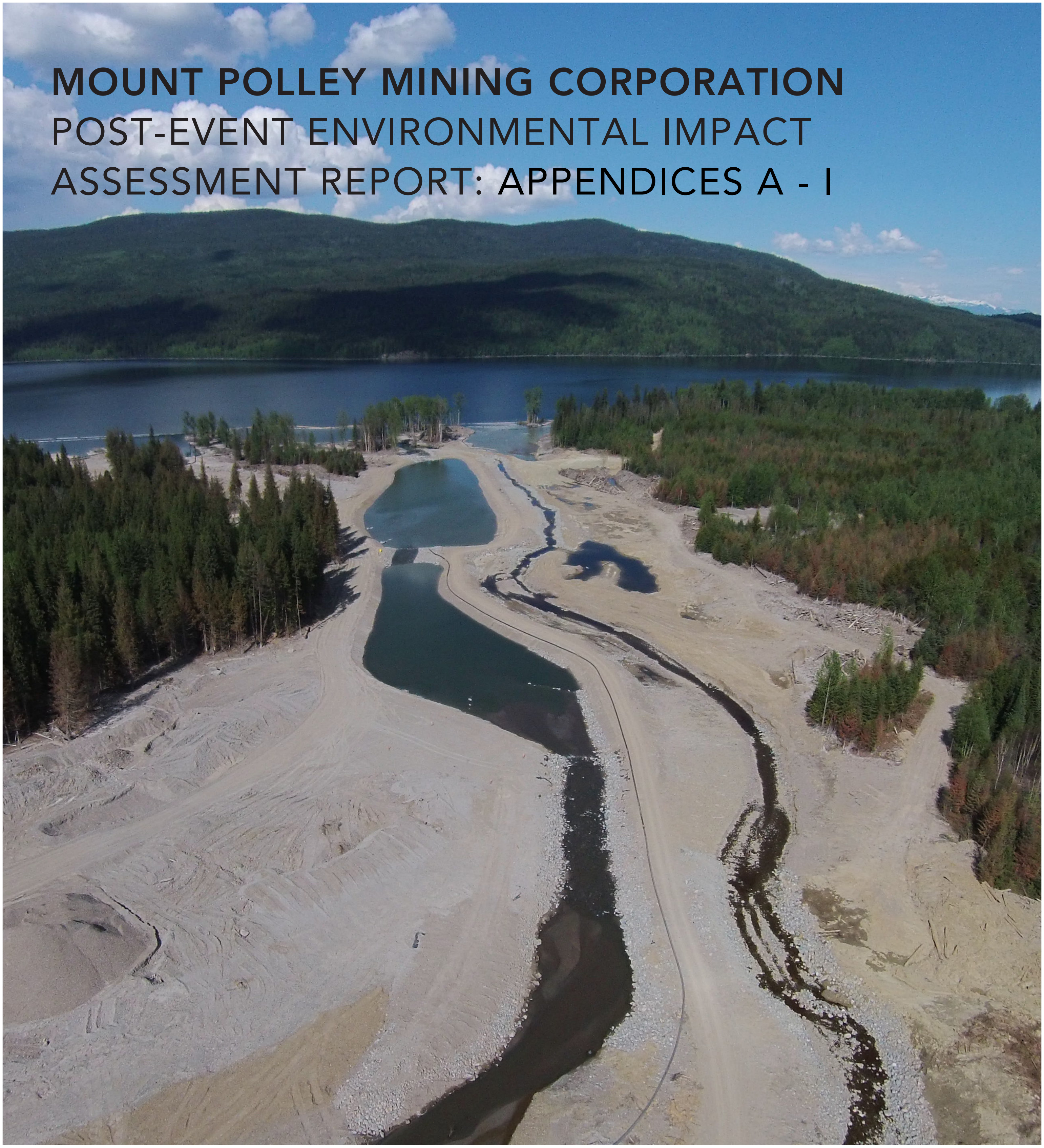
MOUNT POLLEY MINING CORPORATION
POST-EVENT ENVIRONMENTAL IMPACT ASSESSMENT REPORT: APPENDICES A - I



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8.0 TECHNICAL APPENDICES

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APPENDIX A: HYDROTECHNICAL AND GEOMORPHOLOGICAL ASSESSMENT

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SNC-Lavalin Inc.

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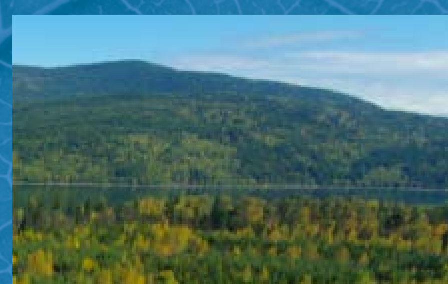
MOUNT POLLEY

Hydrotechnical and Geomorphological Impact Assessment

Prepared For:

Mount Polley Mining Corporation



SNC-LAVALIN INC.

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ABBREVIATIONS

AIA	Archeology Impact Assessment
CHC	Canyon Hazeltine Creek
DEM	Digital Elevation Model
DFO	Department of Fisheries and Oceans
FSR	Forestry Service Road
GIS	Geographic Information System
Golder	Golder Associates Ltd.
HIA	Hydrology –Geomorphology Impact Assessment
LEC	Lower Edney Creek
LiDAR	Light Detection and Ranging
LHC	Lower Hazeltine Creek
LWD	Large Woody Debris
MAF	Mean Annual Flood
Minnow	Minnow Environmental Ltd.
MPMC	Mount Polley Mining Corporation
MPI	Mount Polley Investigation
NPU	Nephelometric Turbidity Unit
PEEIAR	Post-Event Environmental Impact Assessment Report
PIR	Panel Investigation Report
PHABSIM	Physical Habitat Simulation
PP	Polley Plug
RISC	Resources Information Standards Committee
SIA	Soils Impact Assessment
SNC-Lavalin	SNC-Lavalin Inc.
TRIM	Terrain Resource Information Management
TSF	Tailings Storage Facility
UHC	Upper Hazeltine Creek
WSC	Water Survey of Canada

UNITS OF MEASURE

ha	hectares
km	kilometres
m	metres
Mm^3	million cubic metres

GLOSSARY

Aggradation	Increase in channel bed elevation due to the deposition of sediment. Aggradation occurs in areas in which the supply of sediment is greater than the amount of material that the system is able to transport. Opposite to degradation.
Angle of Repose	Steepest angle, relative to the horizontal plane, at which a granular material will come to rest when added a pile of similar material.
Antecedent Conditions	Conditions that existed at a site prior to an event under consideration.
Avulsion	The formation of a new stream channel. Avulsions typically occur during flood events.
Bankfull Depth	Average flow depth at bankfull discharge.
Bankfull Discharge	Discharge that occurs just before water flows out of a channel and onto the surrounding floodplain in a vertically stable channel. Bankfull discharge is the dominant channel forming flow that is exceeded on average every 1 – 2 years.
Bankfull Width	Channel width at bankfull discharge.
Blanket	Surface expression characteristic used in terrain mapping to differentiate thickness of surface material greater than 1 m.
Braided	Channel pattern resembling hair braid, consisting of small channels separated by bars that divide and rejoin at low flows.
Channel	The bed and banks of a stream, whether or not it usually contains water. Channels are linear depressions through which water and sediment is conveyed through a watershed.
Debris	Soil that contains a significant portion of coarse material; 20% to 80% inorganic particles greater than 2 mm, and the remainder less than 2 mm.
Debris Fall	Detachment of debris from a steep slope or river bank. Material is transported through the air by falling, rolling, or bouncing.
Debris Flood	Hyper-concentrated sediment flow that is transitional between a debris flow and a purely hydrologic flood.
Debris Flow	A debris flow is a very rapid to extremely rapid mass movement (typically greater than 5 m/s) of saturated non-plastic debris in a channel. Debris flows normally have volumetric sediment concentrations of 50-90%. In this report, we utilize the term debris flow to describe the rapid to extremely rapid surges of fine grain tailings and native material that travelled down Hazeltine Creek Channel following the tailings storage facility failure on August 4, 2014.
Degradation	The process by which a channel down cuts due to erosion of sediment from the stream bed.

GLOSSARY (Cont'd)

Delta	A fan-shaped deposit of sediments occurring where a stream meets standing water.
Deltaic Deposits	Sediment deposited within a delta by a river.
Deposition	The process by which transported sediment, soil, and rock comes to rest. Deposition occurs when the force of transportation is overcome by the forces of friction and gravity.
Digital Elevation Model (DEM)	The most common digital representation of the shape of the earth's surface. A DEM uses a network of cells, each with a single elevation value, to create a continuous topographic surface.
Displaced Material	Material removed from its original position by erosion processes.
Entrenched	Vertically incised, relatively narrow channel that is hydrologically disconnected from the floodplain.
Erosion	Geomorphic processes (excluding weathering and mass movement) that involve the removal and entrainment of material or rock by an erosive force. Includes vertical and lateral removal of material from a river bed, channel banks and floodplain.
Fall	Detachment of soil or rock from a steep slope or river bank. Falling describes a process where there is effectively no shear displacement along the failure surface and where material is transported through the air by falling, rolling, or bouncing.
Floodplain	Floodplains are generally broad, gently sloped valley floors that provide a spatial link between the river and the surrounding lands. They form through deposition of sediment within the channel during channel migration and deposition over the channel bank during floods.
Frost Heave	The uneven lifting or upward movement, and general distortion, of surface soils, rocks, vegetation, and structures such as pavements, due to subsurface freezing of water and growth.
Frost Jacking	Frost jacking is the upward movement of improperly anchored surface structures as a result of frost heaving.
Glacial Till (Moraine)	Sediment deposited directly by or from a glacier with little to no reworking by water. Till deposits are typically diamictons, consisting of large clasts set within a fine grained matrix of silt and clay.
Gully Erosion	Entrainment and transport of soil material by water resulting in the enlargement of a gully. Gullies are ephemeral channels deeper than 30 cm occurring where flows concentrate to cut a channel through erodible soil. Gullies are relatively deeper and narrower than stream channels, with steep sidewalls and steep channel slopes.

GLOSSARY (Cont'd)

Hysteresis	Hysteresis occurs when the relationship between discharge and suspended sediment concentration or turbidity values change through a hydrograph. A common pattern is created when the suspended sediment concentration or turbidity values are higher during the rising limb of a storm hydrograph than the falling limb for a given discharge, forming the shape of a loop on the plot of discharge and suspended sediment or turbidity.
Incising	Process of a channel eroding vertically into its bed.
Knickpoint	A short over-steepened segment of the longitudinal profile of a river caused by the headward erosion of a resistant layer in the river bed. Knickpoints migrate upstream with time.
Lacustrine Deposits	Sediments that have settled from suspension in bodies of standing freshwater, or sediments that have accumulated at their margins through the action of waves. Lacustrine deposits are typically fine grained, consisting of stratified sands, silts, and clays. Glaciolacustrine deposits result from similar processes in ice-dammed lakes, and share many characteristics with lacustrine deposits.
LiDAR	Light Detection and Ranging (LiDAR) is a remote sensing technology which determines the range of an object by measuring the time delay between the transmission of a laser pulse and detection of the reflected signal. LiDAR sensors are commonly aircraft-mounted, and used to acquire high resolution data of the Earth's topographic surface.
Native Material	Native material refers to the soils, surficial deposits, and bedrock that were present in the study area prior to the event.
Nival Hydrologic Regime	Hydrological system that is dominated by snow melt.
Peak Stage	Highest elevation that the surface of a flow attains during a flood or debris flow.
Planform	Pattern a river channel makes on a map or aerial photograph. River planforms include braided, meandering, straight, wandering, and anastomosed.
Reach	Any length of the channel similar in hydrological and/or geomorphological characteristics.
Remobilize	Entrainment of a particle following deposition.
Retrogression	Slope failure in which the surface of rupture propagates upslope.
Riffle-Pool Morphology	Riffle-pools are channels characterized by a sequence of bars, pools, and riffles. Pools are topographic low points within the longitudinal profile of the channel, while riffles are topographic high points. Riffle-pool channels occur at moderate to low gradients, and are generally unconfined with well developed floodplains.

GLOSSARY (Cont'd)

Rill Erosion	Rills are shallow drainage channels from 50 mm and 300 mm in width and up to 300 mm in depth. They develop when runoff concentrates in depressions or low points and erodes the soil.
Scour	Vertical erosion of the river bed and floodplain.
Shear Stress	A force produced by water flowing at the bed of the channel.
Sinuosity	Measure of the total length of a channel, where channel length increases with number and size of bends. Sinuosity Index (SI) is calculated by dividing the main channel length by the valley length.
Slope Failure	Movement of a mass of soil, rock or debris down a slope.
Soil (earth)	Material that contains more than 80% of inorganic particles smaller than 2 mm.
Soil/Earth Fall	Detachment of soil (earth) from a steep slope or river bank. Material is transported through the air by falling, rolling, or bouncing.
Step-Pool morphology	Step-pool channels are characterized by steps made up of large rocks that span the channel alternating with pools containing finer material. Step-pool channels develop on steep gradients, are generally narrow and deep, and confined by valley sides.
Storativity	Dimensionless quantity, and ranges between 0 and the effective porosity of the aquifer.
Tailings	Fine-grained, residual materials remaining after valuable resources have been extracted from the ore at a mineral processing plant (CDA, 2007).
Terrace	Horizontal fragments of floodplains recorded in the landscape above the modern floodplain. Terraces are created by the incision (downcutting) of a stream channel, leaving the former floodplain level(s) higher than the modern floodplain.
Thalweg	The deepest part of a channel formed by joining the lowest points along the length of a waterway. The thalweg is almost always the line of fastest flow in a watercourse.
Topple	Forward rotation, out of the slope, of a block of soil/rock, about a point or axis below the centre of gravity of the displaced mass (Couture, 2011).
Veneer	Surface expression characteristic used in terrain mapping to differentiate thickness of surface material less than 1 m.

1 INTRODUCTION

SNC-Lavalin was retained to prepare a hydrotechnical and geomorphological assessment of impacts to Hazeltine Creek following the Tailings Storage Facility (TSF) dam failure (event) at Mount Polley Mine (Mine) on August 4, 2014. This report describes the impacts of the TSF dam failure between Polley Lake and Quesnel Lake, including impacted areas of Hazeltine Creek and Lower Edney Creek. Both immediate physical impacts from the failure and potential long-term effects on sediment production and channel morphology were considered. Herein we report on the hydrological characteristics of Hazeltine Creek and the pre-and post-event channel and floodplain geomorphology, and identify areas of concern for future erosion and bank failures within the study area. This report is a technical appendix to the Post-Event Environmental Impact Assessment Report (PEEIAR) authored by Golder Associates Ltd. (Golder) on behalf of Mount Polley Mining Corporation (MPMC).

1.1 Scope

The work described herein was conducted in general accordance with Chapter II of SNC-Lavalin's proposal, *Mount Polley Comprehensive Environmental Impact Assessment Work Plan* (August 29, 2014). The scope of the assessment included:

1) A gap analysis to determine data requirements for Hazeltine Creek[1];
2) An update of the regional hydrological analysis;
3) Monitoring of Hazeltine and Edney Creeks post-event discharge;
4) Determination of pre-event geomorphology of Hazeltine Creek through analysis of historical data and channel time-series mapping;
5) Determination of post-event geomorphology of Hazeltine Creek through field observations and channel mapping;
6) Determination of the volume of material eroded from the channel and floodplain;
7) Determination of the volume of material deposited on the channel and floodplain;
8) A characterization of surficial material; and,
9) An analysis of the hydraulic patterns of Hazeltine Creek following the debris flow.[1]

[1] The gap analysis is not explicitly reported on but was used to inform the analyses included in the assessment.

1.2 Report Structure

The report uses three main sections to document the impacts of the TSF dam failure on the geomorphology of Hazeltine and Edney Creeks. The first section summarizes the hydrology of Hazeltine Creek and includes an update to the regional flood frequency and presentation of post-event discharge and turbidity recorded at hydrometric stations. The second section documents pre-event geomorphology of Hazeltine and Edney Creeks using previous reports and mapping of the channels from historical aerial photographs. The reaches defined by Minnow Environmental Ltd. (Minnow, 2007) are used to define the pre-event channel characteristics. The third section documents the post-event geomorphology of Hazeltine and Edney Creeks based on a field program, analysis of the post-event LiDAR derived digital elevation model (DEM), and aerial and field photographs. The reaches defined by Minnow (2007) were modified and used to document the geomorphology of Hazeltine and Edney Creek channels. The third section utilizes hydraulic model results and the post-event DEM to define areas within the channel that are unstable and to assess the stability of the slopes within the valley.

The appendix section represents an atlas that documents the physical impacts of the debris flows on Hazeltine and Edney Creeks. The maps and photographs within the appendices are used to document the impacts of the debris flows and locate them spatially. Appendix A provides maps of the area affected by the debris flow and the locations of the reaches used in the analysis. Appendix B provides maps of the geomorphic characteristics of the pre-event channel. Appendix C provides cross-sections and photographs of the pre-event channel reaches. Appendix D provides maps of the estimated volumes of material eroded from the Hazeltine Creek valley. Appendix E provides maps of the estimated volumes of material deposited within the Hazeltine Creek valley and includes the surficial material types. Appendix F provides maps of the depth, velocity and shear stress results from a 2D hydrodynamic model for an average (mean annual flood), moderate (10-year) and large (100-year) flow in the post-event channel. Appendix G provides maps of the results of the slope stability analysis. Appendix H provides cross-sections and photographs of the post-event channel reaches.

1.3 Study Area

The study area follows the flow path of the debris flow from the TSF dam failure site to Polley Lake and down the Hazeltine Creek valley to Quesnel Lake. The width of the study area ranges from 23 m within the canyon to 1 km in Lower Hazeltine Creek. The study area is sub-divided into five sub-areas based on morphology and characteristics: the Plug area, Upper Hazeltine Creek, Hazeltine Creek Canyon, Lower Hazeltine Creek and Edney Creek.

2 HYDROLOGY OF HAZELTINE CREEK

Hazeltine Creek is a tributary stream within the Quesnel River Watershed in the Cariboo Plateau, south-central British Columbia. This region is characterized by low hills and broad valleys (Cathro et al., 2003). Prior to the event, Hazeltine Creek was the main outlet of Polley Lake, flowing from its south end at 920 masl (Knight Piesold Ltd, 2009c). The creek flowed 10.3 km, draining an area of 112 km^2 (Minnow, 2014a) into Quesnel Lake at an elevation of 730 masl (Knight Piesold Ltd., 2009c). Bootjack and Edney Creek supply surface water to Hazeltine Creek. The confluence with Edney Creek was located 9.5 km downstream of the Polley Lake outlet, adding 81.3 km^2 of drainage basin area (Minnow, 2014b) into the channel before being discharged into Quesnel Lake (Figure 1). The confluence with Bootjack Creek was located 850 m downstream of the Polley Lake outlet, adding 2.74 km^2 of drainage basin area (Minnow, 2014b).

Streams in the Cariboo Plateau follow a nival hydrologic regime driven by spring snowmelt. Regional average monthly climate data from 1989 to 2006 (Horsefly Lake / Gruhs Lake, Climate Station 1093600[2]) are presented in Figure 2-1. Snow is the dominant form of precipitation from mid-September through to late April (based on Horsefly weather station data) and remains in storage within the drainage basin until spring melt. As a result, streams of this region experience low flows throughout the winter and peak flows during the spring months as warmer temperatures induce snowmelt. Precipitation falls almost entirely as rain for the rest of the year and contributes directly to stream flow as well as indirectly through rain-on-snow melting events. Low precipitation amounts through the late summer and early fall combined with an exhausted snowpack result in seasonal low flow conditions.

The historical hydrologic regime of Hazeltine Creek was altered as a result of water diversions for placer mining. A water diversion ditch was dug in the late 1890's (Mulvihill *et al*., 2005) to channel water from Polley Lake to the Bullion Pit for hydraulic mining. Bootjack Lake originally drained into Hazeltine Creek via Bootjack Creek until an earthen dam was erected in 1913 and lake water was diverted to Moorhead Creek (IMC, 1990). This resulted in the loss of 14 km^2 of drainage area input into Hazeltine Creek. Construction of runoff collection ditches at the mine site has also influenced the watershed area (Minnow, 2014b).

Conifer species are the dominant vegetation within the floodplain, with an abundant shrub and moss layer below the closed coniferous canopy (Lord, 1984). There are potential impacts on Hazeltine Creek from grazing on Crown range land and private farmland, and forest harvesting and subsequent replanting (IMC, 1990). Studies of the direct effects of logging and cattle grazing on the hydrology of Hazeltine or Edney Creeks were not found during the gap analysis. However, Hazeltine Creek is highly impacted by logging (DFO, 1990). Large areas (42%) of the Hazeltine

[2] Data from climate.weather.gc.ca

Creek drainage basin were logged (Rood and Hamilton, 1995) and the high percentage of cut has resulted in sedimentation and extreme water temperature fluctuations within the creek (Rowland and MacDonald, 1996). Nener and Wernick (2000) indicated that livestock grazing may have caused some impacts to Edney Creek watershed and large areas (45%) of the Edney Creek drainage basin have been logged (Rood and Hamilton, 1995).

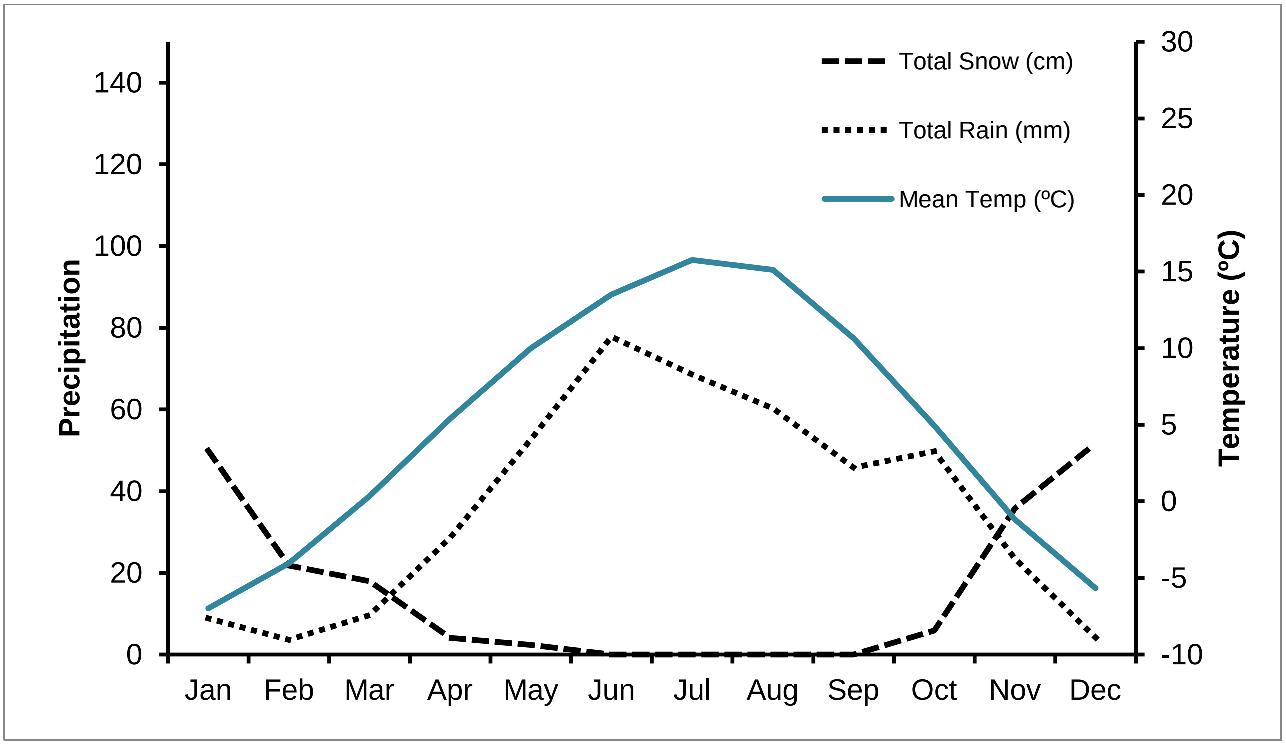

Figure 2-1: Mean monthly precipitation and temperatures for the Horsefly Lake/ Gruhs Lake weather station

2.1 Hydrometric Stations

Stream flow data has been collected on Hazeltine Creek since 1994 at a hydrometric station located at the Gavin Lake road bridge (Figure 2-2). The hydrometric station was installed and operated by Water Survey of Canada (WSC) until 1995 (08KH027), when MPMC assumed operation and maintenance of the station. The catchment area for the Upper Hazeltine Creek station was 24.3 km^2 (Golder, 2015).

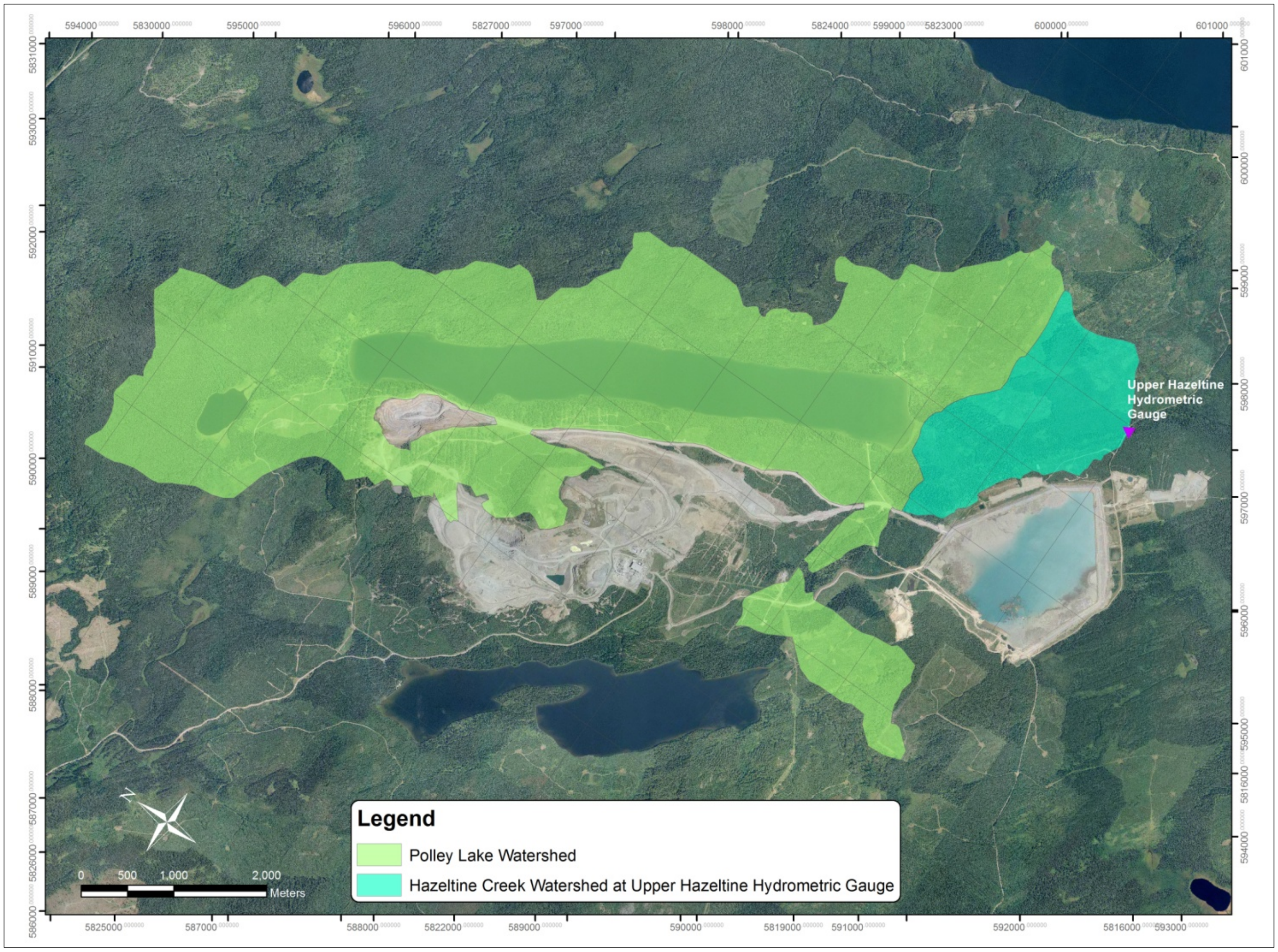

Figure 2-2: Map of the Hazeltine Creek Watershed above the Upper Hazeltine Creek hydrometric station. Modified from Golder 2015

Hazeltine Creek discharge was gauged between the onset of the annual freshet (usually April) and the occurrence of the first frost (usually October/November). The stage-discharge rating curve from data collected between 1994 and 2006 displayed distinctive shifts between years of record, likely due to frost jacking of the gauge staff. Knight Piésold (2009a) created a synthetic data series to correct the shifting of the dataset and to model the months when data were not collected on Hazeltine Creek through a regional analysis using a nearby watershed with similar characteristics (Moffat Creek, Water Survey of Canada Hydrometric Station 08KH019). This yielded an annual hydrograph (Figure 2-3) which began its ascent in mid-March, reaching a peak discharge of 0.74 m^3/s in early April, and with low flow conditions extending from mid-July to mid-March.

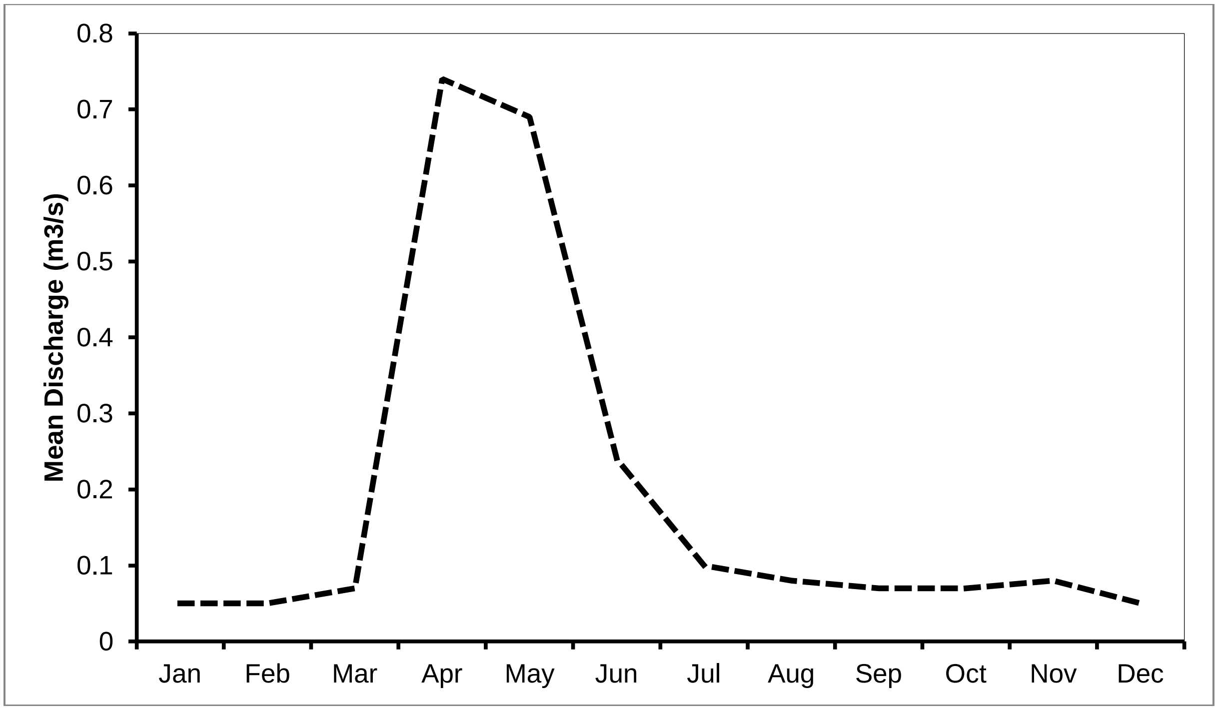

Figure 2-3: Annual hydrograph for Hazeltine Creek generated from synthetic dataset created by Knight Piésold (2009a)

The hydrometric station on Hazeltine Creek was destroyed by the TSF dam failure and subsequent flood in 2014, and replaced by three stations in November 2014: one at the previous location at the Gavin Lake Road bridge (Upper Hazeltine Creek), one in Lower Hazeltine Creek and one on Lower Edney Creek (see Table 2-1 for site details). Two of these stations were installed along the disturbed sections of Hazeltine Creek (Lower Hazeltine Creek Station and Upper Hazeltine Creek Station) and a third station was installed along an undisturbed section (Lower Edney Creek). The Lower Edney Creek station was impacted by construction of a beaver dam immediately downstream from the station shortly after installation and was re-established on March 5, 2015 along the disturbed section of Edney Creek following channel reconstruction.

Details regarding discharge monitoring program (i.e. station installation and benchmarking, station calibration, data processing, field records and recommendations for future monitoring) are provided in WaterSmith Research Inc. (2015).

At each station, a Solinst Level Logger (recording water level [i.e., stage] and temperature) was installed in the bottom of a stilling well. A Solinst Baro Logger (recording barometric pressure) was installed in the top of the stilling well at each Hazeltine station. All loggers were programmed to record data at 10-minute intervals. A staff gauge was installed adjacent to each stilling well.

Benchmark elevations were established at all hydrometric stations during installation, as recommended by the Resources Information Standards Committee (RISC) for hydrometric monitoring (BC Ministry of Environment, 2009). A local elevation datum was defined for each station at an elevation 1.00 m below the Level Logger port. The stations were surveyed by MPMC staff on March 11, 2015, to determine the absolute elevations (meters above sea level). Site schematics are provided in Figure 2-4.

Table 2-1: Measurement variables and location information for the hydrometric stations

Station name	Measurement variables	Channel characteristics	Hardware anchoring system	Universal Transverse Mercator (UTM) easting / northing	Elevation at logger port (m)[1]
Upper Hazeltine (Gavin Lake road bridge)	Stream discharge, barometric pressure, water temperature, turbidity	Shallow pool in riffle-pool alluvial reach (disturbed section)	Welded to bridge span	0596944 / 5819047	901.64
Lower Hazeltine	Stream discharge, barometric pressure, water temperature, turbidity	Shallow pool in bedrock controlled reach (disturbed section)	Bolted to bedrock	0600544 / 5817369	754.91
Lower Edney	Stream discharge, water temperature	Deep pond (reconstructed section)	Bolted to boulder	0601356 / 5817042	734.42

1. Elevation based on a GPS survey conducted by MPMC staff on March 11, 2015 using the TSF Grid.

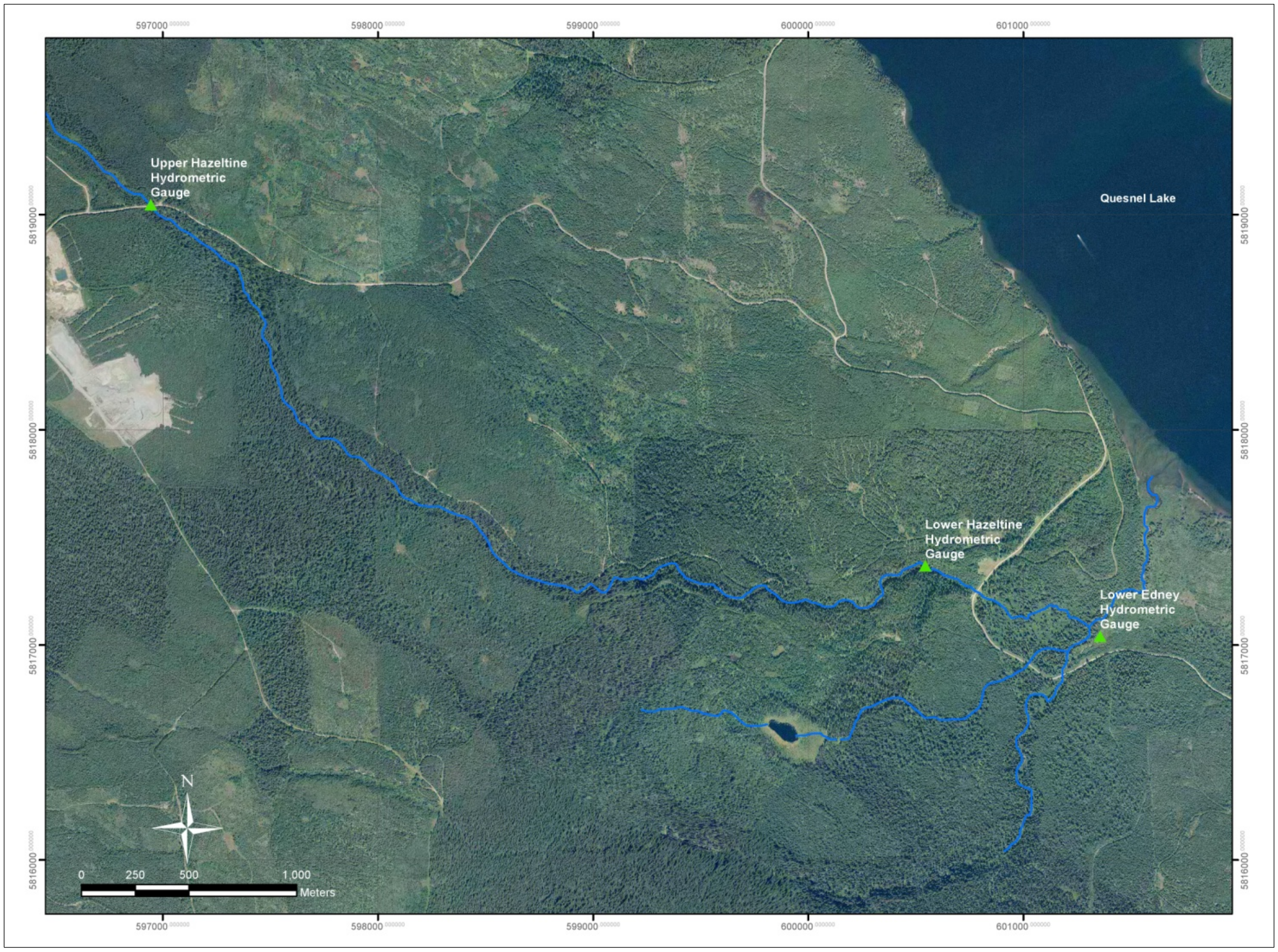

Figure 2-4: Location of current hydrometric gauges on Hazeltine and Edney Creeks

To record the temporal patterns in turbidity, Manta 2 automated turbidity probes were installed at the Upper and Lower Hazeltine hydrometric stations, allowing for comparison between sites. The probes were installed between November 5 and 7, 2014. The probes were encased in perforated steel pipes bolted to bedrock (Lower station) and the underside of a bridge span (Upper station). Prior to installation, the turbidity sensors were calibrated using deionized water (0 NTU) and a polymer turbidity standard (3000 NTU). The loggers were set to record turbidity and water temperature at 30-minute intervals.

The accuracy of the Manta 2 turbidity sensor is reported to be ±1% of the reading plus 1 NTU over the range of 0 to 400 NTU (e.g., at 50 NTU, the accuracy is ±1.5 NTU; at 400 NTU, the accuracy is ±5 NTU), and ±3% of the reading over the range of 400 to 3000 NTU. The accuracy at readings above 3000 NTU is unknown, of which there were 16 readings at the Lower Hazeltine Creek station and none at the Upper Hazeltine Creek station.

2.2 Regional Flow Frequency

Hazeltine Creek flows were estimated by a regional flood frequency analysis (Golder, 2015). Flow data from the pre-event Upper Hazeltine Creek station were of insufficient length and quality for flood frequency analysis. An assessment of regional stations (15) by Knight Piésold (2014) determined that flows derived from the Moffat Creek Water Survey of Canada hydrometric station (08KH019) provided an analog to estimate Hazeltine Creek flows based on catchment characteristics and hydrologic regime. A daily synthetic flow series was produced for Hazeltine Creek from the Moffat Creek record (47 years) using empirical frequency pairing (Knight Piésold, 2014). Results from this analysis are presented in Table 2-2 and include mean annual discharge (MAD), mean annual flood (MAF), mean 7-day low flow, and 10-, 100-, and 200-year discharges,.

Table 2-2: Flood frequency analysis for the Upper Hazeltine Creek Station (Golder, 2015)

Location	Catchment area (km^2)	Mean Annual Discharge (MAD) (m^3/s)	Mean 7-day low flow (m^3/s)	Mean Annual Flood (MAF) (m^3/s)	10-year (m^3/s)	100-year (m^3/s)	200-year (m^3/s)
Hazeltine Creek hydrometric station	24.3	0.19	0.016	1.6	2.5	3.7	4.0

2.3 Post-event discharge and turbidity from hydrometric stations

The record of discharge from the hydrometric stations is presented in Figure 2-5. Following the event the discharge of Hazeltine Creek was largely controlled by storm generated runoff and by water pumped by MPMC from Polley Lake into Hazeltine Creek.

The discharge record for the Upper Hazeltine Creek station is 5 days long, between the date of establishment (November 05, 2014 at 15:50) and the time when the record became unreliable (November 09, 2014 at 14:20). The short discharge record is due to changes in channel morphology shortly after installation of the Upper Hazeltine station that altered the stage rating curve used to determine discharge. The Upper Hazeltine station was established in a newly formed channel incised into exposed glacial till. Channel aggradation occurred at the hydrometric station during and after a rainfall runoff event on November 9, 2014. The data after November 9 were, thus, considered unreliable and were discarded (Figure 2-5). The record for Upper Hazeltine Creek shows changes in discharge due to pump operations upstream of the station and in response to rainfall events.

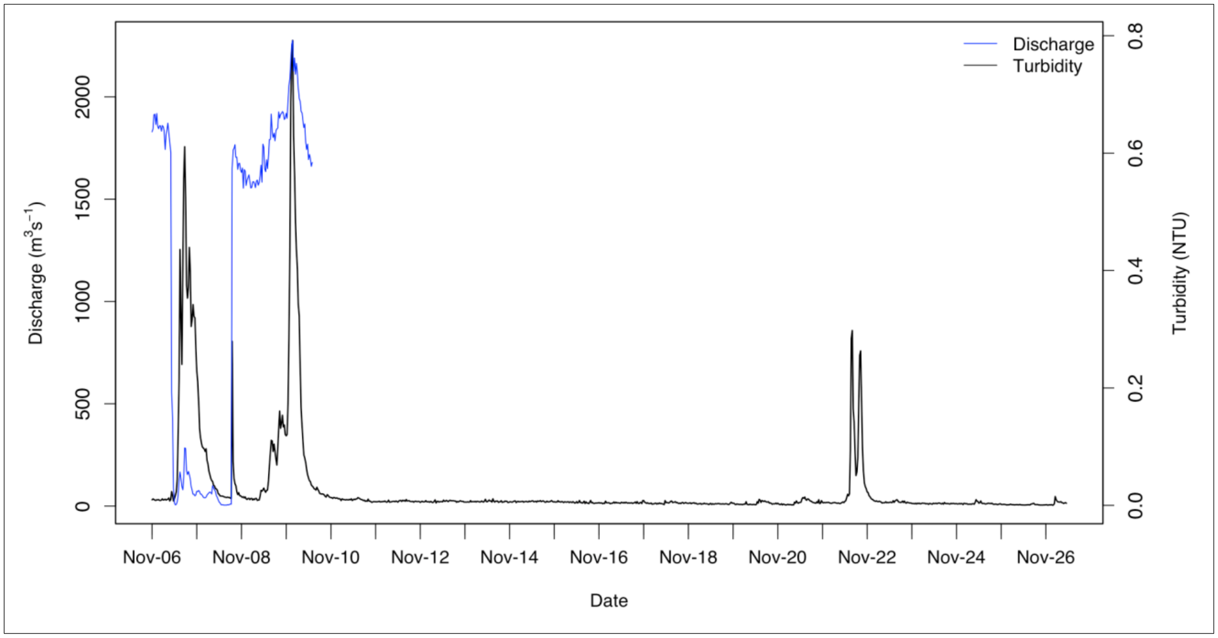

Figure 2-5: Turbidity and stream discharge time series plot for Upper Hazeltine Creek station

The discharge record for the Lower Hazeltine station is 99.6% complete, with only two minor gaps (< 1 day) between the date of establishment (October 09, 2014 at 14:20) and the most recent data download (March 04, 2015 at 14:10) (Figure 2-6). As with the upstream station the record for the Lower Hazeltine Creek station shows changes in discharge due to pump operations upstream of the station and rainfall events.

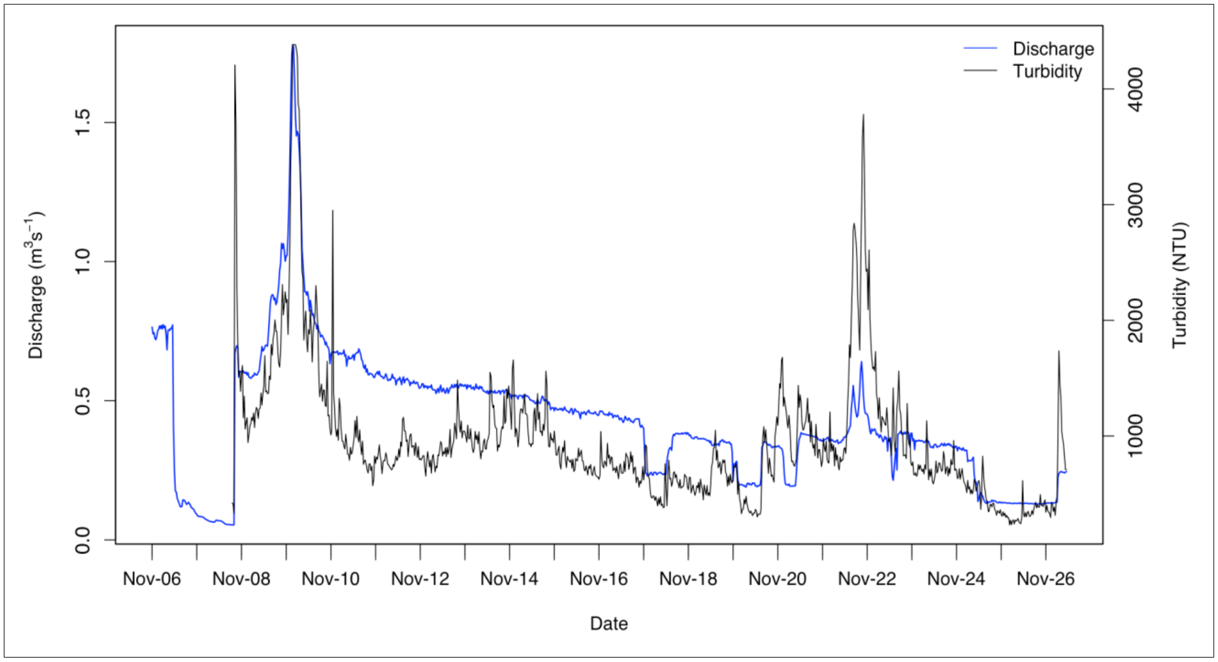

Figure 2-6: Turbidity and stream discharge time series plot for the Lower Hazeltine Creek station

The discharge record for Lower Edney Creek station became unreliable shortly after its initial installation due to beaver impacts along Edney Creek.

2.4 Post-event temporal turbidity patterns

Temporal patterns in suspended sediment were analyzed using the discharge and turbidity data collected at the two hydrometric stations on Hazeltine Creek. Patterns of turbidity against discharge were analyzed for storm events. This analysis provides evidence of areas where sediment is produced, the discharge conditions when sediment is produced, and indicates limits on sediment production.

The discharge and turbidity record for the two hydrometric stations on Hazeltine Creek, including colour coding for storm events, is presented in Figure 2-7 and Figure 2-8. Turbidity ranged from 4 to 2276 NTU at the Upper Hazeltine Creek station and 232 to 4383 NTU at the Lower Hazeltine Creek station, with median values of 21 and 828 NTU during the 22- and 20-day periods of record, respectively.

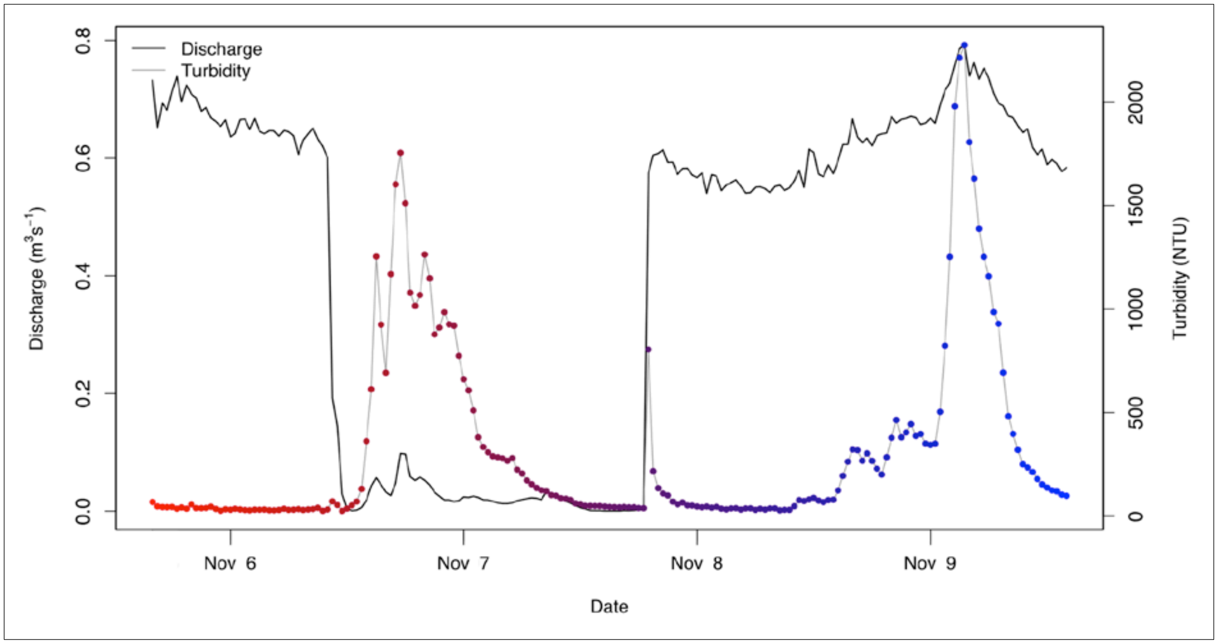

Figure 2-7: Turbidity and discharge time series plot for the Upper Hazeltine Creek Station per storm event

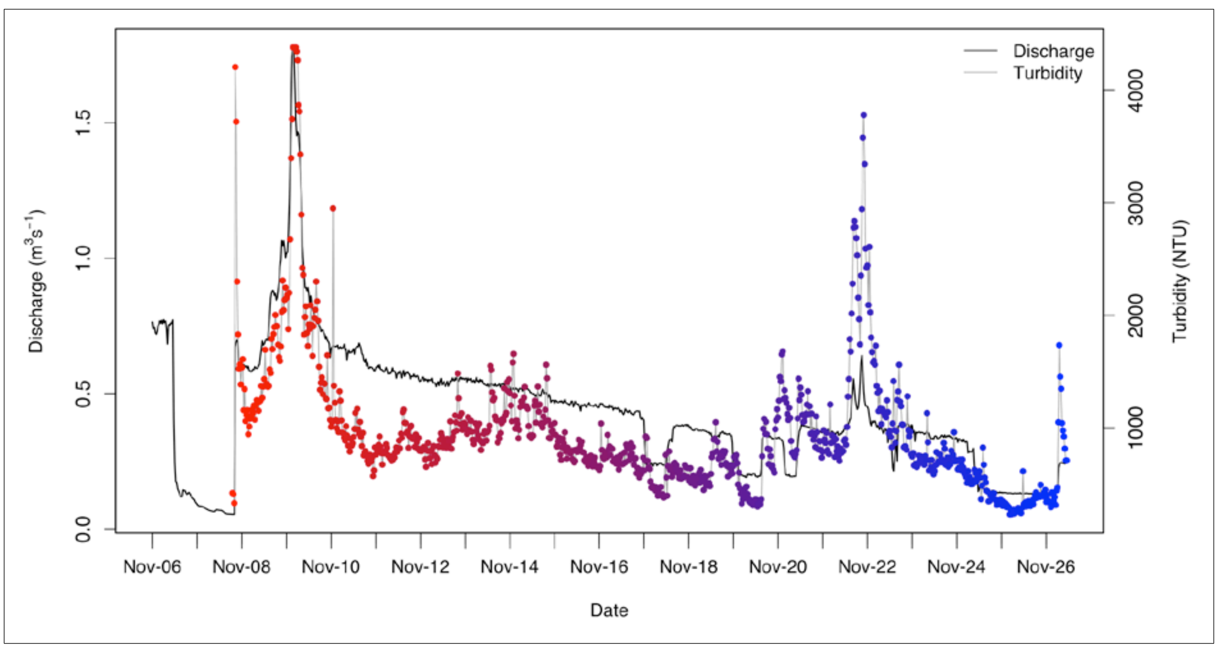

Figure 2-8: Turbidity and discharge time series plot for the Lower Hazeltine Creek station per storm event

Turbidity at the Lower Hazeltine Creek station was greater than at the Upper Hazeltine Creek station throughout the record (Figure 2-9). Turbidity ranged from 195 to 4100 NTU higher in the Lower station than the Upper station (with the exception of one measurement). Cumulative distributions of turbidity showed values remained under 38 NTU 80% percent of the time at the Upper Hazeltine Creek station, and under 1197 NTU 80% percent of the time at Lower Hazeltine Creek station (Figure 2-10). These results are consistent with observations made on the September 22, 2014 flight over Hazeltine Creek where the water was visibly less turbid near the Upper Hazeltine Creek hydrometric station (Figure 2-11) and more turbid downstream near the Lower Hazeltine Creek hydrometric station (Figure 2-12).

These results indicate that sediment in Hazeltine Creek is produced mainly in the ~ 4.7 km between the two hydrometric stations. The higher turbidity levels in Lower Hazeltine Creek (average value of 973 NTU) compared to Upper Hazeltine Creek (average value of 83 NTU) are likely related to (1) outflow from Polley Lake having relatively low turbidity, and (2) lower rates of sediment delivery to the channel within the upper ~ 2.2 km of Hazeltine Creek than within the ~ 4.7 km between the Upper and Lower stations. The channel between the Upper Hazeltine Creek hydrometric station and the upstream end of the Hazeltine Creek Canyon contains relatively steep channel gradients with active knickpoint erosion and steep valley sides. Sediment sources likely include a combination of tailings deposits, native material eroded through bed degradation, lateral bank erosion, and sloughing along the valley sides.

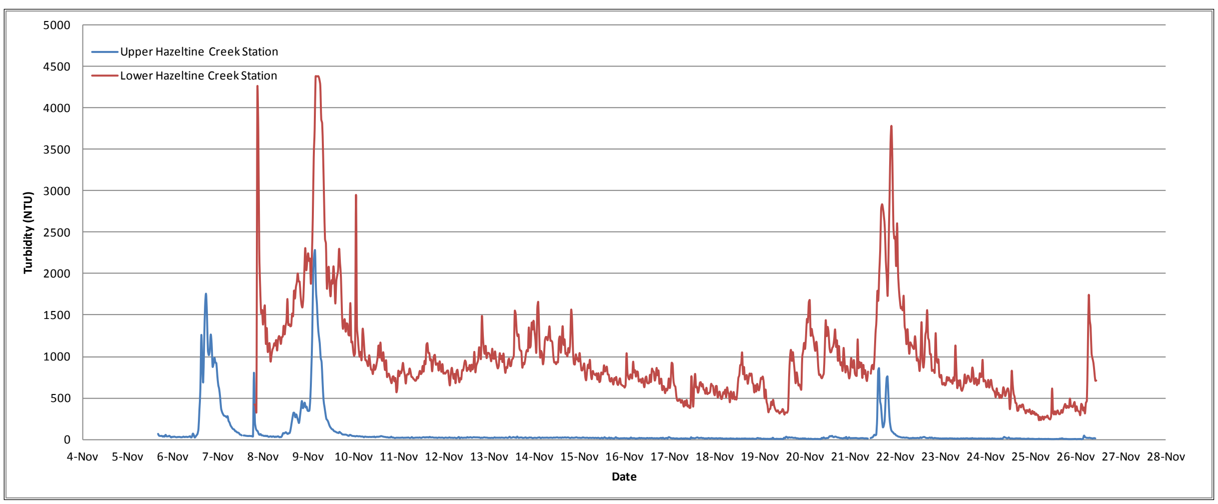

Figure 2-9: Turbidity for the Upper and Lower Hazeltine Creek stations in November 2014

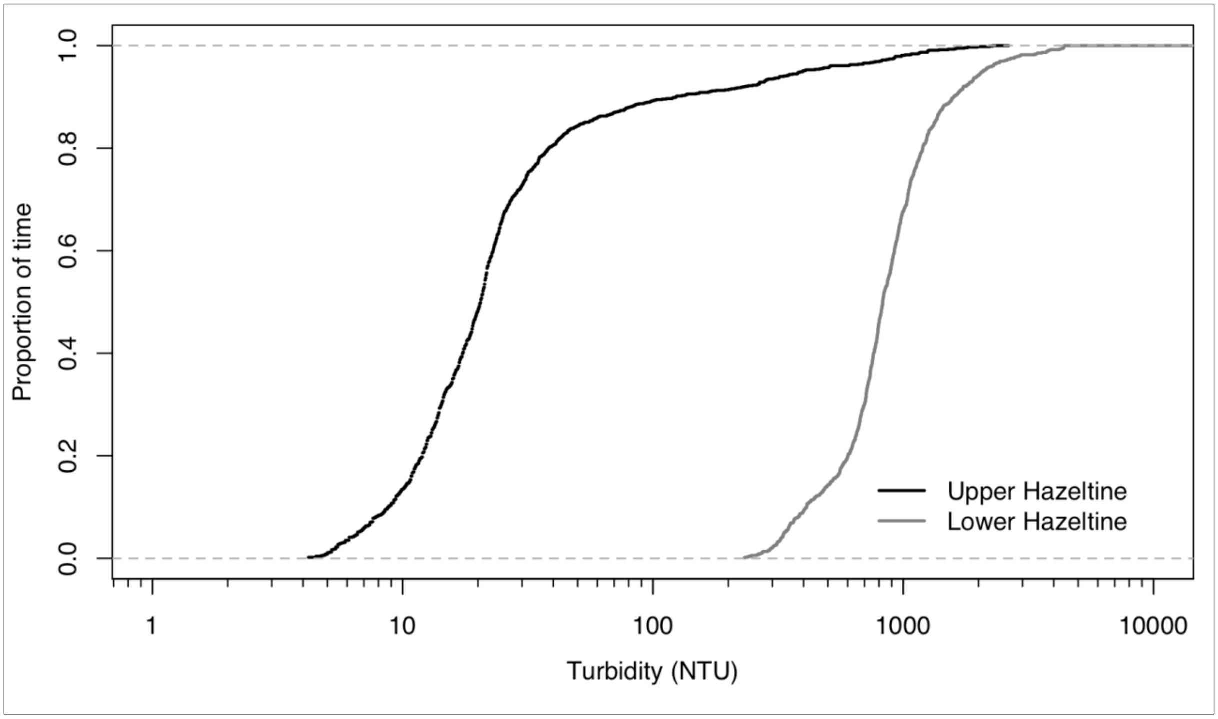

Figure 2-10: Cumulative distribution plot for Hazeltine Creek turbidity

Figure 2-11: Visibly less turbid water in channel upstream of the Upper Hazeltine Creek hydrometric station (September 23, 2014)

Figure 2-12: Visibly turbid water in channel downstream of the Lower Hazeltine Creek hydrometric station (September 23, 2014)

There is a positive relationship between turbidity and discharge seen in both records. The relationship is non-linear and highly dependent on antecedent conditions. Turbidity response is event specific, and likely a function of sediment availability, which is determined by the influx of new sediments into the channel and the storage of sediments within the channel during the days or hours preceding an event. For example, following a period of sustained low flow and deposition of suspended sediments within the channel, an initial increase in discharge will result in a rapid rise in turbidity as in-channel sediments are remobilized. This is followed by a decrease and potential stabilization in turbidity levels as the event progresses and the in-channel sediment source is depleted (Williams, 1989). For this reason, peak turbidity may occur prior to peak discharge resulting in hysteresis. This response behaviour is evident in the Lower Hazeltine data for events starting November 7, 21, and 26, 2014 (Figure 2-13). In contrast, the turbidity response to increasing discharge is more moderate after flows have already been elevated prior to an event, as evident in the Lower Hazeltine data for an event starting November 9 (Figure 2-14).

Notwithstanding the limited discharge dataset for the Upper Hazeltine site, the Upper and Lower Hazeltine sites both appear to have a lower limit of turbidity (Figure 2-15 and Figure 2-16). This minimum turbidity level is much lower at Upper Hazeltine station (~ 20-40 NTU for flows below 0.8 m^3/s) than at Lower Hazeltine station (~ 200-900 NTU for flows below 0.8 m^3/s). Moreover, the lower limit is clearly a function of discharge for the Lower Hazeltine site. After an initial rise in turbidity with increasing discharge, turbidity appears to stabilize above a minimum level that is controlled by the discharge rate.

These initial data suggest that the turbidity response at Upper Hazeltine Creek is higher for discharge increases caused by rainfall events than those caused by increased outflow (pumping) from Polley Lake. For instance, the November 7, 2014 pumping related event resulted in a lower turbidity response than the November 6 and 9, 2014 rainfall generated events, which had lower discharge increases (Figure 2-14, and Figure 2-15). The greater turbidity response associated with rainfall is likely related to mobilization of sediment within the disturbed areas adjacent to the channel, whereas outflow from Polley Lake would be capable of mobilizing only sediments stored within the channel. This difference in turbidity response behaviour elucidates the large potential of rainfall or runoff events to contribute sediment from adjacent areas within the TSF dam failure corridor.

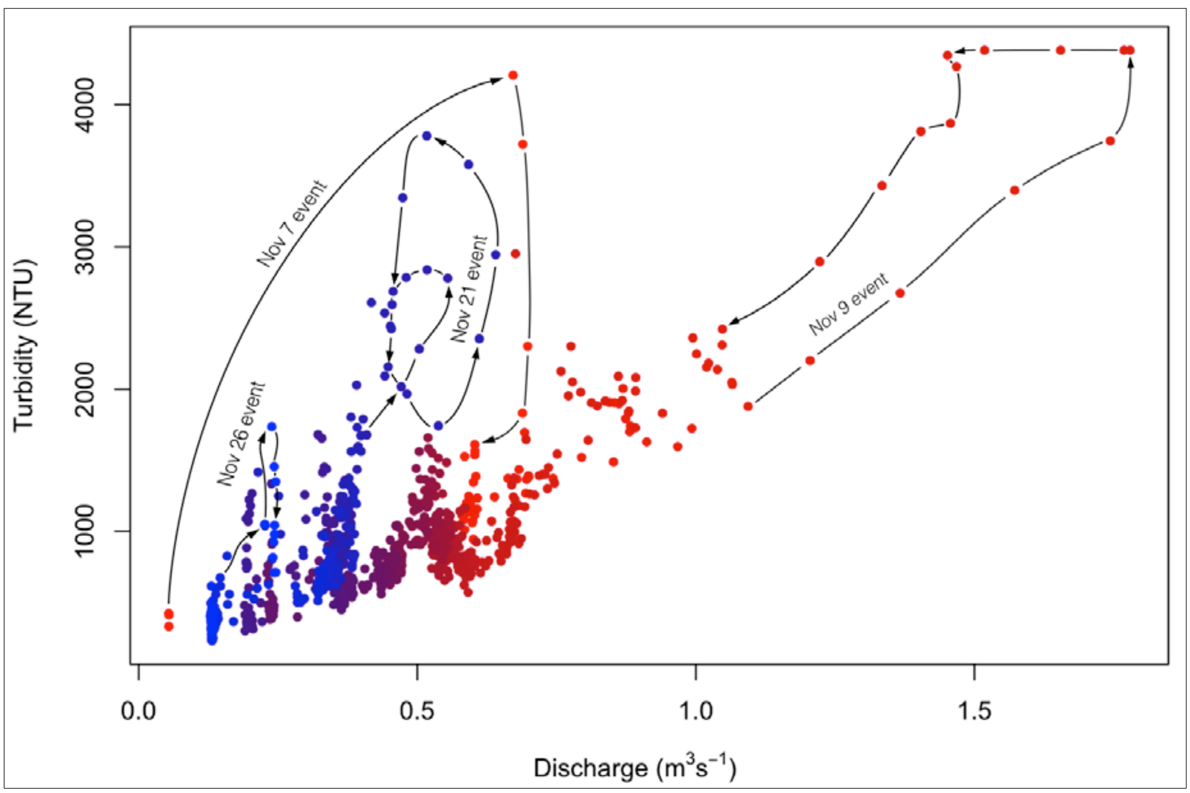

Figure 2-13: Stream discharge versus turbidity for Lower Hazeltine Creek station

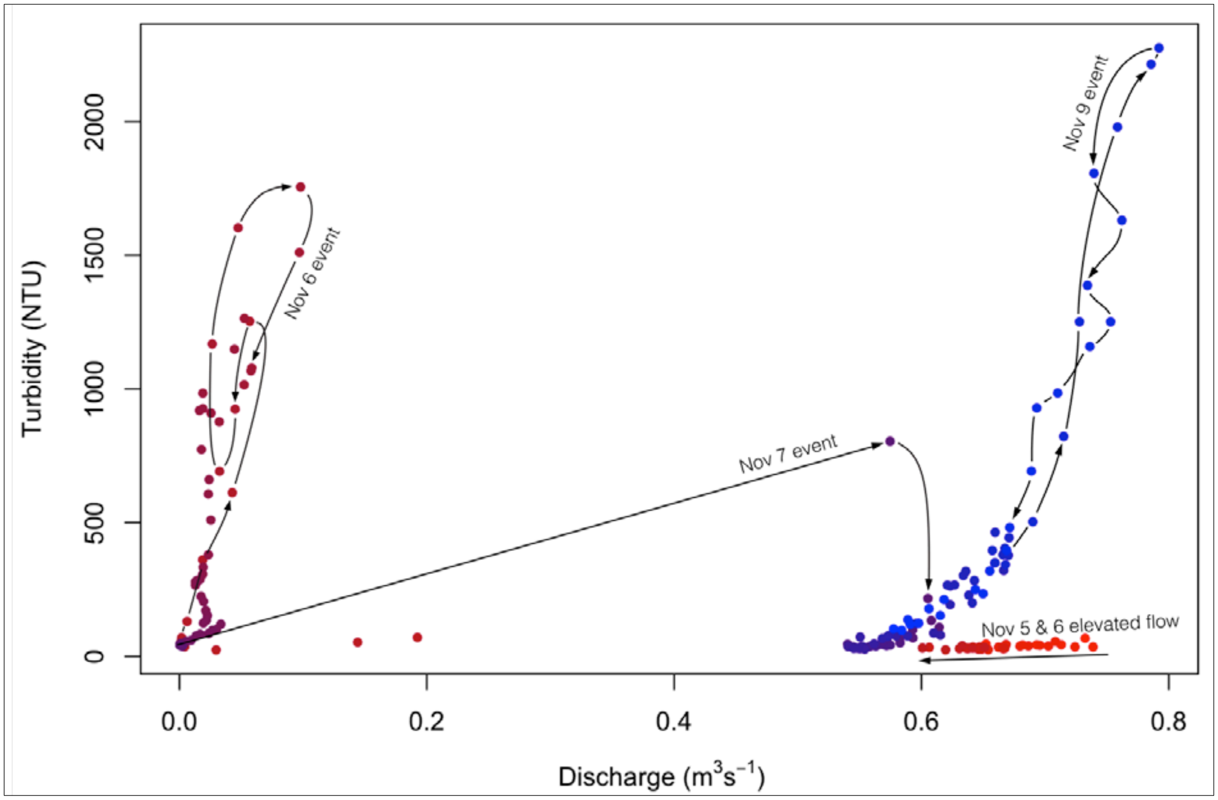

Figure 2-14: Stream discharge versus turbidity for Upper Hazeltine Creek station.

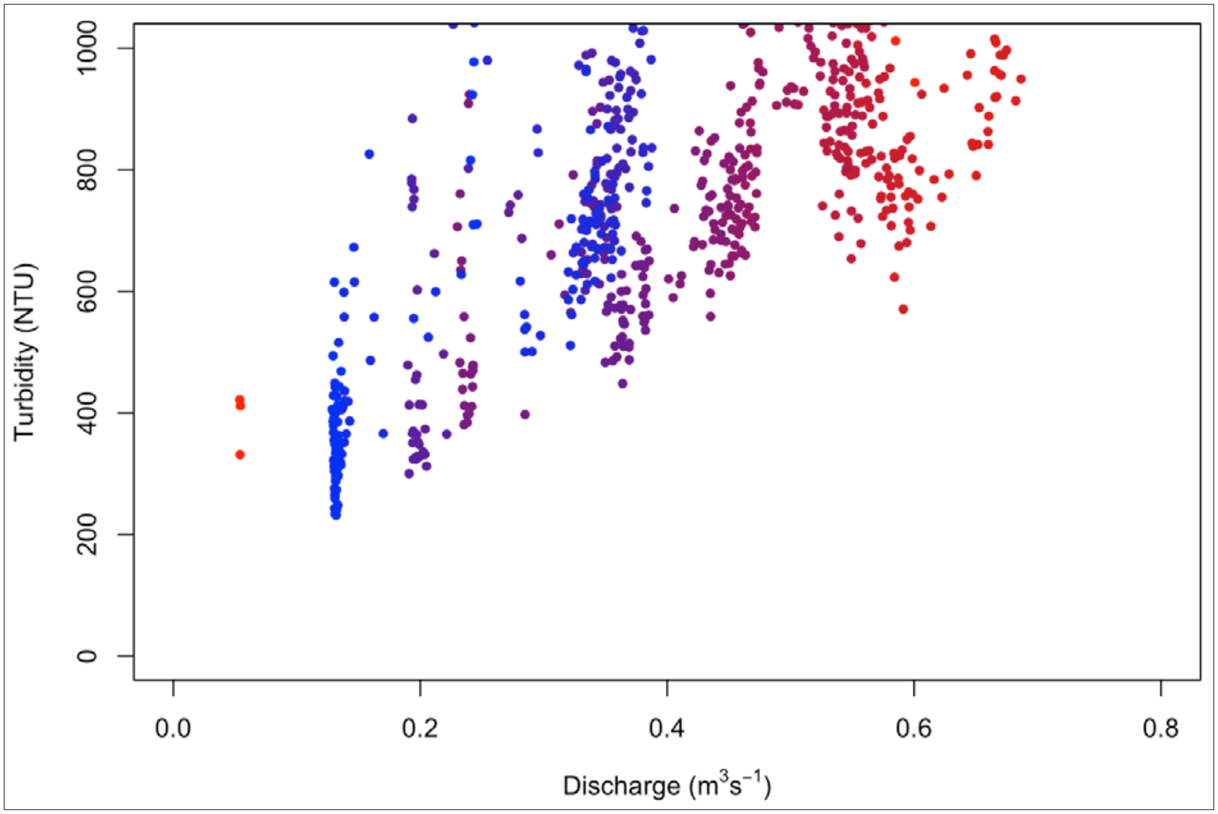

Figure 2-15: Stream discharge versus turbidity for Lower Hazeltine Creek station. The vertical scale is constrained to highlight the turbidity response at low flow

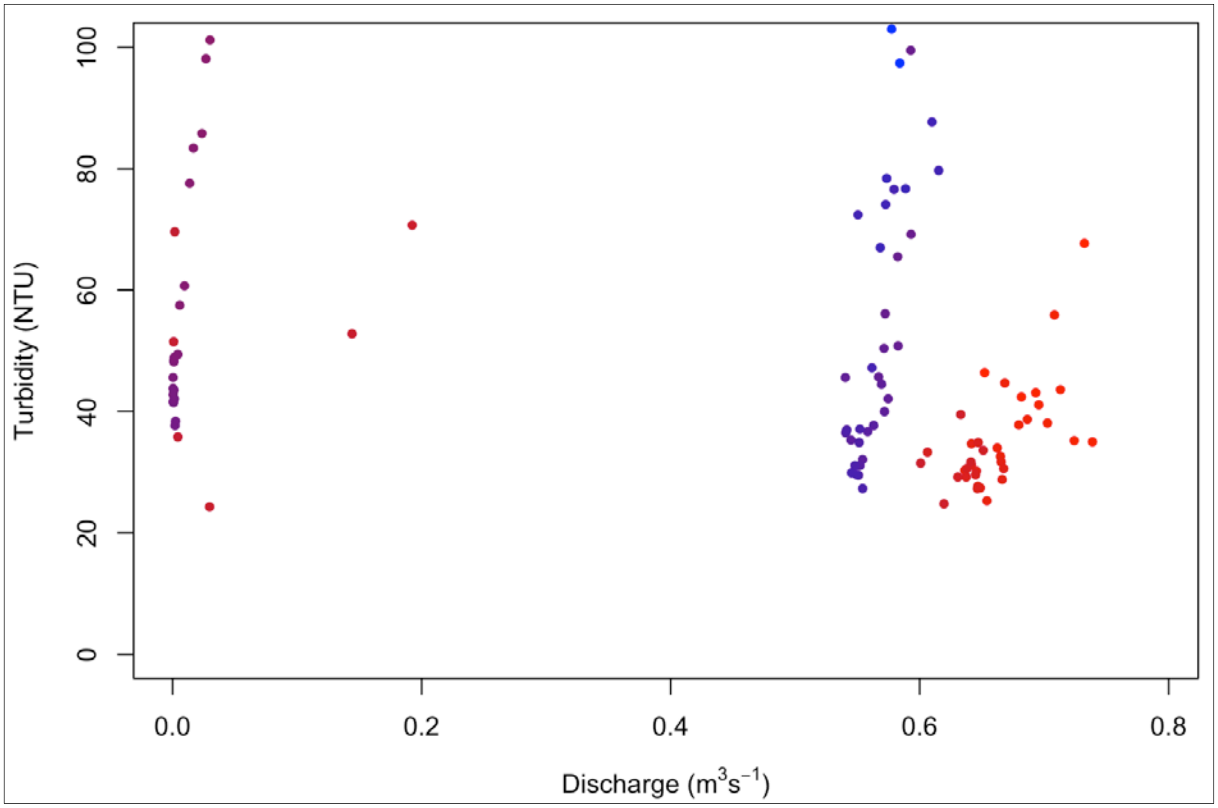

Figure 2-16: Stream discharge versus turbidity for Upper Hazeltine Creek station. The vertical scale is constrained to highlight the turbidity response at low flow

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3 CHANNEL AND FLOODPLAIN GEOMORPHOLOGY METHODS

3.1 Data Sources and Methods

3.1.1 Previous reports

Descriptions of the pre-event Hazeltine and Edney Creek watersheds were informed by published reports and datasets summarized below.

- Mount Polley Project - Stage I Environmental And Socioeconomic Impact Assessment. (Imc, 1990):
  - Impact assessment to support the proposed mine operation. The report includes a compilation of Hazeltine and Edney watershed characteristics, including descriptions of geology, climate and hydrology, water and sediment quality as well as projections of requirements for access, transportation and infrastructure and potential impacts of mine establishment and operation.
- Quesnel Habitat Management Area Resource Assessment, Volume 2. (Triton, 1991):
  - Provides a detailed assessment of historic, contemporary, and future impacts on fish habitat in the Quesnel Lake watershed due to the changing biophysical environment (including physiography, biogeoclimatic zones, precipitation, air temperature and hydrologic regime) and resource use (forestry, placer mining, hard rock mining, agriculture and recreation).
- Hydrology and Water Use for Salmons Streams in The Quesnel Lake Habitat Management Area, British Columbia. (Rood and Hamilton, 1995):
  - Describes the hydrologic and climatic regimes, surficial geology and soil characteristics of the Quesnel Lake Watershed. The report details the response of the regimes to land use activities (resource management and recreation) with an emphasis on salmon habitat sensitivity, as part of the Fraser River Action Plan.
- Salmon Watershed Planning Profiles for the Fraser River Basin within the Cariboo-Chilcotin Land Use Plan (CCLUP) Area. (Rowland and MacDonald, 1996).
  - Presents background information, including descriptions of the geographic and hydrologic regimes, as well as fish habitat management objectives for salmon bearing watersheds. Includes the Quesnel Lake Watershed within the Cariboo-Chilcotin region.
- Quesnel River study area - Fish habitat assessment procedure. (Pedersen, 1998):
  - Assessment of the fish habitat of Quesnel River watershed, identifying limiting factors in fish production and habitat restoration opportunities to improve fish stocks as part of a watershed restoration program.

- Aquatic environmental description report: Mount Polley mine discharge of treated water to Polley Lake. (Minnow, 2014a):
    - Documentation of biophysical conditions, water quality, sediment quality, fish communities, and sentinel fish populations in Hazeltine and Edney Creek Watersheds.
- Technical assessment report: Mount Polley Mine discharge of treated water to Polley Lake. (Minnow, 2014a):
    - Technical assessment to inform the release of accumulated surplus effluent from the Mount Polley Mine. The report outlines the permitting process, describes and provides a technical assessment for the proposed strategy, and outlines plans for mitigation, monitoring and contingency. Pre- and post-mine watershed areas described in this report were valuable to the current investigation.
- Hazeltine Creek habitat characterization. (Minnow, 2007):
    - Documents baseline channel characteristics (including channel widths, depths, slopes, bed and bank material and general morphology) and fish habitat features (functional instream cover and migration barriers) of Hazeltine Creek with a focus on salmonid spawning habitat.
- Recommended maximum discharges from the Mount Polley TSF to Hazeltine Creek. (Knight Piésold, 2009a):
    - Provides recommendation for maximum discharge in Hazeltine Creek with respect to effects on hydrologic regime, channel morphology, fish lifecycle and habitat suitability. Also considers acceptable rate of flow increase (flow ramping). The maximum acceptable discharge is set as a percentage of the creek's mean annual discharge (used as a proxy for formative discharge) based on month and uses fish habitat criteria outlined in Tennant (1976). Conducted to support MPMC's application for increase to allowable discharge of Mine waste-water.
- Hazeltine Creek Geomorphology - Regime modelling to predict changes in channel characteristics. (Knight Piésold, 2009b):
    - Provides prediction of relative changes to channel morphology in response to changes to discharge in Hazeltine Creek using a regime model developed by Eaton *et al.* (2004). Conducted to support MPMC's application to discharge of Mine effluent into Hazeltine Creek.
- Mount Polley Mine supplemental aquatic monitoring. (Minnow, 2012):
    - Physical, chemical, biological characterization of Hazeltine and Edney Creek to expand the dataset from the Minnow (2007) baseline report.

3.1.2 Historical aerial photographs

The pre-event location and dynamics of Hazeltine Creek channel were documented by mapping sequential historical aerial photographs (1974, 1996 and 2009). Aerial photographs were imported into the three-dimensional, heads-up mapping software DAT/EM® Summit Evolution™ and rectified to a base projection. The channel location and historical areas of erosion and deposition were digitized in 3D directly into ESRI® ArcMap™ for each year of aerial photographs. Three (3) historical aerial photographs of the site were used, captured at intervals of 22 and 13 years (Table 3-1). A summary of geomorphic feature classes used in mapping is provided in Table 3-2. Morphological change over time was interpreted qualitatively through comparison of features from one period to the next.

Table 3-1: Inventory of aerial photographs used in analysis

Date (Day/Month/Year)	Roll	Frame	Nominal Scale	Colour
10/08/1974	BC7600 BC7628	116-119, 147 – 152, 187-193, 218-223 014-017, 042-045	1:16,000	No
07/08/1996 09/08/1996 24/08/1996 10/08/1996 10/08/1996	30BCC 96073 30BCC96075 30BCC96109 30BCC96119 30BCC96120	045-050 160-164 043, 044 034-039 022-025	1:15,000	Yes
22/07/2009 23/07/2009	15BCC09021 15BCC09023	028-032, 122-127, 175-179 168-171, 204, 205	1:20,000	Yes

Table 3-2: Feature identification, code, and definition used for river channel mapping

Feature	Geomorphic Feature	Description
Channel	Main	Largest channel containing water with distinct banks; carries the majority of flow. Always active.
	Side	Channel containing water with distinct banks that carries a portion of the river discharge less than the main channel. Always active.
	Back	Channel containing water with distinct banks that is smaller than the main channel and connected to another channel at the outlet. Always active.
	Flood	Channel with distinct banks connected to a main or side channel only during flows at bankfull stage or greater.
	Cutoff channel	Dormant channel remnant(s). No longer directly connected to main flow (e.g., oxbow lake).
Bars	Lateral/point	Deposits of sand and/or gravel connected to the bank.

Table 3-2 (Cont'd): Feature identification, code, and definition used for river channel mapping

Feature	Geomorphic Feature	Description
Bars	Medial	Deposits of sand or gravel within the channel.
Other	Floodplain	Flat areas of overbank flow during flood events.
	Valley wall	Side slope of stream valley.
	Dominant Fan or Delta	Fan shaped deposit radiating from a point source and fed by an upstream drainage basin.
Activity	Active	Fluvial processes have acted on the channel or feature within 1 to 2 years from the date of remote imagery; features are considered active until vegetation is established.
	Dormant	Fluvial processes have not acted on the channel or feature within 2 years from the date of remote imagery; features are considered dormant when vegetation is established

Limitations of the interpretation of aerial photographs include:

- The scale and resolution of available aerial photographs; and
- Vegetative cover obscuring the channel and floodplain.

3.1.3 Digital Elevation Models (DEMs)

Three DEMs were available for analysis, including:

- A pre-event Terrain Resource Information Management (TRIM) DEM;
- A pre-event DEM from 2013 (Upper Hazeltine Creek only); and
- A post-event DEM created from LiDAR from August 5, 2014.

The dates, data type, scale / resolution and source of each DEM are presented in Table 3-3.

Table 3-3: Metadata for digital elevation models

Pre- or Post-event	Data Type	Date	Resolution / Scale	Compiled By
Pre-event	Photogrammetry	27 September 2013	1:57,000	Eagle Mapping Ltd.
Pre-event	Terrain Resource Information Management (TRIM)	093A.042 and 093A.052: 2006-07 093A.043 and 093A.053: 1999-00	1:20,000	BC Ministry of Environment, Lands and Parks
Post-event	LiDAR	5 August 2014	0.25m	McElhanney Consulting Services Ltd.

Unfortunately, each DEM was generated at a different time and using a different technique, making accurate and systematic comparisons between pre- and post-event DEMs impractical. Elevations were different between the TRIM, 2013 and 2014 (LiDAR) DEMs and differences were non-systematic outside of the area affected by the TSF dam failure. Previous DEMs were coarser than the LiDAR surface and the 2013 DEM was restricted to the upper portion of Hazeltine Creek. Ultimately, LiDAR data collected post-event was chosen for analysis because of the substantial detail and event-relevant information it provided. The 2014 LiDAR DEM was used to create 1 m contours, hillshades and slope maps for interpretation and analysis.

3.1.4 Field geomorphic assessment

The post-event geomorphology of Hazeltine and Edney Creeks was assessed in the field using procedures modified from those outlined in the BC guidelines for channel assessment procedure (Ministry of Forests, 1996) and incorporated into SNC-Lavalin's specialized fluvial geomorphology assessment procedure. A field program was conducted from September 22-28, 2014. The objectives of the field program were to:

- Document the geomorphology of Hazeltine and Edney Creeks following the TSF dam failure and subsequent debris flow;
- Measure the location, thickness and characteristics of tailings and reworked sediments on the floodplain and channel;
- Characterize the impacts on the channel and floodplain (i.e., sedimentation, bank erosion, changes in morphology, slope and cross-sectional changes and debris flow); and.
- Identify areas of active erosion and sedimentation.

72 soil pits and exposures within 23 reaches along the Hazeltine Creek were characterized. The following data was recorded (Figure 3-1):

- Site station and UTM coordinates (NAD 1983, zone 10);
- Main-channel characteristics (channel form and field morphology, sediment patterns and channel and bank stability) recorded on SNC-Lavalin's specialized channel assessment field cards;
- Cross-sectional sketches;
- Site photographs;
- Field indicators for stream disturbance (Ministry of Forests, 1996); and,
- Flood heights where appropriate.

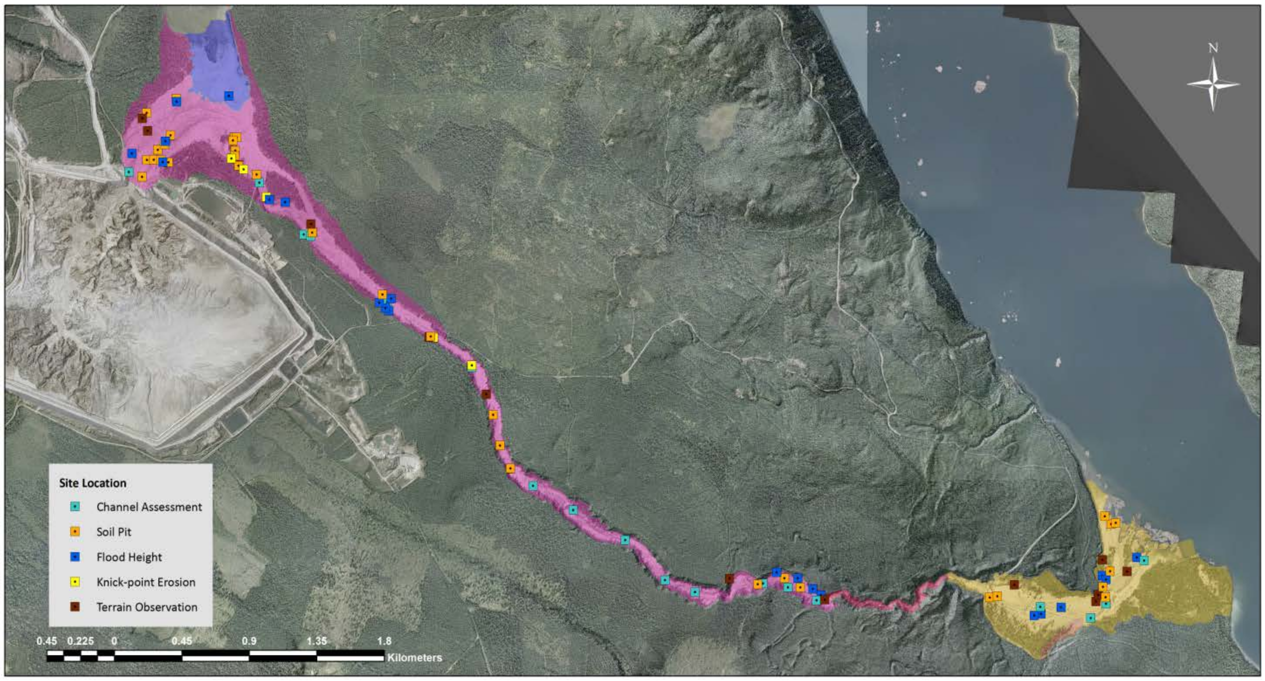

Figure 3-1: Geomorphology assessment site investigation locations

3.1.5 Video and air reconnaissance

The Cariboo Regional District shot video (Cariboo video) from a helicopter on the morning of August 4, 2014, about 8 hours after the TSF dam failure, but while it was still in progress (Morgenstern *et. al.*, 2015). This video was reviewed to inform the geomorphology assessment of Hazeltine Creek.

Three reconnaissance flights were conducted by helicopter on August 29, September 5 and September 22, 2014 by Leif Burge, Vanessa Cuervo, Richard Guthrie and Jeremy Zandbergen with the purpose of identifying:

- Active geomorphologic processes in the Hazeltine Creek channel (areas of active erosion and deposition);
- Hazeltine Creek geomorphology and bank stability;
- Critical areas for ground inspection; and,
- Accessibility and safety conditions for ground inspection.

Photographs were taken during all flights.

3.1.6 Delineation of the area affected by the event

The extent of area affected by the event was manually digitized on-screen using ESRI® ArcMap™ at a scale of 1:1,000. The terrestrial affected area was delineated based on a hillshade model, slope model, 1 m contours derived from the 2014 LiDAR, post-event orthophoto and field data (soil pits, photographs and field notes). Topographic data derived from the 2014 LiDAR data were created using the Spatial Analyst extension of ESRI® ArcMap™ software.

The following criteria were used to delineate the terrestrial affected area boundaries:

- Field evidence (from soil pits and photographs) indicating either erosion or deposition of material from the event; and,
- Observable evidence on the post-event orthophotographs indicating geomorphological impacts from the event (e.g., removal of vegetation, disturbed ground, eroded bedrock, debris jams or wood and boulders with some logs splintered, shattered or broken, etc.).

When visual confirmation was not possible, the delineation of the terrestrial affected area boundary was based on morphological features (slope and elevation contours).

Two different areas were defined:

- Terrestrial affected area: zones of erosion and/or deposition, including Large Woody Debris (LWD).
- Displaced material: material removed from its original position by erosion processes. Includes areas absent from the distal zone of the pre-event Hazeltine Creek delta surface.

The total impacted area includes both the terrestrial affected area and displaced material. Uncertainty in the delineation of the terrestrial affected area was due to dense forest cover that obscured the affected area boundary. In these locations, topography was used to interpolate between areas where the boundary of the terrestrial affected area was easily identified on the orthophotographs or from soil data.

3.1.7 Post-event distribution of surficial materials

Soil data and field mapping of the post-event Hazeltine Creek bed and floodplain displays evidence of the deposition of tailings and reworked native material. Material deposited within the channel and on the floodplain of Hazeltine Creek is composed of fine tailings, coarse tailings, native material, LWD, and a mixture of tailings, native material and LWD. Native material includes glacial till, lacustrine silts and glacial sands.

Understanding the location and extent of surficial materials and interaction between active geomorphic processes (during and following the event) and the surface material, provides insight into the Hazeltine Creek channel and floodplain evolution following the August 2014 event.

This analysis provides:

- The location and extent of surficial material (tailings and native materials);
- Identification of active geomorphic processes on the channel and floodplain;
- An estimate of the volume of tailings deposited within the terrestrial affected area. Volume deposition in Polley and Quesnel Lakes and volume balance are presented in Tetra Tech EBA Inc. (2015) report.

The surficial material was mapped within the terrestrial affected area. The map classifies areas (polygons) with defined material type (tailings and native soil), surficial landforms and geomorphic processes. A terrain unit symbol was assigned to each identified polygon based on the British Columbia terrain classification scheme (Howes and Kenk, 1997). The classification was modified to include processes related to this particular event. The following information was recorded during the mapping:

- Surficial material type (tailings and native soil);
- Texture where appropriate;
- Surface expression; and,
- Geomorphological processes (e.g., knickpoint erosion, slope failures, and avulsion).

An example of the terrain coding is presented in Figure 3-2.Terrain unit polygons were manually digitized on-screen using ESRI® ArcMap™ at a scale of 1:1,000. Topographic data described in Section 3.1.6 were used as baseline information to delineate terrain polygons.

Surficial material and tailings extent data were obtained from post-event field programs conducted during Fall 2014 and Winter 2015. Field data on the thickness of deposited material were compiled from different site investigation programs (Table 3-4) and georeferenced for analysis. In total, 229 locations were used in the surficial material-tailings extent mapping and deposition analysis.

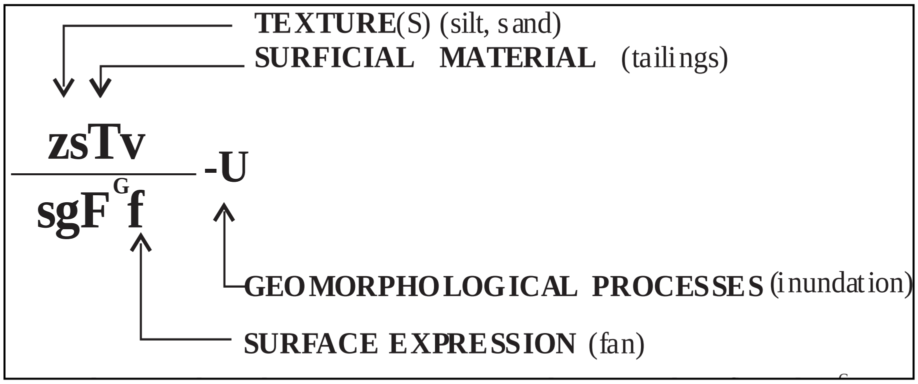

Figure 3-2: Example terrain unit symbol that describes a silty-sandy (zs) Tailings (T) veneer (v) overlaying a glaciofluvial (FG) fan (f) composed of sandy gravel (sg) modified by inundation (U)

All site locations included in the analysis contain UTM coordinates and depth of tailings and texture (where appropriate). Locations of thickness measurements were well distributed in areas of greatest deposition, including upper Hazeltine Creek adjacent to the TSF, the Plug area and Lower Hazeltine Creek.

Table 3-4: Site investigation soil pit locations used in surficial mapping and deposition analysis

Source of data	Number of soil locations	Remediation Area	Data collection method	Reference
Hydrology – Geomorphology Impact Assessment (HIA)	72	PP, UHC, CHC, LHC, LEC	Soil pit	Hydrotechnical and geomorphological Impact Assessment, 2015 (Appendix 1, Post-Event Environmental Assessment Report)
Soil Quality Impact Assessment (SIA)	89	PP, UHC, CHC, LHC, LEC	Soil pit	SNC-Lavalin Inc.(2015) (Appendix 4, Post-Event Environmental Assessment Report)
Panel Investigation Report (PIR)	23	UHC	Drill hole	Independent Expert Engineering Investigation and Review Panel (2015)
Mount Polley Investigation (MPI)	45	PP, UHC	Excavator	Eagle Crest Silviculture (Field data from February, 2015)
Archeology Impact Assessment (SIA)	317	LHC	Soil pit, trenches	ARCHER Field data

Note: Polley Plug (PP); Upper Hazeltine Creek (UHC); Canyon Hazeltine Creek (CHC); Lower Edney Creek (LEC); Lower Hazeltine Creek (LHC).

3.1.8 Volume of deposited material

The pre-event DEMs were insufficient for direct comparison against post-event topography to determine the volume of deposits within Hazeltine Creek. Volumes of materials deposited on channel and floodplain were therefore estimated based on field data collected on the thickness of deposited material (Table 3-4), mapping of surficial material within the channel and floodplain (Appendix E), and photographs taken in the field.

Terrain polygons derived from the surficial material mapping were used to interpolate tailings thickness. When tailings thickness data were not available for a terrain polygon, the closest thickness value in similar terrain was used. The following thickness intervals were defined and assigned to terrain polygons (less than or equal 0.1 m, 0.11-0.19 m, 0.20-0.49 m, 0.5-0.99 m, 1.0-1.49 m, 1.50-1.99 m, 2.0-2.49 m, 2.50-2.99 m, 3.00-3.49 m and greater than or equal 3.5 m). Volume of deposition was estimated by multiplying average deposition thickness in the polygon by the area of the terrain polygon.

The thickness of deposits along Hazeltine Creek is spatially heterogeneous. No estimation method is likely to provide 100% accuracy in the estimation of deposition volumes. Limitations and sources of uncertainties to this analysis are:

- The delineation of the terrestrial affected area is based on the interpretation of the post-event orthophoto and LiDAR. Limited field data exist outside the identified terrestrial affected area and ground truthing of this area has not been conducted. Potential errors in the delineation of the terrestrial affected area boundaries could lead to errors in the estimation; and,
- Soil field data are not systematically distributed within the study area and terrain polygons. Furthermore, few soil pit locations are available within the canyon section making the estimation less reliable. This may result in over or under estimation of deposition volumes.

Limitations related to collection of soil field data in the different site investigation programs are outlined in their respective reports.

3.1.9 Post-event estimation of net erosion

Overall, the post-event Hazeltine Creek bed shows evidence of net erosion. Evidence for erosion includes the lack of vegetation, lack of well developed soil, exposure of native glacial material within the erosion zone and large knickpoints. Digital pre-event data (2013 and TRIM DEMs) are not of sufficient accuracy for direct comparison between pre- and post-event topography to determine the net volume or depth of erosion which occurred during the event.

Net volume and depth of erosion were estimated based on the determination of pre-event floodplain elevations using morphological, sedimentological and photographic evidence. 96 cross-sections were extracted from the post-event LiDAR-derived DEM. Each cross-section was georeferenced in GIS for analysis. The location of the pre-event floodplain was determined from the:

- Remnant floodplain levels seen in the post-event LiDAR;
- Shape of the adjacent valley sides, used to estimate the floodplain levels where appropriate;
- Downstream profile of the estimated elevation of the floodplain, used to corroborate the floodplain levels at each cross-section; and,
- Post-event orthophotographs, field photographs and oblique aerial photographs taken from helicopter, used to aid in the interpretation of the remnant floodplain locations. In some areas in situ roots indicate the location of former floodplain.

A floodplain elevation was estimated for the right and left bank by identifying terrace levels. Cross-sections were compared upstream and downstream for consistency. The floodplain level was represented for each cross-section as a horizontal line from the average of the right and left bank elevations. Often cross-sections show several terrace levels. The analysis was conducted separately by two specialists with training and experience in river geomorphology. At each cross-section, the lowest and highest terrace levels that represent the likely floodplain elevation were estimated for each bank. This provided a minimum and maximum estimate for the volume eroded from the valley and quantified the level of uncertainty in the estimate. A large difference in the floodplain elevation between interpreters at any particular cross-section represents lower confidence in the identification. The maximum and minimum erosion volumes were mapped to show areas of lower and higher confidence in the estimates.

To estimate the net erosion depths, elevations of stations on each cross-section elevations were subtracted from the estimation for the minimum and maximum elevation of the former floodplain at each cross-section. The average of these depths provided an estimate of net erosion depth for each cross-section.

To estimate the net volume of erosion, the mean net erosion depth was multiplied by the area of erosion represented for each cross-section. The width of erosion for each cross-section was calculated based on linear difference between points where average elevation of the estimated floodplain level encountered the ground surface. The length of channel segment at each cross-section was calculated based on length between the point halfway between each cross-section and the next upstream cross-section and the point halfway between the cross-section and the next downstream cross-section.

The volume represented by the typical pre-event channel cross-section as defined in Minnow (2007) was subtracted from the estimated erosion volume for each post-event cross-section for the length of the stream.

Limitations and sources of uncertainty:

- The pre-event floodplain is represented by a horizontal line; however floodplains are not strictly horizontal and have topographic differences across a section. These topographic differences are unknown because they were erased by the event and the pre-event data is unreliable (See Section 3.1.3);
- The erosion of soil and vegetation on the floodplain is not accounted for in this analysis;
- Higher terraces identified as floodplain may be relic and may not represent the true pre-event floodplain level; and,
- Lower terraces identified as the floodplain may have formed during or following the TSF dam failure and may not represent of the true pre-event floodplain level.

3.1.10 Assessment of slope and bank stability

The post-event banks and valley walls of Hazeltine Creek display evidence of slope failures. Stability of valley slopes was determined using a ranking system based on the combination of input factors that are considered important for slope stability in the area (slope class, surficial material and active processes). Expert knowledge was used to weight these factors (Table 3-5). Weights for each factor were added up and final scores were grouped into five categories ranging from Class I (no significant slope stabilities) to Class V (highly unstable terrain).

Slope stability was mapped based on the following data:

- Slope angles derived from LiDAR;
- Mean annual flow levels; and,
- Post-event orthophotograph, ground truthing, field photographs, and oblique aerial photographs taken from a helicopter.

Table 3-5: Weight values to define valley wall slope stability classes

Weight Value	Dominant Slope Class	Surficial Material	Active Processes
1	Very gentle slope (0-3°)	Bedrock (R)	Gully and rill erosion (-V) and slope failures runout areas (-R)
2	Gentle slope (3.1-15°)	Till (M)	Slope failure initiation areas (-R")
3	Moderate slope (15.1-26°)	Glaciofluvial (F^G), Fluvial (F), Colluvial (C),	-
4	Moderately steep slope (26.1-35°)	Glaciolacustrine (L^G), Fluvial (F), and tailings (T)	-
5	Steep slope (> 35°)	-	-

The stability of the channel banks of Hazeltine and Lower Edney Creek was calculated using a modified version of the Bank Erosion Stability Index procedure, or Bank Erosion Hazard Index (BEHI) developed by Rosgen (1996; 2001). This methodology utilizes a rank system based on channel banks characteristics that contribute to bank stability. Channel bank criteria used to determine BEHI is presented in Table 3-6. Channel bank stability was mapped based on the following data:

- Depths of flow for the mean annual flow obtained from River2D model (model and data described in Section 5.3.1.11) results.
- Ground surface elevations along channel cross-sections collected from 2014 LiDAR data;
- Bank slope angles calculated as the ratio of the bank height to the horizontal distance between the bank top and bank toe; and,
- Surficial material map.

BEHI values were calculated for both the left and right banks of cross-sections spaced at approximately 100 m intervals along Hazeltine Creek and the lower reach of Edney Creek. The bank height-depth ratio was calculated using the vertical distance from the top to the toe of the bank and the mean annual flow depth. Elevations of the ground surface along channel cross-sections were collected from 2014 LiDAR data. Bank angles were calculated from the bank height and the horizontal distance between the bank top and the bank toe. The bank material adjustment value was determined from surficial material deposits observed in the field.

The present channel banks lack vegetation or surface protection, resulting in assignment of the maximum BEHI value for these variables for each cross-section bank. Maximum BEHI values for bank stratification were also assigned to all banks. Root density, surface protection and root depth to bank height ratio values were zero and therefore were excluded from the calculations to provide meaningful results. Rating scale was adjusted to reflect normalized values allowing for differences in relative bank stability along the channel. An empirical function was applied to each variable to obtain BEHI ratings for each variable. Ratings were then summed to give the total BEHI score. The score was categorized from very low to very high to describe relative stability of the banks at each cross-section.

Table 3-6: Criteria to define bank erosion hazard index (modified from Rosgen, 2001)

Bank Erosion Potential	Slope Angle (degrees)	Bank Height Ratio[1]	Bank Surface Protection (%)[(2)]	Totals
I (Very Low)	–less than 2°	Stable (>1.1)	80-100	2 - 3.9
II (Low)	2 – 3.9°	slightly incised (1.1-1.19)	55-79	4 - 7.9
III (Moderate)	4.0-5.9°	moderately incised (1.2-1.5)	30-54	8 - 11.9
IV (High)	6.0-7.9°	Incised (1.6-2.0)	15-29	12 – 15.9
V (Very High)	greater than or equal 8°	deeply incised (>2.1)	< 15	Greater than 16

Notes: 1. The ratio of bank height to depth of flow under bankfull conditions.
2. Present channel banks lack vegetation or surface protection. Maximum score was used for these variables. Adjustment for nature of bank materials and stratification: (i) Bank Materials: Bedrock (very low), Boulders (low), cobble (subtract 10 points unless gravel/sand greater than 50%, then no adjustment), gravel (add 5-10 points depending on % sand), sand (add 10 points), silt/clay (no adjustment). (ii) Stratification: Add 5-10 points depending on the number and position of layers.

3.1.11 Post-event hydraulic patterns

A hydraulic model was developed to identify areas susceptible to erosion and deposition following the event. The model was developed to predict patterns of inundation extent, depth and velocity and shear stress for the MAF, 10-year and 100-year return intervals.

3.1.11.1 Modeling Approach

The hydraulic modeling of Hazeltine Creek was completed with the two-dimensional hydrodynamic model River2D developed in the University of Alberta by Steffler and Blackburn (2002). River2D has been applied in numerous studies of natural streams and rivers to compute 2D flow distribution and habitat characterization. The model has the capabilities of computing subcritical and supercritical flows, and wetting and drying up of channel bed, which are important features for natural channels with varying inflows. This model was selected for studying general two-dimensional mean flow pattern for selected flows in Hazeltine Creek due to our previous successful experiences with this model in application to small creeks.

The total length of the Hazeltine Creek modeling study reach was 7.9 km. A short reach of Edney Creek (0.7 km long) was included in the study area to model Hazeltine Creek-Edney Creek confluence and the downstream reach. The upstream boundary was set near the TSF, and the modeling domain extended 0.6 km beyond the confluence of Hazeltine and Edney Creeks, approaching Quesnel Lake. The study area was divided into four reaches considering channel characteristics, topography and flows. To provide 2D model design flow boundary conditions Hazeltine Creek was modeled initially with the one-dimensional HEC-RAS model (USACE, 2010).

3.1.11.2 2D Model Parameters

Model parameters for 2D modeling were selected based on characteristics of individual reaches. River2D is a two-dimensional, depth averaged hydrodynamic and fish habitat model developed based on Finite Element formulation. The model generally runs in unsteady flow mode which can be used to obtain a steady state solution. The details of the model theory are available in the Steffler and Blackburn (2002).

The hydrodynamic component of the River2D model solves the two-dimensional, depth averaged St. Venant Equations expressed in conservative form. Three equations representing the conservation of water mass, and momentum vectors in two directions (x and y) are solved with appropriate boundary and initial conditions. Triangular mesh elements with a linear distribution of variables between the nodes are used. The dependent variables for solutions are the depth and discharge intensities in the two respective coordinate directions.

Friction slope terms in the depth averaged momentum equations are related to the bed shear stress, which are dependent on the depth average velocity vector, depth of flow and bed roughness. The effective roughness height (k_s) is one of the important parameters for natural channel bed boundary. The Boussinesq type eddy viscosity formulation is used in the model for computing depth averaged turbulent shear stresses with the eddy viscosity coefficient (η_t) as a multiplier of velocity gradients. The eddy viscosity coefficient is composed of three terms: a constant, bed shear generated term, and the transverse shear generated term. The parameters related with eddy viscosity are important for model calibration. River2D handles wetting-drying phenomena by using groundwater flow equations assuming an artificial aquifer in those areas which provide a continuous stable solution in both wet and dry areas. The drying up threshold depth, transmissivity and storativity are another three parameters which are adjusted during model calibration based on the site conditions.

3.1.11.3 Data Preparation

Data and information used in the model development were:

- High resolution LiDAR topography data acquired on August 5, 2014. This provided model bathymetry. The horizontal and vertical accuracy of the data was 5 cm or better. No further channel bathymetric measurements were conducted;
- Regional flow analysis. This provided discharges for Mean Annual Flood, and 10-year and 100-year return period floods for different reaches of Hazeltine and Edney Creeks; and,
- Post-event satellite imagery and photographs from site reconnaissance following the August 2014 TSF dam failure. This provided a guide to determine the physical status of the channel.

GIS software was used initially to process DEM data and to develop a HEC-GeoRAS model to determine water level elevations at different sections of the creek with HEC-RAS. It is noted that LiDAR data were collected shortly after the TSF dam failure. Thus, the channel bathymetry created from the LiDAR data does not provide a truthful representation of the channel bed due to pooled water and liquid tailings in the relatively low areas of the creek. Also, the captured LiDAR bathymetry does not represent a fully water-worked channel as no large flood flow occurred between the original TSF dam failure debris flow and the LiDAR data acquisition. Current bathymetry condition in some sections of the creek is likely to be different than the LiDAR surface.

3.1.11.4 Model Setup Procedures

The model for the study area was developed by creating bathymetry for the reaches. The physical model boundaries and model reach lengths for numerical space discretization were determined based on anticipated flow conditions at the boundaries and the size of the computational mesh. Preliminary numerical simulations were conducted for defining the final domain boundaries in each river reach. Table 3-7 and and Table 3-8 present the extent of model reaches, and boundary conditions used for model setup. Four separate models were created for the reaches, introduced below.

- Upstream Reach Model: The upstream reach model inflow boundary was located at the Hazeltine Creek section closest to the TSF dam failure site. The total channel length was 2.7 km which extended 1.2 km downstream of the Gavin Bridge Road crossing. The average slope of the channel was 0.71%, varying from 0.7 to 1.2%. Several steep sections and/or knickpoints of the channel bed were located in this reach.
- Middle Reach Model: The length of this reach was 1.45 km. This model reach consisted of local steep sections, and multiple narrow channels. One section of creek upstream of the largest knickpoint was too tall for hydraulic modeling using River 2D because the model results cannot be converged. This section was therefore excluded from analysis.
- Downstream Reach Model: The upstream boundary of this model reach overlapped with the middle reach model and extended up to the Horsefly-Likely Forest Service Road (FSR) (Ditch Road) crossing. The 2.4 km long reach was characterized by bifurcated channels and the steep narrow canyon.
- Confluence Area and Delta Reach Model: To model the Hazeltine and Edney Creek confluence and the downstream area to Quesnel Lake, a 0.7 km reach of the Edney Creek was included in the model. Edney Creek flows are in the order of double the flows of Hazeltine Creek (Table 3-8).

The accuracy of the model also depends upon the mesh resolution for a given computational algorithm (Steffler and Blackburn, 2002). For Hazeltine Creek modeling, initially a model response analysis approach was employed to determine an appropriate mesh resolution. Results of initial simulations were analysed by comparing water surface elevations, velocity distribution and overall model convergence and stability. The mesh was modified and refined until there was no significant variation in computed flows and a logical flow pattern was computed through narrow channels and drops. The final mesh was composed of triangular elements with a spatial resolution of nodes ranging from 0.25 m to 1 m in the wetted areas and up to 4 m in dry areas. Figure 3-3 shows a typical model section of mesh and bathymetry.

Field observations and LiDAR data indicated that the main channel and lower floodplain were composed of predominantly finer materials and vegetation was absent on the floodplain. In many sections the main channel was poorly defined as it had not yet been reworked under high flows following the TSF dam failure.

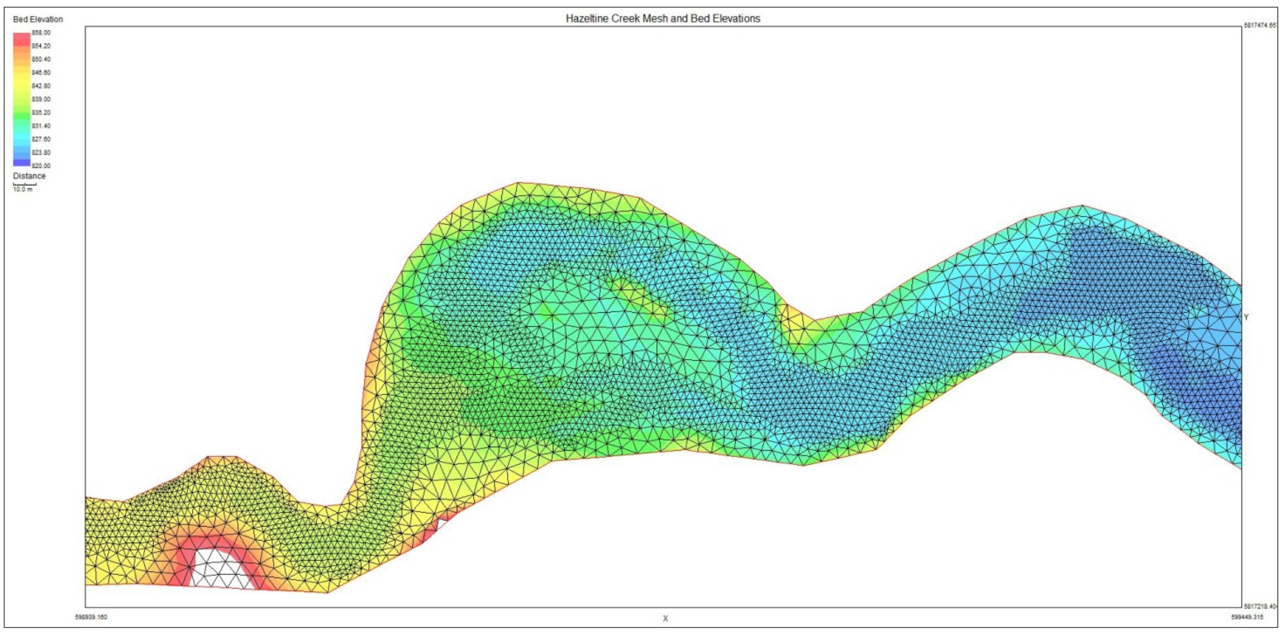

Figure 3-3: Typical meshing and bathymetry used in the model (selected from Downstream Reach Model)

Parameterizations of the model consisted of the selection of appropriate bed resistance, eddy viscosity coefficients, wetting-drying parameters and time step (Steffler and Blackburn, 2002). Eddy viscosity represents the loss of energy due to creation of eddies in turbulent flow. Bed resistance is important for stream flow modelling because the prediction of flow (velocity and bed shear) using the shallow water equations is largely dependent on the friction parameter values adopted in the model. Following trial model runs and examination of model response, parameter values were selected based on reach characteristics and modeler experience. Calibration of the model was not performed in this study as observed data (water level and velocity) were not available but a cross-comparison of results was conducted with mean velocities obtained from simplified calculations.

Table 3-7: Hazeltine Creek 2D model reaches

Reach Name	Upstream Boundary Easting (m)	Downstream Boundary Easting (m)	Total Length of Channel (km)
Upstream Reach	597599	597600	2.70
Middle Reach	697666	598856	1.45
Downstream Reach	598645	600731	2.40
Confluence and Delta Reach	600685	601814	2.00

Table 3-8: Hazeltine Creek model boundary conditions

Model	Model Run ID	Flow Return Period	Inflow (m^3/s)	Downstream Boundary Water Level Elevation (masl)
Upstream Reach	HCUSQ100	Mean Annual Flood	1.6	879.84
	HCUSQ10	10 Year	2.5	879.89
	HCUSQ2	100 Year	3.7	879.94
Middle Reach	HCMQ100	Mean Annual Flood	1.8	845.06
	HCMSQ10	10 Year	2.8	845.10
	HCMSQ2	100 Year	3.7	845.15
Downstream Reach	HCDSQ100	Mean Annual Flood	1.8	746.51
	HCDSQ10	10 Year	2.8	746.54
	HCDSQ2	100 Year	3.7	746.56
Confluence and Delta Reach	LEC-HCQ100	Mean Annual Flood	1.8 (Hazeltine Cr), 4 (Edney Cr)	726.42
	LEC-HCQ10	10 Year	2.8 (Hazeltine Cr), 6.2 (Edney Cr)	726.32
	LEC-HCQ2	100 Year	3.7 (Hazeltine Cr), 9.2 (Edney Cr)	726.23

4 PRE-EVENT CHANNEL AND FLOODPLAIN GEOMORPHOLOGY

Prior to the TSF dam failure, Hazeltine Creek flowed through a well-defined, generally single unconfined channel within a largely alluvial valley incised into the Fraser Plateau from Polley Lake to Quesnel Lake (Minnow, 2012). The slope of the Hazeltine Creek channel increased downstream after leaving Polley Lake, flowing through a wetland and reaching a maximum within the Hazeltine Creek Canyon (Triton Environmental Consultants Ltd., 1991)(Triton Environmental Consultants Ltd. , 1991). Downstream of the Canyon the slope decreased as the channel flowed into the Hazeltine Creek Delta located at the creek interface with Quesnel Lake (Minnow, 2007). Minnow (2007) records the geomorphology of eight (8) reaches in Hazeltine creek. Data from this report are used extensively to document the geomorphology of the pre-event channel and floodplain geomorphology of Hazeltine Creek.

Historical anthropogenic activities including water diversion, livestock grazing, mining and logging within the Hazeltine Creek watershed have affected the geomorphic characteristics of Hazeltine Creek (IMC, 1990; DFO, 1990; Rood and Hamilton, 1995; Rowland and MacDonald, 1996 and Nener and Wernick, 2000). In 1991 the Hazeltine watershed was 53% forested, 26% recent harvest, 9% green-up (logged greater than 30 years prior) and 12% lake (Triton Environmental Consultants Ltd., 1991). However, logging efforts in the watershed have been scaled back over the last decade and decrease in forest cover is now primarily associated with mining activities (Knight Piesold, 2014; Rowland and MacDonald, 1996). Early diversion of Hazeltine Creek (c. 1913) associated with placer mining was remediated following World War II and flow to the original channel restored (Knight Piesold, 2009; Imperial Metals Corporation, 1990. Given the time frame, it is likely that the geomorphic regime of Hazeltine Creek had reached equilibrium following the altered discharge regime.

Time series analysis was conducted using aerial photographs from 1974, 1996 and 2009. Analysis shows that overall channel planform has remained relatively stable over time. Changes observed between historical aerial photographs occurred in areas of low slope where beaver (*Castor canadensis*) dams have been reported (Imperial Metals Corporation, 1990; Pedersen, 1998; Minnow, 2007). The presence of beaver dams is a control on the channel's geomorphology. The presence of a dam impounds water and sediment upstream and generally alters downstream velocity and discharge of water and sediment. However, high flow conditions can lead to the formation of spillways and, over time, these spillways may become permanent channels, shifting the overall planform of the stream (Gurnell, 1998).

Depositional areas observed along Hazeltine Creek were mostly thin accumulations in backwaters and small shallow pools, likely depositing and eroding seasonally (Minnow, 2012). Channel width, depth and bed material were highly variable due to woody debris in the channel (Knight Piesold Consulting, 2009b). The creek was characterized by dense riparian vegetation (Minnow, 2007) (Figure 4-1).

Five areas, defined in the report introduction, will be used to describe the pre-event channel and floodplain condition: the Plug area, Upper Hazeltine Creek, Hazeltine Creek Canyon, Lower Hazeltine Creek and Edney Creek.

Figure 4-1: (A): Second reach of Lower Hazeltine Creek (HC-R8) flowing through cedar lowland habitat. (B) First reach of Upper Hazeltine Creek (HC-R1) showing densely vegetated riparian zone (January 20, 2007)

4.1 Plug Area

The “Plug area” of Hazeltine Creek extends from the creek’s outlet at Polley Lake to 1,750 m downstream. Prior to the TSF dam failure, the Plug area was characterized by a wide, low sloping wetland region (Minnow, 2007). Channel sinuosity in this area was 1.1 as measured from 2009 aerial photographs. Time series analysis showed historically within this section, and extending into Upper Hazeltine Creek, the creek split into two main channels with a network of minor interconnecting channels and ponds. However, by 2009 only a single well-defined channel remained. In some channel sections, flow was controlled by beaver activity (e.g., USW7 Pond, Minnow, 2007). No detailed pre-event field data have been found for this area.

The confluence of Bootjack Creek and Hazeltine Creek was within the Plug area, 770 m downstream from the Polley Lake outlet. Contribution of discharge from Bootjack Creek was limited by the diversion of Bootjack Lake flow circa 1913 (Pederson, 1998). Diversion reduced the watershed area of Bootjack Creek above its confluence with Hazeltine Creek by 70% (to approximately 4.2 km^2) (Knight Piésold Consulting, 2009a). MPMC has further reduced the watershed area through water management.

4.2 Upper Hazeltine Creek

Upper Hazeltine Creek begins 1,750 m downstream of the Polley Lake outlet and extends to the upstream end of the Hazeltine Creek Canyon, 5,897 m downstream. Channel sinuosity in this area was 1.2 as measured from 2009 aerial photographs. Time series analysis reveals channel shifting over time near the upper boundary of this section. However, this section is more typically defined by a stable channel, with greater stability in its downstream reaches. Channel aggradation in Upper Hazeltine Creek appears to fluctuate throughout time. This area coincides with reaches one (1) to five (5) as described by Minnow Environmental Inc. (2007). Time series analysis reveals no observable change in channel position within Upper Hazeltine Creek.

This section of channel displays several morphologies divided into five (5) distinct reaches defined in (Minnow, 2007).

The first uppermost reach of Hazeltine Creek (HC-R1), was 445 m in length, displayed a riffle-pool morphology characterized by a low gradient (1.4%), and bankfull depth and width of 0.36 m and 7.0 m, respectively (Pedersen, 1998; Minnow, 2007). Banks were generally stable, composed of fine-grained material and stabilized by the presence of dense vegetation (Minnow, 2007).

The second reach (HC-R2), a 210 m section downstream of the first reach, was characterized by ponded flow resulting from a downstream beaver dam (W7 Pond, Minnow Environmental Ltd., 2007). The length of ponded channel was 210 m and ponding typically occupied the entire floodplain at 45 m wide and 100 cm deep (Minnow, 2007).

Downstream of the beaver dam, the third reach (HC-R3) was 157 m in length, ending at the Gavin Lake Road. This riffle-pool reach was low gradient (0.8%) with a bankfull width and depth of 7.9 m and 0.12 m, respectively. It was characterized by the presence of side-channels and unstable banks (Minnow, 2007). The presence of beaver ponds likely exerted control over local patterns of deposition and erosion in Upper Hazeltine Creek. Beaver dams create retention ponds which slow velocity and trap sediment, causing overall aggradation of the channel bed. Downstream of the dam, sediment starvation can lead to erosion of the channel bed and banks, which over time can result in bed degradation or lateral channel migration (Gurnell, 1998). This may have contributed to the low bank stability reported by Minnow (2007).

Downstream of Gavin Lake Road, within reach four (HC-R4), the channel became more confined as gradient steepened (1.7%), channel width narrowed (4.7 m) and bed material coarsened in the next 2,200 m downstream (Minnow, 2007). Surface water flow was variable and hyporheic flow (mixing of shallow groundwater and surface water) was suspected. Bank stability was low within the reach, with some areas of undercutting (Minnow, 2007) (Figure 4-2).

Figure 4-2: Undercut banks in reach four of Hazeltine Creek. Photo from Minnow (January 20, 2007)

The downstream most fifth reach (HC-R5) in Upper Hazeltine Creek displayed riffle-pool morphology. Channel gradient (3.7%) and confinement continued to increase, producing corresponding changes in bankfull width (4.5 m) and depth (0.38 m) (Minnow, 2007). Banks were considered moderately stable and in two locations (Minnow, 2007) the valley walls had failed into the creek (Minnow, 2007) (Figure 4-3).

Figure 4-3: Bank failure in reach five of Hazeltine Creek. Photo from Minnow (January 20, 2007)

4.3 Hazeltine Creek Canyon

Hazeltine Creek entered a 1,510 m long canyon (HC-R6) 5,897 m downstream of the Polley Lake outlet. Channel sinuosity in this area was 1.1 as measured from 2009 aerial photographs. Time series analysis reveals this section of the creek is extremely stable showing no change over time. Both channel confinement and slope (7.3 %) were at a maximum through the canyon reach. Bankfull depth and width decreased to 0.27 m and 3.7 m, respectively (Minnow, 2007). The channel bed in this reach was lined with bedrock, boulders and cobbles, and displayed step-pool morphology. Steepening of channel gradient resulted in groundwater resurfacing and low flow discharges that were 25% higher than in the previous reach (Minnow, 2007). The Hazeltine Creek

Canyon included numerous debris jams and a 1.2 m cascade (Minnow, 2007). In some locations cobble had aggraded over log debris, resulting in sections of hyporheic flow (Minnow, 2007) (Figure 4-4).

Figure 4-4: Aggraded cobble over large woody debris within Hazeltine Creek Canyon producing sections of hyporheic flow. Photo from Minnow (January 20, 2007)

4.4 Lower Hazeltine Creek

Lower Hazeltine Creek includes the channel downstream of the Hazeltine Creek Canyon to the outlet at Quesnel Lake. Channel sinuosity in this area was 1.2 as measured from 2009 aerial photographs. Time series analysis reveals a widening channel and floodplain in this section. A large pool below the canyon exit and in the upper reaches of this section evident in 1974, disappeared by

1996. In addition, delta growth was recognized between 1974 and 1996. This section is defined by three (3) distinct reaches.

The first reach of Lower Hazeltine Creek (HC-R7) extended 350 m from the mouth of the canyon to just below Horsefly-Likely FSR (Ditch Road). This riffle-pool reach displayed a moderate gradient (2.7%) and a bankfull width and depth of 5.3 m and 0.37 m, respectively. Channel substrate was cobble with some areas of aggraded small cobbles. Banks were considered stable (Minnow, 2007).

The second reach (HC-R8) extended 555 m downstream of R7, from downstream of Horsefly-Likely FSR (Ditch road) to the confluence of Hazeltine and Edney Creeks. Slope decreased in the second reach (0.8%) and substrate decreased in grain size from cobble to gravel. The banks became less stable, comprised of a higher proportion of fines in the banks and bankfull width and depth decreased to 5 m and 0.27 m, respectively (Minnow, 2007).

The third and final reach (HC-R9) included the channel from the confluence of Edney and Hazeltine Creeks to the outlet at Quesnel Lake. Due to beaver activity Edney Creek contributed flow to Hazeltine Creek via two channels. The reach gradient increased to 1.0%, demonstrating riffle-pool morphology with small cobble and gravel substrates. Banks were considered to be relatively stable. Bankfull width and depth increased to 11.3 m and 0.43 m, respectively (Minnow, 2007).

4.5 Edney Creek

Prior to the TSF dam failure, the confluence of Edney and Hazeltine Creeks was located 850 m upstream of the outlet to Quesnel Lake[3]. Channel sinuosity in this area was 1.1 as measured from 2009 aerial photographs. Edney Creek contributed approximately 60% of the flow in Lower Hazeltine Creek (Minnow, 2007). Historically, the Edney Creek watershed was impacted by extensive logging practices. In 1991, 54% of the watershed was forested, 45% harvested and 1% was lake (Triton Environmental Consultants Ltd., 1991)(Triton Environmental Consultants Ltd. , 1991). In some cases, timber from the riparian area was harvested and cutblocks extended to the creek edge (Pedersen, 1998). There was potential for high impact from livestock grazing (Nener and Wernick, 2000).

The Edney Creek channel was considered relatively stable, with increasing gradient in its lower reaches (Triton Environmental Consultants Ltd., 1991)(Triton Environmental Consultants Ltd. , 1991). According to Triton Environmental Consultants Ltd. (1991) the stream appeared to be incised into the Fraser Plateau in the lower reach. Edney Creek was ponded by beaver dams upstream of the confluence of the creeks (Minnow, 2007) (Figure 4-5).

[3] Measured as distance along channel.

Figure 4-5: Ponded area in lower reaches of Edney Creek upstream of confluence with Hazeltine Creek. Photo from Minnow (January 20, 2007)

Table 4-1: Summary of Hazeltine Creek physical habitat characteristics from Minnow (2007)

Feature		Measure	Hazeltine Creek Reach									
			HC-R1	HC-R2[ii]	HC-R3	HC-R4	HC-R5	HC-R6	HC-R7	HC-R8	HC-R9	Average[i]
Channel Hydrology	Reach Length	Length (m)	445	210	157	2,200	1,110	1,510	350	555	760	na
	Width	Wetted (m)	3.0	-	2.9	3.1	1.9	2.8	3.2	2.0	5.8	3.0
		Bankfull (m)	7.0	-	7.9	4.7	4.5	3.7	5.3	5	11.3	5.2
		Floodplain (m)	37	-	41	22	12	7.2	9.4	17	23	17
	Depth	Mean (cm)	10	-	12	5	7	8	6	13	14	8
		Bankfull (cm)	36	-	38	43	38	27	37	27	43	36
	Slope	Channel (%)	1.4	-	0.8	1.7	3.7	7.3	2.7	0.7	1.0	3.0
		Left Bank (◦)	64	-	65	77	67	90	83	70	63	73
		Right Bank (◦)	64	-	65	83	90	83	52	85	87	79
	General Morphology	% Pool	20	-	20	33	13	33	8	27	17	25
		% Riffle	18	-	10	37	60	67	57	27	10	41
		% Run	63	-	70	30	27		35	47	73	31
	Flow	Discharge (m^3/s)	0.0059	-	na	0.0079	0.0137	0.0173	0.0143	0.0254	0.0630	na

Table 4-1 (Cont'd: Summary of Hazeltine Creek physical habitat characteristics from Minnow (2007)

Feature		Measure	Hazeltine Creek Reach									
			HC-R1	HC-R2[ii]	HC-R3	HC-R4	HC-R5	HC-R6	HC-R7	HC-R8	HC-R9	Average[i]
Channel Bed & Bank Features	In-stream Substrate	% Bedrock	-	-	-	-	-	10	-	-	-	2
		% Boulder	-	-	-	-	3	20	10	-	-	5
		% Cobble	-	-	-	43	78	53	80	33	43	47
		% Gravel	60	-	40	47	11	13	10	53	33	31
		% Sand	40	-	60	8	8	3	-	13	17	11
		% Silt & Finer	-	-	-	2	-	-	-	-	7	1
	Left Bank Material	% Bedrock	-	-	-	-	-	37	-	-	-	8
		% Boulder	-	-	-	-	-	20	7	-	-	4
		% Cobble	-	-	-	3	3	3	40	2	-	4
		% Gravel	10	-	5	2	5	10	13	13	-	6
		% Sand	20	-	25	30	47	15	23	43	60	32
		% Silt & Finer	70	-	70	65	45	15	17	42	40	43
	Left Bank Condition	% Unstable	-	-	20	8	-	-	-	-	-	3
		% Moderate	40	-	20	35	50	5	20	23	15	26
		% Stable	60	-	60	57	50	95	80	77	52	64
	Right Bank Material	% Bedrock	-	-	-	-	-	2	-	-	-	0
		% Boulder	-	-	-	-	5	30	3	-	-	7
		% Cobble	-	-	-	5	18	25	60	7	5	13
		% Gravel	10	-	5	5	10	2	2	17	20	7
		% Sand	25	-	25	33	42	17	25	40	38	30
		% Silt & Finer	70	-	70	57	28	25	10	37	37	39

Table 4-1 (Cont'd: Summary of Hazeltine Creek physical habitat characteristics from Minnow (2007)

Feature		Measure	Hazeltine Creek Reach									
			HC-R1	HC-R2[ii]	HC-R3	HC-R4	HC-R5	HC-R6	HC-R7	HC-R8	HC-R9	Average[i]
Channel Bed & Bank Features (Cont'd)	Right Bank Condition	% Unstable	-	-	20	20	10	-	-	15	-	9
		% Moderate	35	-	20	47	57	33	10	45	30	39
		% Stable	65	-	60	33	33	67	90	40	70	49
	Root Density	% of Bank Depth	100	-	100	100	100	40	75	95	70	80
	Bank Surface Protection	% of Bank Depth	95	-	85	75	70	85	85	60	75	75
Riparian Features	Overhead Canopy	% Dense	30	-	40	30	8	10	28	60	10	22
		% Partially Open	35	-	20	27	47	23	20	20	18	27
		% Open	35	-	40	43	45	67	52	20	72	48
	Riparian Vegetation	Dominant Overstory (Type)	red cedar, fir, spruce	conifers	-	conifers (fir, spruce)	fir, spruce, red cedar	hemlock, red cedar, spruce	red cedar, spruce	conifers, cottonwood	red cedar	na
		Dominant Understory (Type)	alder, hardhack, dogwood	alder	alder, hardhack	alder, hardhack, forbs	alder, dogwood	hardhack, dogwood, alder	alder, dogwood	alder, hardhack	alder, willow	na

i Average value representing weitghted average of all reach values except R2, a ponded reach

ii Ponded conditions resulting from beaver activity meant not stream measurements were collected in this reach

5 POST- EVENT CHANNEL AND FLOODPLAIN GEOMORPHOLOGY

On August 4th 2014, the TSF dam failure produced a complex response downstream. The resulting event travelled 9.4 km down through Hazeltine Creek, displaying both characteristics of a debris flood and debris flow. The estimated outflow volume was 25 Mm^3 (Imperial Metals, 2014; Table 5-1).

Field evidence indicates the event occurred as a sequence of surges characterized initially by discharge with high sediment concentrations typical of debris flows, followed by a decrease in discharge with low sediment concentrations typical of debris floods. In this report, the term debris flow is used to describe the rapid to extremely rapid surges of fine grain tailings, large woody debris and native material that travelled down Hazeltine Creek Channel following the TSF dam failure.

Table 5-1: Volume estimation for TSF dam failure.

Volume Estimation	Total
Supernatant water (Mm^3)	10.6
Tailings solids (Mm^3)	7.3
Interstitial water (Mm^3)	6.5
Construction materials (Mm^3)	0.6
Total outflow volume (Mm^3)	25.0
Net volume of eroded material (Mm^3)	0.6 To 1.7
Total volume of the event (Mm^3)[3]	25.6 To 26.7

The post-event geomorphology of Hazeltine and Edney Creeks is dominated by erosion of the pre-event channel and floodplain by materials released from and mobilized by the TSF dam failure, and the deposition of tailings, embankment material, and eroded native material. Flow from the event eroded Hazeltine Creek along its entire length, resulting in a wider and deeper channel. Sediments on the channel bed, native soil and forest located in and around the former Hazeltine Creek channel were removed from the valley floor.

Across the post-event surface, there is evidence for at least three different mechanisms of disturbance:

- Erosion, identified when native material remains present at the surface, indicating that erosion was the last process in these locations;

- Erosion followed by deposition identified when deposited material is present at the surface and the native vegetation is removed, indicating that the native material was eroded and deposition was the last process occurring in these locations. It is possible that cycles of erosion and fill occurred during the event and that evidence is absent due to subsequent erosion; and,
- Deposition identified by deposited material at the surface over native vegetation, indicating that the area experienced little or no erosion and deposition was the last process occurring.

5.1 Area Affected by the TSF Dam Failure

The release of tailings and water from the TSF produced direct impacts on the Hazeltine Creek channel and floodplain. The terrestrial area (including wetlands) affected by the dam failure and subsequent debris flow covers approximately 237.5 ha (Figure 5-1).

Figure 5-1: Pre- (A) and post-event (B) view of Hazeltine Creek channel

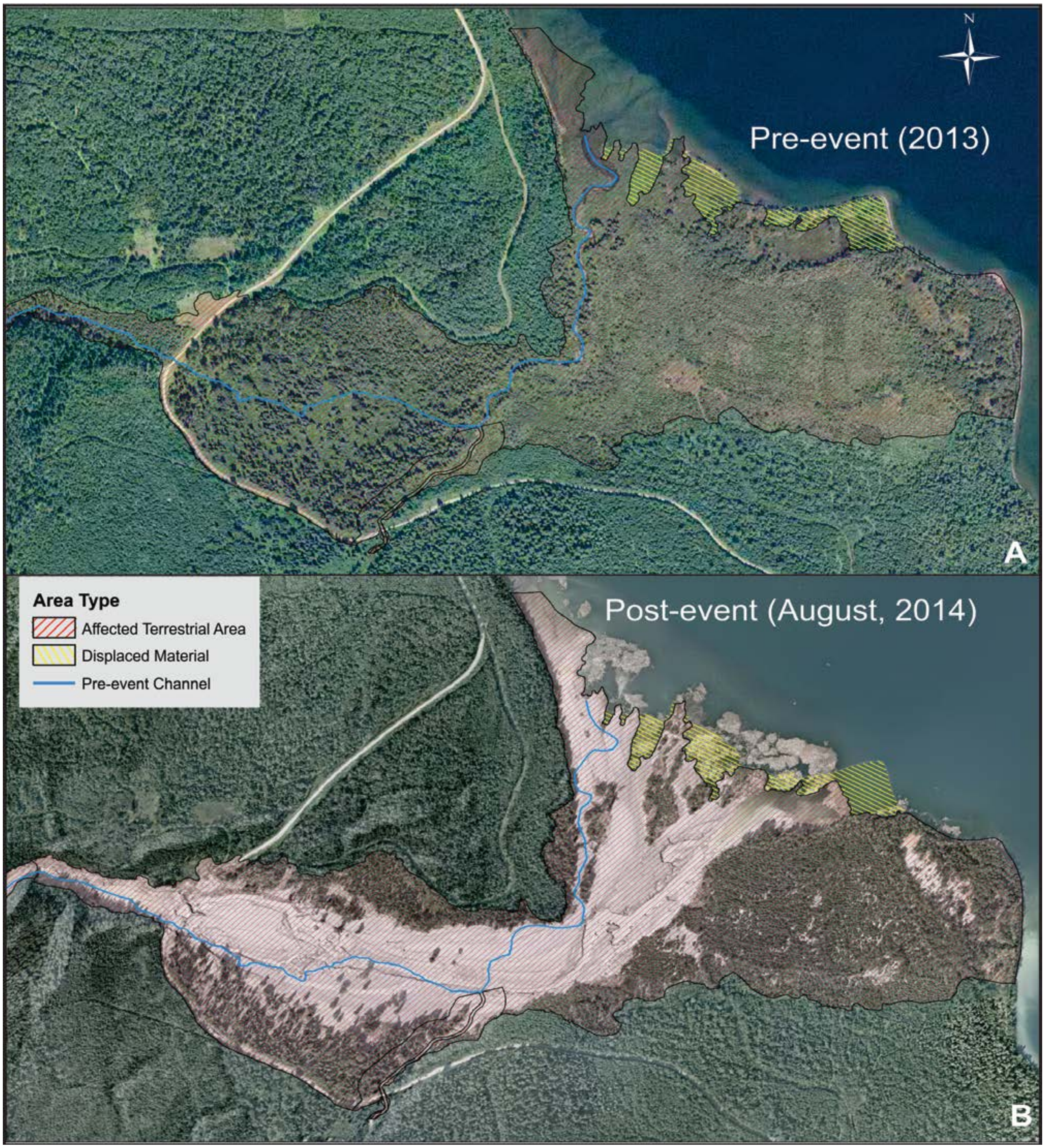

Figure 5-2: Pre- (A) and post-event (B) view of Hazeltine Creek delta

5.2 Key Geomorphic Results

As with the discussion of the pre-event channel and floodplain geomorphology, the five areas defined in the report introduction will be used for consistency in reporting. Key geomorphic characteristics from the analysis of the post-event channel and floodplain are presented in Table 5-2.

Table 5-2: Summary of post-event key geomorphic results

Geomorphic Indicator	Area					Total
	Plug	Upper Hazeltine Creek	Canyon Hazeltine Creek	Lower Hazeltine Creek	Edney Creek	
Terrestrial affected area (m^2)	171,800	1,352,900	47,400	780,000	22,600	2,374,700
Downstream length (m)[1]	485.1	6,166.2	1019.9	1321.1	176.5	8507.2
Mean width of terrestrial affected area (m)	354.2	135.3	30.9	248.1	41.3	-
Mean net erosion depth (m^2)[1]	-	2.7	2.9	2.1	-	-
Maximum erosion depth (m)[1,2]	-	10.3	7.18	10.25	-	-
Net volume of eroded material (Mm^3)	-	0.4 To 1.3	Less than 0.01	0.2 To 0.4	-	0.6 To 1.7
Total volume of deposited material (Mm^3)[3]	0.5 To 0.6	0.5 To 0.8	Less than 0.01	0.3 To 0.4	0 To 0.1	1.4 To 1.8
Channel bed slope %	-	1.8	6.1	1.6	1.5	-

Note: (1) average of cross-sectional mean values for maximum elevations; (2) absolute maximum erosion depth value within the area; (3) estimation within the terrestrial affected area. This value does not include the area that was displaced to Quesnel Lake in Lower Hazeltine Creek area.

Post-event Hazeltine Creek was divided into reaches as defined by Minnow Minnow Environmental Inc. (2007). However, the event altered the channel and floodplain morphology of the pre-event channel reaches and necessitated reaches HC-R4 and HC-R5 to be divided into homogeneous units. The resulting post-event reaches are HC-R4a and HC-R4b; HC-R5a and HC-R5b. In addition, two reaches (HC-R0a and HC-R0b) were added upstream of the uppermost reach (HC-R1), but below the Plug area. The post-event channel characteristics are presented in Table 5-3.

Table 5-3: Summary of post-event channel physical characteristics

	Feature	Measure	POST-EVENT HAZELTINE CREEK CHARACTERISTICS[1]													
			UHC								CHC	LHC			LEC	Average
			HC-R0b	HC-R1	HC-R2	HC-R3	HC-R4a	HC-R4b	HC-R5a	HC-R5b	HC-R6	HC-R7	HC-R8	HC-R9		
Channel Hydrology	Reach Length	Length (m)	2011	444	222	169	1247	1192	597	916	1153	297	620	513	497	760
	Area	(m^2)	16021	7521	3874	2638	18776	27104	13904	20672	11874	7106	9369	13327	6886	12236
	Width	Bankfull (m)	8.0	16.9	17.4	15.6	15.1	22.7	23.3	22.6	10.3	23.9	15.1	26.0	13.9	18.1
		Floodplain (m)	-	-	-	-	-	-	-	-	-	-	-	-	-	
		Mean (cm)	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Depth	Bankfull (cm)	0.18	0.18	0.18	0.21	0.20	0.26	0.22	0.32	0.28	0.20	0.31	0.28	0.31	0.24
	Slope	Channel (%)	0.95	0.73	0.45	1.1	1.76	2.15	2.4	2.86	6.12	3.34	1.18	0.92	1.51	1.96
		Left Bank (◦)	18.14	6.32	3.06	18.93	13.61	17.39	20.91	21.22	44.39	26.67	18.20	26.85	6.46	18.63
		Right Bank (◦)	14.23	7.01	8.67	11.59	14.37	17.97	33.87	26.33	39.88	27.23	25.47	34.26	14.75	21.20
	General Morphology	% Pool	-	10	20	35	50	15	40	35	-	30	20	30		
		% Riffle	-	10	15	25	20	20	20	15	-	10	15	10		
		% Run	100	80	65	40	30	65	40	50	-	60	65	70		
Channel Bed & Bank Features	Median Bed Material		Sand	Sand	Sand	Sand	Sand	Sand	Sand	Gravel	Bedrock	Sand	Sand	Gravel	Sand	
	Left Bank Material		Sandy Silt	Silty Sand	Silty Sand	Silty Sand	Silty Sand	Sand	Gravelly Sand	Gravelly Sand	Bedrock	Silt, clay, sand	Silt, clay, sand	Silty Sand	Silty Sand	
	Left Bank Condition	Bank Erosion Hazard	High	High	High	High	High	High	High	Very Low	Very Low	High	High	High	Moderate	
	Right Bank Material		Sandy Silt	Silty Sand	Sand	Silty Sand	Silt, Clay, Sand	Silty Sand	Sand	Silt, Gravel, Sand.	Bedrock	Silt, Clay, Sand	Silt, Clay, Sand	Silty Sand	Silty Sand	
	Right Bank Condition	Bank Erosion Hazard	High	High	High	High	High	High	High	Very Low	Very Low	High	High	High	High	
	Root Density	% of Bank Depth	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Bank Surface Protection	% of Bank Depth	0	0	0	0	0	0	0	0	0	0	0	0	0	

1. HC-R0a not included as it is not within the pre-event channel area.

The long profile of the post-event channel thalweg displays several high slope knickpoints followed by low slope zones (Figure 5-3). Most of the knickpoints are located in the Upper Hazeltine Creek section within reaches HC-R4b and HC-R5. The slope of the post-event thalweg is relatively stable until the first large knickpoint located in reach HC-R4. Slope increases in the Hazeltine Creek Canyon section. Slope then decreases in Lower Hazeltine Creek toward Quesnel Lake.

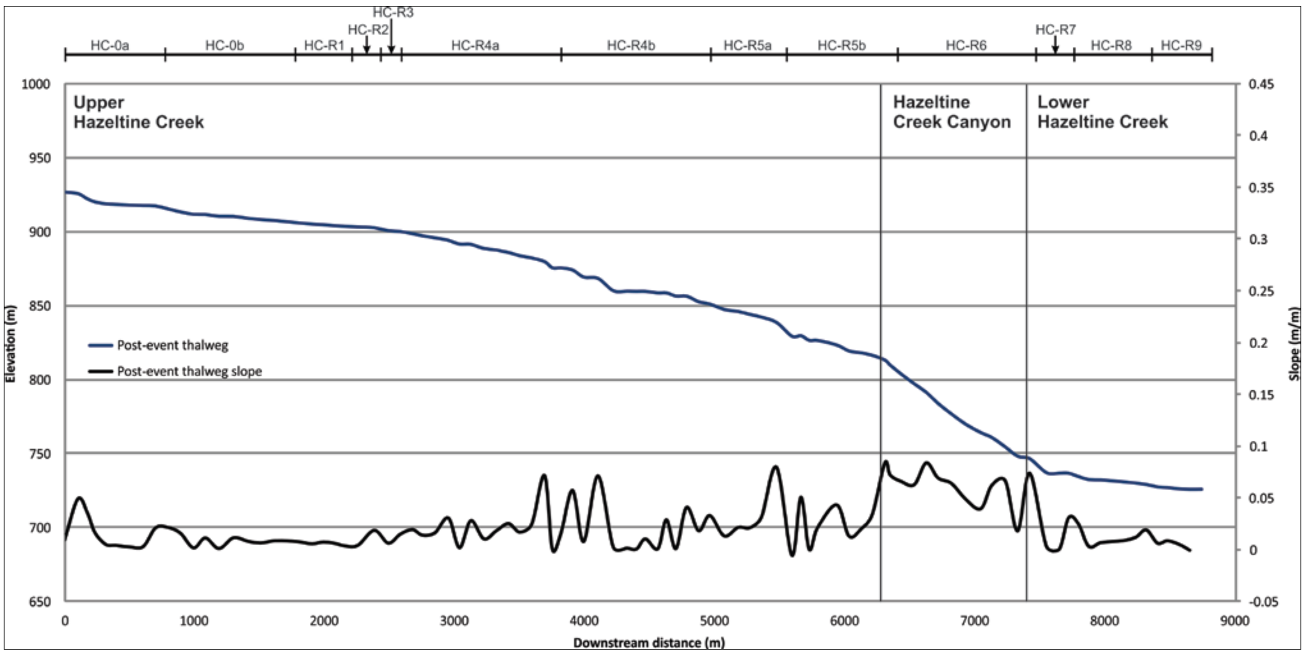

Figure 5-3: Downstream long profile of the post-event thalweg elevation and the thalweg slope

Surficial geology of the study area predominantly reflects glacial processes of the Fraser Glaciation in the Late Wisconsin period (Bichler and Bobrowsky, 2003). Native deposits identified in the field consist of thick blankets of till (~ 42%), glaciofluvial and fluvial sediments on terraces and floodplains (~ 39%), glaciolacustrine and lacustrine material on steep slopes (~ 4.2%) and exposed bedrock (2.8%). Other materials (anthropogenic and colluvial) comprise ~ 12% of the mapped area. Native deposits correlate with the stratigraphic sequence described by Clague *et al.* (1990) and Bichler and Bobrowsky (2003). These materials are covered or mixed with veneers and blankets of tailings.

A summary of tailings deposits and native materials identified in the study area are described in Table 5-4 and Appendix E.

Table 5-4: Summary of typical tailings deposits and native material encountered in the area

Surficial Material	Areas	Surface Expression	Symbol	Description
Tailings	PP, UHC, CHC, LHC, LEC	Thin veneer (x) and veneer(v)	sTb, sTv, sTx	Fine-grained, well sorted and stratified red layer of sandy tailings. Soil particle sizes vary from sand to sandy –loam. These deposits typically occur at the edge of the post-event channel and on top of channel bars. Sediments deposited within the channel are being mobilized by Hazeltine Creek.
	PP, UHC, CHC, LHC,	Thin veneer (x), veneer(v) and blanket (b)	zcTv	Stratified gray layer of highly saturated silty-clay and silt-loam tailings.
Anthropogenic	UHC	Blanket(b)	A	Rock fill and fill from displaced embankment material.
Undifferentiated (U)	PP, UHC, LHC	Blanket(b)	U	LWD deposits mixed with tailings and native soil. Typically occurs at wide overbank areas. Percentage of tailings and native material is varied and difficult to determine.
Organic	PP	Plain(p)	O	Soft, saturated organics overlying lacustrine deposits of fine-grained sand, silt and clays. Located at outlet of Polley Lake.
Till	PP, UHC, CHC, LHC	Blanket(b)	Mb	Massive, matrix supported and poorly sorted deposit composed of various lithology clasts. Clasts are rounded to sub-angular in a very stiff to hard sandy silt matrix. Independent Expert Engineering Investigation and Review Panel (2015) interpreted this as possible ablation till. Till is the dominant native material in the study area.

Table 5-4 (Cont'd): Summary of typical tailings deposits and native material encountered in the area

Surficial Material	Areas	Surface Expression	Symbol	Description
Bedrock	UHC, CHC	Hummocky (h)	R	Exposed bedrock was visible along the channel bed and valley walls during the field investigation. Bedrock type was not identified.
Fluvial	UHC, LEC, LHC	Plain(p), terrace (t)	Fp, Ft	Remnants of recent fluvial material transported by Hazeltine Creek located on pre-event floodplain. Deposits are moderately sorted, sandy to pebbly, sub-rounded to rounded clasts.
Glaciofluvial	UHC, LEC, LHC	Terrace (t), fan(f)	F^G	Glaciofluvial sediments on fan and wide terraces composed of gravely to cobbly material with a sand matrix. Deposits are clast supported, rounded to sub-angular and mixed lithology.
Colluvial	UHC, LEC, LHC	Blankets(b) and veneers(v)	C	Colluvial materials identified in the field are from four different sources: 1) Products of bank failures on till and glaciolacustrine steep slopes. These deposits typically occur at the bottom of banks and within channel; 2) Matrix supported and poorly sorted, debris flow deposit composed of a mix of tailings and native materials; 3) Poorly sorted, clast supported, rounded to sub-angular hyperconcentrated flow deposit composed of a mix of tailings and native material; and, 4) Blocks of rounded massive till transported by the flow. Blocks vary in size (diameter greater than 90 cm were measured in the field).
Glaciolacustrine	UHC, LEC, LHC	Blanket(b), Steep slopes (s)	L^G	Two types of glaciolacustrine materials were encountered in the area: 1) Grey, firm, thinly laminated clay and silty-clay deposits located at the distal zone of Hazeltine Creek. 2) Grey-brown, massive, very stiff (inferred) and no evident structure.

Slope failures occurred at different locations along the debris flow path. Highly unstable and unstable areas (defined in Table 5-5) are located in the Upper and Lower Hazeltine Creek section. At Upper Hazeltine Creek, slope failures occurred at steep sections (greater than 20°). Slopes remain unstable after the event, displaying long and deep (>50 cm) tension cracks and multiple tilting blocks. These features indicate that further slope failures are likely in the near future. The unstable area identified at reaches HC-R1 and HC-R2 in Upper Hazeltine Creek corresponds to fluvial materials affected by gully and rill erosion.

At Lower Hazeltine, unstable and highly unstable areas are related to bank failures occurring on glaciolacustrine steep banks. A summary of slope stability classes is presented in Table 5-5. A color coded map indicating slope stability classes is shown in Appendix G.

Table 5-5: Slope stability of valley walls

Terrain Stability Class	Stability Score	Description	Plug (%)	Upper Hazeltine Creek (%)	Canyon Hazeltine Creek (%)	Lower Hazeltine Creek (%)	Edney Creek (%)	Total Terrestrial Affected Area
I (Stable)	0 - 4	No significant slope failures or erosion problems exist or are expected following the 2014 event.	6.9	80.3	1.7	10.4	0.7	34
II (Slightly unstable)	5	There is a low spatial likelihood (less than 30%) of slope failures or erosion following the 2014 event.	9.5	38.9	0.7	49.6	1.3	50
III (Moderately unstable)	6	Erosion problems along gullies and rills can develop after the 2014 event. There is a moderate spatial likelihood (30% - 50%) of slope failures or erosion following the event.	1.7	63.2	11.2	23.8	0.1	10

Terrain Stability Class	Stability Score	Description	Plug (%)	Upper Hazeltine Creek (%)	Canyon Hazeltine Creek (%)	Lower Hazeltine Creek (%)	Edney Creek (%)	Total Terrestrial Affected Area
IV (Unstable)	7 - 8	Expected to contain areas with a high spatial likelihood (50% to 75%) of developing slope failures or erosion problems following the 2014 event.	-	83.6	1.3	15.1	-	4
V (Highly unstable)	9 -11	Terrain is currently unstable and is expected to contain areas with a very high spatial likelihood (> 75%) of slope failure initiation (or reactivation) and erosion problems following the 2014 event. Slope failure indicators in this class include: active landslides (initiations zones), gully erosion and rills, tension cracks.	-	76.4	-	23.6	-	2

5.3 Plug Area

5.3.1 Key Features

- Removal of floodplain vegetation; and,
- Thick deposits of tailings blocking the outlet of Polley Lake.

5.3.2 Geomorphology

The Plug area is defined by the deposition of material near the Polley Lake outlet. The affected area is approximately 171, 800 m^2.

The debris flow travelled from the TSF downhill towards Hazeltine Creek and Polley Lake, covering a swath approximately 350 m wide and filling a portion of the south end of Polley Lake and upper portion of the Hazeltine Creek channel and floodplain with mixtures of tailings, embankment material, and eroded native material. This material plugged the outlet of Polley Lake (the plug) (Figure 5-4).

The former Hazeltine Creek channel is no longer evident. The upstream end of the decommissioned diversion ditch, dug in the late 1890's (Mulvihill et al., 2005), that diverted water from Polley Lake to the Bullion Pit for hydraulic mining is located within the Plug area. Water from Polley Lake filled the upstream end of the diversion ditch (Figure 5-5).

Evidence of erosion within the Plug area includes the absence of trees and wetland vegetation seen in the pre-event aerial photographs. Scour was limited in several areas within the Plug including where trees remain in situ, one "tree-island" located at Polley Lake (Figure 5-4) and toppled in situ trees located on the western shore of Polley Lake, between the "tree-island", remaining vegetation and in situ organic layers (Figure 5-6).

Typical pre-existing materials encountered in this area consisted of soft, saturated organics overlying lacustrine deposits of fine-grained sand, silt and clays (Polley Lake shore) (KP, 1995) and hard, low permeability silty, clayey glacial till. Deposited tailings included both, gray silty-clay tailings and red sandy tailings. Tailing layers were completely saturated during field investigations. At some soil pit locations the gray and red tailings layer were clearly differentiated.

Some of the greatest volumes of deposition occurred in the Plug area due to proximity to the TSF dam and the relatively low slope of the Plug area. In the field, safe access to the Plug area was limited by the high water content within deposited materials. The volume of deposition is estimated to be within 0.5 Mm^3 and 0.6 Mm^3.

There are no unstable slopes within the plug area. Hydraulic modeling was not conducted in the Plug area because no post-event channel exists there.

Figure 5-4: Deposition within the Plug area looking East across the Polley lake post-event shoreline (September 22, 2014)

Figure 5-5: Nineteenth century diversion ditch containing water from Polley Lake within the Plug area looking down valley at the post-event shoreline (September 22, 2014)

Figure 5-6: Photograph showing in situ toppled trees near Polley Lake in the Plug area

5.4 Upper Hazeltine Creek

5.4.1 Key features

- Removal of floodplain vegetation;
- Zones of deep channel bed erosion;
- Knickpoints within the channel bed;
- Thin spatially heterogeneous deposits; and,
- Unstable slopes adjacent to the channel.

5.4.2 Geomorphology

Upper Hazeltine Creek represents the area from the TSF dam downstream to the beginning of the Hazeltine Creek Canyon. The total affected area is approximately 1,352,900 m^2. Upper Hazeltine Creek is the longest and most complex section of the debris flow, containing a newly formed channel originating at the TSF dam failure site and continuing through the Hazeltine Creek floodplain, knickpoints, flow bifurcation and bank failures.

The mean thalweg slope for the Upper Hazeltine Creek channel is 1.8 %; however, the slope ranges from near vertical to flat. Evidence of erosion within Upper Hazeltine Creek includes the absence of trees and wetland vegetation seen in the pre-event aerial photographs. Five tree islands are located in the first ~ 1,400 m downstream of the TSF dam failure site.

Upper Hazeltine Creek is divided into reaches modified from those defined by Minnow (2007) (see Appendix HIA-A002 and HIA-A003). One reach with two sub-reaches (HC-R0a and HC-R0b) was added to those defined by Minnow:

1) HC-R0a – the section between the TSF dam failure site and the former Hazeltine Creek floodplain (approximately the limit of the Plug); and,

2) HC-R0b - the section between the plug and the upstream limit of HC-R1.

The longest reach defined by Minnow (HC-R4) was divided into two sub-reaches (HC-R4a and HC-R4b).

1) HC-R4a is located between the Gavin Lake road bridge and the upstream most large knickpoint in HC-R4; and,

2) HC-R4b is located between the upstream largest knickpoint in HC-R4 and HC-R5a.

The reach downstream of HC-R4 defined by Minnow (HC-R5) was divided into two sub-reaches (HC-R5a and HC-R5b).

1) HC-R5a is located between the downstream end of HC-R4b and the entrance to a wide and laterally unstable section of valley; and,

2) HC-R5b is located between HC-R5a and HC-R6.

Reaches HC-R1 to HC-R3 are described together due to their similarities in morphology as are reaches HC-R4b and HC-R5a.

5.4.2.1 HC-R0a

The debris flow eroded a swath ~ 350 m wide through this reach through the formerly forested wetland area downslope of the TSF dam. Two (2) new channels were cut into native material. The channels merge near the location of the pre-event Hazeltine Creek channel. The larger 42 m wide channel curves to follow the pre-event channel location. The slope of the thalweg decreased downstream of the TSF dam failure site. The slope of channel ~ 320 m nearest the breach was 0.028 m/m. The slope decreased to 0.0036 m/m for the following 400 m downstream.

One (1) remnant tree island remains ~ 325 m downslope of the dam failure site and two (2) individual in situ trees stand further downslope. Deposition occurred on the edge of the flow, within the area that remains forested and between the forested area and the larger channel on the inside of the channel curve.

Nearer to the TSF and west of Hazeltine Creek, the terrain is slightly eroded compared to pre-existing ground, or slightly above original ground elevation due to deposition. Typical surficial materials encountered in this area consist of anthropogenic material (material displaced from the dam consisting of rock and till fill), native till, large woody debris, tailings and a mix of tailings and anthropogenic material (Figure 5-7).

Hydraulic modelling was not conducted in this section because it is not part of the pre-existing Hazeltine Creek channel.

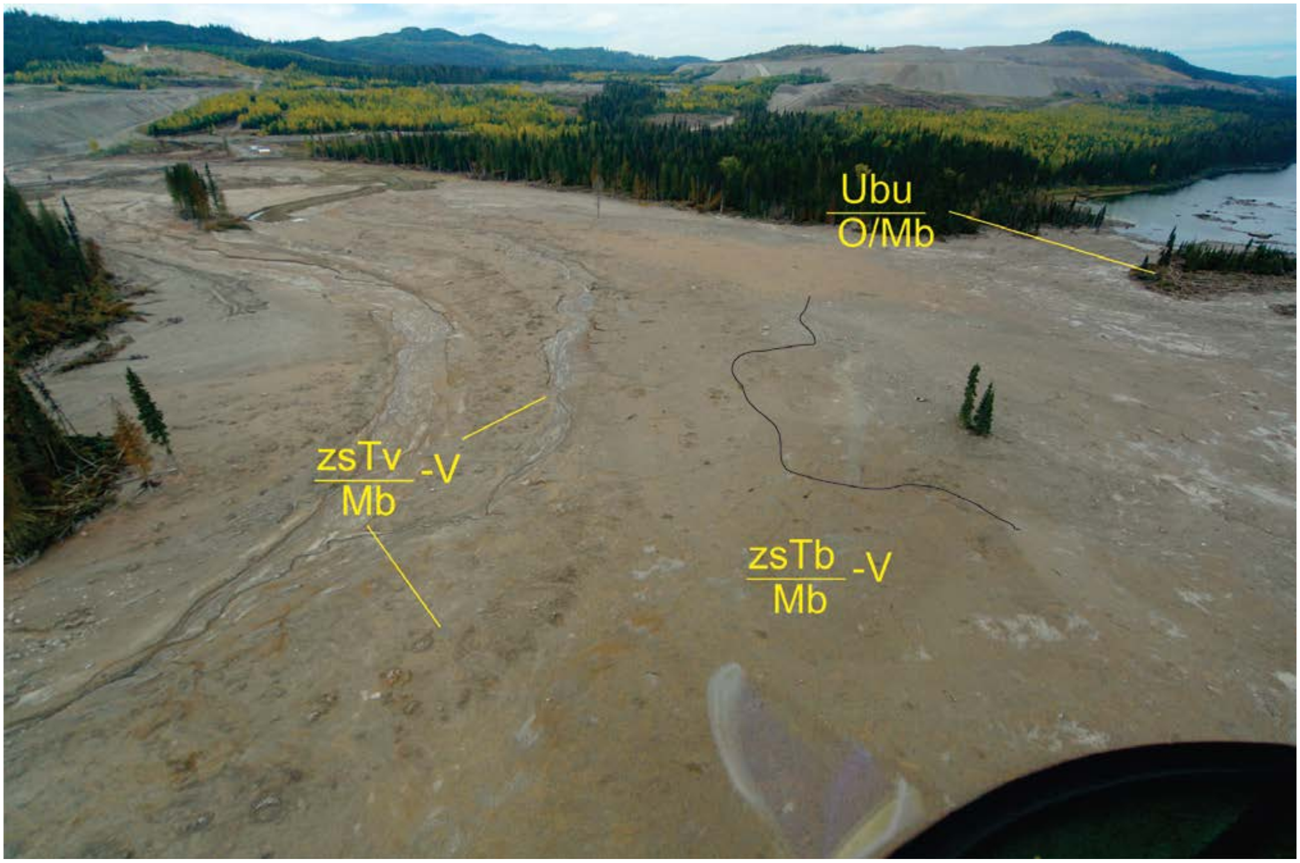

Figure 5-7: Deposition and surficial material at reach HC-R0a (September 22, 2014)

5.4.2.2 HC-R0b

After joining the pre-event Hazeltine Creek floodplain, the debris flow continued downstream of the Plug within the Hazeltine Creek floodplain. The average slope of this section is 0.95%. Water from Polley Lake has been pumped from Polley Lake into Hazeltine Creek at a location approximately 1,300 m upstream of the Gavin Lake Road crossing.

The post-event channel largely follows a similar path to the pre-event channel in this section (Figure 5-8). The post-event channel curves before and after it flows between two small tree islands similar to the pre-event channel geometry. Four (4) remnant tree islands are located between the downstream end of the Plug and the next ~ 800 m. These tree islands created bifurcations within the debris flow. The largest of these is ~ 370 m long and 170 m wide, with LWD accumulated at the upstream end of the tree island. Material was deposited around the trees in these areas.

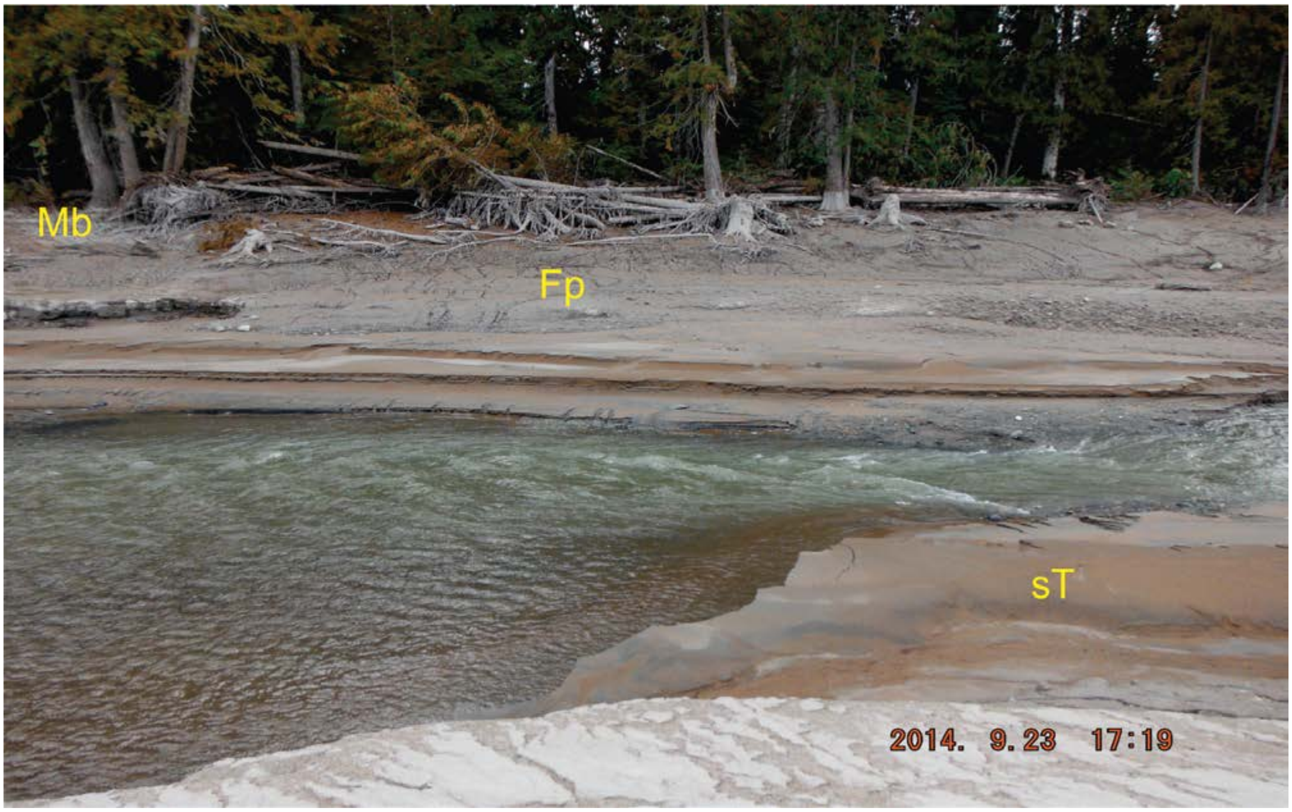

Figure 5-8: Surficial material at HC-R0-b (September 23, 2014)

Beside the largest tree island, the post-event main-channel is located in the right channel of the debris flow near the original channel location. Within this section, a 1.0 m tall knickpoint occurs on the bed of Hazeltine Creek located ~ 1200 m downstream of the TSF dam failure site. The channel abruptly curves (~ 90°) 80 m downstream of the knickpoint. For ~ 250 m, the knickpoint vertically eroded into native material through headcut migration creating a deeper channel downstream of the knickpoint compared to upstream of the knickpoint. Upstream migration of the knickpoint and lateral erosion at the outside of the bend formed ~ 6 m tall near vertical bank. This is an area of continued instability within the bed and bank.

Between the downstream end of the largest tree island and HC-R01, the channel is ~ 100 m wide, shallow and relatively flat. The channel is defined by a lack of trees and limited thickness of deposits. Vertical erosion by the debris flow was limited in this area and no knickpoints occur.

The post-event bankfull channel is 8 m wide and 18 cm deep (Table 5-3), as estimated by the two-dimensional hydraulic modelling results of the MAF discharge. Detailed geomorphological data for HC-R0b is unavailable prior to the event. The deepest pool in the post-event reach occurs immediately downstream of the knickpoint. Smaller pools occur downstream of the large pool. The highest velocity and shear stress values occur at the knickpoint and the section immediately downstream of the large pool. Bed degradation is expected to continue at the knickpoint while the rest of the reach is more stable. Pool depth increases with discharge from the MAF to the 100-year flow.

Slopes are stable except for a steep eroding bank located outside of a meander bend 80 m downstream of the knickpoint (Figure 5-9).

Figure 5-9: Photo shows slope failures at reach HC-R0b and red tailings deposited within the Hazeltine Creek channel (September 23, 2014).

5.4.2.3 HC-R1 to HC-R3

The main debris flow channel is ~ 100 m wide, shallow and has a relatively flat slope in the section (HC-R1 to HC-R3) between the downstream end of HC-0b and the Gavin Lake road bridge (Figure 5-10). The channel is defined by a lack of trees and limited thickness of deposits. Vertical erosion by the debris flow was limited in this area and no knickpoints occur.

Figure 5-10: Hazeltine creek channel in reaches HC-R1 to HC-R3 (September 22, 2014)

Hydraulic modelling of the MAF show the channel to be 15.6 m to 17.4 m wide and 18 - 21 cm deep wider and shallower than the pre-event channel that was 7 m to 7.9 m wide and 36 cm to - 38 cm deep (Table 4-1). The beaver dam and pond present in pre-event HC-R2 is absent from the reach. Generally, the reach displays a homogenous pattern of depth, velocity and shear stress with the exception of high velocities and shear stresses seen immediately upstream of the Gavin Lake Road bridge abutments. Generally, depth, velocity and shear stress values increase as discharge increases from the MAF to the 10-year and 100-year flow. Channel width remains stable as discharge increases resulting from the shape of the debris flow channel it flows within.

5.4.2.4 HC-R4a

The debris flow channel width varies from 15 to 35 m. This section is defined by vertical and lateral instabilities. The post-event channel reach HC-R4a is 1,247 m long and located immediately downstream of Gavin Lake Road. Channel slope is 1.76%. The active wetted channel width during the field investigation varied between 1.5 to 10 m along the reach. Within this section, the debris flow travelled rapidly eroding several meters into native material (Figure 5-11). As a result, the post-event channel displays different morphologies controlled mainly by changes in bed slope and channel bed substrate.

At wide sections, the channel displays braided riffle-pool morphology with extensive, mid-channel bars. Bars are composed of gravel (native material) with a veneer of tailings on top. In narrower sections, channel morphology is characterized by steep, entrenched step-pools. The channel bed is unstable and presently incising. Substrate channel material is mainly gravel, sandy tailings (braided riffle-pool) and eroded till (entrenched step-pool).

Figure 5-11: Eroded till zones within reach HC-R4a. Figure shows depth of scour and unstable slopes following the debris flow (September 24, 2014)

Banks are nearly vertical and unstable at several locations. Debris falls and topplings are the most common slope failures found in the reach caused by the destabilization of the slope that resulted from the debris flow (Figure 5-12). Soil topples are composed of clayey till that disintegrate as they enter into the channel contributing volumes of fine, suspended sediments to Hazeltine Creek flows. Banks were actively failing at the time of site investigation. Slope changes were evident within several hours during field inspections. Ongoing undercutting at incised sections of the channel is the main cause of ongoing slope failure. This condition will persist until the bank reaches a stable slope angle. High flow events have the potential to increase the rate of retrogression of these vertical banks (Figure 5-12). Deep and long tension cracks are evident on both left and right banks (Figure 5-12), indicating future retrogression.

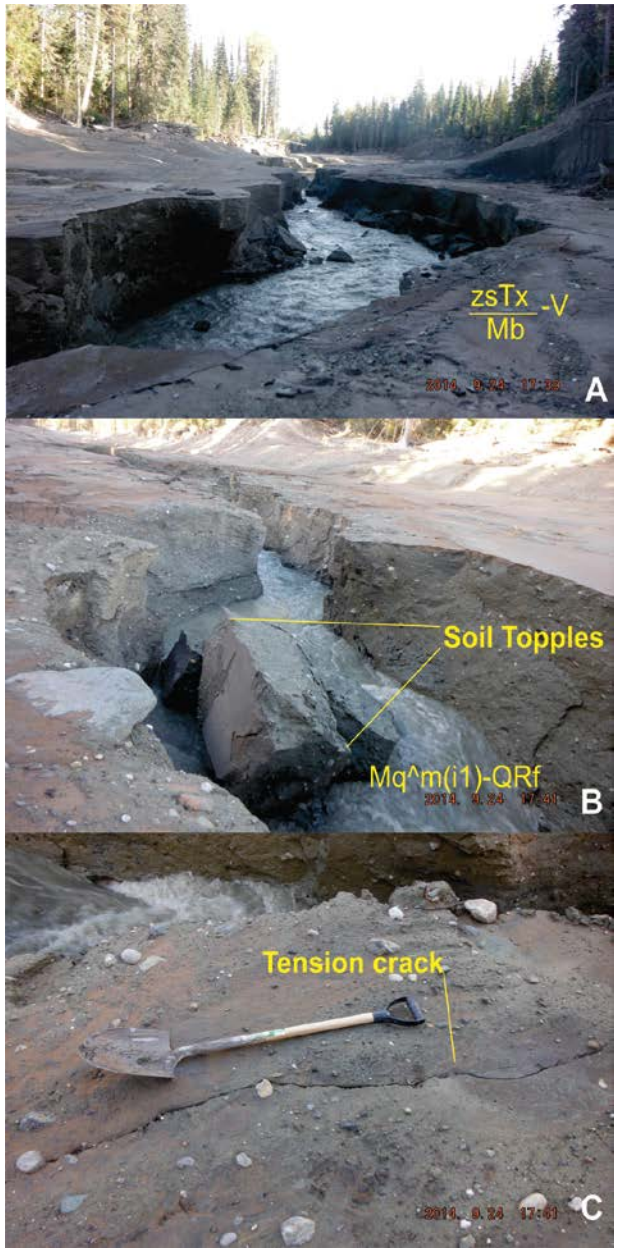

Figure 5-12: Slope failures at HC-R4a. A - shows the extension of slope failures on both banks. (Symbol is a silty-sandy thin veneer of tailings overlying a morainal blanket modified by overland erosion (-V)). B- Topples entering into the channel. Channel bed is composed of till (M). C- Long tension crack on right bank.

Hydraulic modelling of the MAF predicts the post-event channel in HC-R4a to be 15.1 m wide and 20 cm deep, wider and shallower than the pre-event channel that was 4.7 m wide and 43 cm deep (Table 4-1). The reach displays a pattern of lower depth, higher velocity and higher shear stress zones alternating with higher depth, lower velocity and lower shear stress zones likely related to the development of riffles and pools within the channel. Higher velocities meander from side to side in the channel in the lower end of the reach, indicating incipient meandering similar to the process described by Lewin (1978). The highest velocities within the reach occur where the channel narrows. These areas will likely widen due to the higher shear stresses resulting from the high velocities. Generally, depth, velocity and shear stress values increase as discharge increases from the MAF to the 10-year and 100-year flow. Generally, channel width remains stable as discharge increases resulting from the shape of the debris flow channel it flows within.

5.4.2.5 HC-R4b and 5a

The post-event reaches R4b and R5a are 1191.6 m and 596.6 m long, respectively. They are similar and are reported on together. These reaches are defined by two major knickpoints located ~ 2.5 and 2.0 km upstream of the Hazeltine Creek Canyon. The knickpoints are 6 m and 10 m in height, respectively (Figure 5-13). The channel narrows and steepens in this section, and displays a braided, riffle-pool morphology along most of its length. Bed material is mainly composed of sandy tailings. Banks are composed of sandy-pebbly fluvial, sandy-cobbly glaciofluvial, clayey till and glaciolacustrine material. A thin veneer of sandy tailings (less than 10 cm) covers the top of both banks.

Slope failures are extensive and are located at till and glaciolacustrine banks with slopes greater than 15°. Soil and debris falls are the most common mechanism of failure. Indicators of active slope failures include fallen and tilted soil blocks, fallen trees, overhanging root mats and tension cracks. High discharge undercutting at the base of these steep banks may increase the current failure rate. Steep glaciolacustrine slopes and walls at major knickpoint features are the best examples of these unstable areas (Appendix HIA-H-006 and Figure 5-14).

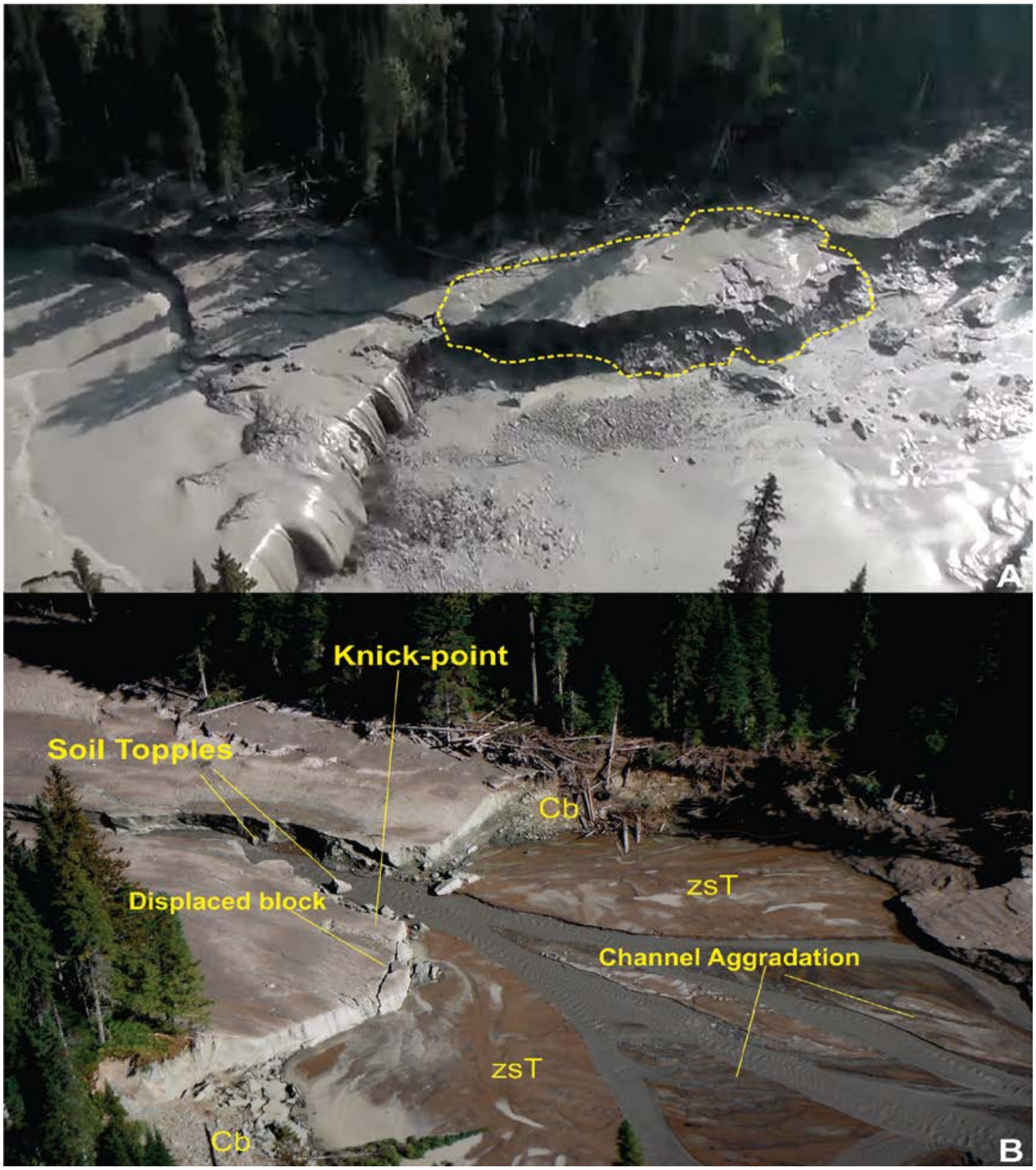

Figure 5-13: Knickpoint located 2.5 km upstream of Hazeltine Creek Canyon (HC-5a). A - Screen-shot taken from the Cariboo video. The yellow dashed line indicates material that was mobilized at a later stage of the event. B- Figure shows slope failures on both banks. Deposits of tailings (zsT) are estimated to be deeper than 1 m on both edges of the active channel.

Figure 5-14: Slope failures at reach HC-R4a and HC-R4b. A- Figure shows extension of bank failures on right bank and location of sandy tailings. B – Figure shows extension of bank failures on left bank.

Hydraulic modelling of the MAF predicts the post-event channel in HC-R4b and HC-R5a to be 22.7 to 23.3 m wide and between 22 and 26 cm deep, wider and shallower than the pre-event channel that was 4.5 to 4.7 m wide and 38 to 43 cm deep (Table 4-1). A deep (~ 80 cm) and long (~ 100 m) pool occurs between the large knickpoints. A wide and shallow pool created by the upstream migration of the knickpoint occurs downstream of the second knickpoint. An additional smaller knickpoint, and associated downstream pool, occurs downstream of the second large knickpoint. Velocity and shear stress values are highest at knickpoints and high slope sections. These sections have experienced down-cutting following the event and erosion is predicted to continue. The area of channel exposed to erosive shear stresses and velocities increases with higher discharge. The channel width generally remains stable as discharge increases due to the steep side slopes and channel banks.

5.4.2.6 HC-R5b

Reach HC-R5b in Upper Hazeltine Creek is characterized by a 900 m long and 100 m wide debris flow channel that narrows for approximately 30 m (bedrock canyon) and then widens downstream until it reaches the canyon section. The channel displays both step-pool and riffle-pool morphologies. From the short bedrock canyon downstream to Hazeltine Creek Canyon the debris flow eroded and scoured extensive wide sections. The floodplain and glaciofluvial terraces were eroded by the debris flow. Bedrock is exposed at some locations (Appendix HIA-H-007). Channel morphology is mainly controlled by changes in bed slope and/or changes in substrate material. Channel bed material is varied composed primarily of bedrock, till and a thin layer of tailings.

Post-event banks are composed of different materials, including sandy fluvial, sandy-cobbly glaciofluvial and bedrock. Thin veneers and veneers of sandy tailings cover the top of the channel banks. At wide sections within this reach, the channel includes extensive bar deposits consisting primarily of gravel and sandy tailings. At narrow sections, the channel is entrenched and currently incising into native material. Extensively scoured zones, slope failures and eroding banks are the typical field indicators of channel disturbance identified in the area.

Slopes within this reach show clear signs of active slope failures. At ~ 590 m upstream of Hazeltine Creek Canyon there is a wide section, immediately downstream of the short bedrock canyon that experienced focused scour and erosion. The section extends for about 250 m with very steep slopes (40°) on the left bank and moderately steep slopes on the right bank (15°). The left bank is composed of glaciolacustrine material and shows indicators of active slope failures (i.e., wide and deep tension cracks, tilted and toppling blocks, overhanging root mats) (Figure 5-15). A blanket of colluvial material was observed covering ~1742 m^2 of the toe of this steep section.

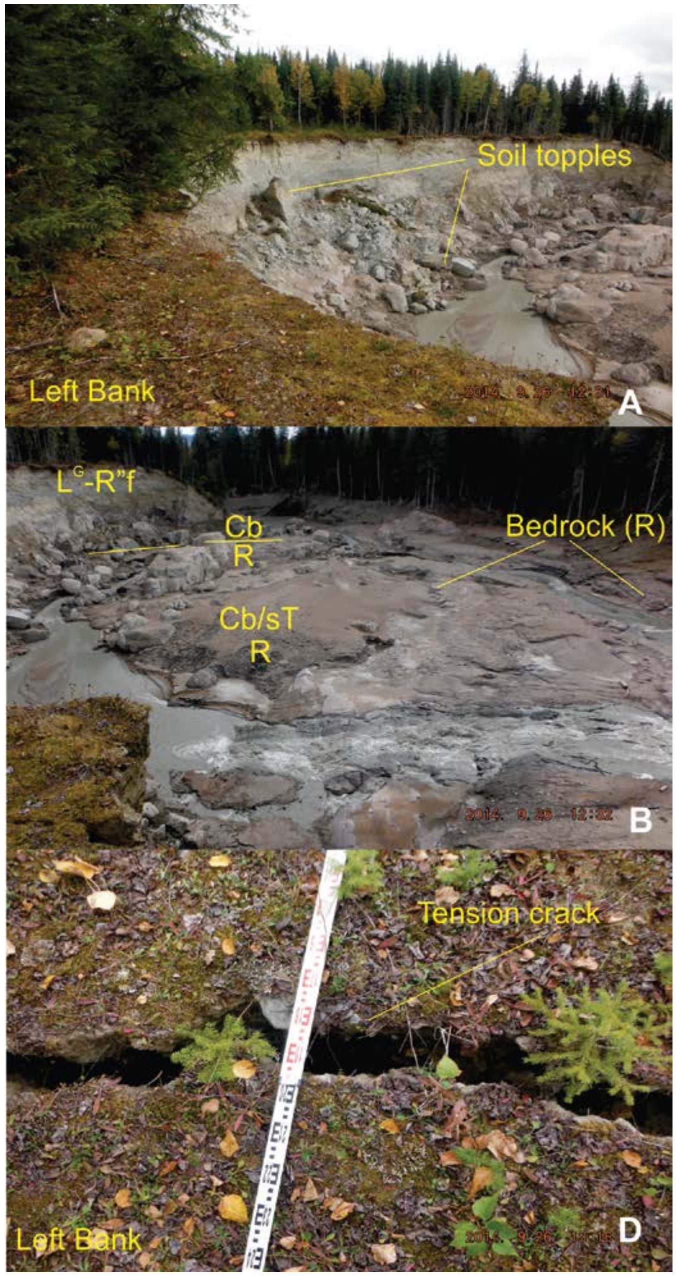

Figure 5-15: Wide scoured and eroded section downstream of short length bedrock canyon in HC-RC5b. A- Figure shows a vertical glaciolacustrine banks with fallen blocks and topples. B- Location of exposed bedrock and identified surface material. C-Shows 10 cm wide tension crack on left bank.

Hydraulic modelling of the MAF predicts the post-event channel in HC-R5b to be 22.6 m wide and 32 cm deep, wider and shallower than the pre-event channel that was 4.5 m wide and 38 cm deep (Table 4-1). A deep pool is located beside the unstable right bank of the creek and deeper sections also occur where the channel narrows. High shear stress and velocity values are concentrated locally at a knickpoint. Shear stress and velocity increase between the MAF and 10-year flow but decrease due to back flooding at the 100-year flow. As with the other sections, the channel width is generally stable.

5.5 Hazeltine Creek Canyon

5.5.1 Key features

- Removal of vegetation;
- Channel bed erosion; and,
- Thin tailings deposits.

5.5.2 Geomorphology

The Hazeltine Creek Canyon (HC-R6) is the steepest section of the channel. The affected area is approximately 47,400 m^2 (Figure 5-16). Geomorphologic impacts from the debris flow are related to removal of vegetation and erosion of the channel bed (Figure 5-17).

Hazeltine Creek Canyon was a ~ 1020 m long pre-existing steep and narrow gorge cut into surrounding bedrock. The canyon is not straight but instead meanders with a sinuosity of 1.18. The post-event canyon descends ~ 27 m (from 16 - 49 m) into the Fraser Plateau. Within the canyon the total area affected by the debris flow is ~ 47,400 m^2 and the mean width of the area affected is ~ 31 m, representing the narrowest section of the debris flow path. The post-event Hazeltine Creek Canyon also displays the steepest slope 6.1 %.

The debris flow removed the pre-event Hazeltine Creek channel, vegetation at the base of the canyon and eroded virtually all native material from the canyon (Figure 5-17). The post-event canyon bed and banks are composed of exposed bedrock which controls the morphology of the channel and canyon walls (Figure 5-18).

Reconstruction of the pre-event floodplain elevations within the Hazeltine Creek Canyon was difficult as high shear stresses and erosion removed the pre-event floodplain levels.

Post-event, thin veneers of tailings sand and gravel cover the bottom of the Hazeltine Creek Canyon (Figure 5-19). This is the area with the least deposition. Volumes of deposition are estimated to be less than 0.1 M m^3.

Figure 5-16: Overview of the Hazeltine Creek Canyon (HC-R6)

Figure 5-17: Upstream entrance to the Hazeltine Creek Canyon (HC-R6) (September 26, 2014)

Figure 5-18: Photographs within the Hazeltine Creek Canyon showing exposed bedrock at a narrow section (HC-R6) looking upstream (August 26, 2014)

Figure 5-19: Photograph within the Hazeltine Creek Canyon showing exposed bedrock and a thin veneer of tailings at a wider section (HC-R6) looking upstream (August 26, 2014)

Hydraulic modelling of the MAF predicts the post-event channel in HC-R6 to be 10.3 m wide and 28 cm deep, again wider and shallower than the pre-event channel that was 3.7 m wide and 27 cm deep (Table 4-1). Depth, velocity and shear stress values are more homogeneous within the canyon, with the exception of a wider section in the middle of the reach. High velocity and shear stress zones are localized and related to bed rock topography. Higher shear stresses and velocity values follow the middle of the channel due to the generally symmetrical channel geometry. The channel width generally remains stable as discharge increases resulting from the steep side slopes and channel banks. The bed and banks of the canyon are predicted to be stable due to the exposed bedrock.

5.6 Lower Hazeltine Creek

5.6.1 Key features

- Removal of floodplain vegetation;
- Channel avulsion;
- Zones of deep erosion;
- Knickpoints within the channel bed;
- Thick deposits of tailings and colluvial material; and
- Changes to the Quesnel Lake shoreline.

5.6.2 Geomorphology

Lower Hazeltine Creek includes the channel downstream of the mouth of the canyon to the channel outlet at Quesnel Lake. The affected area, including the displaced material along the Quesnel Lake shoreline is approximately 780,000 m^2. The mean slope of the eroded channel within Lower Hazeltine Creek is 1.6 %. Geomorphological processes evident in this area during and after the debris flow include: erosion and deposition, knickpoints within the channel bed, channel avulsion, and slope and bank failures. After exiting Hazeltine Creek Canyon, the channel within Lower Hazeltine Creek widens and steepens. Identified impacts at this section are related to the development of multiple debris flow paths during the event. From the canyon, the debris flow continued down Hazeltine Creek channel towards the delta and Quesnel Lake eroding till, fluvial, glaciofluvial and glaciolacustrine material and depositing tailings and LWD in wide overbank areas.

The debris flow bifurcated. One portion modified the outlet of Hazeltine Creek at Quesnel Lake. Both erosion and deposition occurred at the shoreline, with erosion of materials, including low sloping deltaic deposits. Deposition of material near the pre-event Hazeltine Creek channel outlet that resulted in a gain of 16,887 m^2 of terrestrial area.

The estimation of terrestrial area gained is linked to corresponding water level of Quesnel Lake Aggradation of the pre-event channel caused the avulsion of Hazeltine Creek. Hazeltine Creek's new outlet is located about 400 meters north-east of its pre-event location.

A second portion of the debris flow, travelled down the creek following the pre-event channel. Both, erosion and deposition occurred along this flow path. Deposition of sandy tailings, silty-clay tailings and LWD resulted in wide, forested overbank areas. Three different types of post-event erosion are evident in this area: channel scour, lateral erosion and overbank erosion (surficial erosion).

Channel scour exposed long sections of glaciolacustrine material situated underneath of glaciofluvial deposits. Maximum average net scour depth was estimated to be within 4.55 m and 5.44 m. Lateral erosion from the destabilization of channel banks is evident along new channel banks. Overland erosion caused the removal of surficial material via rills and gullies.

As the debris flow reached Quesnel Lake it eroded large portions of the shoreline and deposited these materials into the lake. The total displaced material removed at the distal zone of the delta was approximately 32,200 m^2.

Lower Hazeltine Creek is divided into three (3) distinct reaches: HC-R7, HC-R8, and HC-R9.

Figure 5-20: A - Former location of the Hazeltine Creek channel looking downstream (HC-R9).B - Post-event Hazeltine Creek delta near the pre-event outlet (HC-R9).

5.6.2.1 HC-R7

The first reach below the canyon is a ~ 300 m long, steep (3.34%) and contains a large knick point incising into native material (Figure 5-21). The debris flow bifurcated ~ 170 m downstream of the Hazeltine Creek Canyon within this reach. A portion of the debris flow traveled down the left bank eroding into native material and scouring sections up to a maximum of 7 meters deep (Figure 5-22).

Figure 5-21: Knickpoint and origin of debris flow bifurcation located in reach HC-R7

Figure 5-22: Erosion of till material in reach HC-R7 at former Horsefly-Likely Forest Service Road (Ditch Road) bridge location

Hydraulic modelling of the MAF predicts the post-event channel in HC-R7 to be 23.9 m wide and 20 cm deep, wider and shallower than the pre-event channel that was 5.3 m wide and 37 cm deep (Table 4-1). Flow splits (bifurcates) upstream of the knickpoint, creating a confluence in HC-R8 downstream. High velocity and shear stress zones occur at the knickpoint. The area exposed to high shear stresses increases with increasing discharge. The knickpoint is predicted to continue to migrate upstream and downcut.

5.6.2.2 HC-R8

The second reach of Lower Hazeltine Creek (HC-R8) extends ~ 620 m downstream of HC-R7, from downstream of the former location of Horsefly-Likely FSR (Ditch Road) to the confluence of Hazeltine and Edney Creeks. The reach is 620 m long. Slope gradient is 1.18% and bed substrate is now composed primarily of tailings and exhibits riffle-pool morphology. Banks are composed of pebbly-cobbly fluvial and glaciofluvial material. A thin veneer of sandy tailings covers the top of both banks. Two flood channels converge 235 m downstream of HC-R7 (Figures 5-23 and 5-24) and the channel widens and shallows as a result. At wide sections, extensive bar formations occur. Bars are mainly composed of a layer of sandy tailings on top of coarse alluvial material.

Figure 5-23: Overview of reach HC-R8 looking downstream showing bifurcation and confluence of the debris flow. Note eroding slope on the left bank

Figure 5-24: Reach HC-R8 looking downstream showing confluence of the debris flow bifurcation

Hydraulic modelling of the MAF predicts the post-event channel in HC-R8 to be 15.1 m wide and 31 cm deep, wider and shallower than the pre-event channel that was 5.0 m wide and 27 cm deep (Table 4-1). The confluence created by the flow bifurcation in HC-R7 occurs in HC-R8 (Figures 5-23 and 5-24). Higher velocity and shear stress zones occur in narrow sections upstream of the confluence and in the center of the channel upstream of the confluence with Edney Creek. The area exposed to high shear stresses at the knickpoint increases with increasing discharge.

5.6.2.3 HC-R9

The third reach of Lower Hazeltine Creek (HC-R9) is ~ 500 m long between the confluence of Edney and Hazeltine creeks and the outlet at Quesnel Lake (Figure 5-25). This channel displays irregular braided morphology with riffles and pools (Figure 5-26). The morphology changes to an irregular braided channel downstream until the outlet (Appendix HIA-H011). The reach gradient is 0.92%. Channel bed material is mainly composed of sandy tailings. Common field indicators of channel impact at this reach includes: the development of extensive channel bars and multiple channels, deep scoured zones, eroding banks and the presence of LWD.

Figure 5-25: Overview of reach HC-R9 from the confluence of Edney and Hazeltine Creeks

Figure 5-26: The lowest most reach (HC-9) downstream of the confluence with Edney Creek

Pre-existing deposits within Lower Hazeltine Creek section consist of pebbly to cobbly fluvial and glaciofluvial material on terraces and floodplain and lacustrine/glaciolacustrine blankets (Appendix HIA-H-011). Following the event, colluvial material consisting of a mix of tailings and native sediments entrained from the channel bed and banks was deposited at the distal zone of the delta near the shoreline. Deposits of LWD mixed with tailings and coarse material are located on the edges of the debris flow path (Figure 5-27). Material was deposited overbank on the delta within the adjacent forests.

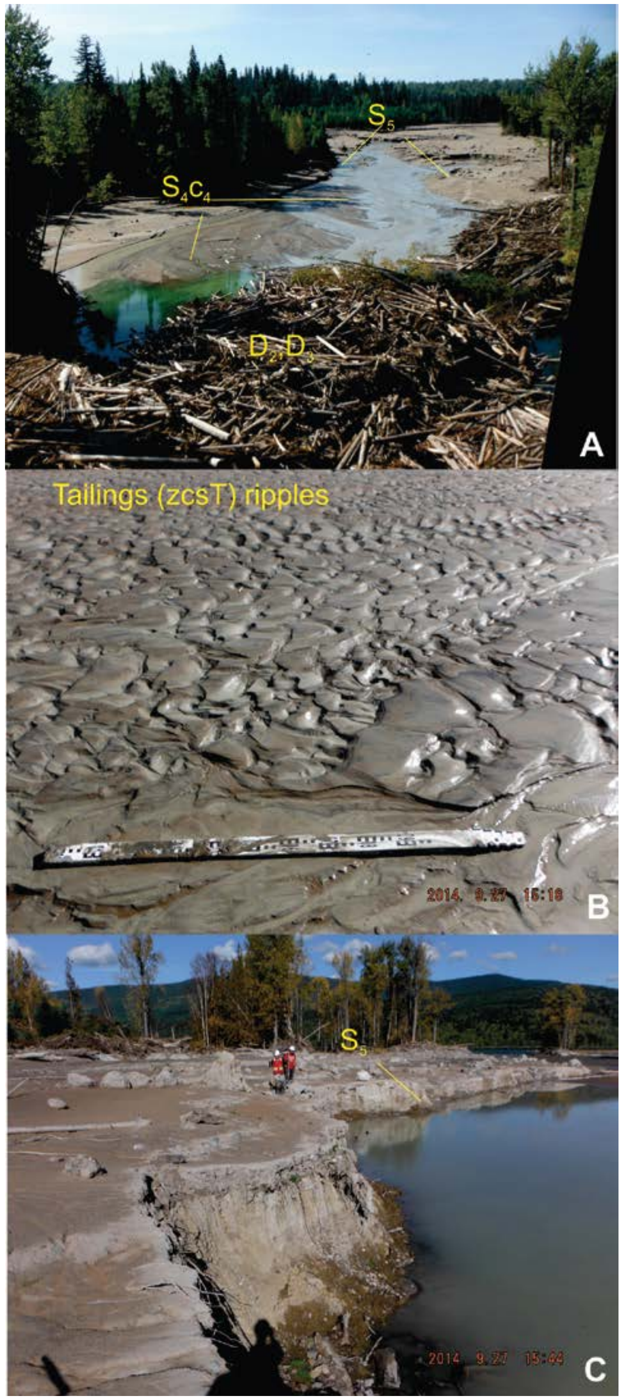

Figure 5-27: A, B & C: Field indicators of channel disturbance at Lower Hazeltine Creek, reach nine (HC-R9)

Within this reach, the post-event channel banks are steep and composed of exposed clayey glaciolacustrine material. Banks are generally unstable, showing evidence of topples and falling blocks into the channel as a consequence of lateral erosion (Figure 5-28). These blocks are contributing fine sediments to Hazeltine Creek discharge. Deep tension cracks are visible along the banks indicating likelihood of continued bank failures in the future. These characteristics extent along the entire exposed glaciolacustrine deposit.

Figure 5-28: A&B – Hazeltine Creek right bank erosion of native glacial lacustrine material (HC-R9)

Hydraulic modelling of the MAF predicts the post-event channel in HC-R9 to be 26 m wide and 28 cm deep, wider and shallower than the pre-event channel that was 11.3 m wide and 43 cm deep (Table 4-1). The channel widens and velocities and shear stresses increase downstream of the confluence with Edney Creek due to the additional discharge. Depth, velocity and shear stresses are more homogeneous in HC-R9. Shear stress and velocity values increase as the channel deepens and with increasing discharge. The channel width does not increase with discharge due to steep banks.

5.7 Edney Creek

5.7.1 Key features

- Removal of floodplain vegetation;
- Channel avulsion;
- Knickpoint at the confluence of Hazeltine and Edney Creek; and,

- Thin spatially heterogeneous deposits.

5.7.2 Geomorphology

Edney Creek mouth comprises the section that extends from the confluence of Hazeltine and Edney Creeks to ~ 500 m up the Edney Creek channel. The affected area is approximately 22,600 m^2. At the downstream section of this reach, Edney Creek is an entrenched (~ 2.5 m deep) riffle-pool channel. The debris flow caused deposition of tailings and colluvial material, channel avulsion and knickpoint erosion on Edney Creek.

A thin layer of sandy tailings was deposited on the Edney Creek floodplain and banks as a result of the debris flow (Figure 5-29). The event forced the Edney Creek channel down valley. The channel confluence moved about 100 m down from the pre-event location. At the new confluence, the area is defined by a knickpoint (Figure 5-30).

Erosion from overland flow occurred on top of the banks. Roots and disturbed vegetation are evident in the area. The right bank of Edney Creek is steep and unstable. Fallen blocks of clayey glaciolacustrine material were observed at the confluence of Edney and Hazeltine Creeks. The left bank is composed of glaciofluvial material and is mainly stable.

Figure 5-29: Post-event Edney Creek channel looking upstream showing tailings deposited within the channel (November 2, 2014)

Figure 5-30: Confluence of Edney and Hazeltine creeks (September 22, 2014)

Hydraulic modelling of the MAF predicts the post-event channel in Edney Creek to be 13.9 m wide and 31 cm deep. Detailed field data on the pre-event morphology of this section of Edney Creek were not found. Upstream of the Horsefly-Likely FSR bridge, the channel is largely unaffected by the debris flow. High velocity riffles and lower velocity pools occur in this zone. Downstream of the bridge, the channel is wider and the velocity and shear stresses are more homogeneous and generally lower than upstream of the bridge. High velocities and shear stresses occur at a knickpoint located just upstream of the confluence of Hazeltine and Edney Creeks. The knickpoint subsequently migrated upstream and degraded (Figure 5-30). At higher flows the channel widens and flows onto the floodplain because, unlike Hazeltine Creek, the post-event area surrounding Edney Creek is largely depositional and not erosional.

6 CONCLUSIONS

The Hydrotechnical and Geomorphological Impact Assessment documents the physical impacts to the channel and floodplain of Hazeltine and Edney Creeks from the debris flow created by the Mount Polley Mine tailings storage facility (TSF) dam failure. The terrestrial area (237.4 ha) affected by the debris flow extends from the failure site downslope to Hazeltine Creek, upstream to Polley Lake and downstream to Quesnel Lake. Historical aerial photographs and information in previous reports were used to document the physical characteristics of Hazeltine and Edney Creeks prior to the event. Impacts of the event were documented through analysis of digital elevation models, aerial photography taken after the event, field assessment, hydraulic modeling, and monitoring of discharge and turbidity following the event.

The pre-event channel and floodplain geomorphology was analysed and a literature review conducted to define the pre-event hydrologic and geomorphic conditions of Hazeltine and Edney Creeks. The creeks are characterized by a nival hydrologic regime modified by historical diversions. Three hydrometric stations were installed following the event to monitor discharge and turbidity. Turbidity results showed sediment production is related to both high erosion rates in Upper Hazeltine Creek above the canyon and rain fall events. Time series analysis conducted on three (3) years of historical aerial photographs (1974, 1996 and 2009) showed the Hazeltine Creek channel was largely stable over the period of record. Changes observed between historical aerial photographs occurred mainly in areas of low slope where beaver dams were reported (Appendices 621717-HIA-B001 to B015).

Impacts of the debris flow to Hazeltine and Edney Creeks were documented through mapping of surficial material, hydraulic modelling, estimation of valley erosion volumes and terrain stability. 10 post-event channel reaches were described using field data. Key hydrological and geomorphological changes observed within the study area were:

- removal of vegetation (1,358,540 m^2 representing 57 % of the total terrestrial affected area);
- widening and shallowing of the channel;
- formation of deep erosion zones (e.g., two large-knickpoint features 6 m and 10 m high located approximately 2.5 and 2.0 km upstream of the Hazeltine Creek Canyon, respectively);
- greater number of channel bars;
- thick deposits of tailings and colluvial material;
- formation of multiple channels and braids;
- creation of eroded and unstable banks;
- increase in LWD (terrestrial area impacted by LWD deposition is 74,275 m^2);

- channel avulsion (e.g., Lower Hazeltine Creek); and,
- changes to Quesnel Lake shoreline (approximately 32,200 m^2 of material was removed at the distal zone of the delta).

Tailings and reworked native materials were deposited within the post-event Hazeltine Creek channel and on the floodplain. Surficial material maps (Appendix 621717-HIA-E001 to E006) classify areas (polygons) with defined material type (tailings and native soil), surficial landforms and geomorphic processes. Typical terrain units in the area include terraces and fans composed of glaciofluvial material, blankets of till and steep valley walls composed of bedrock and glaciolacustrine materials. Two types of tailings (sandy-tailings and silt-loam tailings) were documented within the terrestrial affected area.

The deposition map (Appendix 621717-HIA-E001 to E006) shows thickness of tailings by terrain polygons. 10 deposition intervals are defined ranging from less than 0.1 m to greater than 3.5 m. Total volume of deposition within the terrestrial area is estimated to be between 1.3 and 1.9 Mm^3. Areas of larger volume deposition include the Polley Plug (0.5 to 0.6 Mm^3) and Lower Hazeltine Creek (0.2 to 0.6 Mm^3). A thin veneer of tailings was deposited along the remainder of the channel. These tailings are being quickly mobilized by post-event Hazeltine Creek discharge and largely deposited into Quesnel Lake.

The post-event Hazeltine Creek valley shows evidence of erosion. Main indicators of erosion include: lack of vegetation cover and lack of well-developed soil, exposed bedrock, rills and gullies and knickpoints. Net volume and maximum depth of erosion is estimated based on the difference in elevation between the pre-event floodplain elevation and the post-event surface. Net volume of eroded material is estimated to be between 0.6 and 1.7 Mm^3.

The post-event banks and valley walls of Hazeltine Creek display evidence of slope failures. The slope stability map (Appendix 621717-HIA-G001 to G006) shows a classification of five (5) terrain stability classes and associated processes. Main active processes identified in the area are slope failures in the form of soil toppling and soil/debris falls. A minor extent of overland erosion also occurs. The assigned stability classes range from Class I (no significant slope or bank failures) to Class V (unstable terrain, very high likelihood of slope and bank failures) (Table 5-5). The terrain stability map shows areas with high and very high likelihood to contain or develop slope failures following the event. These areas include slopes greater than 26°. Conditions observed during the field assessment indicate these areas will remain unstable until angle of repose is reached.

To identify areas on the Hazeltine Creek bed susceptible to erosion and deposition, the River2D hydraulic model was used to simulate patterns of inundation extent, depth and velocity and shear stress for the MAF, 10-year and 100-year return intervals. These results show areas where riffles and pools are establishing, and areas of incipient meandering. Areas of high shear stresses, indicating erosion potential, occur at knickpoints and high slope sections in HC-0b, HC-4b, HC-5a and HC-R7. These sections have experienced incision following the event and erosion is predicted to continue. Deep and wide pools with low shear stresses, indicating the potential for deposition, occur downstream of knickpoints. High velocity and shear stress zones in the canyon are localized and related to bed rock topography (Appendix 621717-HIA-F001 to F054).

7 RECOMMENDATIONS AND MONITORING

The plan for mitigating the impacts of the debris flow on Hazeltine Creek are presented within the PEEIAR summary report and will therefore not be discussed here.

The three hydrometric stations were installed by Watersmith Research Inc., (2015). It is recommended that the three hydrometric stations be maintained until hydrology and turbidity levels return to natural background levels.

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9 ACKNOWLEGMENTS

This report was written by Leif Burge, M.Sc., Ph.D., P.Ag. (Project Manager) and Vanessa Cuervo, M.Sc., with senior technical review provided by Richard Guthrie, M.Sc., Ph.D. P.Geo and Project Sponsor Gordon Johnson, M.Sc., P.Eng. Other SNC-Lavalin contributors included Hawley Beaugrand, M.Sc., Megan Hendershot, M.Sc., and Cory McGregor, B.Sc. GIT. Faruk Bhuiyan, M.Sc., Ph.D. conducted the hydraulic modelling. Russell Smith, Ph.D., M.Sc., P.Geo. and Patrick Little, M.Sc., A.Ag. from Watersmith Research Inc. contributed to sections on hydrometric stations and analysis of turbidity patterns.

The field program was executed by Leif Burge, Vanessa Cuervo, Megan Hendershot, and Cory McGregor. Additional material depth data was provided by Trevor McConkey, M.Sc., P.Ag. and Daniel Schneider, R.P.Bio., P.Ag., MPMC, and Archer CRM.

10 CLOSURE

This report was prepared based on objectives and available information at the time of writing. Contributions and comments were provided by internal and external geoscientists and agrologists.

Prepared by:

BRITISH COLUMBIA INSTITUTE OF AGROLOGISTS
2863
Leif M. Burge
P.Ag.

June 4, 2015

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Geohazards Specialist
Environment & Water

11 NOTICE TO READER

This report has been prepared and the work referred to in this report have been undertaken by SNC-Lavalin Inc. (SNC-Lavalin) for the exclusive use of Mount Polley Mining Corporation, who has been party to the development of the scope of work and understands its limitations. The methodology, findings, conclusions and recommendations in this report are based solely upon the scope of work and subject to the time and budgetary considerations described in the proposal and/or contract pursuant to which this report was issued. Any use, reliance on, or decision made by a third party based on this report is the sole responsibility of such third party. SNC-Lavalin accepts no liability or responsibility for any damages that may be suffered or incurred by any third party as a result of the use of, reliance on, or any decision made based on this report.

The findings, conclusions and recommendations in this report (i) have been developed in a manner consistent with the level of skill normally exercised by professionals currently practicing under similar conditions in the area, and (ii) reflect SNC-Lavalin's best judgment based on information available at the time of preparation of this report. No other warranties, either expressed or implied, are made as to the professional services provided under the terms of our original contract and included in this report. The findings and conclusions contained in this report are valid only as of the date of this report and may be based, in part, upon information provided by others. If any of the information is inaccurate, new information is discovered, site conditions change or applicable standards are amended, modifications to this report may be necessary.

Any soil and rock descriptions in this report and associated logs have been made with the intent of providing general information on the subsurface conditions of the site. This information should not be used as geotechnical data for any purpose unless specifically addressed in the text of this report. Groundwater conditions described in this report refer only to those observed at the location and time of observation noted in the report.

This report must be read as a whole, as sections taken out of context may be misleading. If discrepancies occur between the preliminary (draft) and final version of this report, it is the final version that takes precedence. Nothing in this report is intended to constitute or provide a legal opinion.

The contents of this report are confidential and proprietary. Other than by Mount Polley Mining Corporation, copying or distribution of this report or use of or reliance on the information contained herein, in whole or in part, is not permitted without the express written permission of Mount Polley Mining Corporation.

APPENDIX A

Maps of the terrestrial area affected by the debris flow and the locations of the reaches used in the analysis

LEGEND

- Terrestrial Affected Area
- Creek
- Lake

Hazeltine Creek Sections

- Polley Plug
- Upper Hazeltine Creek
- Canyon
- Lower Hazeltine Creek
- Edney Creek Mouth

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 125 250 500 750 1,000 Meters

1. Data provided by Mount Polley Mining Corporation.
2. Data downloaded from Data.Gov.BC.ca Data Distribution Service.
3. Orthophoto collected by McElhanney on August 5th, 2014.
4. Background image by Bing Maps aerial image.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Creek Sections

BY: HB	SCALE: 1:25,000	DATE: 3/26/2015	REF No:	REV: 0
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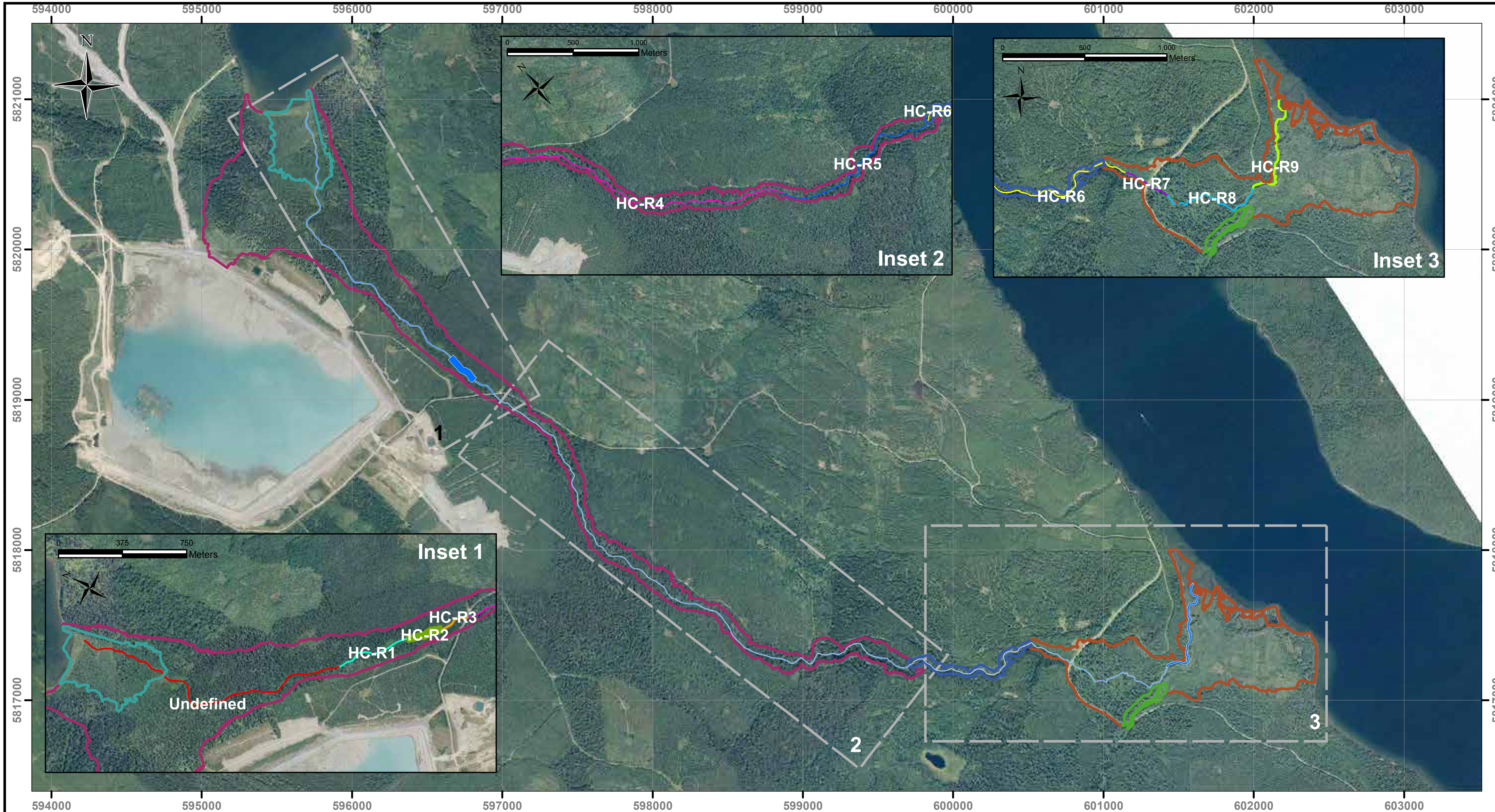

LEGEND

Inset Boundary	Edney Creek Mouth	HC-R5
Hazeltine Creek Instream Area	**Minnow (2007) Reach**	HC-R6
Hazeltine Creek Sections	Undefined	HC-R7
Polley Plug	HC-R1	HC-R8
Upper Hazeltine Creek	HC-R2	HC-R9
Canyon	HC-R3	
Lower Hazeltine Creek	HC-R4	

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 210 420 840 1,260 Meters

1. Orthophoto and Hazeltine Creek sections provided by Mount Polley Mining Corporation.
2. Orthophoto collected 5 August, 2014 by McElhanney Consulting Services Ltd.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine & Edney Creek Reaches (Minnow, 2007) versus Contemporary Creek Sections

BY: HB	SCALE: 1:25,000	DATE: 4/1/2015	REF No:	REV: 0
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Project Path: P:\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\

LEGEND

- Post-Event Channel
- Inset Boundary

Reach

- HC-0a
- HC-0b
- HC-R1
- HC-R2
- HC-R3
- HC-R4a
- HC-R4b
- HC-R5a
- HC-R5b
- HC-R6
- HC-R7
- HC-R8
- HC-R9
- LEC-R1

NOTES

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2. Orthophoto collected 5 August, 2014 by McElhanney Consulting Services Ltd.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine & Edney Creek Post-Event Reaches

BY: HB	SCALE: 1:25,000	DATE: 4/1/2015	REF No:	REV: 0
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APPENDIX B

Maps of the geomorphic characteristics of the pre-event channel

LEGEND

— 1974 Channel

Feature Type

Channel Aggradation

Hazeltine Creek Sections

Polley Plug

Upper Hazeltine Creek

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 37.5 75 150 225 300 Meters

1. Data provided by Mount Polley Mining Corporation.

2. Data downloaded from Data.Gov.BC.ca Data Distribution Service.

3. Orthophoto collected in 2008. Orthophoto provided by Mount Polley Mining Corporation. Exact imagery date unknown.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Time Series Analysis
1974 Polley Plug and Upper Hazeltine Creek

BY: HB	SCALE: 1:6,000	DATE: 3/26/2015	REF No: REV: 0
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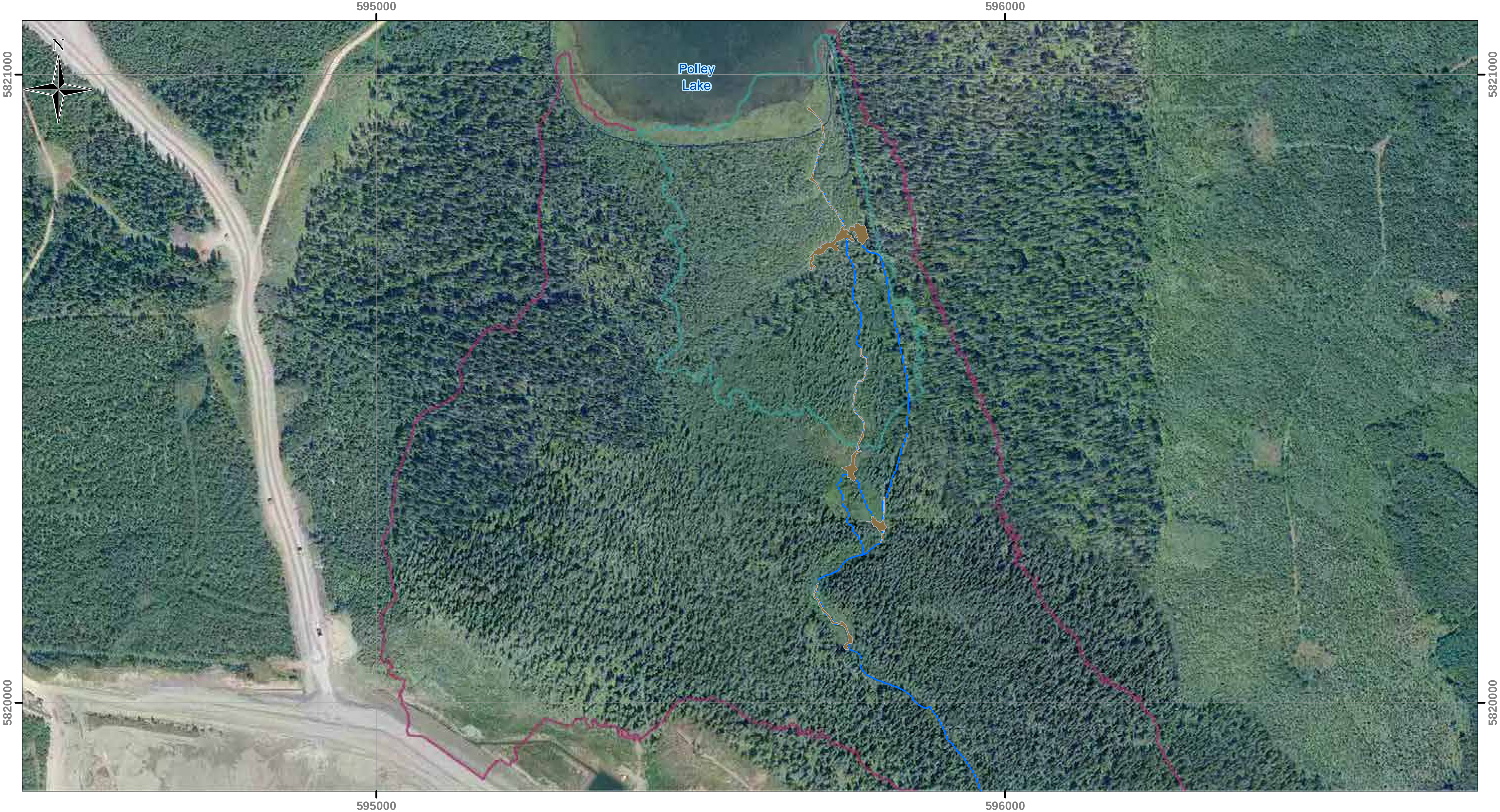

LEGEND

— 1996 Channel

Feature Type

Channel Aggradation

Hazeltine Creek Sections

Polley Plug

Upper Hazeltine Creek

NOTES

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3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

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2. Data downloaded from Data.Gov.BC.ca Data Distribution Service.

3. Orthophoto collected in 2008. Orthophoto provided by Mount Polley Mining Corporation. Exact imagery date unknown.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation	PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Time Series Analysis
1996 Polley Plug and Upper Hazeltine Creek

BY: HB	SCALE: 1:6,000	DATE: 3/26/2015	REF No: REV: 0
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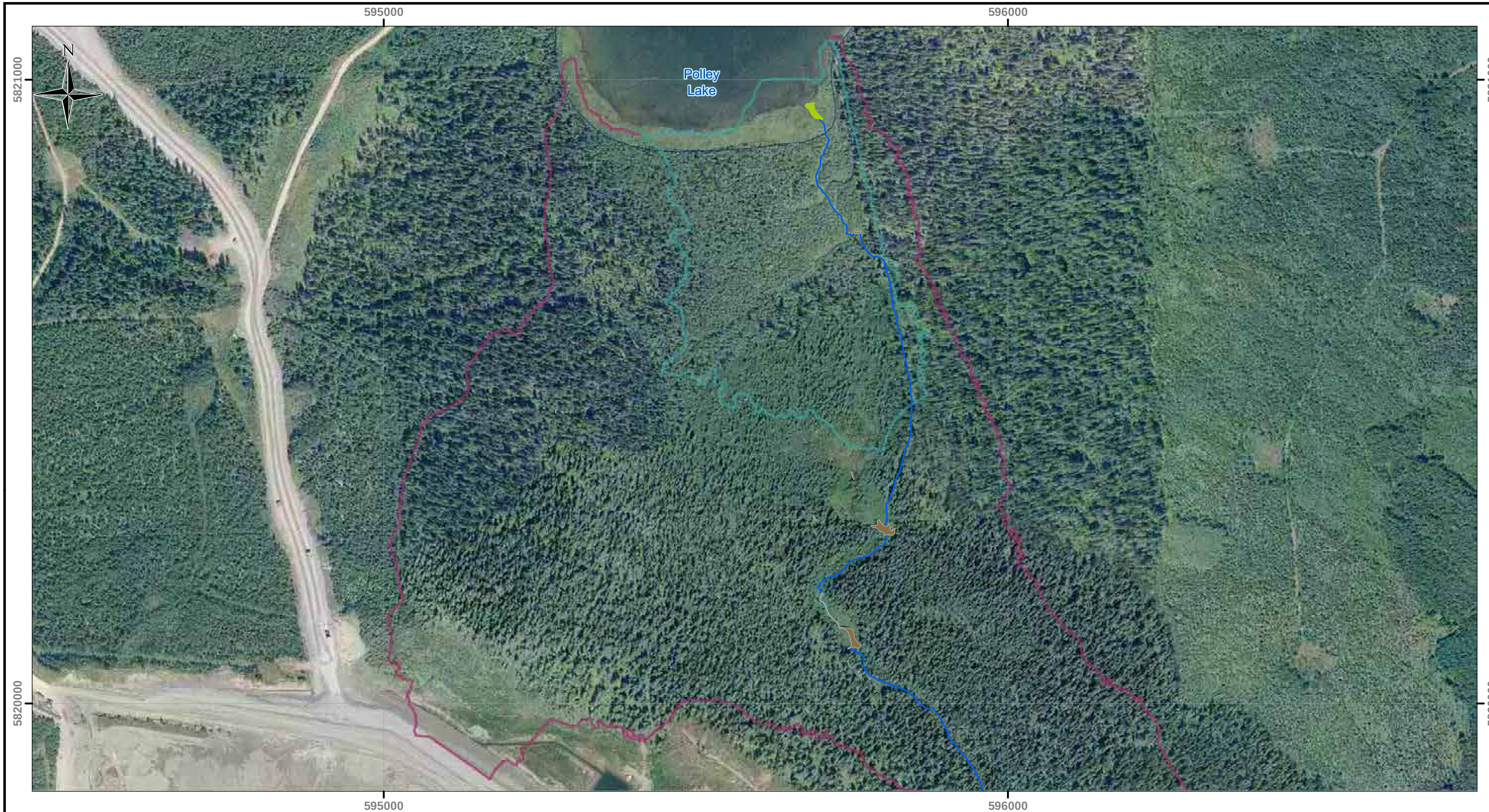

LEGEND

— 2009 Channel

Feature Type

- Active Floodplain
- Channel Aggradation

Hazeltine Creek Sections

- Polley Plug
- Upper Hazeltine Creek

NOTES

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2. Data downloaded from Data.Gov.BC.ca Data Distribution Service.

3. Orthophoto collected in 2008. Orthophoto provided by Mount Polley Mining Corporation. Exact imagery date unknown.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Time Series Analysis
2009 Polley Plug and Upper Hazeltine Creek

BY: HB	SCALE: 1:6,000	DATE: 3/26/2015	REF No:	REV: 0
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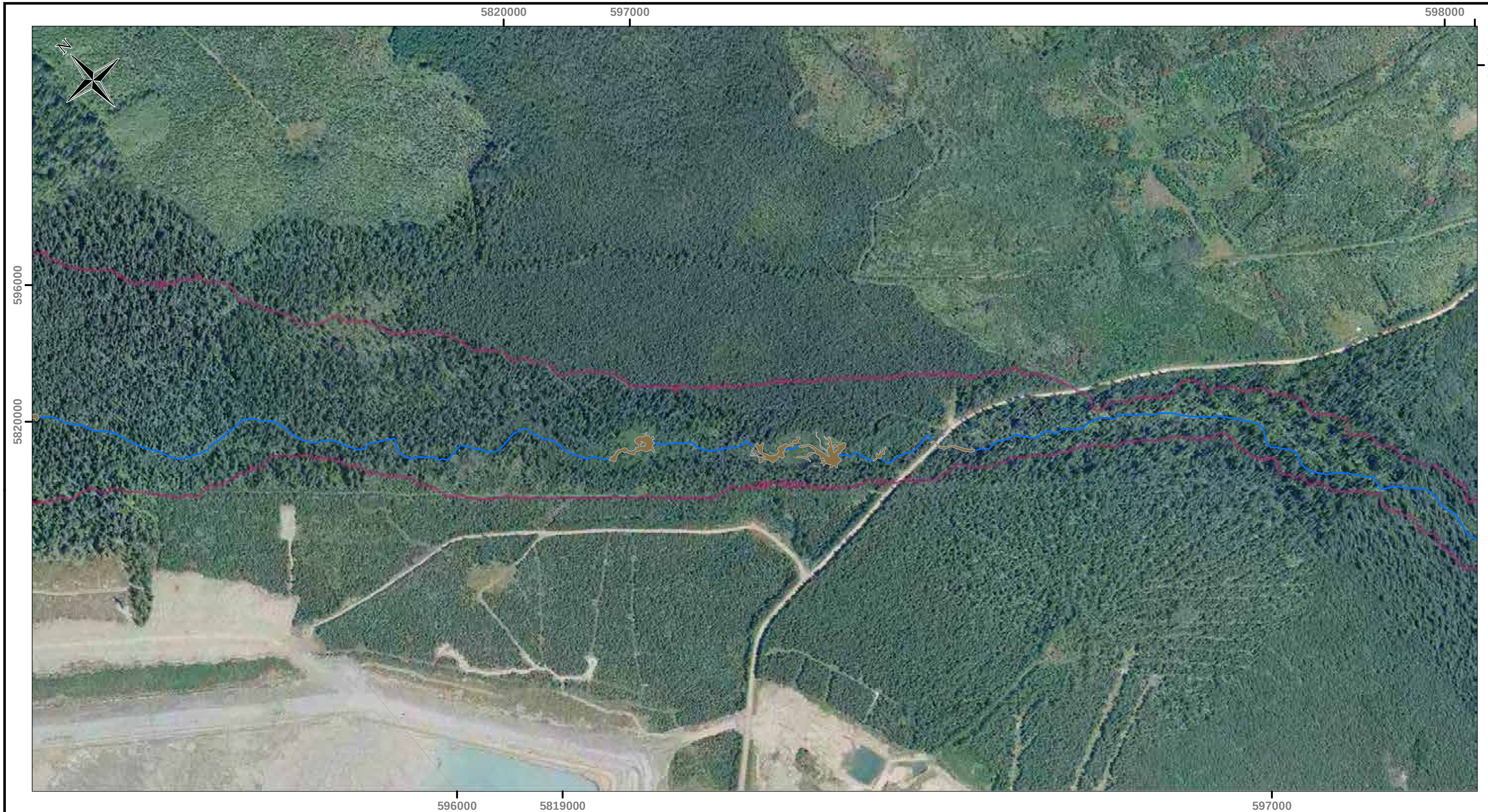

LEGEND

1974 Channel

Feature Type

Channel Aggradation

Hazeltine Creek Sections

Upper Hazeltine Creek

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

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REFERENCES

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2. Data downloaded from Data.Gov.BC.ca Data Distribution Service.

3. Orthophoto collected in 2008. Orthophoto provided by Mount Polley Mining Corporation. Exact imagery date unknown.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Time Series Analysis
1974 Upper Hazeltine Creek at Gavin Lake Rd

BY: HB	SCALE: 1:6,000	DATE: 3/26/2015	REF No: REV: 0
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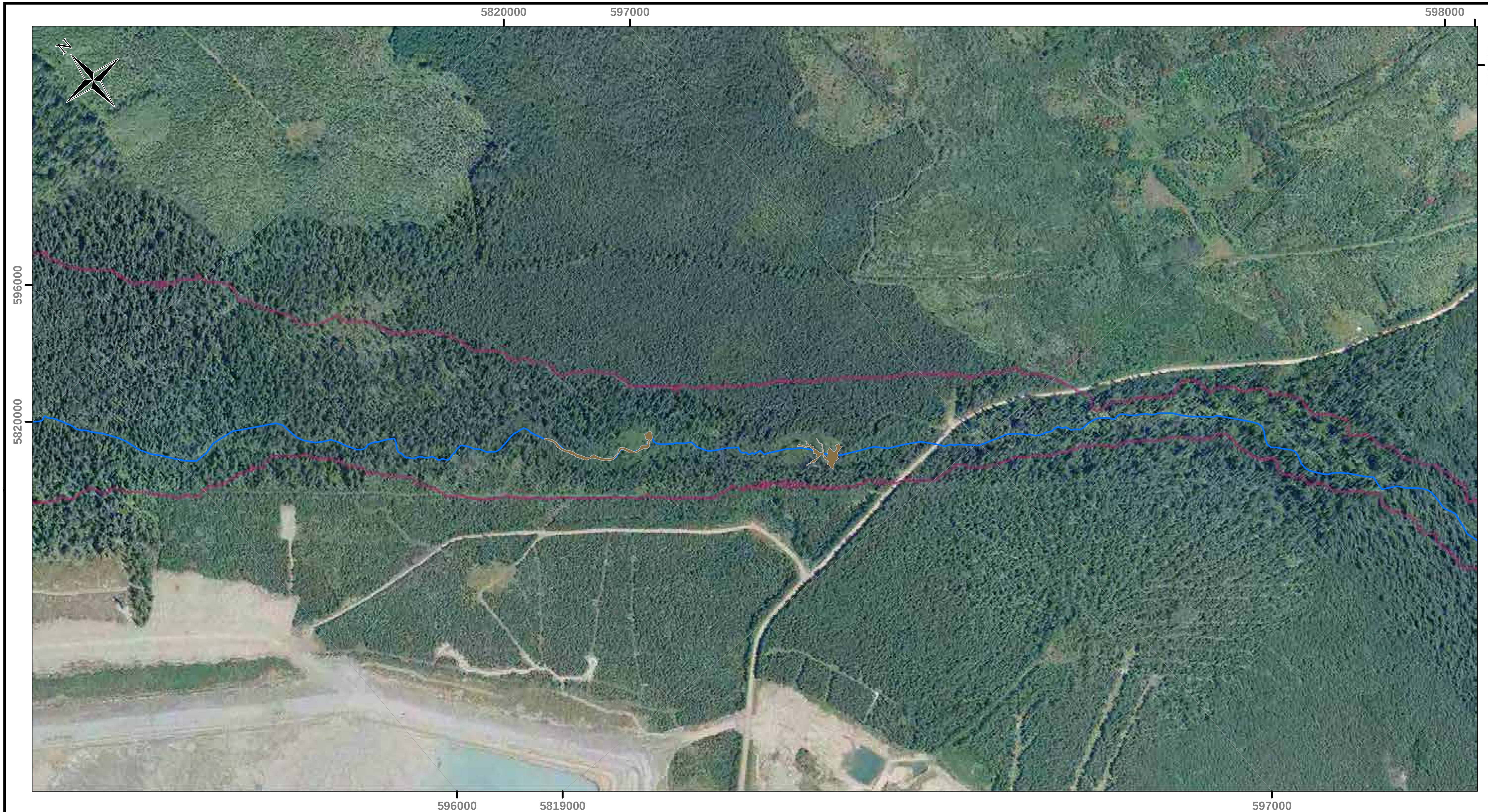

LEGEND

1996 Channel

Feature Type

Channel Aggradation

Hazeltine Creek Sections

Upper Hazeltine Creek

NOTES

1. Original in colour.

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REFERENCES

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2. Data downloaded from Data.Gov.BC.ca Data Distribution Service.

3. Orthophoto collected in 2008. Orthophoto provided by Mount Polley Mining Corporation. Exact imagery date unknown.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Time Series Analysis
1996 Upper Hazeltine Creek at Gavin Lake Rd

BY: HB	SCALE: 1:6,000	DATE: 3/26/2015	REF No: REV: 0
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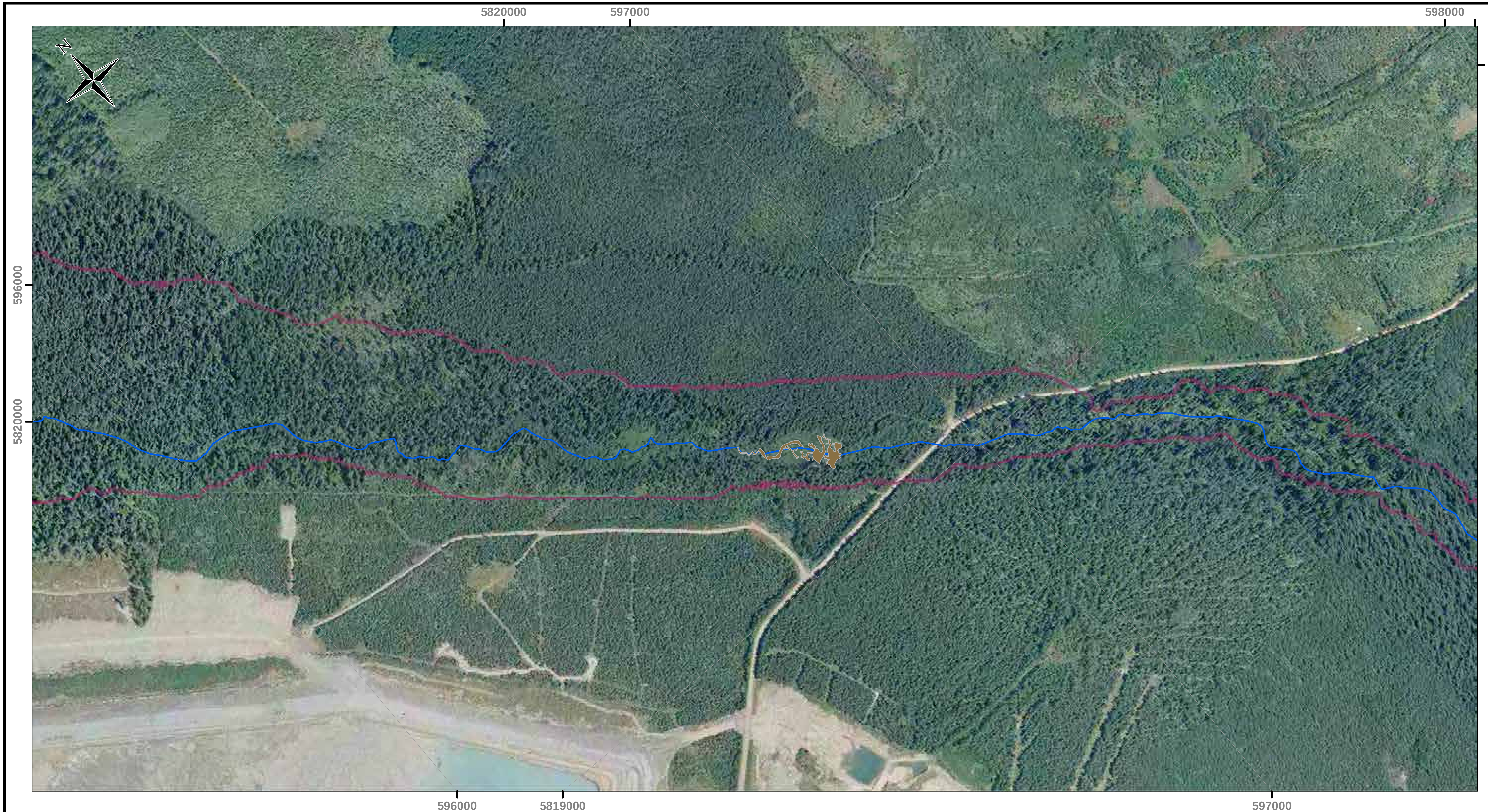

LEGEND

2009 Channel

Feature Type

Channel Aggradation

Hazeltine Creek Sections

Upper Hazeltine Creek

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

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SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Time Series Analysis
2009 Upper Hazeltine Creek at Gavin Lake Rd

BY: HB	SCALE: 1:6,000	DATE: 3/26/2015	REF No:	REV: 0
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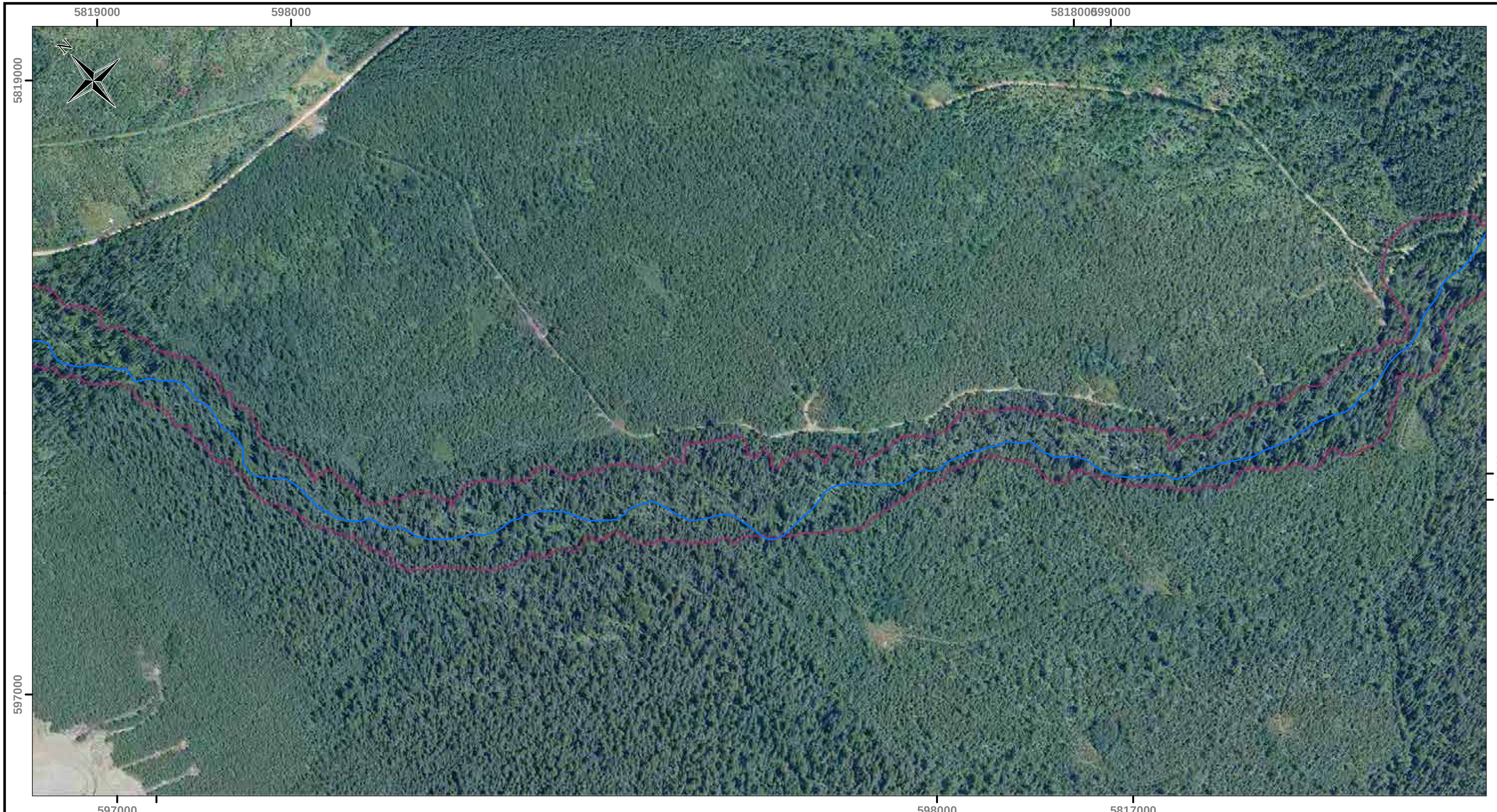

LEGEND

— 1974 Channel

Hazeltine Creek Sections

Upper Hazeltine Creek

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 37.5 75 150 225 300 Meters

1. Data provided by Mount Polley Mining Corporation.

2. Data downloaded from Data.Gov.BC.ca Data Distribution Service.

3. Orthophoto collected in 2008. Orthophoto provided by Mount Polley Mining Corporation. Exact imagery date unknown.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Time Series Analysis
1974 Upper Hazeltine Creek Below Gavin Lake Rd

BY: HB	SCALE: 1:6,000	DATE: 3/26/2015	REF No: REV: 0
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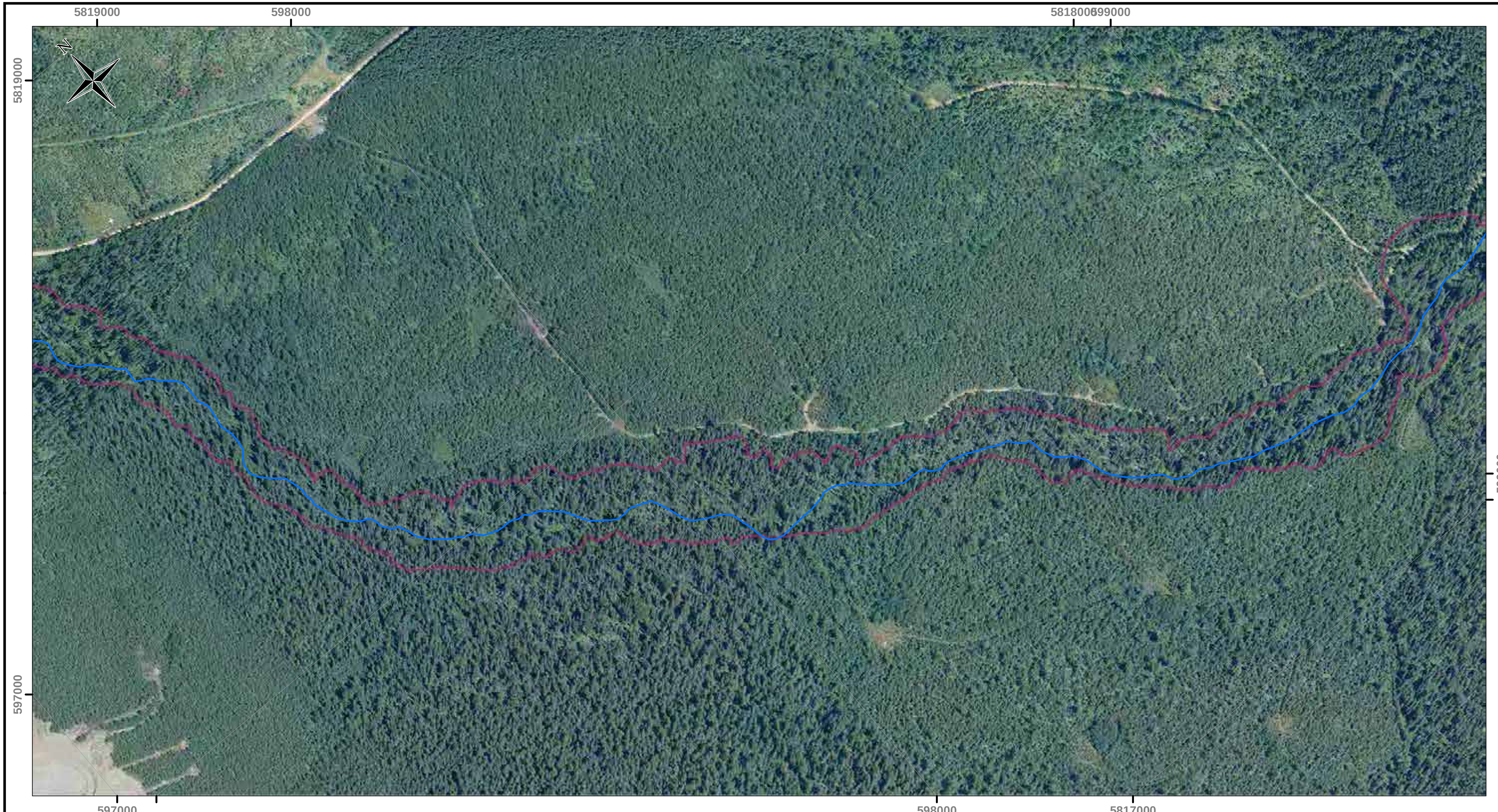

LEGEND

1996 Channel

Hazeltine Creek Sections

Upper Hazeltine Creek

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

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REFERENCES

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SNC·LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Time Series Analysis
1996 Upper Hazeltine Creek Below Gavin Lake Rd

BY: HB	SCALE: 1:6,000	DATE: 3/26/2015	REF No: REV: 0
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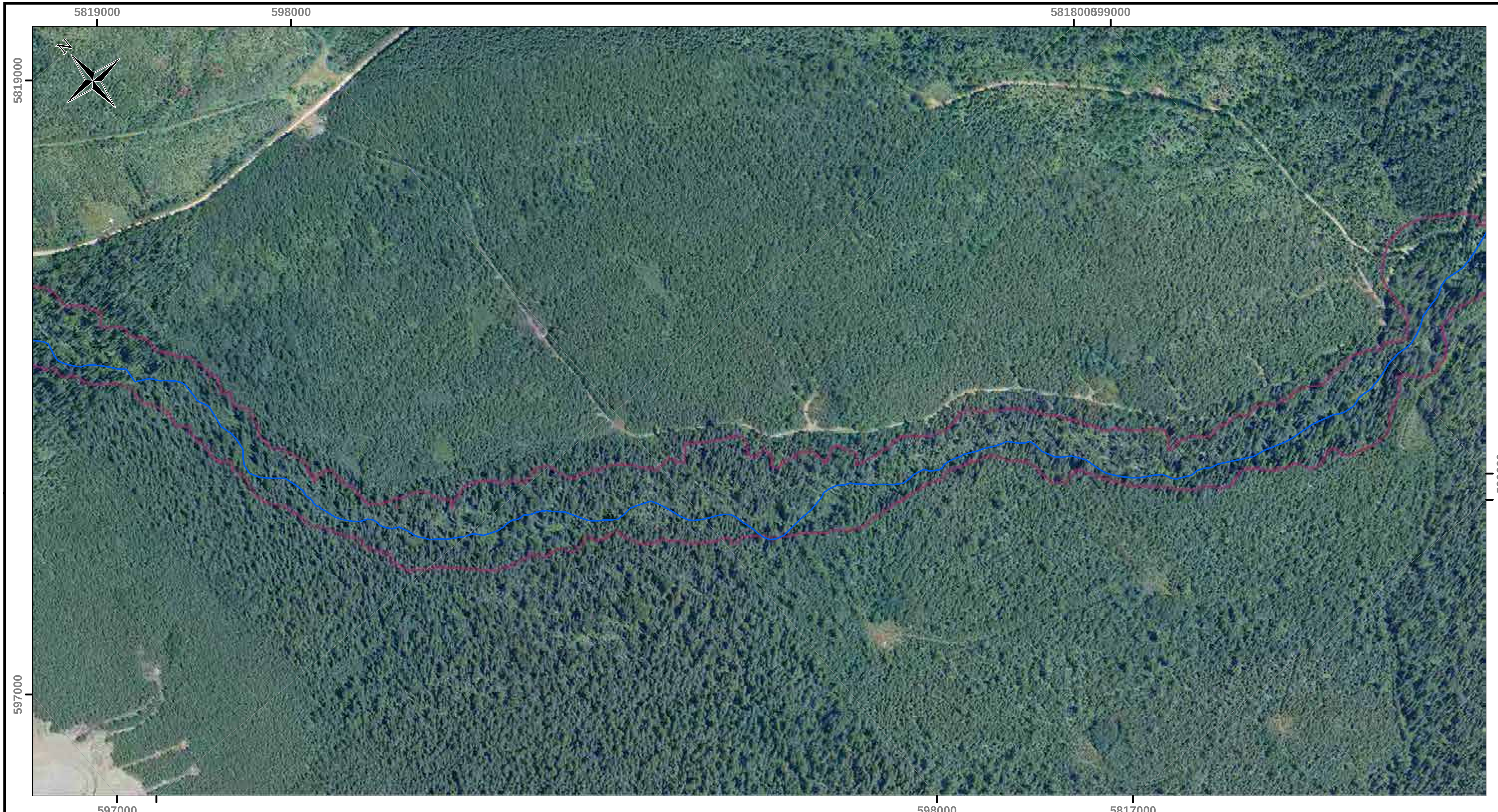

LEGEND

- 2009 Channel

Hazeltine Creek Sections

- Upper Hazeltine Creek

NOTES

1. Original in colour.
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2. Data downloaded from Data.Gov.BC.ca Data Distribution Service.
3. Orthophoto collected in 2008. Orthophoto provided by Mount Polley Mining Corporation. Exact imagery date unknown.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Time Series Analysis
2009 Upper Hazeltine Creek Below Gavin Lake Rd

BY: HB	SCALE: 1:6,000	DATE: 3/26/2015	REF No: REV: 0
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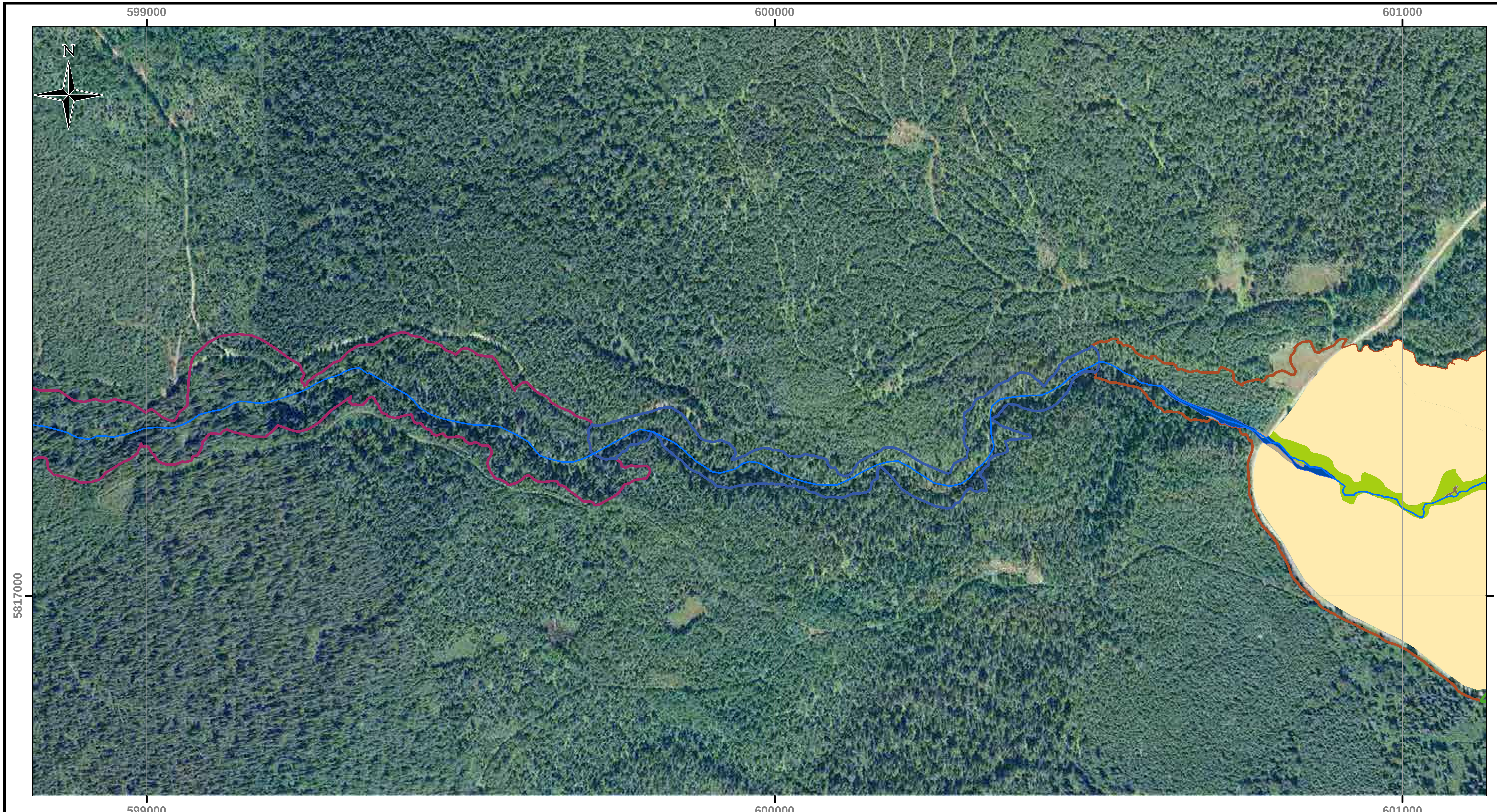

LEGEND

1974 Channel

Feature Type

- Active Floodplain
- Active Lateral Bar
- Channel Aggradation
- Dormant Fan
- Main Channel

Hazeltine Creek Sections

- Upper Hazeltine Creek
- Canyon
- Lower Hazeltine Creek
- Edney Creek Mouth

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

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3. Orthophoto collected in 2008. Orthophoto provided by Mount Polley Mining Corporation. Exact imagery date unknown.

SNC·LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Time Series Analysis
1974 Hazeltine Creek Canyon

BY: HB	SCALE: 1:6,000	DATE: 3/26/2015	REF No:	REV: 0
CHK'D: VC	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-B010	

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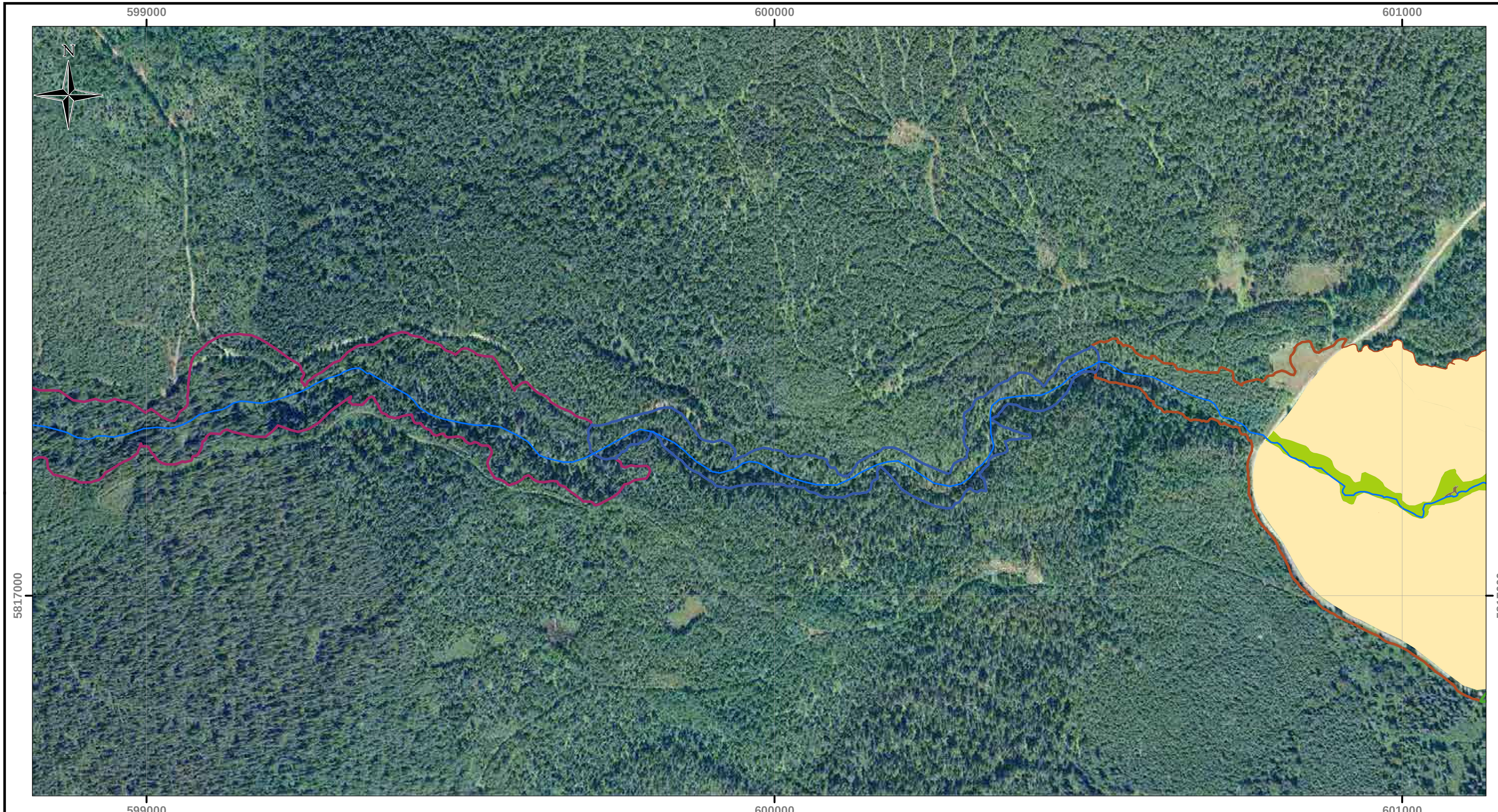

LEGEND

- 1996 Channel

Feature Type

- Active Floodplain
- Channel Aggradation
- Dormant Fan

Hazeltine Creek Sections

- Upper Hazeltine Creek
- Canyon
- Lower Hazeltine Creek
- Edney Creek Mouth

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 37.5 75 150 225 300 Meters

1. Data provided by Mount Polley Mining Corporation.

2. Data downloaded from Data.Gov.BC.ca Data Distribution Service.

3. Orthophoto collected in 2008. Orthophoto provided by Mount Polley Mining Corporation. Exact imagery date unknown.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Time Series Analysis
1996 Hazeltine Creek Canyon

BY: HB	SCALE: 1:6,000	DATE: 3/26/2015	REF No: REV: 0
CHK'D: VC	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-B011

MXD Path: \\proj_srv\PROJECTS\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\4.0 Execution\4.5 GIS and Drawings\GIS\PEEIAR Figures\HIA \621717-HIA-11x17.mxd

Project Path: P:\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\

LEGEND

2009 Channel

Feature Type

- Active Floodplain
- Channel Aggradation
- Dormant Fan

Hazeltine Creek Sections

- Upper Hazeltine Creek
- Canyon
- Lower Hazeltine Creek
- Edney Creek Mouth

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

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2. Data downloaded from Data.Gov.BC.ca Data Distribution Service.

3. Orthophoto collected in 2008. Orthophoto provided by Mount Polley Mining Corporation. Exact imagery date unknown.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Time Series Analysis 2009 Hazeltine Creek Canyon

BY: HB	SCALE: 1:6,000	DATE: 3/26/2015	REF No: REV: 0
CHK'D: VC	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-B012

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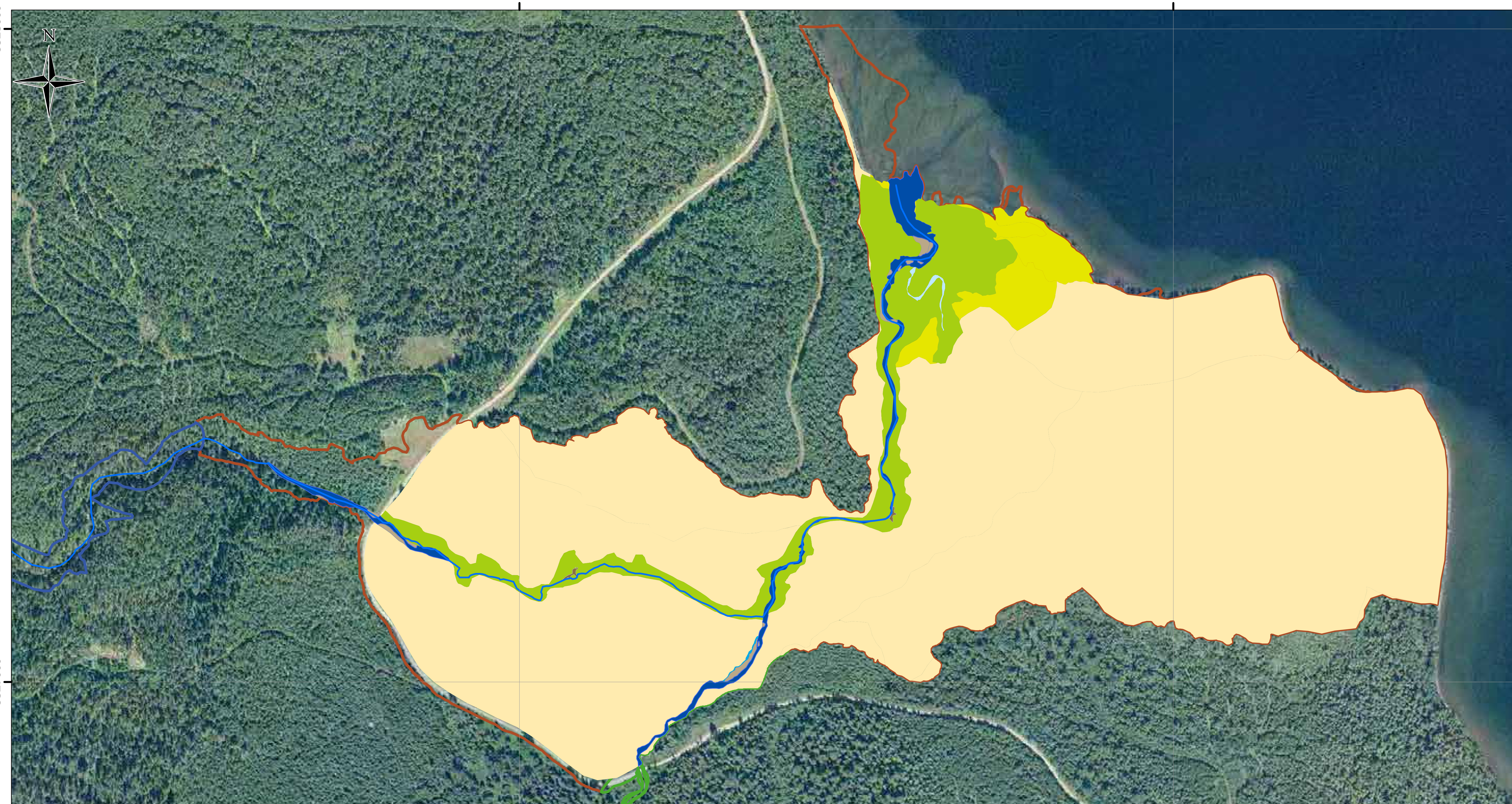

LEGEND

- 1974 Channel

Feature Type

- Active Fan
- Active Floodplain
- Active Lateral Bar
- Active Medial Bar
- Back Channel
- Channel Aggradation
- Dormant Fan
- Main Channel
- Side Channel

Hazeltine Creek Sections

- Canyon
- Lower Hazeltine Creek
- Edney Creek Mouth

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 37.5 75 150 225 300 Meters

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2. Data downloaded from Data.Gov.BC.ca Data Distribution Service.

3. Orthophoto collected in 2008. Orthophoto provided by Mount Polley Mining Corporation. Exact imagery date unknown.

SNC·LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Time Series Analysis
1974 Lower Hazeltine Creek & Edney Creek Mouth

BY: HB	SCALE: 1:6,000	DATE: 3/26/2015	REF No: REV: 0
CHK'D: VC	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-B013

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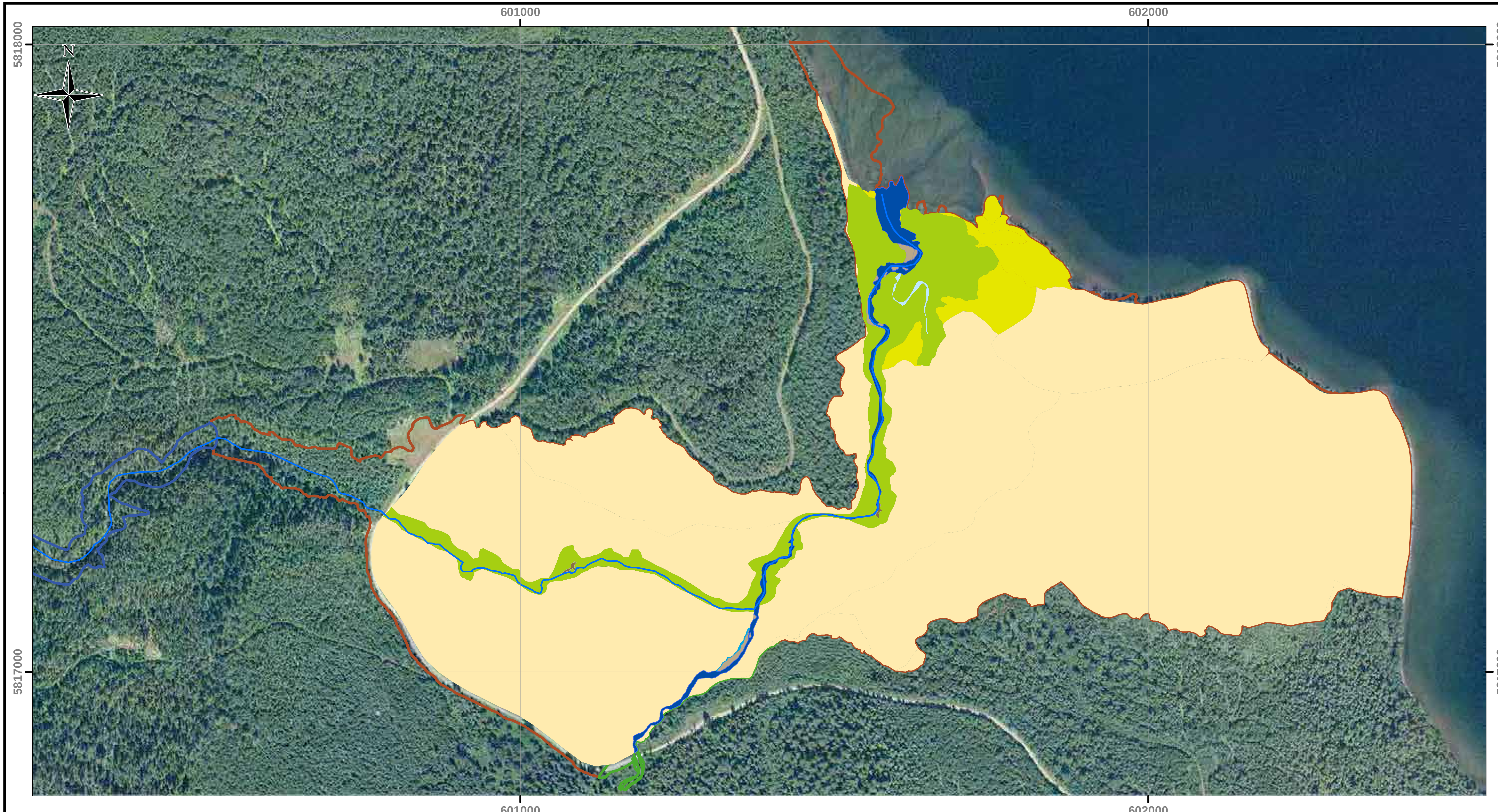

LEGEND

1996 Channel

Feature Type

- Active Fan
- Active Floodplain
- Active Lateral Bar
- Active Medial Bar
- Back Channel
- Channel Aggradation
- Dormant Fan
- Main Channel
- Side Channel

Hazeltine Creek Sections

- Canyon
- Lower Hazeltine Creek
- Edney Creek Mouth

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 37.5 75 150 225 300 Meters

1. Data provided by Mount Polley Mining Corporation.

2. Data downloaded from Data.Gov.BC.ca Data Distribution Service.

3. Orthophoto collected in 2008. Orthophoto provided by Mount Polley Mining Corporation. Exact imagery date unknown.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Time Series Analysis
1996 Lower Hazeltine Creek & Edney Creek Mouth

BY: HB	SCALE: 1:6,000	DATE: 3/26/2015	REF No: REV: 0
CHK'D: VC	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-B014

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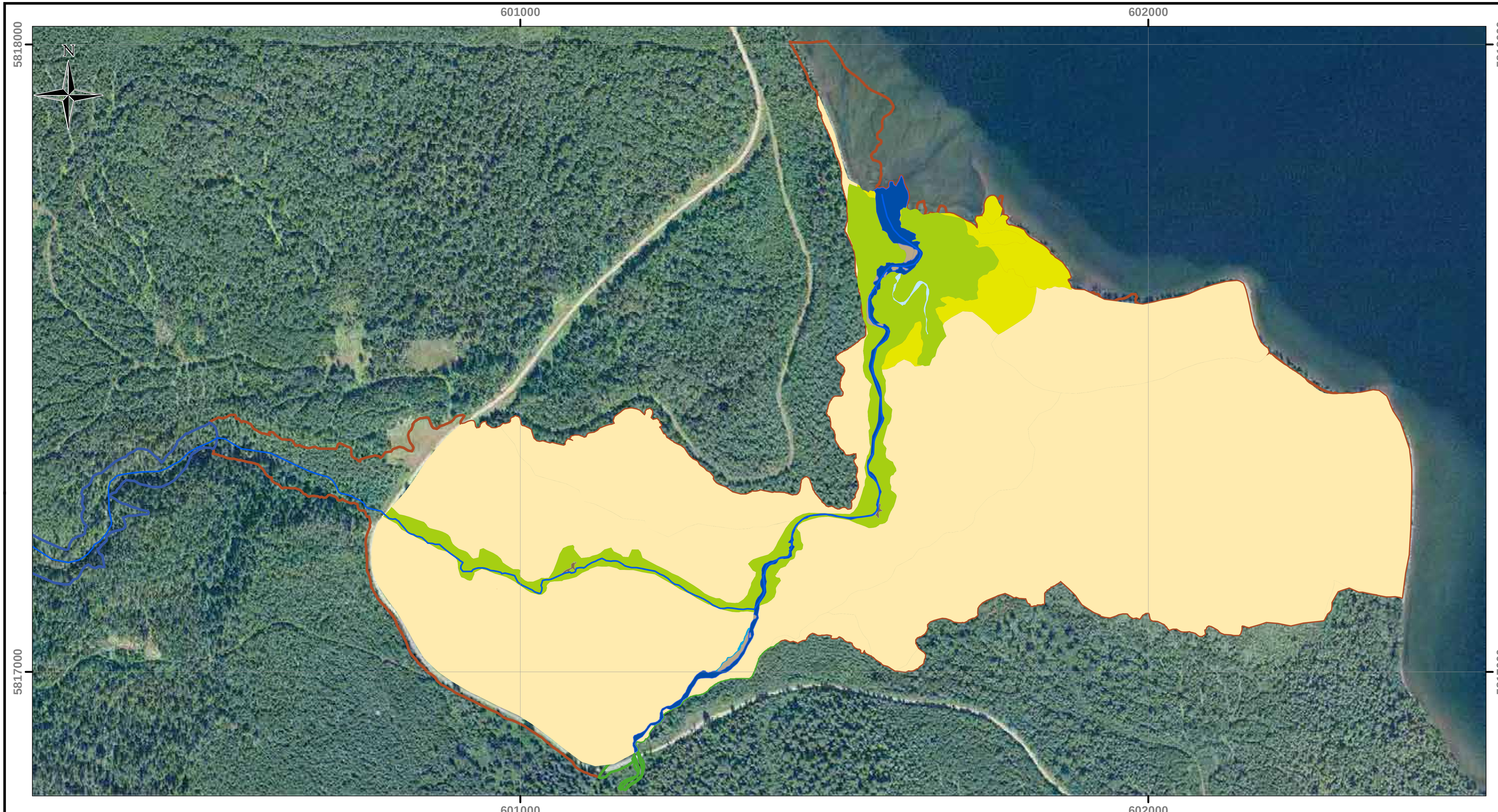

LEGEND

- 2009 Channel

Feature Type

- Active Fan
- Active Floodplain
- Active Lateral Bar
- Active Medial Bar
- Back Channel
- Channel Aggradation
- Dormant Fan
- Main Channel
- Side Channel

Hazeltine Creek Sections

- Canyon
- Lower Hazeltine Creek
- Edney Creek Mouth

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

1. Data provided by Mount Polley Mining Corporation.

2. Data downloaded from Data.Gov.BC.ca Data Distribution Service.

3. Orthophoto collected in 2008. Orthophoto provided by Mount Polley Mining Corporation. Exact imagery date unknown.

SNC·LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Time Series Analysis

2009 Lower Hazeltine Creek & Edney Creek Mouth

BY: HB	SCALE: 1:6,000	DATE: 3/26/2015	REF No:	REV: 0
CHK'D: VC	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-B015	

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Project Path: P:\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\

APPENDIX C

Cross-sections and photographs of the pre-event channel in the reaches from the Minnow (2007) report

REF No: REV: 0	REACH:	CLIENT NAME:	PROJECT LOCATION:	DATE:
621717-HIA-C001	**HC-R1a Upper Hazeltine Creek**	**Mount Polley Mining Corporation**	**Mount Polley Mine, Likely, BC**	**2015/04/01**

SNC • LAVALIN

Area Overview

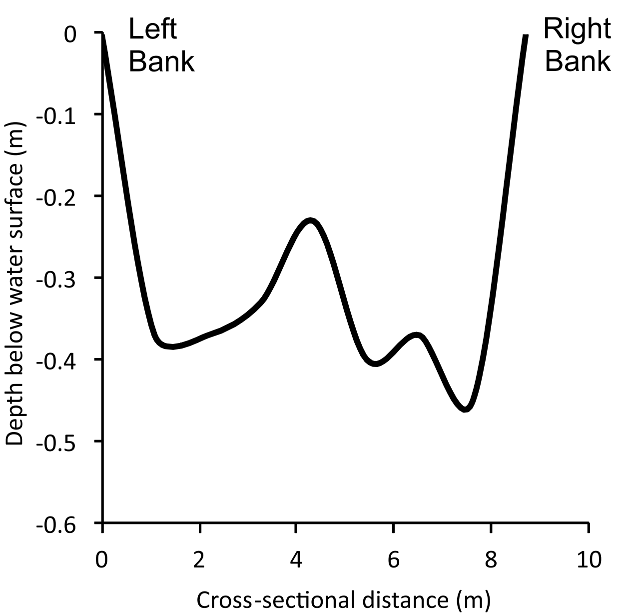
The uppermost reach HC-R1 was 445 m in length and displayed riffle-pool morphology. Banks were composed of fine grained material and stabilized by dense vegetation.

Hazeltine Creek Photographs (January 20, 2007)

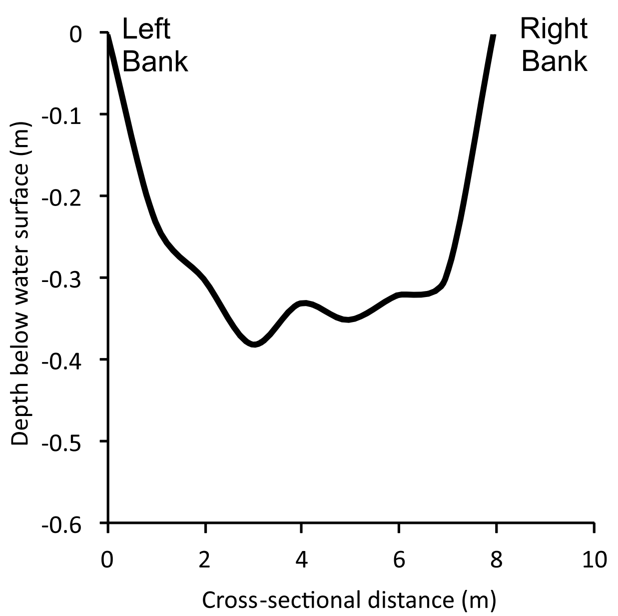
Downstream view characteristically unconfined channel conditions at HC-R1. Substrate at such areas was typically fine gravel to sand.

Upstream view of channel at HC-R1 illustrating low gradient and densely vegetated riparian zone. 'Run' habitat was the dominant morphology type.

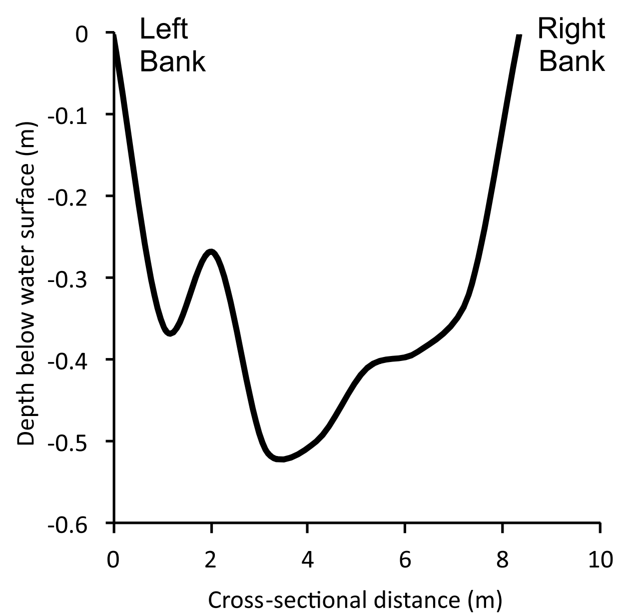
Cross Section 1



Cross Section 2



Cross Section 3



REF No: REV: **0**	REACH:	CLIENT NAME:	PROJECT LOCATION:	DATE:	SNC • LAVALIN
621717-HIA-C002	**HC-R1b Upper Hazeltine Creek**	**Mount Polley Mining Corporation**	**Mount Polley Mine, Likely, BC**	**2015/04/01**	

Area Overview

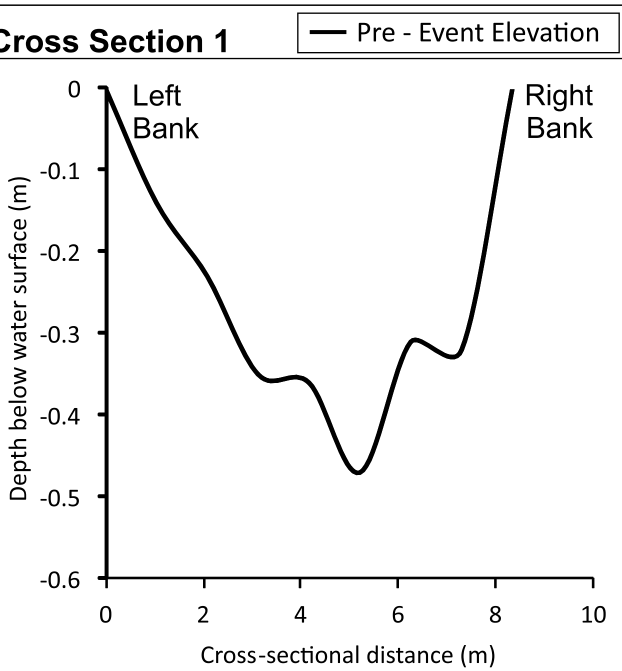
The uppermost reach HC-R1 was 445 m in length and displayed riffle-pool morphology. Banks were composed of fine grained material and stabilized by dense vegetation.

Hazeltine Creek Photographs (January 20, 2007)

Downstream view characteristically unconfined channel conditions at HC-R1.
Substrate at such areas was typically fine gravel to sand.

Upstream view of channel at HC-R1 illustrating low gradient and densely vegetated riparian zone. 'Run' habitat was the dominant morphology type.

Cross Section 1



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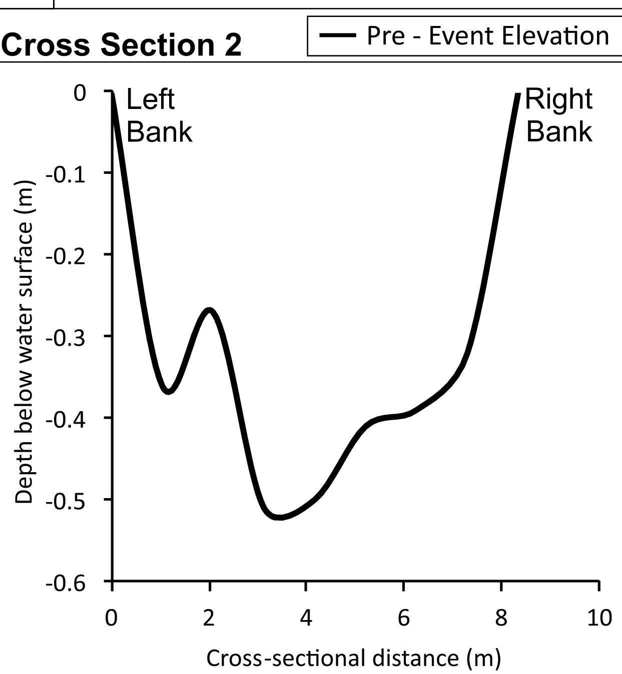

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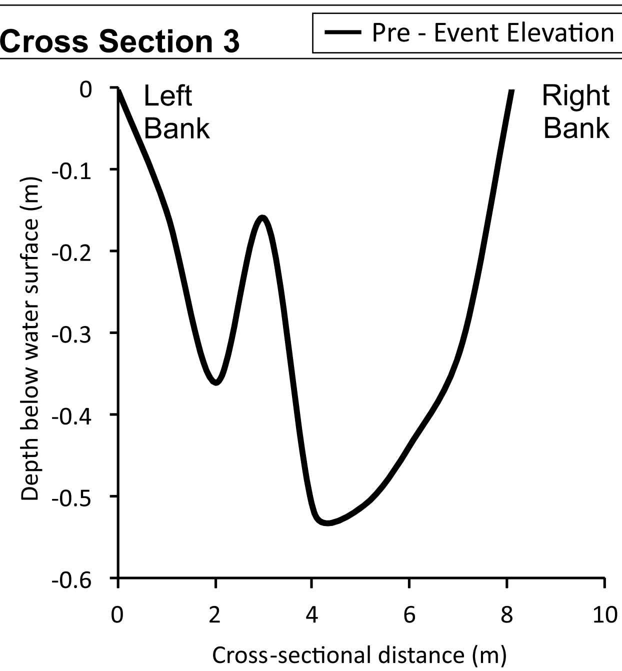


REF No: REV: **0**	REACH:	CLIENT NAME:	PROJECT LOCATION:	DATE:	SNC • LAVALIN
621717-HIA-C003	**HC-R3 Upper Hazeltine Creek**	**Mount Polley Mining Corporation**	**Mount Polley Mine, Likely, BC**	**2015/04/01**	

Area Overview

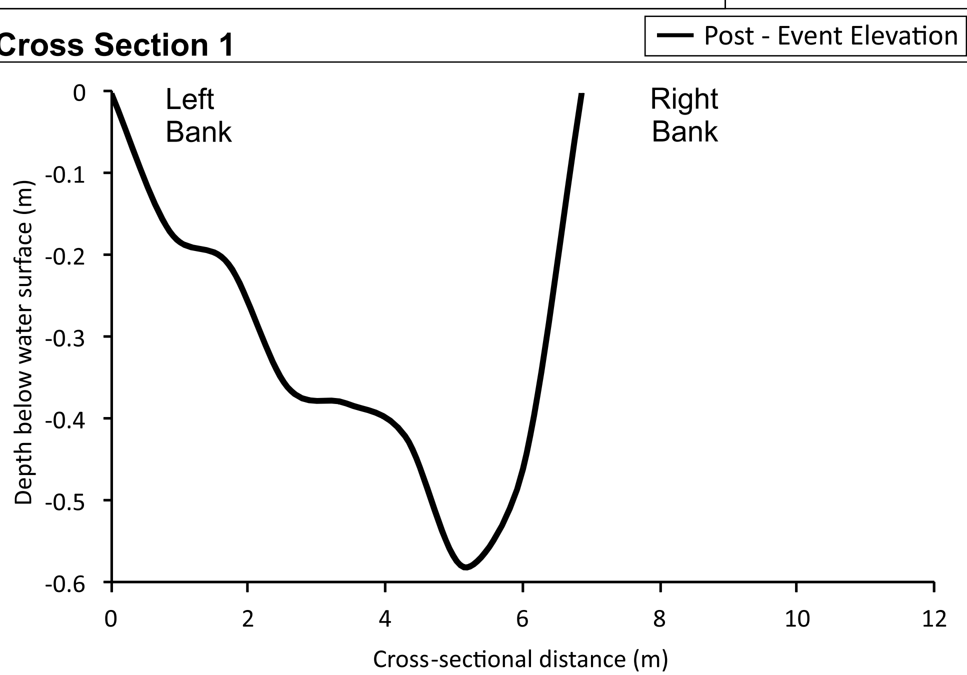
HC-R3 was located downstream of a beaver ponded area. This reach displayed riffle-pool morphology, and was characterized by low gradient and side-channels.

Hazeltine Creek Photographs (January 20, 2007)

Habitat at Reach HC-R3 was characterized by low gradient, run morphology with predominantly sand substrate.

Side channels and the occurrence of unstable banks were more prevalent at Reach HC-R3, likely as a result of multiply overflow points across a beaver dam that marked the upper boundary of the reach.

Cross Section 1



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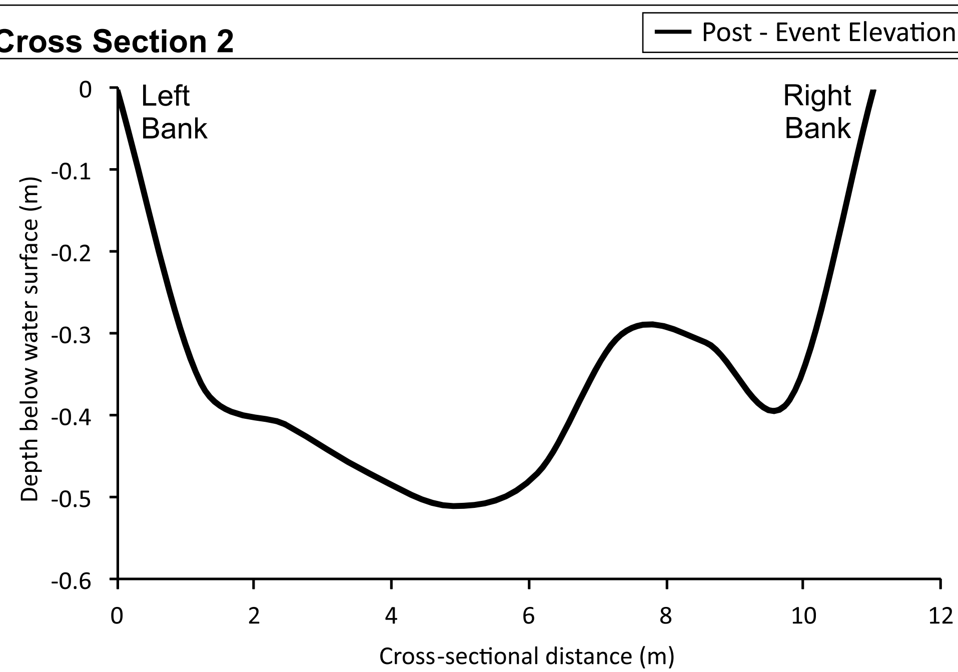


REF No: 621717-HIA-C004	REV: **0**	REACH: **HC-R4 Upper Hazeltine Creek**	CLIENT NAME: **Mount Polley Mining Corporation**	PROJECT LOCATION: **Mount Polley Mine, Likely, BC**	DATE: **2015/04/01**	SNC • LAVALIN

Area Overview

Reach HC-R4 began downstream of the Gavin Lake road bridge. Surface water flow was variable and hyporheic flow was suspected. Bank stability was low in this reach, and undercutting was observed.

Hazeltine Creek Photographs (January 20, 2007)

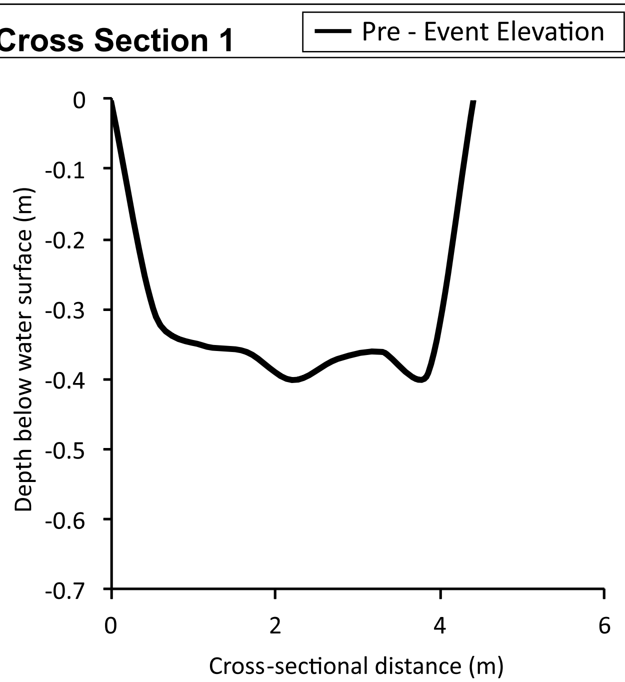
Upstream view towards the Mount Polley Mine water gauge station on Hazeltine Creek at Gavin Lake Road. This is the upper boundary of Reach HC-R4.

Example of an undercut bank in HC-R4. Although undercut banks were common through this reach, overall bank stability was generally considered moderate.

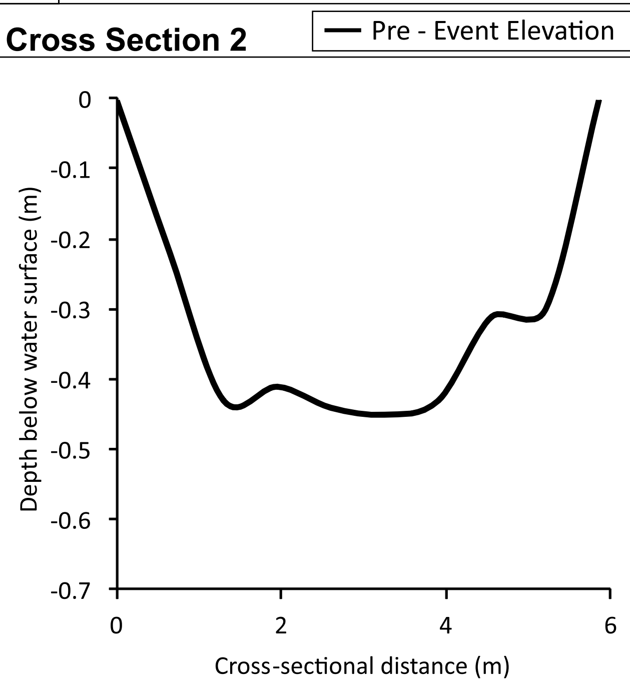
Upstream view of general stream conditions through HC-R4. Low water levels at the time resulted in higher stream-bed exposure. Substrate consisted of cobble-gravel.

Although Edney Creek was the only surface water tributary feeding Hazeltine Creek, groundwater seeps containing high iron content were occasionally observed. This small seep is an example.

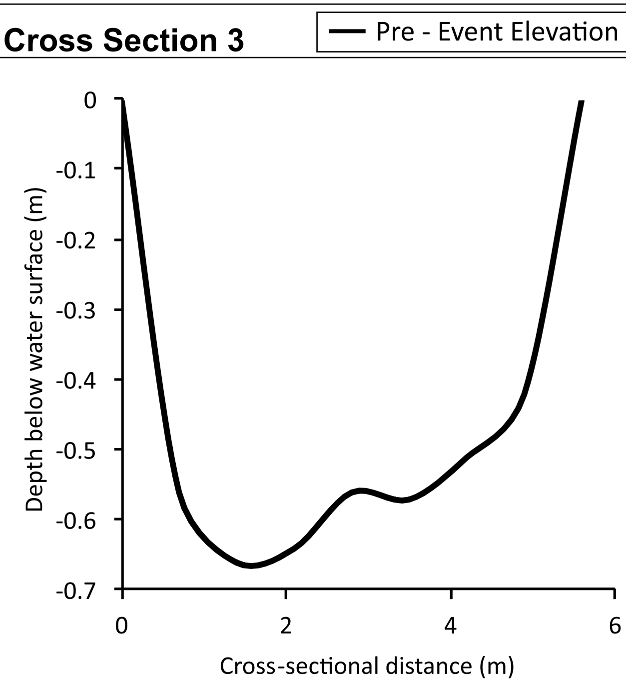
Cross Section 1



Cross Section 2



Cross Section 3



REF No: REV: 0	REACH:	CLIENT NAME:	PROJECT LOCATION:	DATE:	SNC • LAVALIN
621717-HIA-C005	**HC-R5 Upper Hazeltine Creek**	**Mount Polley Mining Corporation**	**Mount Polley Mine, Likely, BC**	**2015/04/01**	

Area Overview

HC-R5 displayed riffle-pool morphology and higher gradient (3.7 %) relative to upstream reaches. Banks were considered moderately stable, and some valley sides had slumped into the channel.

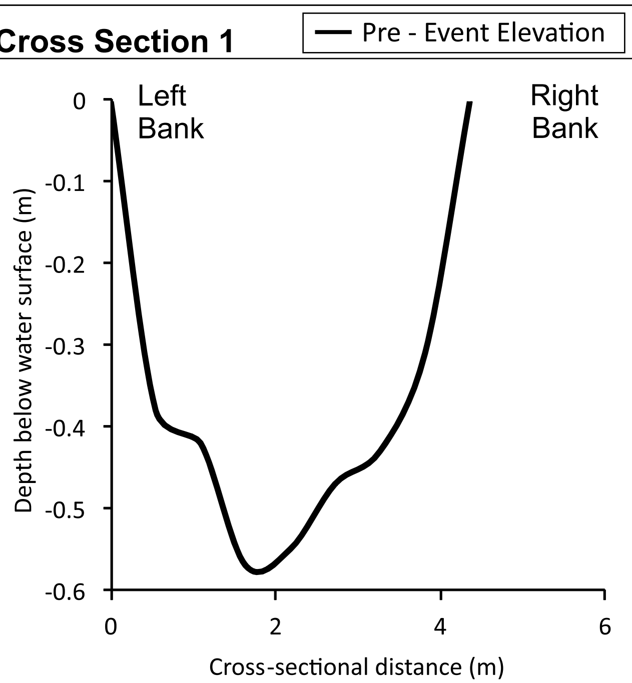
Hazeltine Creek Photographs (January 20, 2007)

Downstream view of typical channel through HC-R5. This reach was characterized by a clear gradient shift (3.7 %) relative to upstream areas.

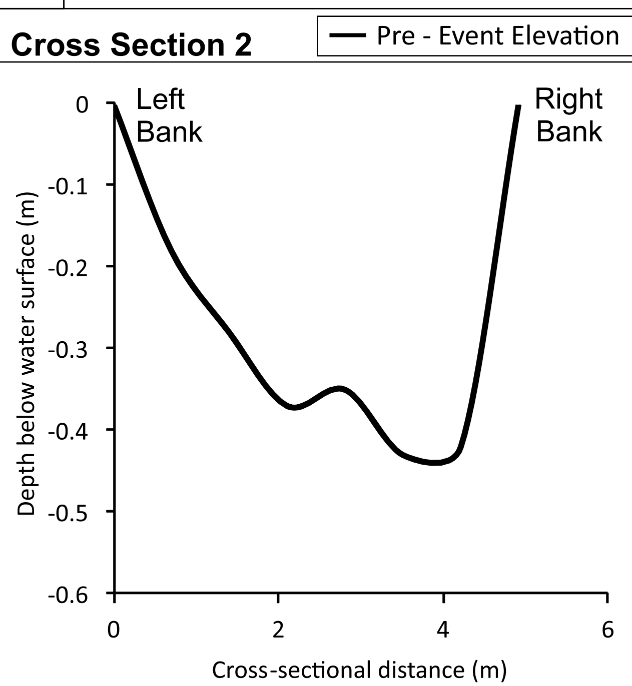
Slumping valley walls such as the one illustrated above were observed at two locations along Hazeltine Creek, both of which were within HC-R5.

Upstream view of an approximately 1.2 m high cascade found in the lower portion of Reach HC-R5. This cascade likely acted as a barrier to upstream fish migration, particularly during low flow periods.

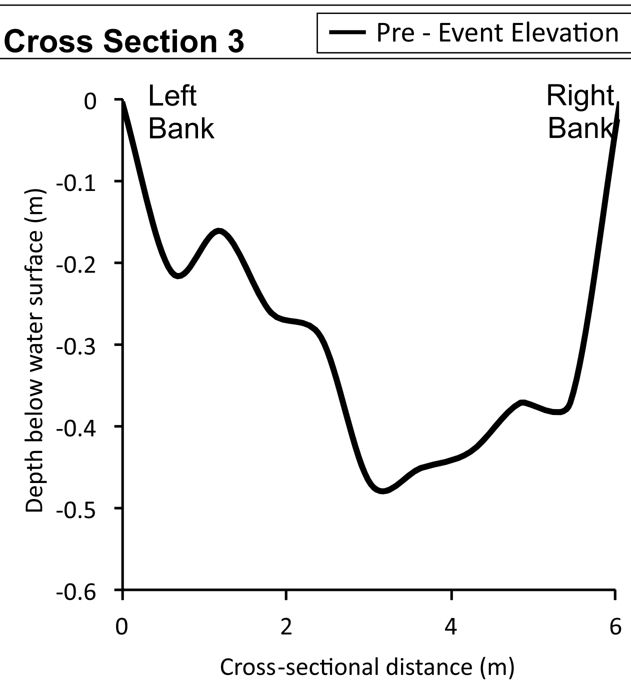
Cross Section 1



Cross Section 2



Cross Section 3



REF No: REV: **0**	REACH:	CLIENT NAME:	PROJECT LOCATION:	DATE:
621717-HIA-C006	**HC-R6 Hazeltine Creek Canyon**	**Mount Polley Mining Corporation**	**Mount Polley Mine, Likely, BC**	**2015/04/01**

SNC • LAVALIN

Area Overview

Hazeltine Creek entered a 1,510 m long canyons at HC-R6. The channel was lined with bedrock, boulders and cobbles, and displayed step-pool morphology. This reach was extremely stable.

Hazeltine Creek Photographs (January 20, 2007)

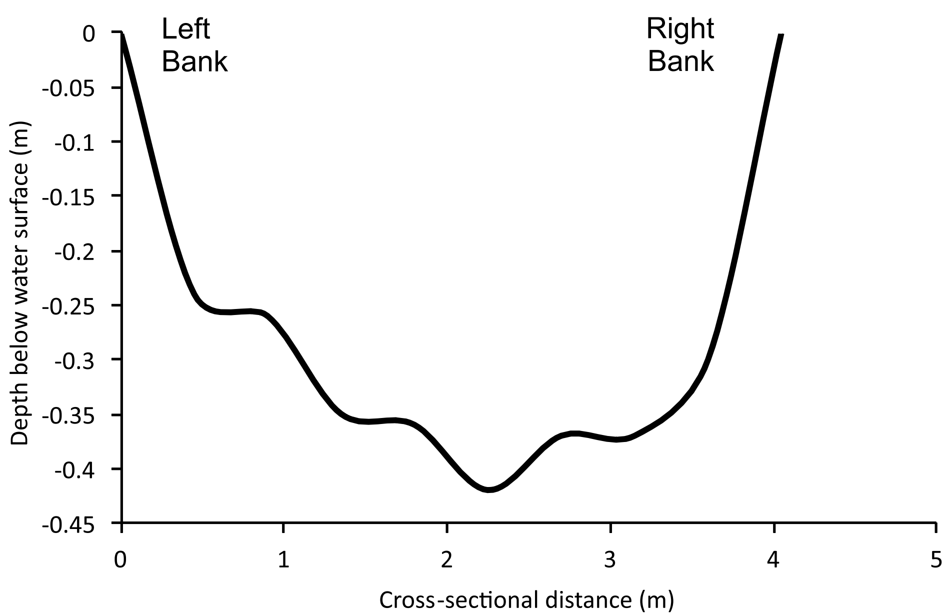
HC-R6 represented that portion of Hazeltine Creek which passed through a steep-walled gorge. Bank stability was considered good at HC-R6 as a result of a high proportion of bedrock/cobble in the banks.

In-stream barriers, such as this large debris jam, were common through HC-R6, likely preventing upstream fish migration at all but the highest flows.

Step-pools with cobble substrate characterized HC-R6 habitat. Mean gradient through this reach was approximately 7%.

In-stream barriers at HC-R6 also included areas of aggraded cobble over log debris, which resulted in short sections of hyporheic flow.

Cross Section 2



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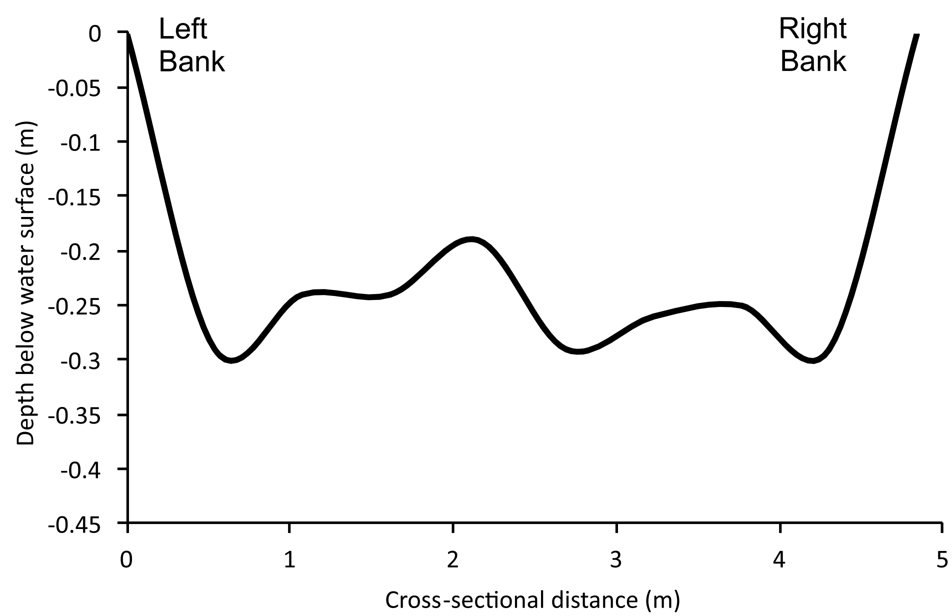


REF No: 621717-HIA-C007	REV: **0**	REACH: **HC-R7 Lower Hazeltine Creek**	CLIENT NAME: **Mount Polley Mining Corporation**	PROJECT LOCATION: **Mount Polley Mine, Likely, BC**	DATE: **2015/04/01**	SNC • LAVALIN

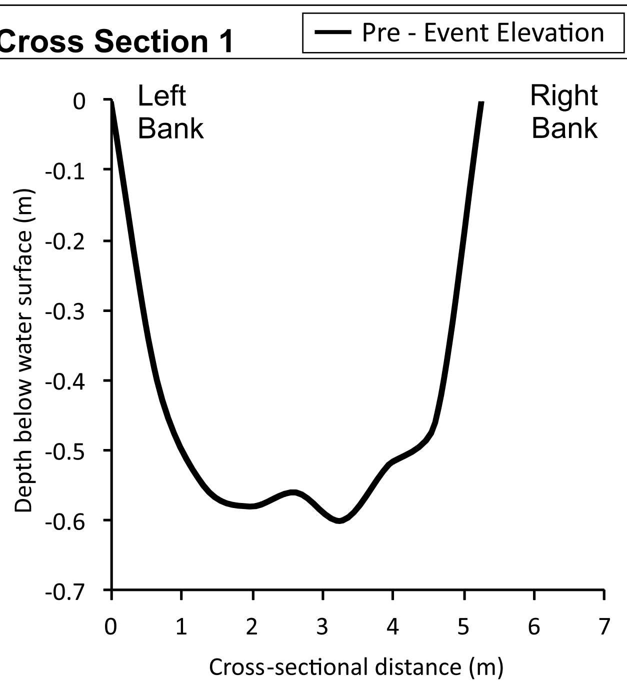
Area Overview

HC-R7 was the first reach of Lower Hazeltine Creek, extending from the mouth of the canyon to just below the ditch road. The channel displayed riffle-pool morphology with stable banks.

Hazeltine Creek Photographs (January 20, 2007)

Downstream view of typical Reach HC-R7 habitat. Moderate gradient, riffle-run stream morphology and cobble substrate were key features of this reach.

Cross Section 1



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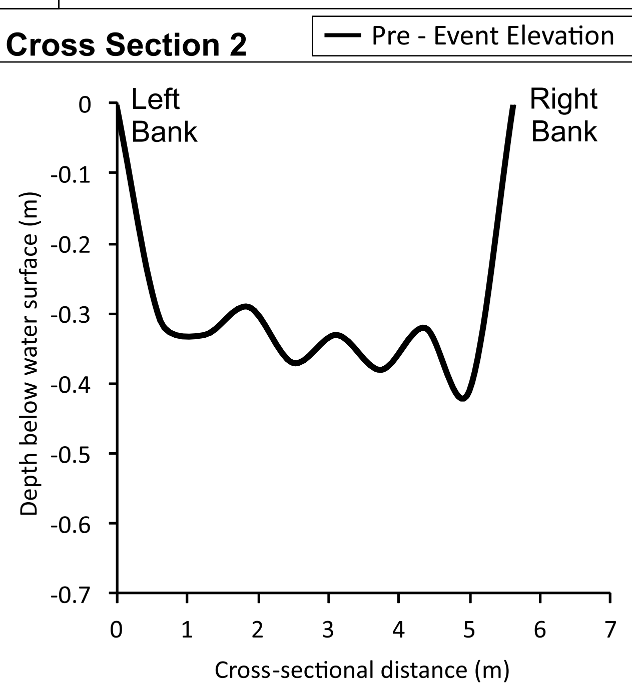

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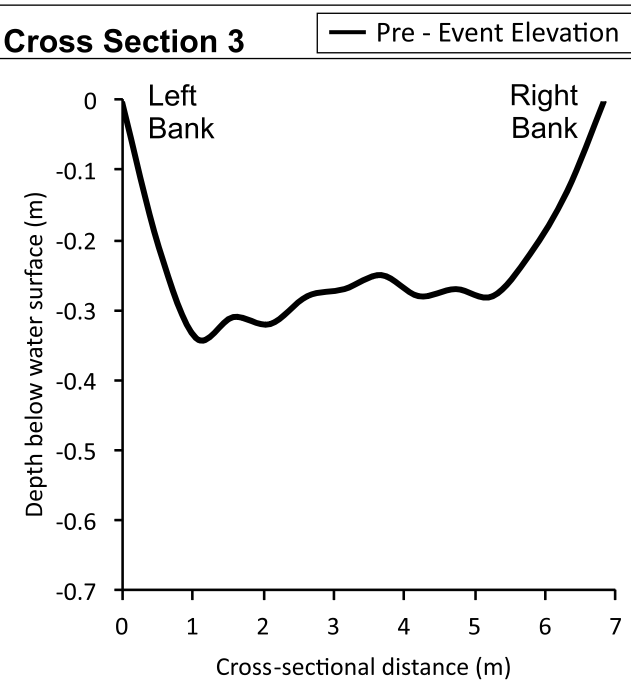


REF No: REV: **0**	REACH:	CLIENT NAME:	PROJECT LOCATION:	DATE:	
621717-HIA-C008	**HC-R8 Lower Hazeltine Creek**	**Mount Polley Mining Corporation**	**Mount Polley Mine, Likely, BC**	**2015/04/01**	SNC · LAVALIN

Area Overview

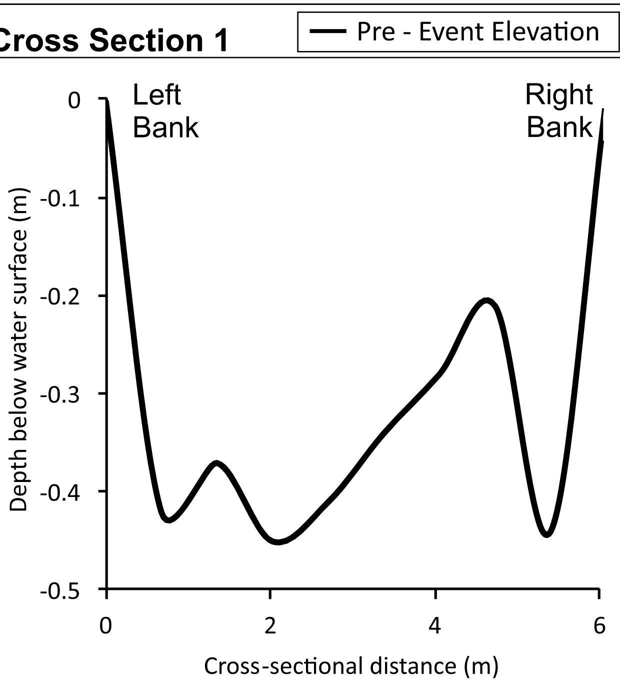
HC-R8 extended 555 m downstream of HC-R7 to the confluence with Edney Creek. The reach was characterized by relatively lower gradient, smaller substrate grain size, and lower bank stability.

Hazeltine Creek Photographs (January 20, 2007)

Downstream view of Reach HC-R8 in its upper portion. Low gradient run habitat with gravel substrate and dense overhanging vegetation were dominant features of this reach.

Downstream view of Reach HC-R8 in its lower portion. At this area, the creek flows through cedar lowland habitat and some bank undercutting occurs. Stream flow increases substantially at HC-R8 relative to upstream areas.

Cross Section 1



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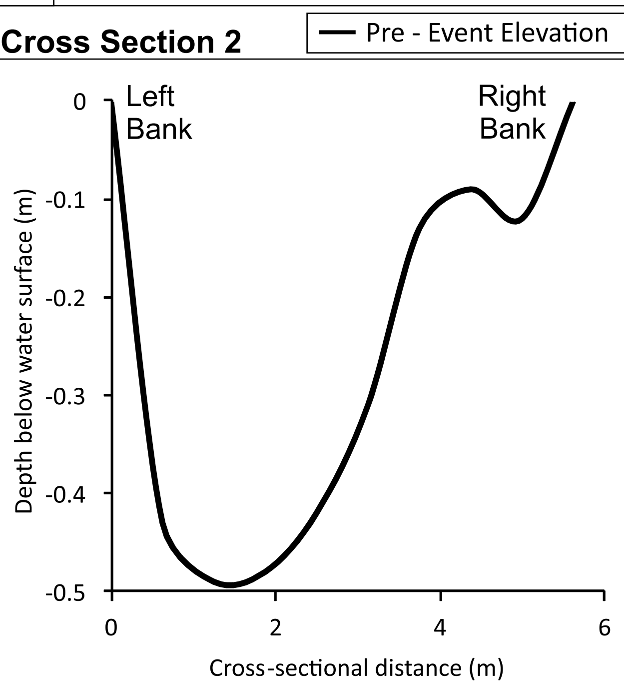

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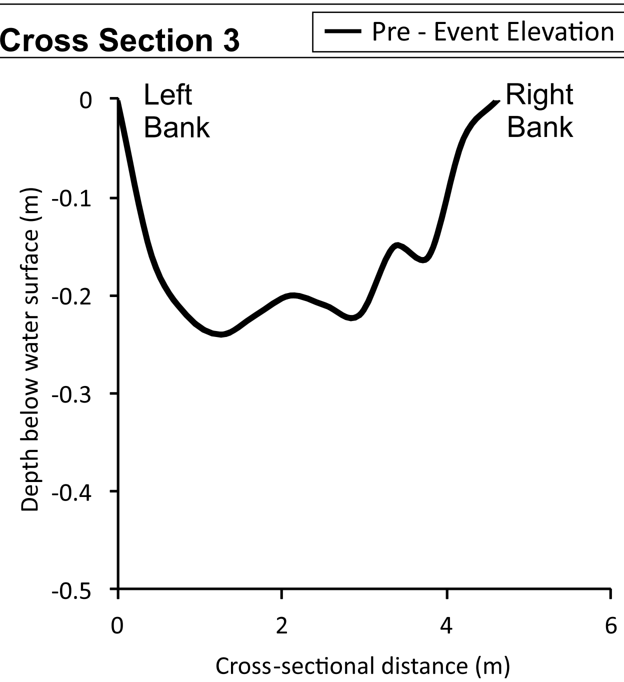


REF No: REV: 0	REACH:	CLIENT NAME:	PROJECT LOCATION:	DATE:	SNC • LAVALIN
621717-HIA-C009	**HC-R9 Lower Hazeltine Creek**	**Mount Polley Mining Corporation**	**Mount Polley Mine, Likely, BC**	**2015/04/01**	

Area Overview

HC-R9 is the final reach of Hazeltine Creek, extending from the confluence with Edney Creek to Quesnel Lake. This reach displayed riffle-pool morphology and relatively stable banks.

Hazeltine Creek Photographs (January 20, 2007)

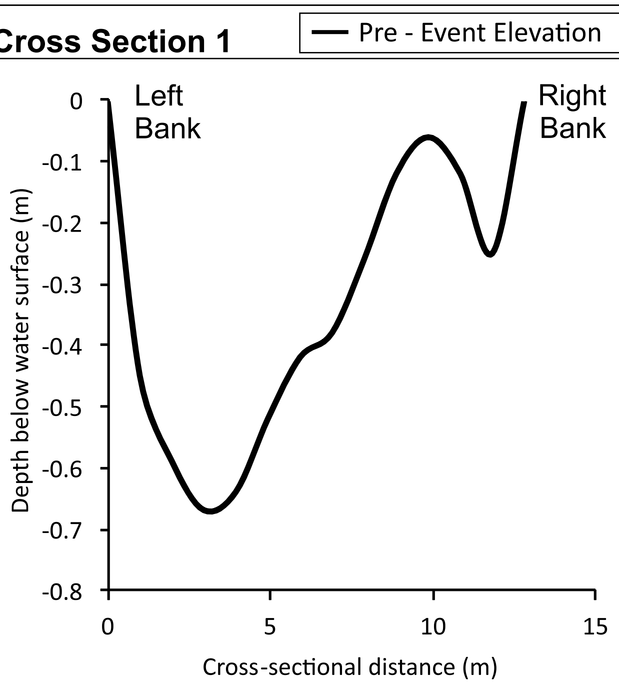
Upstream view of HC-R9 in its upper portion. Low gradient run habitat and cobble-grael substrate characterized this reach.

Hazeltine Creek approximately 400 m upstream of Quesnel Lake. Fish habitat included some pool and woody debris in lower Hazeltine Creek, although the relative amount of functional habitat was considered low.

Upstream view of HC-R9 approximately 385 m upstream of the outlet of Hazeltine Creek. This is the location of water sample Station W11.

Riffle habitat in lower Hazeltine Creek was generally shallow (< 10 cm deep) and likely to restrict upstream movement of large fish.

Cross Section 1



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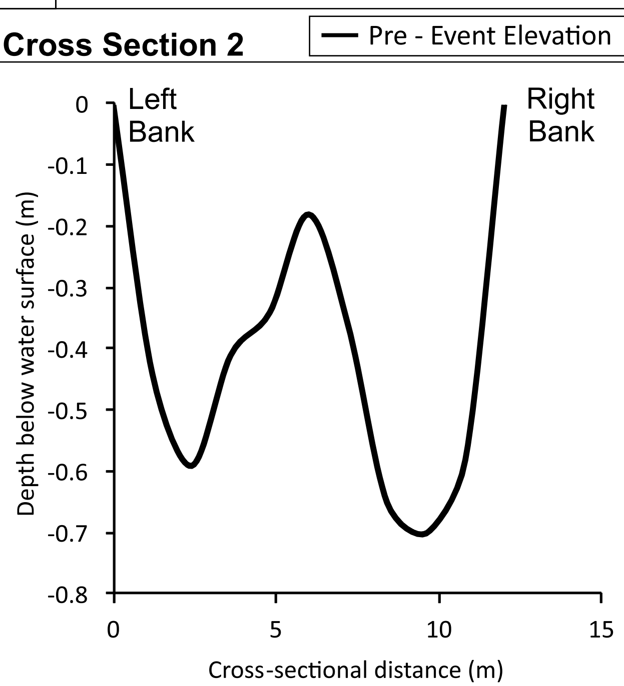

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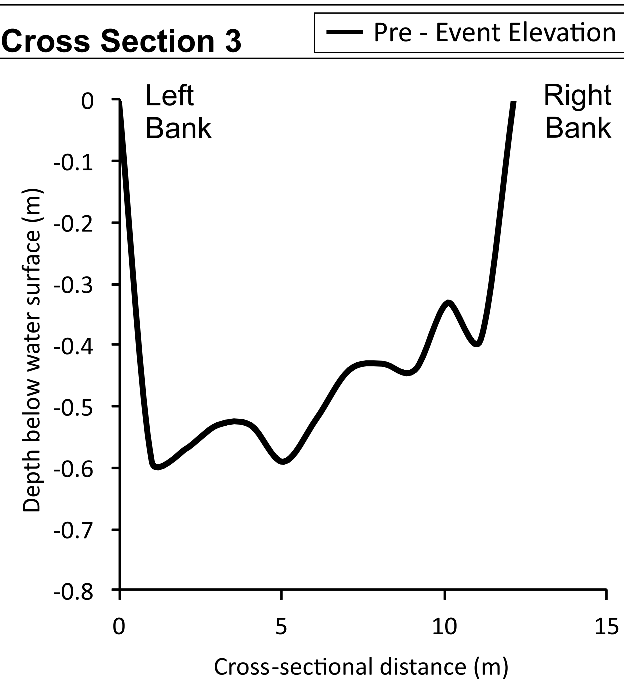
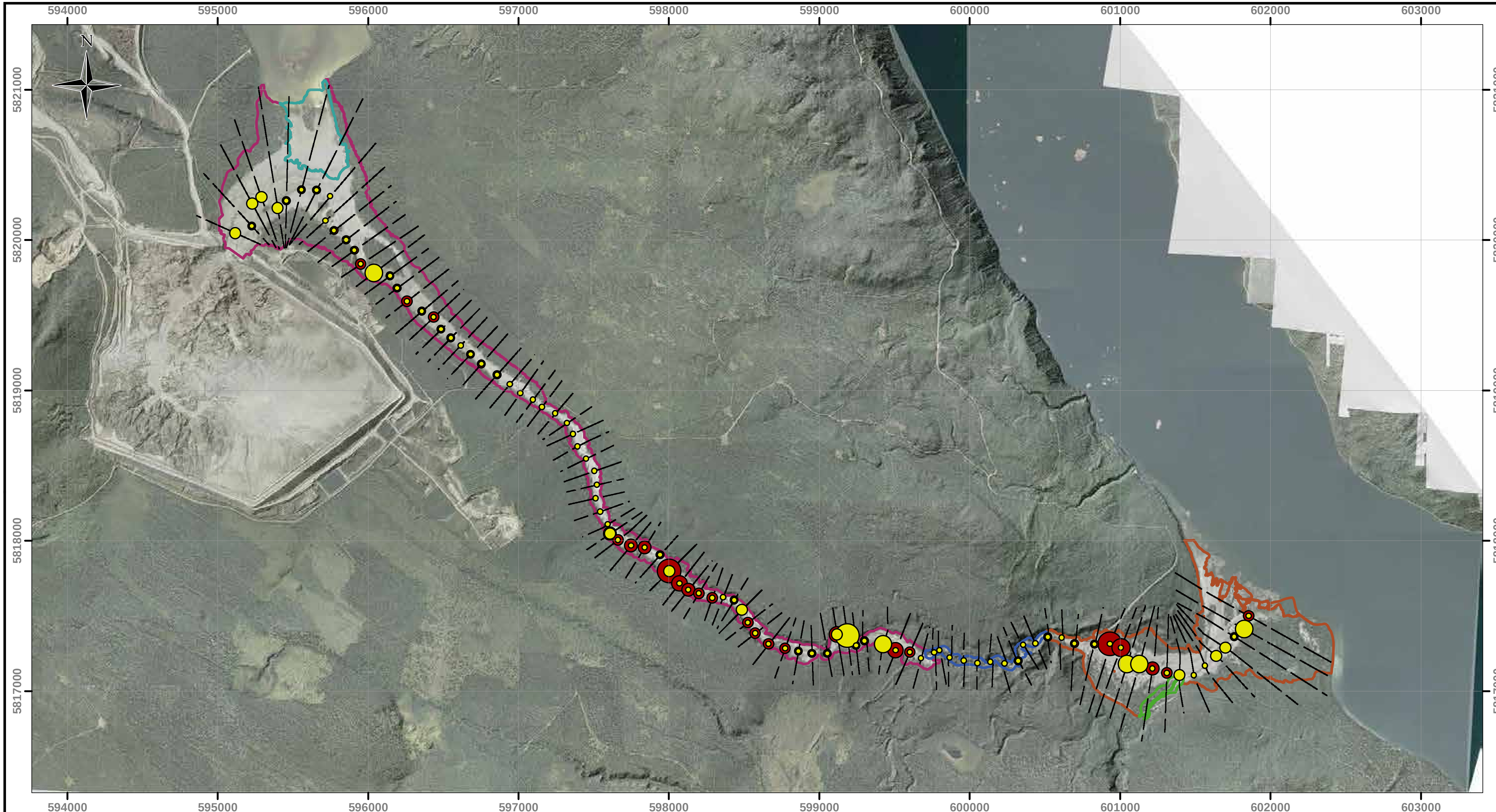


APPENDIX D

Maps of the estimated volumes of material eroded from the Hazeltine Creek valley



LEGEND

— Cross-Sections

Hazeltine Creek Sections

- Polley Plug
- Upper Hazeltine Creek
- Canyon
- Lower Hazeltine Creek
- Edney Creek Mouth

Minimum Volume Scoured (cubic meters)

- 0 - 10,000
- 10,001 - 20,000
- 20,001 - 30,000
- 30,001 - 40,000

Maximum Volume Scoured (cubic meters)

- 0 - 10,000
- 10,001 - 20,000
- 20,001 - 30,000
- 30,001 - 40,000
- 40,001 - 50,000
- 50,001 - 60,000
- 70,001 - 80,000

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

4. Uncertainty in estimate indicated by difference in size of Minimum and Maximum circles.

REFERENCES

0 500 1,000 Meters

1. Orthophoto and Hazeltine Creek sections provided by Mount Polley Mining Corporation.

2. Orthophoto collected 5 August, 2014 by McElhanney Consulting Services Ltd.

SNC·LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Creek
Maximum and Minimum Volumes Scoured

BY: HB	SCALE: 1:25,000	DATE: 4/23/2015	REF No: REV: 0
CHK'D: VC	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-D001

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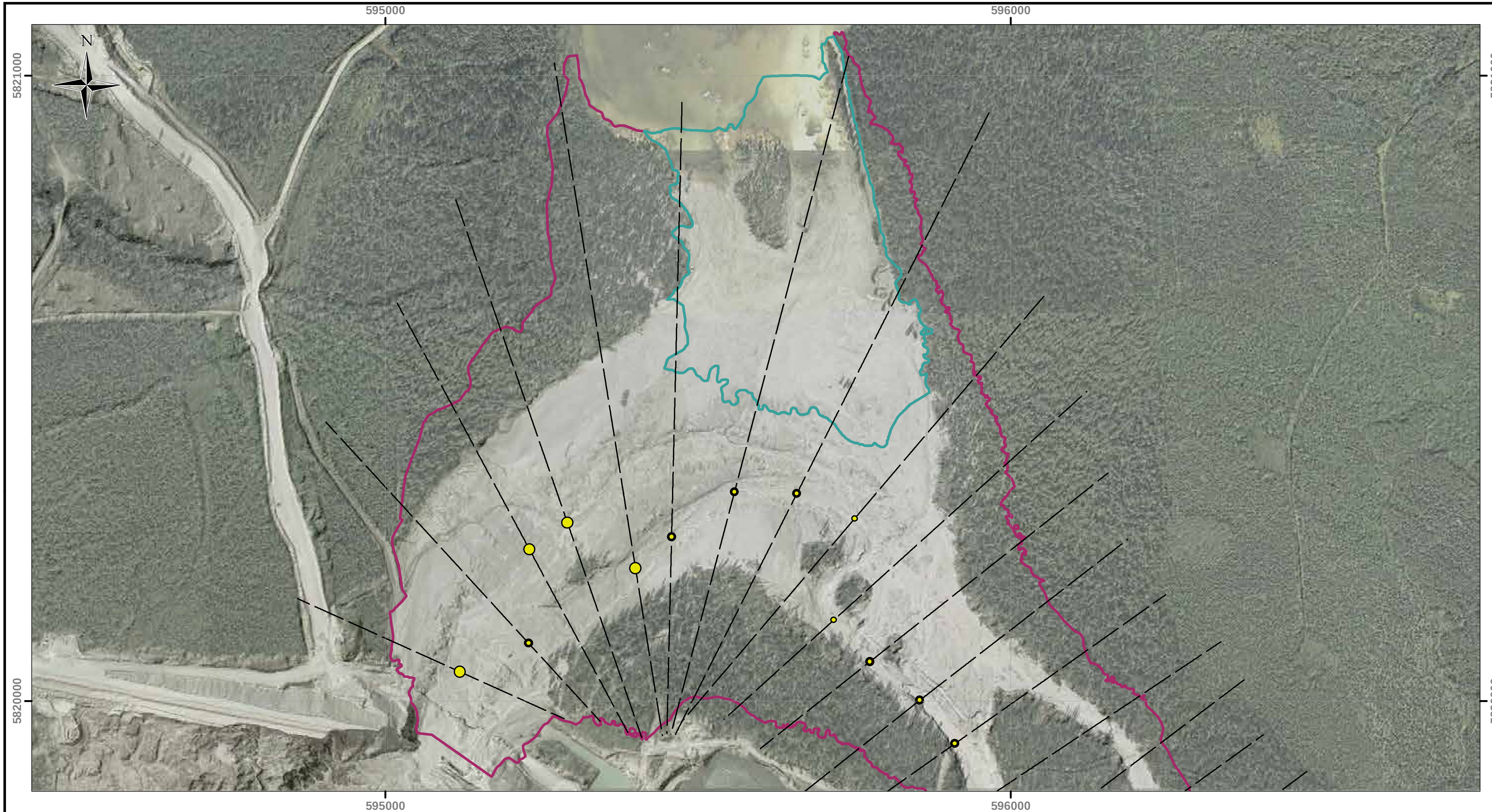

LEGEND

— Cross-Sections

Hazeltine Creek Sections
- Polley Plug
- Upper Hazeltine Creek

Minimum Volume Scoured (cubic meters)
- 0 - 10,000
- 10,001 - 20,000

Maximum Volume Scoured (cubic meters)
- 0 - 10,000
- 10,001 - 20,000
- 20,001 - 30,000

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

4. Uncertainty in estimate indicated by difference in size of Minimum and Maximum circles.

REFERENCES

0 120 240 Meters

1. Orthophoto and Hazeltine Creek sections provided by Mount Polley Mining Corporation.

2. Orthophoto collected 5 August, 2014 by McElhanney Consulting Services Ltd.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Polly Plug and Upper Hazeltine Creek Maximum and Minimum Volumes Scoured

BY: HB	SCALE: 1:6,000	DATE: 4/23/2015	REF No:	REV: 0
CHK'D: VC	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-D002	

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LEGEND

— Cross-Sections

Hazeltine Creek Sections

Upper Hazeltine Creek

Minimum Volume Scoured (cubic meters)

- 0 - 10,000
- 20,001 - 30,000

Maximum Volume Scoured (cubic meters)

- 0 - 10,000
- 10,001 - 20,000
- 20,001 - 30,000
- 40,001 - 50,000

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

4. Uncertainty in estimate indicated by difference in size of Minimum and Maximum circles.

REFERENCES

0 120 240 Meters

1. Orthophoto and Hazeltine Creek sections provided by Mount Polley Mining Corporation.

2. Orthophoto collected 5 August, 2014 by McElhanney Consulting Services Ltd.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Upper Hazeltine Creek at Gavin Lake Road
Maximum and Minimum Volumes Scoured

BY: HB	SCALE: 1:6,000	DATE: 4/23/2015	REF No: REV: 0
CHK'D: VC	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-D003

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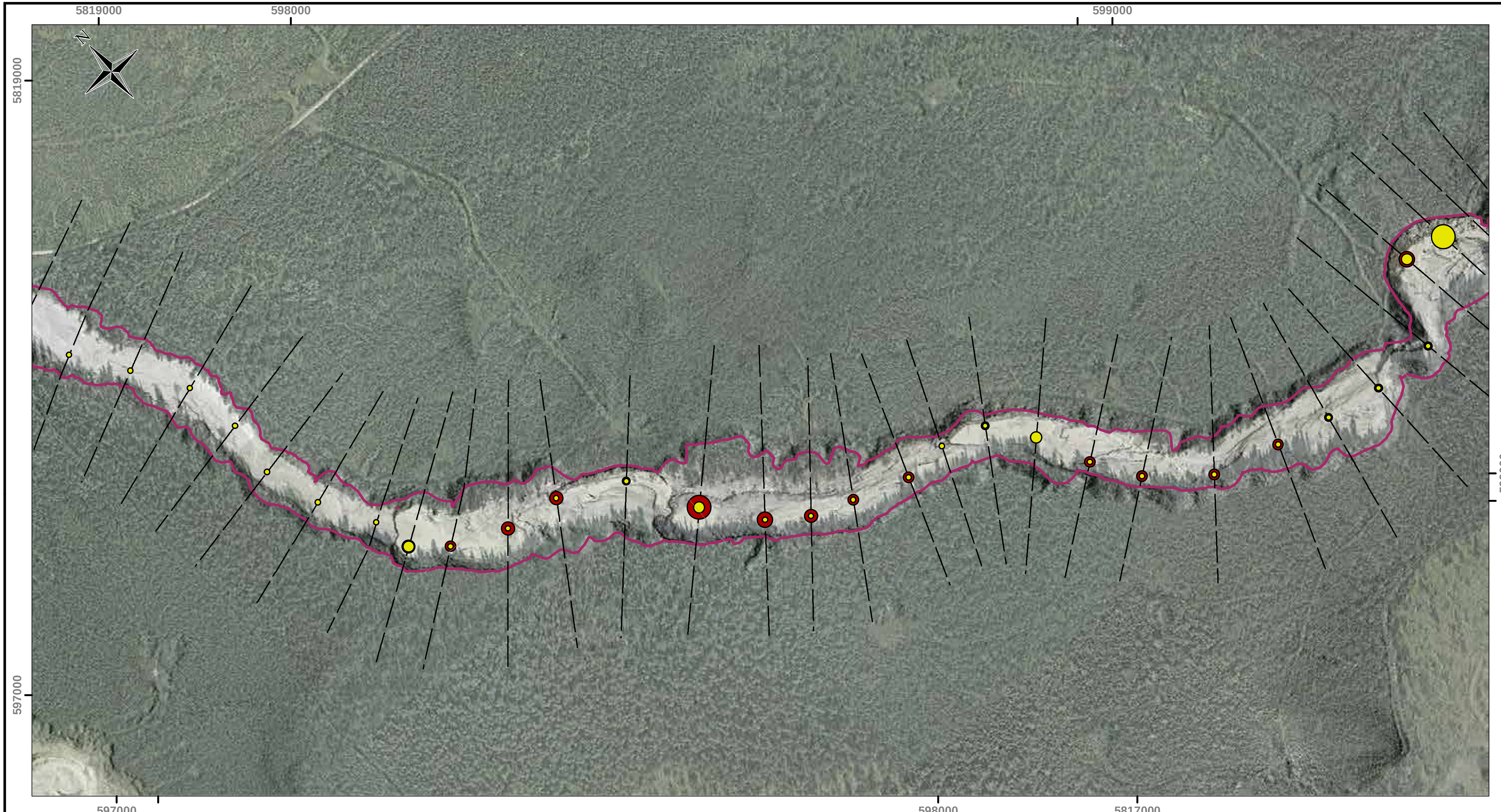

LEGEND

— Cross-Sections

Hazeltine Creek Sections

Upper Hazeltine Creek

Minimum Volume Scoured (cubic meters)

- 0 - 10,000
- 10,001 - 20,000
- 30,001 - 40,000

Maximum Volume Scoured (cubic meters)

- 0 - 10,000
- 10,001 - 20,000
- 20,001 - 30,000
- 30,001 - 40,000
- 40,001 - 50,000
- 70,001 - 80,000

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.
4. Uncertainty in estimate indicated by difference in size of Minimum and Maximum circles.

REFERENCES

0 120 240 Meters

1. Orthophoto and Hazeltine Creek sections provided by Mount Polley Mining Corporation.
2. Orthophoto collected 5 August, 2014 by McElhanney Consulting Services Ltd.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Upper Hazeltine Creek Below Gavin Lake Road Maximum and Minimum Volumes Scoured

BY: HB	SCALE: 1:6,000	DATE: 4/23/2015	REF No:	REV: 0
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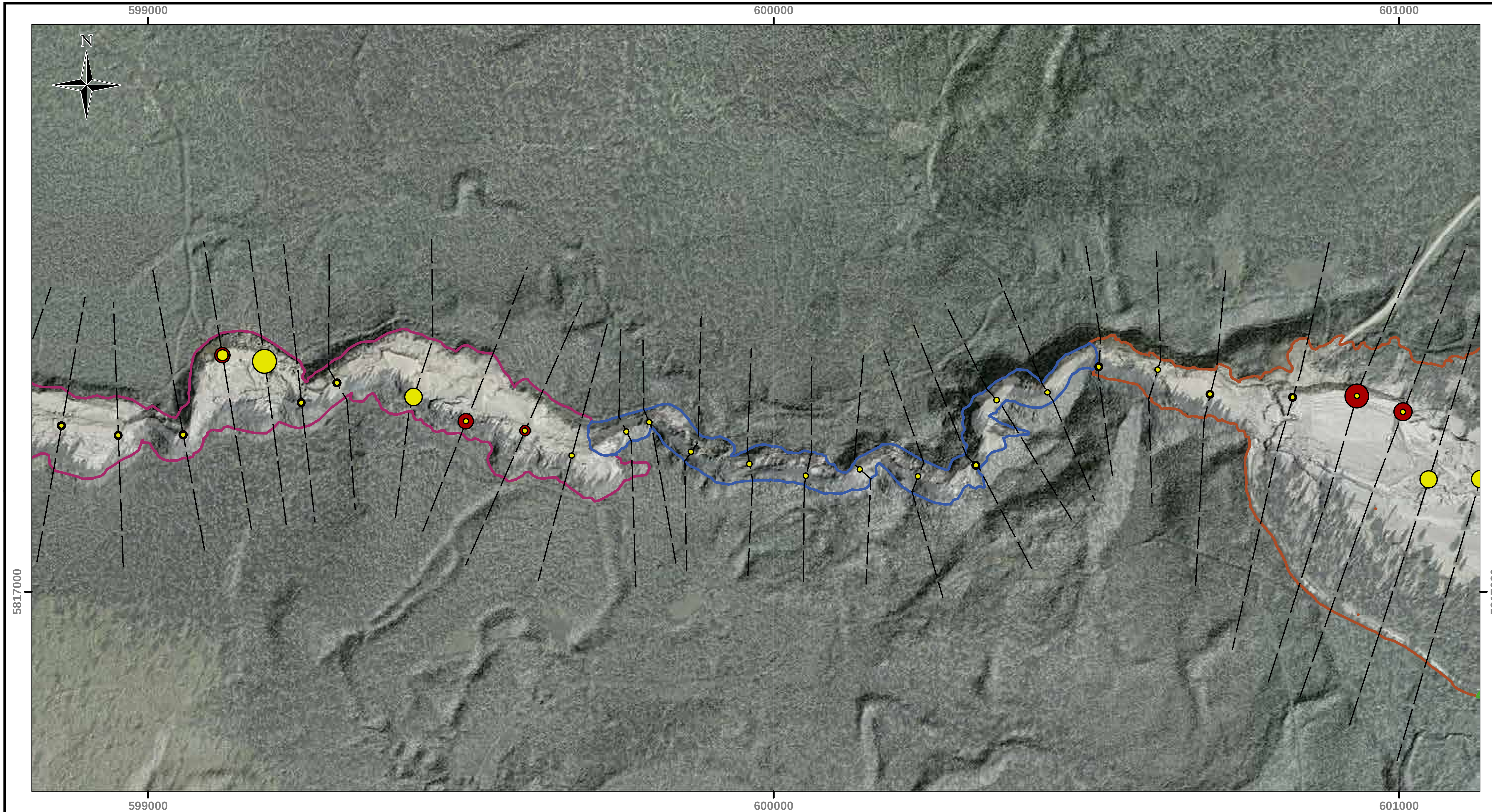

LEGEND

— Cross-Sections

Hazeltine Creek Sections
- Polley Plug
- Upper Hazeltine Creek
- Canyon
- Lower Hazeltine Creek
- Edney Creek Mouth

Minimum Volume Scoured (cubic meters)
- 0 - 10,000
- 10,001 - 20,000
- 20,001 - 30,000
- 30,001 - 40,000

Maximum Volume Scoured (cubic meters)
- 0 - 10,000
- 10,001 - 20,000
- 20,001 - 30,000
- 30,001 - 40,000
- 40,001 - 50,000
- 50,001 - 60,000
- 60,001 - 70,000
- 70,001 - 80,000

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.
4. Uncertainty in estimate indicated by difference in size of Minimum and Maximum circles.

REFERENCES

0 120 240 Meters

1. Orthophoto and Hazeltine Creek sections provided by Mount Polley Mining Corporation.
2. Orthophoto collected 5 August, 2014 by McElhanney Consulting Services Ltd.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Creek Canyon
Maximum and Minimum Volumes Scoured

BY: HB	SCALE: 1:6,000	DATE: 4/23/2015	REF No:	REV: 0
CHK'D: VC	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-D005	

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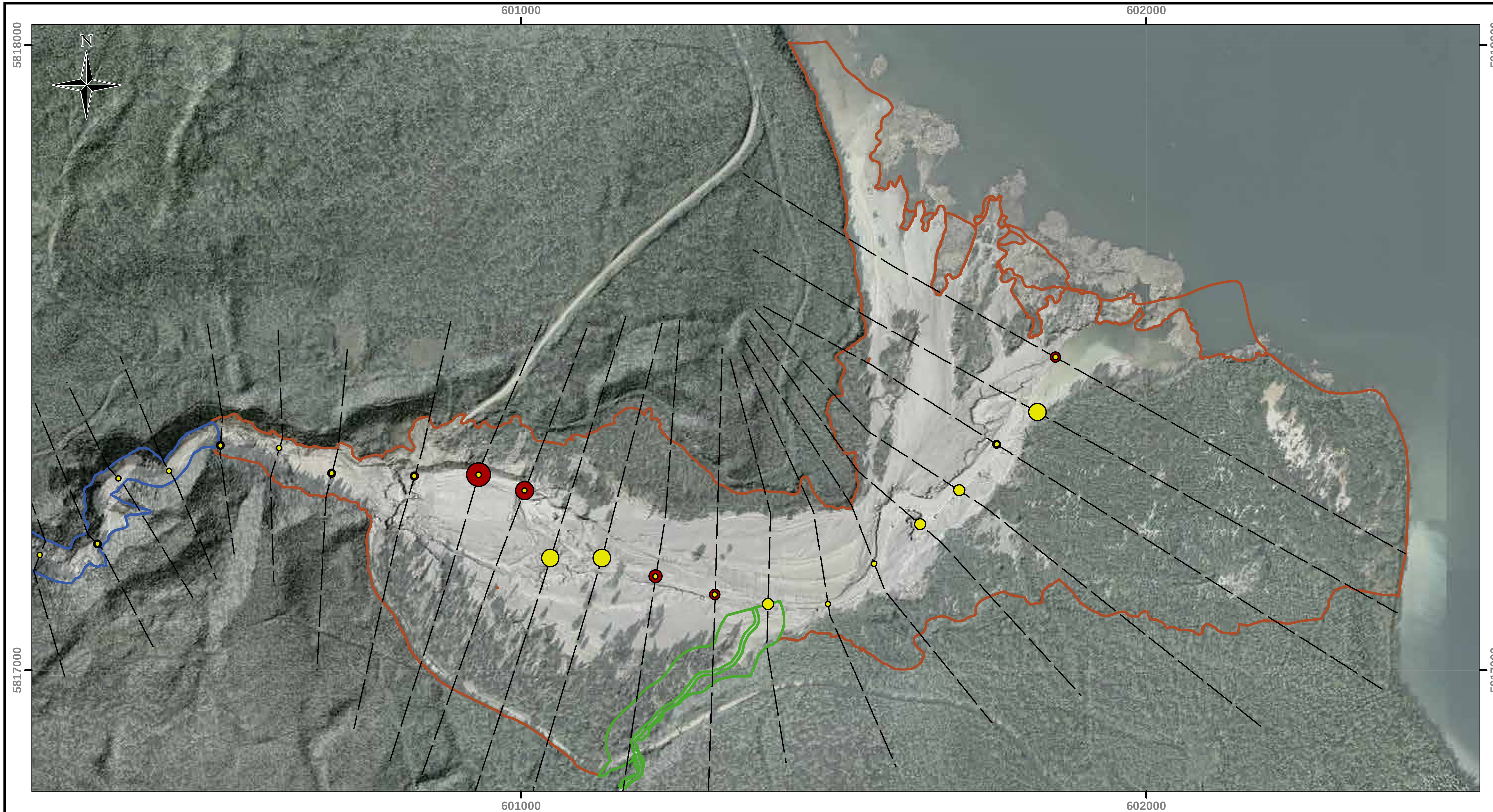

LEGEND

— Cross-Sections

Hazeltine Creek Sections
- Polley Plug
- Upper Hazeltine Creek
- Canyon
- Lower Hazeltine Creek
- Edney Creek Mouth

Minimum Volume Scoured (cubic meters)
- 0 - 10,000
- 10,001 - 20,000
- 20,001 - 30,000
- 30,001 - 40,000

Maximum Volume Scoured (cubic meters)
- 0 - 10,000
- 10,001 - 20,000
- 20,001 - 30,000
- 30,001 - 40,000
- 40,001 - 50,000
- 50,001 - 60,000
- 60,001 - 70,000
- 70,001 - 80,000

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

4. Uncertainty in estimate indicated by difference in size of Minimum and Maximum circles.

REFERENCES

0 120 240 Meters

1. Orthophoto and Hazeltine Creek sections provided by Mount Polley Mining Corporation.

2. Orthophoto collected 5 August, 2014 by McElhanney Consulting Services Ltd.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Lower Hazeltine Creek and Edney Creek Mouth Maximum and Minimum Volumes Scoured

BY: HB	SCALE: 1:6,000	DATE: 4/23/2015	REF No:	REV: 0
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Project Path: P:\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\

APPENDIX E

Maps of the estimated volumes of material deposited within the Hazeltine Creek valley, including surficial material types

LEGEND

Thickness of Deposition

- 0 m
- < 0.1 m
- 0.10-0.19 m
- 0.20-0.49 m
- 0.50-0.99 m
- 1.00-1.49 m
- 1.50-1.99 m
- 2.0-2.49 m
- 2.5-2.99 m
- 3.0-3.49 m
- > 3.5 m
- N/A

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 500 1,000 Meters

1. Orthophoto provided by Mount Polley Mining Corporation.
2. Orthophoto collected 5 August, 2014 by McElhanney Consulting Services Ltd.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Overview Map of Thickness of Deposition

BY: HB	SCALE: 1:25,000	DATE: 5/22/2015	REF No: REV: 0
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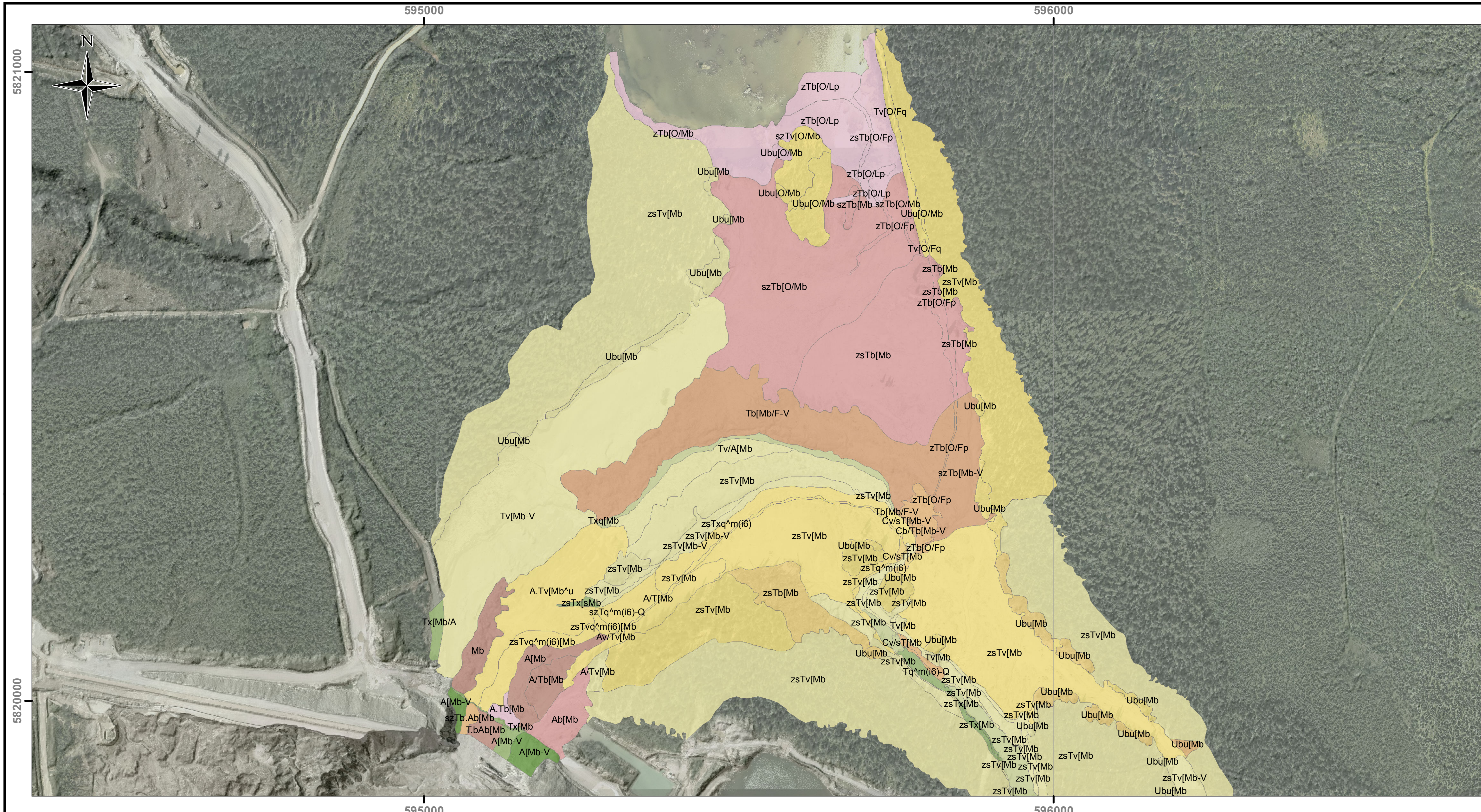

LEGEND

Thickness of Deposition

- 0 m
- < 0.1 m
- 0.10-0.19 m
- 0.20-0.49 m
- 0.50-0.99 m
- 1.00-1.49 m
- 1.50-1.99 m
- 2.0-2.49 m
- 2.5-2.99 m
- 3.0-3.49 m
- > 3.5 m
- N/A

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 125 250 Meters

1. Orthophoto provided by Mount Polley Mining Corporation.

2. Orthophoto collected 5 August, 2014 by McElhanney Consulting Services Ltd.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation	PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Polley Plug and Upper Hazeltine Creek
Thickness of Deposition and Surficial Material

BY: HB	SCALE: 1:6,000	DATE: 5/22/2015	REF No:	REV: 0
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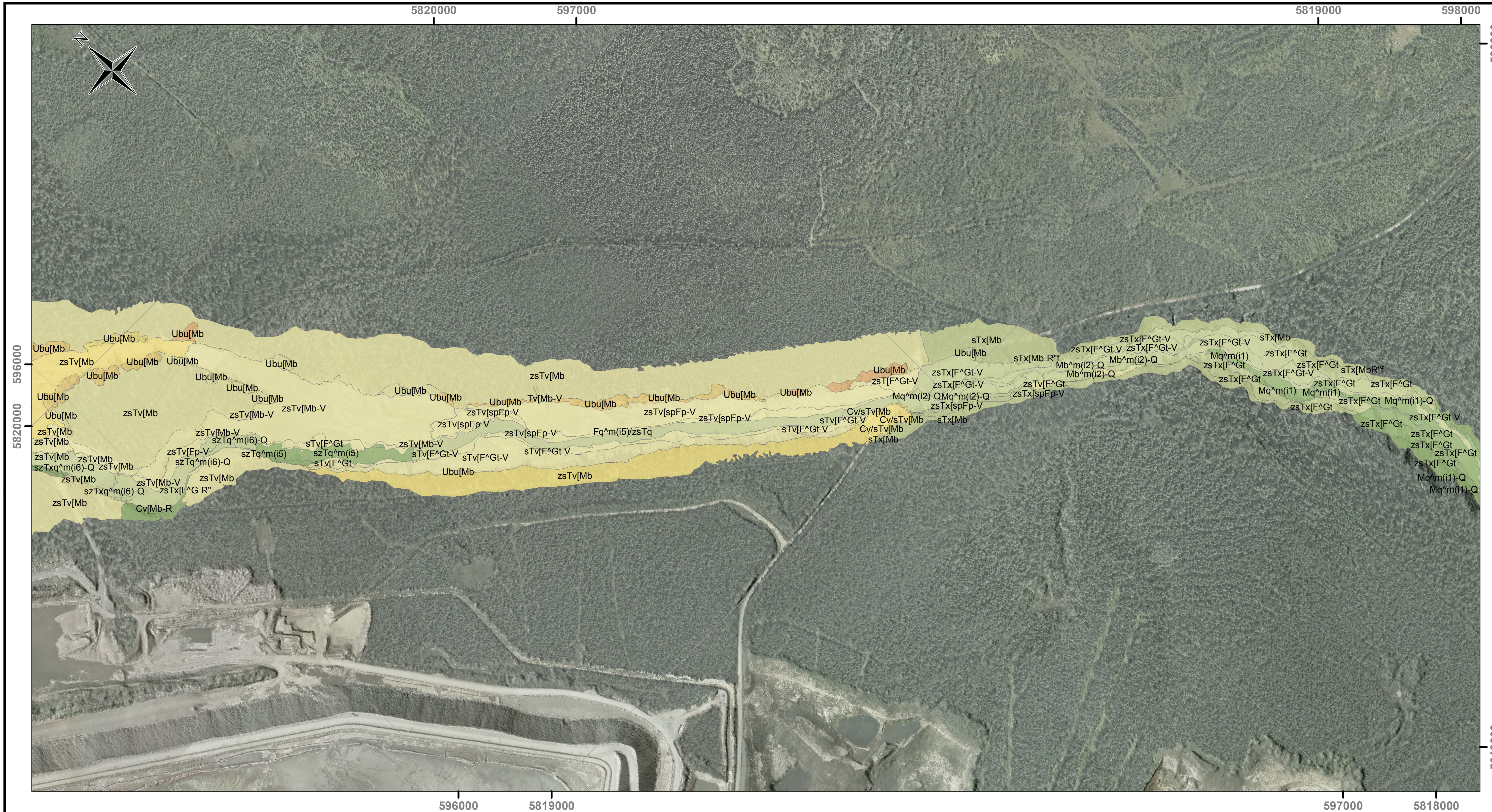

LEGEND

Thickness of Deposition

- 0 m
- < 0.1 m
- 0.10-0.19 m
- 0.20-0.49 m
- 0.50-0.99 m
- 1.00-1.49 m
- 1.50-1.99 m
- 2.0-2.49 m
- 2.5-2.99 m
- 3.0-3.49 m
- > 3.5 m
- N/A

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 125 250 Meters

1. Orthophoto provided by Mount Polley Mining Corporation.

2. Orthophoto collected 5 August, 2014 by McElhanney Consulting Services Ltd.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Upper Hazeltine Creek at Gavin Lake Road
Thickness of Deposition and Surficial Material

BY: HB	SCALE: 1:6,000	DATE: 5/22/2015	REF No:	REV: 0
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Project Path: P:\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\

LEGEND

Thickness of Deposition

- 0 m
- < 0.1 m
- 0.10-0.19 m
- 0.20-0.49 m
- 0.50-0.99 m
- 1.00-1.49 m
- 1.50-1.99 m
- 2.0-2.49 m
- 2.5-2.99 m
- 3.0-3.49 m
- > 3.5 m
- N/A

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 125 250 Meters

1. Orthophoto provided by Mount Polley Mining Corporation.
2. Orthophoto collected 5 August, 2014 by McElhanney Consulting Services Ltd.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Upper Hazeltine Creek Below Gavin Lake Road Thickness of Deposition and Surficial Material

BY: HB	SCALE: 1:6,000	DATE: 5/22/2015	REF No:	REV: 0
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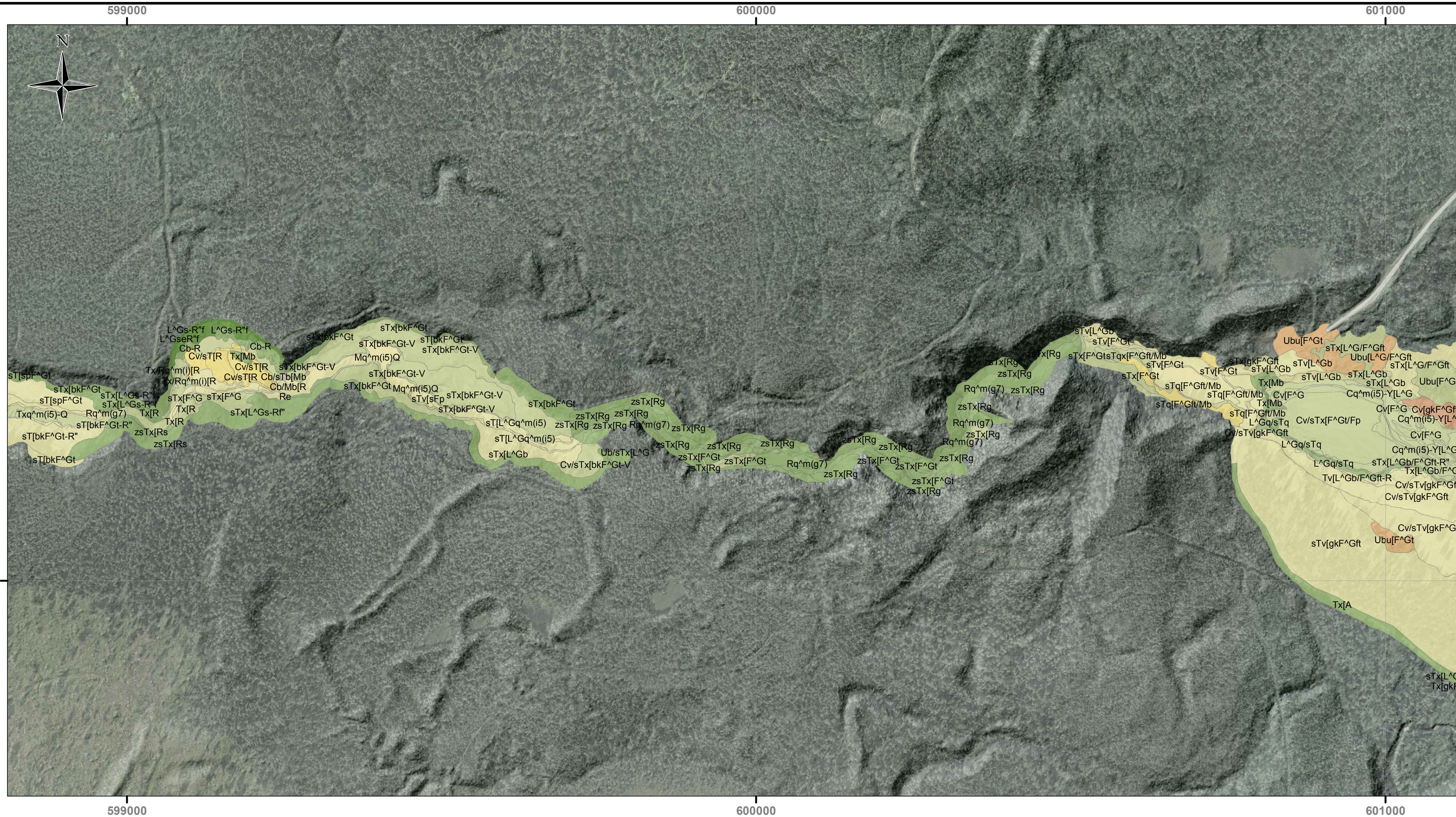

LEGEND

Thickness of Deposition

- 0 m
- < 0.1 m
- 0.10-0.19 m
- 0.20-0.49 m
- 0.50-0.99 m
- 1.00-1.49 m
- 1.50-1.99 m
- 2.0-2.49 m
- 2.5-2.99 m
- 3.0-3.49 m
- \> 3.5 m
- N/A

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 125 250 Meters

1. Orthophoto provided by Mount Polley Mining Corporation.
2. Orthophoto collected 5 August, 2014 by McElhanney Consulting Services Ltd.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation	PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Creek Canyon
Thickness of Deposition and Surficial Material

BY: HB	SCALE: 1:6,000	DATE: 5/22/2015	REF No:	REV: 0
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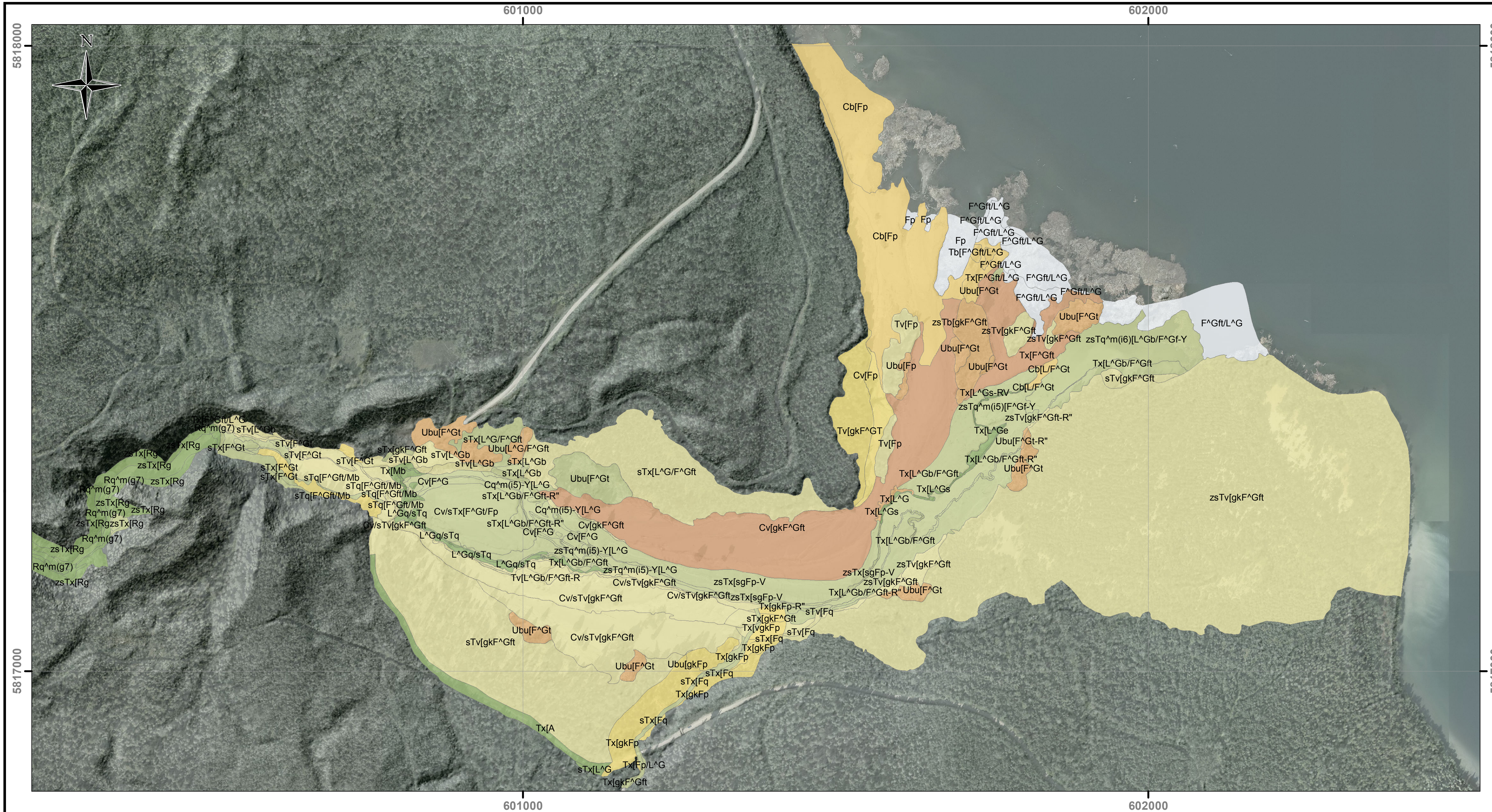

LEGEND

Thickness of Deposition

- 0 m
- < 0.1 m
- 0.10-0.19 m
- 0.20-0.49 m
- 0.50-0.99 m
- 1.00-1.49 m
- 1.50-1.99 m
- 2.0-2.49 m
- 2.5-2.99 m
- 3.0-3.49 m
- > 3.5 m
- N/A

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 125 250 Meters

1. Orthophoto provided by Mount Polley Mining Corporation.
2. Orthophoto collected 5 August, 2014 by McElhanney Consulting Services Ltd.

SNC·LAVALIN

CLIENT NAME: Mount Polley Mining Corporation	PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Lower Hazeltine Creek and Edney Creek Mouth Thickness of Deposition and Surficial Material

BY: HB	SCALE: 1:6,000	DATE: 5/22/2015	REF No:	REV: 0
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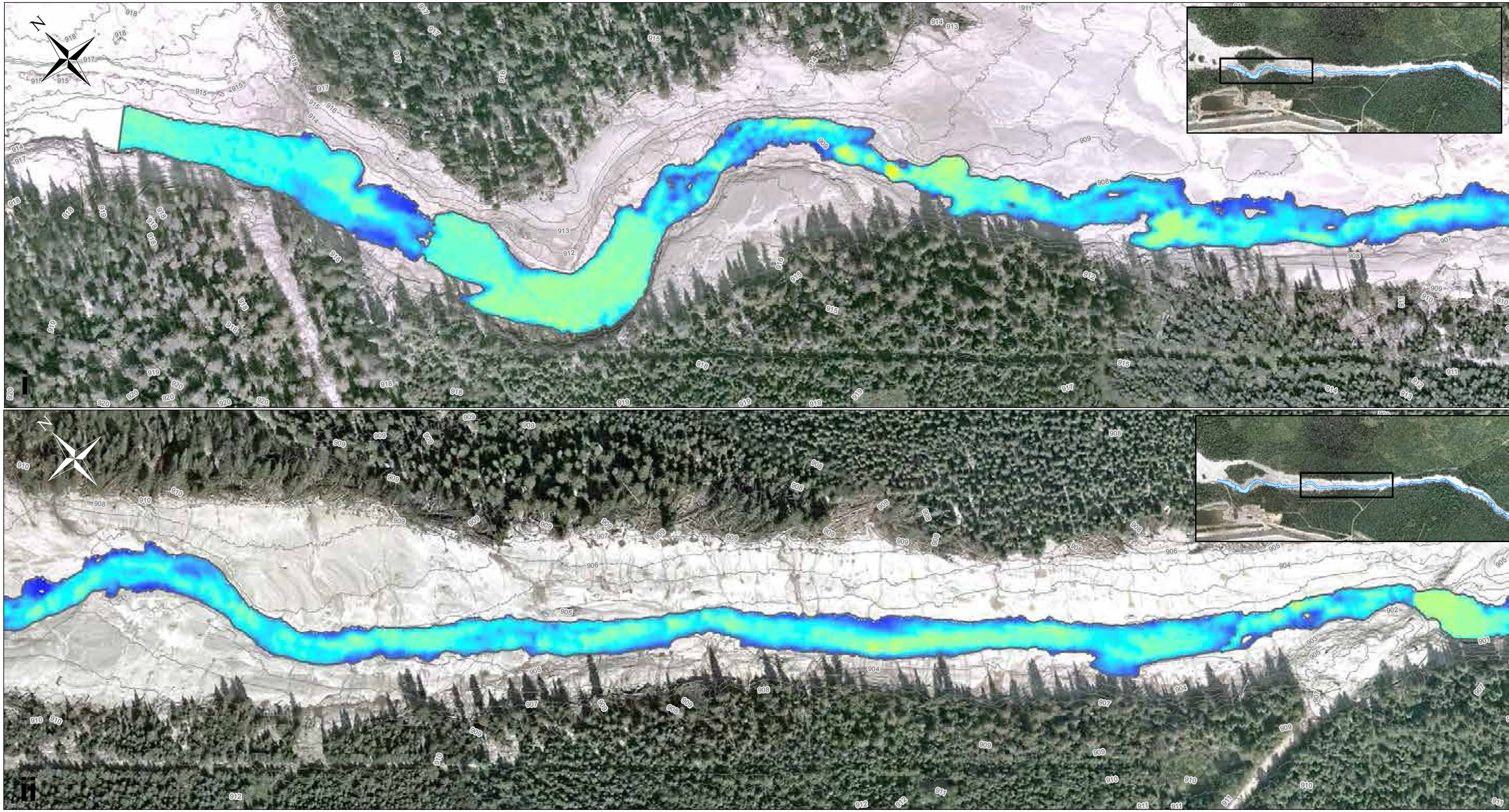
Project Path: P:\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\

APPENDIX F

Maps of the depth, velocity and shear stress results from a 2D hydrodynamic model for mean annual flood, 10-year and 100-year flows



LEGEND

- Mean Annual Flood Level

Mean Annual Flood Depth Values (m)

- 0 - 0.02
- 0.02 - 0.04
- 0.04 - 0.06
- 0.06 - 0.08
- 0.08 - 0.1
- 0.10 - 0.12
- 0.12 - 0.14
- 0.14 - 0.16
- 0.16 - 0.18
- 0.18 - 0.2
- 0.2 - 0.22
- 0.22 - 0.24
- 0.24 - 0.26
- 0.26 - 0.28
- 0.28 - 0.3
- 0.3 - 0.32
- 0.32 - 0.34
- 0.34 - 0.36
- 0.36 - 0.38
- 0.38 - 0.4
- 0.4 - 0.42
- 0.42 - 0.44
- 0.44 - 0.46
- 0.46 - 0.48
- 0.48 - 0.5
- 0.5 - 0.52
- 0.52 - 0.54
- 0.54 - 0.56
- 0.56 - 0.58
- 0.58 - 0.6

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation	PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: Mean Annual Flood Depth Values

BY: HB	SCALE: 1:2,000	DATE: 4/9/2015	REF No: REV: 0
CHK'D: FB	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-F001

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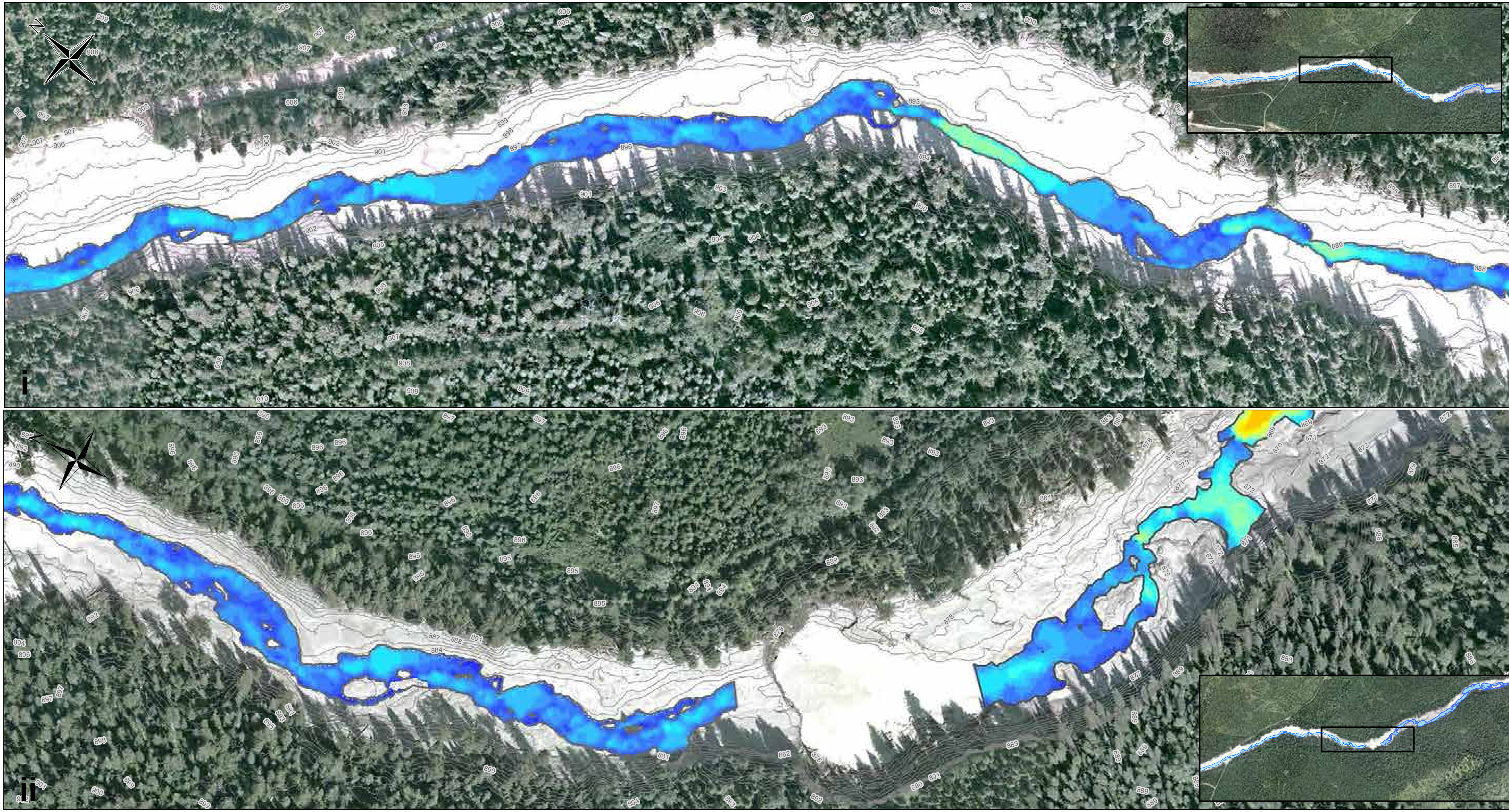

LEGEND

Mean Annual Flood Level

Mean Annual Flood Depth Values (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.25
- 0.25 - 0.3
- 0.3 - 0.35
- 0.35 - 0.4
- 0.4 - 0.45
- 0.45 - 0.5
- 0.5 - 0.55
- 0.55 - 0.6
- 0.6 - 0.65
- 0.65 - 0.7
- 0.7 - 0.75
- 0.75 - 0.8
- 0.8 - 0.85
- 0.85 - 0.9
- 0.9 - 0.95
- 0.95 - 1

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: Mean Annual Flood Depth Values

BY: HB | SCALE: 1:2,000 | DATE: 4/9/2015 | REF No: 621717-HIA-F002 | REV: 0

CHK'D: FB | PROJ COORD SYS: NAD 1983 UTM Zone 10N

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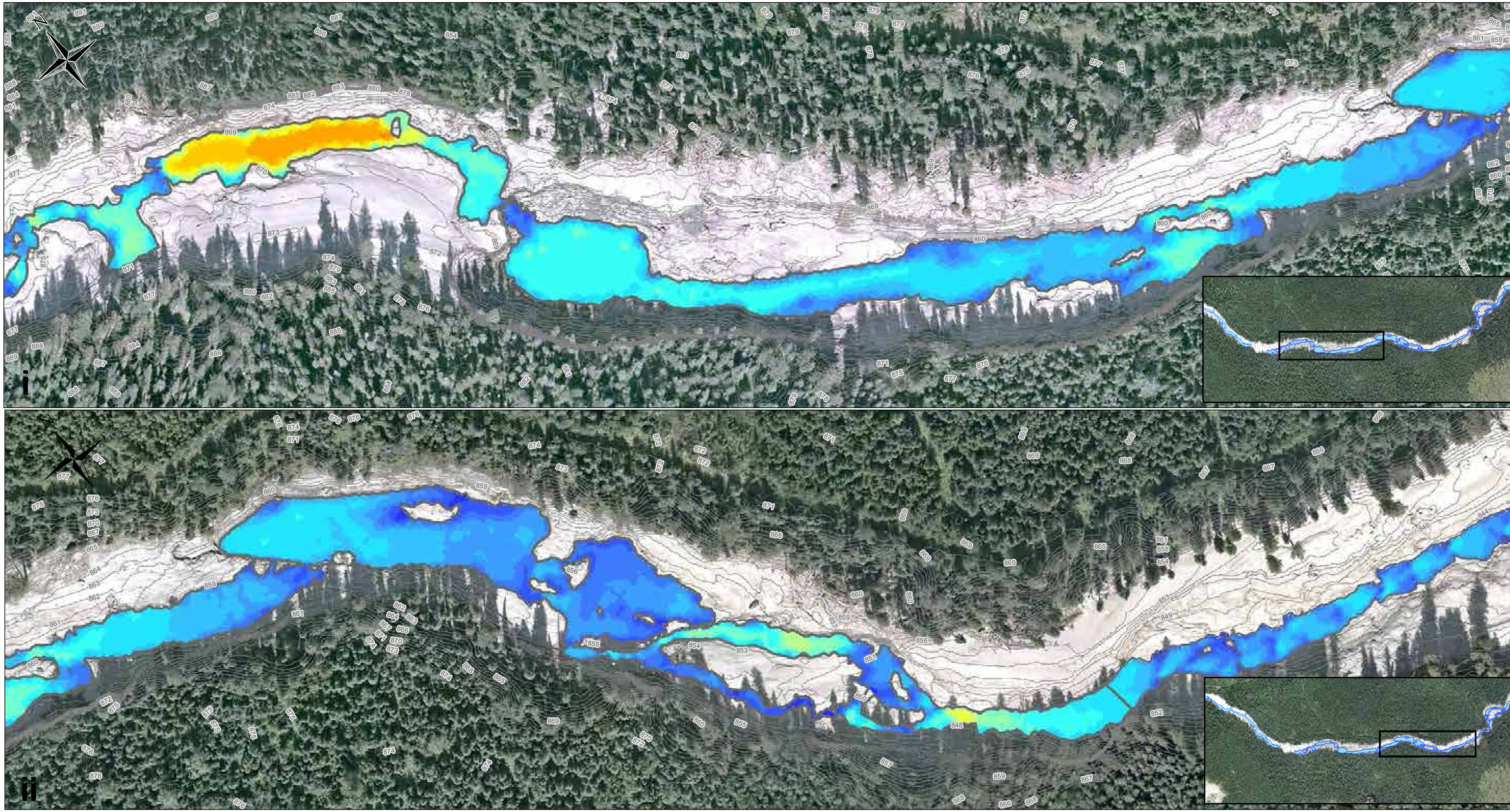

LEGEND

Mean Annual Flood Level

Mean Annual Flood Depth Values (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.25
- 0.25 - 0.3
- 0.3 - 0.35
- 0.35 - 0.4
- 0.4 - 0.45
- 0.45 - 0.5
- 0.5 - 0.55
- 0.55 - 0.6
- 0.6 - 0.65
- 0.65 - 0.7
- 0.7 - 0.75
- 0.75 - 0.8
- 0.8 - 0.85
- 0.85 - 0.9
- 0.9 - 0.95
- 0.95 - 1

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: Mean Annual Flood Depth Values

BY: HB	SCALE: 1:2,000	DATE: 4/17/2015	REF No:	REV: 0
CHK'D: FB	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-F003	

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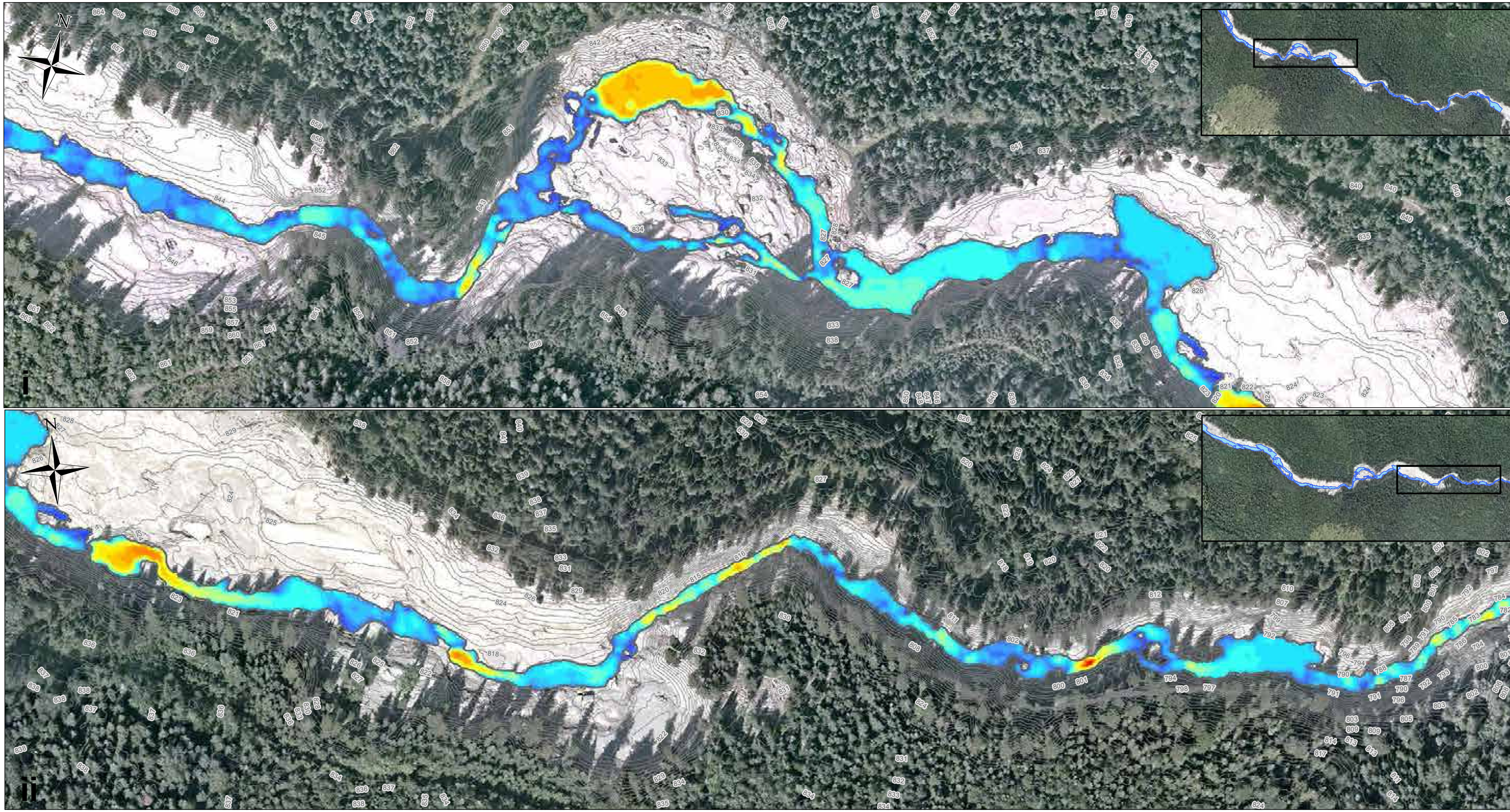

LEGEND

Mean Annual Flood Level

Mean Annual Flood Depth Values (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.25
- 0.25 - 0.3
- 0.3 - 0.35
- 0.35 - 0.4
- 0.4 - 0.45
- 0.45 - 0.5
- 0.5 - 0.55
- 0.55 - 0.6
- 0.6 - 0.65
- 0.65 - 0.7
- 0.7 - 0.75
- 0.75 - 0.8
- 0.8 - 0.85
- 0.85 - 0.9
- 0.9 - 0.95
- 0.95 - 1

NOTES

1. Original in colour.
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3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: Mean Annual Flood Depth Values

BY: HB	SCALE: 1:2,000	DATE: 4/20/2015	REF No: REV: 0
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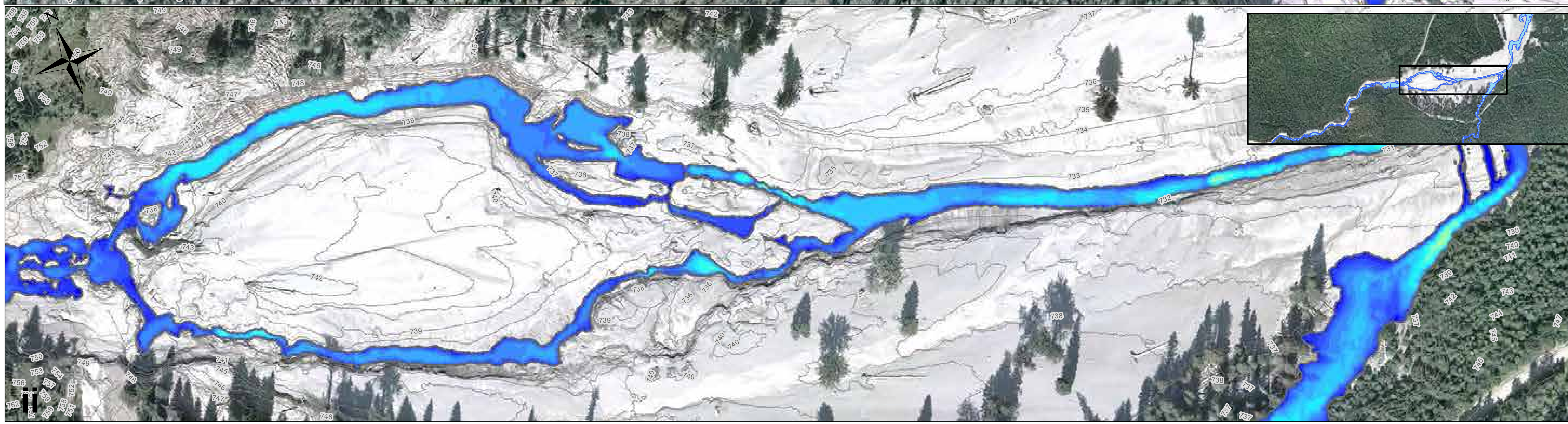

LEGEND

Mean Annual Flood Level

Mean Annual Flood Depth Values (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.25
- 0.25 - 0.3
- 0.3 - 0.35
- 0.35 - 0.4
- 0.4 - 0.45
- 0.45 - 0.5
- 0.5 - 0.55
- 0.55 - 0.6
- 0.6 - 0.65
- 0.65 - 0.7
- 0.7 - 0.75
- 0.75 - 0.8
- 0.8 - 0.85
- 0.85 - 0.9
- 0.9 - 0.95
- 0.95 - 1
- 1 - 1.05
- 1.05 - 1.1
- 1.1 - 1.15
- 1.15 - 1.2

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: Mean Annual Flood Depth Values

BY: HB	SCALE: 1:2,000	DATE: 4/22/2015	REF No: REV: 0
CHK'D: FB	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-F005

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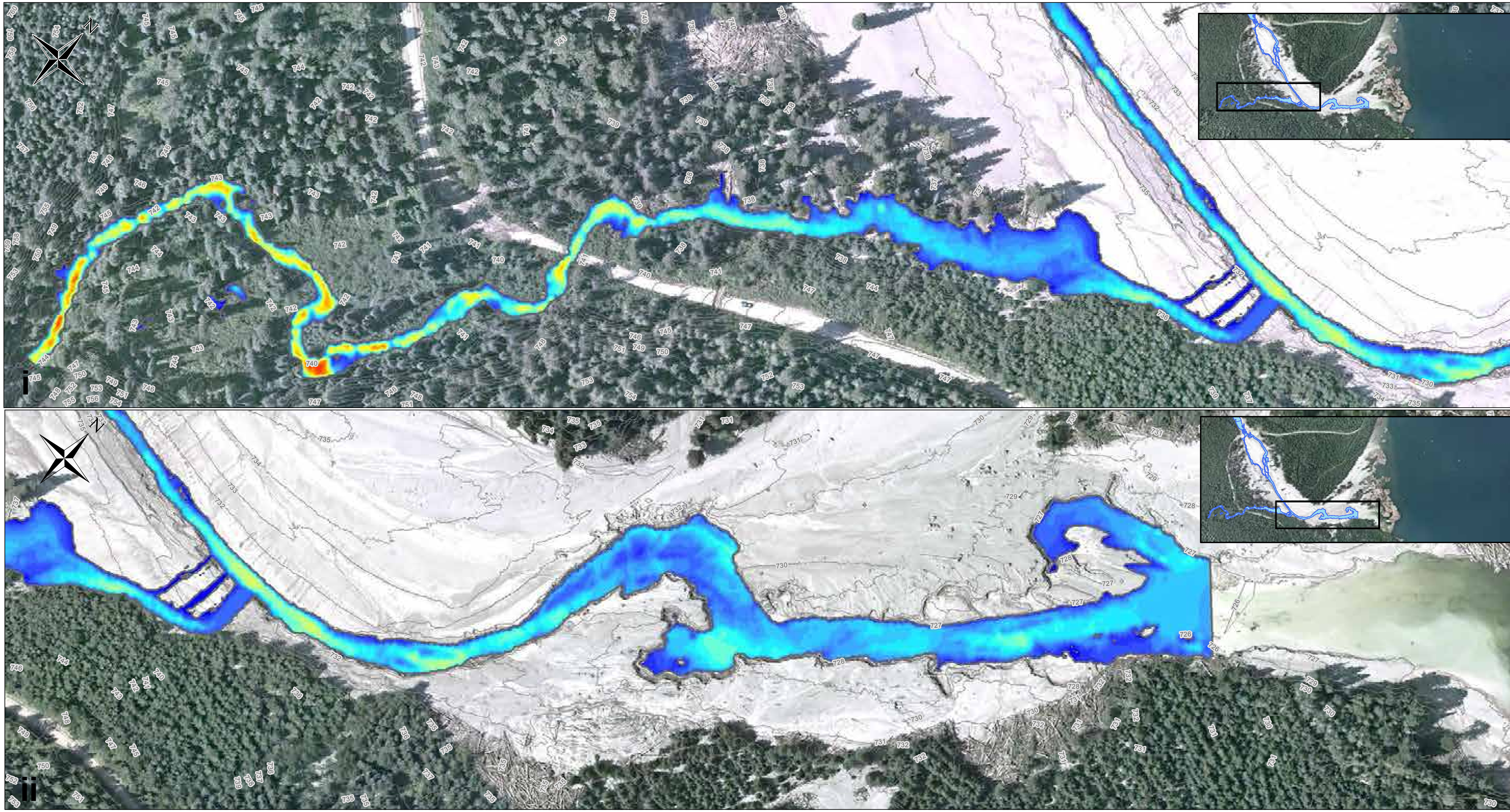

LEGEND

Mean Annual Flood Level

Mean Annual Flood Depth Values (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.25
- 0.25 - 0.3
- 0.3 - 0.35
- 0.35 - 0.4
- 0.4 - 0.45
- 0.45 - 0.5
- 0.5 - 0.55
- 0.55 - 0.6
- 0.6 - 0.65
- 0.65 - 0.7
- 0.7 - 0.75
- 0.75 - 0.8
- 0.8 - 0.85
- 0.85 - 0.9
- 0.9 - 0.95
- 0.95 - 1
- 1 - 1.05
- 1.05 - 1.1
- 1.1 - 1.15
- 1.15 - 1.2

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: Mean Annual Flood Depth Values

BY: HB	SCALE: 1:2,000	DATE: 4/23/2015	REF No: REV: 0
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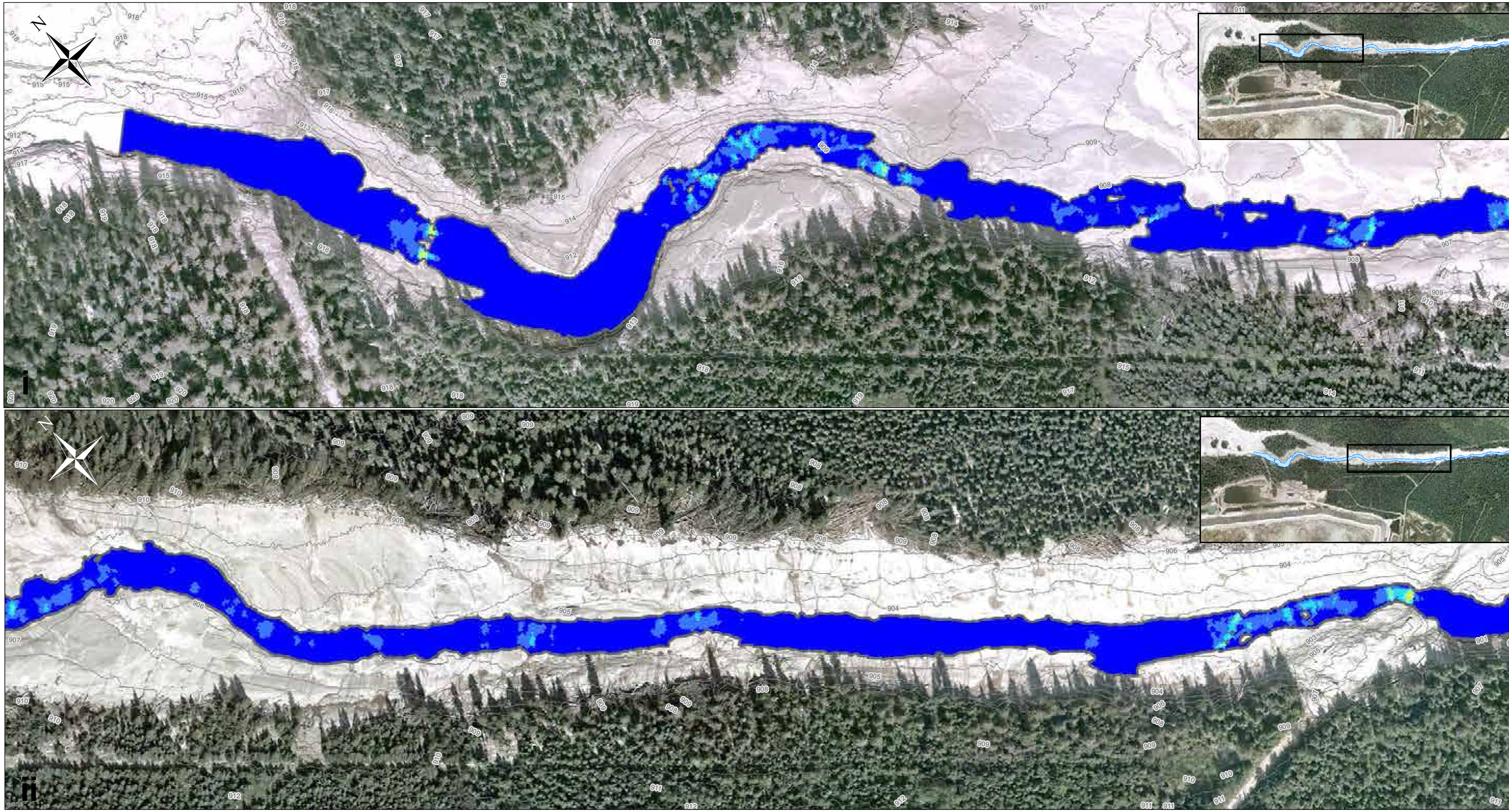

LEGEND

Mean Annual Flood Level

Mean Annual Flood Shear Stress Values (N/sqr m)

- 0 - 16
- 16 - 32
- 32 - 64
- 64 - 128
- 128 - 256
- 256 - 512
- 512 - 1024
- >1024

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: Mean Annual Flood Shear Stress Values

BY: HB	SCALE: 1:2,000	DATE: 4/28/2015	REF No:	REV: 0
CHK'D: FB	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-F007	

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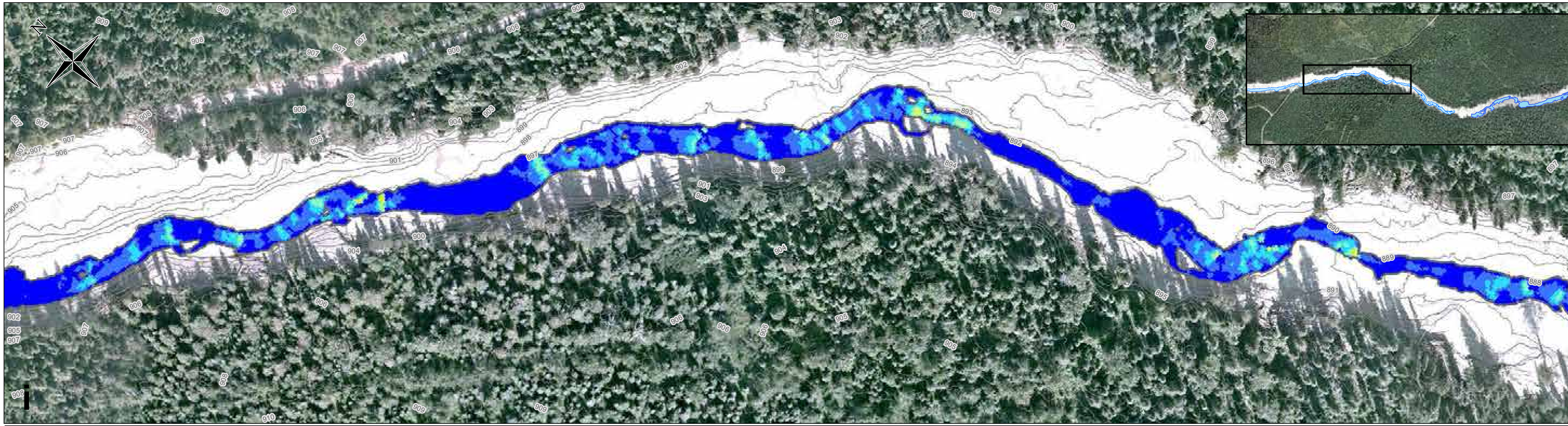

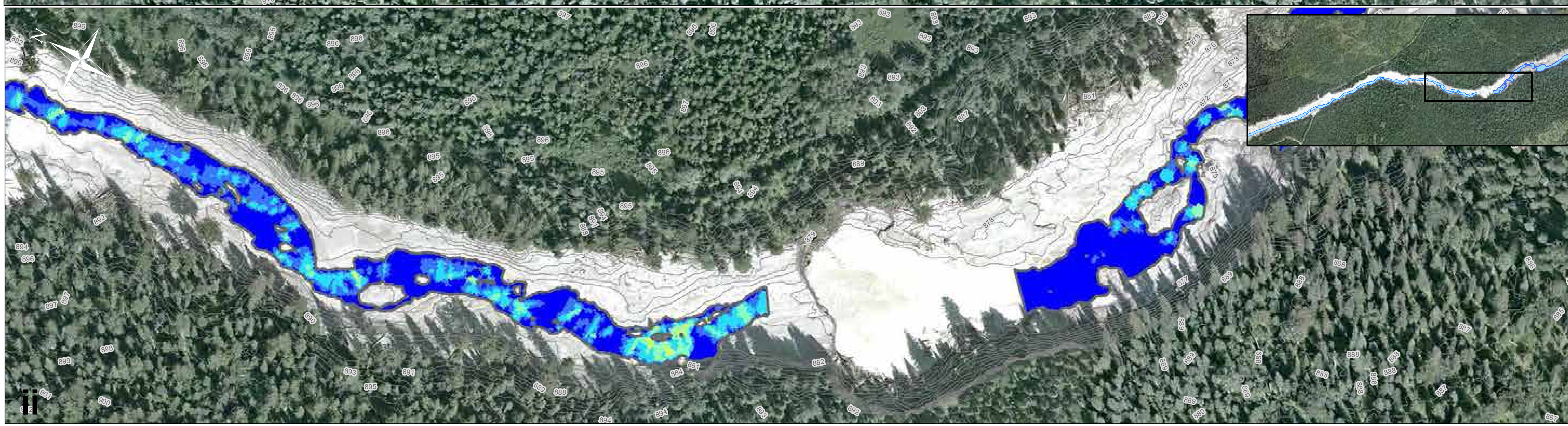

LEGEND

Mean Annual Flood Level

Mean Annual Flood Shear Stress Values (N/sqr m)

- 0 - 16
- 16 - 32
- 32 - 64
- 64 - 128
- 128 - 256
- 256 - 512
- 512 - 1024
- >1024

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: Mean Annual Flood Shear Stress Values

BY: HB	SCALE: 1:2,000	DATE: 4/28/2015	REF No: REV: 0
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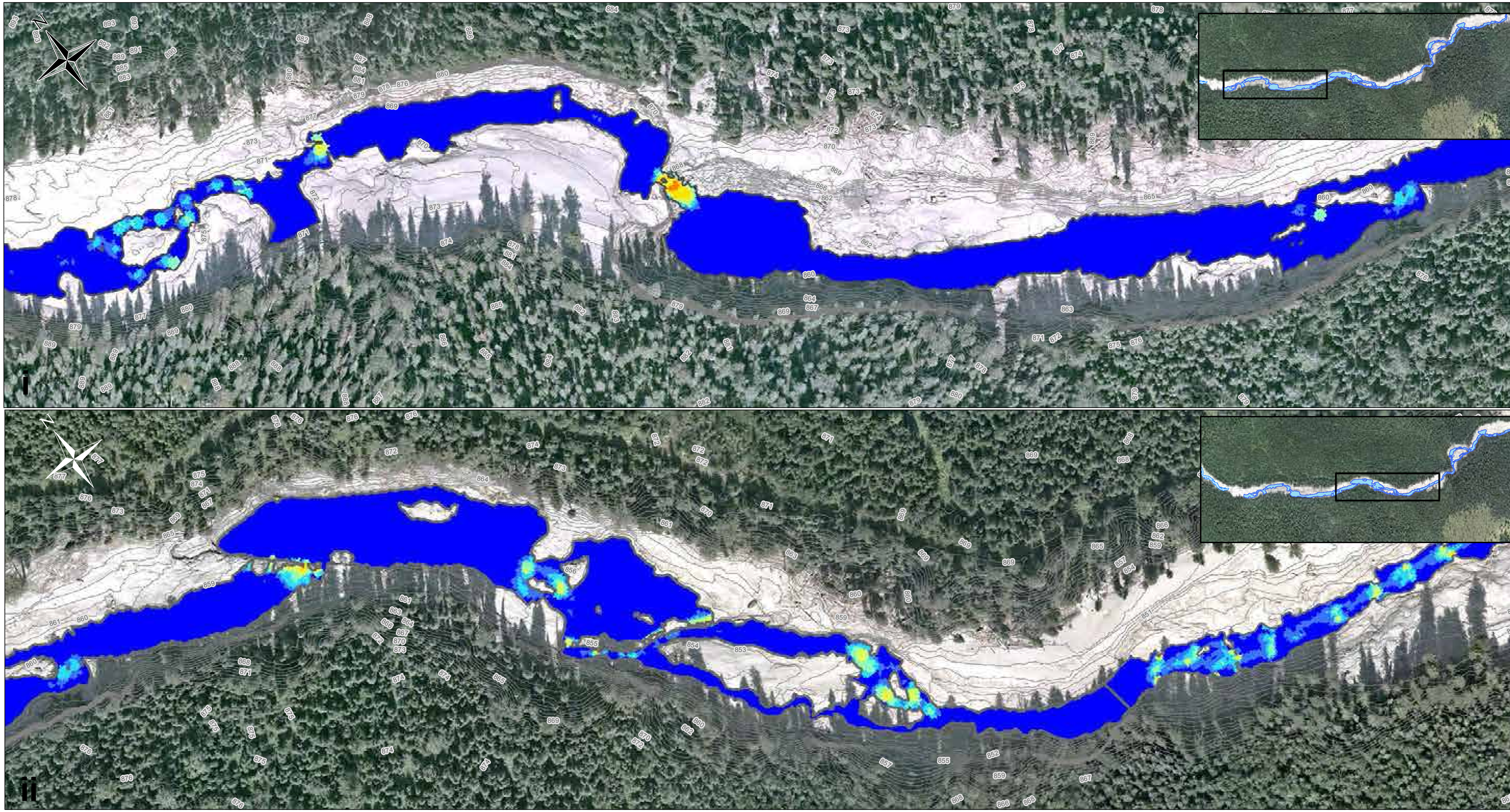

LEGEND

- Mean Annual Flood Level

Mean Annual Flood Shear Stress Values (N/sqr m)

- 0 - 16
- 16 - 32
- 32 - 64
- 64 - 128
- 128 - 256
- 256 - 512
- 512 - 1024
- >1024

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: Mean Annual Flood Shear Stress Values

BY: HB	SCALE: 1:2,000	DATE: 4/28/2015	REF No:	REV: 0
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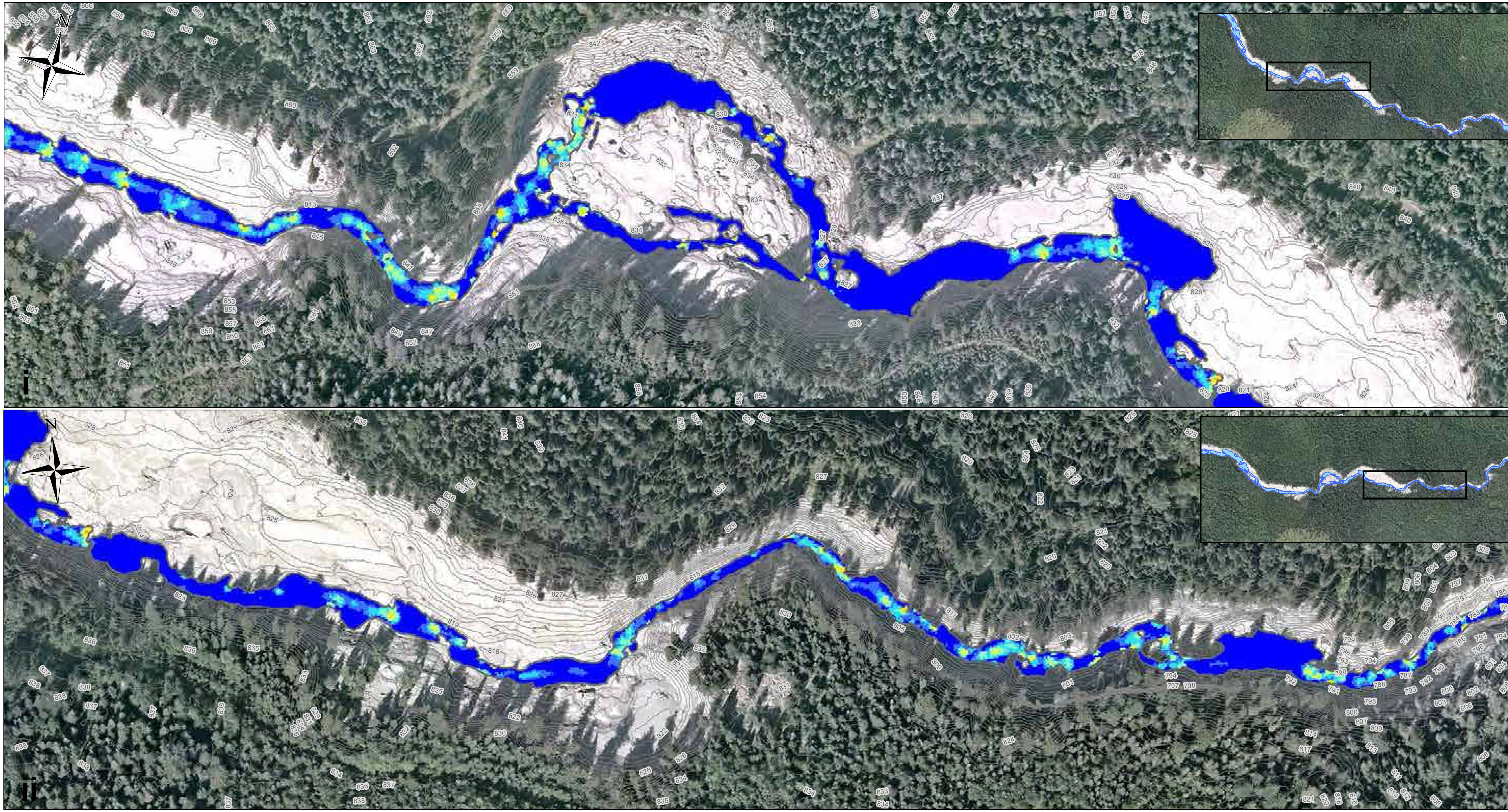

LEGEND

Mean Annual Flood Level

Mean Annual Flood Shear Stress Values (N/sqr m)

- 0 - 16
- 16 - 32
- 32 - 64
- 64 - 128
- 128 - 256
- 256 - 512
- 512 - 1024
- >1024

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

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REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC · LAVALIN

CLIENT NAME:	PROJECT LOCATION:
Mount Polley Mining Corporation	Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: Mean Annual Flood Shear Stress Values

BY: HB	SCALE: 1:2,000	DATE: 4/28/2015	REF No:	REV: 0
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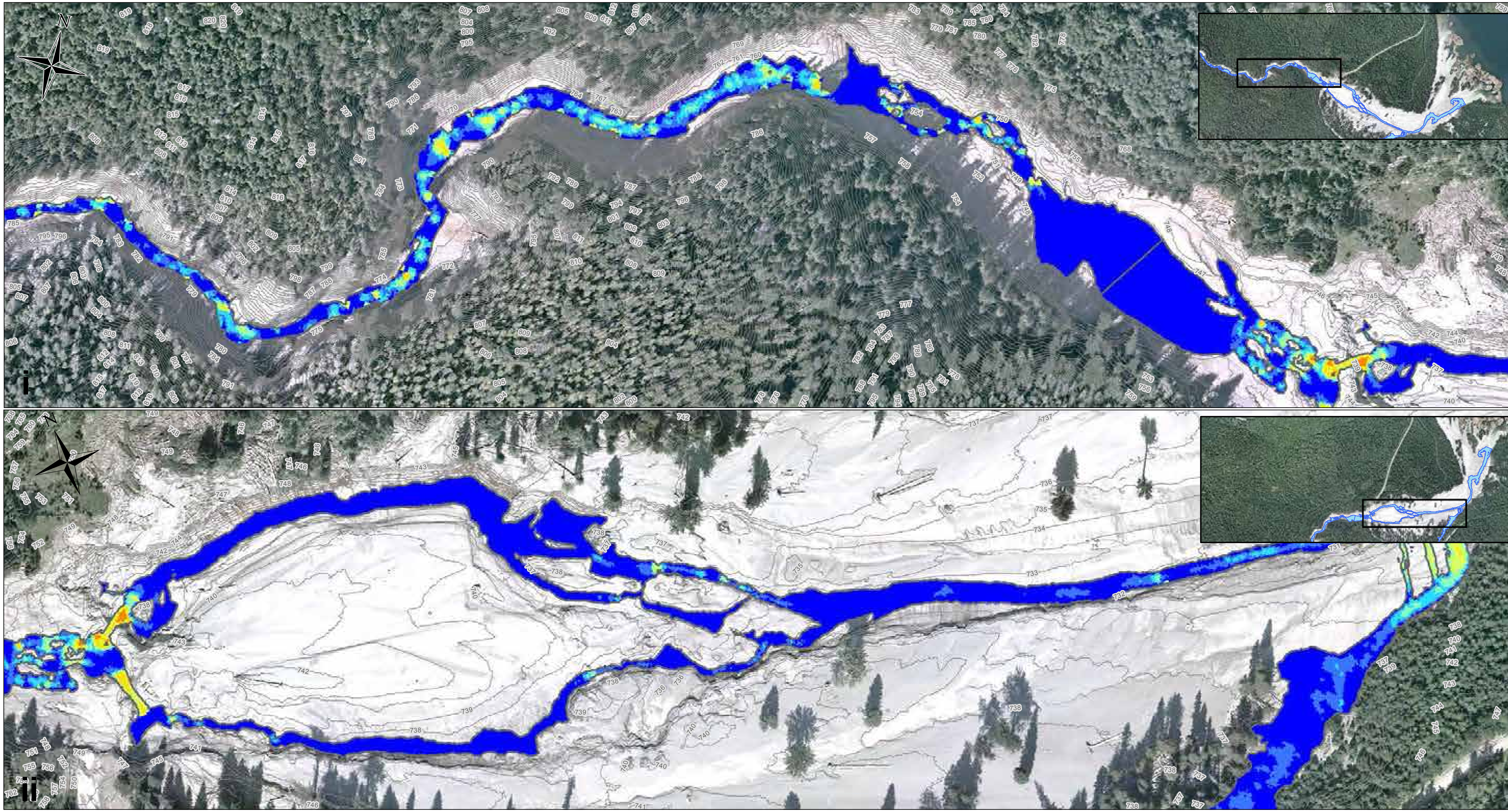

LEGEND

Mean Annual Flood Level

Mean Annual Flood Shear Stress Values (N/sqr m)

- 0 - 16
- 16 - 32
- 32 - 64
- 64 - 128
- 128 - 256
- 256 - 512
- 512 - 1024
- >1024

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

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REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: Mean Annual Flood Shear Stress Values

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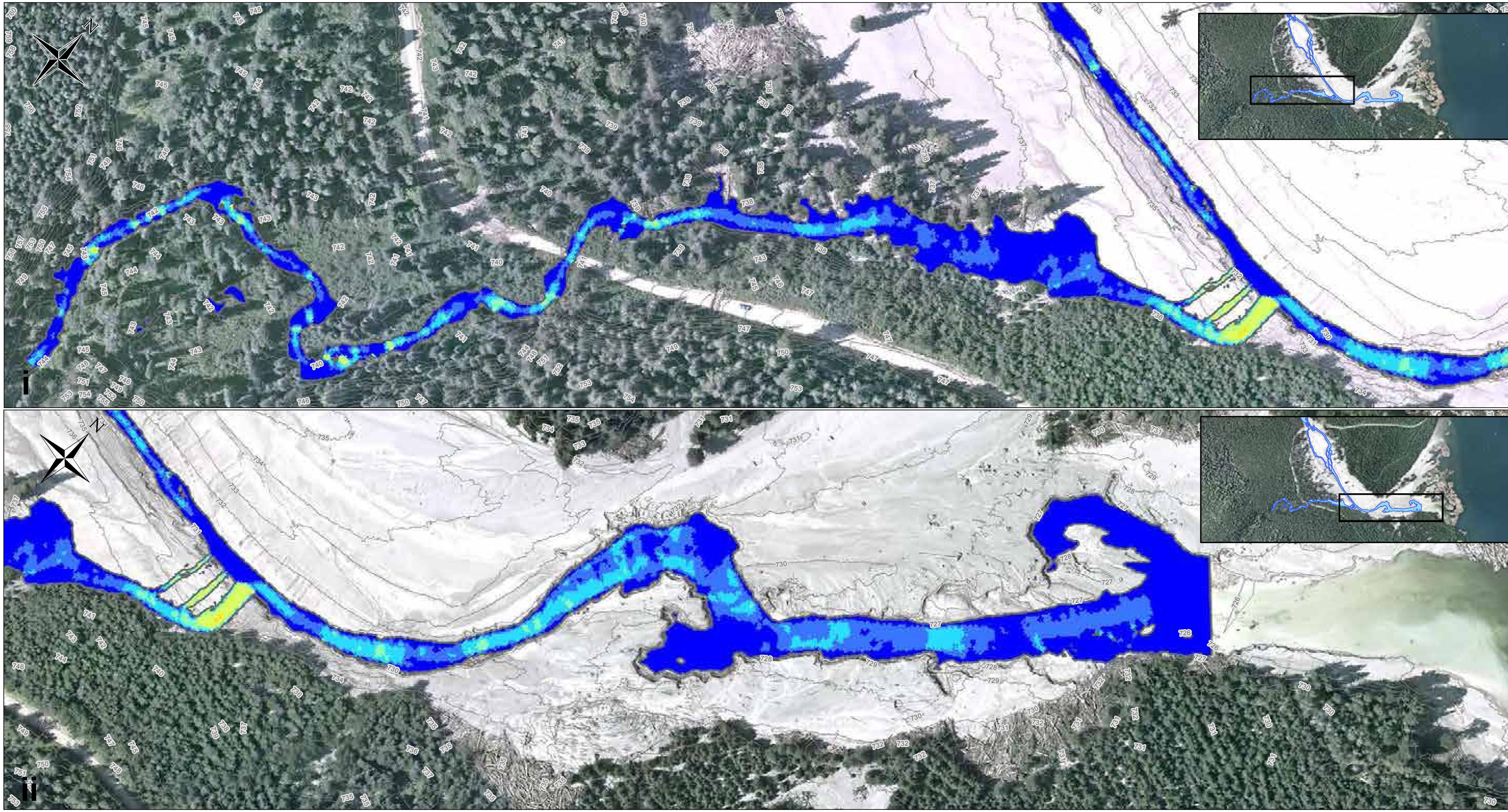

LEGEND

Mean Annual Flood Level

Mean Annual Flood Shear Stress Values (N/sqr m)

- 0 - 16
- 16 - 32
- 32 - 64
- 64 - 128
- 128 - 256
- 256 - 512
- 512 - 1024
- >1024

NOTES

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REFERENCES

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1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: Mean Annual Flood Shear Stress Values

BY: HB	SCALE: 1:2,000	DATE: 4/28/2015	REF No: REV: 0
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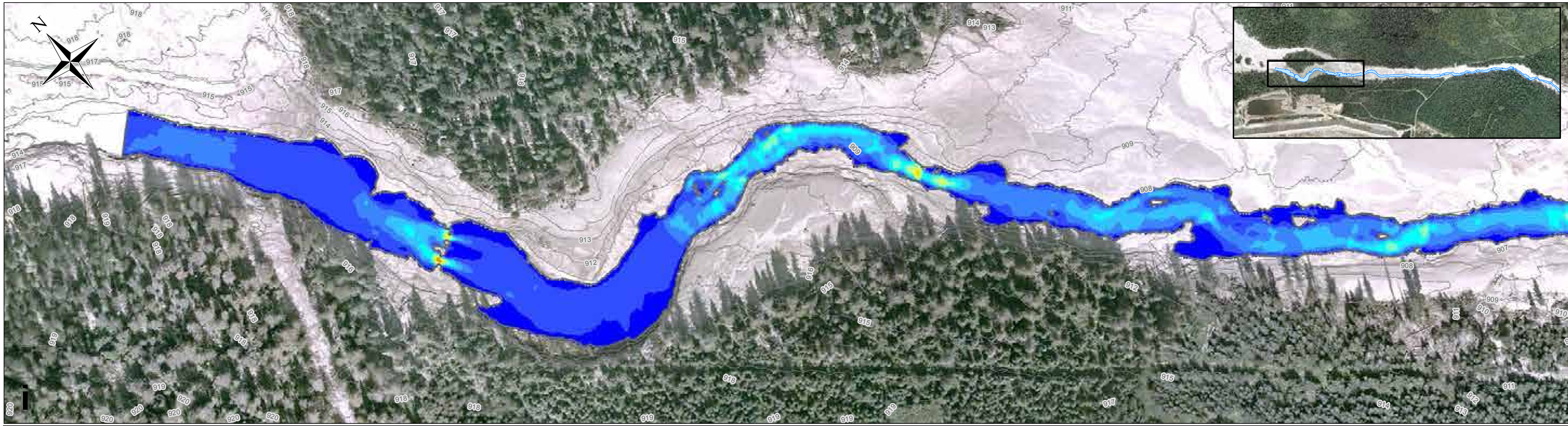

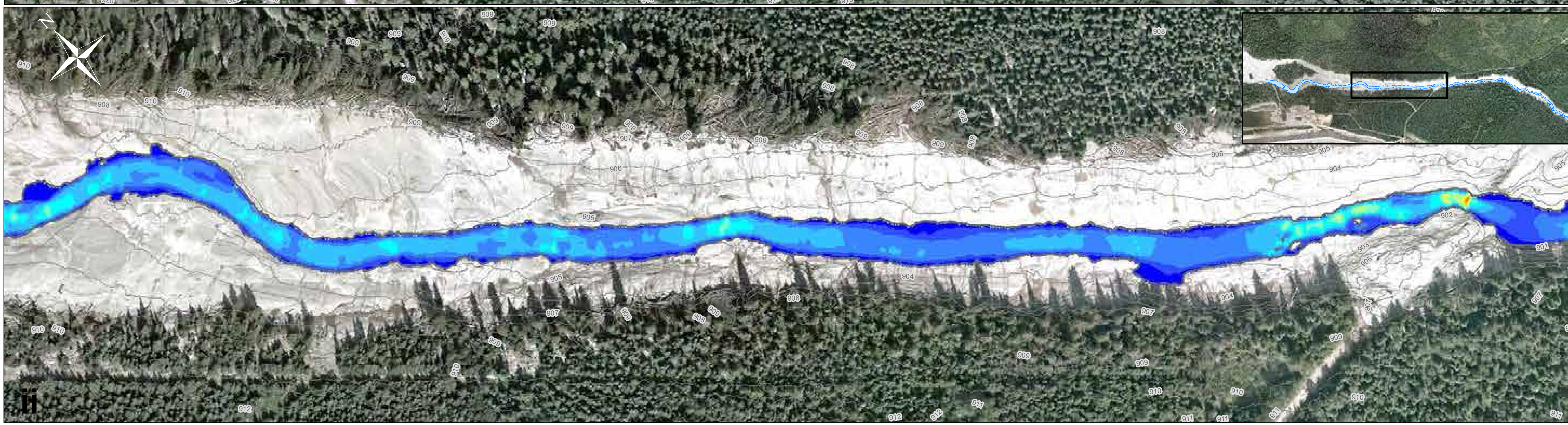

LEGEND

Mean Annual Flood Level

Mean Annual Flood Velocity Values (m/s)

- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- 1.2 - 1.4
- 1.4 - 1.6
- 1.6 - 1.8
- 1.8 - 2
- 2.0 - 2.2
- 2.2 - 2.4
- 2.4 - 2.6

NOTES

1. Original in colour.

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REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC · LAVALIN

CLIENT NAME:
Mount Polley Mining Corporation

PROJECT LOCATION:
Hazeltine Creek Study Area,
Mount Polley Mine, BC

Hazeltine Hydraulic Modelling:
Mean Annual Flood Velocity Values

BY: HB	SCALE: 1:2,000	DATE: 4/9/2015	REF No:	REV: 0
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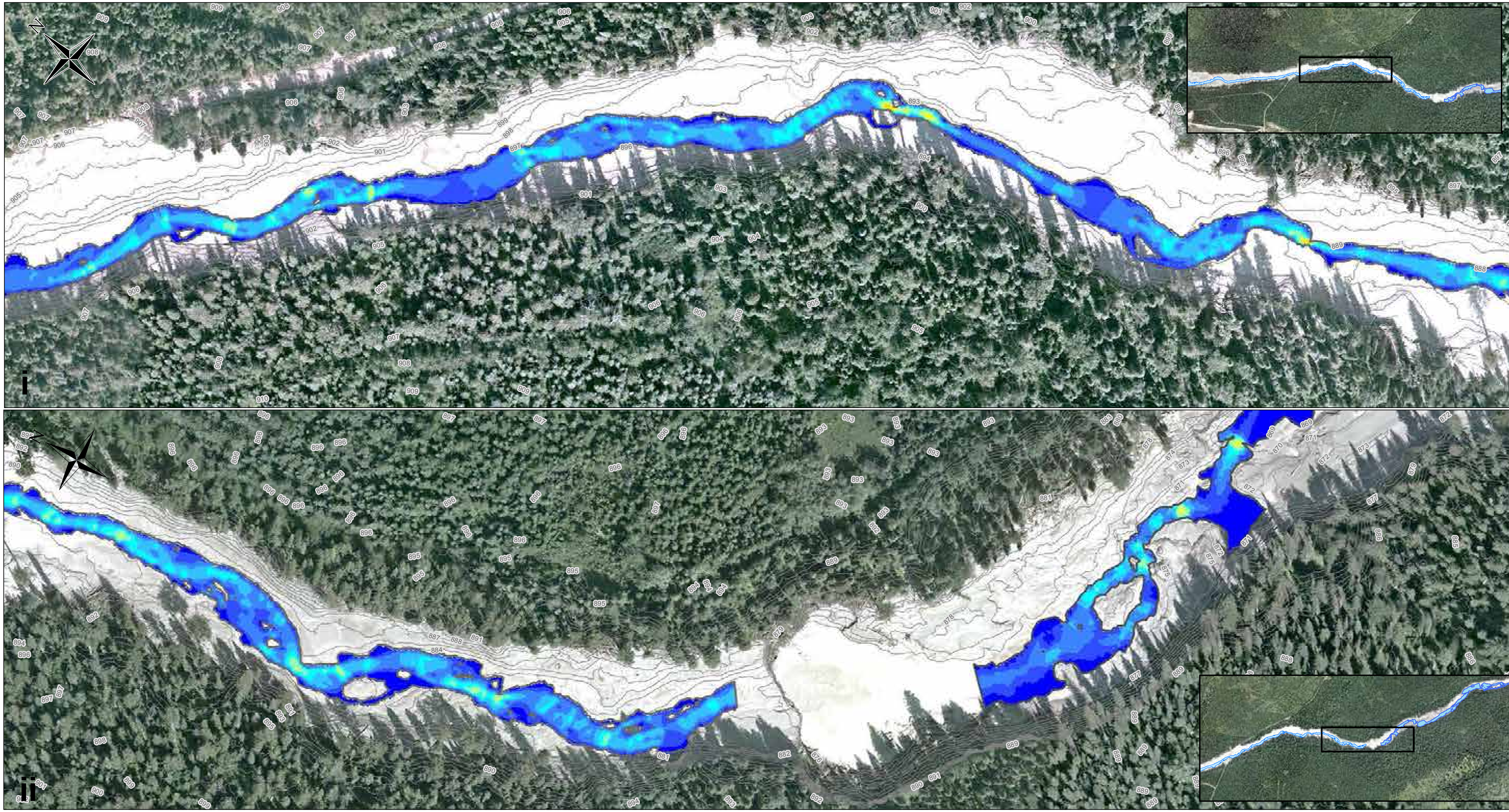

LEGEND

Mean Annual Flood Level

Mean Annual Flood Velocity Values (m/s)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1.0
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2.0
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3.0
- 3.0 - 3.25

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

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REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation	PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: Mean Annual Flood Velocity Values

BY: HB	SCALE: 1:2,000	DATE: 4/9/2015	REF No: REV: 0
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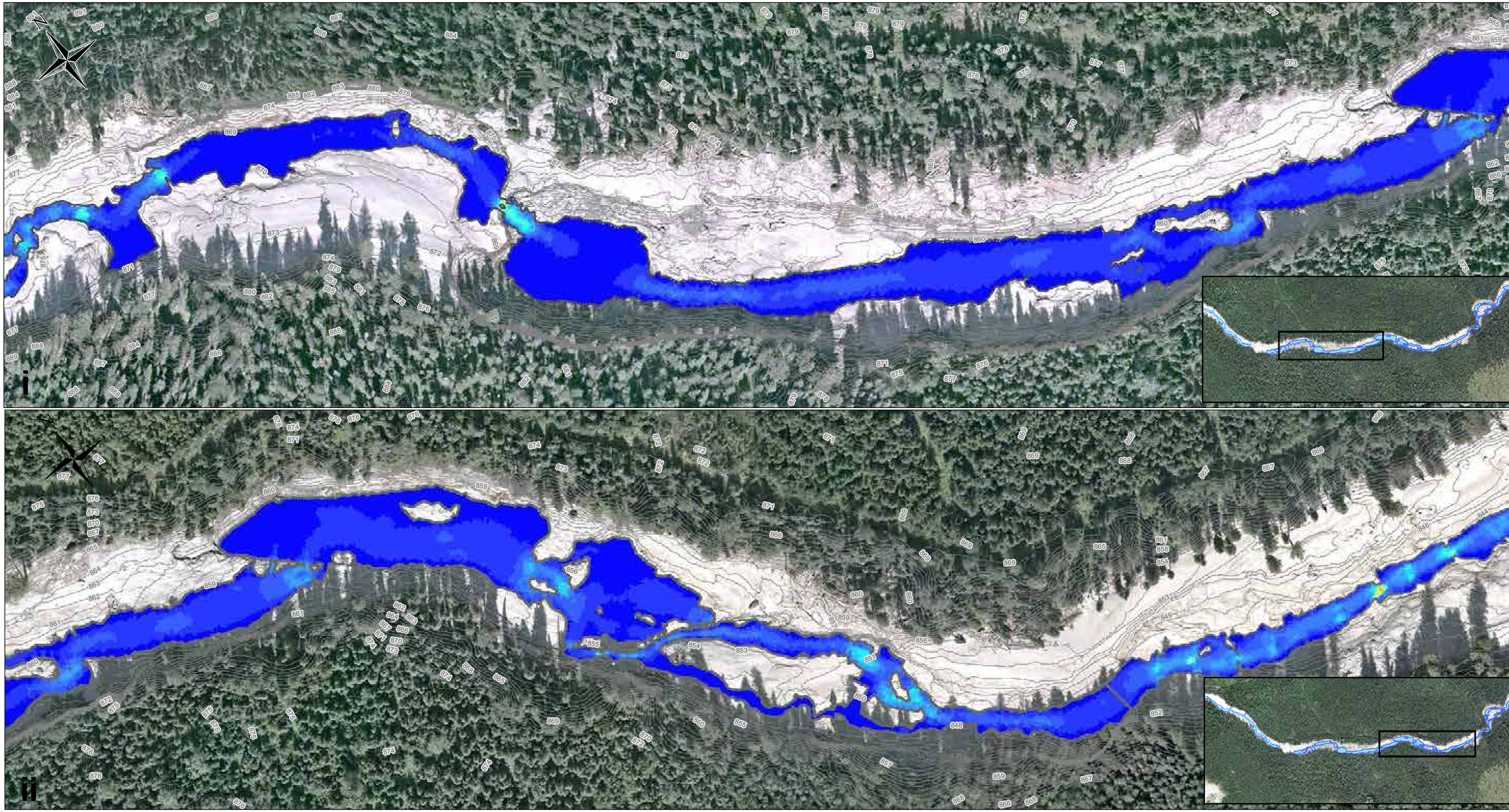

LEGEND

Mean Annual Flood Level

Mean Annual Flood Velocity Values (m/s)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4. 75 - 5

NOTES

1. Original in colour.

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REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation	PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: Mean Annual Flood Velocity Values

BY: HB	SCALE: 1:2,000	DATE: 4/20/2015	REF No:	REV: 0
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Project Path: P:\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\

LEGEND

Mean Annual Flood Level

Mean Annual Flood Velocity Values (m/s)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4. 75 - 5

NOTES

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REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: Mean Annual Flood Velocity Values

BY: HB	SCALE: 1:2,000	DATE: 4/20/2015	REF No:	REV: 0
CHK'D: FB	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-F016	

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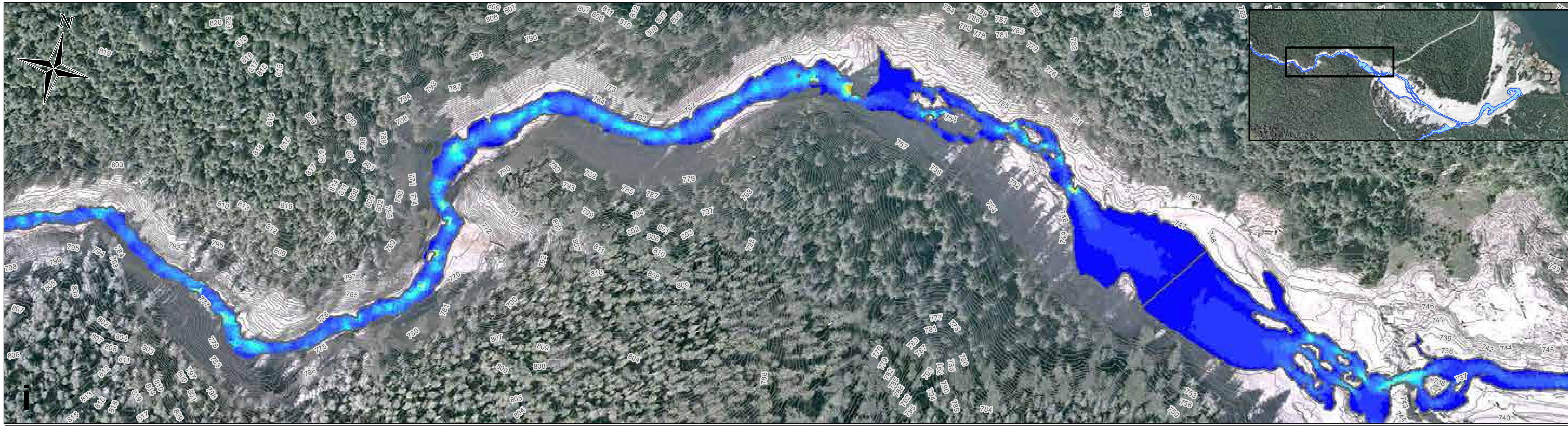
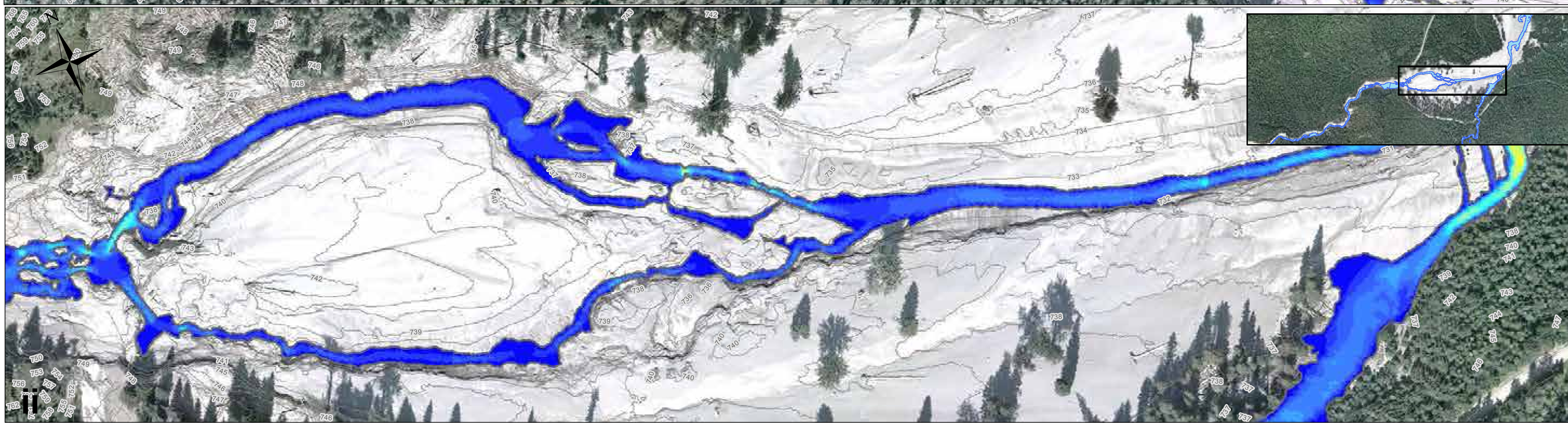




LEGEND

- Mean Annual Flood Level

Mean Annual Flood Velocity Values (m/s)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4. 75 - 5

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

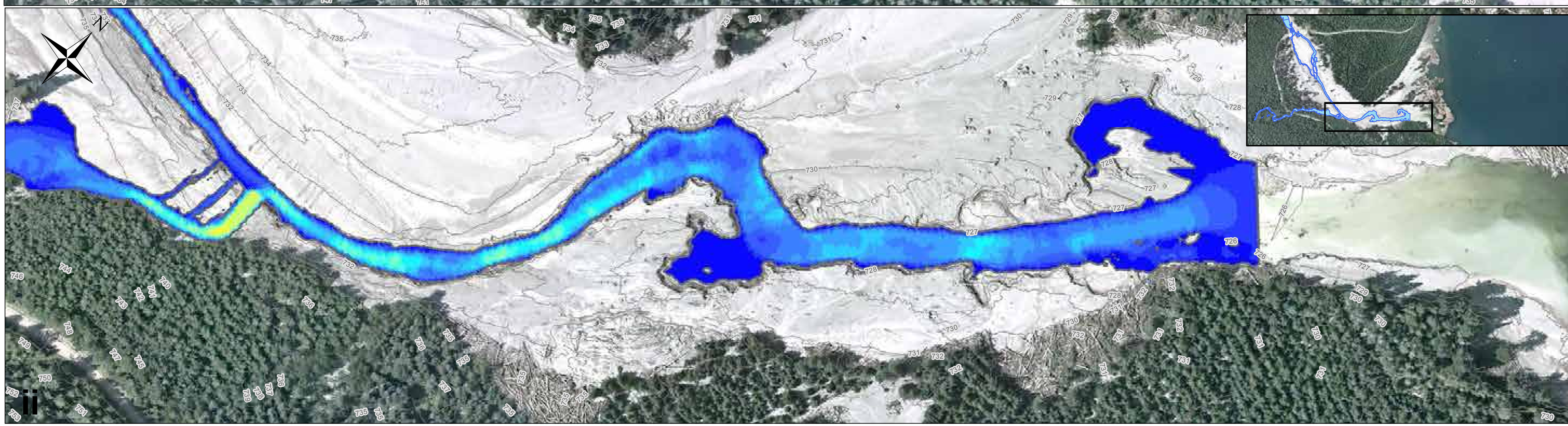
PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: Mean Annual Flood Velocity Values

BY: HB	SCALE: 1:2,000	DATE: 4/22/2015	REF No: REV: 0
CHK'D: FB	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-F017

MXD Path: \\proj_srv\PROJECTS\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\4.0 Execution\4.5 GIS and Drawings\GIS\PEEIAR Figures\HIA \621717-HIA-11x17.mxd

Project Path: P:\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\



LEGEND

Mean Annual Flood Level

Mean Annual Flood Velocity Values (m/s)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4. 75 - 5

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation	PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: Mean Annual Flood Velocity Values

BY: HB	SCALE: 1:2,000	DATE: 4/23/2015	REF No: REV: 0
CHK'D: FB	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-F018

MXD Path: \\proj_srv\PROJECTS\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\4.0 Execution\4.5 GIS and Drawings\GIS\PEEIAR Figures\HIA \621717-HIA-11x17.mxd

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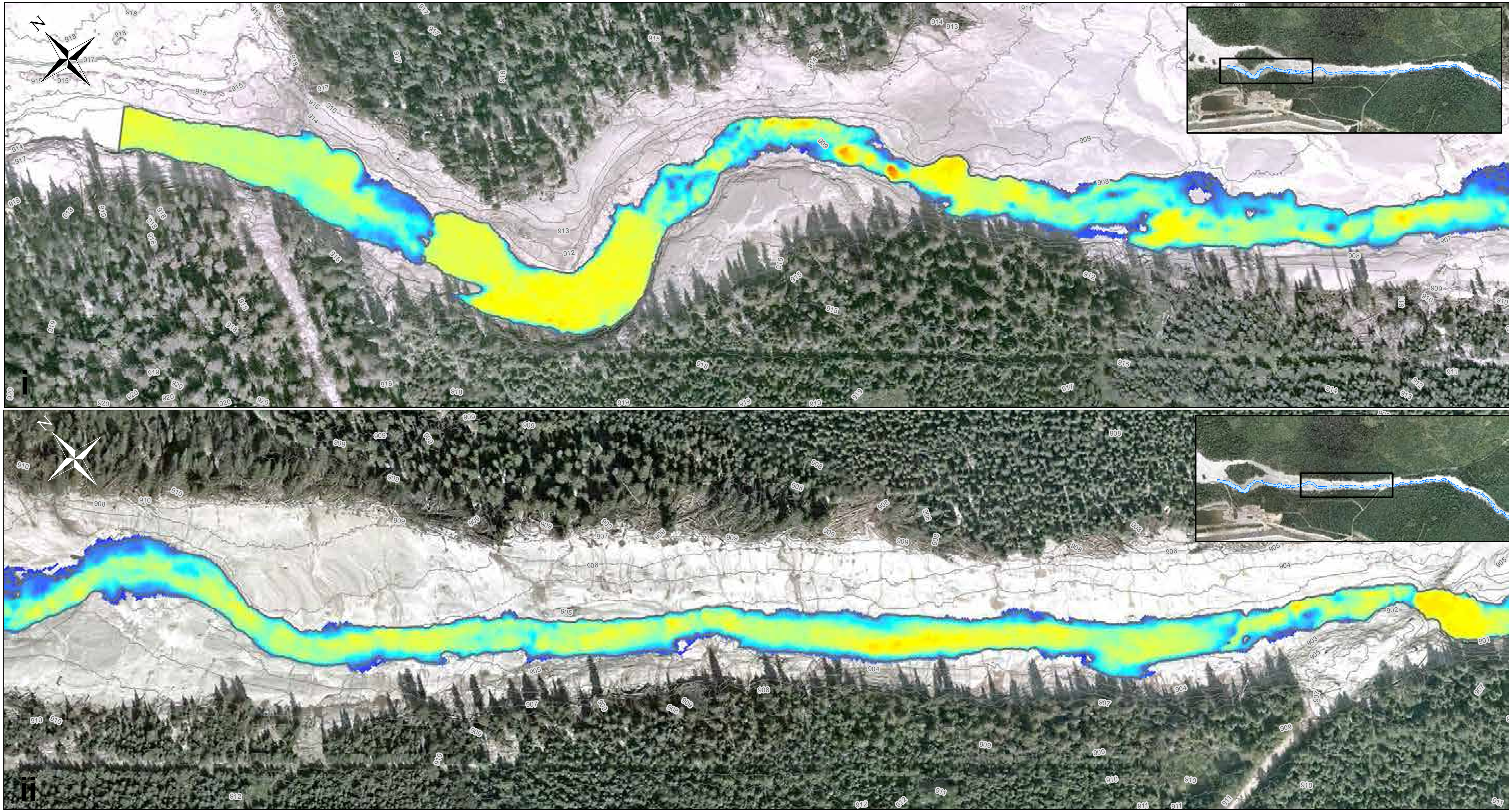

LEGEND

10 Year Water Level

10 Year Depth Values (m)

0	0.16 - 0.18	0.38 - 0.4
0 - 0.02	0.18 - 0.2	0.4 - 0.42
0.02 - 0.04	0.2 - 0.22	0.42 - 0.44
0.04 - 0.06	0.22 - 0.24	0.44 - 0.46
0.06 - 0.08	0.24 - 0.26	0.46 - 0.48
0.08 - 0.1	0.26 - 0.28	0.48 - 0.5
0.10 - 0.12	0.28 - 0.3	0.5 - 0.52
0.12 - 0.14	0.3 - 0.32	0.52 - 0.54
0.14 - 0.16	0.32 - 0.34	0.54 - 0.56
	0.34 - 0.36	0.56 - 0.58
	0.36 - 0.38	0.58 - 0.6

NOTES

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3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

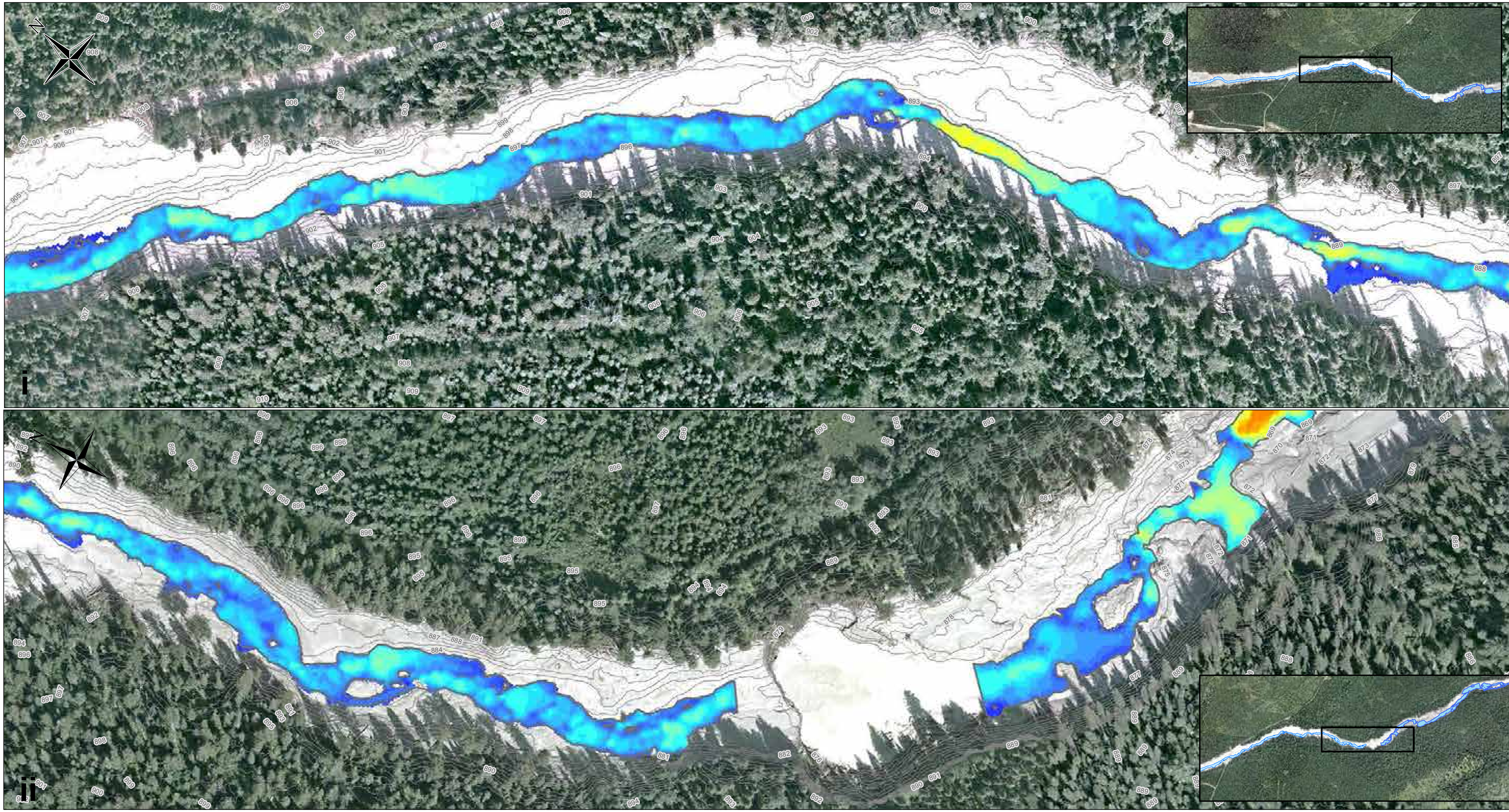
PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 10 Year Depth Values

BY: HB	SCALE: 1:2,000	DATE: 4/9/2015	REF No: REV: 0
CHK'D: FB	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-F019

MXD Path: \\proj_srv\PROJECTS\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\4.0 Execution\4.5 GIS and Drawings\GIS\PEEIAR Figures\HIA \621717-HIA-11x17.mxd

Project Path: P:\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\



LEGEND

- 10 Year Water Level

10 Year Depth Values (m)

- 0
- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.25
- 0.25 - 0.3
- 0.3 - 0.35
- 0.35 - 0.4
- 0.4 - 0.45
- 0.45 - 0.5
- 0.5 - 0.55
- 0.55 - 0.6
- 0.6 - 0.65
- 0.65 - 0.7
- 0.7 - 0.75
- 0.75 - 0.8
- 0.8 - 0.85
- 0.85 - 0.9
- 0.9 - 0.95
- 0.95 - 1

NOTES

1. Original in colour.
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3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 10 Year Depth Values

BY: HB	SCALE: 1:2,000	DATE: 4/9/2015	REF No:	REV: 0
CHK'D: FB	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-F020	

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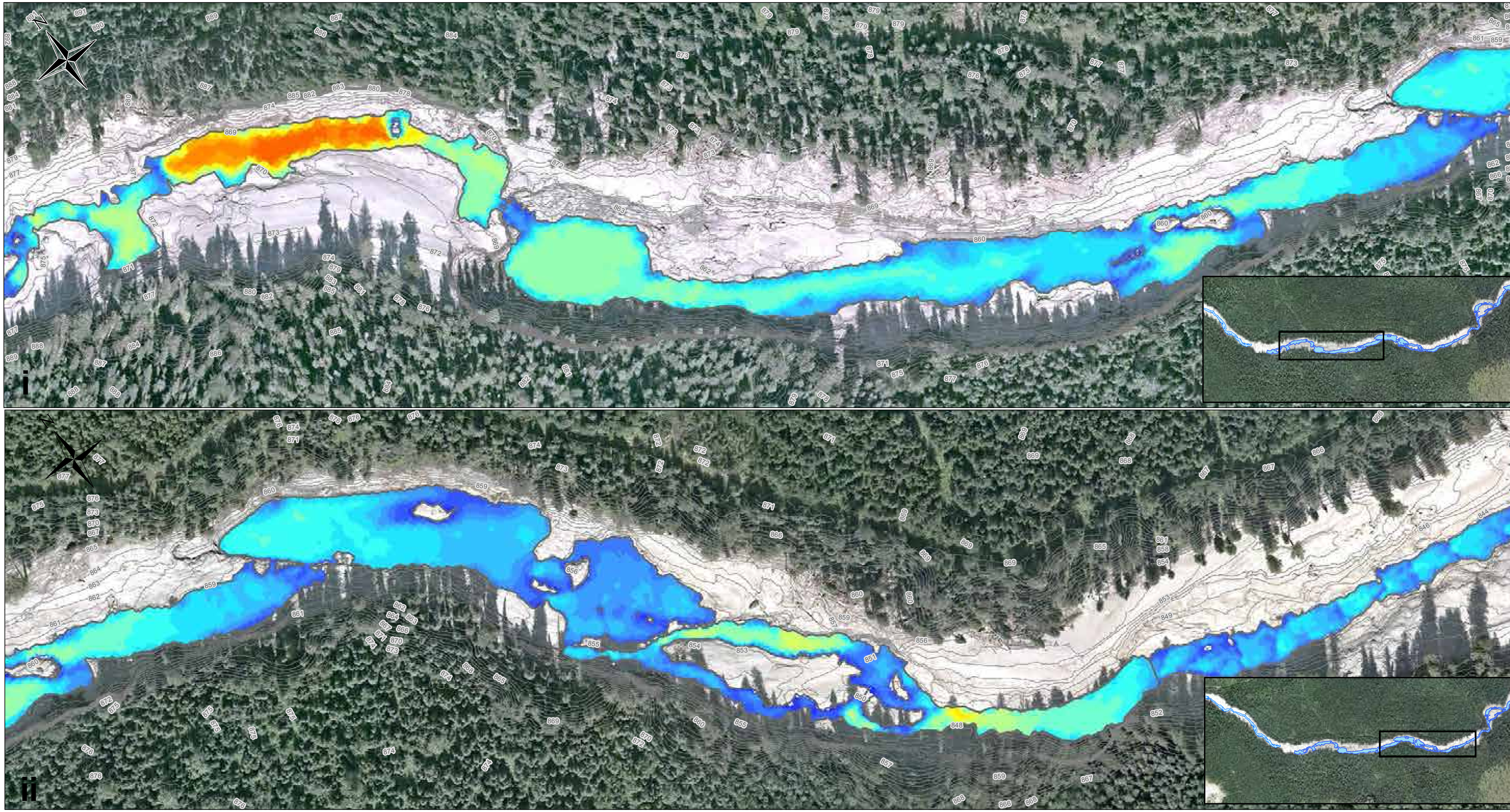

LEGEND

10 year water level	0.2 - 0.25	0.55 - 0.6	0.9 - 0.95
10 Year Depth Values (m)	0.25 - 0.3	0.6 - 0.65	0.95 - 1
0	0.3 - 0.35	0.65 - 0.7	
0 - 0.05	0.35 - 0.4	0.7 - 0.75	
0.05 - 0.1	0.4 - 0.45	0.75 - 0.8	
0.1 - 0.15	0.45 - 0.5	0.8 - 0.85	
0.15 - 0.2	0.5 - 0.55	0.85 - 0.9	

NOTES

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3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 10 Year Depth Values

BY: HB	SCALE: 1:2,000	DATE: 4/20/2015	REF No:	REV: 0
CHK'D: FB	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-F021	

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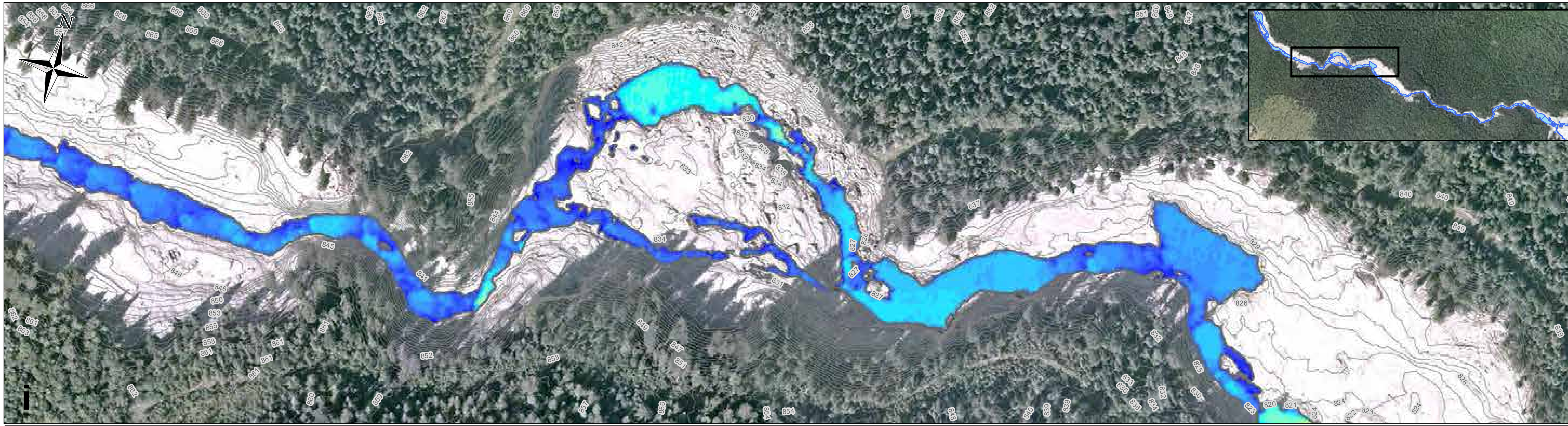

LEGEND

10 Year Water Level

10 Year Depth Values (m)

0 - 0.05	0.35 - 0.4	0.8 - 0.85	1.25 - 1.3
0.05 - 0.1	0.4 - 0.45	0.85 - 0.9	1.3 - 1.35
0.10 - 0.15	0.45 - 0.5	0.9 - 0.95	1.35 - 1.4
0.15 - 0.2	0.5 - 0.55	0.95 - 1	
0.2 - 0.25	0.55 - 0.6	1 - 1.05	
0.25 - 0.3	0.6 - 0.65	1.05 - 1.1	
0.3 - 0.35	0.65 - 0.7	1.1 - 1.15	
	0.7 - 0.75	1.15 - 1.2	
	0.75 - 0.8	1.2- 1.25	

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 10 Year Depth Values

BY: HB	SCALE: 1:2,000	DATE: 4/23/2015	REF No:	REV: 0
CHK'D: FB	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-F022	

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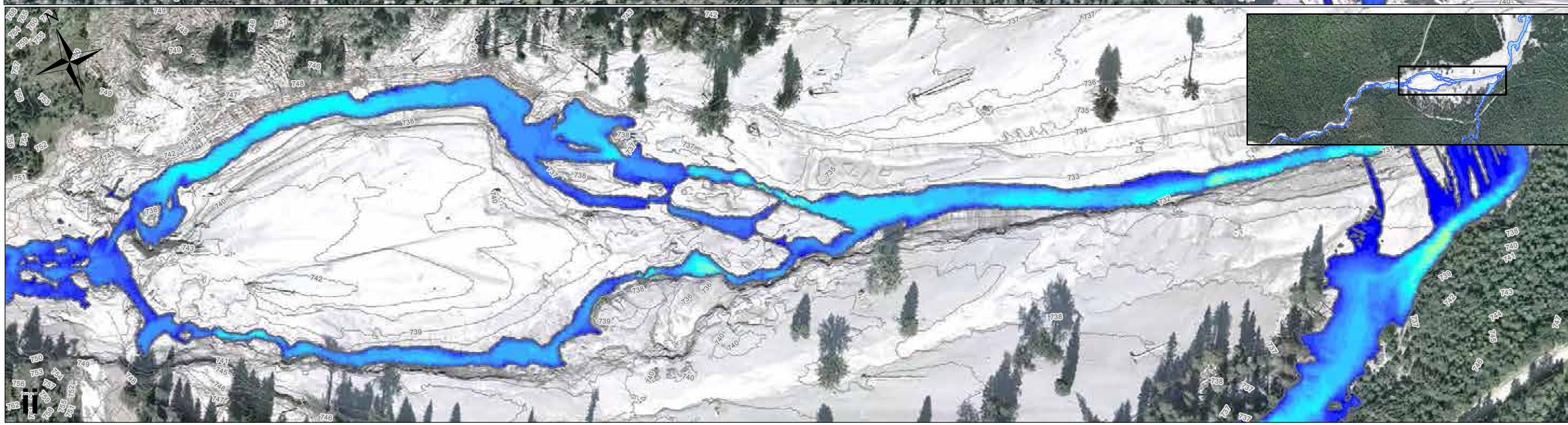

LEGEND

10 Year Water Level

10 Year Depth Values (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.10 - 0.15
- 0.15 - 0.2
- 0.2 - 0.25
- 0.25 - 0.3
- 0.3 - 0.35
- 0.35 - 0.4
- 0.4 - 0.45
- 0.45 - 0.5
- 0.5 - 0.55
- 0.55 - 0.6
- 0.6 - 0.65
- 0.65 - 0.7
- 0.7 - 0.75
- 0.75 - 0.8
- 0.8 - 0.85
- 0.85 - 0.9
- 0.9 - 0.95
- 0.95 - 1
- 1 - 1.05
- 1.05 - 1.1
- 1.1 - 1.15
- 1.15 - 1.2
- 1.2- 1.25
- 1.25 - 1.3
- 1.3 - 1.35
- 1.35 - 1.4

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 10 Year Depth Values

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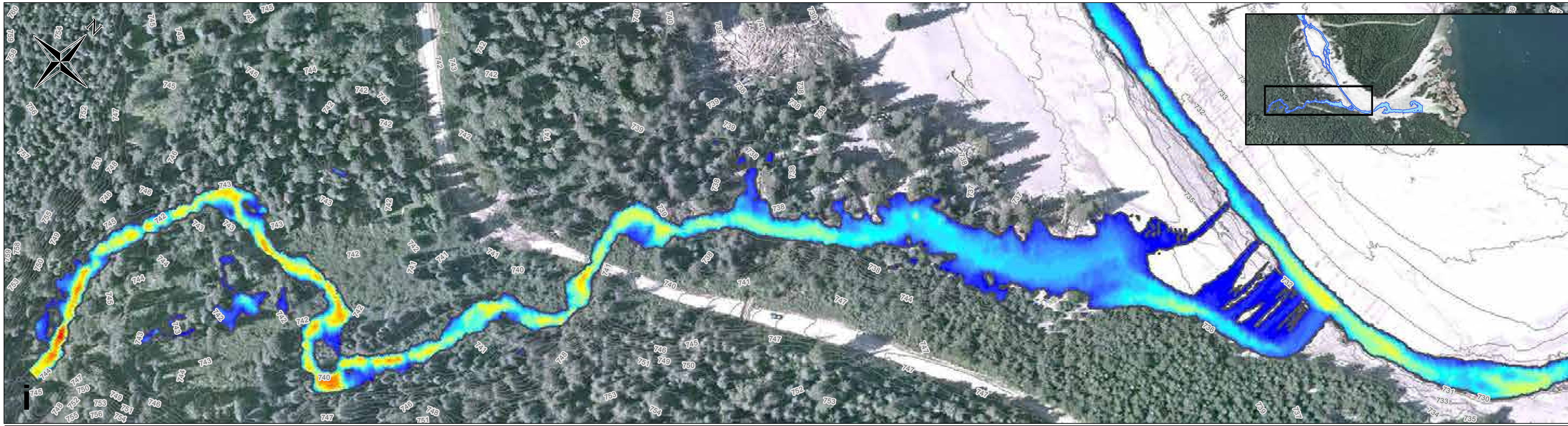

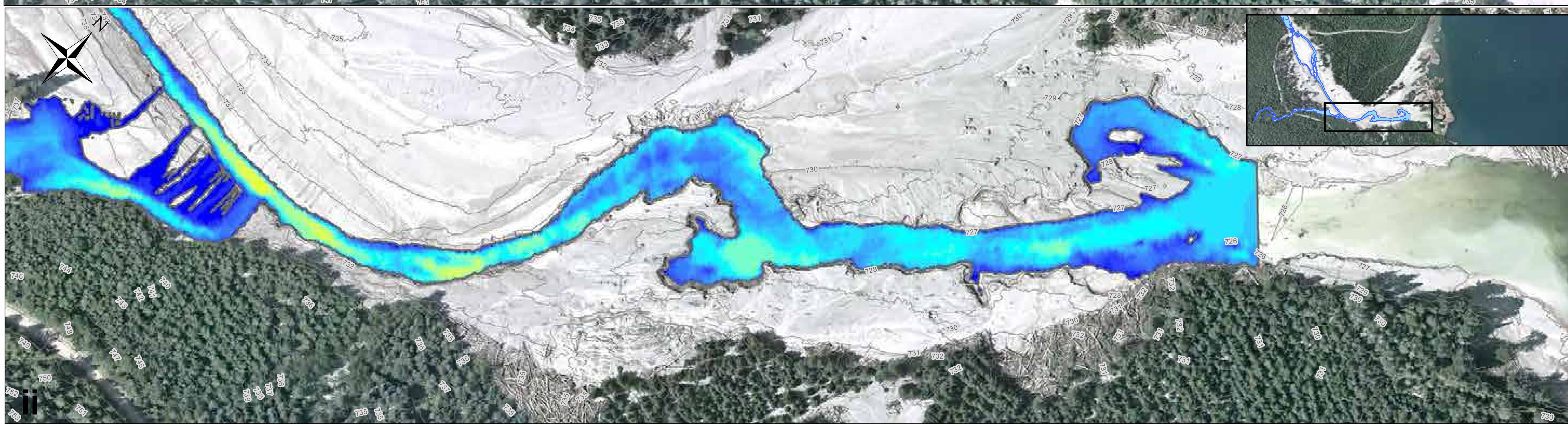

LEGEND

- 10 Year Water Level

10 Year Depth Values (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.10 - 0.15
- 0.15 - 0.2
- 0.2 - 0.25
- 0.25 - 0.3
- 0.3 - 0.35
- 0.35 - 0.4
- 0.4 - 0.45
- 0.45 - 0.5
- 0.5 - 0.55
- 0.55 - 0.6
- 0.6 - 0.65
- 0.65 - 0.7
- 0.7 - 0.75
- 0.75 - 0.8
- 0.8 - 0.85
- 0.85 - 0.9
- 0.9 - 0.95
- 0.95 - 1
- 1 - 1.05
- 1.05 - 1.1
- 1.1 - 1.15
- 1.15 - 1.2
- 1.2- 1.25
- 1.25 - 1.3
- 1.3 - 1.35
- 1.35 - 1.4

NOTES

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REFERENCES

0 50 100 Meters

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SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 10 Year Depth Values

BY: HB	SCALE: 1:2,000	DATE: 4/23/2015	REF No:	REV: 0
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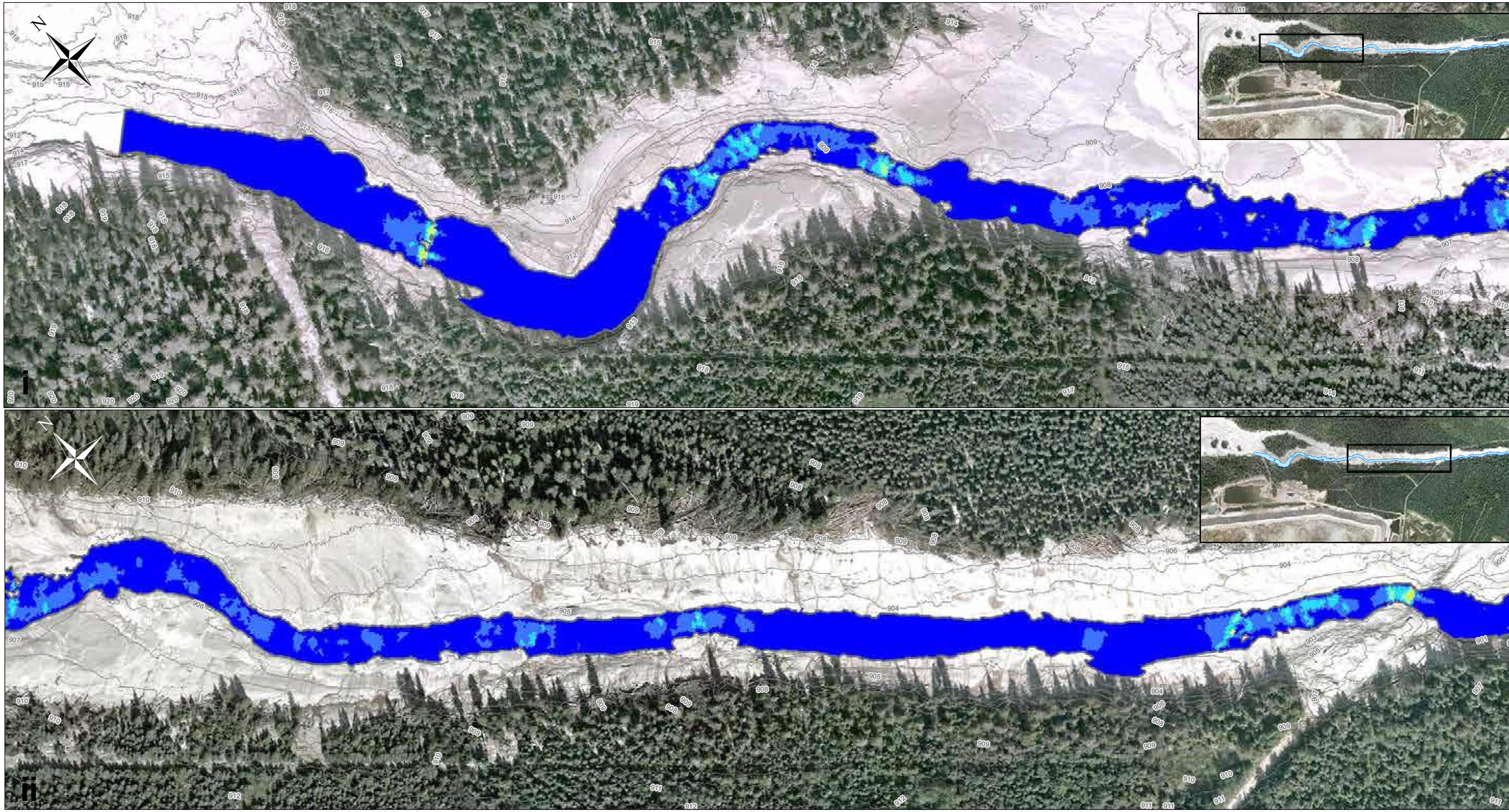

LEGEND

10 Year Water Level

10 Year Shear Stress Values (N/ sqr m)

- 0 - 16
- 16 - 32
- 32 - 64
- 64 - 128
- 128 - 256
- 256 - 512
- 512 - 1024
- >1024

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 10 Year Shear Stress Values

BY: HB	SCALE: 1:2,000	DATE: 4/28/2015	REF No: REV: 0
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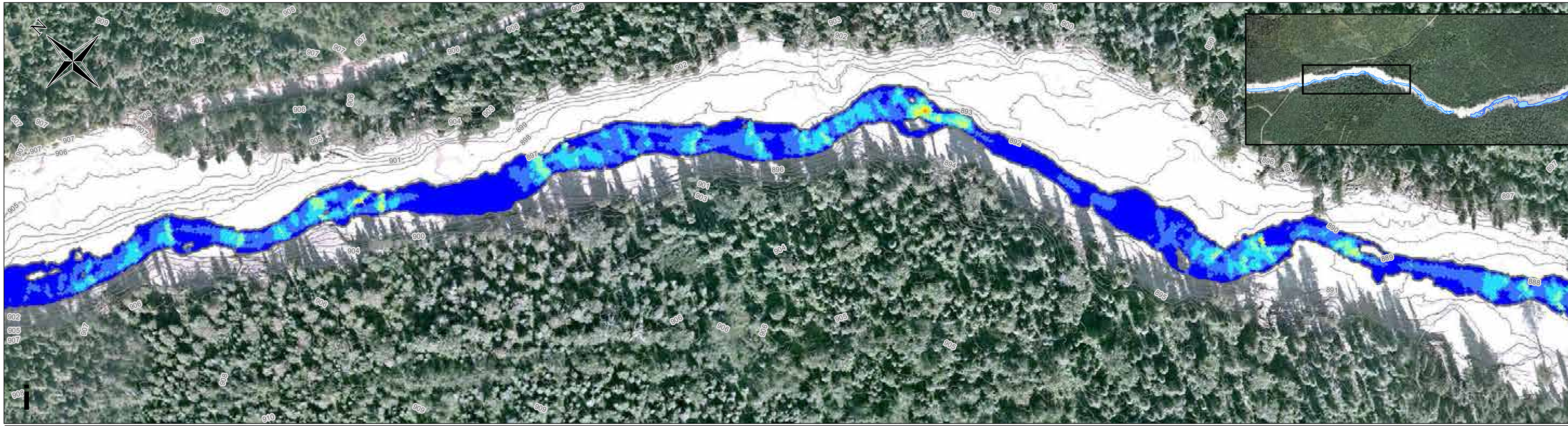

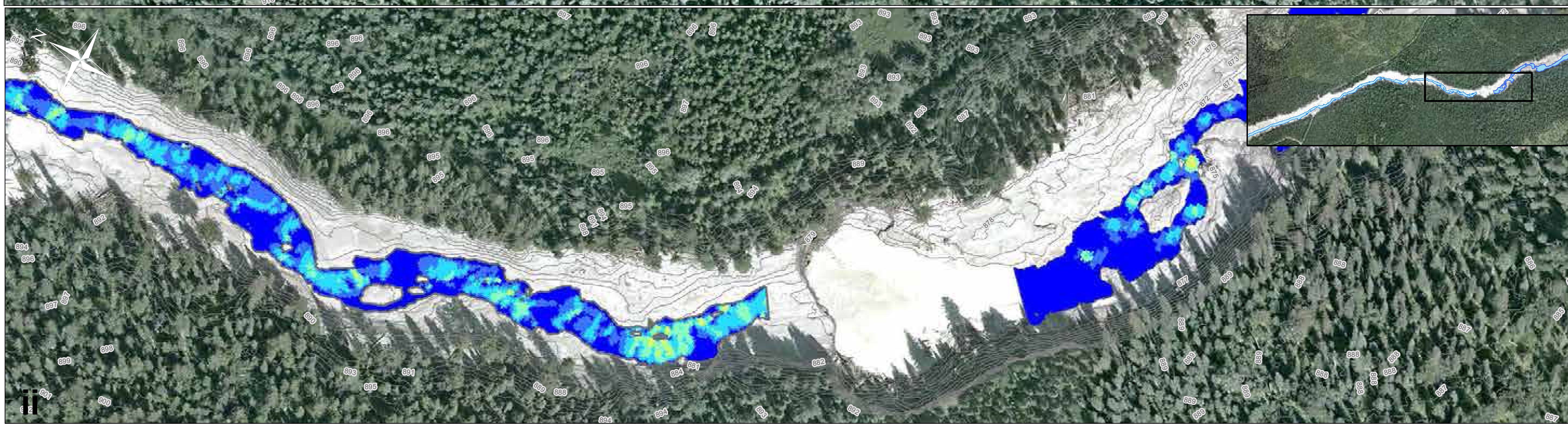

LEGEND

- 10 Year Water Level

10 Year Shear Stress Values (N/ sqr m)

- 0 - 16
- 16 - 32
- 32 - 64
- 64 - 128
- 128 - 256
- 256 - 512
- 512 - 1024
- >1024

NOTES

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REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 10 Year Shear Stress Values

BY: HB	SCALE: 1:2,000	DATE: 4/28/2015	REF No:	REV: 0
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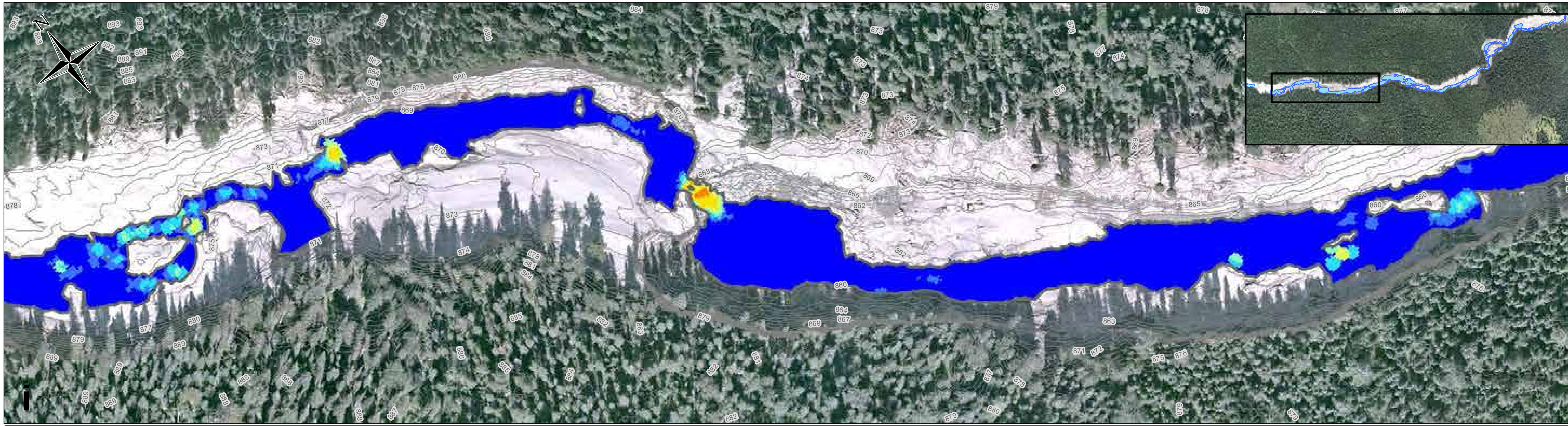

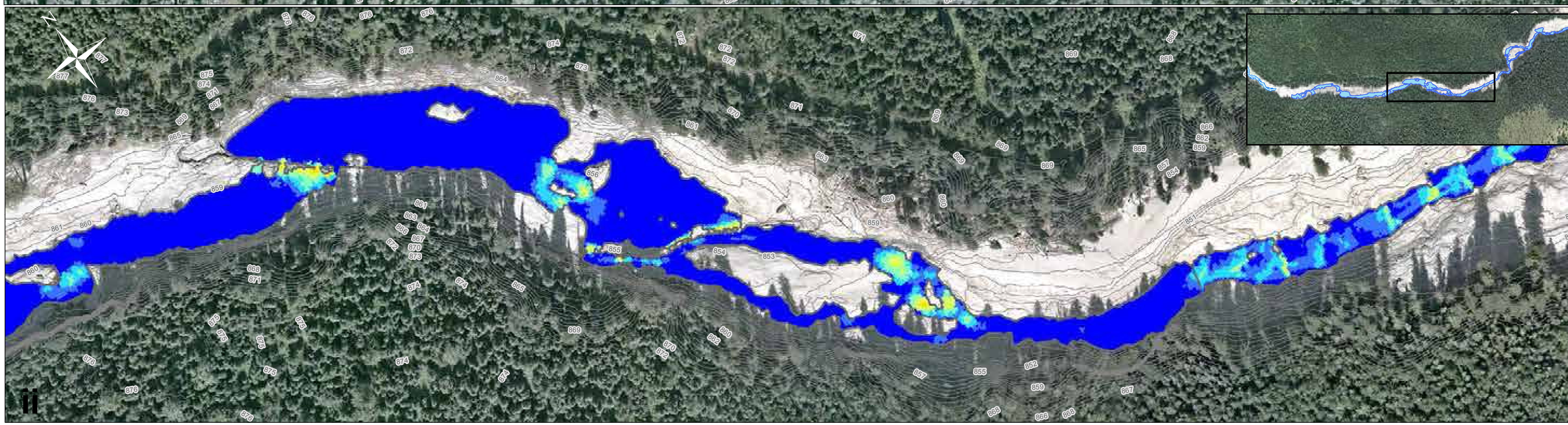

LEGEND

- 10 year water level

10 Year Shear Stress Values (N/sqr m)

- 0 - 16
- 16 - 32
- 32 - 64
- 64 - 128
- 128 - 256
- 256 - 512
- 512 - 1024
- >1024

NOTES

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REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 10 Year Shear Stress Values

BY: HB	SCALE: 1:2,000	DATE: 4/28/2015	REF No: REV: 0
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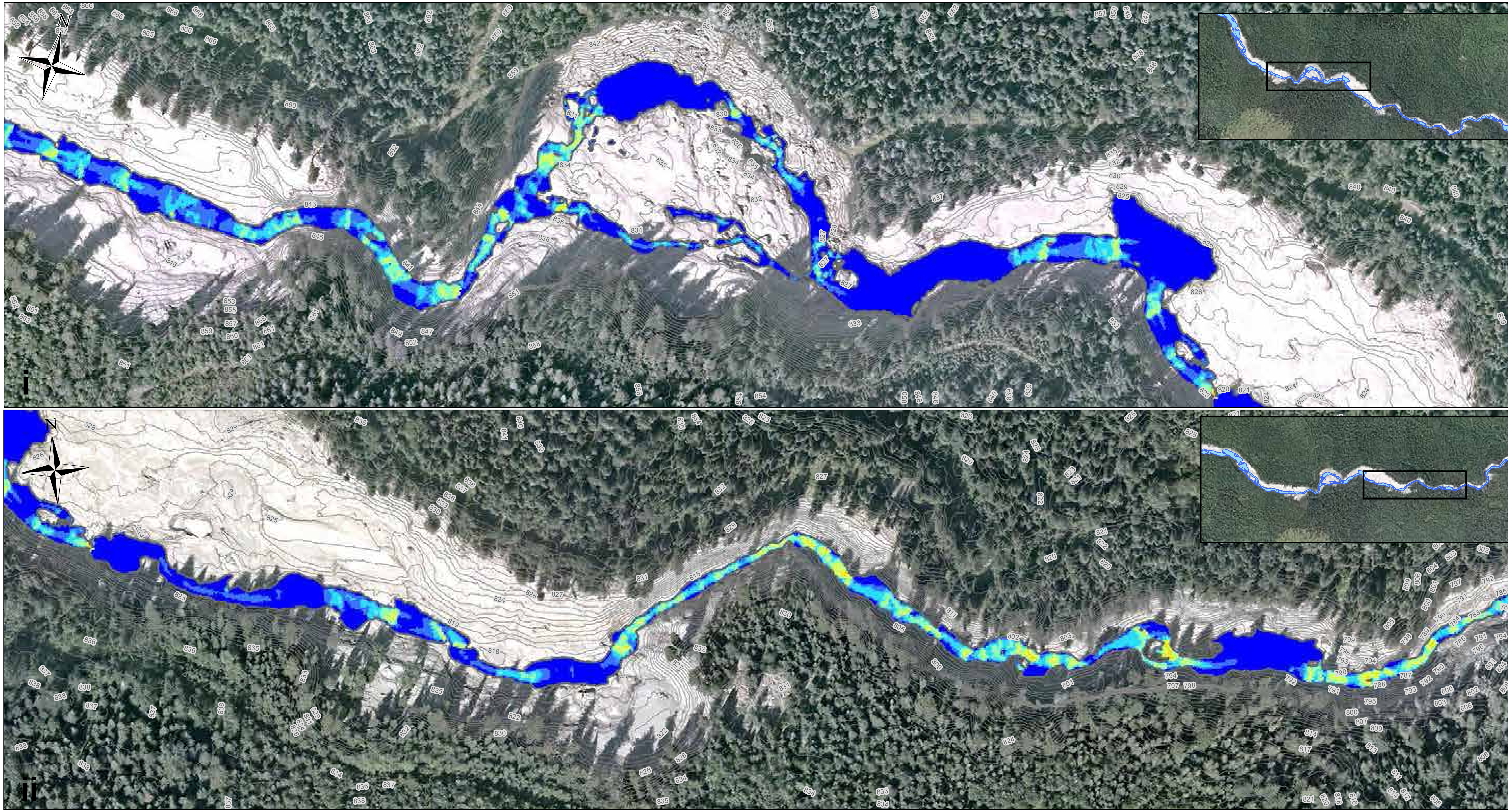

LEGEND

10 Year Water Level

10 Year Shear Stress Values (N/sqr m)

- 0 - 16
- 16 - 32
- 32 - 64
- 64 - 128
- 128 - 256
- 256 - 512
- 512 - 1024
- >1024

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REFERENCES

0 50 100 Meters

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SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 10 Year Shear Stress Values

BY: HB	SCALE: 1:2,000	DATE: 4/28/2015	REF No:	REV: 0
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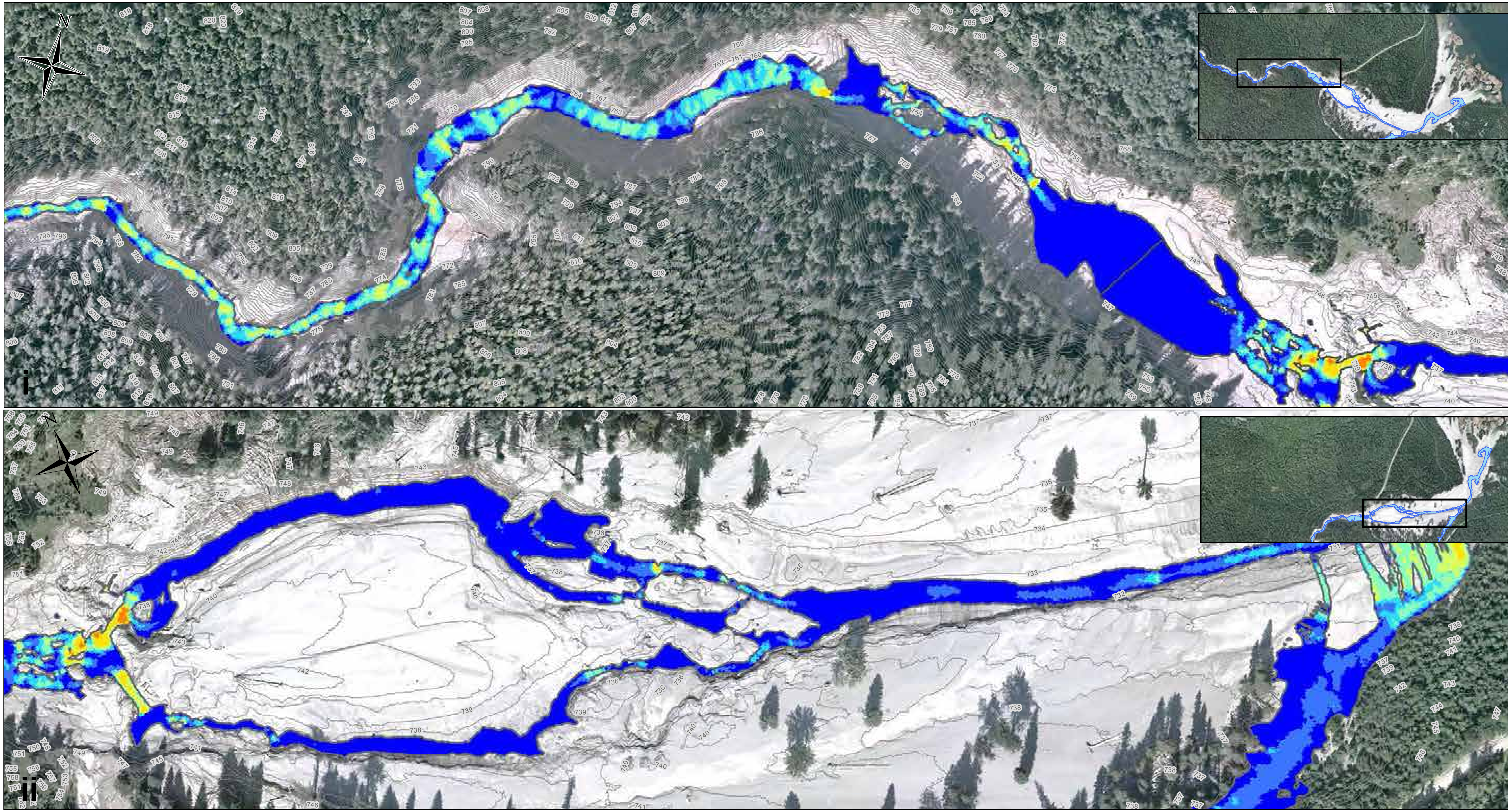

LEGEND

10 Year Water Level

10 Year Shear Stress Values (N/sqr m)

- 0 - 16
- 16 - 32
- 32 - 64
- 64 - 128
- 128 - 256
- 256 - 512
- 512 - 1024
- >1024

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 10 Year Shear Stress Values

BY: HB	SCALE: 1:2,000	DATE: 4/28/2015	REF No: REV: 0
CHK'D: FB	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-F029

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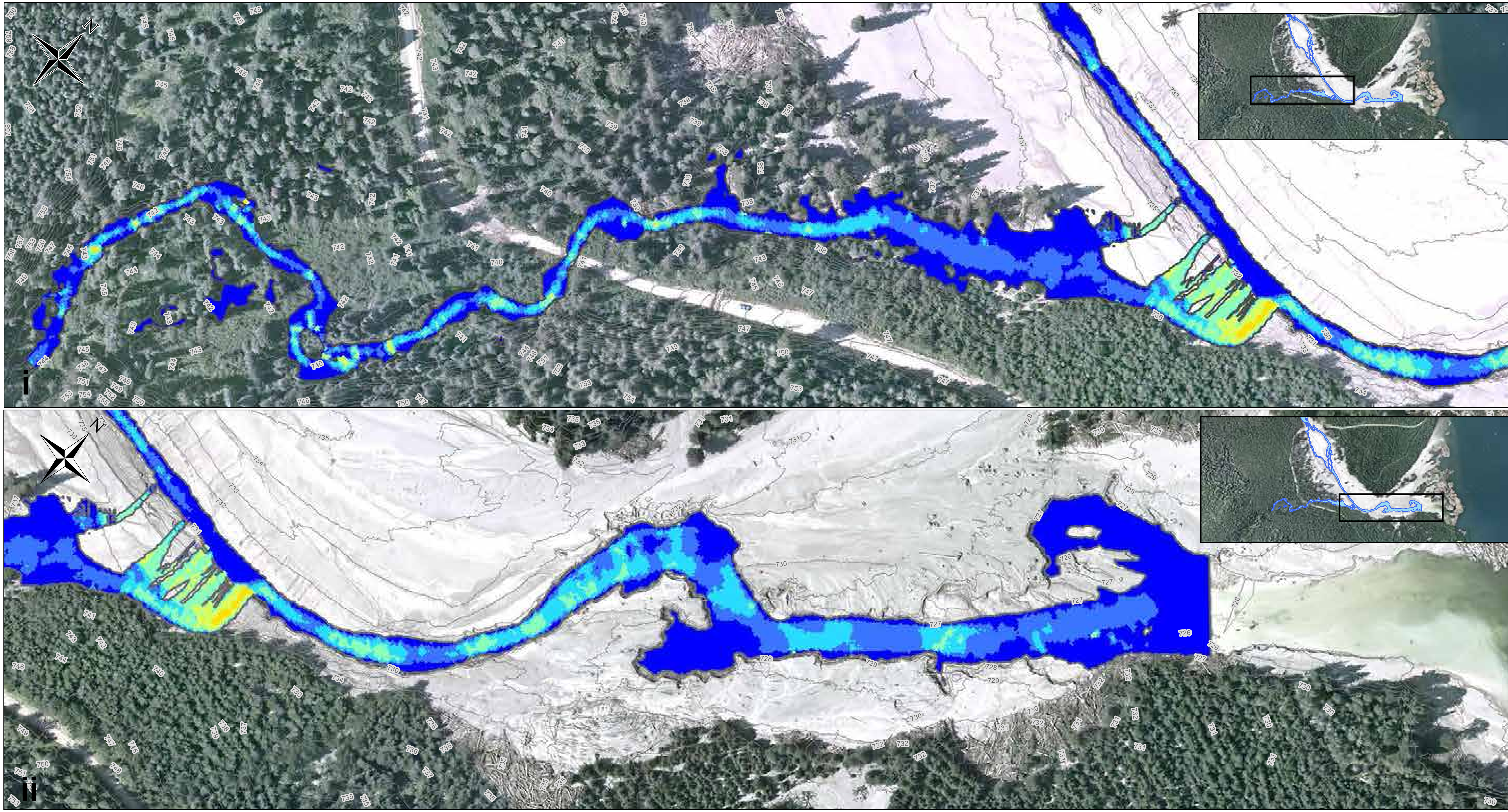


LEGEND

- 10 Year Water Level

10 Year Shear Stress Values (N/sqr m)

- 0 - 16
- 16 - 32
- 32 - 64
- 64 - 128
- 128 - 256
- 256 - 512
- 512 - 1024
- >1024

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

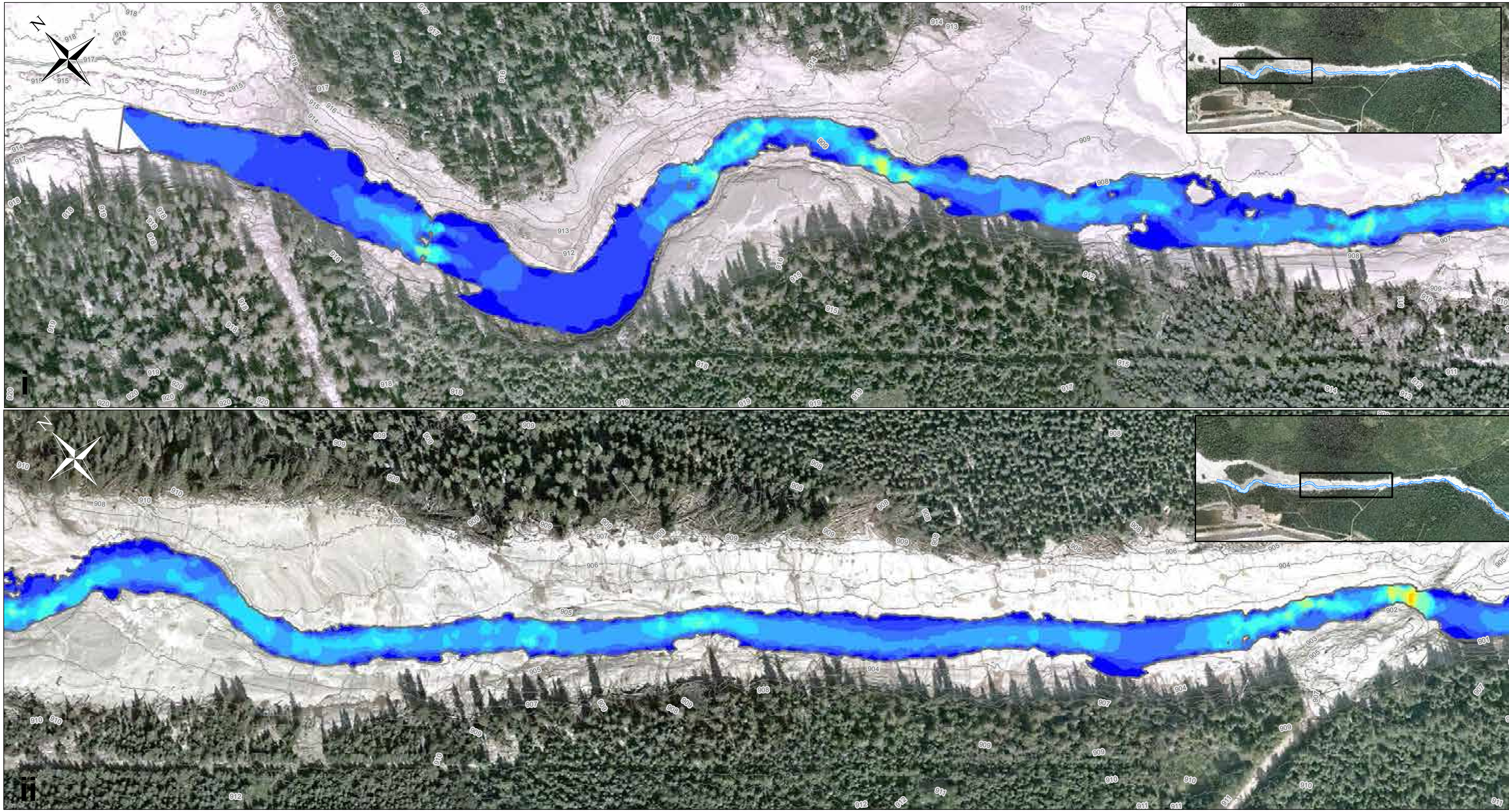
CLIENT NAME: Mount Polley Mining Corporation	PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 10 Year Shear Stress Values

BY: HB	SCALE: 1:2,000	DATE: 4/28/2015	REF No: REV: 0
CHK'D: FB	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-F030

MXD Path: \\proj_srv\PROJECTS\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\4.0 Execution\4.5 GIS and Drawings\GIS\PEEIAR Figures\HIA \621717-HIA-11x17.mxd

Project Path: P:\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\



LEGEND

- 10 Year Water Level

10 Year Velocity Values (m/s)

- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- 1.2 - 1.4
- 1.4 - 1.6
- 1.6 - 1.8
- 1.8 - 2.0
- 2.0 - 2.2
- 2.2 - 2.4
- 2.4 - 2.6
- 2.6 - 2.8
- 2.8 - 3.0

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

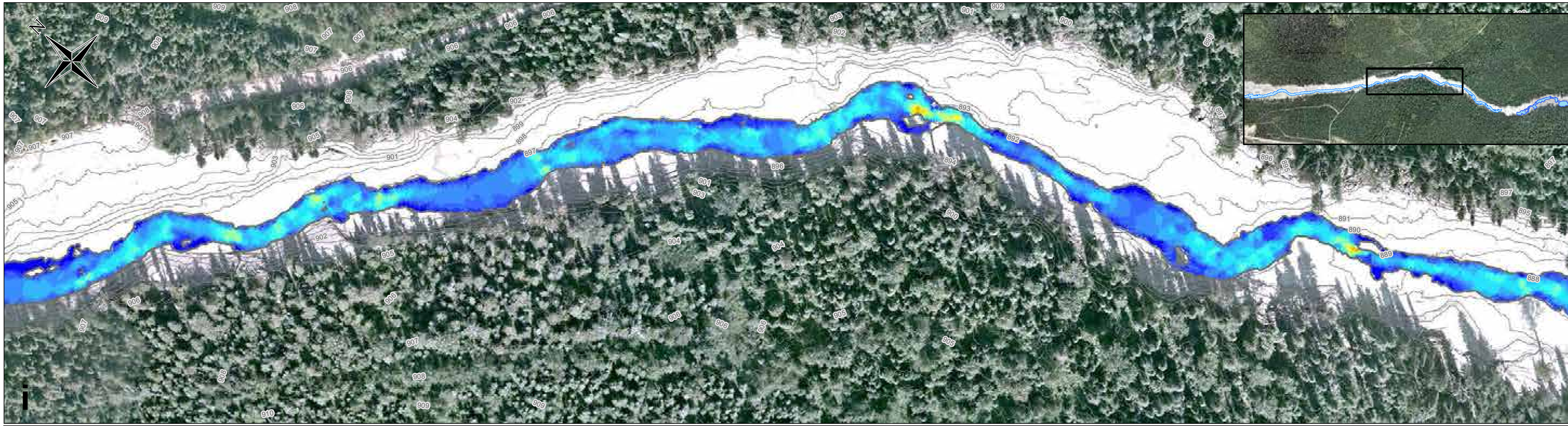
PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

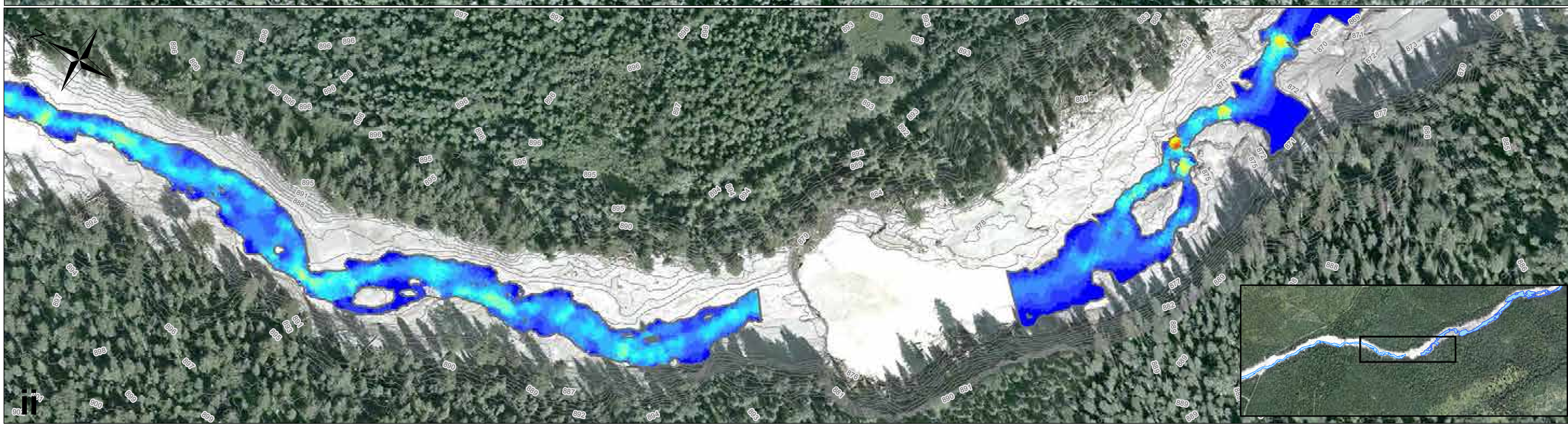
Hazeltine Hydraulic Modelling: 10 Year Velocity Values

BY: HB	SCALE: 1:2,000	DATE: 4/9/2015	REF No:	REV: 0
CHK'D: FB	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-F031	

MXD Path: \\proj_srv\PROJECTS\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\4.0 Execution\4.5 GIS and Drawings\GIS\PEEIAR Figures\HIA \621717-HIA-11x17.mxd

Project Path: P:\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\





LEGEND

10 Year Water Level

10 Year Velocity Values (m/s)

0 - 0.2	0.8 - 1	2.2 - 2.4
0.2 - 0.4	1 - 1.2	2.4 - 2.6
0.4 - 0.6	1.2 - 1.4	2.6 - 2.8
0.6 - 0.8	1.4 - 1.6	2.8 - 3
	1.6 - 1.8	3 - 3.2
	1.8 - 2	3.2 - 3.4
	2 - 2.2	3.4 - 3.6

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

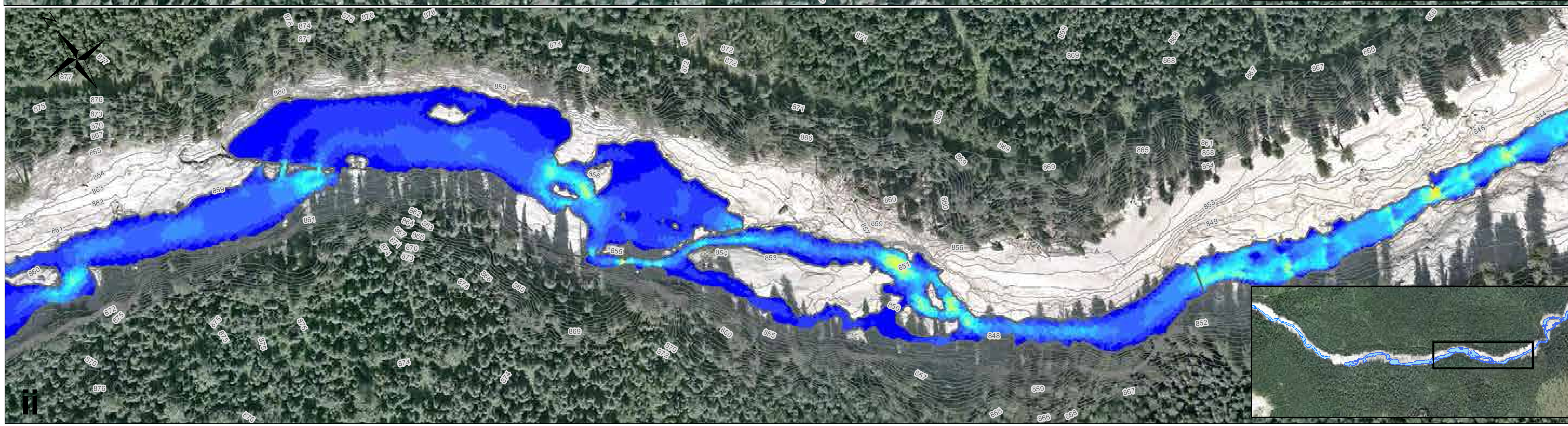
PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 10 Year Velocity Values

BY: HB	SCALE: 1:2,000	DATE: 4/12/2015	REF No:	REV: 0
CHK'D: FB	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-F032	

Project Path: P:\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\

MXD Path: \\proj_srv\PROJECTS\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\4.0 Execution\4.5 GIS and Drawings\GIS\PEEIAR Figures\HIA \621717-HIA-11x17.mxd



LEGEND

10 year water level	0.8 - 1	2.2 - 2.4
10 Year Velocity Values (m/s)	1 - 1.2	2.4 - 2.6
0 - 0.2	1.2 - 1.4	2.6 - 2.8
0.2 - 0.4	1.4 - 1.6	2.8 - 3
0.4 - 0.6	1.6 - 1.8	3 - 3.2
0.6 - 0.8	1.8 - 2	3.2 - 3.4
	2 - 2.2	3.4 - 3.6

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC·LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 10 Year Velocity Values

BY: HB	SCALE: 1:2,000	DATE: 4/20/2015	REF No: REV: 0
CHK'D: FB	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-F033

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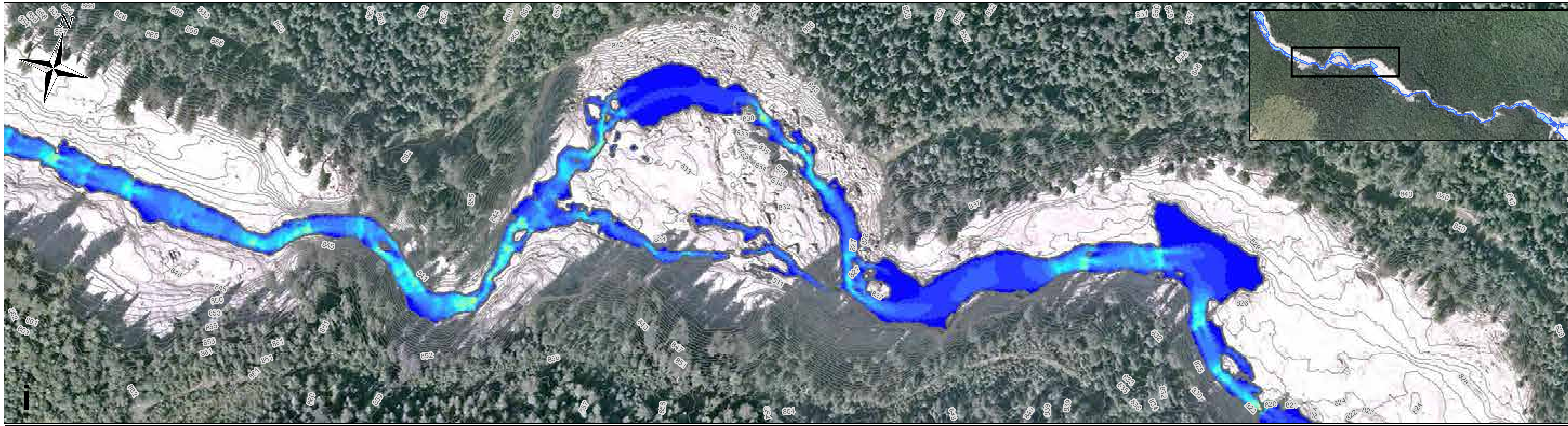

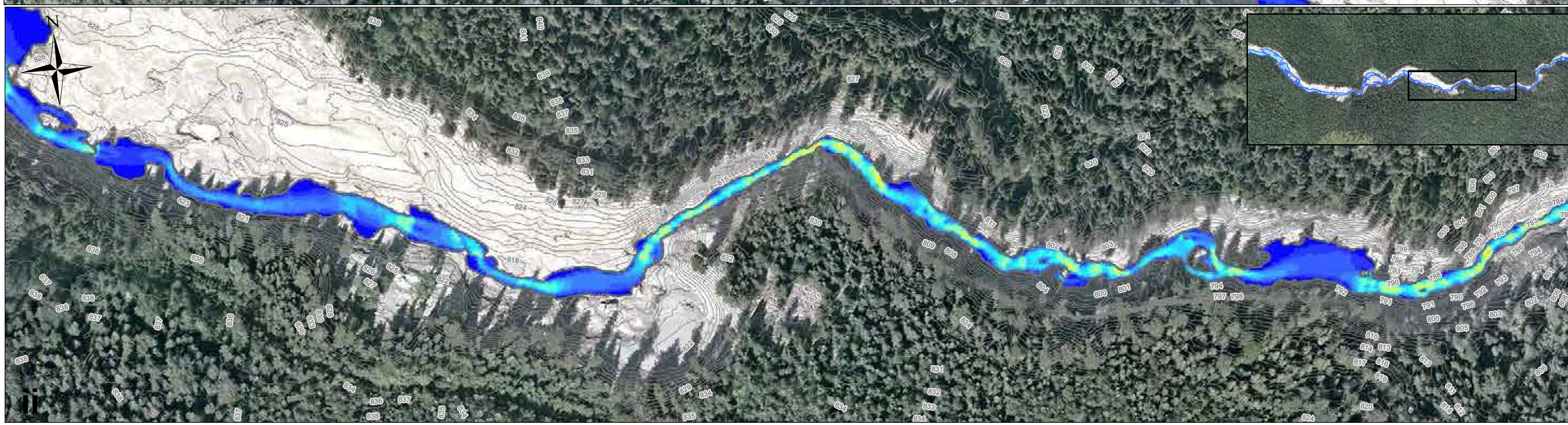

LEGEND

10 Year Water Level

10 Year Velocity Values (m/s)

0 - 0.25	1 - 1.25	2.75 - 3
0.25 - 0.5	1.25 - 1.5	3 - 3.25
0.5 - 0.75	1.5 - 1.75	3.25 - 3.5
0.75 - 1	1.75 - 2	3.5 - 3.75
	2 - 2.25	3.75 - 4
	2.25 - 2.5	4 - 4.25
	2.5 - 2.75	4.25 - 4.5
		4.5 - 4.75
		4. 75 - 5

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 10 Year Velocity Values

BY: HB	SCALE: 1:2,000	DATE: 4/23/2015	REF No: REV: 0
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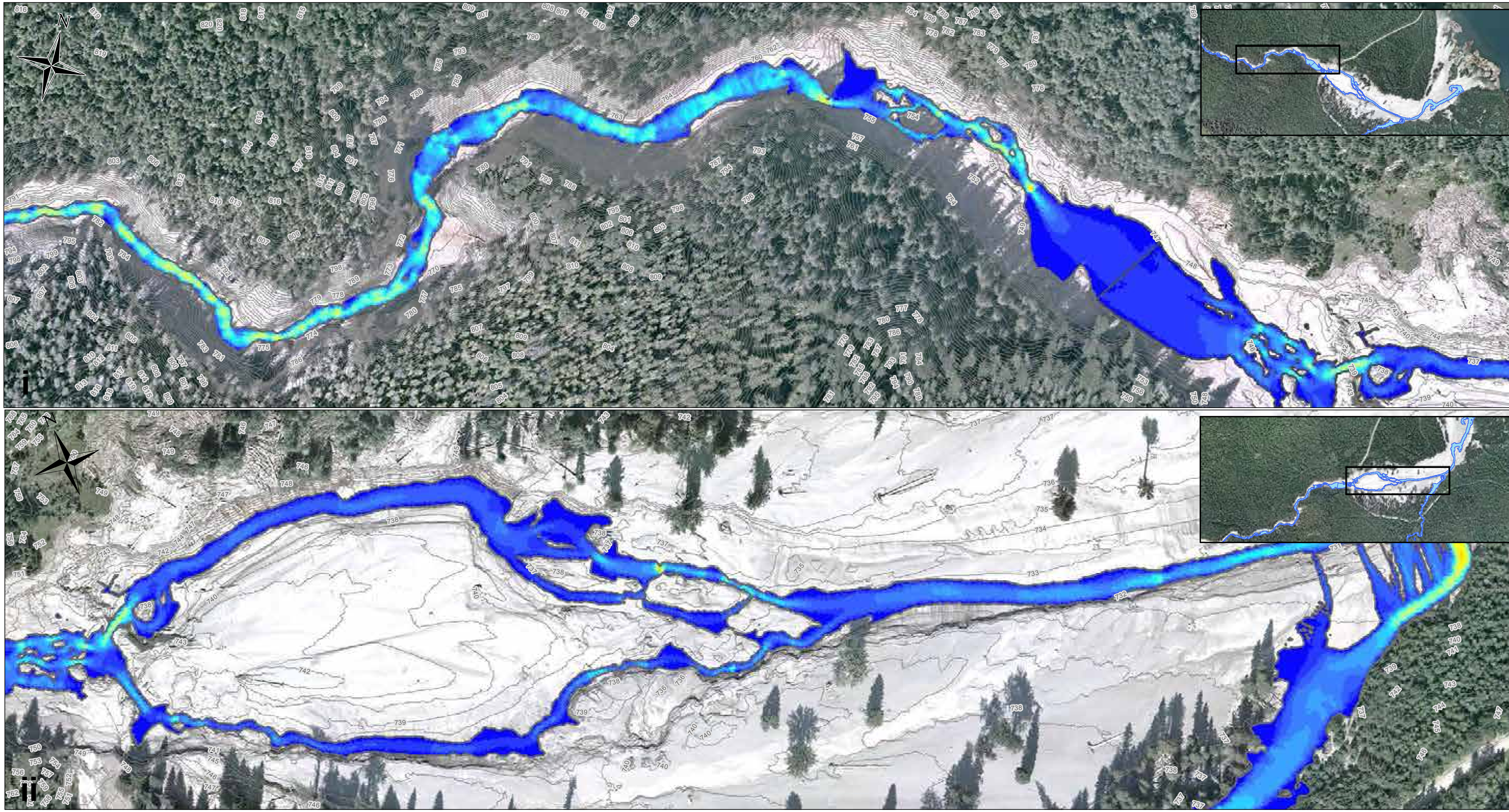

LEGEND

10 Year Water Level

10 Year Velocity Values (m/s)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4. 75 - 5

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 10 Year Velocity Values

BY: HB	SCALE: 1:2,000	DATE: 4/23/2015	REF No:	REV: 0
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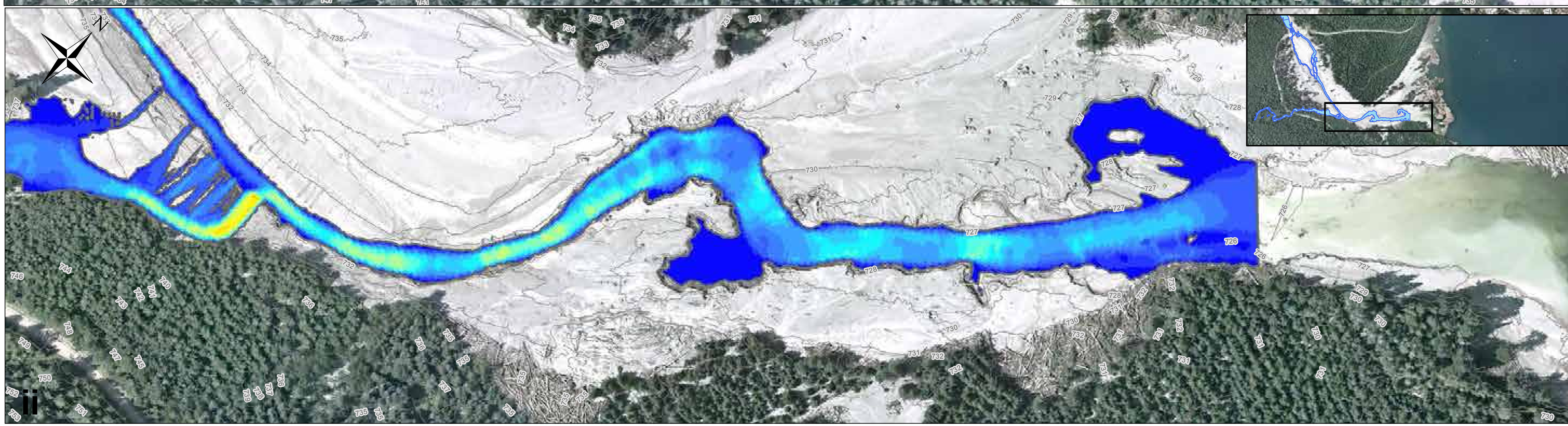

LEGEND

10 Year Water Level

10 Year Velocity Values (m/s)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4. 75 - 5

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 10 Year Velocity Values

BY: HB	SCALE: 1:2,000	DATE: 4/23/2015	REF No:	REV: 0
CHK'D: FB	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-F036	

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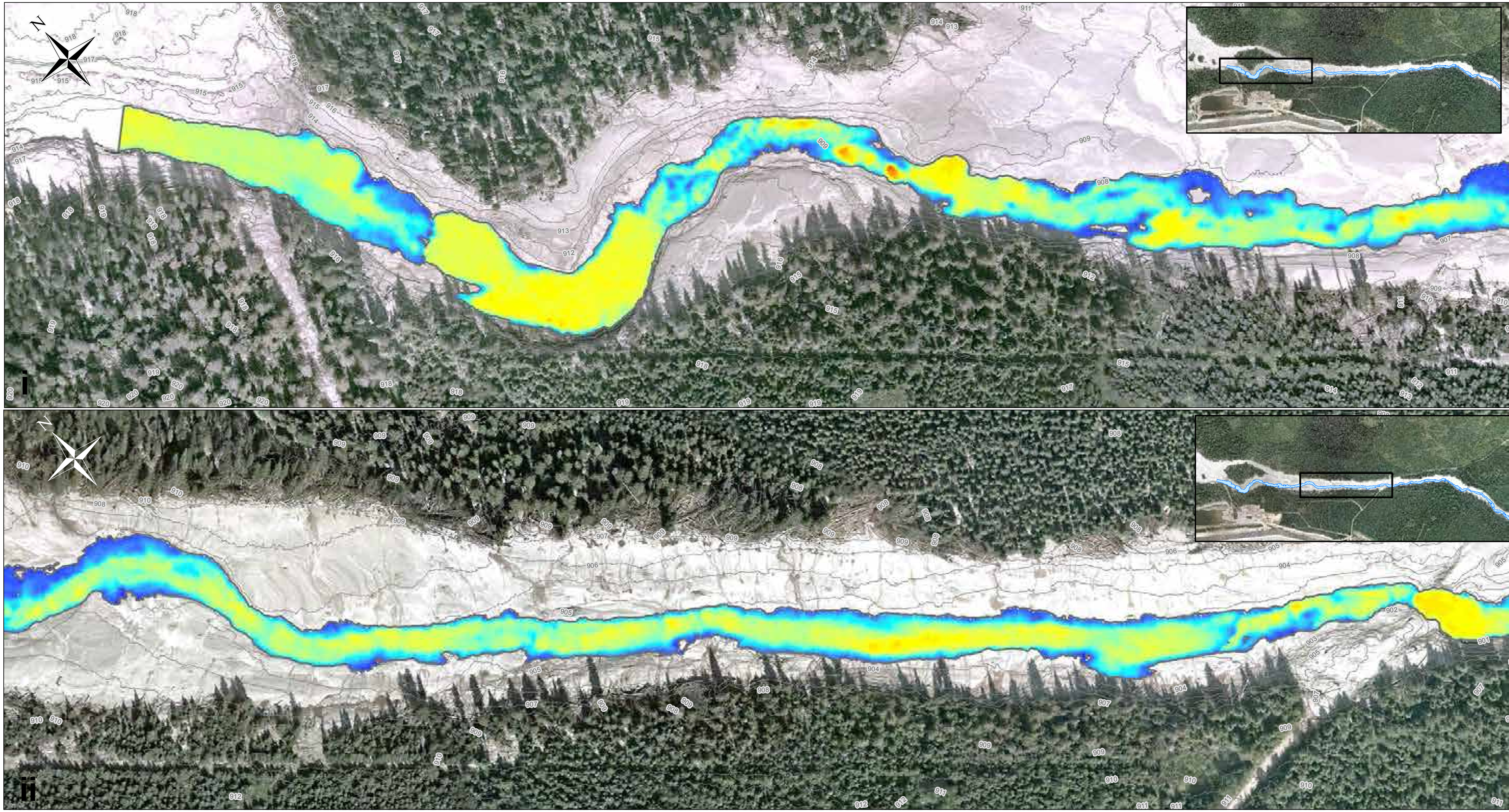

LEGEND

100 Year Water Level

100 Year Depth Values (m)

- 0 - 0.02
- 0.02 - 0.04
- 0.04 - 0.06
- 0.06 - 0.08
- 0.08 - 0.1
- 0.10 - 0.12
- 0.12 - 0.14
- 0.14 - 0.16
- 0.16 - 0.18
- 0.18 - 0.2
- 0.2 - 0.22
- 0.22 - 0.24
- 0.24 - 0.26
- 0.26 - 0.28
- 0.28 - 0.3
- 0.3 - 0.32
- 0.32 - 0.34
- 0.34 - 0.36
- 0.36 - 0.38
- 0.38 - 0.4
- 0.4 - 0.42
- 0.42 - 0.44
- 0.44 - 0.46
- 0.46 - 0.48
- 0.48 - 0.5
- 0.5 - 0.52
- 0.52 - 0.54
- 0.54 - 0.56
- 0.56 - 0.58
- 0.58 - 0.6

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 100 Year Depth Values

BY: HB	SCALE: 1:2,000	DATE: 4/9/2015	REF No: REV: 0
CHK'D: FB	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-F037

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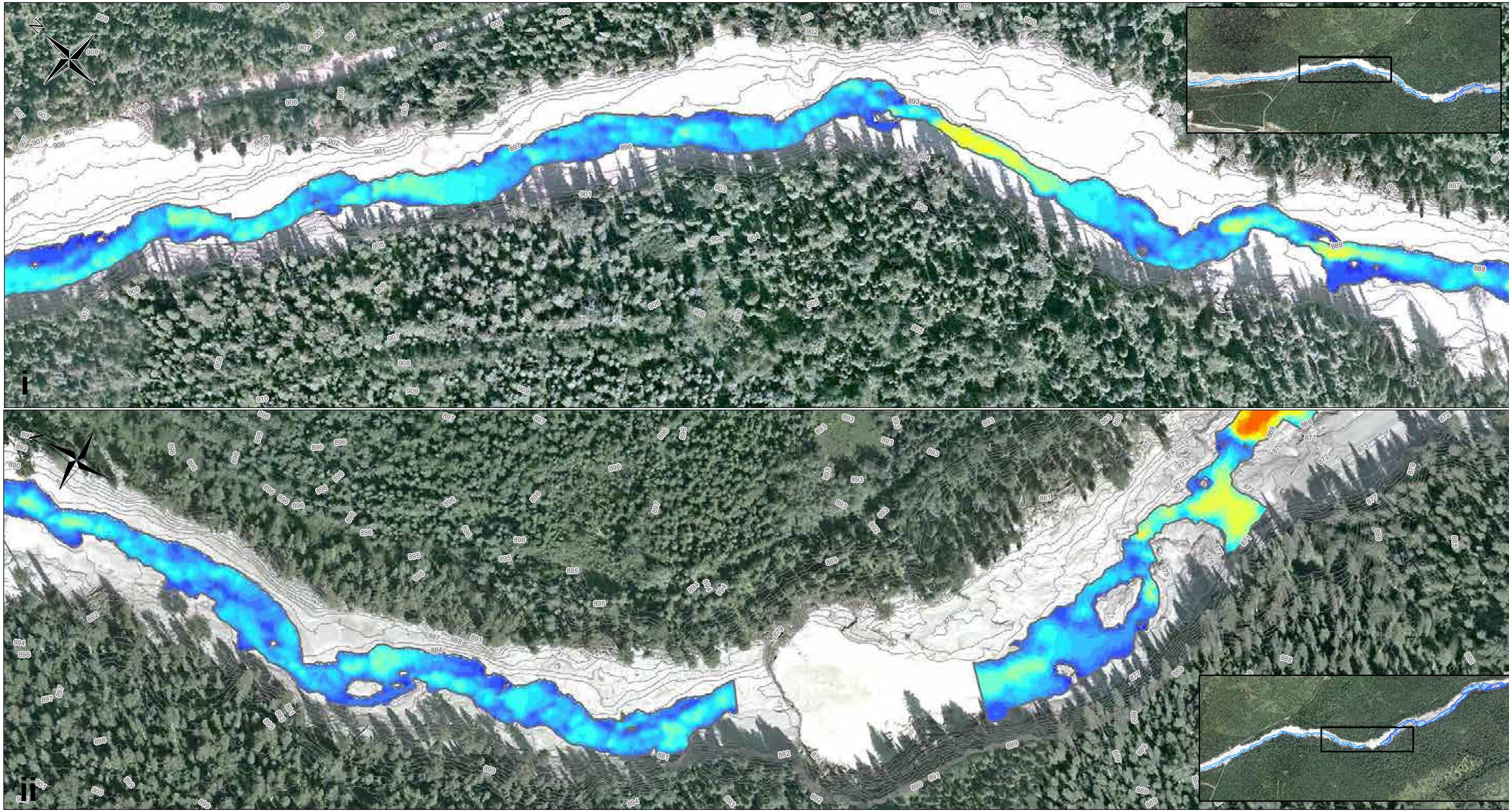

LEGEND

- 100 Year Water Level

100 Year Depth Values (m)

0 - 0.05	0.2 - 0.25	0.55 - 0.6	0.9 - 0.95
0.05 - 0.1	0.25 - 0.3	0.6 - 0.65	0.95 - 1
0.1 - 0.15	0.3 - 0.35	0.65 - 0.7	
0.15 - 0.2	0.35 - 0.4	0.7 - 0.75	
	0.4 - 0.45	0.75 - 0.8	
	0.45 - 0.5	0.8 - 0.85	
	0.5 - 0.55	0.85 - 0.9	

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 100 Year Depth Values

BY: HB	SCALE: 1:2,000	DATE: 4/12/2015	REF No: REV: 0
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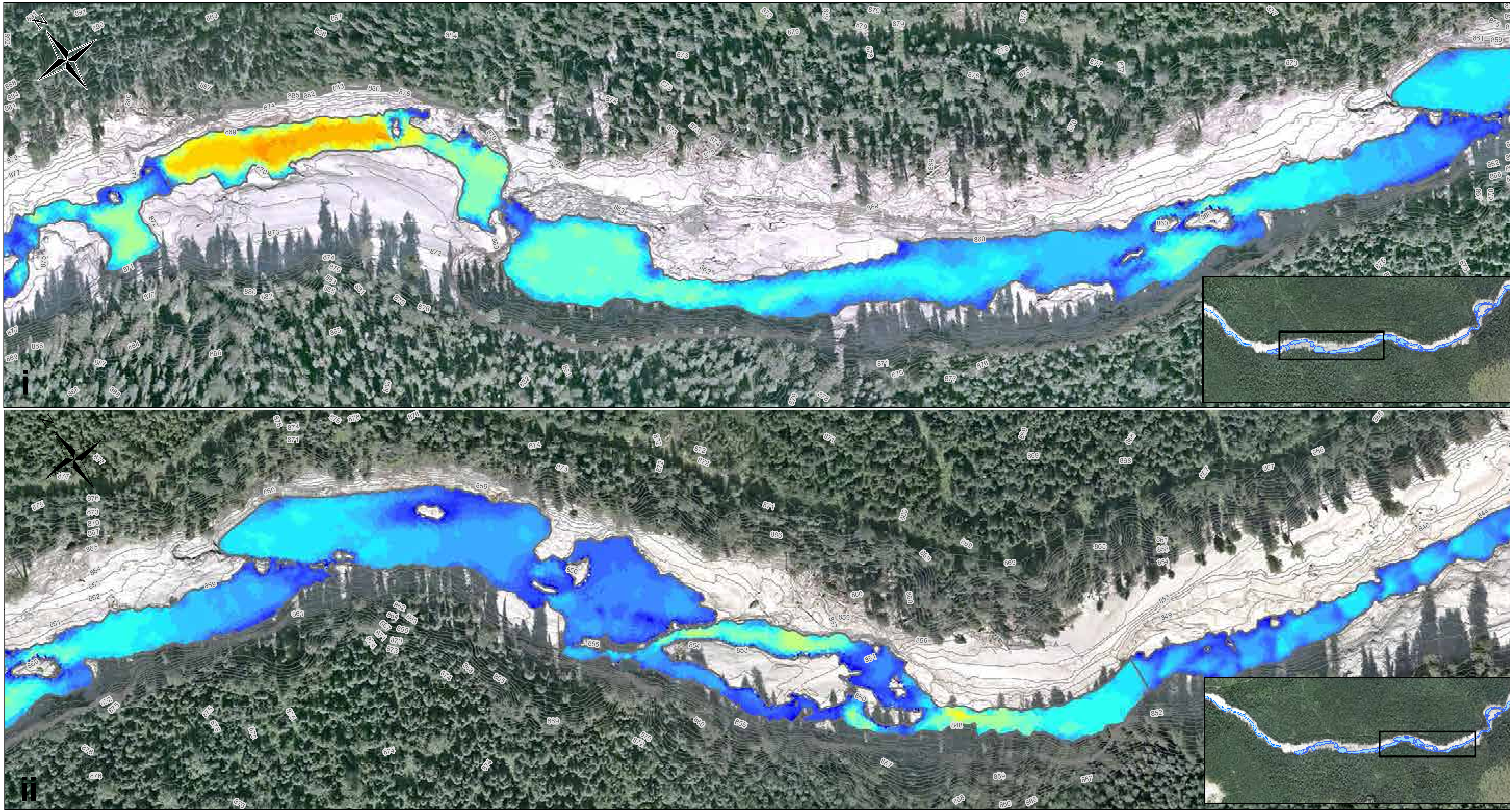

LEGEND

100 Year Water Level	0.3 - 0.35	0.7 - 0.75	1.1 - 1.15
100 Year Depth Values (m)	0.35 - 0.4	0.75 - 0.8	1.15 - 1.2
0 - 0.05	0.4 - 0.45	0.8 - 0.85	
0.05 - 0.1	0.45 - 0.5	0.85 - 0.9	
0.1 - 0.15	0.5 - 0.55	0.9 - 0.95	
0.15 - 0.2	0.55 - 0.6	0.95 - 1	
0.2 - 0.25	0.6 - 0.65	1 - 1.05	
0.25 - 0.3	0.65 - 0.7	1.05 - 1.1	

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 100 Year Depth Values

BY: HB	SCALE: 1:2,000	DATE: 4/20/2015	REF No: REV: 0
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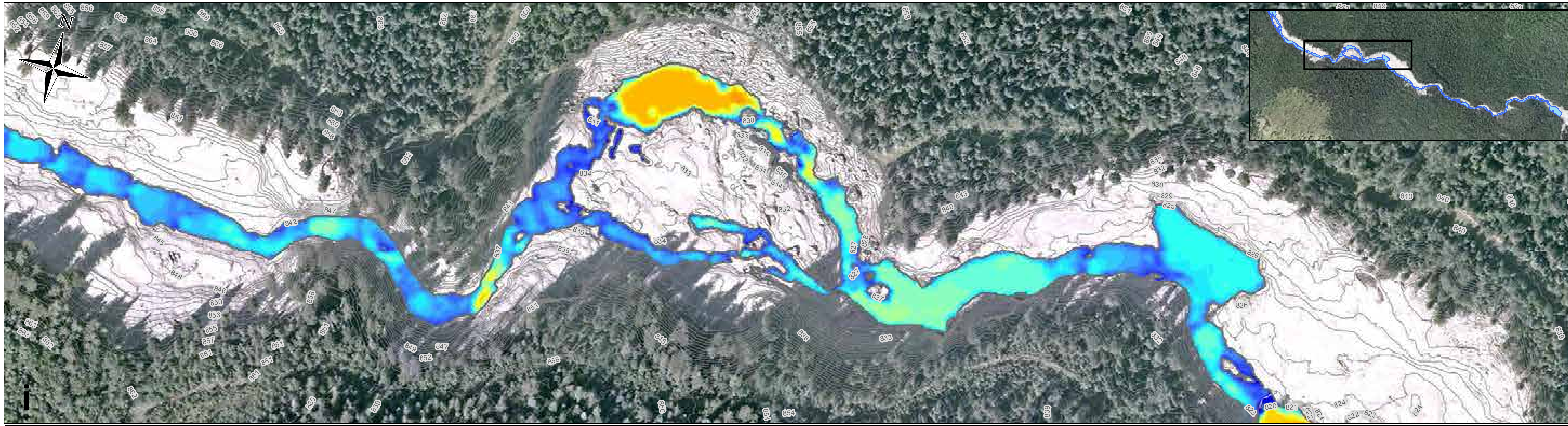

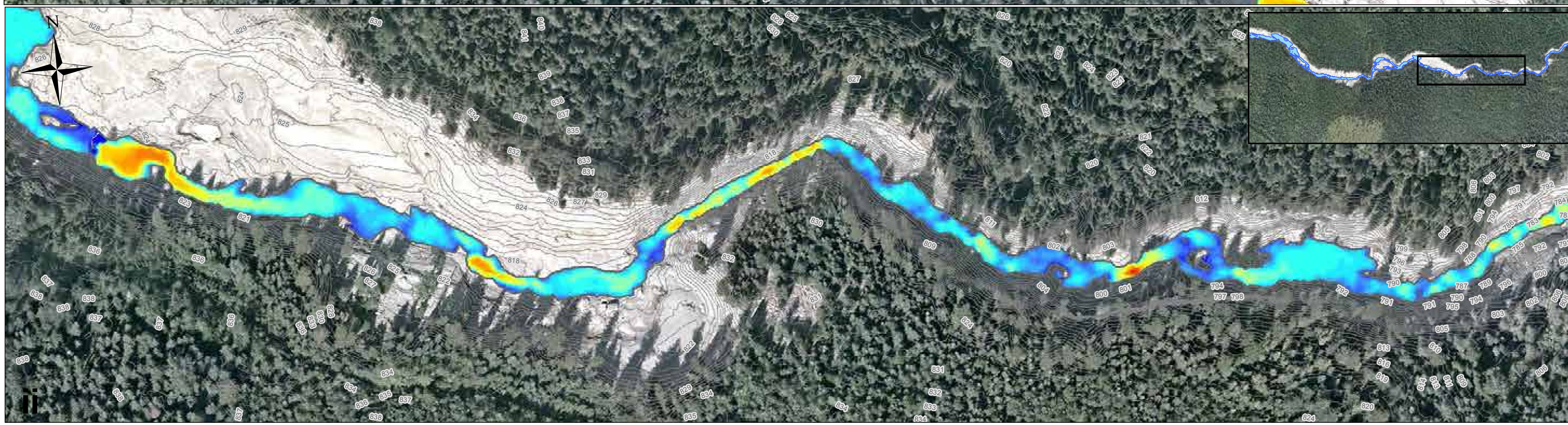

LEGEND

100 Year Water Level

100 Year Depth Values (m)

0 - 0.05	0.3 - 0.35	0.7 - 0.75	1.1 - 1.15
0.05 - 0.1	0.35 - 0.4	0.75 - 0.8	1.15 - 1.2
0.1 - 0.15	0.4 - 0.45	0.8 - 0.85	
0.15 - 0.2	0.45 - 0.5	0.85 - 0.9	
0.2 - 0.25	0.5 - 0.55	0.9 - 0.95	
0.25 - 0.3	0.55 - 0.6	0.95 - 1	
	0.6 - 0.65	1 - 1.05	
	0.65 - 0.7	1.05 - 1.1	

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 100 Year Depth Values

BY: HB	SCALE: 1:2,000	DATE: 4/20/2015	REF No: REV: 0
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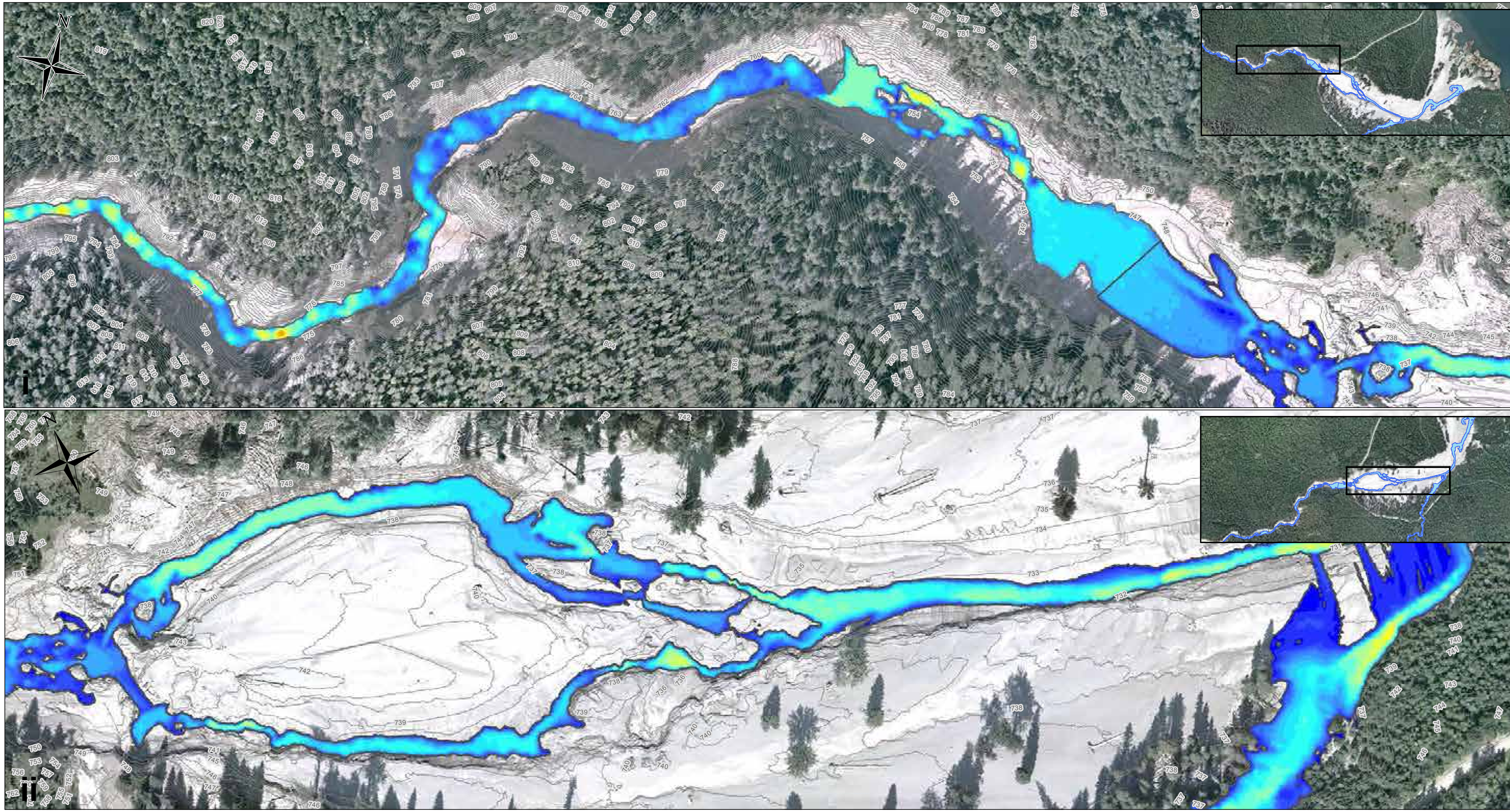

LEGEND

- 100 Year Water Level

100 Year Depth Values (m)

0 - 0.05	0.3 - 0.35	0.7 - 0.75	1.1 - 1.15
0.05 - 0.1	0.35 - 0.4	0.75 - 0.8	1.15 - 1.2
0.1 - 0.15	0.4 - 0.45	0.8 - 0.85	
0.15 - 0.2	0.45 - 0.5	0.85 - 0.9	
0.2 - 0.25	0.5 - 0.55	0.9 - 0.95	
0.25 - 0.3	0.55 - 0.6	0.95 - 1	
	0.6 - 0.65	1 - 1.05	
	0.65 - 0.7	1.05 - 1.1	

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 100 Year Depth Values

BY: HB	SCALE: 1:2,000	DATE: 4/23/2015	REF No:	REV: 0
CHK'D: FB	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-F041	

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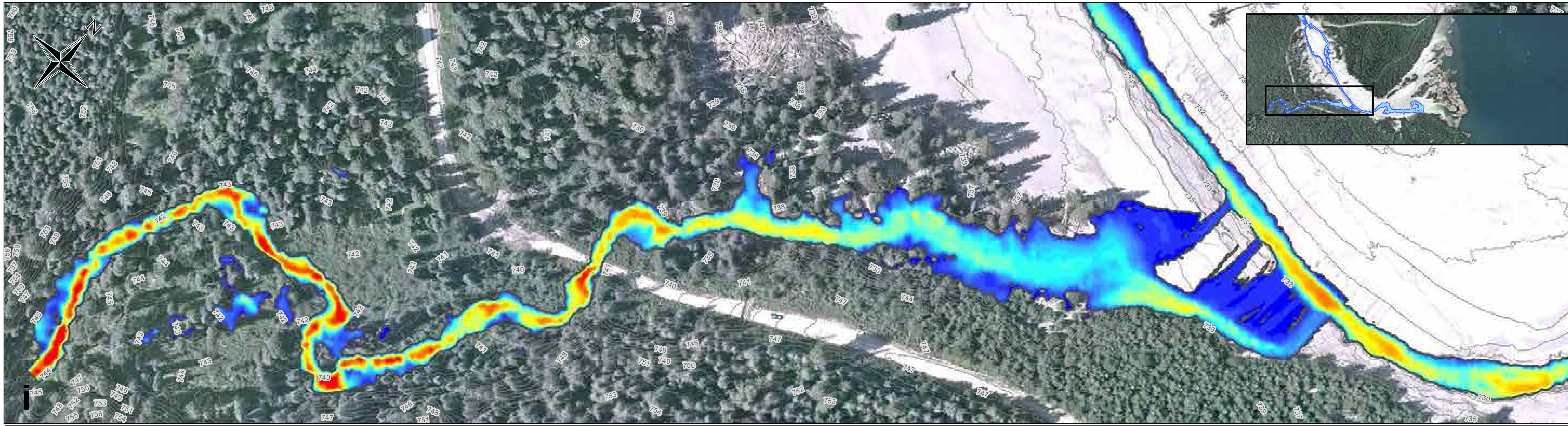

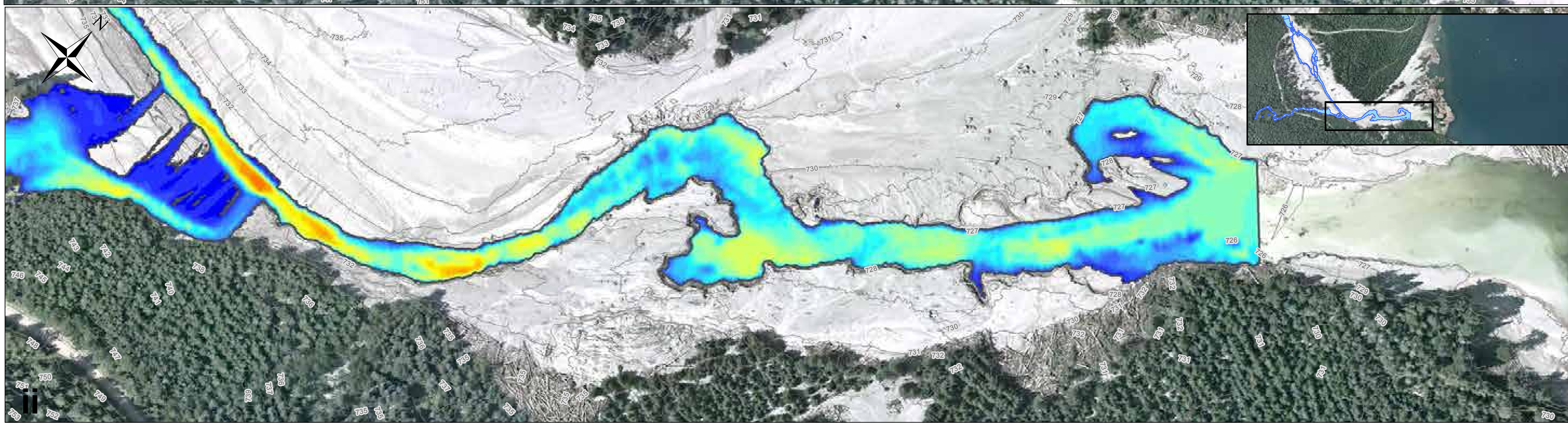

LEGEND

- 100 Year Water Level

100 Year Depth Values (m)

0 - 0.05	0.3 - 0.35	0.7 - 0.75	1.1 - 1.15
0.05 - 0.1	0.35 - 0.4	0.75 - 0.8	1.15 - 1.2
0.1 - 0.15	0.4 - 0.45	0.8 - 0.85	
0.15 - 0.2	0.45 - 0.5	0.85 - 0.9	
0.2 - 0.25	0.5 - 0.55	0.9 - 0.95	
0.25 - 0.3	0.55 - 0.6	0.95 - 1	
	0.6 - 0.65	1 - 1.05	
	0.65 - 0.7	1.05 - 1.1	

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 100 Year Depth Values

BY: HB	SCALE: 1:2,000	DATE: 4/23/2015	REF No:	REV: 0
CHK'D: FB	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-F042	

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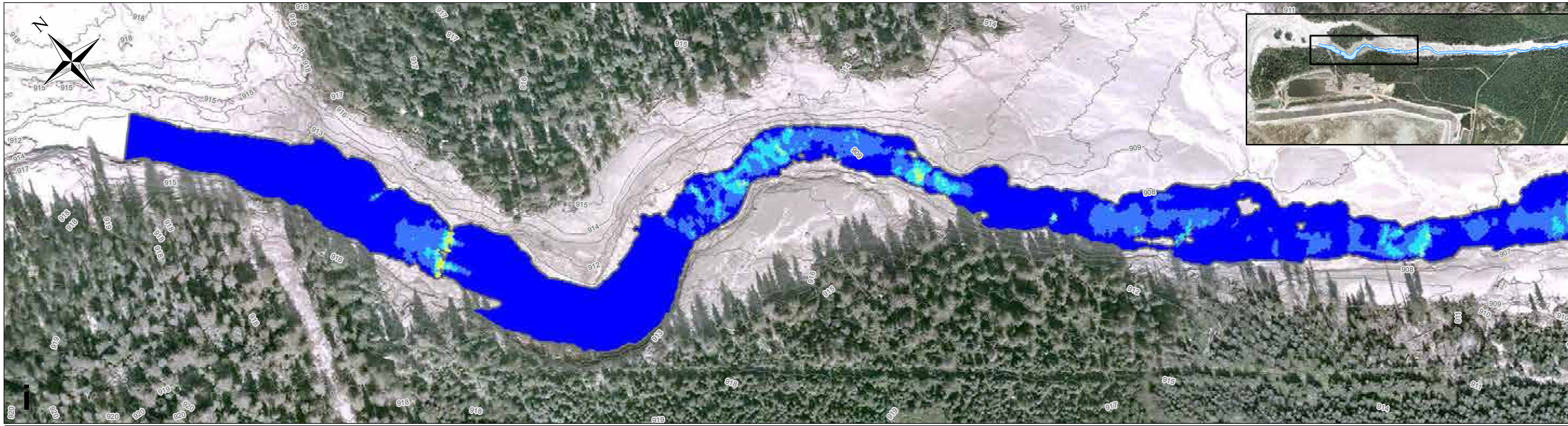

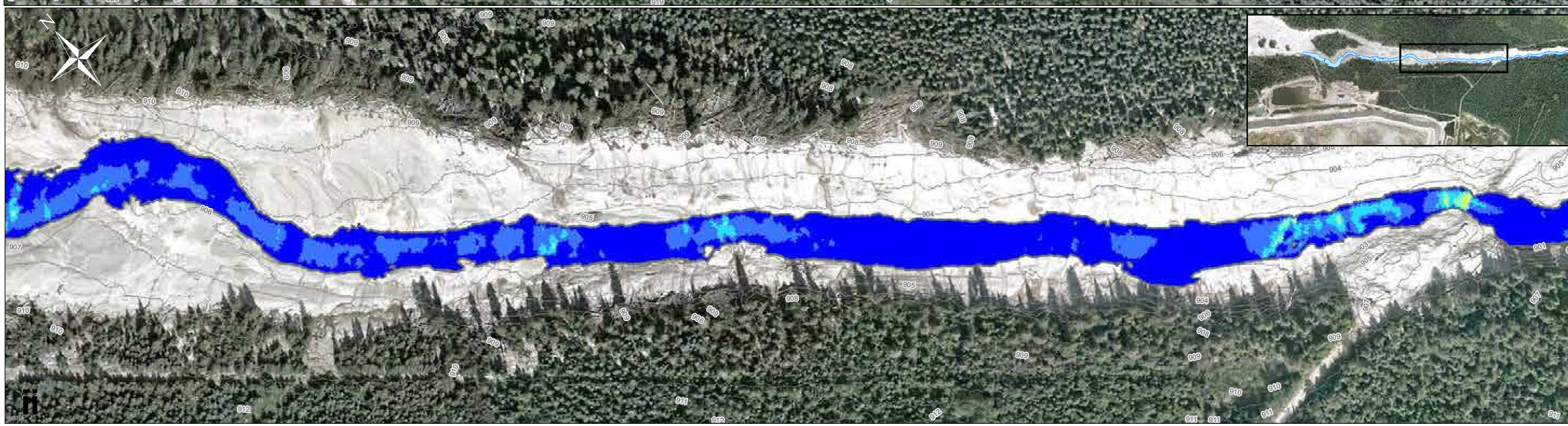

LEGEND

100 Year Water Level

100 Year Shear Stress Values (N/ sqr m)

- 0 - 16
- 16 - 32
- 32 - 64
- 64 - 128
- 128 - 256
- 256 - 512
- 512 - 1024
- >1024

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 100 Year Shear Stress Values

BY: HB	SCALE: 1:2,000	DATE: 4/28/2015	REF No:	REV: 0
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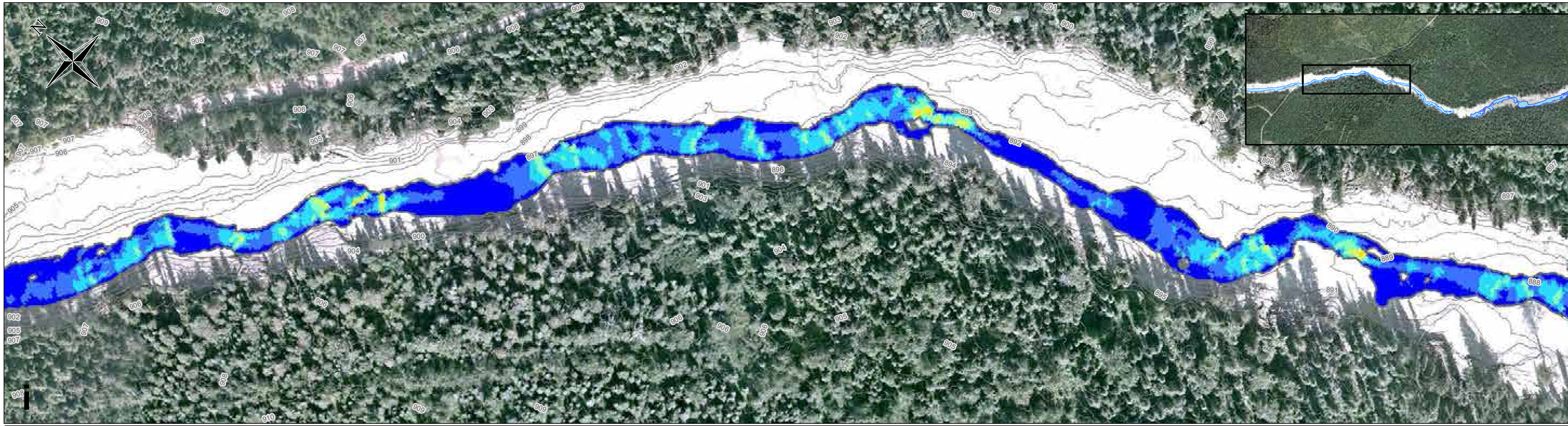
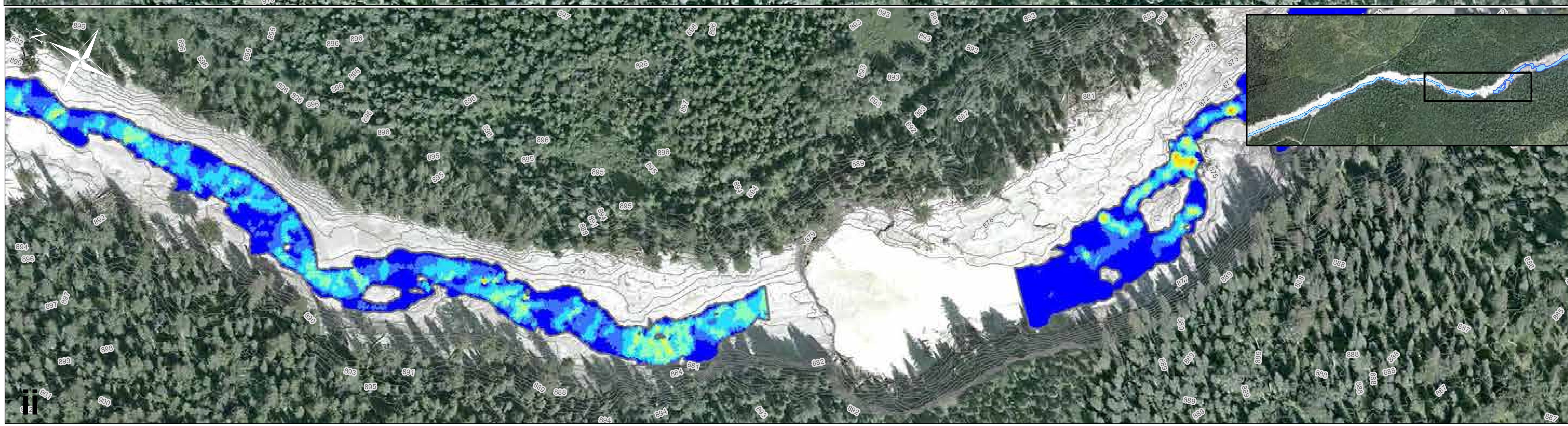
Project Path: P:\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\





LEGEND

100 Year Water Level

100 Year Shear Stress Values (N/ sqr m)

- 0 - 16
- 16 - 32
- 32 - 64
- 64 - 128
- 128 - 256
- 256 - 512
- 512 - 1024
- >1024

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 100 Year Shear Stress Values

BY: HB	SCALE: 1:2,000	DATE: 4/28/2015	REF No:	REV: 0
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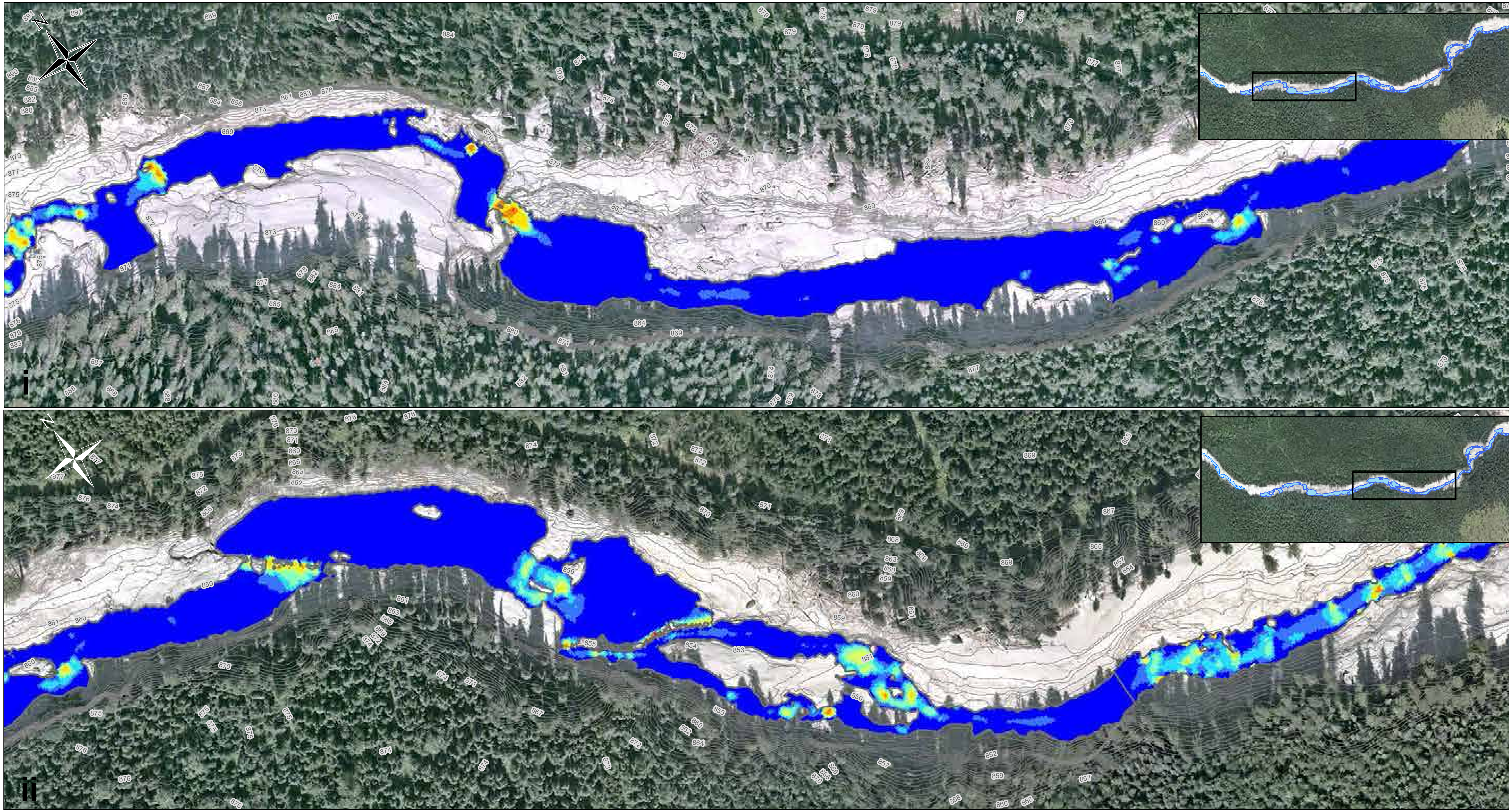
Project Path: P:\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\



LEGEND

100 Year Water Level

100 Year Shear Stress Values (N/sqr m)

- 0 - 16
- 16 - 32
- 32 - 64
- 64 - 128
- 128 - 256
- 256 - 512
- 512 - 1024
- >1024

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 100 Year Shear Stress Values

BY: HB	SCALE: 1:2,000	DATE: 4/29/2015	REF No:	REV: 0
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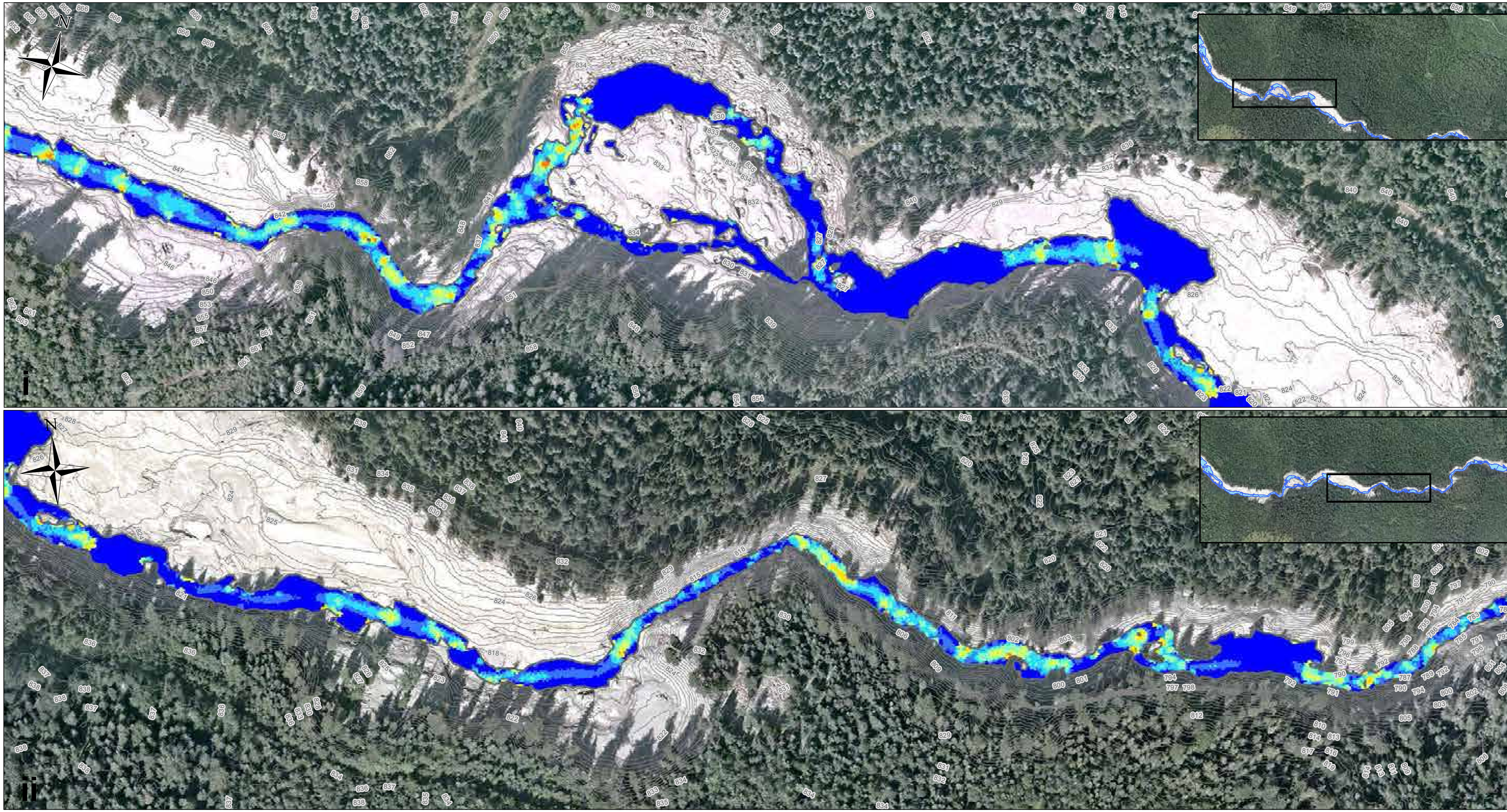

LEGEND

- 100 Year Water Level

100 Year Shear Stress Values (N/sqr m)

- 0 - 16
- 16 - 32
- 32 - 64
- 64 - 128
- 128 - 256
- 256 - 512
- 512 - 1024
- >1024

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 100 Year Shear Stress Values

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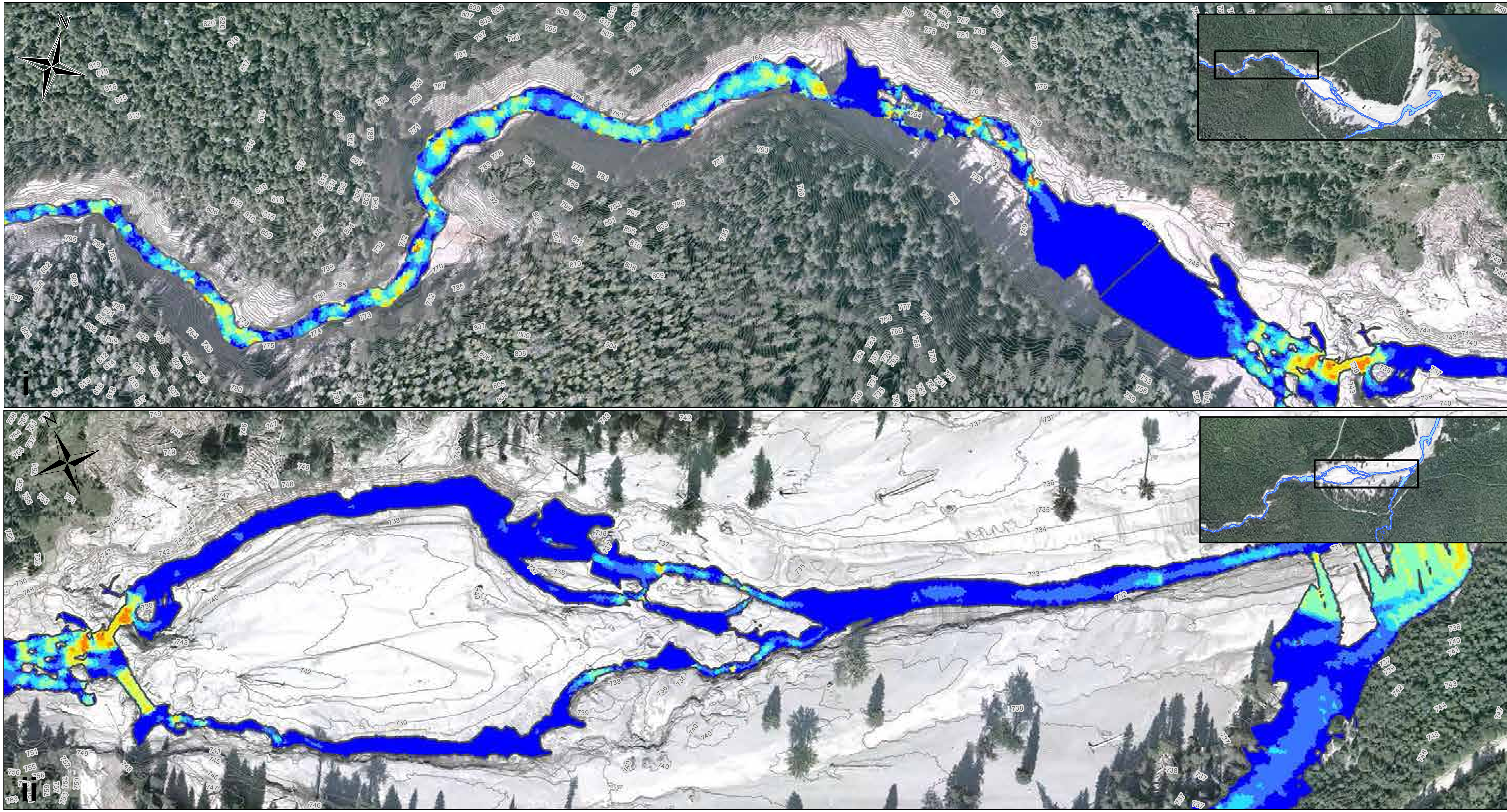

LEGEND

100 Year Water Level

100 Year Shear Stress Values (N/sqr m)

- 0 - 16
- 16 - 32
- 32 - 64
- 64 - 128
- 128 - 256
- 256 - 512
- 512 - 1024
- >1024

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 100 Year Shear Stress Values

BY: HB	SCALE: 1:2,000	DATE: 4/29/2015	REF No: REV: 0
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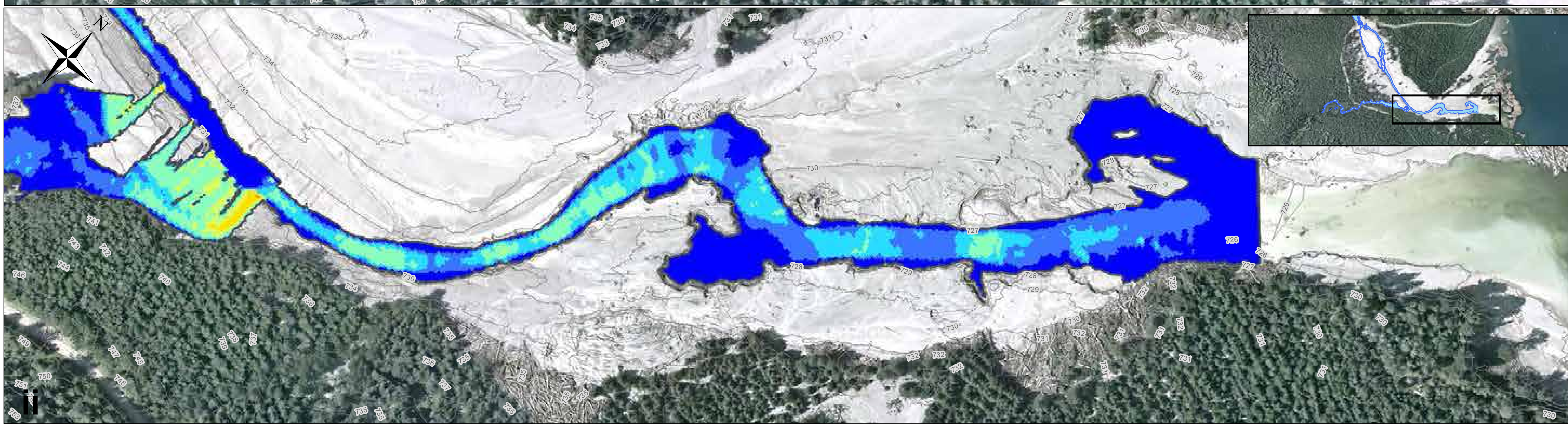

LEGEND

100 Year Water Level

100 Year Shear Stress Values (N/sqr m)

- 0 - 16
- 16 - 32
- 32 - 64
- 64 - 128
- 128 - 256
- 256 - 512
- 512 - 1024
- >1024

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC · LAVALIN

CLIENT NAME:	PROJECT LOCATION:
Mount Polley Mining Corporation	Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 100 Year Shear Stress Values

BY: HB	SCALE: 1:2,000	DATE: 4/28/2015	REF No: REV: 0
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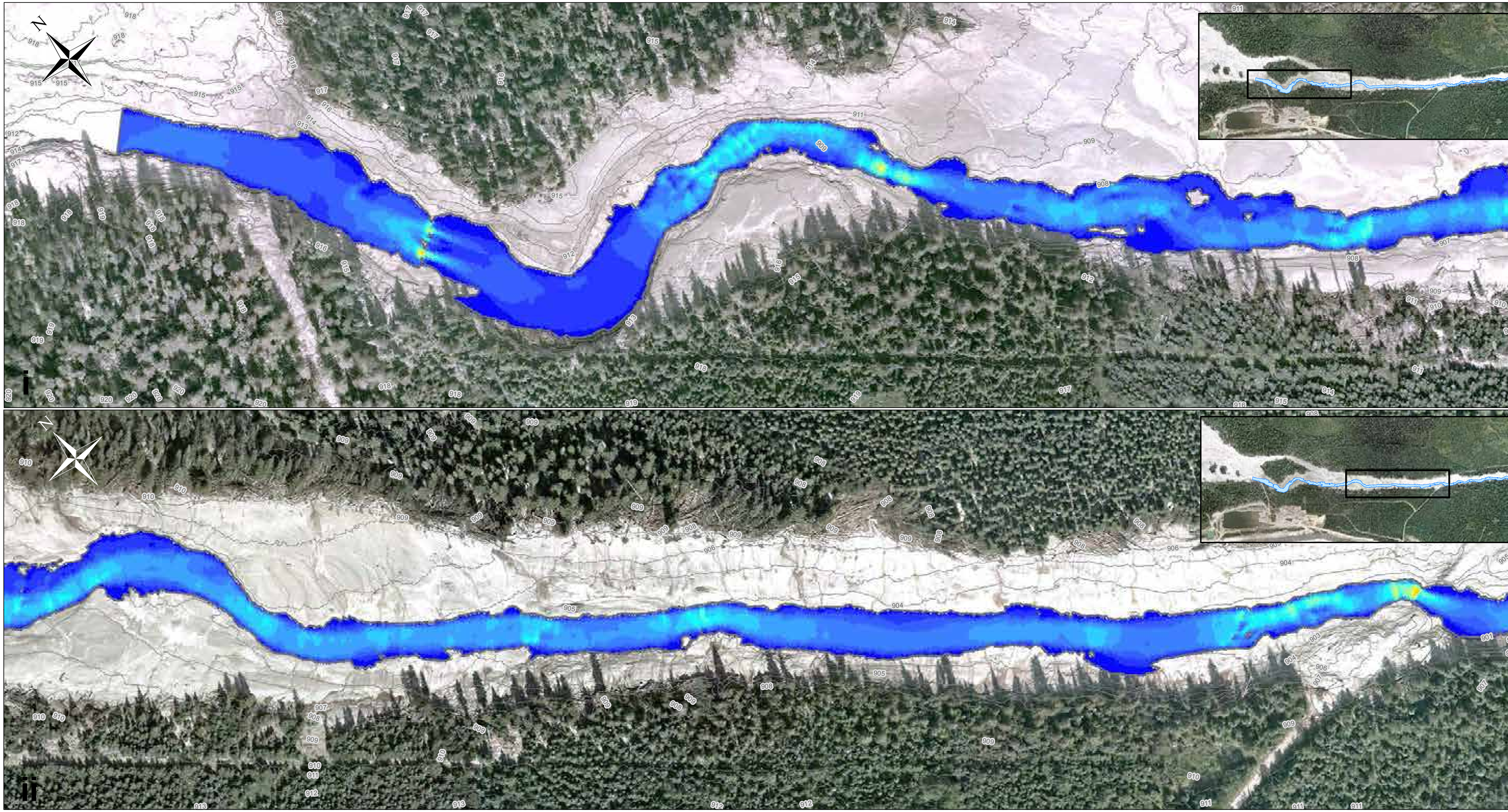

LEGEND

100 Year Water Level

100 Year Velocity Values (m/s)

- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- 1 - 1.2
- 1.2 - 1.4
- 1.4 - 1.6
- 1.6 - 1.8
- 1.8 - 2
- 2 - 2.2
- 2.2 - 2.4
- 2.4 - 2.6
- 2.6 - 2.8
- 2.8 - 3
- 3 - 3.2
- 3.2 - 3.4
- 3.4 - 3.6
- 3.6 - 3.8
- 3.8 - 4

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC·LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 100 Year Velocity Values

BY: HB	SCALE: 1:2,000	DATE: 4/28/2015	REF No:	REV: 0
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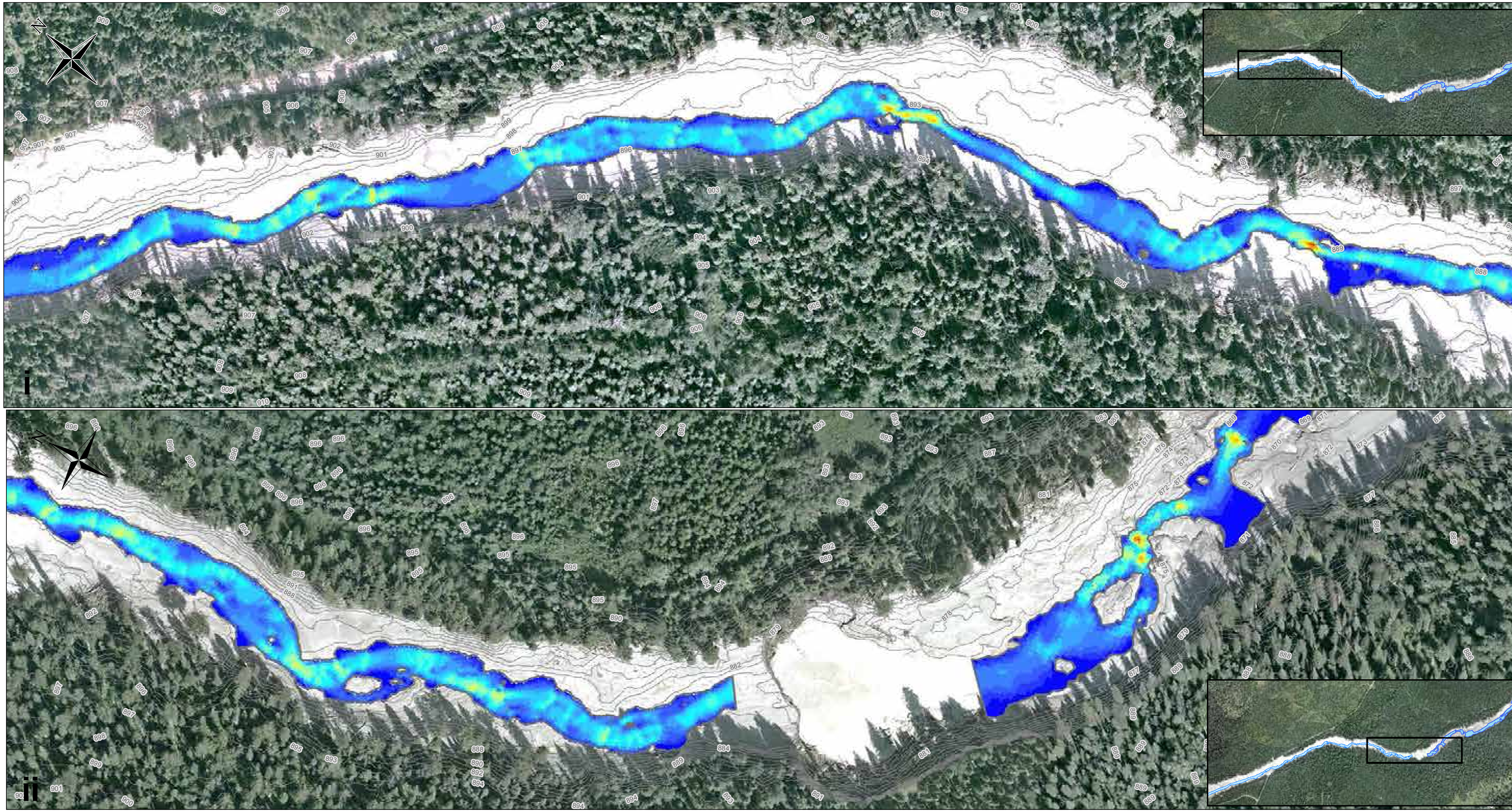

LEGEND

- 100 Year Water Level

100 Year Velocity Values (m/s)

0 - 0.2	0.8 - 1	2.2 - 2.4	3.6 - 3.8
0.2 - 0.4	1 - 1.2	2.4 - 2.6	3.8 - 4
0.4 - 0.6	1.2 - 1.4	2.6 - 2.8	
0.6 - 0.8	1.4 - 1.6	2.8 - 3	
	1.6 - 1.8	3 - 3.2	
	1.8 - 2	3.2 - 3.4	
	2 - 2.2	3.4 - 3.6	

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC·LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 100 Year Velocity Values

BY: HB	SCALE: 1:2,000	DATE: 4/20/2015	REF No:	REV: 0
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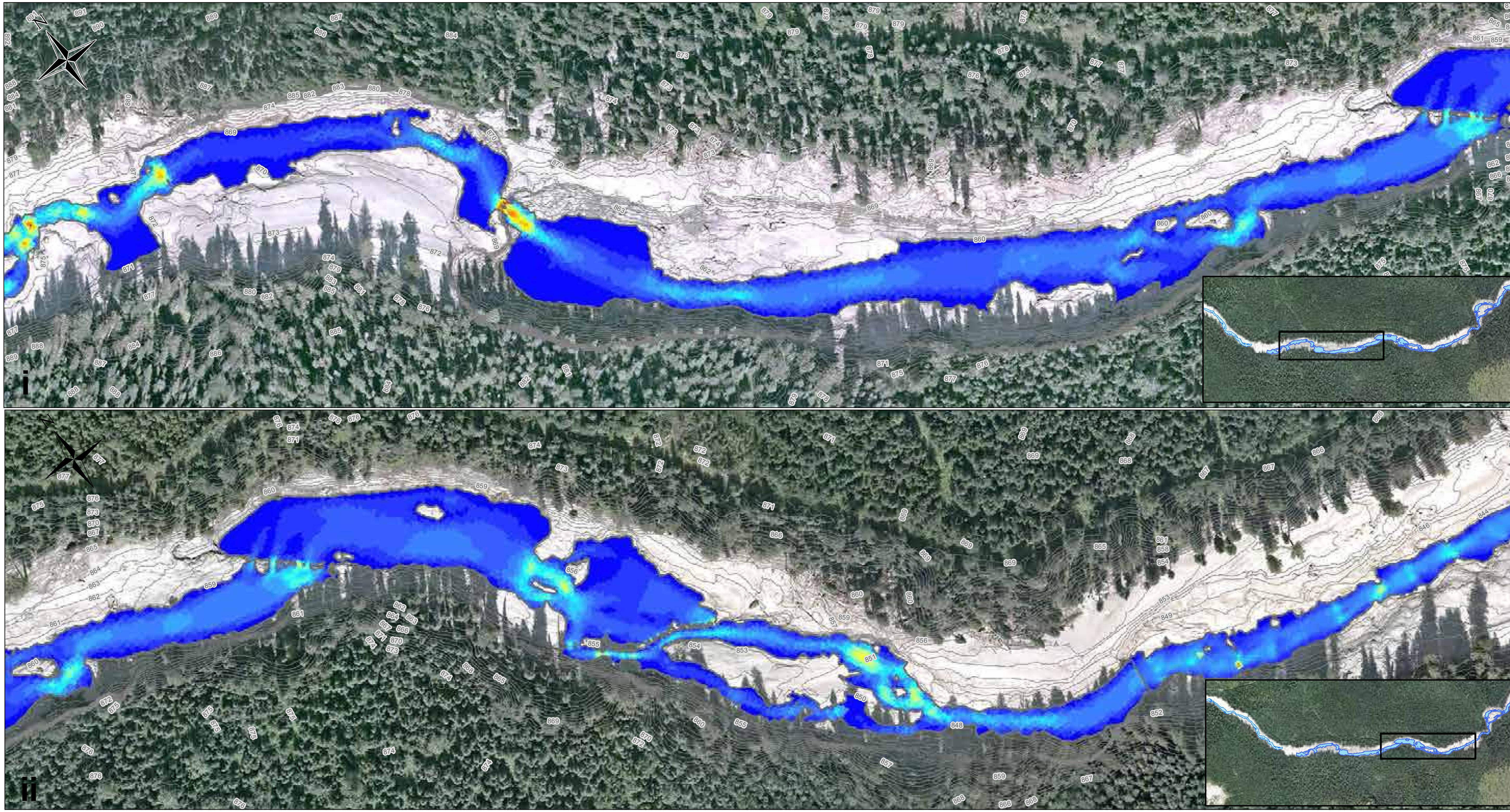

LEGEND

- 100 Year Water Level

100 Year Velocity Values (m/s)

0 - 0.2	1 - 1.2	2.6 - 2.8
0.2 - 0.4	1.2 - 1.4	2.8 - 3
0.4 - 0.6	1.4 - 1.6	3 - 3.2
0.6 - 0.8	1.6 - 1.8	3.2 - 3.4
0.8 - 1	1.8 - 2	3.4 - 3.6
	2 - 2.2	3.6 - 3.8
	2.2 - 2.4	3.8 - 4
	2.4 - 2.6	

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 100 Year Velocity Values

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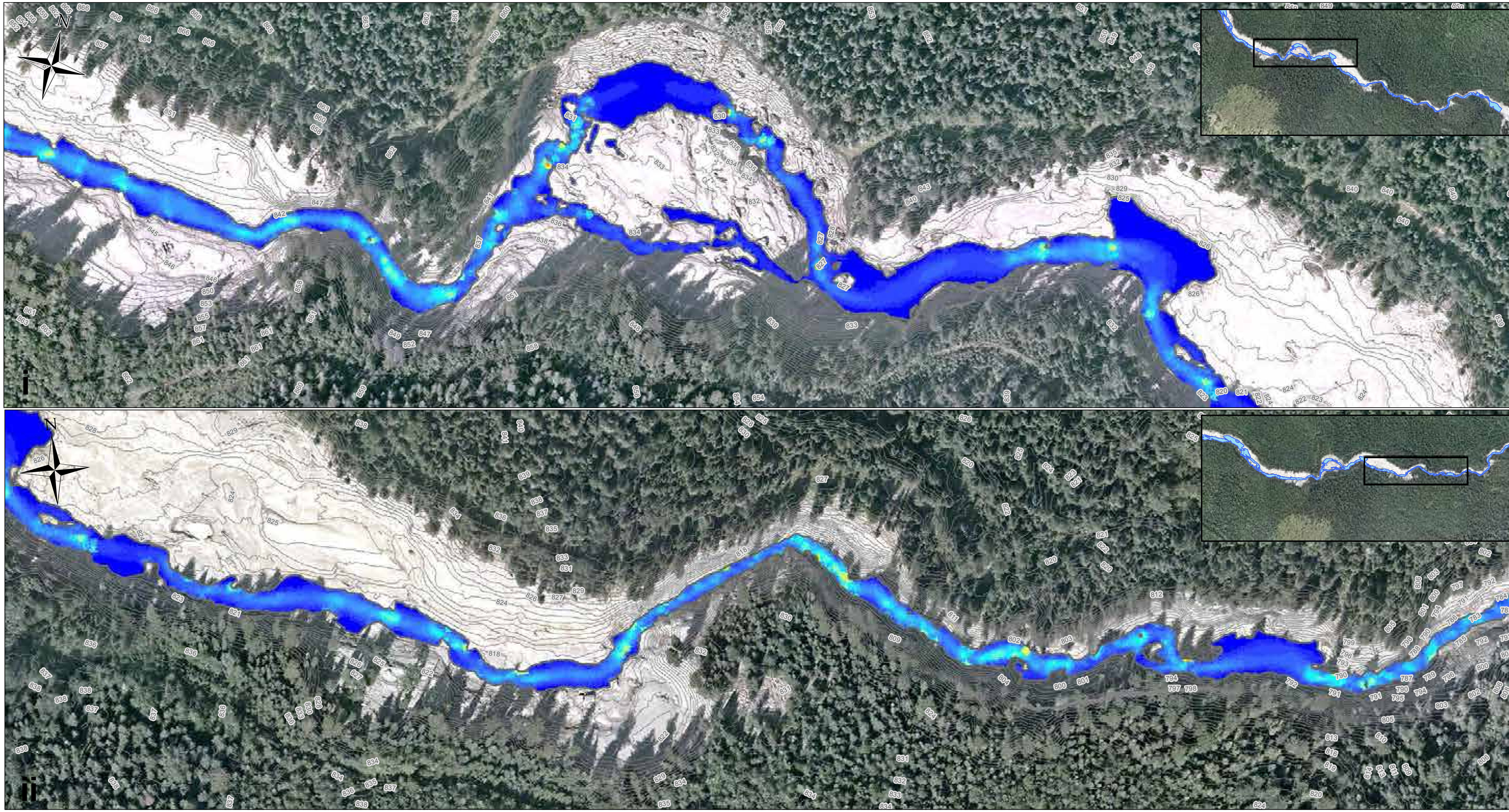

LEGEND

100 Year Water Level

100 Year Velocity Values (m/s)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 5
- 5 - 5.25
- 5.25 - 5.5
- 5.5 - 5.75
- 5.75 - 6
- 6 - 6.25
- 6.25 - 6.5
- 6.5 - 6.75
- 6.75 - 7

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 100 Year Velocity Values

BY: HB	SCALE: 1:2,000	DATE: 4/20/2015	REF No:	REV: 0
CHK'D: FB	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-F052	

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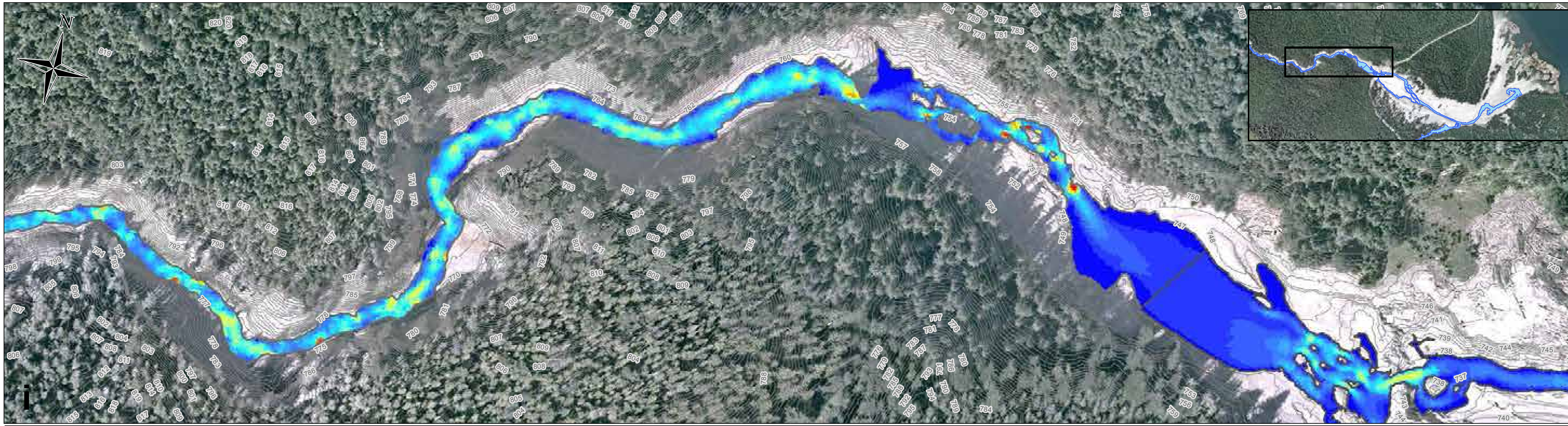

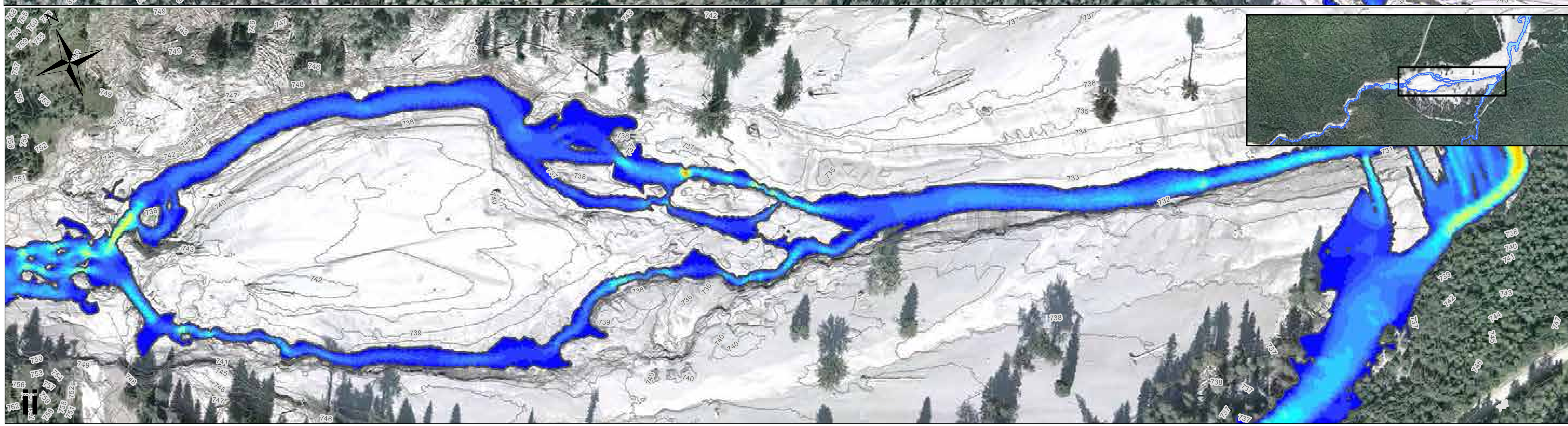

LEGEND

100 Year Water Level

100 Year Velocity Values (m/s)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4. 75 - 5

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC·LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 100 Year Velocity Values

BY: HB	SCALE: 1:2,000	DATE: 4/23/2015	REF No:	REV: 0
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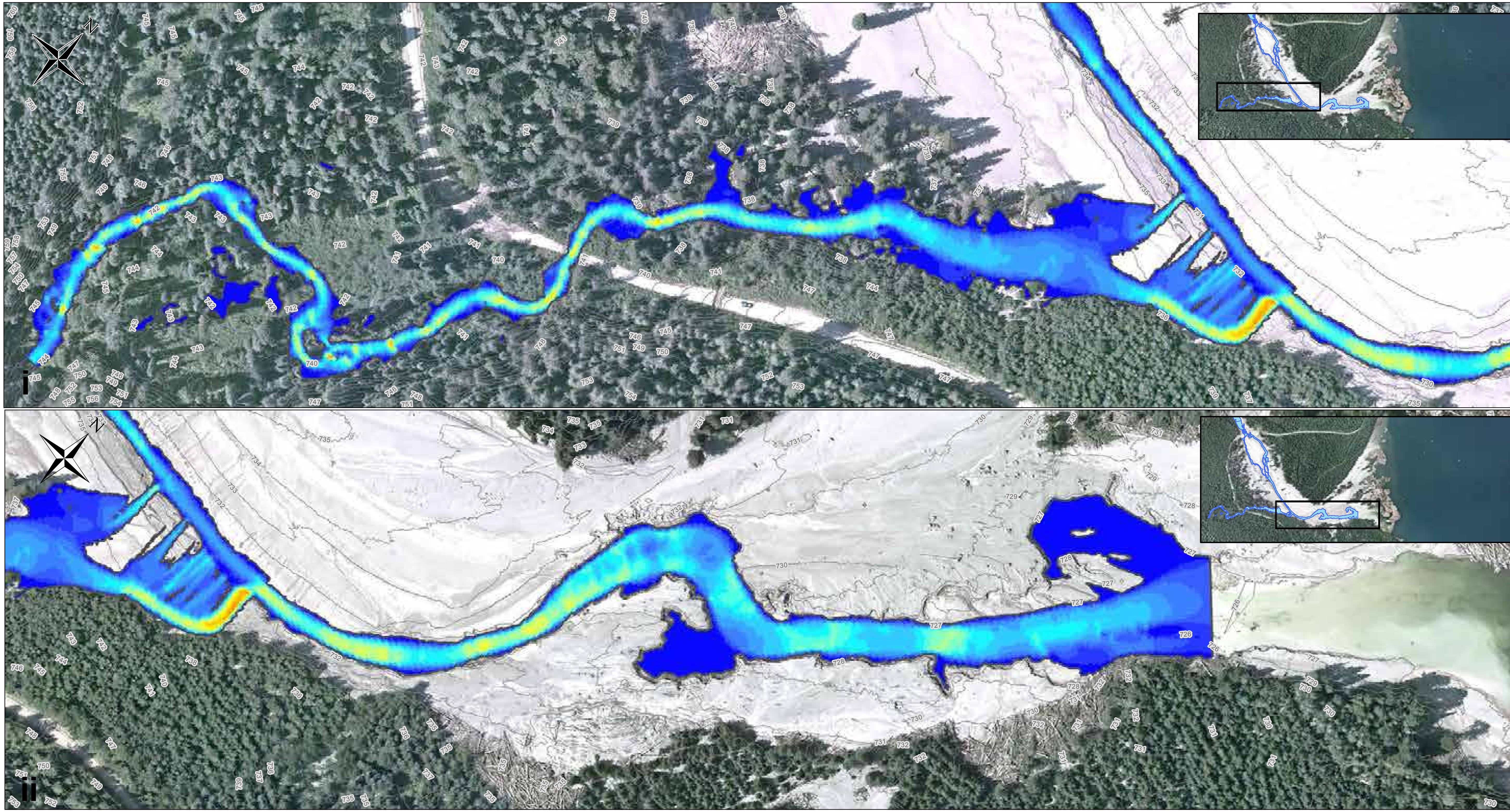

LEGEND

100 Year Water Level

100 Year Velocity Values (m/s)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4. 75 - 5

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 50 100 Meters

1. Orthophoto collected by McElhanney on August 5th, 2014.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Hydraulic Modelling: 100 Year Velocity Values

BY: HB	SCALE: 1:2,000	DATE: 4/23/2015	REF No: REV: 0
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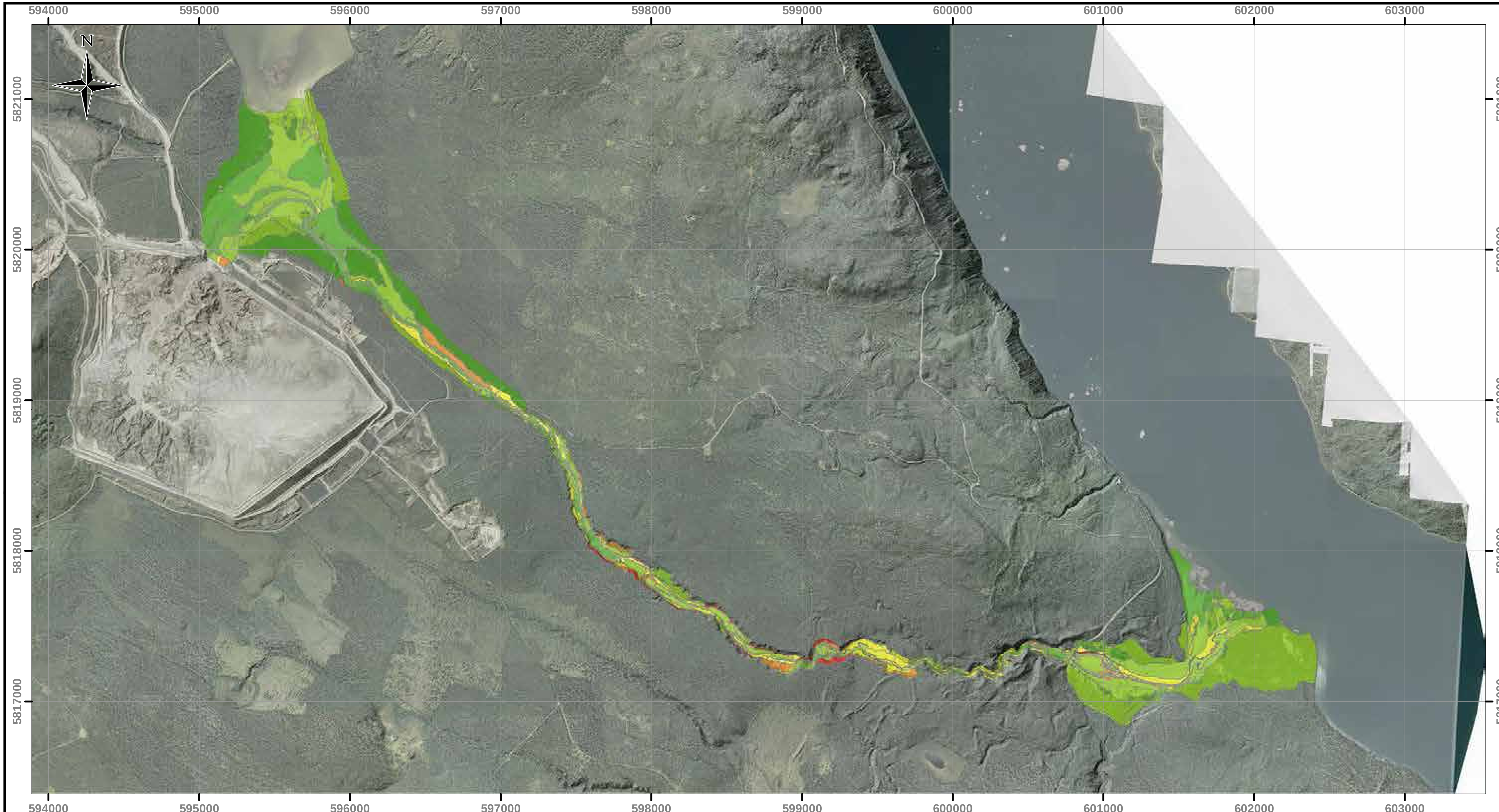
Project Path: P:\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\

APPENDIX G

Maps of slope stability



LEGEND

Slope Stability Classes

- Stable
- Slighly Unstable
- Moderately Unstable
- Unstable
- Highly Unstable

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 500 1,000 Meters

1. Orthophoto provided by Mount Polley Mining Corporation.

2. Orthophoto collected 5 August, 2014 by McElhanney Consulting Services Ltd.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Overview Map of Slope Stability

BY: HB	SCALE: 1:25,000	DATE: 4/29/2015	REF No: REV: 0
CHK'D: VC	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-G001

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Project Path: P:\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\

LEGEND

Slope Stability Classes

- Stable
- Slighly Unstable
- Moderately Unstable
- Unstable
- Highly Unstable

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 125 250 Meters

1. Orthophoto provided by Mount Polley Mining Corporation.

2. Orthophoto collected 5 August, 2014 by McElhanney Consulting Services Ltd.

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Polley Plug and Upper Hazeltine Creek Slope Stability

BY: HB	SCALE: 1:6,000	DATE: 4/29/2015	REF No: REV: 0
CHK'D: VC	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-G002

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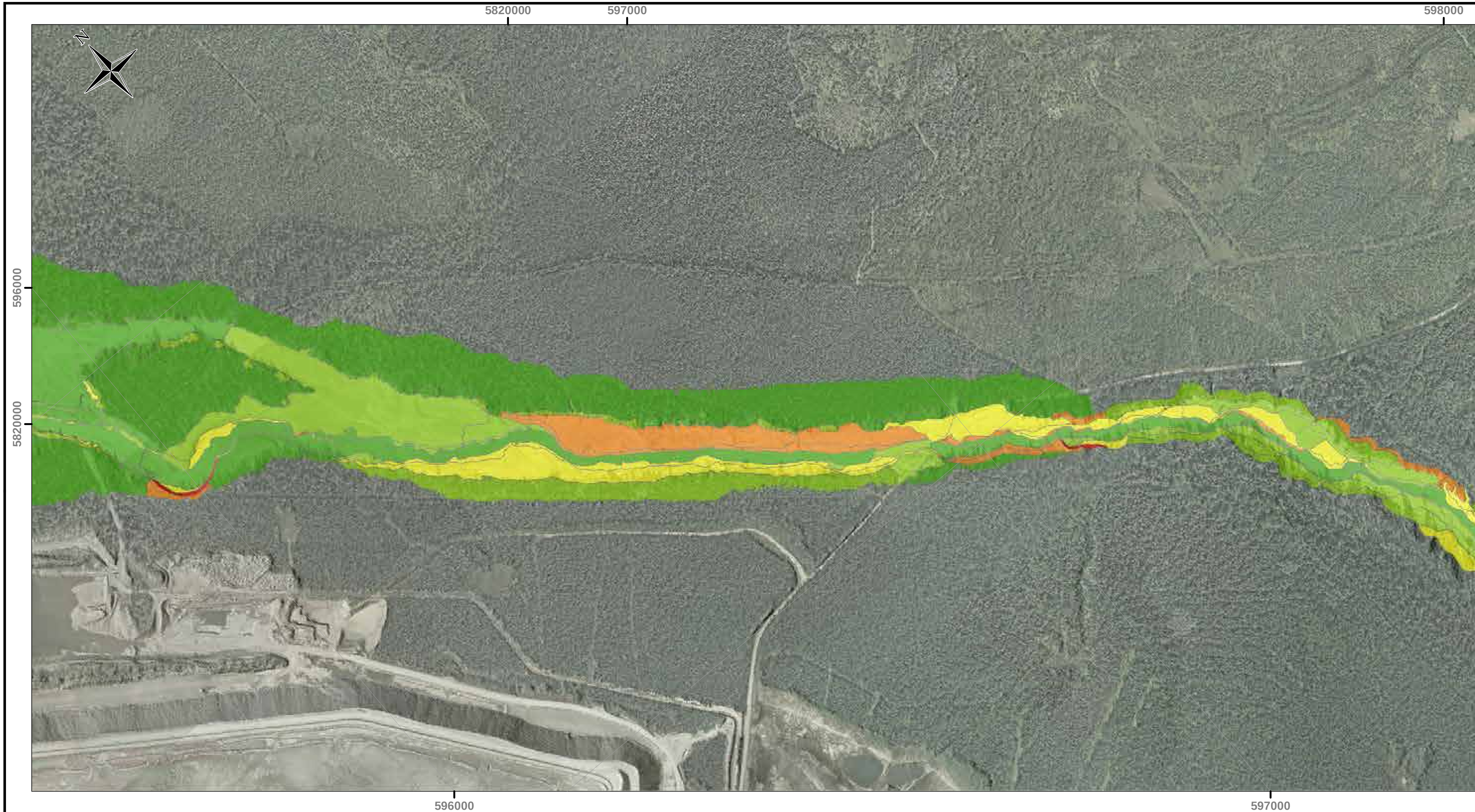

LEGEND

Slope Stability Classes

- Stable
- Slighly Unstable
- Moderately Unstable
- Unstable
- Highly Unstable

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 125 250 Meters

1. Orthophoto provided by Mount Polley Mining Corporation.
2. Orthophoto collected 5 August, 2014 by McElhanney Consulting Services Ltd.

SNC·LAVALIN

CLIENT NAME:	PROJECT LOCATION:
Mount Polley Mining Corporation	Hazeltine Creek Study Area, Mount Polley Mine, BC

Upper Hazeltine Creek at Gavin Lake Road
Slope Stability

BY: HB	SCALE: 1:6,000	DATE: 4/29/2015	REF No: REV: 0
CHK'D: VC	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-G003

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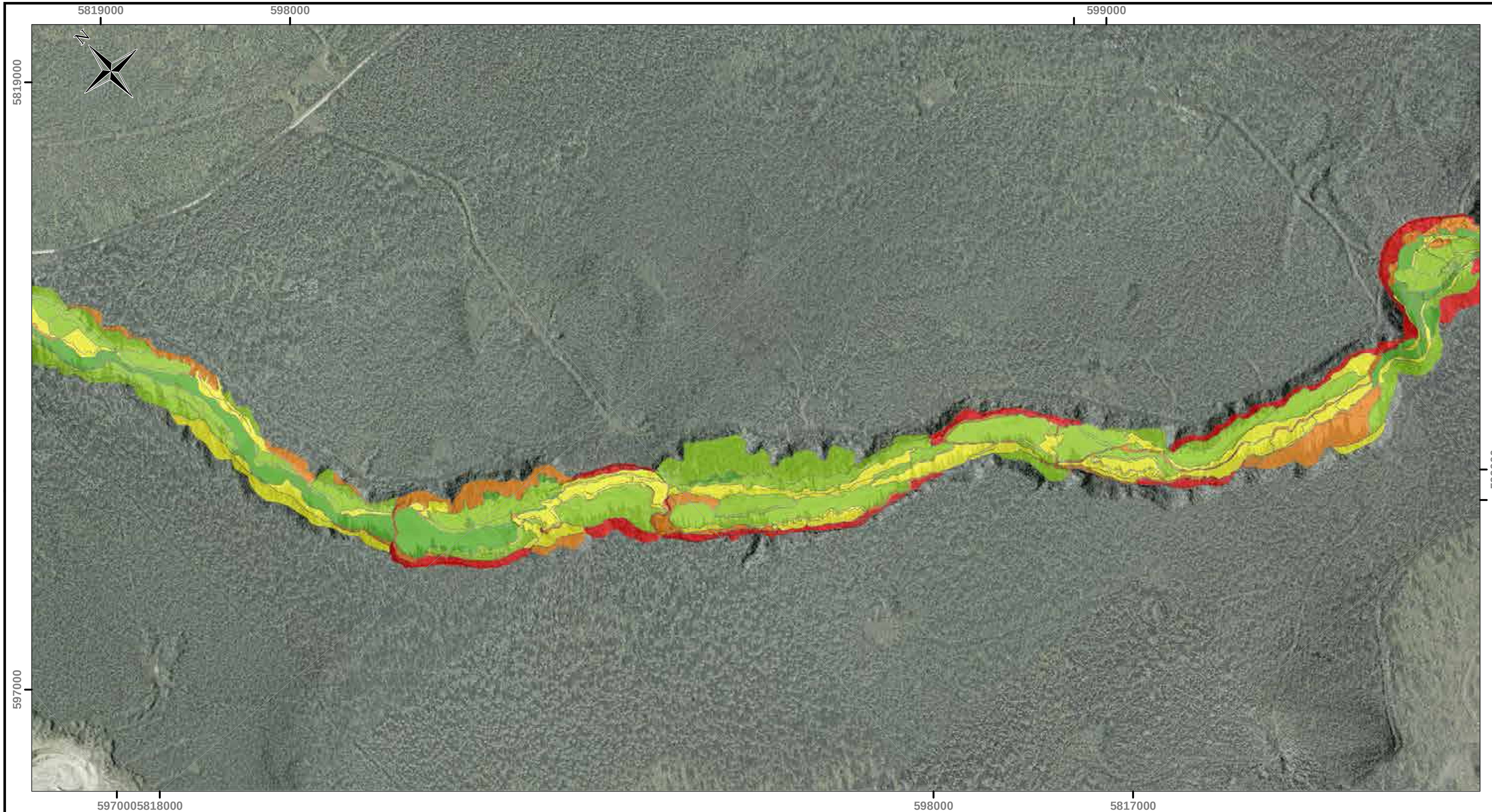

LEGEND

Slope Stability Classes

- Stable
- Slighly Unstable
- Moderately Unstable
- Unstable
- Highly Unstable

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 125 250 Meters

1. Orthophoto provided by Mount Polley Mining Corporation.

2. Orthophoto collected 5 August, 2014 by McElhanney Consulting Services Ltd.

SNC·LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Upper Hazeltine Creek below Gavin Lake Road Slope Stability

BY: HB	SCALE: 1:6,000	DATE: 4/29/2015	REF No:	REV: 0
CHK'D: VC	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-G004	

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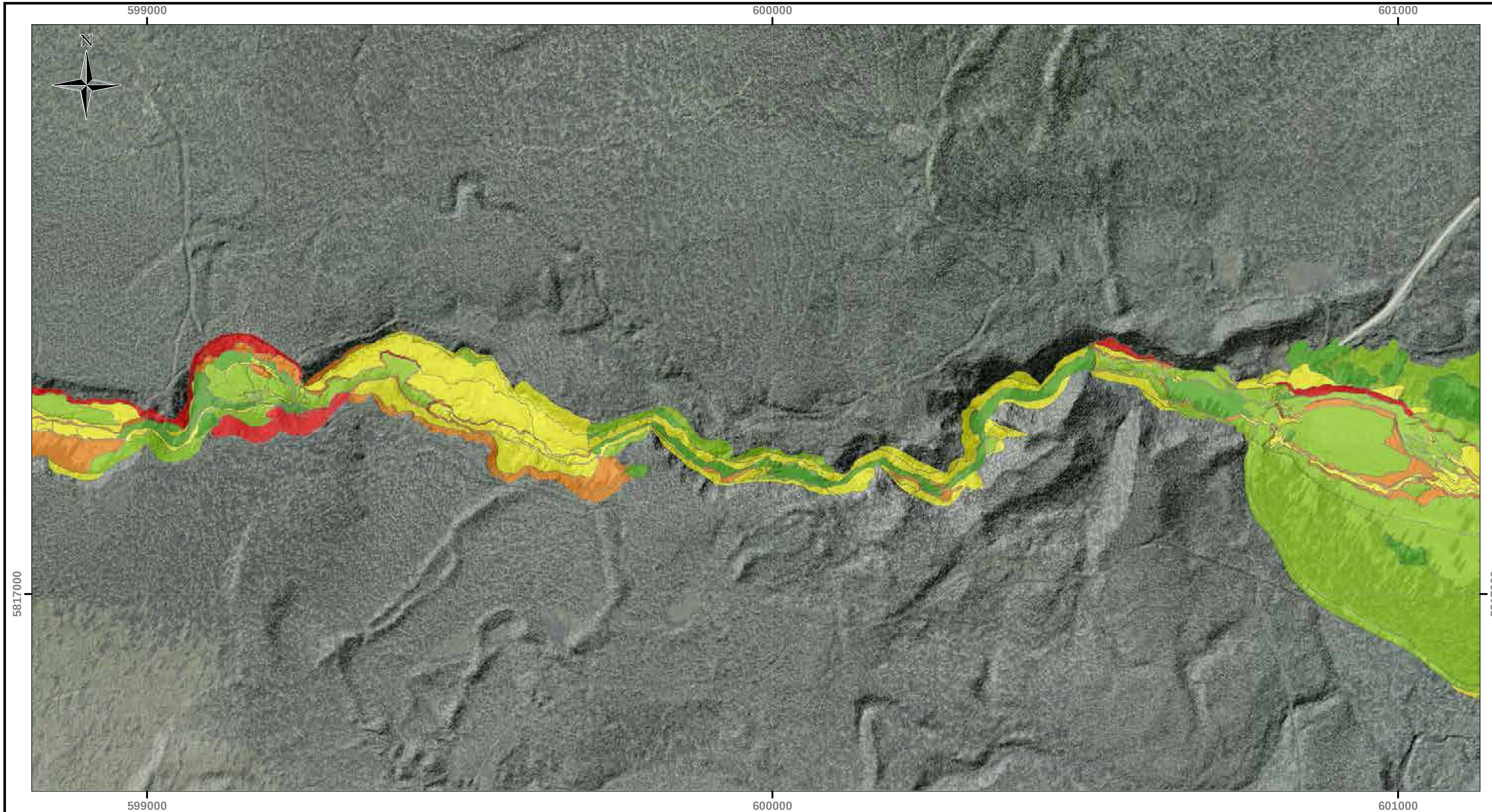

LEGEND

Slope Stability Classes

- Stable
- Slighly Unstable
- Moderately Unstable
- Unstable
- Highly Unstable

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 125 250 Meters

1. Orthophoto provided by Mount Polley Mining Corporation.
2. Orthophoto collected 5 August, 2014 by McElhanney Consulting Services Ltd.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Hazeltine Creek Canyon
Slope Stability

BY: HB	SCALE: 1:6,000	DATE: 4/29/2015	REF No: REV: 0
CHK'D: VC	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-G005

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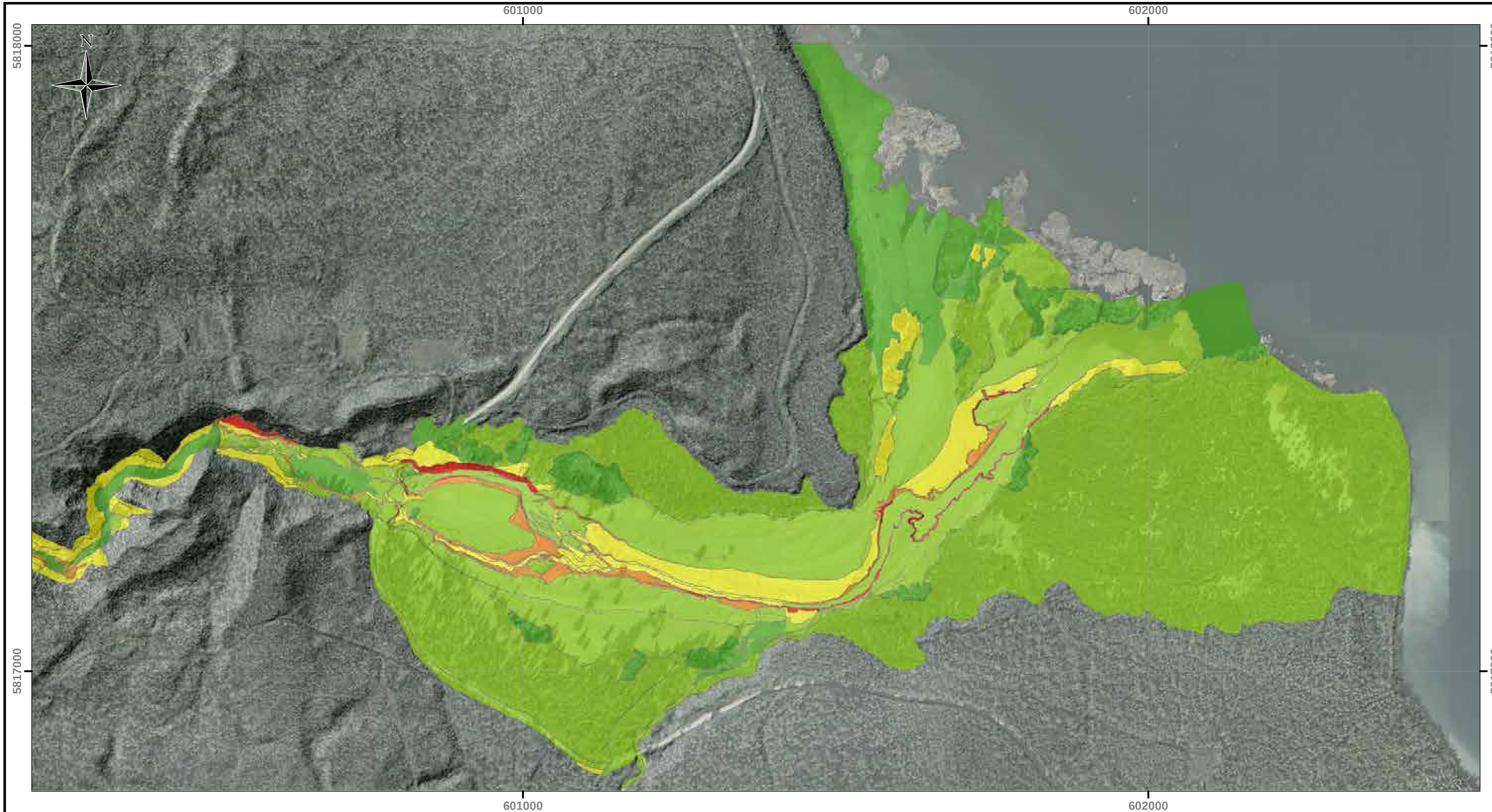
Project Path: P:\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\



LEGEND

Slope Stability Classes

- Stable
- Slighly Unstable
- Moderately Unstable
- Unstable
- Highly Unstable

NOTES

1. Original in colour.

2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.

3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 125 250 Meters

1. Orthophoto provided by Mount Polley Mining Corporation.

2. Orthophoto collected 5 August, 2014 by McElhanney Consulting Services Ltd.

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Lower Hazeltine Creek and Edney Creek Mouth Slope Stability

BY: HB	SCALE: 1:6,000	DATE: 4/29/2015	REF No:	REV: 0
CHK'D: VC	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-HIA-G006	

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Project Path: P:\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\

APPENDIX H

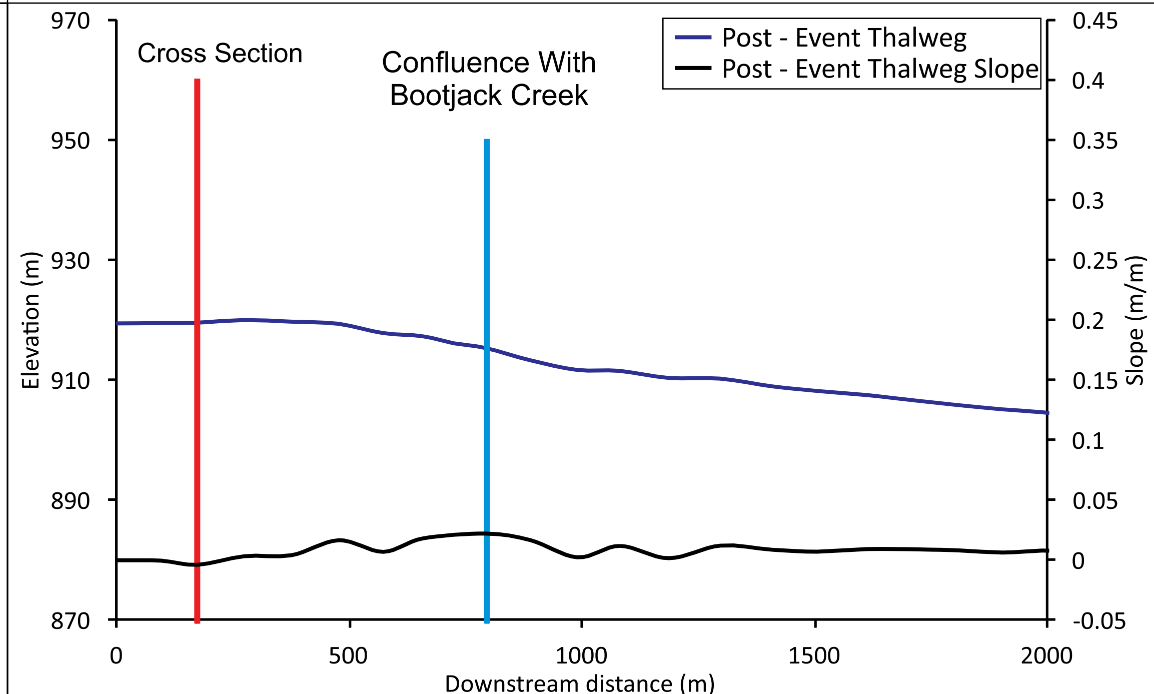
Cross-sections and photographs of the post-event channel in the reaches modified from the Minnow (2007 C) report

REF No: 621717-HIA-H001	REV: **0**	AREA: **Hazeltine Creek Plug**	REACH: **HC-R0**	CLIENT NAME: **Mount Polley Mining Corporation**	PROJECT LOCATION: **Mount Polley Mine, Likely, BC**	DATE: **2015/04/01**	SNC·LAVALIN

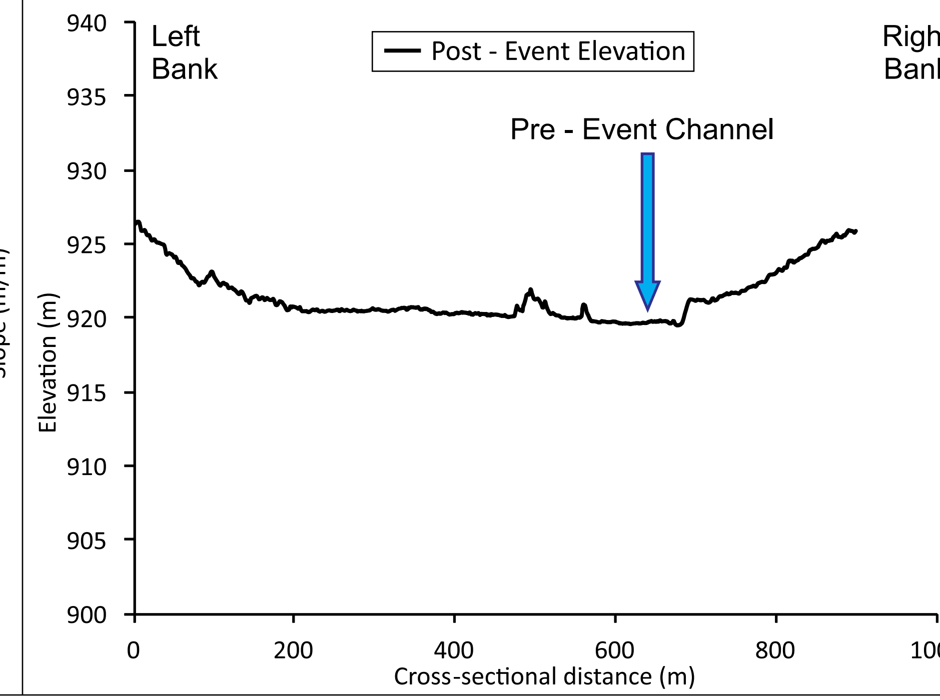
Area Overview

The Plug extends 1,750 m from the south end of Polley Lake. The area is dominated by debris flow deposits composed of tailings, native material and embankment material that span up to 350 m laterally.

Long Profile



Cross Section



Typical Deposits and Surficial Material

Deposition within the plug area looking upstream towards Polley Lake (September 22, 2014).

Aerial view looking west toward the Mount Polley Mine Site at the Polley Lake post-event shoreline (September 22, 2014).

View looking downstream from Polley Lake. Fine grained tailings have been deposited across the wide floodplain to form the Plug.

Aerial view looking east across the Polley Lake post-event shoreline (September 22, 2014).

Key Features and Identified Impacts

View looking toward Polley Lake. The event resulted in the removal of all but a few trees and other vegetation along the path of flow.

The plug contains debris flow deposits from the event, which includes a mixture of tailings, TSF embankment material, and eroded native soils and vegetation.

Deposition within the plug area looking towads Polley Lake, people for scale (September 22, 2014).

Nineteenth century diversion ditch containing water from Polley Lake looking downstream (September 22, 2014).

Eastern edge of plug area with nineteenth century diversion ditch (September 22, 2014).

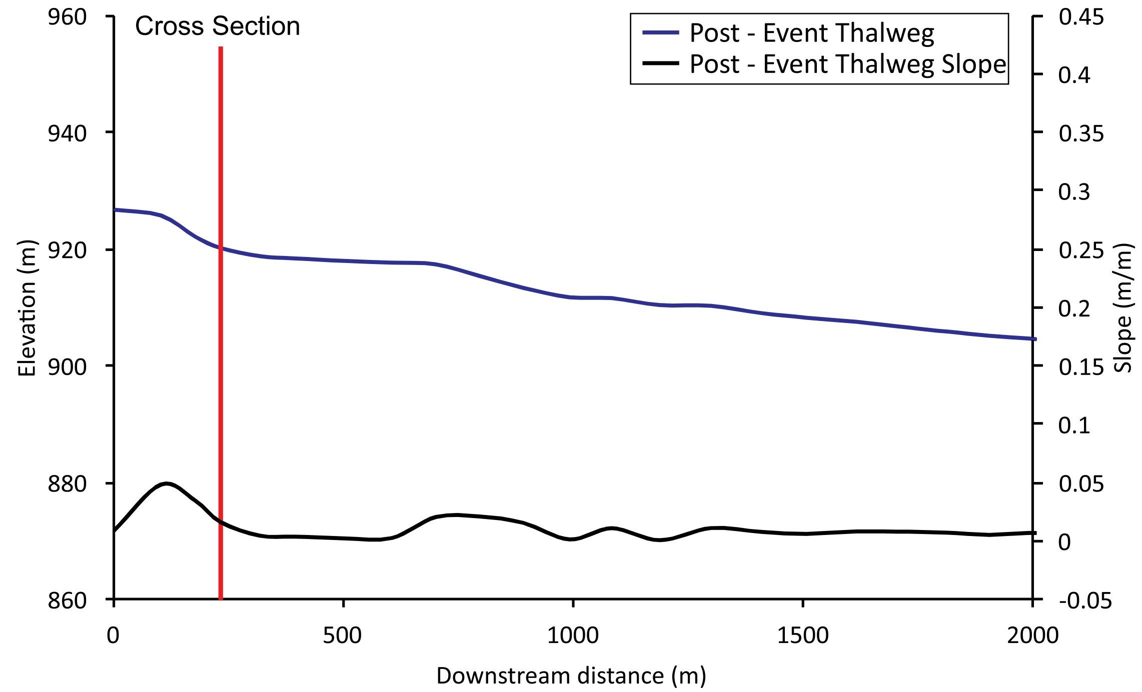
The maximum vertical extent of the debris flow event is shown by scarring and mud lines present on standing vegetation within the path of flow.

REF No: 621717-HIA-H002	REV: 0	AREA: Upper Hazeltine Creek	REACH: HC-R0a	CLIENT NAME: Mount Polley Mining Corporation	PROJECT LOCATION: Mount Polley Mine, Likely, BC	DATE: 2015/04/01	SNC·LAVALIN

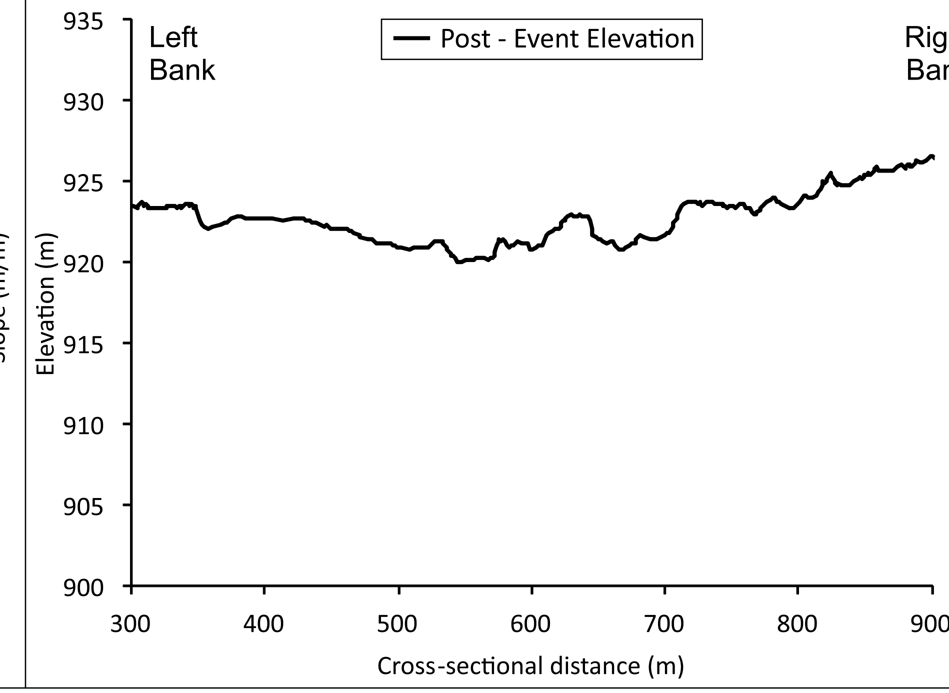
Area Overview

Reach HC-R0a is located directly downstream of the TSF breach and extends downslope to Hazeltine Creek.

Long Profile



Cross Section



Typical Deposits and Surficial Material

Aerial view of the TSF breach looking west. (September 05 2014)

Aerial view of the affected site directly downstream of the breach location. The debris flow removed vegetation in its path (September 5, 2014).

A vertical exposure of embankment material deposited by the event. A thin crust of fine-grained tailings is visible on the surface of the deposit (September 23, 2014).

A block of intact material deposited by the event (September 23, 2014).

Key Features and Identified Impacts

Downstream view towards the confluence of the debris flow and the pre-event Hazeltine Creek channel (September 23, 2014).

Upstream view toward the TSF. Flow from the TSF is incising into the native material and debris flow deposit (September 23, 2014).

Dessication cracks and blocks of transported material are visible on the hummocky post-event surface (September 23, 2014).

Deposition within the HC-R0a area looking downstream from the breach (September 22, 2014).

Upstream view toward the TSF. A small stand of trees remains after the event (September 23, 2014).

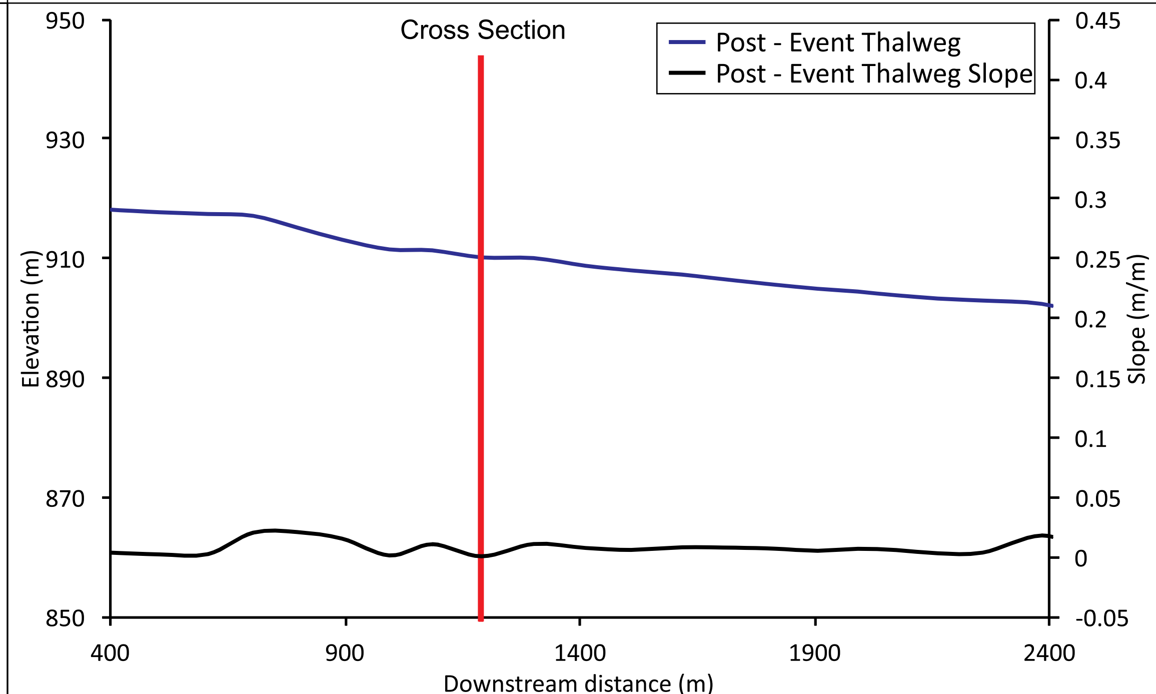
Northern edge of trees showing deposition within HC-R0a (September 22, 2014).

REF No: REV: **0**	AREA:	REACH:	CLIENT NAME:	PROJECT LOCATION:	DATE:	SNC • LAVALIN
621717-HIA-H003	**Upper Hazeltine Creek**	**HC-R0**	**Mount Polley Mining Corporation**	**Mount Polley Mine, Likely, BC**	**2015/04/01**	

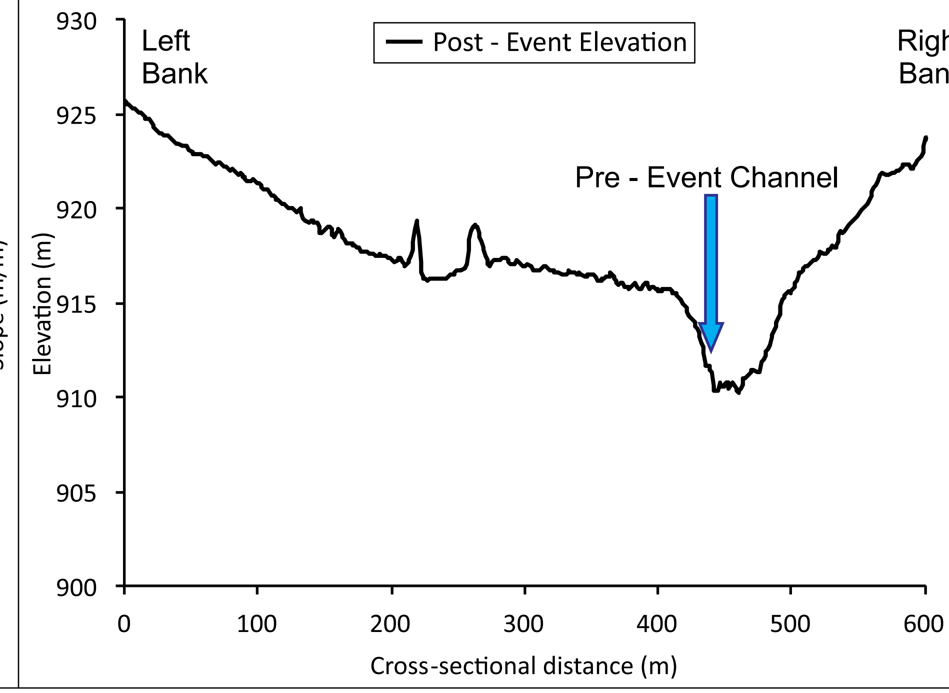
Area Overview

Reach HC-R0b extends downstream of the confluence between the debris flow and Hazeltine Creek. The affected channel contains three tree islands where the event divided into two channels.

Long Profile



Cross Section



Typical Deposits and Surficial Material

View of the right bank, where the steep banks are failing due to lateral erosion (September 23, 2014).

Knickpoints such as this are common features in this reach (September 23, 2014).

View of a dry side-channel eroded into native fluvial/glacio-fluvial material (September 23, 2014).

An exposed fluvial/glacio-fluvial deposit with a thin coating of tailings on the left bank (September 23, 2014).

Key Features and Identified Impacts

Upstream view of a knickpoint incised into native material (September 23, 2014).

Downstream view of a series of knickpoints (September 23, 2014).

A sequence of cutbanks lining the left bank indicate the pattern of flow recession following the event.

Downstream view including a wooden platform that was exposed following the event (September 23, 2014).

View of a tree island with several felled trees (left of photo). Photo facing downstream (September 23, 2014).

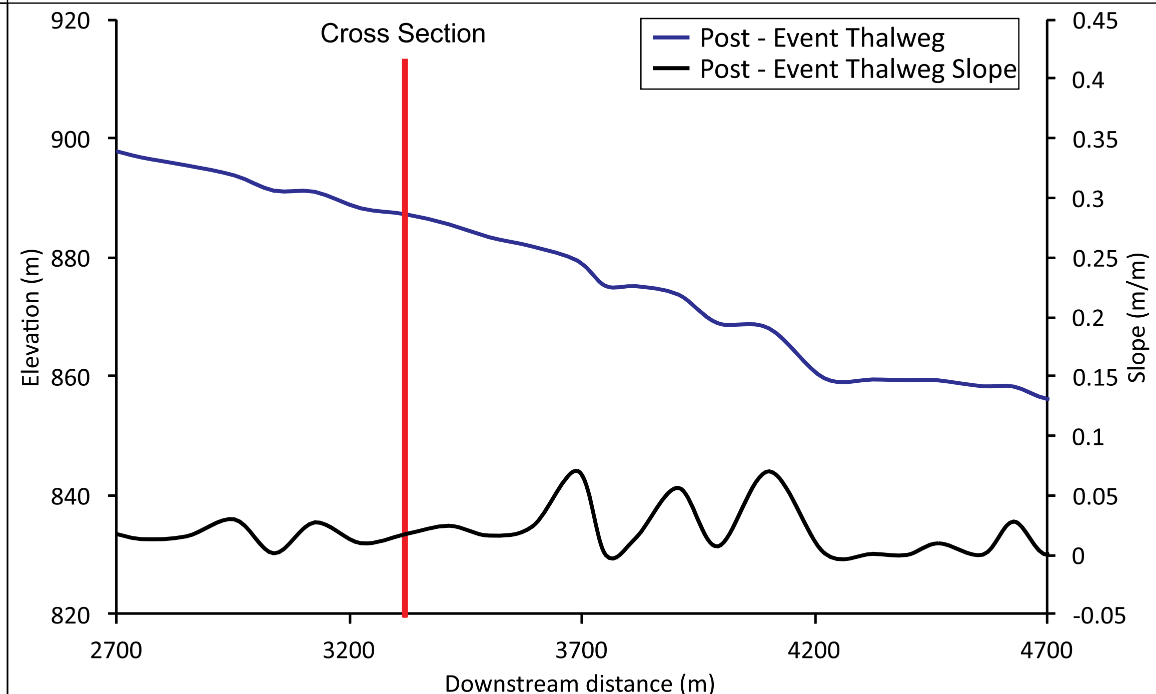
Cutbank exposed on the left bank. Fine grained tailings sands have been deposited at the edge of the channel. (September 23, 2014).

REF No: REV: 0	AREA:	REACH:	CLIENT NAME:	PROJECT LOCATION:	DATE:	SNC·LAVALIN
621717-HIA-H004	**Upper Hazeltine Creek**	**HC-R4a**	**Mount Polley Mining Corporation**	**Mount Polley Mine, Likely, BC**	**2015/04/01**	

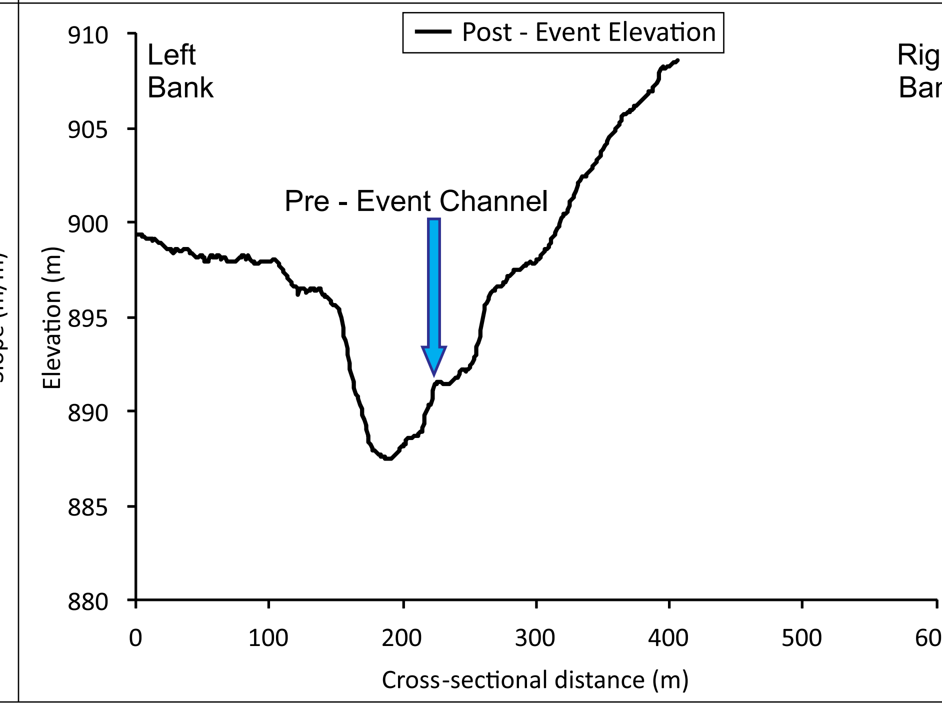
Area Overview

HC-R4a is located between the Gavin Lake Road bridge and the upstream most large knick-point in HC-R4

Long Profile



Cross Section



Typical Deposits and Surficial Material

Upstream view towards the right bank of Hazeltine Creek. The channel is incising into glacial till (September 24, 2014).

The channel flows in an irregular meander through the bed material (September 24, 2014).

Large woody debris deposits on the upper banks of the channel (September 24, 2014).

Upstream view of a thin layer of fine-grained tailings has been deposited on the Hazeltine Creek floodplain (September 24, 2014).

Key Features and Identified Impacts

Downstream view of the main channel and an incising side channel (September 24, 2014).

Upstream view of the post-event channel incising into the bed material, resulting in steep, occasionally undercut banks.

The banks of this reach are marked by large piles of woody debris transported by the event (September 24, 2014).

The washed out Gavin Lake Road bridge has been deposited on the upper left bank of the channel (September 24, 2014).

View upstream of a knickpoint incised into glacial till (September 24, 2014).

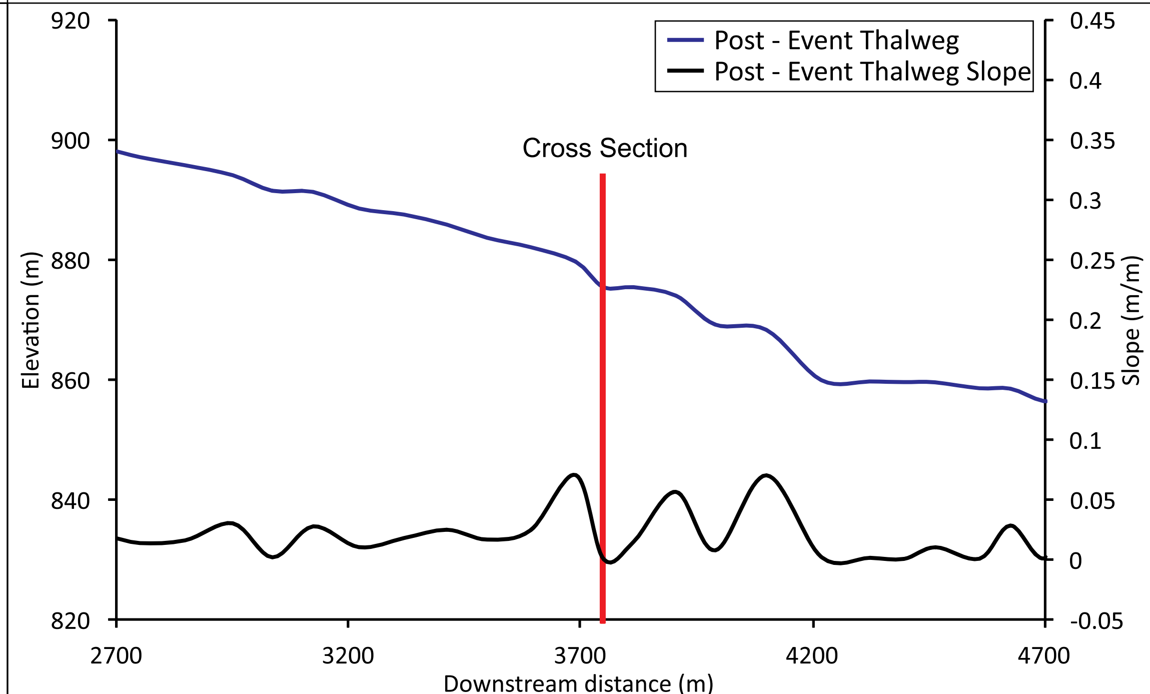
The maximum vertical extent of the event is shown by scarring and mud lines present on standing vegetation. Person for scale (September 24, 2014).

REF No: REV: 0	AREA:	REACH:	CLIENT NAME:	PROJECT LOCATION:	DATE:	SNC • LAVALIN
621717-HIA-H005	**Upper Hazeltine Creek**	**HC-R4b**	**Mount Polley Mining Corporation**	**Mount Polley Mine, Likely, BC**	**2015/04/01**	

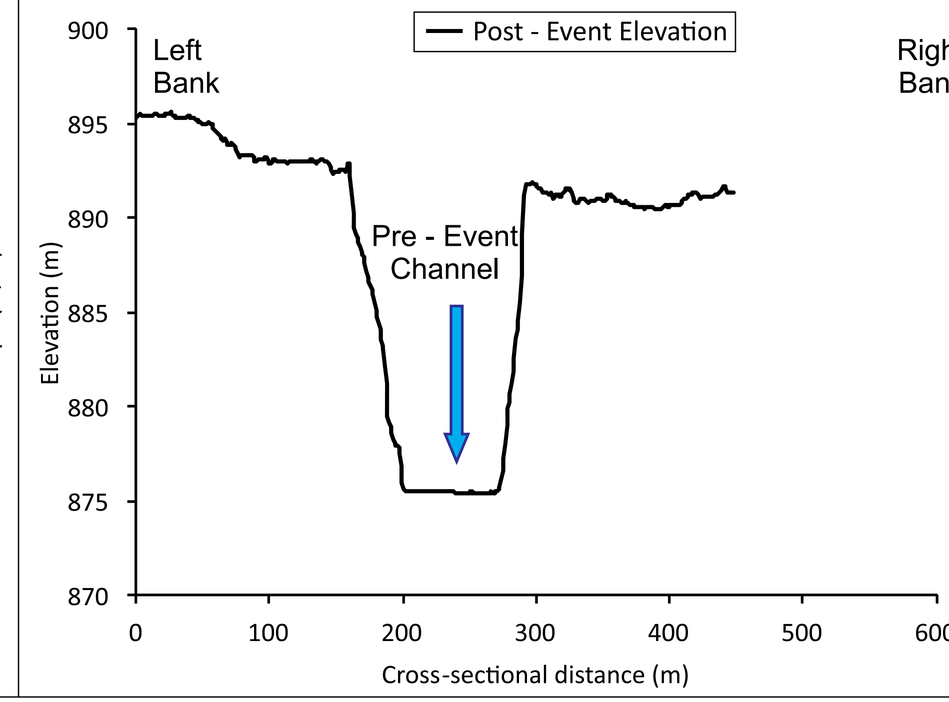
Area Overview

HC-R4b contains large knick-points and is located between the upstream most large knick-point and HC-R5a.

Long Profile



Cross Section



Typical Deposits and Surficial Material

Downstream view of the entrenched channel iincising into fine-grained native material (September 24,2014

View of the left bank of Hazeltine Creek. Large blocks of fine-grained native bank material have calved into the channel.

View of the downstream extent of a deeply entrenched section. Deposition has occurred where the channel widens.

Looking downstream, the channel widens, and depositional bars have formed (September 24, 2014).

Key Features and Identified Impacts

Large tension cracks form at the downstream extent of the lacustrine deposit.

Tension cracks indicate a high potential for failure at the downstream extent of the entrenched section.

Failed sediment and vegetation along the right bank due to lateral bank erosion (September 24, 2014).

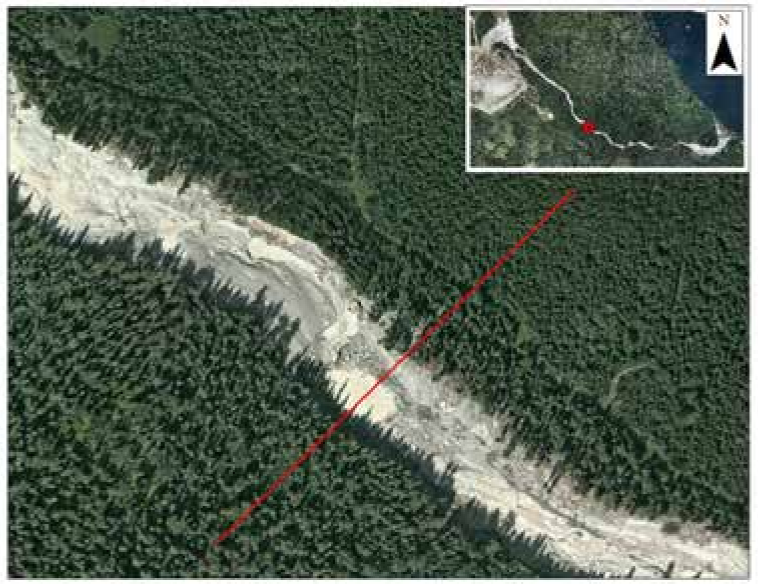
Channel incision into the thick lacustrine/glaciolacustrine deposit has led to rapid lateral erosion with calving blocks.

Downstream view of the channel widening and displaying a braided pattern (September 24, 2014)

Downstream view of tension cracks in a sandy tailings deposit (September 24, 2014).

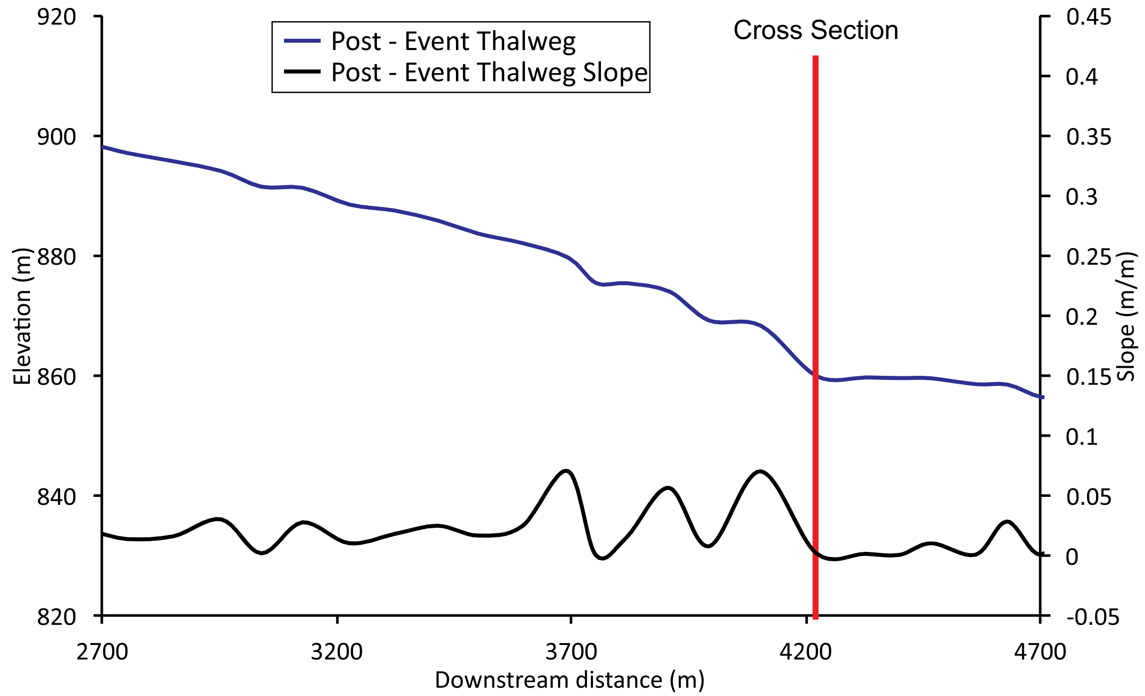
REF No: REV: **0**	AREA:	REACH:	CLIENT NAME:	PROJECT LOCATION:	DATE:	SNC • LAVALIN
621717-HIA-H006	**Upper Hazeltine Creek**	**HC-R4 b**	**Mount Polley Mining Corporation**	**Mount Polley Mine, Likely, BC**	**2015/04/01**	

Area Overview

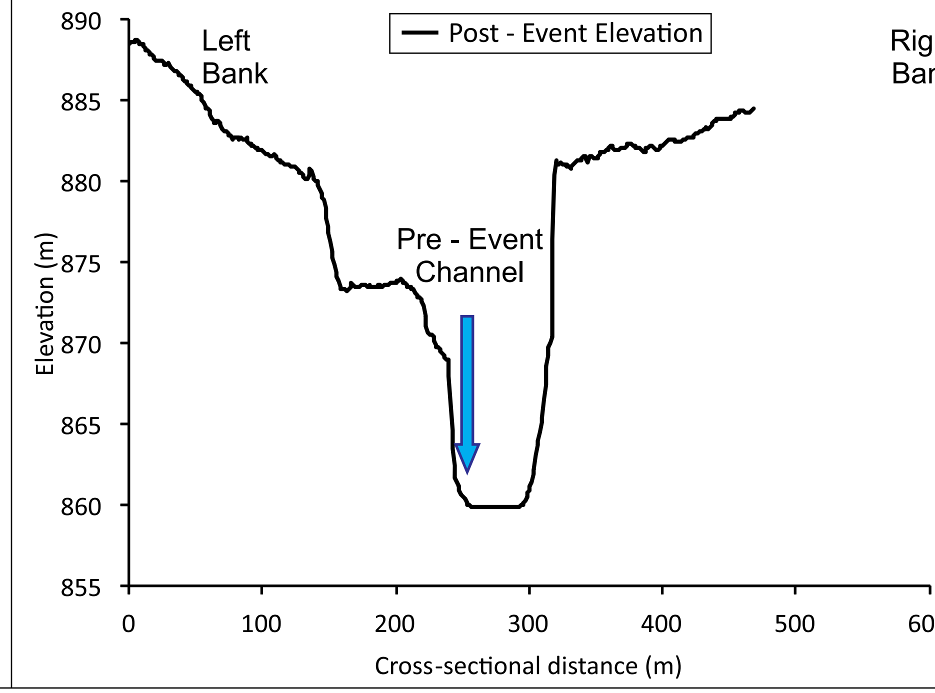


HC-R4b contains large knick-points and is located between the upstream most large knick-point and HC-R5a.

Long Profile



Cross Section



Typical Deposits and Surficial Material

Entrenched channel upstream of a knickpoint. Calved blocks and debris are present in the Hazeltine Creek channel (September 25, 2014).

A sandy tailings deposit overlying native fluvial and lacustrine layers (September 25, 2014).

An abandoned entrenched side channel that was incised during the event. (September 25, 2014)

View downstream of cobble-sized material deposited in the channel, shovel for scale (September 25, 2014).

Key Features and Identified Impacts

View upstream toward the knickpoint. The elevation of the banks decreased abruptly by as much as 5 m (September 25, 2014).

View upstream towards the knickpoint, where the emerging channel displays a braided pattern (September 25, 2014).

Aerial view of the right cutbank (September 5, 2014).

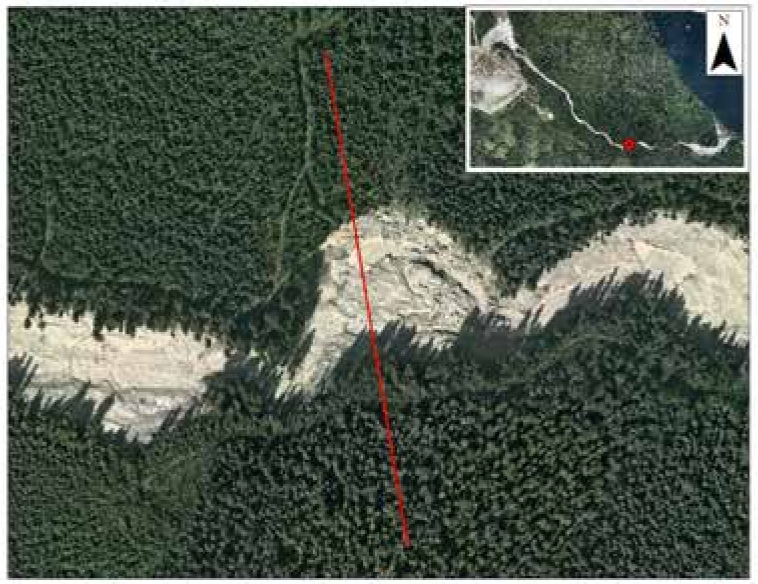
View of the right cutbank. Calved blocks and large woody debris has fallen into the channel (September 25, 2014).

A large boulder in an entrenched section of the channel. The boulder is likely sourced from native till, and deposited as the event flows were receding (September 25, 2014).

Aerial view looking upstream towards the knickpoint. (September 5, 2014).

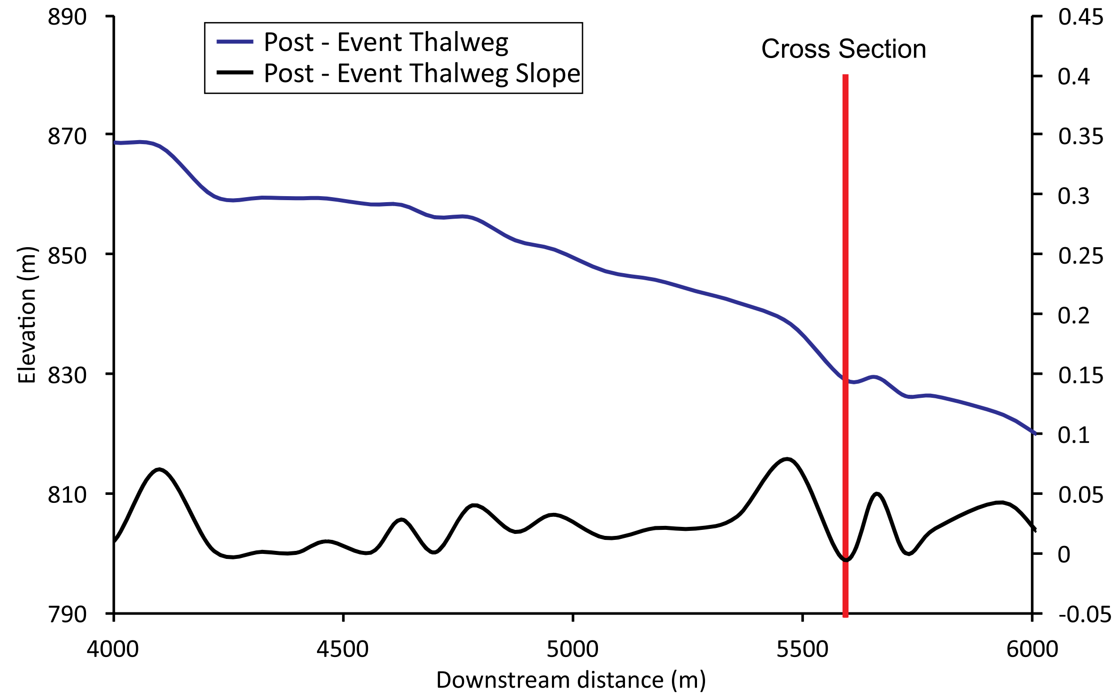
REF No: REV: **0**	AREA:	REACH:	CLIENT NAME:	PROJECT LOCATION:	DATE:	SNC·LAVALIN
621717-HIA-H007	**Upper Hazeltine Creek**	**HC-R5b**	**Mount Polley Mining Corporation**	**Mount Polley Mine, Likely, BC**	**2015/04/01**	

Area Overview

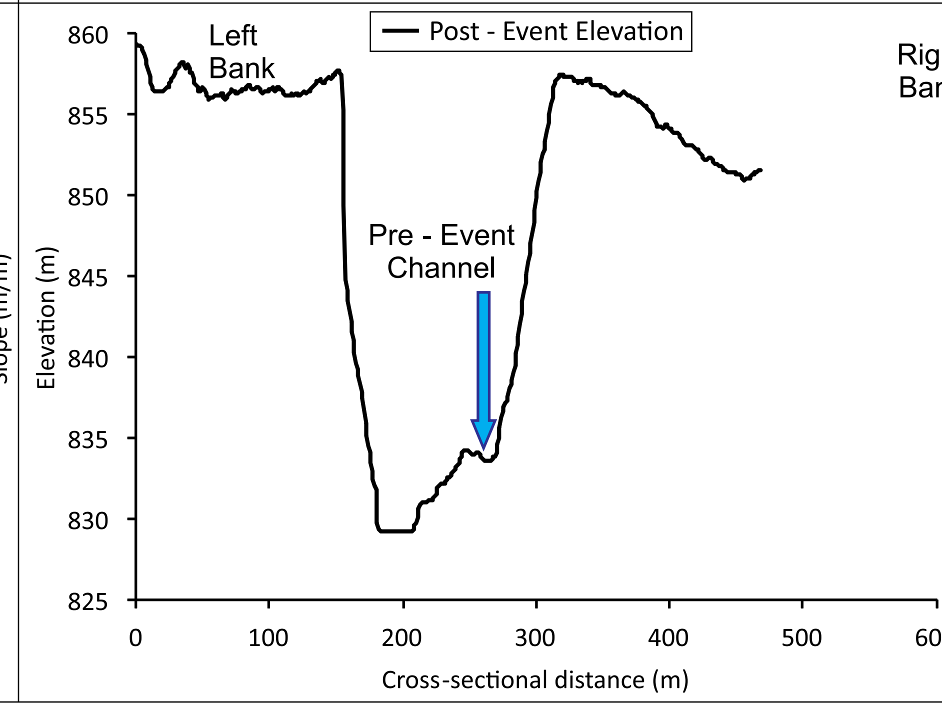


HC-R5b is located in a wide and laterally unstable section of the valley between the downstream end of HC-R5a and the entrance to the Hazeltine Creek Canyon (HC-R6).

Long Profile



Cross Section



Typical Deposits and Surficial Material

Downstream view of the steep failed wall on the left side of the valley (September 26, 2014).

Upstream view towards the failed left valley wall. Large calved blocks are present in the channel (September 26, 2014).

Downstream view where blocks of bedrock and bank material are visible in channel (September 26, 2014).

View of the channel from the top of the left bank. Channel bed is scoured to bedrock (September 26, 2014).

Key Features and Identified Impacts

Downstream view of the channel entering a small bedrock canyon at the upstream extent of the reach (September 26, 2014).

The post-event Hazeltine creek splits into two channels at the upstream extent of this reach, and converges downstream as flow leaves the reach (September 26, 2014).

View downstream, large boulder-sized blocks of cohesive material are present in the channel (September 26, 2014).

Exposed bedrock in the bed of the channel has limited the amount of incision in this reach, but likely increased lateral bank erosion.

Tension cracks at the top of the left bank indicate a high potential for bank failure (September 26, 2014).

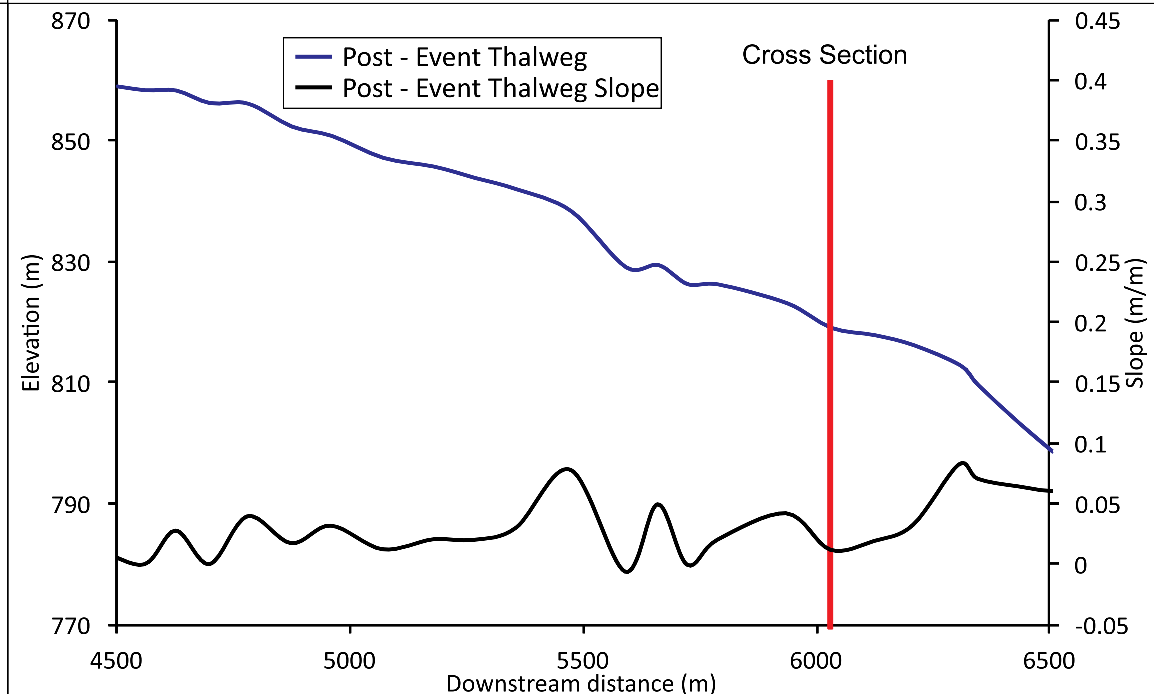
View of the right bank at the downstream extent of the reach (September 26, 2014).

REF No: 621717-HIA-H008	REV: 0	AREA: Upper Hazeltine Creek	REACH: HC-R5b	CLIENT NAME: Mount Polley Mining Corporation	PROJECT LOCATION: Mount Polley Mine, Likely, BC	DATE: 2015/04/01	SNC·LAVALIN

Area Overview

HC-R5b is located in a wide and laterally unstable section of the valley between the downstream end of HC-R5a and the entrance to the Hazeltine Creek Canyon (HC-R6).

Long Profile



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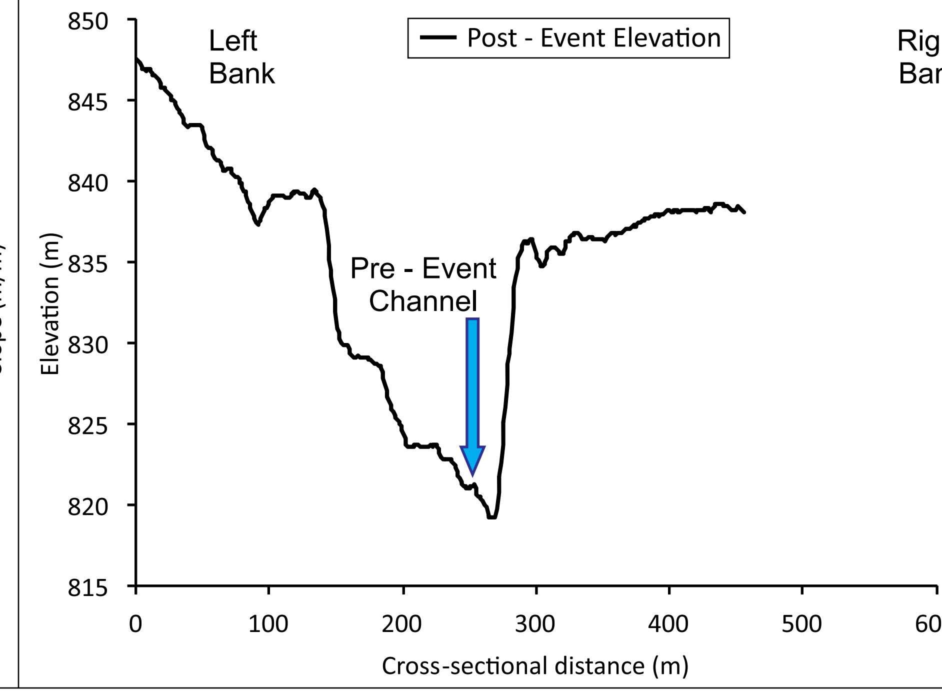


Typical Deposits and Surficial Material

Downstream view of sandy tailings overlying fluvial deposits on the left bank (September 26, 2014).

Downstream view from an abandoned channel (September 26, 2014).

Exposed native fluvial material in an exposed section of the right bank (September 26, 2014).

A root mat overlying native fluvial sediments provides evidence of the pre-event ground surface on the left bank (September 26, 2014).

Key Features and Identified Impacts

Upstream view of a cutbank on the right side of the valley. Mud lines on trees indicates the upper vertical extent of the flow event.

Upstream view of a knickpoint characteristic of this reach (September 26, 2014).

View of the right bank. Boulder-sized blocks of cohesive material deposited on the bank, and mud lines on the trees provide evidence of the vertical extent of the event (September 26, 2014).

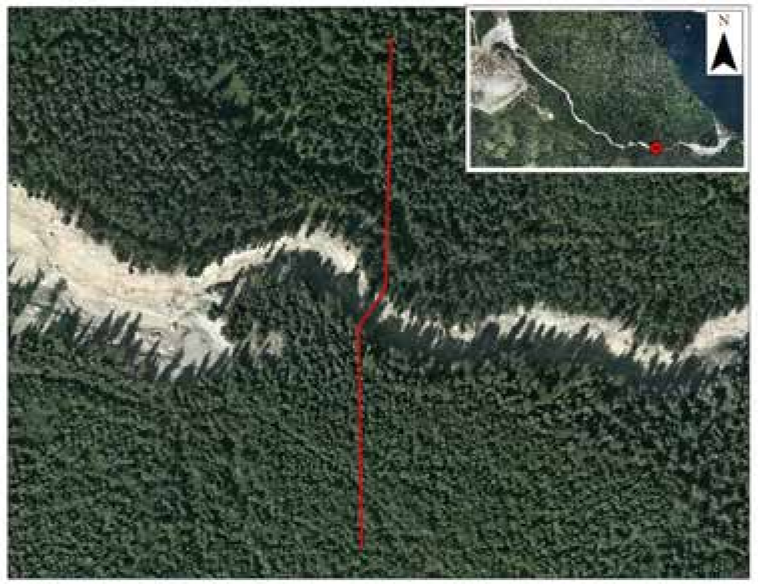
Example of an undercut bank observed in this reach. Undercut banks were common due to the soft underlying lacustrine deposits.

Eroded fluvial terraces on the left bank. Dense roots in the deposit suggest the terraces are near the pre-event ground surface (September 26, 2014).

Upstream view from the top of the left bank. Large cohesive blocks of material are visible on the surface (September 26, 2014).

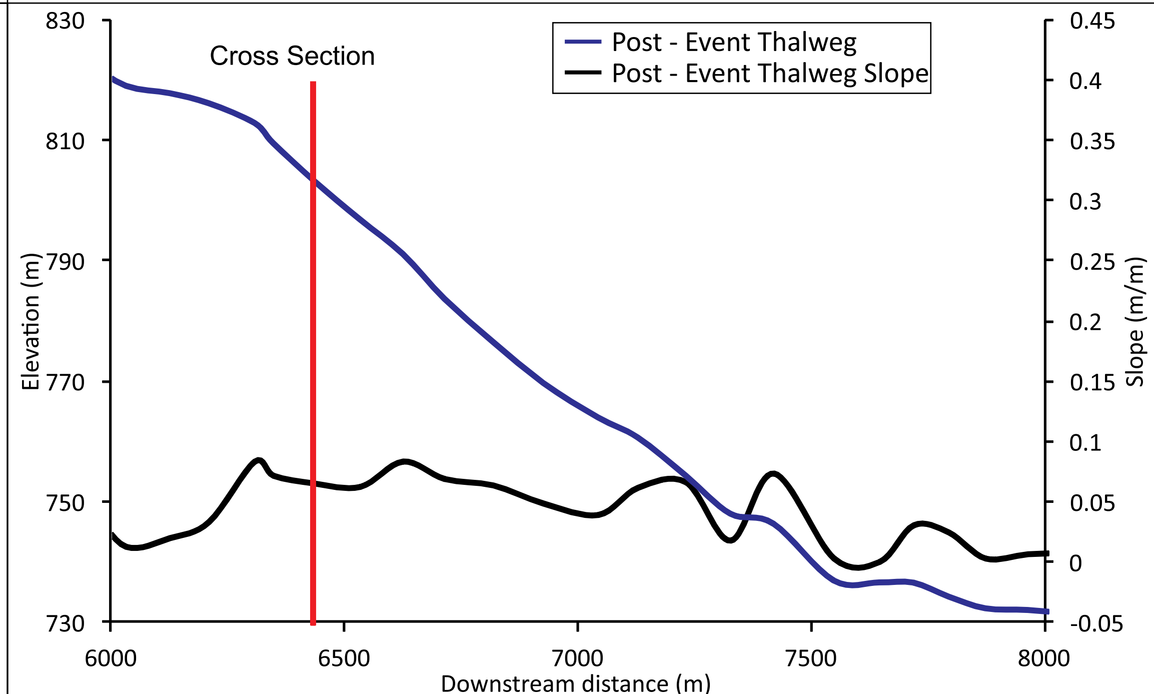
REF No: REV: 0	AREA:	REACH:	CLIENT NAME:	PROJECT LOCATION:	DATE:	SNC • LAVALIN
621717-HIA-H009	Hazeltine Creek Canyon	HC-R6	Mount Polley Mining Corporation	Mount Polley Mine, Likely, BC	2015/04/01	

Area Overview

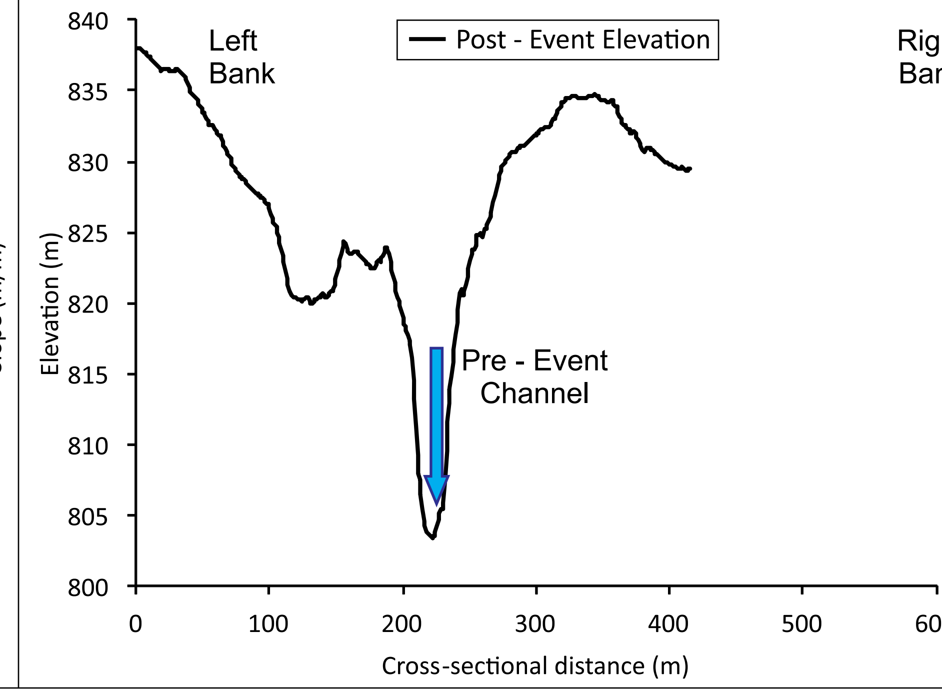


The Hazeltine Creek Canyon is a steep and narrow gorge cut into the surrounding bedrock

Long Profile



Cross Section



Typical Deposits and Surficial Material

Downstream view from the upstream entrance to the Hazeltine Creek Canyon. Banks are scoured to bedrock (September 26, 2014).

Bedrock waterfall present in the channel within Hazeltine Creek Canyon located just upstream of the lower Hazeltine Hydrometric station (October 10, 2014).

Fine gravel deposited on the Hazeltine Creek bed within the Canyon (October 10, 2014).

Hazeltine Creek Canyon looking upstream showing deposition of thin veneer of sand and fine gravel (October 10, 2014).

Key Features and Identified Impacts

Upstream entrance to the Hazeltine Creek Canyon showing exposed bedrock on Canyon walls (September 26, 2014).

Upstream view of Hazeltine Creek Canyon showing gorge scoured to bedrock (August 26, 2014).

Aerial view of the Hazeltine Creek Canyon walls showing scoured bedrock (September 5, 2014).

Right bank of the Hazeltine Creek Canyon showing scoured bedrock at surface (August 26, 2014).

Left bank of the Hazeltine Creek Canyons showing scoured bedrock at surface (August 26, 2014).

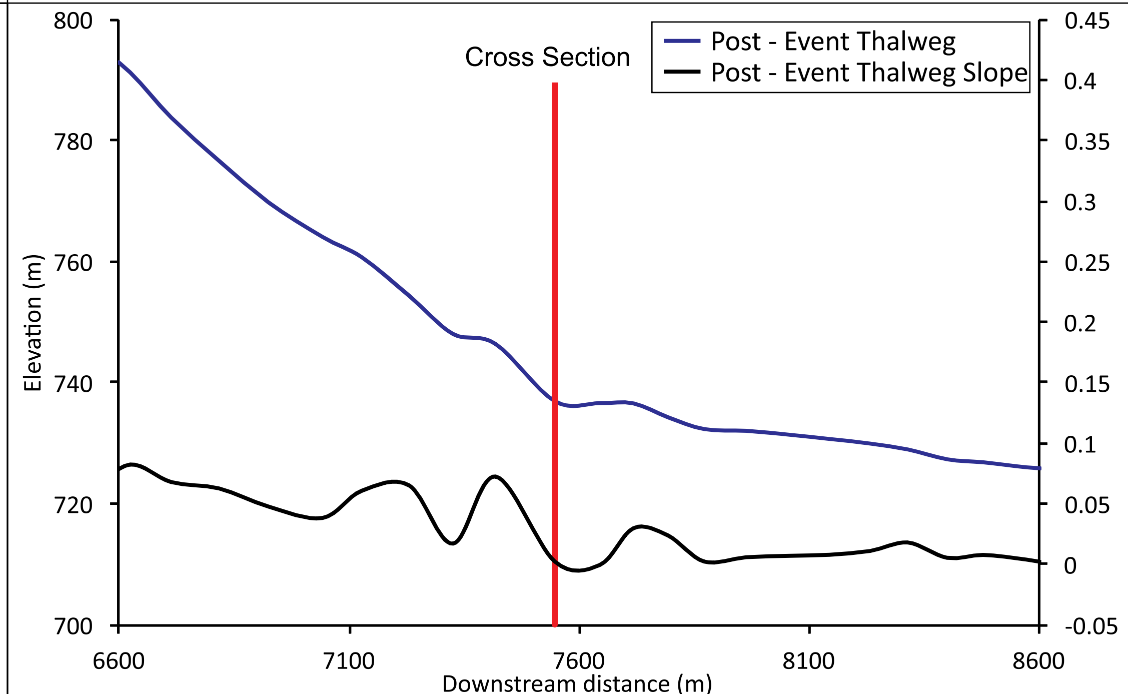
Aerial view of the Hazeltine Creek Canyon walls showing scoured bedrock (September 5, 2014).

REF No: REV: **0**	AREA:	REACH:	CLIENT NAME:	PROJECT LOCATION:	DATE:	SNC·LAVALIN
621717-HIA-H010	**Lower Hazeltine Creek**	**HC-R7-R8**	**Mount Polley Mining Corporation**	**Mount Polley Mine, Likely, BC**	**2015/04/01**	

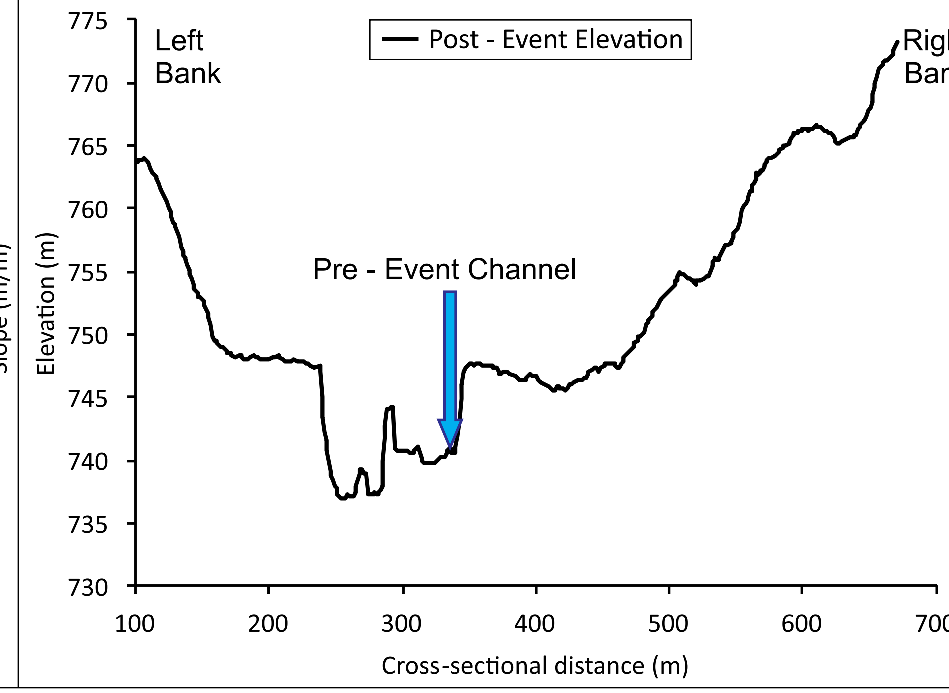
Area Overview

HC-R7-R8, located between the canyon and the confluence of Edney and Hazeltine Creeks, contains a large knick-point and a bifurcation in the debris flow.

Long Profile



Cross Section



Typical Deposits and Surficial Material

Aerial view towards the left side of the floodplain. The upper terrace is composed of native fluvial material, while the lower terrace is composed of lacustrine material (September 5, 2014).

View looking across the channel toward the right bank. A large knickpoint occurs in native till material (September 27, 2014)

Upstream view of the large knickpoint. The drop in elevation is as much as 4 m (September 27, 2014).

View from the top of the right bank. A thin layer of sandy tailings has been deposited on the surface (September 27, 2014).

Key Features and Identified Impacts

View of the left bank. Lateral erosion into the native lacustrine layer has led to undercutting and bank failures in the channel.

A highly sinuous meander incising into the bed downstream of the knickpoint. Flow is from left to right (September 26, 2014).

Downstream view of native fluvial deposits overlain by a thin layer of sandy tailings (September 27, 2014).

Downstream view of bank failures in the native lacustrine deposit (September 27, 2014).

Upstream view toward the knickpoint and the former Ditch Road bridge. Hazeltine Creek displays a braided channel form downstream.

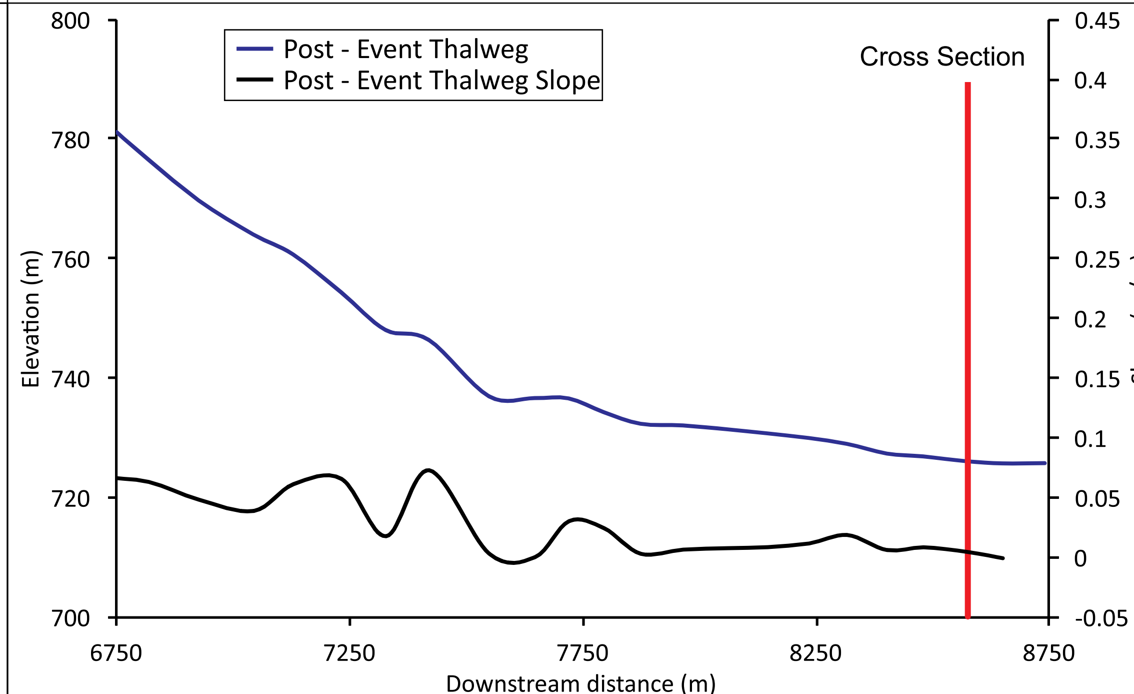
Upstream view from the top of the left bank. Event flow levels are preserved in the eroded terraces in the native fluvial material.

REF No: REV: **0**	AREA:	REACH:	CLIENT NAME:	PROJECT LOCATION:	DATE:	SNC·LAVALIN
621717-HIA-H011	**Lower Hazeltine Creek**	**HC-R9**	**Mount Polley Mining Corporation**	**Mount Polley Mine, Likely, BC**	**2015/04/01**	

Area Overview

HC-R9 is located between the confluence of Edney and Hazeltine creeks and the outlet at Quesnel Lake

Long Profile



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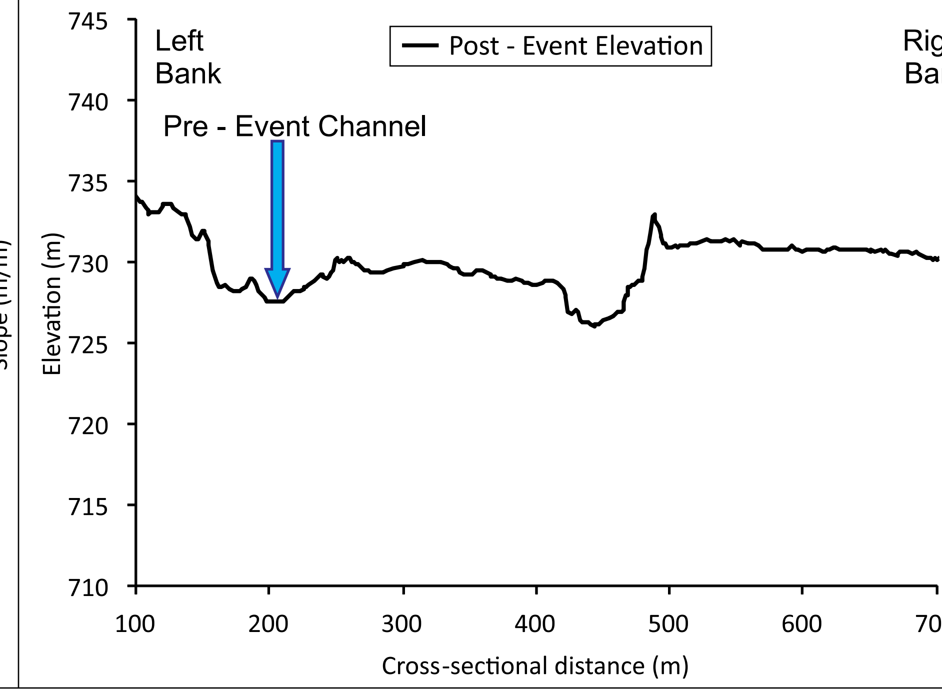


Typical Deposits and Surficial Material

Downstream view of the steep left bank. Stumps and root mats indicate the pre-event ground surface (September 27, 2014).

View of several terraces on the left bank of Hazeltine Creek near Quesnel Lake (September 27, 2014).

A large woody debris jam has been deposited at the upstream end of a tree island. View is downstream (September 27, 2014).

Large, cohesive blocks of material deposited on the floodplain near Quesnel Lake (September 27, 2014).

Key Features and Identified Impacts

Downstream view of the pre-event Hazeltine Creek channel at the left edge of the flood plain. The channel has avulsed and now flows on the right side of the flood plain (September 27, 2014).

Downstream view of the post-event Hazeltine Creek channel at Quesnel Lake, on the right side of the flood plain.

The post-event Hazeltine Creek channel is entrenched into native material. Pre-event elevation indicated by the tree stump.

Upstream view of the pre-event Hazeltine Creek channel (September 27, 2014).

Downstream view near Quesnel Lake. Most vegetation has been removed except for isolated tree islands (September 27, 2014).

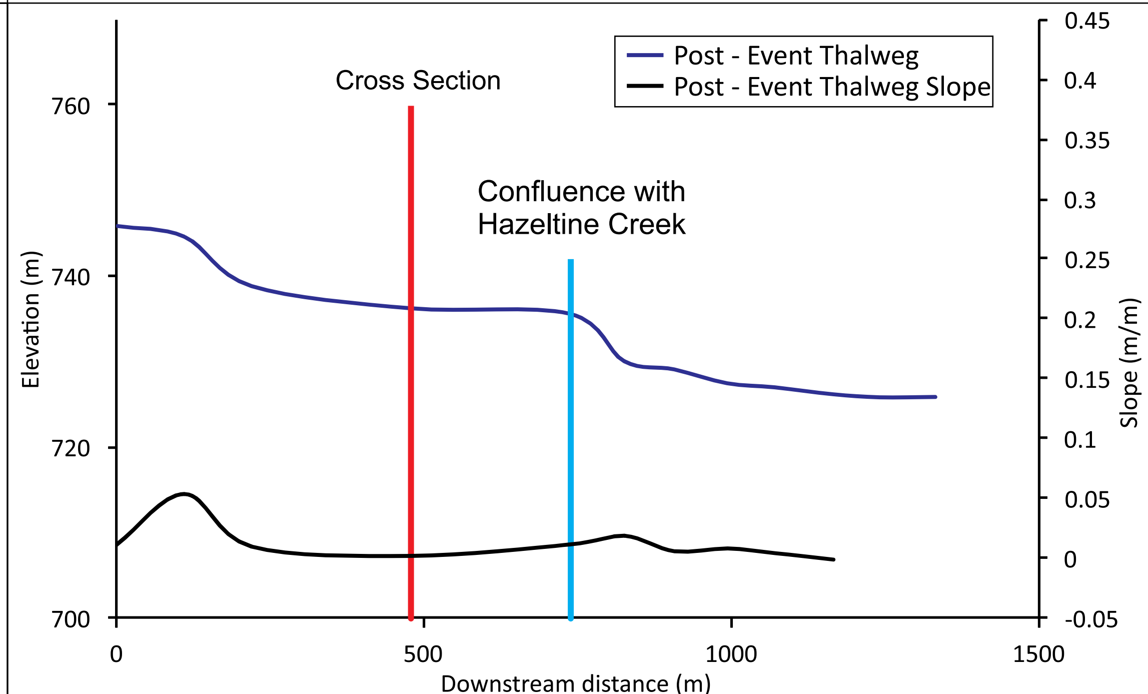
View near Quesnel Lake where large woody debris from the event has accumulated in the lake (September 27, 2014).

REF No: REV: **0**	AREA:	REACH:	CLIENT NAME:	PROJECT LOCATION:	DATE:	SNC • LAVALIN
621717-HIA-H012	**Edney Creek**	**EC**	**Mount Polley Mining Corporation**	**Mount Polley Mine, Likely, BC**	**2015/04/01**	

Area Overview

The affected area of Edney Creek extends 420 m upstream from the confluence with Hazeltine Creek. Near the confluence with Hazeltine Creek, Edney Creek is incised. Tailings are deposited within the channel above the incision.

Long Profile



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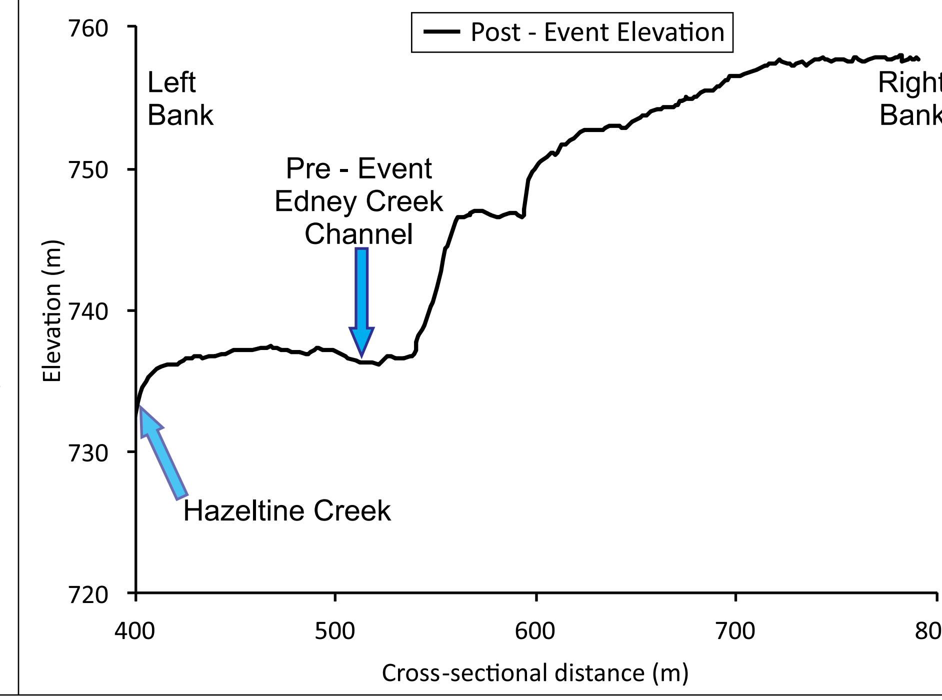

Typical Deposits and Surficial Material

Upstream view from the confluence of Edney Creek and Hazeltine Creek. The channel is deeply incised into native material.

Downstream view of tailings deposited along Edney Creek channel (November 4, 2014).

Cutbank on Edney Creek exposing the sequence of native fluvial and glacio-fluvial deposits.

Incision of the Edney Creek channel into native material between the confluence with Hazeltine Creek and the Ditch Road Bridge (December 10, 2014).

Key Features and Identified Impacts

Upstream limit of affected area on Edney Creek (October 9, 2014).

Downstream view of the confluence of Edney Creek and Hazeltine Creek (December 10, 2014).

Upstream view of the confluence of Edney Creek and Hazeltine Creek (September 27, 2014).

Upstream limit of affected area on Edney Creek. Photo taken upstream of the ditch road bridge (November 3, 2014).

Channel incision and erosion of Edney Creek between the confluence with Hazeltine Creek and the ditch road bridge.

Edney Creek channel, upstream of the confluence with Hazeltine Creek (November 3, 2014).

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APPENDIX B: BATHYMETRY ANALYSIS AND VOLUME BALANCE

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QUESNEL LAKE WATER COLUMN OBSERVATIONS AND MODELLING

Justin Rogers, M.Sc., Daniel Potts, M.A.Sc., P.Eng., Ali Oveisy, Ph.D., P.Eng., and Jim Stronach, Ph.D., P.Eng.

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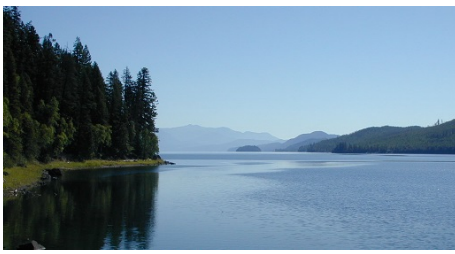
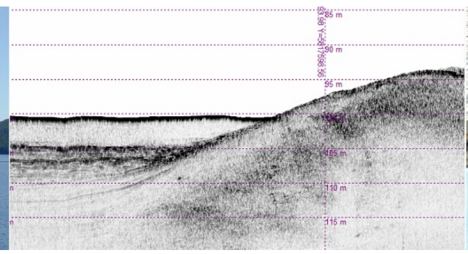
BATHYMETRY ANALYSIS AND VOLUME BALANCE



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OQM | Organizational Quality Management Program

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ACRONYMS & ABBREVIATIONS

ADCP	Acoustic Dopper Current Profiler (instrument)
CUBE	Combined Uncertainty Bathymetry Estimator (data processing technique)
CTD	Conductivity Temperature and Depth (instrument)
GAPS	Global Acoustic Positioning System
GPS	Global Positioning System
JSF	Edgetech digital file format
Minnow	Minnow Environmental Inc.
MPMC	Mount Polley Mining Corporation
R/V	Research Vessel
TSS	Total Suspended Solids
USBL	Ultra Short BaseLine (Acoustic positioning system)
WSC	Water Survey of Canada

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Mount Polley Mining Corporation and their agents. Tetra Tech EBA Inc. (Tetra Tech EBA) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Mount Polley Mining Corporation, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Tetra Tech EBA's Services Agreement. Tetra Tech EBA's General Conditions are provided in Appendix A of this report.

1.0 INTRODUCTION

Mount Polley Mine is adjacent to Polley Lake, whose outflow forms Hazeltine Creek. About 8 km downstream of Polley Lake and the Mount Polley Mine, Hazeltine Creek enters the West Basin of Quesnel Lake. Quesnel Lake is a long, narrow fjord lake reaching from the Cariboo Mountains into the Interior Plateau of BC. Its average and maximum depths are 157 and 511 m, respectively, making it the deepest fjord-type lake in the world (Laval et al, 2008). It has a surface area of about 266 km^2 and a volume of 42 km^3. A contraction and sill at Cariboo Island, 21 km from the western end of Quesnel Lake, partially separates the main body of the lake from the so-called "West Basin," which represents 8.6% and 2.3% of Quesnel Lake's surface area and volume, respectively. With a mean annual outflow of 128 m^3/s through the Quesnel River, the whole lake has an average hydraulic residence time of 10 years, whereas the West Basin has an average hydraulic residence time of only 3 months.

Following the August 4, 2014 failure of the Tailings Storage Facility (TSF) at the Mount Polley Mine and the subsequent debris flow along Hazeltine Creek, suspended particulate material entered Quesnel Lake. Tetra Tech EBA Inc. (Tetra Tech EBA) was retained by Mount Polley Mining Corporation to perform both field measurements and numerical analyses to develop a predictive model that would evaluate the behaviour and fate of the suspended particulate material in Quesnel Lake. The modelling and field methods focussing on the lake's water column are detailed in the report "Quesnel Lake Water Column Observations and Modelling" (Tetra Tech EBA, 2015a).

Additionally, Tetra Tech EBA was requested to assess the overall volume balance of the failure event, giving consideration to all available sources of data, both on land and within Quesnel Lake. The bathymetry and sub-bottom profile data collected by Tetra Tech EBA in September 2014 are given particular attention. This report provides a synthesis of these data and presents a narrative and quantitative interpretation of the movement and fate of the displaced materials. The degree of uncertainty in estimated quantities is documented wherever possible.

2.0 FIELD METHODS

Field observations in Quesnel Lake involved water column profiling by MPMC and Tetra Tech EBA, bathymetric and geophysical data collection by Tetra Tech EBA, and sediment sampling carried out by Minnow Environmental Inc. (Minnow), supported by Tetra Tech EBA's research vessels. This report presents data collected by Tetra Tech EBA during a field program from August 28 to September 6, 2014, where the research vessels R/V Storm and R/V Ugle Duckling were mobilized from Tetra Tech's Bothell, WA, marine mapping group (Tetra Tech Bothell). Data collected in fall 2014 and early 2015 by a joint Mount Polley Mining Corporation (MPMC)/SNC-Lavalin water sampling and profiling program are also referenced. The water column profiling is described in detail in Tetra Tech EBA (2015a). Bathymetric, sidescan and sub-bottom profiling measurements are discussed in this report. A preliminary data report discussing bathymetric and geophysical methods and data collection, "Mount Polley Tailings Fate Survey" by Tetra Tech Bothell is attached as Appendix B, produced in September 2014. Any preliminary interpretation provided in Appendix B is superseded by this report.

2.1 Water Column Profiling

Water column profiles are the primary method of gathering physical limnological data. Conductivity, temperature, and depth (CTD) casts measure three parameters essential for understanding the vertical density structure of a water body. Profiling equipment used at Quesnel Lake also logged turbidity, an optical measure of water cloudiness, closely related to suspended sediment concentration. Collection of the water column profiles was a key objective of the August 28 to September 6, 2014, field program. Water column profiles were used to estimate the amount of suspended material in the water column on the observation dates. Profile data, methods, and results are reported in detail in Tetra Tech EBA (2015a).

2.2 Multibeam Bathymetry

The primary equipment mobilized onto the survey vessels included a multibeam echosounder sonar, side-scan sonar, sub-bottom profiler, acoustic Doppler current profiler (ADCP), CTD/turbidity sensor systems, and vessel positioning equipment. These systems and the ancillary positioning and vessel attitude systems that were used to conduct the seabed mapping are listed in Table 2.1 and discussed in more detail in Appendix B.

Table 2.1: Survey Equipment

Primary Equipment	Make/Model
Multibeam	RESON SeaBat 7125
Side-scan Sonar	EdgeTech 2000-DSS 100/600kHz chirp
Sub-bottom Profiler	EdgeTech 2000-DSS 2-16kHz chirp
ADCP	Teledyne RDI Workhorse Sentinel 600 kHz
USBL	IXBLUE GAPS
Positioning Systems	Applanix POS/MV 320, Trimble SPS65x with OmniStar
Heading, and Motion Reference Systems	Applanix POS/MV 320, IXBLUE GAPS
CTD with Turbidity	Seabird 19 Plus, YSI CastAway
Grab Sampler	WILDCO Standard Ponar (or similar)

The collected bathymetry data were processed with CARIS HIPS software to generate three dimensional maps in the survey coordinate system and units. Data quality control and assurance was also performed as described in Appendix B. The bathymetric chart produced by the multibeam survey is reproduced in Figure 2.1.

2.3 Sidescan Sonar

Additional data collected during the project included side-scan imagery sonar and sub-bottom profiler data from the towed EdgeTech 2000-DSS system. This system, referred to as a towfish, is connected to the vessel by a cable and allows measurements to be made closer to the lake bottom. These data provided detailed images of features and textures on the lake bed, and information on the subsurface stratigraphy below the profiler.

Side-scan sonar imagery were acquired in proprietary EdgeTech format (JSF) using EdgeTech's Discover acquisition software and then imported into Chesapeake SonarWiz 5 for post-processing. Towfish position from the acoustic positioning system (GAPS USBL) was recorded directly into the raw data file and/or HYPACK for geo-referencing all raw data. The SonarWiz processing package was used to remove erroneous navigation points, apply gains and conduct other signal processing, bottom track the data to remove the water column, and prepare the sonar data for final export. The imagery was exported from SonarWiz as 0.25-meter resolution geotiffs and is displayed on Figure 2.2.

2.4 Sub-Bottom Profiling

Sub-bottom profiler data were processed using the SonarWiz software. As with the side-scan sonar files, towfish position was acquired with the GAPS USBL and embedded in the raw data files acquired in the EdgeTech Discover and/or HYPACK programs. The files were recorded in the proprietary EdgeTech JSF format. The sub-bottom profile data were bottom-tracked and gains were applied where appropriate to distinguish different sediment layers on the lake bed where sediment layering was observed.

Penetration depth of the sub-bottom profiler provides information on sediment type and thickness. Areas that show distinct layering tend to be comprised of finer grained sediments such as fine sand, silt and clay because the sub-bottom profiler beam does not penetrate larger grained sediments such a coarse sand, gravel and cobble.

Selected sub-bottom profiles are shown and discussed in this report.

2.5 Acoustic Doppler Current Meter (ADCP)

ADCP data were collected and processed using the Teledyne-RDI WinRiver software. The ADCP transmits a set of four beams at different angles from vertical and measures the Doppler shift versus time from each beam to derive current directions and magnitudes at closely-spaced depths through the water column. It also tracks the return from the bottom to measure water depths and provides measurements of reflectivity versus depth in the water column that can be used to detect and delineate plumes of suspended sediment in the water column. The current data were used to help develop the hydrodynamic model and locate sediment plumes, but are not discussed further in this report.

2.6 Water and Sediment Sampling

MPMC conducted an extensive water column sampling program, discussed in detail in Golder (2015). Water was analyzed for physical parameters and metals. Laboratory results related to turbidity and suspended sediment concentration are discussed in Tetra Tech EBA (2015a). Long-term results from the suspended sediment modelling are discussed in Section 5 of this report.

3.0 EVENT VOLUME BALANCE

Before the dam failure, water normally flowed from Polley Lake into Hazeltine Creek and then into Quesnel Lake. The TSF dam failure discharge and subsequent debris flow entered Hazeltine Creek approximately 0.5 km downstream of Polley Lake and 8 km upstream of Quesnel Lake. The relatively flat terrain connecting the location of the TSF failure and the outlet of Polley Lake, and the great volume of discharge, allowed the initial surge to flow "upstream" into Polley Lake. This section seeks to reconcile the volumes of material that entered Polley and Quesnel Lakes with the debris flow discharge, deposit and scour volumes. A secondary goal of this section is to identify uncertainties in these estimates.

3.1 Discharged Volume

MPMC staff produced an estimate of the material lost from the TSF during the failure event based on prior survey data, TSF design, and water level data. The estimated volumes of released materials are as follows (MPMC, 2014):

- Supernatant water: 10.6 million m^3
- Tailings solids: 7.3 million m^3
- Interstitial water: 6.5 million m^3
- Construction materials: 0.6 million m^3

Thus, the total discharge volume is estimated at 25.0 million m^3 of liquid and solid materials combined.

Interstitial water refers to the water stored in between the individual grains of sediment in the TSF. The amount of interstitial water stored per amount of solids is termed the void ratio. The void ratio of soil can change: compaction or consolidation can reduce the void ratio, while mobilization such as a debris flow can increase the void ratio by mixing in additional water.

3.2 Polley Lake Volume Increase

The discharge entered Polley Lake, raising its level by 1.7 m (MPMC, 2015). Mount Polley Mining Corporation (2015) estimated that "approximately 6 million cubic metres of water flowed into Polley Lake." Independently, Tetra Tech EBA estimated the surface area of the lake as 3.77 km^2 based on aerial imagery; without allowing for an increase in surface area, the water level rise of 1.7 m thus implies a volume increase of 6.4 million m^3. Uncertainty in both these estimates comes from a lack of precise topographic data around the edge of the lake and from a lack of precise pre-event lake elevation. For the purposes of the volume balance, the MPMC estimate will be used, with an assumed uncertainty of ±0.5 million m^3. This volume is understood to be predominantly water (MPMC, 2015).

3.3 Quesnel Lake Volume Increase

Quesnel Lake has a water level gauge operated by Water Survey of Canada (WSC). Real-time data from this gauge, #08KH011, are available online, and showed an abrupt increase in lake level on August 4th, 2014. The lake level normally varies gradually due to seasonal patterns of inflow and outflow. By fitting straight lines to the observed lake level in the week surrounding the incident, it can be deduced that the sudden level increase was between 0.068 and 0.079 m (Figure 3.1). The river outflow and inflows are accounted for by the slopes of the fit lines; therefore, this level increase is due solely to additional materials that entered the lake as a result of the dam failure.

The observed lake level at the time was approximately 1.6 m on the gauge. At this level, the surface area of Quesnel Lake is approximately 267.5 km^2, indicating that the lake volume increased by between 19.7 ± 1.5 million m^3 as a result of the incident.

3.4 Hazeltine Creek Bed Volume Changes

Following the TSF dam failure, some material deposited almost immediately, forming a "plug" at the outlet of Polley Lake, while more of the material deposited in the bed of Hazeltine Creek. However, the debris flow also scoured some amount of native material out of Hazeltine Creek. These volumes were estimated by SNC-Lavalin (2015): the total volume of deposited material was approximately 1.6 ± 0.3 million m^3, while the eroded or scoured volume was 1.2 ± 0.6 million m^3. The estimated net deposition (i.e. deposition minus scour) on land is therefore 0.4 ± 0.9 million m^3.

On the time scale of the dam failure and subsequent debris flow – some hours – the water table within any deposited materials would likely not drop much below the surface due to the high fraction of fine tailings materials present. Scoured materials came from within or near the Hazeltine Creek bed, and were therefore likely saturated or nearly so. Therefore, for the purposes of this volume balance, the eroded and scoured volumes are both assumed to include a negligible volume of air in void spaces.

3.5 Volume Balance and Interpretation

Based on the above volumes, Tetra Tech EBA has estimated the general movement of displaced materials as follows:

- Construction materials from the dam (0.6 million m^3) deposited almost immediately, forming part of the plug at the outlet of Polley Lake.

- Some of the supernatant water (10.6 million m^3 total) went into Polley Lake (6 ± 0.5 million m^3) and the remainder went down Hazeltine Creek and entered Quesnel Lake (4.6 ± 0.5 million m^3).
- Some of the tailings solids and interstitial water (13.8 million m^3 total) contributed to the Polley Lake plug and other deposits: 1.0 ± 0.3 million m^3 makes up the balance of the deposited material (1.6 ± 0.3 million m^3 total). The remainder went down Hazeltine Creek and entered Quesnel Lake (12.8 ± 0.3 million m^3).
- Native material scoured from Hazeltine Creek also entered Quesnel Lake (1.2 ± 0.6 million m^3).

It is possible that some amount of tailings and interstitial water entered Polley Lake but this was not directly assessed by this study. The interpretation of primarily water entering Polly Lake is conservative from the perspective of maximizing the assumed volume of tailings, as opposed to water, that entered Quesnel Lake. Additionally, pre-impact bathymetry is of insufficient quality to enable quantification of Polley Lake depth changes. For the present purposes, it has been assumed that, effectively, Polley Lake received mostly water and the SNC-Lavalin (2015) volume estimates account for the solids deposition on the periphery of Polley Lake. Should it become possible to derive estimates for Polley Lake solids volume, then the Quesnel Lake solids volumes would be adjusted proportionally downward.

It is also possible that some volume of construction materials reached Quesnel Lake, which would imply a greater deposition of tailings materials on land, and correspondingly less in Quesnel Lake. The above interpretation assumes that the on-land deposition included all the construction materials, and is therefore conservative from the perspective of maximizing the assumed volume of tailings, as opposed to construction materials, that entered Quesnel Lake.

The above estimate specifies that the following volumes of displaced material entered Quesnel Lake through the debris flow:

- Supernatant water: 4.6 ± 0.5 million m^3
- Tailings solids and interstitial water: 12.8 ± 0.3 million m^3
- Native material from Hazeltine Creek: 1.2 ± 0.6 million m^3

The total volume estimated to have entered Quesnel Lake is therefore 18.6 ± 1.4 million m^3 by the above interpretation. This agrees well with the volume inferred from the lake level gauge, which indicated approximately 19.7 ± 1.5 million m^3. Of this total, solids and interstitial water make up approximately 14.0 ± 0.9 million m^3, and supernatant water accounts for the other 4.6 ± 0.5 million m^3.

4.0 BATHYMETRIC DATA ANALYSIS

4.1 2001 Bathymetric Survey

Coast Pilot Ltd. conducted a bathymetric survey of Quesnel Lake in October 2001 using an echo sounder and GPS with data logging software (Campbell, 2001). Sounding lines were spaced 1 km apart. The resulting bathymetric map and survey reference notes are reproduced in Figure 4.1. The raw data from the 2001 bathymetric survey were made available by the Institute of Ocean Sciences (Zotter, pers. comm.). The maximum surveyed depth in the West Basin was 121 m below the zero of the WSC gauge at Likely.

4.2 2014 Bathymetric Survey

A new and more detailed multibeam bathymetric survey was carried out by Tetra Tech EBA in the West Basin of Quesnel Lake in from August 30 to September 6, 2014, as described in Section 2.2. This survey had complete coverage within the 60-m depth contour of the West Basin and partial coverage north to Cedar Creek and east beyond Plato Island (see Figure 2.1). The maximum surveyed depth in the West Basin was 108 m below the zero of the WSC gauge. Figure 4.2 shows depth contours (lines) and a slope map (shading) derived from these survey data. The shading indicates the slope of the lake bottom, with lighter shades indicating a flat bottom and dark shades representing steeper slopes. Changes in slope are useful in delineating erosion and deposition features, discussed below.

4.3 Comparison of 2001 versus 2014 Bathymetry

Tetra Tech EBA compared the new (2014) and old (2001) bathymetry data by interpolating the new data onto the old survey points, and correcting to a common datum (taken as the zero of the WSC level gauge at Likely). The pattern of soundings taken in 2001 allows the reconstruction of both transverse and longitudinal sections in the area of interest. The inset map on Figure 4.3 shows the locations of the 2001 soundings, while the panels labelled "Section V" and "Midline 1" show vertical cross-sections along the corresponding lines (highlighted in yellow on the inset map). In the deepest portion of the West Basin, there are obvious depth changes between 2001 and 2014. From the "Midline 1" section (Figure 4.3), an infill or decrease in depth of at least 10 m is apparent, from Sections F through I. There is also a step of about 4 m in the 2014 bottom elevation just north of Section H, which will be discussed later.

In the main body of the lake, where no significant event deposition is expected, the 2001 and 2014 bathymetry agree closely. For example, the old and new bathymetry along Section V are almost indistinguishable visually (Figure 4.3). A point-by-point comparison of the depths on Section V shows a root-mean-square depth difference of 3.1 m and an average difference of 0.5 m. These differences can be attributed to the inaccuracies inherent in the respective surveying methods.

The four West Basin sections with maximum depth greater than 100 m are shown in Figure 4.4, with an inset map indicating their locations. Note the change of vertical scale from Figure 4.3. Sections F, G and I show a clear similarity in overall shape between 2001 and 2014, with a horizontal shift of about 50 m suggested. This horizontal shift is likely an artifact of 2001-era surveying and GPS accuracy and is not of consequence in the present study. However, in these three sections the West Basin has become shallower due to recent deposition of solid materials.

It is worth observing here that the Midline 1 sounding track did not follow the thalweg, or line of greatest depth, in the West Basin (see Section G in Figure 4.4, for example). This means that Midline 1 does not reflect the full degree of infill at all locations.

The comparison of bathymetry along section H, adjacent to the Hazeltine delta, shows a 60 metre difference in bathymetry on the western side. Confidence in the 2001 data along this section, and their interpretation, is substantially undermined by the 2001 bathymetric map, in which the surveyor plotted the 100-m contour line through the shallower data points around 40 m depth (see Figures 4.1 and 4.4). Tetra Tech EBA contacted the surveyor, who acknowledged that there was evidently an error of some sort at that location. Thus, these data points are not relied on in this document to draw any quantitative conclusions.

4.4 Estimation of West Basin Volume Changes

The volume of the West Basin below the 100-m contour can be estimated from both the 2001 data and the 2014 data. Interpolating between sections F, G and I (thus excluding section H), Tetra Tech EBA estimated volumes based on both data sets and found the volume to be approximately 18 million m^3 less in 2014.

In seven other sections where no deposition is expected, the typical disagreement between 2001 and 2014 bathymetry is about 1000 m^2 in the cross-sectional area of the bottom 15 m of a given section. Since the volume change happened in a region about 5 km long, the estimated uncertainty in the volume difference is ±1000 m^2 x 5 km = ±5 million m^3, or ±30%.

In summary, the comparison between 2001 and 2014 bathymetry data in the West Basin shows definite deposition below the 100-m contour. The deposited material is likely a combination of solids that entered the lake after the TSF dam failure and redistributed material from underwater erosion (discussed in Section 4.6 below) of the underwater lake sideslope below the Hazeltine area. The relative proportions of these materials are addressed below.

4.5 Discussion of 2014 Sub-bottom Profiler Data

In 2014, Tetra Tech Bothell conducted a sub-bottom profile survey of the West Basin in the vicinity of Hazeltine Creek. The sub-bottom profiler data and field interpretation are discussed in Tetra Tech Bothell's report (Appendix B). This section is concerned with comparing and reconciling the sub-bottom profiler data with the bathymetry changes discussed above. Interpretation in this report supersedes the Appendix B report due to additional available information and analysis. Sub-bottom imagery is best interpreted relative to other observations, such as previous surveys or boreholes, as sub-bottom reflectors could be either recent (event-related) or much older soil horizons. In this case, the 2001 survey provides data on former lake bed depth and improves understanding of the sub-bottom reflectors. The sub-bottom profiles show approximate depth (with 0 being at the water surface on the day of the survey) on the vertical axis and along-track distance on the horizontal axis; with both axes in meters.

Figure 4.5 shows the survey tracks of the sub-bottom profiles collected in 2014, overlaid with the positions of the 2001 depth soundings. Tetra Tech Bothell's report provided sub-bottom profiler imagery for those portions of the tracklines indicated with magenta rectangles (Figure 4.5). Trackline "Line 04" is approximately parallel to and slightly west of the 2001 soundings along Midline 1, and proceeded from southeast to northwest.

Imagery for profiles 4-1 and 4-2 is reproduced in Figure 4.6. Note that these profiles are presented from the point of view of an observer on the northeast bank of Quesnel Lake, looking back toward Hazeltine Creek. Higher acoustic reflectivity is shown in darker colours. Bedrock and coarse sediments are more difficult for the acoustic signal to penetrate, and appear as a single surface with no distinct reflective layers beneath. Fine-grained sediments appear as a series of reflective layers.

Profile 4-1 (Figure 4.6) is near the intersection of Midline 1 and Section I, in which the bathymetry comparison showed an infill of approximately 10 m (see Figures 4.3 and 4.4). Profile 4-1 shows over 10 m of fine-grained sediments likely deposited on the southeast part of the profile, with the upper surface of the deposited material at approximately 100 m depth. This observation agrees closely with Midline 1 and Section I, which also show an upper surface near 100 m depth. As the survey vessel continued northwest the profile line intersected the underwater lake sideslope, which appears as a raised feature.

Profile 4-2 is offshore of the Hazeltine delta, near the intersection of Midline 1 and Section H (see Figure 4.5). This profile indicates coarse-grained sediment rather than fine-grained, but still with an upper surface around 100 m depth (Figure 4.6). Moving from southeast to northwest there is a noticeable step down of about 3-4 m at the edge of the coarse-grained deposition area. This observation matches Midline 1, which also shows a step down at this location. This makes physical sense as the higher-relief area is closer to the Hazeltine source, and coarser material sinks faster and would therefore tend to deposit near the source.

Profile 4-3 is north of the Hazeltine delta, near the intersection of Midline 1 and Section G (see Figure 4.5). This sub-bottom profile shows over 10 m of fine-grained likely sediments deposited (Figure 4.7), with an upper surface around 104 m depth and a lower surface below 115 m depth. These depths agree with Section G (Figure 4.4), although profile 4-3 appears to be east of the deepest part of the section.

Trackline “Line 10” lies between the lake’s shoreline and Line 04, along the underwater lake sideslope at intermediate depth (see Figure 4.5), proceeding from northwest to southeast (Note: opposite to Line 04). Profile 10-1 (Figure 4.7) crosses through Section H over what appears to be a deltaic depositional cone formed by Hazeltine Creek prior to the TSF dam failure. No differentiable deposition of fine-grained material is evident except at the southeast end of the profile beyond the edge of the depositional cone.

Profiles 10-2 and 10-3 (Figure 4.8) are offshore of the Hazeltine delta near the middle and the southeast extent, respectively, of the visibly eroded underwater lake sideslope (see Figure 4.5). These two profiles each show channels in the underwater lake sideslope which appear to have been scoured out or destabilized by an underwater debris flow during the event. The channel visible in profile 10-2 is about 20 m deep by 250 m wide, while that in profile 10-3 is about 5 m deep by 100 m wide. The reflectors to the sides of the scoured channels in profiles 10-2 and 10-3 are interpreted as pre-existing lake bed deposition having occurred over geologic time scales, as this pattern of layers appears repeatedly on sections more distant from the Hazeltine area (not shown).

The coarse-grained sediments observed in profile 4-2 (Figure 4.6) are offshore of the channel in profile 10-2, which implies that underwater lake sideslope erosion occurred in channelized fashion, quickly depositing in the area around profile 4-2. During this erosion event, the underwater lake sideslope materials would have become mixed with the displaced materials from the TSF and Hazeltine Creek, resulting in a mixed-composition deposit. The step in profile 4-2 and Midline 1 appears to be the edge of the coarse-grained deposit from this phase of the underwater debris flow.

4.6 Estimation of Underwater Lake Sideslope Scour Volumes

The scour channels visible in sub-bottom profiles 10-2 and 10-3 are identifiable in the 2014 bathymetric data from the uppermost limit of the survey at about 20 m depth, down to about 85 m depth, at which point the channel shapes intermingle with the depositional fans.

Assuming that the underwater lake sideslope was previously smooth, it is possible to estimate the volume missing from the scour channels. At the 30-m depth contour, for example, Tetra Tech EBA traced the contour line along the base of the scour channel and then connected the upper edges of the channel with a straight line, forming a closed polygon. This technique was repeated for each contour at 5-m intervals from 20 to 85 m depth, and for both scour channels. Figure 4.9 shows example polygons in each scour channel at depth contours of 30 and 55 m.

At the water surface, some degree of shoreline recession is evident in aerial photographs. Tetra Tech EBA delineated the shoreline before and after the event, using aerial imagery, and found the difference in land area to be approximately 45,000 m^2. This differs from the SNC-Lavalin (2015) figure of 32,200 m^2 because Tetra Tech EBA included the Hazeltine mouth and traced the waterline further upstream the new Hazeltine channel, while SNC-Lavalin reported upstream Hazeltine changes elsewhere in their report.

Finally, the areas of the shoreline recession and scour channel polygons were integrated over depth to calculate an estimated total volume of material displaced from the channels. The total scoured volume is approximately 1.9 million m^3, according to this method. The scour channels visible in sub-bottom profiles 10-2 and 10-3 account for approximately 80% and 20% of the total, respectively. This method, however, suffers from the questionable assumption of straight contours prior to the scour event(s). Judging from the shoreline shape prior to the TSF dam failure, the contours could be drawn somewhat concave, possibly eliminating half of the "lost" volume. The scoured volume is therefore most probably between 1.0 and 2.0 million m^3, and will be quoted as 1.5 ± 0.5 million m^3.

4.7 Estimation of Underwater Lake Sideslope Deposition Volumes

There is little evidence of deposition on the underwater lake sideslope offshore of the debris flow paths on land. Large volumes of displaced material would not be expected to deposit on these banks, which are as steep as, or steeper than, the natural Hazeltine fan. The sub-bottom profiler did not show a distinguishable layer of deposition on the Hazeltine fan. The reflectors outside of the scoured channels in Profiles 10-2 and 10-3 are interpreted as pre-existing lake bed deposition having occurred over geologic time scales. Even if an event-related deposited layer of 1-m thickness is assumed, the deposition on the fan would be only 0.05 million m^3. For the purposes of the in-lake volume balance, underwater lake sideslope deposition is assumed to be negligible.

4.8 Discussion of Underwater Processes

An underwater debris flow, or turbidity current, is a coherent body of water which descends a slope under the weight of its suspended sediment load. The TSF dam failure produced a debris flow on land in the Hazeltine Creek channel(s), which continued underwater creating the channels discussed in Section 4.6.

There are two phases of the underwater debris flow discussed in this report, distinguished by the amount of energy available to transport sediment. The amount of energy available to transport sediment increases with the steepness of the slope and with the difference in density between the debris flow and the ambient water. The high-energy phase of the underwater debris flow occurred on the underwater lake sideslope between the shoreline and the relatively flat lake bottom below 100 m. The steepness of the slope allowed this phase of the debris flow to carry all sediments, including fine and coarse tailings and the coarsest native material scoured from above and below the waterline, to the depositional area generally below the 100-m contour. The area affected by this high-energy debris flow, including the flow paths and the depositional zone of the coarse materials, is indicated by the orange dashed line in Figure 4.10, which delineates and area of approximately 0.39 km^2, and includes both erosional and depositional features.

The low-energy phase began at the foot of the scour channels in the underwater lake sideslope after the coarse material deposited, and finer sediments spread gradually in both directions along the axis of the West Basin. The available slopes and density differences were both much less in this phase of the flow, and therefore it is likely that only finer sediments were transported. Figures 4.2 and 4.10 outline the estimated depositional zone of this low-energy debris flow with a green dashed line. The area of event-related infill within the estimated depositional zone is 1.81 km^2 based on data from the bathymetric analysis and sub-bottom profiling of sediment layers. Figure 4.11 schematically illustrates the high- and low-energy debris flow paths over a three-dimensional view of the Hazeltine delta. The timing of these flow phases is not known from the available information.

The two scour channels discussed in Section 4.6 appear to be connected with debris flows at somewhat different energy levels. The debris flow coming down Hazeltine Creek would have had the greatest energy at or near the beginning, when it was carrying the largest volumes and included the coarsest materials. Hours later it would have carried lower volumes and predominantly water and finer material. The channel shown in Profile 10-2 (Figure 4.8) is directly offshore of the Hazeltine Creek and Edney Creek confluence, and it seems that the flows with the highest momentum and energy would have forced a path to that point for discharge to the lake. The alignment of this channel with the on-land flow path is apparent in the three-dimensional view shown in Figure 4.11. Once the energy level decreased, the on-land Hazeltine channel (discussed in SNC-Lavalin (2015)) appears to have veered to the south, and begun discharging into the lake above the underwater channel shown in Profile 10-3 (Figure 4.8) and shown on the left in Figure 4.11.

4.9 In-Lake Volume Balance

The on-land volume balance (Section 3.5) indicated that the total volume of material that entered Quesnel Lake was approximately 18.6 ± 1.4 million m^3, of which 14.0 ± 0.9 million m^3 was solids and interstitial water. In fact, the on-land debris flow would have caused some degree of mixing, likely entraining some of the supernatant water, effectively converting it to interstitial water.

The underwater debris flow would have continued mixing, entraining ambient water into the flow as well as scouring coarse native material from the underwater lake sideslope. The scoured coarse material was estimated at about 1.5 ± 0.5 million m^3. Adding this to the 14.0 ± 0.9 million m^3 of solids and interstitial water, the total volume of the debris flow reaching the bottom of the West Basin was approximately 15.5 ± 1.4 million m^3 plus an unknown volume of entrained ambient water. This agrees with the estimated volume of deposited material as of early September 2014, which was 18 ± 5 million m^3 (Section 4.4).

As deposited fine sediments consolidate, some of the entrained water and interstitial water seeps out. Therefore, as time progresses, the apparent volume of the deposited material will likely decrease.

5.0 DISCUSSION OF SUSPENDED MATERIAL

Some of the material entering Quesnel Lake consisted of very fine-grained material, which takes much longer to sink than coarser material such as sand, or even most silts. Tetra Tech EBA (2015a) discusses field observations, analytical estimates, and numerical modelling of the suspended material present in Quesnel Lake's West Basin due to the TSF failure and subsequent debris flow. The modelling results relevant to the event volume balance are summarized in this section.

5.1 Suspended Material Modelling

Tetra Tech EBA (2015a) estimated the amount of material suspended in the water column on three observation dates based on water column stability for a lower bound, and laboratory analysis of water samples for a more conservative (higher) value to use as a model initial condition. The suspended mass estimates in Quesnel Lake are reproduced in Table 5.1, along with the conversion to cubic metres based on an assumed mineral density of 2650 kg/m^3. Even the highest estimate of suspended sediment is only 0.025 million m^3 –small compared with the erosional and depositional volumes measured and estimated throughout this report.

Table 5.1: Suspended Sediment Mass

	Lower Bound (kg) (based on stability considerations)	Lower Bound (million m^3)	Model Initial Condition (kg) (based on laboratory analyses)	Model Initial Condition (million m^3)
August 13	28.8 - 37.8 x 106	0.011	65.5 x 106	0.025
September 1	23.7 x 106	0.0089	41.8 x 106	0.016
October 24	7.7 x 106	0.0029	12.4 x 106	0.0047

The three-dimensional hydrodynamic model described in Tetra Tech EBA (2015a) was initialized with the above total suspended mass estimates, based on three sets of observations in August, September and October 2014. Each model implementation simulated the three-dimensional processes of sediment transport, settling and deposition, horizontal and vertical mixing, and river inflows and outflows.

The models using August and September initial conditions, where much of the suspended material was still in the water column near the bottom of the West Basin, provide the most conservative predictions of the material's fate. Figure 5.1 shows a line plot of the modelled mass balance for the time period September 1, 2014 to December 31, 2015. The model was initialized with 41.8 x 10^6 kg (sediment mass corresponding to 0.016 million m^3*)* of suspended sediment distributed throughout the lake based on a weeklong CTD and turbidity profiling program (Section 2.1). Some suspended material had already exited the West Basin via the Cariboo Island sill and was found in the water column between Cariboo and Plato Islands. Therefore the model started with ~18% of the suspended material already in the main body of the lake.

In the months of September and October 2014 a small amount of suspended material exited via the Quesnel River in wind-driven seiche events, where the lower level of the lake tilts to meet the surface at, in this case, the north end. Most of the decrease in the West Basin water column is likely due to wind events driving occasional outflows of material over the Cariboo Island sill, combined with a steady settling of the suspended material in the West Basin, indicated by the exponential decay form of the deposition time series (Figure 5.1).

The mixing of the water column in November and December 2014 brought suspended material to the surface, where it began to flow out the Quesnel River. The cumulative volume of suspended material flowing out the river increased starting in mid-November, and is predicted here and in Tetra Tech EBA (2015a) to stabilize again in spring 2015.

The distribution of material at the end of the 16-month simulation starting September 1 is presented as a pie chart in Figure 5.2. There is a range in the predictions depending on whether the August 13 or September 1 model is used. The models predict that by summer 2015, between 15% and 20% of the original amount of suspended material will have left Quesnel Lake via Quesnel River. 40% to 50% of the material has settled in the West Basin, and 35-40% of the material has been transported to the main body of the lake and either has settled or is in the process of settling, but remains in the water column at low concentrations covering a wide area.

Uncertainty

Uncertainty regarding the amount of suspended material in the water column is discussed in more detail in Tetra Tech EBA (2015a) but in summary the minimum volume estimates are an absolute lower bound, and the modelled initial condition represents an estimate based on turbidity to TSS (total suspended sediment) scatter plots with ±40% scatter around the best fit line.

There is uncertainty regarding the composition of suspended material and its rate of deposition. Comparison of the two models with August 13 and September 1 start dates, and subsequent measurements and volume estimates provide an indication of the suspended volume balance uncertainty.

The September 1 model started with 41.8 x 10^6 kg of sediment suspended in the water column, 35.2 x 10^6 kg of which was in the West Basin. On October 25, the model indicated that 15.9 x 10^6 kg of material remained suspended in the West Basin. The analytical estimate of material in the West Basin water column on the same date was 9.3 x 10^6 kg (Tetra Tech EBA 2015a).

The model validation to observed turbidity in the Quesnel River provides relatively high certainty in the predictions of total flux out the Quesnel River. Therefore, the model's overestimate of material remaining suspended in the West Basin indicates the model likely underestimated either West Basin deposition or transport across the sill. Recent low turbidity observations in the West Basin support the conclusion that more fine suspended material left the West Basin water column via either settling or transport to the main body of the lake.

5.2 Comparison with Natural Sediment Loads

Approximately 20% of the suspended material from the August 13 and September 1 model's initial condition was predicted to exit the lake via the Quesnel River, and another 40% was predicted to cross the sill into the main body of the lake. The August 13 initial condition contained the highest mass, 65.5 x 106 kg, of suspended material; therefore, the model predicted approximately 13 x 106 kg would exit via the river, and 26 x 106 kg would enter the main body of the lake.

Tetra Tech EBA estimated the annual sediment load in the Quesnel River from TSS concentrations reported by Perrin and Blyth (1998). They compiled sediment data and reported median, mean and maximum TSS concentrations in the river as 2.0, 14.55 and 692 mg/L, respectively, from 190 data points. The raw data were not available. These statistics suggest that samples were taken both on and off freshet, possibly year-round. Data available from WSC, up to 2012, indicate the average annual flow in the Quesnel River near Quesnel is about 230 m3/s. At the mean TSS concentration, this annual flow would transport 106 x 106 kg of sediment. Since TSS concentration is usually associated with high flows, use of the average flow and concentration will tend to underestimate the annual sediment load. Therefore, 106 x 106 kg should be considered a lower bound to the river's sediment load.

The modelled discharge of 13 x 106 kg of suspended material to the Quesnel River following the TSF dam failure represents 12% or less of the river's annual sediment load.

Tetra Tech EBA also estimated the annual sediment load entering Quesnel Lake through Niagara Creek, which generates a visible turbidity plume where it enters the lake during freshet. The plume was observed by Potts (2004) to extend 420 m along the shore. James (2004) took samples throughout the lake including within the Niagara Creek plume, and directly measured the sample density as well as water chemistry. Assuming a solids density of 2650 kg/m3, the difference between the Niagara samples' bulk density and liquid density implies a suspended sediment concentration of 81 mg/L. The samples were taken during freshet, on June 23, 2004. Following the hydrologic methods of Potts (2004), the average annual flow in Niagara Creek is estimated to be 29.5 m3/s with a freshet flow around 82 m3/s. Assuming a three-month freshet, James's data suggest an annual sediment load of about 50 x 106 kg may enter Quesnel Lake through Niagara Creek.

The modelled escape of 26 x 106 kg of dilute suspended material from the West Basin into the main body of the lake following the TSF dam failure is about half the amount of suspended sediment discharged into the East Arm annually by Niagara Creek.

6.0 CONCLUSIONS

Tetra Tech EBA used a research vessel equipped with geophysical and survey equipment to measure the bathymetry of the West Basin of Quesnel Lake. An acoustic instrument called a sub-bottom profiler was also used to detect layers of sediment on the lake bottom.

MPMC estimated that 25.0 million m^3 of material was discharged from the TSF as a result of the dam failure. This total was comprised of 10.6 million m^3 of free water, 13.8 million m^3 of tailings solids plus interstitial water, and 0.6 million m^3 of construction materials.

Based on an observed increase in Polley Lake level after the TSF dam failure, MPMC estimated that 6 ± 0.5 million m^3 of water entered Polley Lake.Based on the observed increase in Quesnel Lake level, Tetra Tech EBA estimated that 19.7 ± 1.5 million m^3 of solids and liquids entered Quesnel Lake.

SNC-Lavalin estimated deposition and erosion volumes in the terrestrial affected areas on land based mapping of surface materials, cores, soil pits, trenches and channel cross-sections. Lack of pre-event data imposes some uncertainty on this analysis. The estimated volumes were 1.6 ± 0.3 million m^3 of deposition, predominantly near Polley Lake, and 1.2 ± 0.6 million m^3 of erosion, predominantly in the middle reaches of Hazeltine Creek.

By Tetra Tech EBA's interpretation, the materials released from the TSF were distributed as follows. Of the free water, 6.0 ± 0.5 million m^3 went into Polley Lake, and the remainder went into Quesnel Lake (4.6 ± 0.5 million m^3). Of the construction materials (0.6 million m^3), essentially all were deposited on land. Of the tailings solids and interstitial water, about 1.0 ± 0.3 million m^3 were deposited on land, and the remainder went into Quesnel Lake (12.8 ± 0.3 million m^3). Adding the material scoured from Hazeltine Creek, therefore, the total amount of displaced material that entered Quesnel Lake was 18.6 ± 1.4 million m^3, which agrees, within the bounds of uncertainty, with the volume estimated from the water level increase.

Based on differences between the observed 2001 and 2014 bathymetry in the West Basin, Tetra Tech EBA estimates that approximately 18 ± 5 million m^3 of displaced material deposited below the 100-m contour, as a result of the TSF dam failure event. This volume is expected to decrease over time as the fine sediments consolidate, releasing some of their interstitial water.

Analysis of the underwater lake sideslope shape suggests that about 1.5 ± 0.5 million m^3 of native material was eroded by underwater debris flows. For the purposes of this volume balance, deposition on the underwater lake sideslopes was negligible. Together with tailings solids, interstitial water and scoured Hazeltine material, a total of 15.5 ± 1.4 million m^3 of displaced material likely reached the bottom of the West Basin. This agrees with the observed depositional volume, based on lake water level change, within the range of uncertainty. Some of the discrepancy between the deposition volume estimates may also be explained by the entrainment of additional interstitial water during the debris flows, both on land and under water. The area of event-related infill within the estimated depositional zone is 1.81 km^2 based on data from the bathymetric analysis and sub-bottom profiling of sediment layers.

The volume of material that remained in suspension in the West Basin after the event was estimated by Tetra Tech EBA to be between 0.01 and 0.025 Mm^3 (28.8 to 65.5 x 10^6 kg) based on profiles of temperature and turbidity on August 13, 2014. Tetra Tech EBA's three-dimensional hydrodynamic model predicts that by summer 2015 up to 20% of this material will have exited the lake via Quesnel River, and up to 40% will have been transported to the main body of the lake at low concentration. For comparison, the Quesnel River's natural annual sediment load downstream of Quesnel Lake near Quesnel is at least 8 times the amount of material predicted to have escaped as a result of the TSF dam failure. The natural annual sediment input to the main body of Quesnel Lake via Niagara Creek is approximately double the amount of material predicted to have dispersed into the main body of the lake as a result of the TSF dam failure.

7.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
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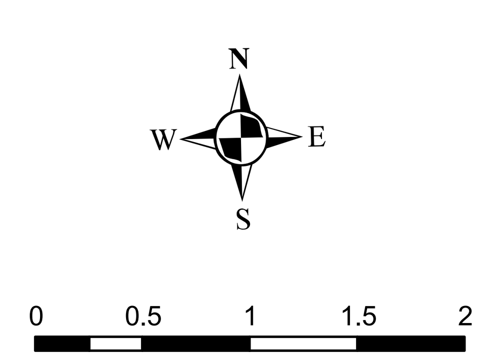
FIGURES

Document Path: D:\Projects\Quesnel_Lake_2014\ArcGIS\maps\Lake_Quesnel_Bathymetry_v3c.mxd



Geodetic Settings	
Horizontal Datum	WGS84
Projection	UTM Zone 10N, Meters
Horizontal Units	Meters
Vertical Units	Meters
Vertical Datum	CGVD28 (HT2_0 geoid)
GPS L1/L2 Corrections	Trimble SPS650 with MarineStar

Survey Equipment	
Bathymetry Sensor	RESON SeaBat 7125
Positioning System	Trimble SPS65x with Omnistar
Heading and Motion Sensors	Applanix POS MV 320, IXBLUE GAPS
USBL	IXBLUE GAPS
Sound Speed Profilers	YSI Castaway, SeaBird SBE-19plus
Dates Surveyed	08/30/14 - 09/06/14

Multibeam Bathymetry

Tetra Tech EBA
Oceanic Plaza, 9th Fl.
1066 W. Hastings St.
Vancouver, BC V6E 3X2

TETRA TECH

Crew Chief:	Richard Funk	
Drafted by:	Burr Bridge	FIGURE
Reviewed by:	Robert Feldpausch	2.1

Notes:
1. Survey period: 08/30/14 - 09/06/14

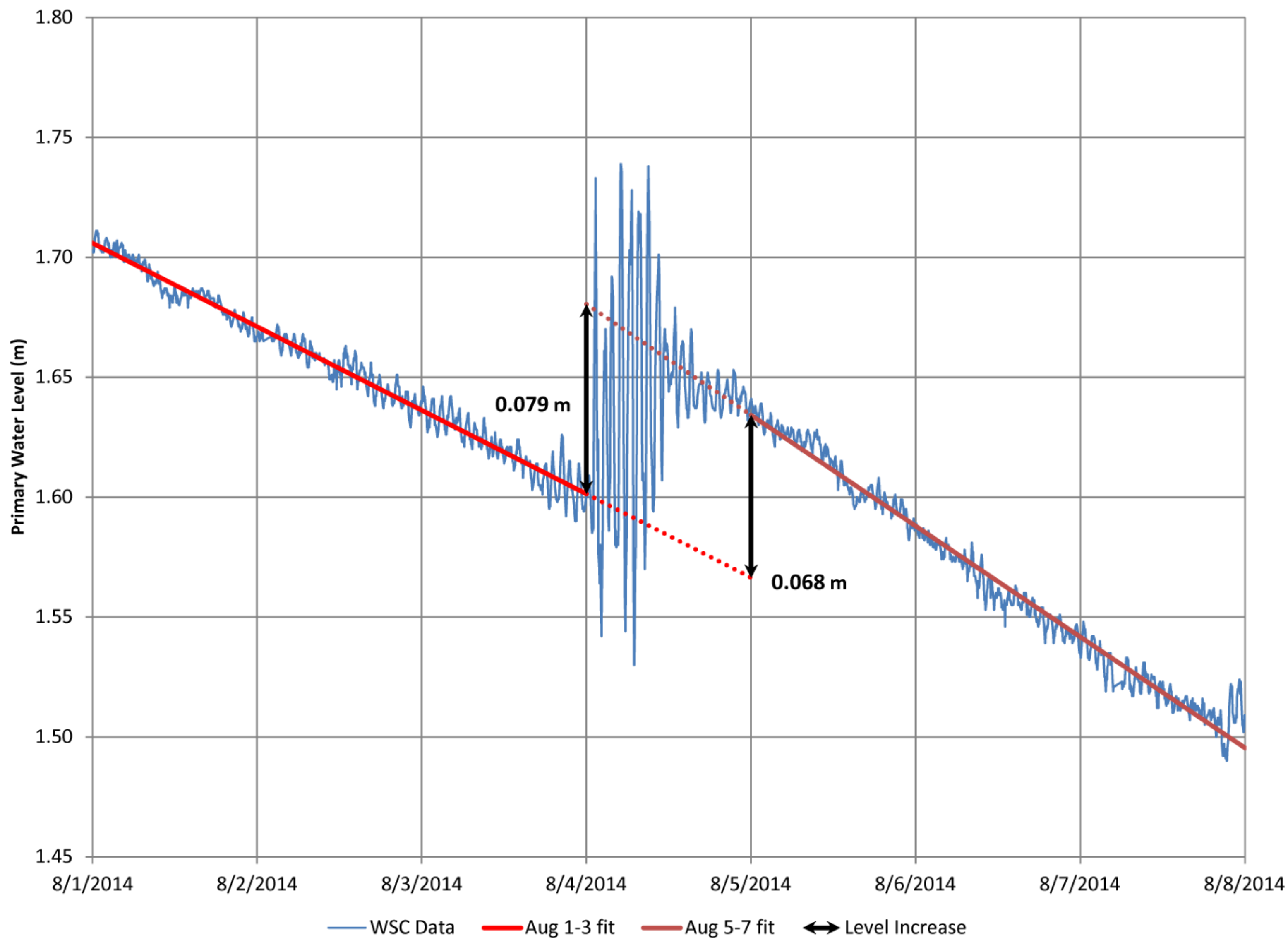
Geodetic Settings		Survey Equipment	
Horizontal Datum	WGS84	**Bathymetry Sensor**	RESON SeaBat 7125
Projection	UTM Zone 10N, Meters	**Positioning System**	Trimble SPS65x with Omnistar
Horizontal Units	Meters	**Heading and Motion Sensors**	Applanix POS MV 320, IXBLUE GAPS
Vertical Units	Meters	**USBL**	IXBLUE GAPS
Vertical Datum	CGVD28 (HT2_0 geoid)	**Sound Speed Profilers**	YSI Castaway, SeaBird SBE-19plus
GPS L1/L2 Corrections	Trimble SPS650 with MarineStar	**SideScan/Sub-Bottom Profiler**	Edgetech 2000DSS

Multibeam Bathymetry / Side Scan Imagery

Tetra Tech EBA
Oceanic Plaza, 9th Fl.
1066 W. Hastings St.
Vancouver, BC V6E 3X2

TETRA TECH

Crew Chief:	Richard Funk	
Drafted by:	Burr Bridge	Figure
Reviewed by:	Robert Feldpausch	2.2



NOTES

Fit lines show lake level trend in the three days before and three days after the TSF breach incident.

Data are from the WSC Gauge: QUESNEL LAKE NEAR LIKELY (08KH011)

STATUS
ISSUED FOR USE

CLIENT

MPMC

TETRA TECH EBA

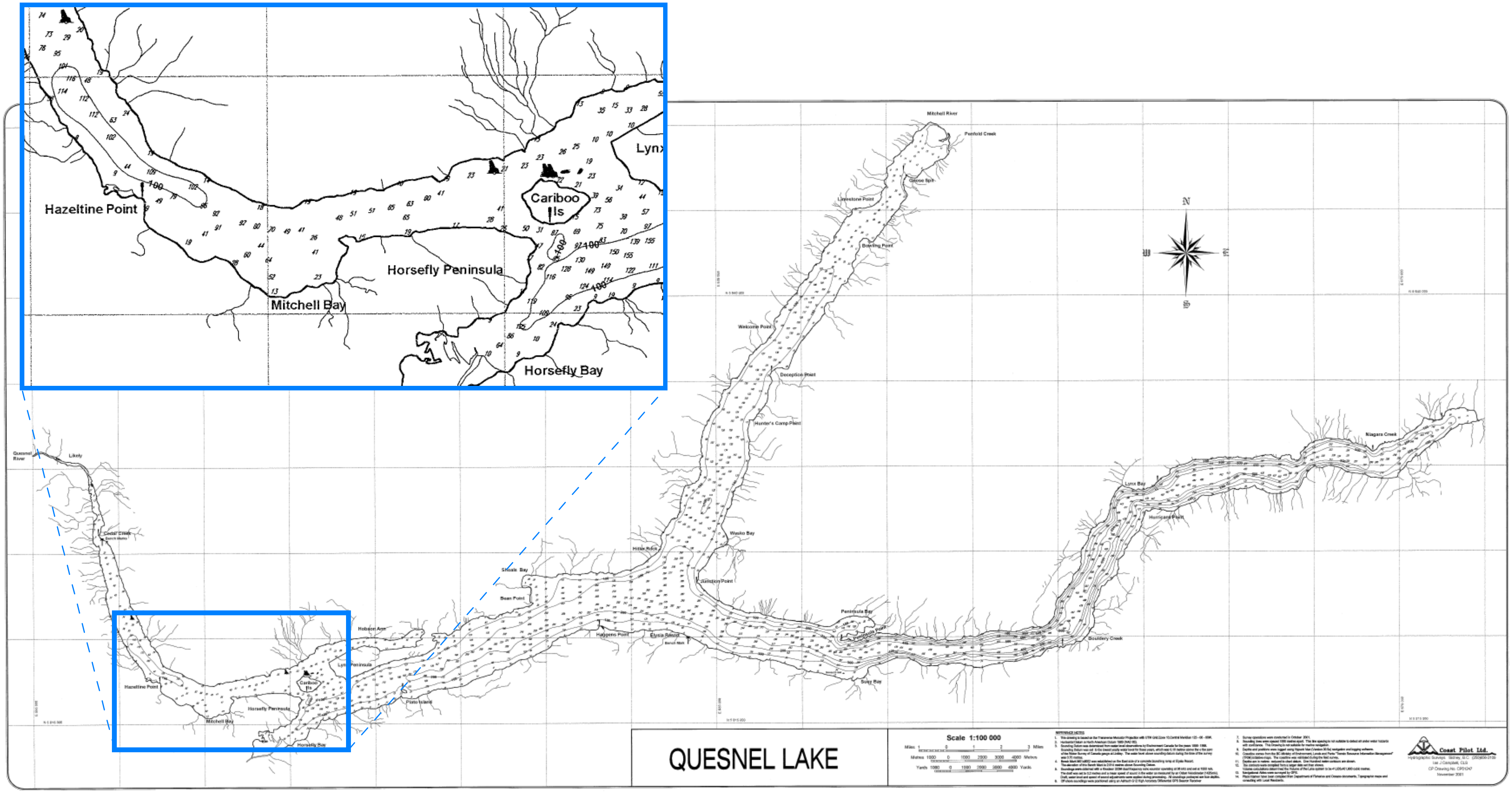
BATHYMETRY ANALYSIS AND VOLUME BALANCE

Increase in Quesnel Lake Level on August 4, 2014

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	DP	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	March 11, 2015

Figure 3.1



NOTES

REFERENCE NOTES

1. This drawing is based on the Transverse Mercator Projection with UTM Grid Zone 10,Central Meridian 123 - 00 - 00W.
2. Horizontal Datum is North American Datum 1983 (NAD 83).
3. Sounding Datum was determined from water level observations by Environment Canada for the years 1956- 1999. Sounding Datum was set to the lowest yearly water level for these years, which was 0.10 metres above the e the zero of the Water Survey of Canada gauge at Lickley. The water level above sounding datum during the time of the survey was 0.70 metres.
4. Bench Mark M01c9002 was established on the East side of a concrete launching ramp at Elysia Resort. The elevation of this Bench Mark is 2.914 metres above Sounding Datum.
5. Soundings were obtained with a Knudsen 320M dual frequency echo sounder operating at 38 kHz and set at 1500 m/s. The draft was set to 0.2 metres and a mean speed of sound in the water as measured by an Odom Velocimeter (1425m/s). Draft, water level and speed of sound adjustments were applied during processing. All soundings portrayed are true depths.
6. Off-shore soundings were positioned using an Ashtech G12 High Accuracy Differential GPS Beacon Receiver
7. Survey operations were conducted in October 2001.
8. Sounding lines were spaced 1000 metres apart. This line spacing is not suitable to detect all under water hazards with confidence. This Drawing is not suitable for marine navigation.
9. Depths and positions were logged using Hypack Max (Version 00.5a) navigation and logging software.
10. Coastline comes from the BC Ministry of Environment, Lands and Parks "Terrain Resource Information Management" (TRIM) initiative maps. The coastline was validated during the field survey.
11. Depths are in metres reduced to chart datum. One Hundred metre contours are shown.
12. The contours were compiled from a larger data set than shown. Volume calculations determined the Volume of the Lake system to be 41,533,401,900 cubic metres.
13. Navigational Aides were surveyed by GPS.
14. Place Names have been compiled from Department of Fisheries and Oceans documents, Topographic maps and consulting with Local Residents.

Source: Coast Pilot, Ltd., 2001. Notes reproduced directly from source.

STATUS
ISSUED FOR USE

CLIENT
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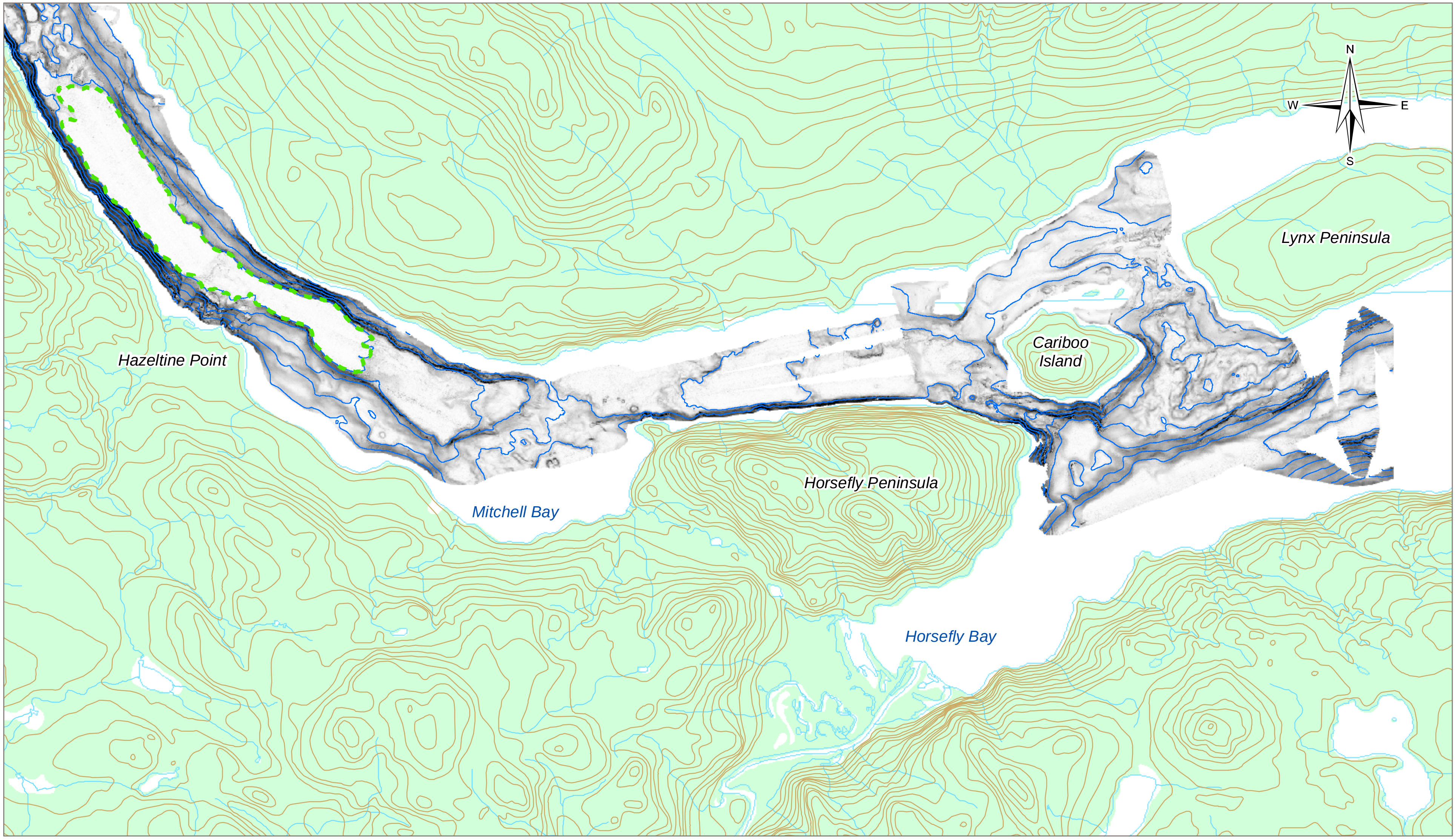
BATHYMETRY ANALYSIS AND VOLUME BALANCE

Quesnel Lake Bathymetric Map 2001

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	DP	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	March 4, 2015

Figure 4.1



LEGEND

- Estimated Deposition Zone
- Depth Contour (20 m)
- Contour
- Watercourse
- Waterbody
- Vegetation

Slope (Degrees)
High : 35
Low : 0

NOTES
1. Vertical datum is the zero on the WSC lake level gauge at Likely
2. Base data source: CanVec 1:50,000 Topo Data and Tetra Tech 2014 Bathymetry Survey

STATUS
ISSUED FOR USE

Scale: 1:60,000
1 0.5 0 1
Kilometres

PROJECTION	DATUM
UTM Zone 10	NAD83

FILE NO.
V13203212-01_Figure04-2.mxd

CLIENT

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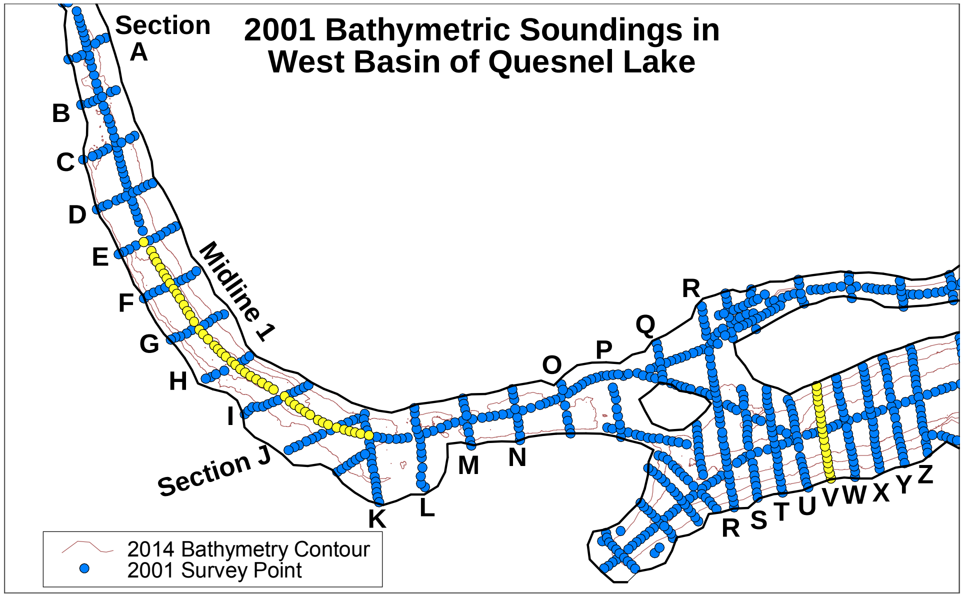
BATHYMETRY ANALYSIS AND VOLUME BALANCE

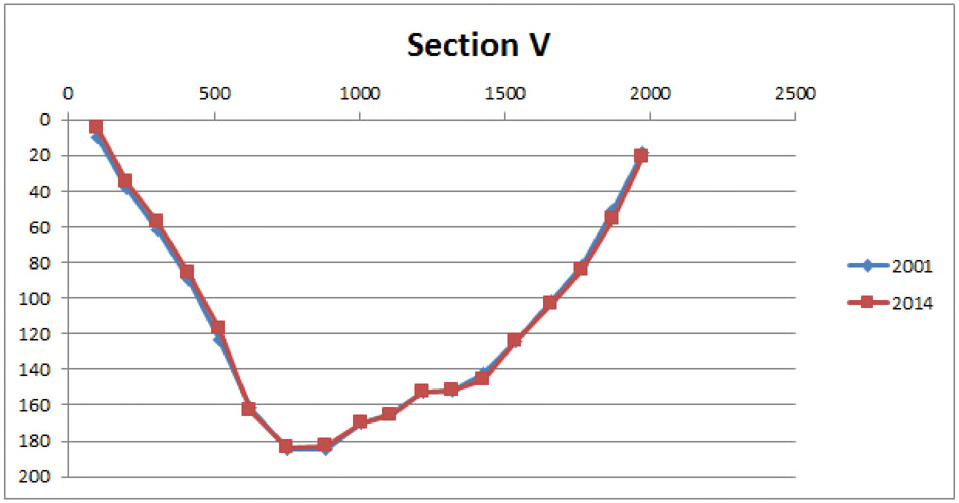
Bathymetry and Slope Map of West Basin from 2014 Survey

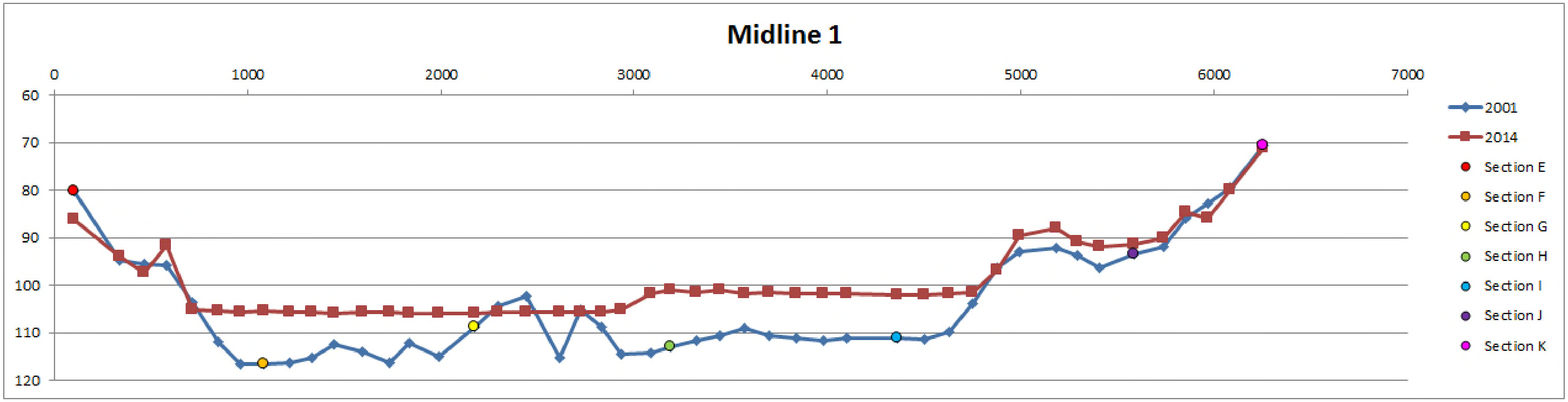
PROJECT NO.	DWN	CKD	APVD	REV
V13203212	MEZ	SL	JR	0

OFFICE	DATE
Tt EBA-VANC	May 28, 2015

Figure 4.2







NOTES

Section depths and distances are in metres.
The vertical datum is the zero of the WSC lake level gauge at Likely.
Horizontal distances are measured from an arbitrary point.

Inset map shows locations of 2001 bathymetry survey points, with sections labeled.
Contours are 2014 depths at 50-m intervals.

STATUS
ISSUED FOR USE

CLIENT
MPMC

TETRA TECH EBA

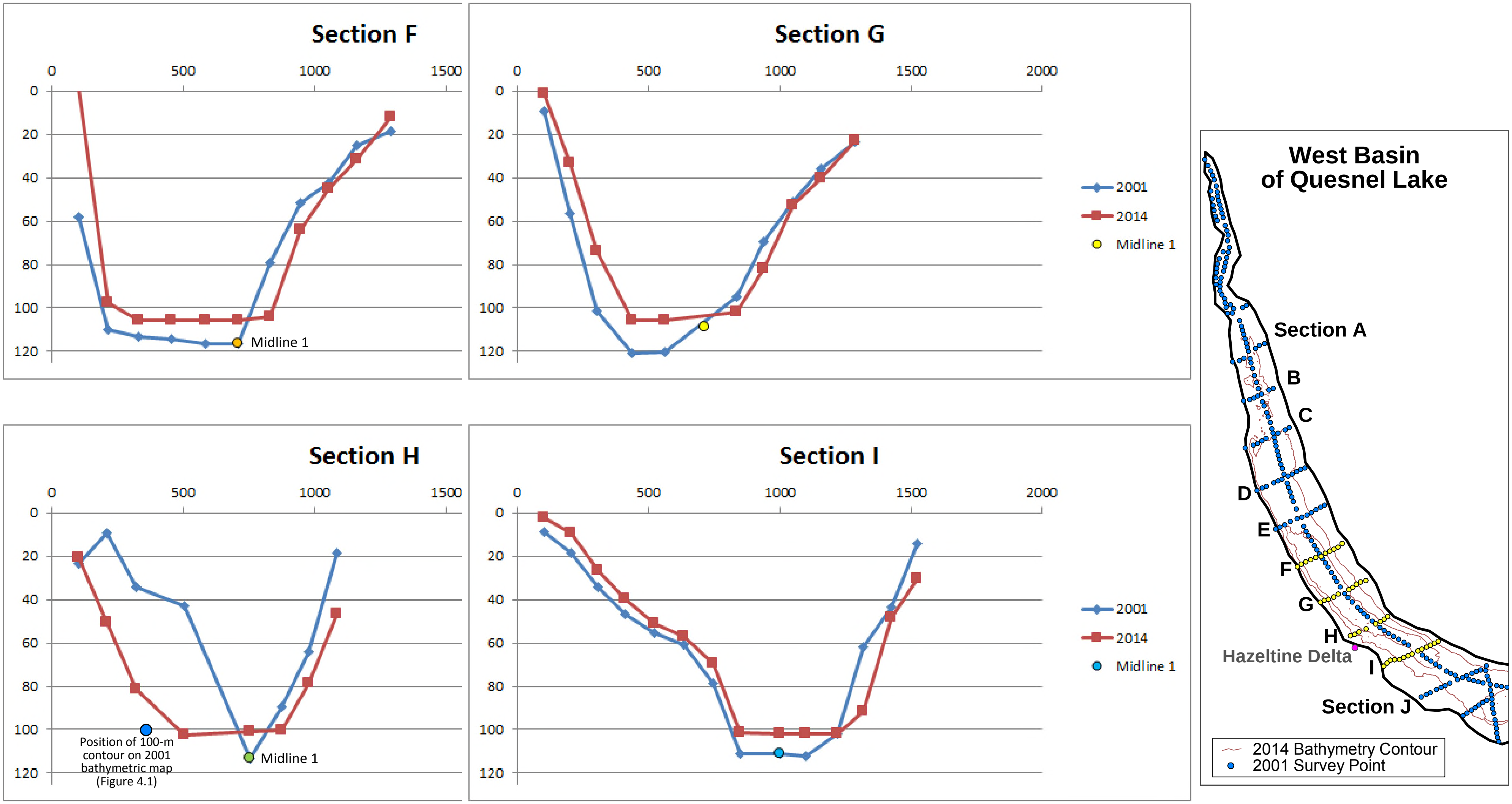
BATHYMETRY ANALYSIS AND VOLUME BALANCE

Bathymetry Comparison: 2001 Versus 2014 Data

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	DP	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	April 30, 2015

Figure 4.3



NOTES

Section depths and distances are in metres.
The vertical datum is the zero of the WSC lake level gauge at Likely.
Horizontal distances are measured from an arbitrary point, from west to east.

Inset map shows locations of 2001 bathymetry survey points, with sections labeled. The survey sections are spaced approximately 1 km apart.
Contours are 2014 depths at 50-m intervals.

STATUS
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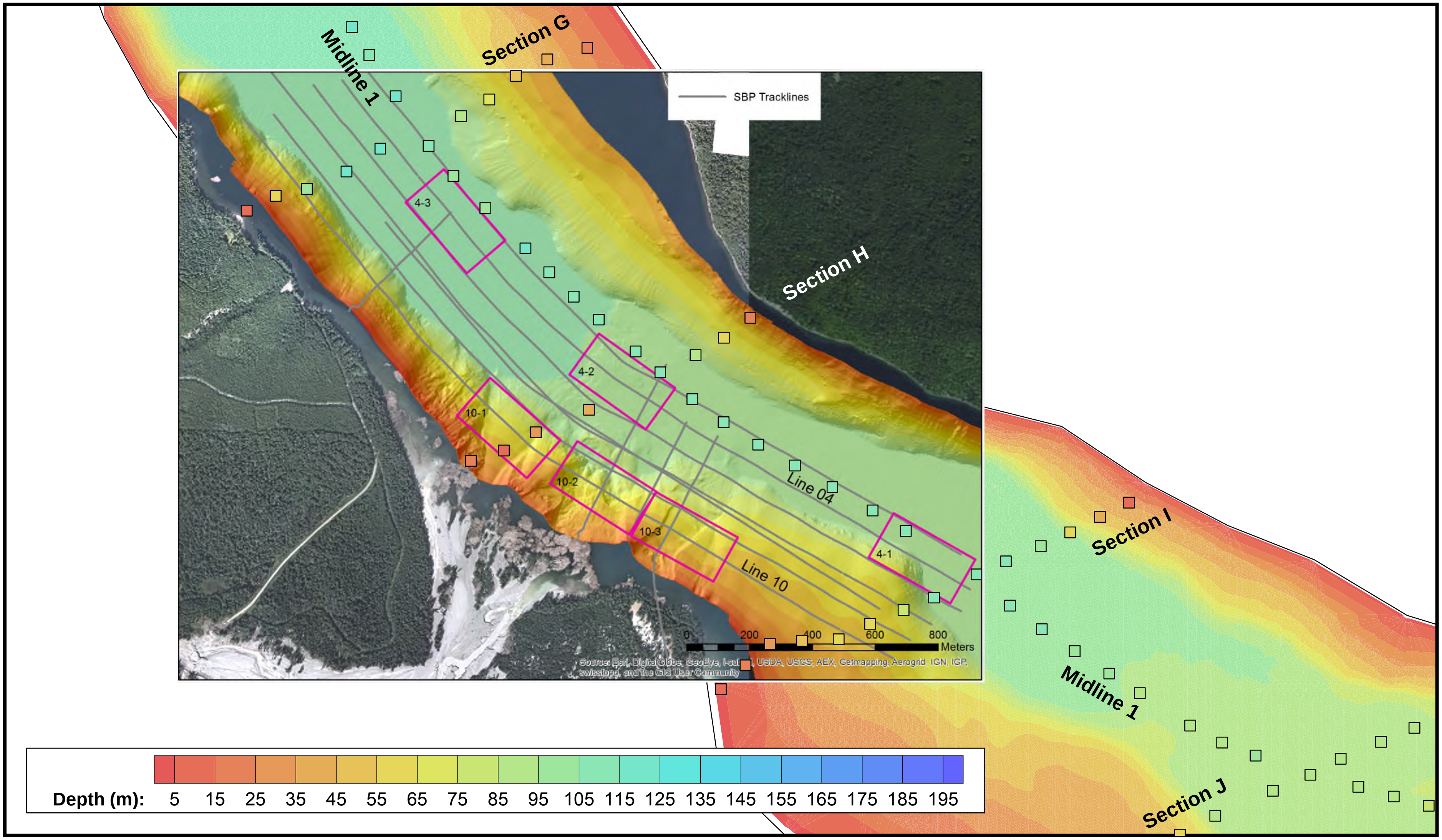
BATHYMETRY ANALYSIS AND VOLUME BALANCE

Bathymetry Comparison in West Basin 2001 Versus 2014 Data

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	DP	JAS	JAS	1

OFFICE	DATE
Tetra Tech EBA - VANC	April 30, 2015

Figure 4.4



NOTES

- Bathymetric sounding from 2001
- Multibeam bathymetry from 2014
- Sub-bottom profiler trackline
- 4-1 Sub-bottom profile data discussed in reporting

Bathymetric colour scale was selected to match the elevation scale in Figure 2.1

STATUS
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CLIENT
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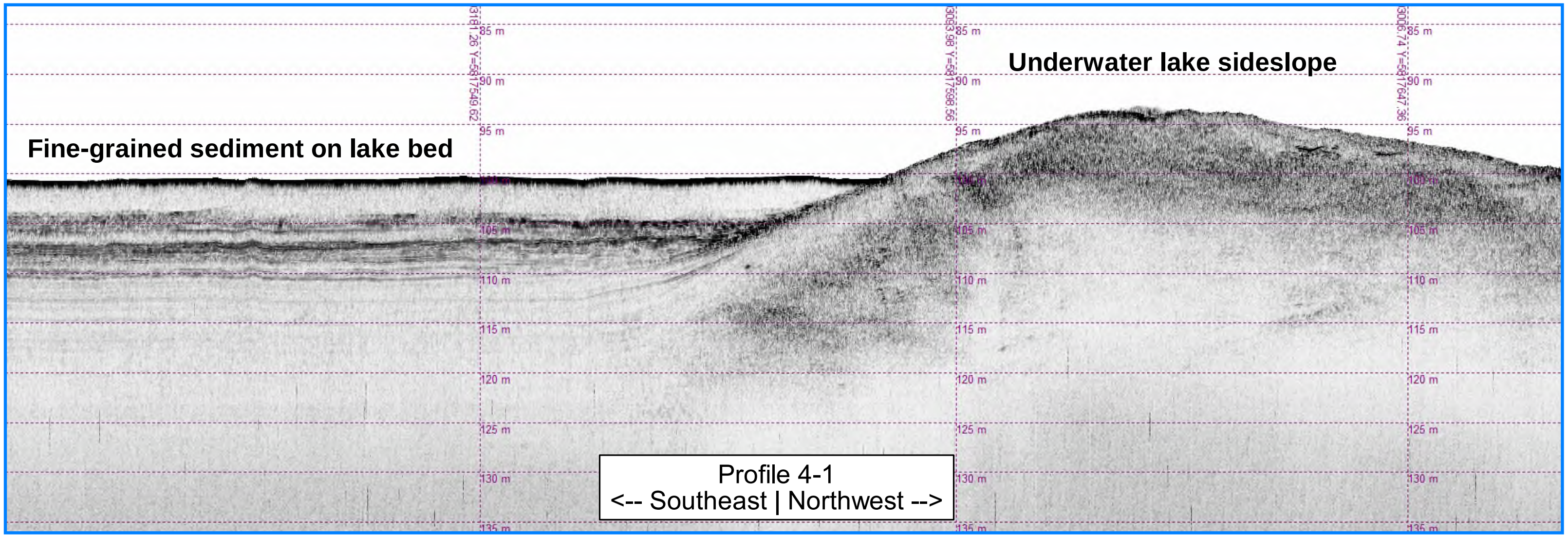
BATHYMETRY ANALYSIS AND VOLUME BALANCE

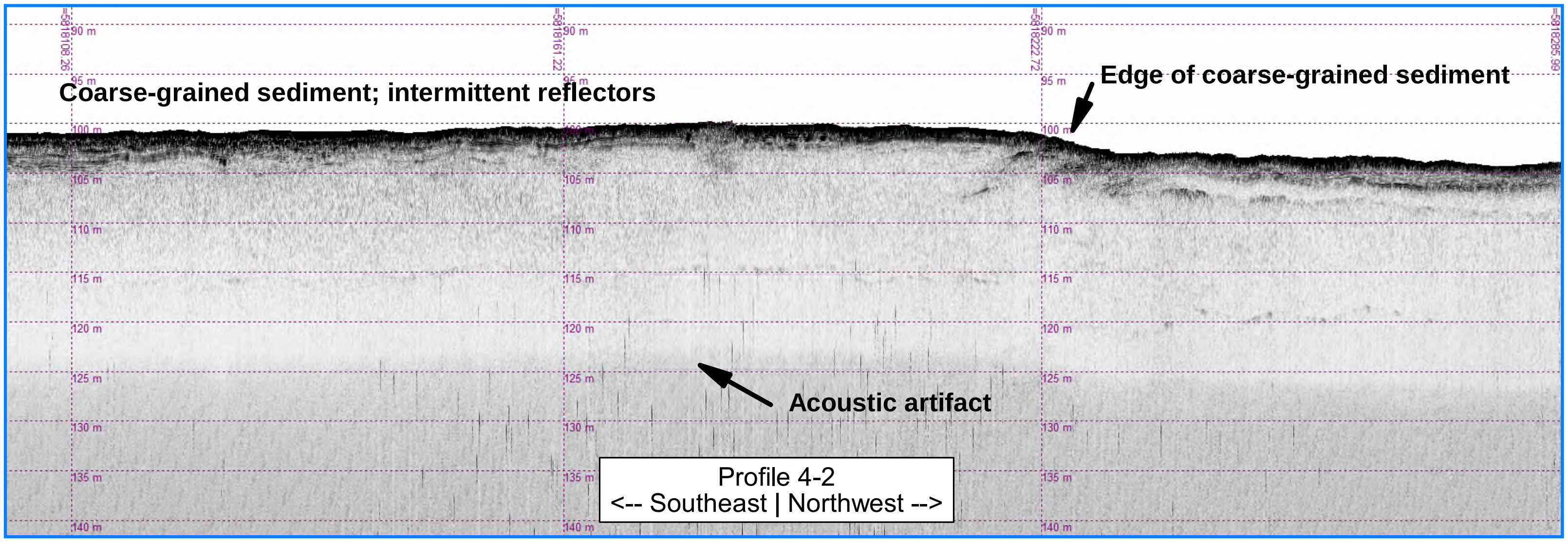
Overlay of 2001 and 2014 Bathymetry Data Sets

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	DP	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	April 27, 2015

Figure 4.5





NOTES

Images collected and interpreted by Tetra Tech Marine Mapping Group (Bothell, WA)

See Figure 4.5 for profile location map.

STATUS
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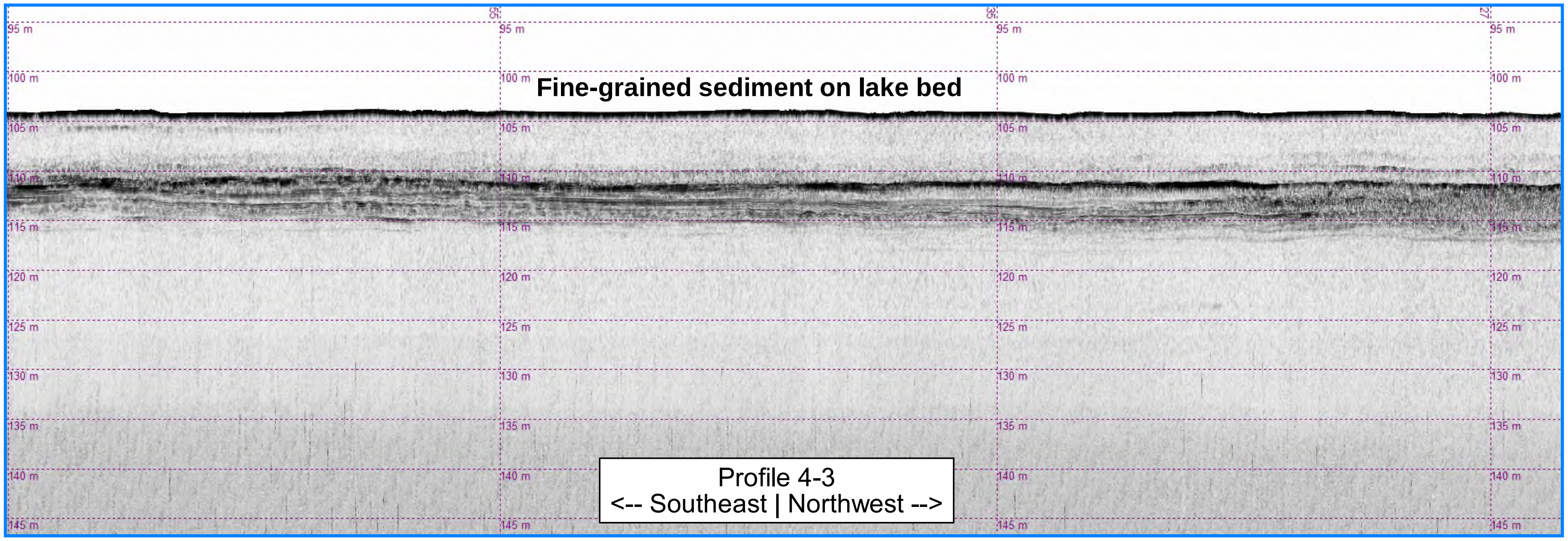
BATHYMETRY ANALYSIS AND VOLUME BALANCE

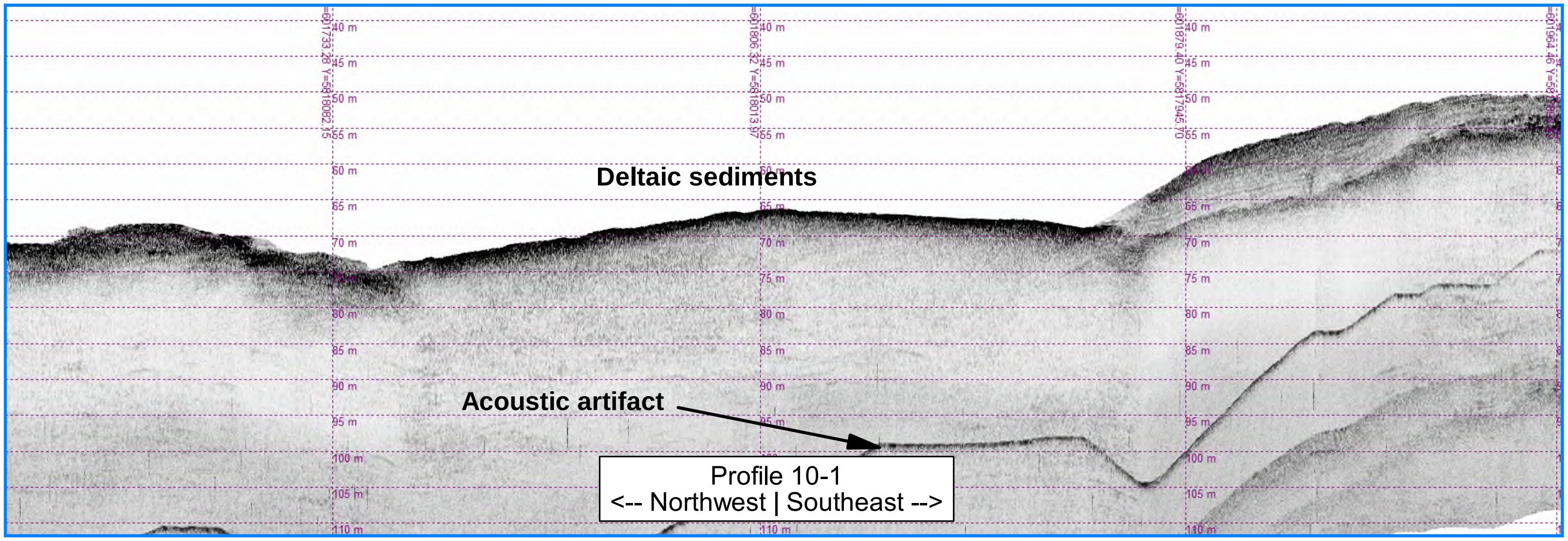
Sub-bottom Profiles 4-1 and 4-2

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	DP	JR	JAS	1

OFFICE	DATE
Tetra Tech EBA - VANC	May 21, 2015

Figure 4.6





NOTES

Images collected and interpreted by Tetra Tech Marine Mapping Group (Bothell, WA)

See Figure 4.5 for profile location map.

STATUS
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CLIENT
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TETRA TECH EBA

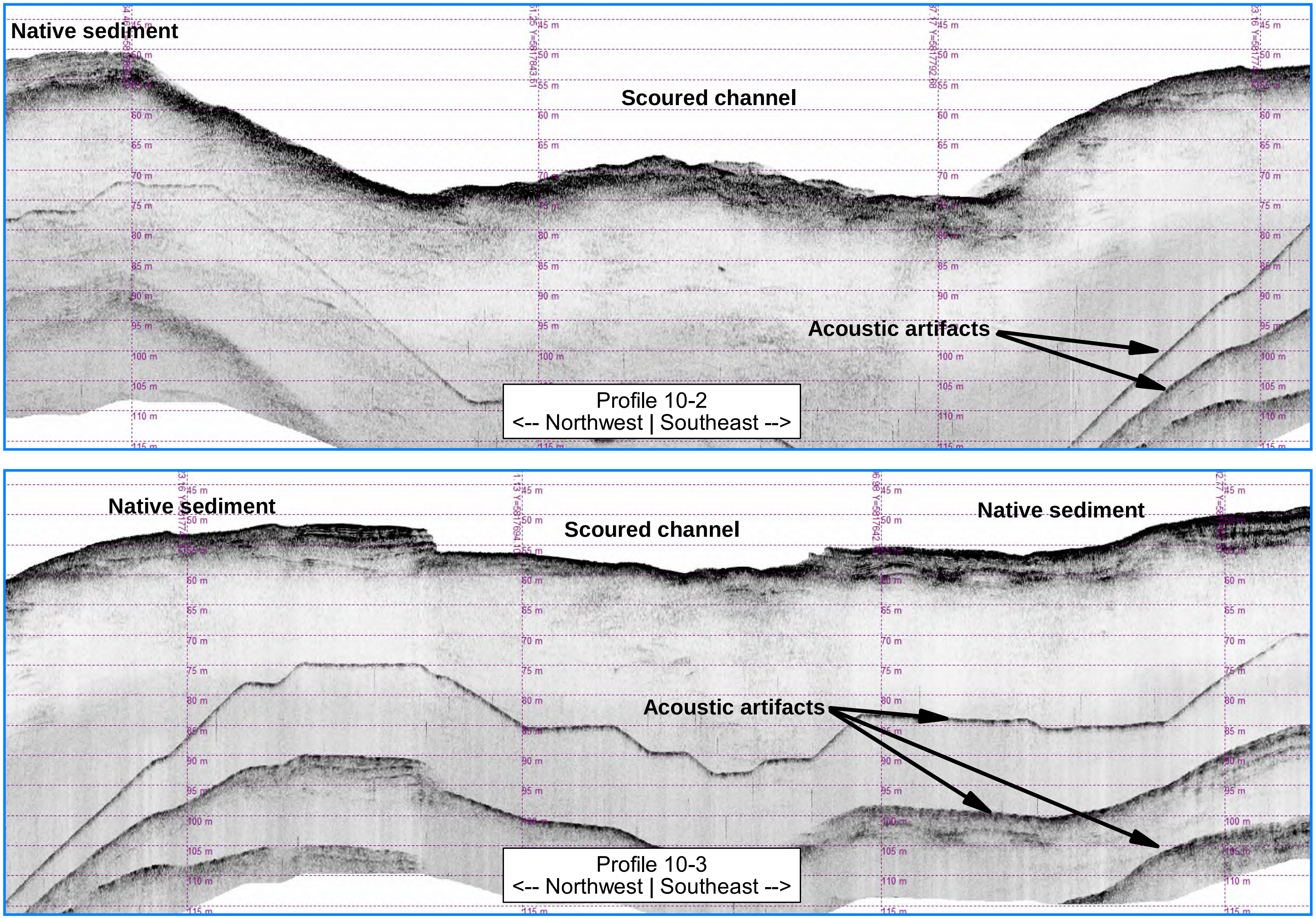
BATHYMETRY ANALYSIS AND VOLUME BALANCE

Sub-bottom Profiles 4-3 and 10-1

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	DP	JR	JAS	1

OFFICE	DATE
Tetra Tech EBA - VANC	May 21, 2015

Figure 4.7



NOTES

Images collected and interpreted by Tetra Tech Marine Mapping Group (Bothell, WA)

See Figure 4.5 for profile location map.

STATUS
ISSUED FOR USE

CLIENT
MPMC

TETRA TECH EBA

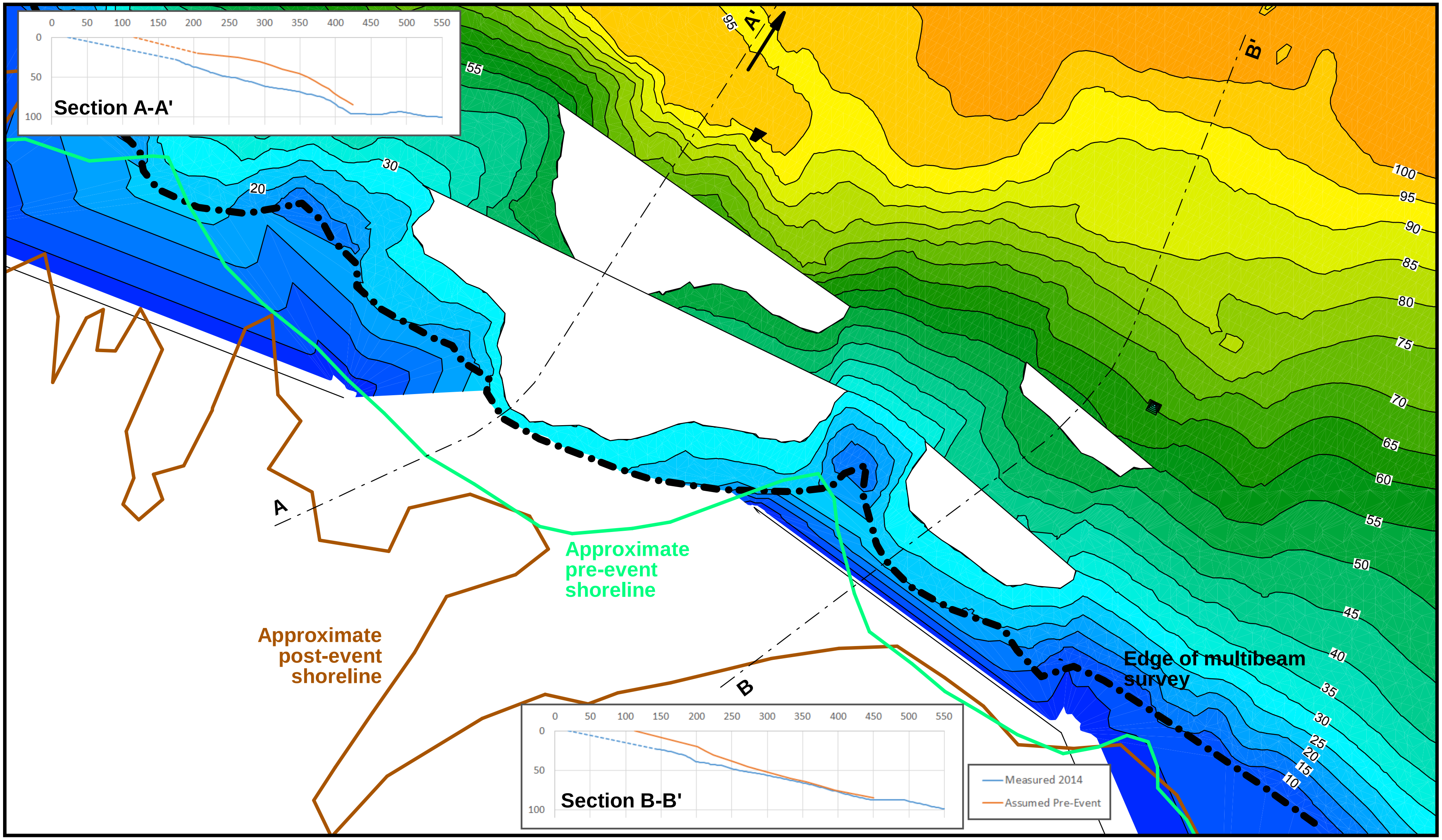
BATHYMETRY ANALYSIS AND VOLUME BALANCE

Sub-bottom Profiles 10-2 and 10-3

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	DP	JR	JAS	1

OFFICE	DATE
Tetra Tech EBA - VANC	May 21, 2015

Figure 4.8



NOTES

White polygons delineate the presumed missing area from scour channels at their specific depths.

Insets show vertical profiles along the two labeled section lines.

STATUS
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CLIENT
MPMC

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BATHYMETRY ANALYSIS AND VOLUME BALANCE

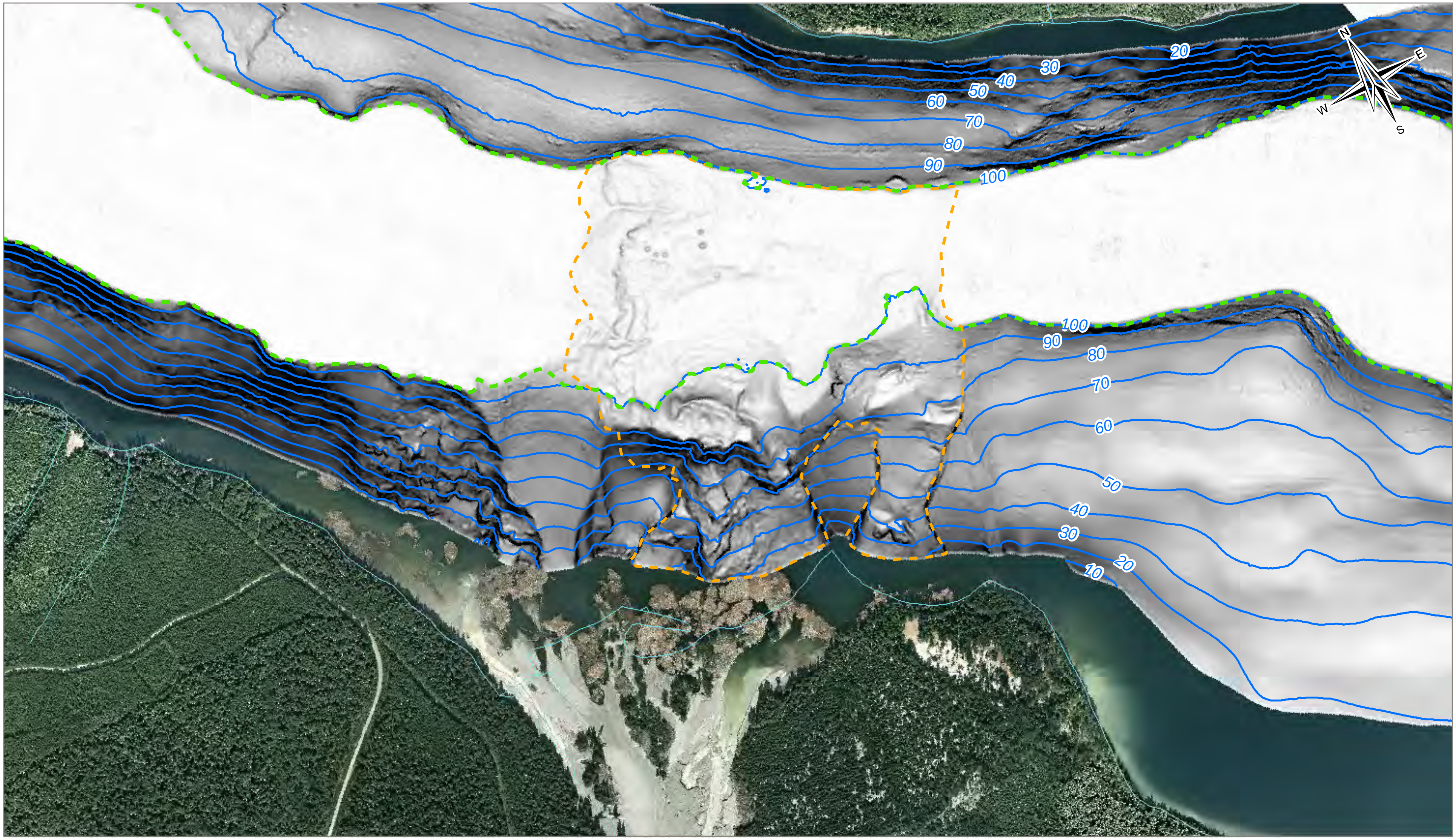
Illustration of Underwater Lake Sideslope Scour Volume Estimation

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	DP	JAS	JAS	1

OFFICE	DATE
Tetra Tech EBA - VANC	May 27, 2015

Figure 4.9

Q:\Vancouver\GIS\ENGINEERING\V132\V13203206-01\Maps\V13203212-01_Figure04-10.mxd modified 5/28/2015 by morgan.zondervan



LEGEND

- Displaced Coarse Material
- Estimated Deposition Zone
- Depth Contour (m)
- Watercourse
- Waterbody

Slope (Degrees)
High : 35
Low : 0

NOTES
1. Vertical datum is the zero on the WSC lake level gauge at Likely
2. Base data source: Imagery provided by MPMC (2014), CanVec 1:50,000 Topo Data, and Tetra Tech 2014 Bathymetry Survey

Scale: 1:10,000
200 100 0 200
Metres

PROJECTION UTM Zone 10
DATUM NAD83
FILE NO. V13203212-01_Figure04-10.mxd
CLIENT

TETRA TECH EBA

STATUS ISSUED FOR USE

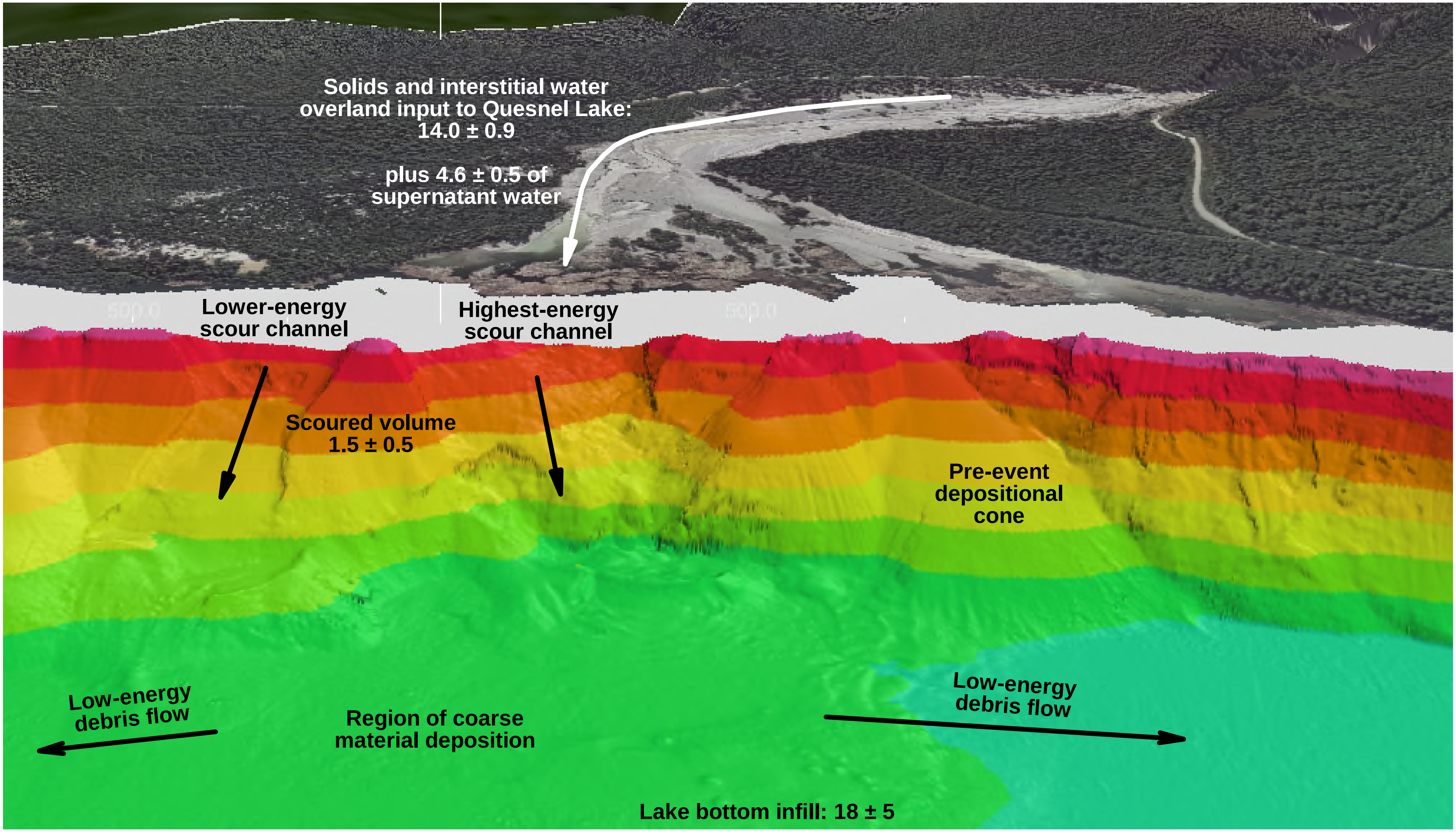
BATHYMETRY ANALYSIS AND VOLUME BALANCE

Bathymetry, Slope and Deposition Delineation

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	MEZ	SL	JR	0

OFFICE Tt EBA-VANC
DATE May 28, 2015

Figure 4.10



NOTES

All volumes in millions of m^3.

The lake bottom infill volume potentially includes entrained supernatant water or lake water, and is subject to consolidation of the fine sediments over time.

This 3-D view was generated using Tetra Tech Bothell's sonar processing software.

STATUS
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CLIENT

MPMC

TETRA TECH EBA

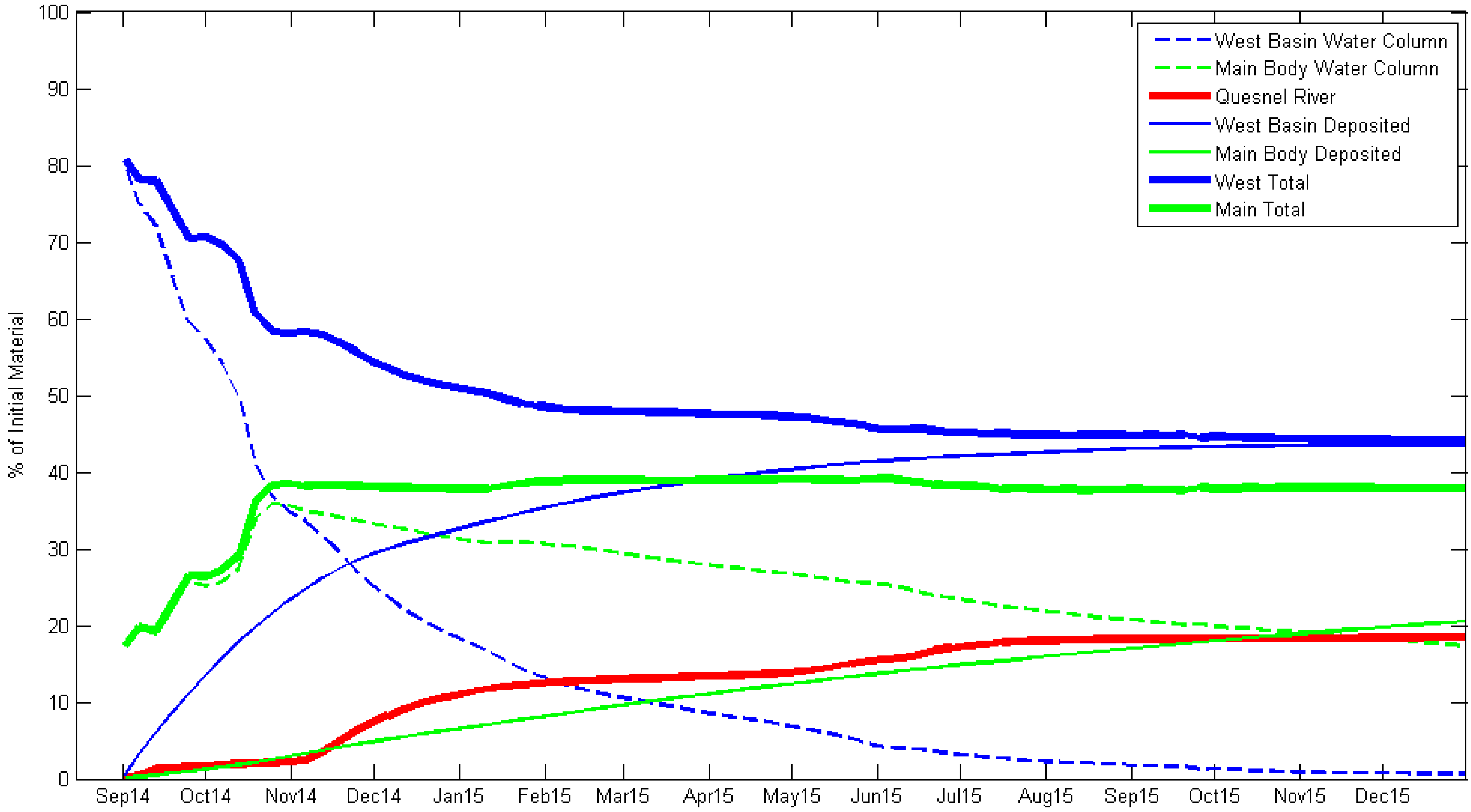
BATHYMETRY ANALYSIS AND VOLUME BALANCE

Three-dimensional Debris Flow Schematic at Hazeltine Delta

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	DP	JR	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 21, 2015

Figure 4.11



NOTES

The line plots show the relative distribution of material with time, as a percentage of the intial modelled suspended material.

The model's initial condition was generated by distributing 41.8 x 10^6 kg of suspended sediment throughout the West Basin and main body of Quesnel Lake based on observed turbidity casts between August 28 and September 6, 2014.

Approximately 80% of the suspended material was in the West Basin of the lake in the model's September 1 initial condition.

STATUS
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MPMC

TETRA TECH EBA

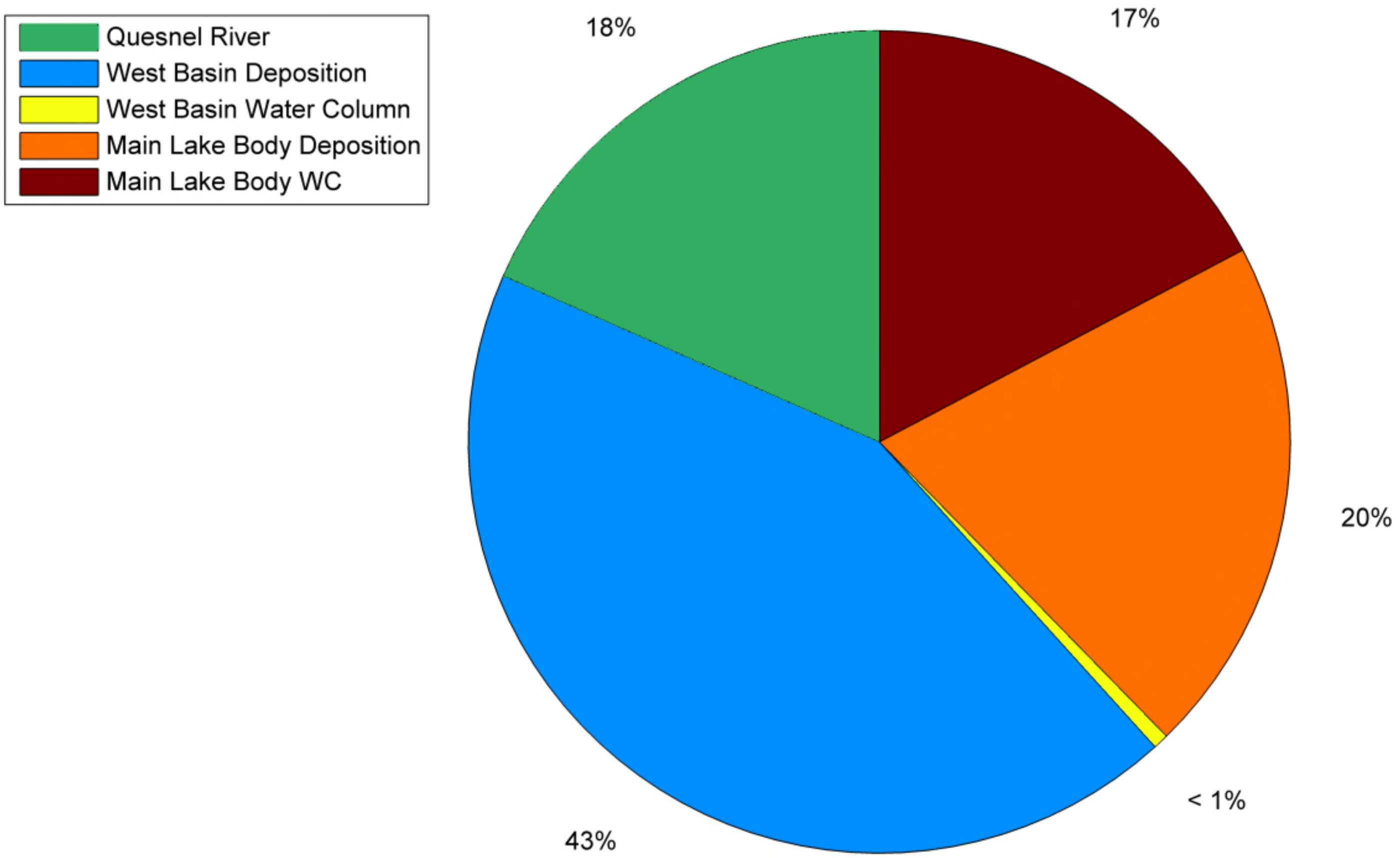
BATHYMETRY ANALYSIS AND VOLUME BALANCE

Modelled Cumulative Sediment Balance September Initial Condition

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	DP	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 5.1



NOTES

The model's initial condition was generated by distributing 41.8 x 10^6 kg of suspended sediment throughout the West Basin and main body of Quesnel Lake based on observed turbidity casts between August 28 and September 6, 2014.

STATUS
ISSUED FOR USE

CLIENT
MPMC

TETRA TECH EBA

BATHYMETRY ANALYSIS AND VOLUME BALANCE

Modelled Sediment Fate from September Initial Condition in December 2015

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	DP	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 5.2

APPENDIX A

TETRA TECH EBA'S GENERAL CONDITIONS

GENERAL CONDITIONS

HYDROTECHNICAL

This report incorporates and is subject to these "General Conditions".

1.0 USE OF REPORTS AND OWNERSHIP

This report pertains to a specific site, a specific development, and a specific scope of work. The report may include plans, drawings, profiles and other supporting documents that collectively constitute the report (the "Report").

The Report is intended for the sole use of Tetra Tech EBA's Client (the "Client") as specifically identified in the Tetra Tech EBA Services Agreement or other Contract entered into with the Client (either of which is termed the "Services Agreement" herein). Tetra Tech EBA does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Report when it is used or relied upon by any party other than the Client, unless authorized in writing by Tetra Tech EBA.

Any unauthorized use of the Report is at the sole risk of the user. Tetra Tech EBA accepts no responsibility whatsoever for any loss or damage where such loss or damage is alleged to be or, is in fact, caused by the unauthorized use of the Report.

Where Tetra Tech EBA has expressly authorized the use of the Report by a third party (an "Authorized Party"), consideration for such authorization is the Authorized Party's acceptance of these General Conditions as well as any limitations on liability contained in the Services Agreement with the Client (all of which is collectively termed the "Limitations on Liability"). The Authorized Party should carefully review both these General Conditions and the Services Agreement prior to making any use of the Report. Any use made of the Report by an Authorized Party constitutes the Authorized Party's express acceptance of, and agreement to, the Limitations on Liability.

The Report and any other form or type of data or documents generated by Tetra Tech EBA during the performance of the work are Tetra Tech EBA's professional work product and shall remain the copyright property of Tetra Tech EBA.

The Report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of Tetra Tech EBA. Additional copies of the Report, if required, may be obtained upon request.

2.0 ALTERNATIVE REPORT FORMAT

Where Tetra Tech EBA submits both electronic file and hard copy versions of the Report or any drawings or other project-related documents and deliverables (collectively termed Tetra Tech EBA's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed version archived by Tetra Tech EBA shall be deemed to be the original. Tetra Tech EBA will archive the original signed and/or sealed version for a maximum period of 10 years.

Both electronic file and hard copy versions of Tetra Tech EBA's Instruments of Professional Service shall not, under any circumstances, be altered by any party except Tetra Tech EBA. Tetra Tech EBA's Instruments of Professional Service will be used only and exactly as submitted by Tetra Tech EBA.

Electronic files submitted by Tetra Tech EBA have been prepared and submitted using specific software and hardware systems. Tetra Tech EBA makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

3.0 STANDARD OF CARE

Services performed by Tetra Tech EBA for the Report have been conducted in accordance with the Services Agreement, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Report.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of Tetra Tech EBA.

4.0 ENVIRONMENTAL AND REGULATORY ISSUES

Unless expressly agreed to in the Services Agreement, Tetra Tech EBA was not retained to investigate, address or consider, and has not investigated, addressed or considered any environmental or regulatory issues associated with the project.

5.0 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with Tetra Tech EBA with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for Tetra Tech EBA to properly provide the services contracted for in the Services Agreement, Tetra Tech EBA has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

6.0 INFORMATION PROVIDED TO TETRA TECH EBA BY OTHERS

During the performance of the work and the preparation of this Report, Tetra Tech EBA may have relied on information provided by persons other than the Client.

While Tetra Tech EBA endeavours to verify the accuracy of such information, Tetra Tech EBA accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

7.0 GENERAL LIMITATIONS OF REPORT

This Report is based solely on the conditions present and the data available to Tetra Tech EBA at the time the Report was prepared.

The Client, and any Authorized Party, acknowledges that the Report is based on limited data and that the conclusions, opinions, and recommendations contained in the Report are the result of the application of professional judgment to such limited data.

The Report is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present at or the development proposed as of the date of the Report requires a supplementary investigation and assessment.

It is incumbent upon the Client and any Authorized Party, to be knowledgeable of the level of risk that has been incorporated into the project design, in consideration of the level of the hydrotechnical information that was reasonably acquired to facilitate completion of the design.

The Client acknowledges that Tetra Tech EBA is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

8.0 JOB SITE SAFETY

Tetra Tech EBA is only responsible for the activities of its employees on the job site and was not and will not be responsible for the supervision of any other persons whatsoever. The presence of Tetra Tech EBA personnel on site shall not be construed in any way to relieve the Client or any other persons on site from their responsibility for job site safety.

APPENDIX B

TETRA TECH BOTHELL MARINE MAPPING REPORT

Mount Polley Tailings Fate Survey

Prepared for:

Prepared by:

TETRA TECH

19803 North Creek Parkway

Bothell, WA 98011

August – September 2014

Mount Polley Tailings Fate Survey

Prepared for:

Prepared by:

TETRA TECH

19803 North Creek Parkway

Bothell, WA 98011

August-September 2014

Contents

Appendices

Tables

Figures

1. Overview and Scope of Work

Tetra Tech was contracted by MPMC to conduct a geophysical survey in Quesnel Lake, British Columbia to map the bottom and water column to provide data to assist in determining the quantity and distribution of mine tailing material that had escaped from the Mount Polley tailings pond into the lake. The survey was performed between August 30 and September 6, 2014 using two vessels. The survey included the area around the material outflow near Hazeltine Point, northwest past Cedar Point Provincial Park, east to the area around Cariboo Island, with reconnaissance level survey extending further east. The primary goals of the survey work were to:

- Perform a multibeam bathymetry, side-scan sonar imagery and sub-bottom profiler survey of the project area to map lake floor bathymetry, areas of deposition and other surficial features of interest;
- perform acoustic imagery, conductivity, temperature and depth (CTD) and turbidity sensor measurements through the water column to map suspended sediment levels; and
- support bottom sampling to map the distribution of tailings deposition on the lake floor.

2. Equipment

Tetra Tech mobilized two survey launches to Lake Quesnel to conduct the geophysical investigation; the R/V Storm, a 21 foot aluminum jet boat, and the R/V Ugle Duckling, a 37 foot aluminum vessel. The larger vessel was equipped with an A frame and oceanographic winch to support towed sensor operations.

The primary equipment mobilized onto the survey vessels included a multibeam echosounder sonar, side-scan sonar, sub-bottom profiler, acoustic Doppler current profiler (ADCP), CTD/turbidity sensor systems, and towfish and vessel positioning equipment. These systems and the ancillary positioning and vessel attitude systems that were used to conduct the seabed mapping are listed in Table 1 and discussed in more detail in Section 3.

Table 1. Survey Equipment

Primary Equipment	Make/Model
Multibeam	RESON SeaBat 7125
Side-scan Sonar	EdgeTech 2000-DSS 100/600kHz chirp
Sub-bottom Profiler	EdgeTech 2000-DSS 2-16kHz chirp
ADCP	600 kHz Teledyne RDI Workhorse Sentinel

USBL	IXBLUE GAPS
Positioning Systems	Applanix POS/MV 320, Trimble SPS65x with OmniStar
Heading, and Motion Reference Systems	Applanix POS/MV 320, IXBLUE GAPS
CTD with Turbidity	Seabird 19 Plus, YSI CastAway
Grab Sampler	WILDCO Standard Ponar (or similar)

3. Field Operations

This section describes the vessels and equipment configurations for the two vessels mobilized to perform the geophysical survey.

3.1 R/V Storm

The R/V Storm was configured with a Teledyne RDI ADCP system to measure current velocities through the water column to aid in modeling sediment transport. The ADCP also provided water column acoustic imagery to aid in mapping suspended sediments. A combination CTD and turbidity sensor, which was lowered through the water column on a line, was deployed at a large number of locations to map the water column turbidity and associated water conditions (conductivity, temperature and depth). All data were geo-referenced using a differential global positioning system (DGPS) mounted on the vessel.

3.2 R/V Ugle Duckling

The R/V Ugle Duckling was configured with a RESON SeaBat 7125 multibeam sonar and an Applanix POS MV GPS aided inertial navigation system (INS) to provide vessel attitude, heading and position. Its equipment suite also included an IXBLUE Global Acoustic Positioning System (GAPS) ultra-short baseline (USBL) acoustic positioning system and GPS aided inertial navigation system used for tracking the towfish containing the side-scan imagery sonar and sub-bottom profiler. A Trimble SPS 650 series GPS provided corrections from the Trimble Marine Star system to the Applanix system to further improve positional accuracy. Mid-way through the survey, the GAPS INS, aided by the Trimble DGPS on the vessel, replaced the POS for primary vessel attitude corrections. Table 2 provides the offsets used for the HYPACK and HYSWEEP hardware setup and CARIS multibeam data processing software.

Table 2. R/V Ugle Duckling Sensor Offsets (in meters)

Sensor	Across (Starboard Positive)	Along (Forward Positive)	Vertical (Down Positive)
IXBLUE GAPS	1.800	-0.652	0.593

SeaBat 7125	-1.817	-0.625	0.821
Trimble SPS651	-1.805	-0.752	-2.619

The GAPS USBL also provided positioning for the towfish used to collect sidescan sonar imagery and sub-bottom profiler data. The Edgetech 2000-DSS towfish was configured with a dual frequency 100/600 kHz chirp side-scan system and a 2 to 16 kHz chirp sub-bottom profiler. The towfish was deployed from the vessel and dynamically flown approximately 10 to 20 meters above the bottom using the oceanographic winch mounted on the back deck of the vessel. During survey operations, the vessel also employed three CTD systems, one of which was configured with a turbidity sensor, to provide sound speed versus depth measurements needed for multibeam survey operations and to augment the water column monitoring being performed by the other vessel (R/V Storm).

3.3 Geodesy Settings

Horizontal (X, Y) positioning data for the project were collected in WGS84 Universal Transverse Mercator (UTM) Zone 10 North. Elevation data were collected CGVD28. The geodesy settings used for the project are presented in Table 3.

Table 3. Survey Geodesy Settings

Parameter	Setting
Horizontal Datum	WGS84
Vertical Datum (Geoid)	CGVD28 (HT2_0 geoid)
Coordinate System	UTM Zone 10N, Meters

4. Data Processing and Analysis

4.1 Geophysical Data Processing and Analysis

Tetra Tech's survey crew performed data processing in parallel with data collection on the vessel, to the extent possible, so that preliminary data products could be used to check data quality and confirm survey coverage. Final data products were prepared in Tetra Tech's offices in Seattle, WA and Vancouver, BC.

4.2 Bathymetry

The RESON SeaBat 7125 multibeam sonar was selected for this project to achieve maximum swath width and resolution given the project parameters. The support sensors used to measure vessel attitude (roll, pitch, and heave), position, and heading were selected to ensure that the associated accuracies were commensurate with the accuracy and resolution of the sonars.

Prior to field data collection, a standard patch test, also known as an installation calibration test, was carried out to calculate the angular offsets between the SeaBat 7125 and the vessel's motion reference units. The installation calibration process is used to derive the roll, pitch and yaw angular offsets between the multibeam sonar and the local reference frame defined by the motion reference unit. The installation calibration tests are also used to determine latency in the positioning equipment. The sonar, positioning system, and data collection computer are all time-synchronized to GPS Universal Coordinated Time (UTC), which should result in zero position latency. Results of the SeaBat 7125 patch test are displayed in Table 4.

Table 4. Multibeam Echosounder Patch Test Results

SeaBat 7125	Value
Roll	1.05 deg.
Pitch	2.35 deg.
Yaw	-1.85 deg.
Latency	0.0 sec.

Tetra Tech also performed a bar check to verify the depth reported by the sonar versus the depth of a target placed in the field of view of the sonar at a measured depth below the waterline. The HYPACK/HYSWEEP Bar Check Utility was used to collect and process the sonar data, correcting for system offsets and vessel attitude. The results are shown in Table 5.

Table 5. Multibeam Echosounder Bar Check Results

Parameter	Value
Bar Depth (m)	3.00
Sonar Measured Depth (m)	3.03
Difference (m)	0.03

The collected bathymetry data were processed with CARIS HIPS software to generate the XYZ soundings in the survey coordinate system and units. Data cleaning was also performed in CARIS HIPS 2D and 3D editing software to eliminate outliers induced by noise in the sensor system or the acoustic environment. A subsequent area-based cleaning, using the merged data from all the survey lines, was then conducted using the CARIS HIPS subset editing tool. Edited sounding data were used to create 2 meter-gridded Combined Uncertainty and Bathymetric

Estimator (CUBE) and uncertainty surfaces. Both types of surfaces were calculated by computing the uncertainty budgets for each sounding, based on beam geometry and the accuracies of the position system(s), motion sensor, and sonar devices, and applying a weight to each sounding based on an estimate of quality. ASCII XYZ files of the gridded BASE surfaces at 2 meter resolution were then exported out of CARIS and are provided in the deliverable digital data (Appendix B).

4.3 Side-scan Sonar

Additional data collected during the project included side-scan imagery sonar and sub-bottom profiler data from the towed EdgeTech 2000-DSS system. These data provided detailed images of features and textures on the lake bed, and information on the subsurface stratigraphy below the profiler.

Side-scan sonar imagery were acquired in proprietary EdgeTech format (JSF) using EdgeTech's Discover acquisition software and then imported into Chesapeake SonarWiz 5 for post-processing. Towfish position from the GAPS USBL was recorded directly into the raw data file and/or HYPACK for geo-referencing all raw data. The SonarWiz processing package was used to remove erroneous navigation points, apply gains and conduct other signal processing, bottom track the data to remove the water column, and prepare the sonar data for final export. The imagery was exported from SonarWiz as 0.25-meter resolution geotiffs and provided with the electronic deliverables in Appendix B and displayed on the charts provided in Appendix A.

4.4 Sub-bottom Profiling

Sub-bottom profiler data were also processed using the SonarWiz software. As with the side-scan sonar files, towfish position was acquired with the GAPS USBL and embedded in the raw data files acquired in the EdgeTech Discover and/or HYPACK programs. The files were recorded in the proprietary EdgeTech JSF format. The sub-bottom profile data were bottom-tracked and gains were applied where appropriate to distinguish different sediment layers on the lake bed where sediment layering was observed.

4.5 ADCP

ADCP data were collected and processed using the Teledyne-RDI WinRiver software. This system transmits a set of four beams at different angles from vertical and measures the Doppler shift vs time from each beam to derive current directions and magnitudes at various depths through the water column. It also tracks the return from the bottom to measure water depths and provides measurements of reflectivity vs depth in the water column that can be used to detect and delineate plumes of suspended sediment in the water column.

The current data at the surveyed positions within the lake and depths in the water column were used to help develop a hydrodynamic model of the portion of the lake where the tailing spill occurred. The water column imagery where used to provide snapshots and, through the use of multiple surveys over time, information on the dynamics of the suspended sediment plumes.

4.6 CTD & Turbidity

The turbidity sensor provided the most direct measurements of the amount of suspended sediment in the water column. Data from this sensor were compared to the conductivity and temperature measurements from the CTD to identify any correlation that would allow the use of the CTD, which has a much faster sample rate then the turbidity sensor, to be used to identify areas of suspended sediment.

The CTD and turbidity sensors could only provide periodic samples of the suspended sediments since the vessel had to move to a sample location, then an operator would lower the sensor system through the water column on a line, retrieve the system and download the data for that site to a computer. The ADCP could collect data and provide an image of any significant suspended sediment in the water column continuously, at rates up to several times a second, depending on water depth. By correlating the absolute measurements of the turbidity sensor to concurrent acoustic measurements with the ADCP, an estimate of a much higher density and volume of sediment plume mapping data than could be accomplished with the turbidity sensor and CTD alone, was obtained.

5. Summary of Findings

Maps showing the data collected from each of the sensor systems are provided in Appendix A.

5.1 Bathymetry and Side-scan Imagery

Figure 1 provides an overview of where the tailings spill occurred and shows the coverage of the bathymetry survey as a 3D surface, color coded for depth from blue (deep) to red (shallow). Sediment deltas and debris were visible in both the bathymetry and side-scan sonar imagery (Figures 1 and 2).

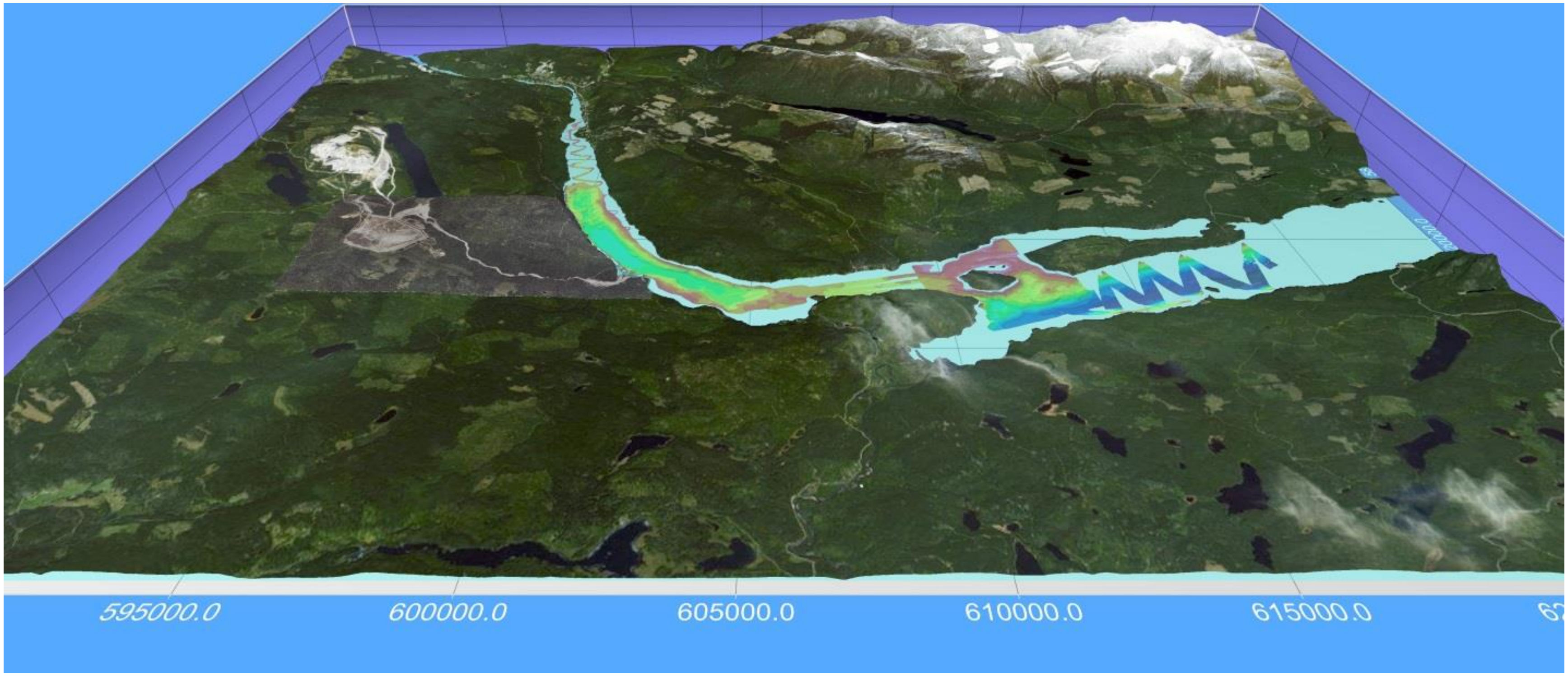


Figure 1 - Overview of Tailings Spill Area and Collected Bathymetry

Figure 2 shows the extent of side-scan sonar coverage near the tailings entrance point. The side-scan sonar towfish emits sound pulses perpendicular to the towfish heading in a narrow band to either side of the towfish. Some of the sound is absorbed by the lakebed and some scatters off the bottom in different directions. Sound that is scattered back towards the towfish receiver is called backscatter, and side-scan sonar images, as shown in Figure 2, represent this backscatter. The intensity of the acoustic backscatter is a function of several things, including:

- Angle of incidence of the acoustic wave front to the lakebed;
- Surface roughness;
- Impedance contrast across the solid/water interface (harder/firmer lakebed sediment or gravel are better reflectors than mud); and
- Topography (up slopes facing the towfish receiver are much better reflectors than down slopes due to a difference in incidence angle).

In general, high backscatter (or high reflectivity) areas show as dark shades while low reflectivity areas show as light shades. In general, areas of high backscatter/dark areas are associated with relatively coarser-grained sediments, hard substrate, steep slopes and rough bottom topography; while areas of low-backscatter/light with relatively finer-grained sediments, flat and smooth lakebed. In Figure 2, the dark areas are primarily the steep slopes along the edges of the lake, hard targets (likely large rocks, boulders and other debris that were washed into the lake with the tailings) found in the middle of the lake across from the tailings entry point, and where the tailings entered the lake on the south side. The lighter areas are primarily covered by fine-grained sediments.

5.2 Figure 2 - Side-scan Sonar Mosaic Adjacent to Tailings SpillSub-bottom Profiler

Penetration depth of the sub-bottom profiler provides information on sediment type and thickness. Areas that show distinct layering tend to be comprised of finer grained sediments such as fine sand, silt and clay; the sub-bottom profiler beam does not penetrate larger grained sediments such a coarse sand, gravel and cobble. The sub-bottom profiler data were reviewed with particular attention to the area around the outflow of the tailings material. Figure 3 shows the tracklines where sub-bottom profiler data were collected overlain on the bathymetry. Boxes show the locations of sub-bottom profiler data examples discussed in Section 5.3. The sub-bottom profiles show approximate depth (with 0 being at the water surface) on the vertical axis and along-track distance on the horizontal axis; with both axes in meters.

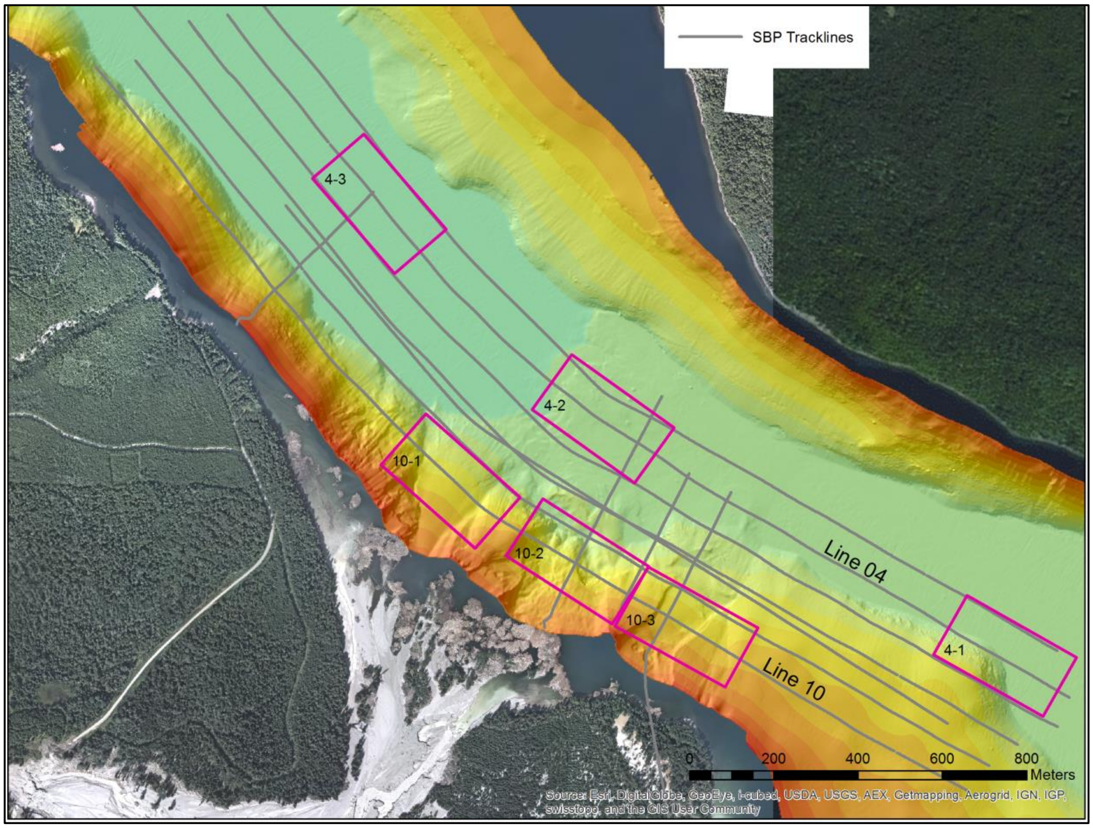


Figure 3 – Sub-bottom Profiler Tracklines; Boxes show locations of data examples discussed in Section 5-3.

5.3 Interpretation

If full coverage bathymetry data from before the spill were available, a comparison could be made with the survey performed by Tetra Tech to see where material had been deposited. Lacking a baseline survey of comparable coverage and quality to that performed after the spill, it was not possible to perform a highly accurate quantitative assessment of the volume and distribution of the tailings within the lake. However, review of the data by experienced geophysicists and hydrographic surveyors and correlation with the data derived from the sampling operations did provide some information on the distribution of the material.

Side-scan sonar data show that lakebed sediments appeared to be somewhat reflective west and east of the tailings entry site but appear to have slightly lower reflectivity in the vicinity of the tailings entry site. Numerous hard targets (primarily 1 to 2 m in size and up to 5 m) are scattered across the lakebed in this area and fan-shaped deposits of highly reflective, coarse-grained sediments were observed where water and tailings burst through the bank and into the lake (Figure 4).

Figure 4 – Hard Targets Scattered Across the Lakebed at the Tailings Entry Area

Sub-bottom profiler data indicate that lakebed sediments to the west and east of the tailings entry site are primarily fine-grained, particularly in the upper 5 to 10 m (refer to Figures 5 and 6).

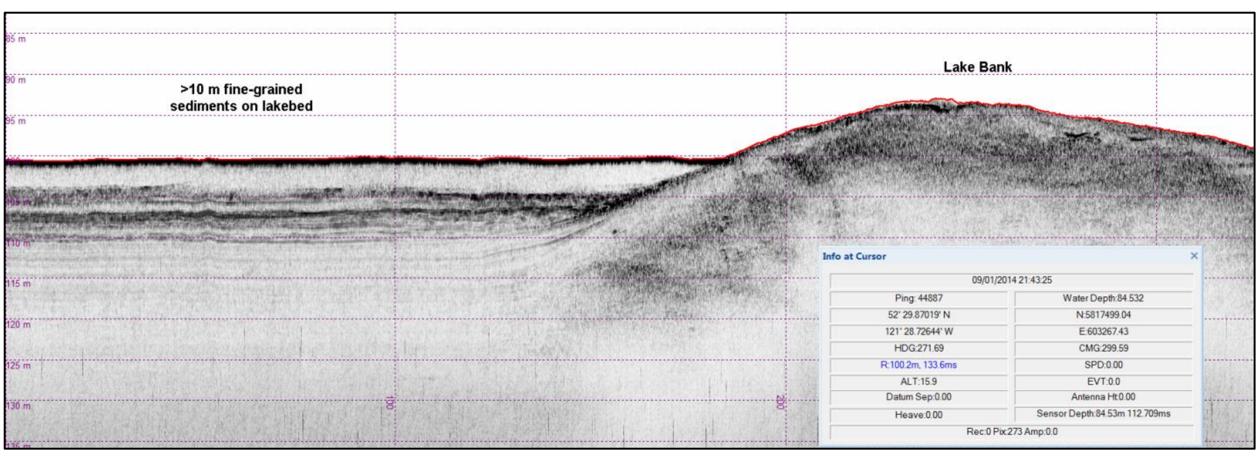


Figure 5 – Sub-bottom Profile East of the Tailings Deposit at Location 4-1 on Line 4 (refer to Figure 3).

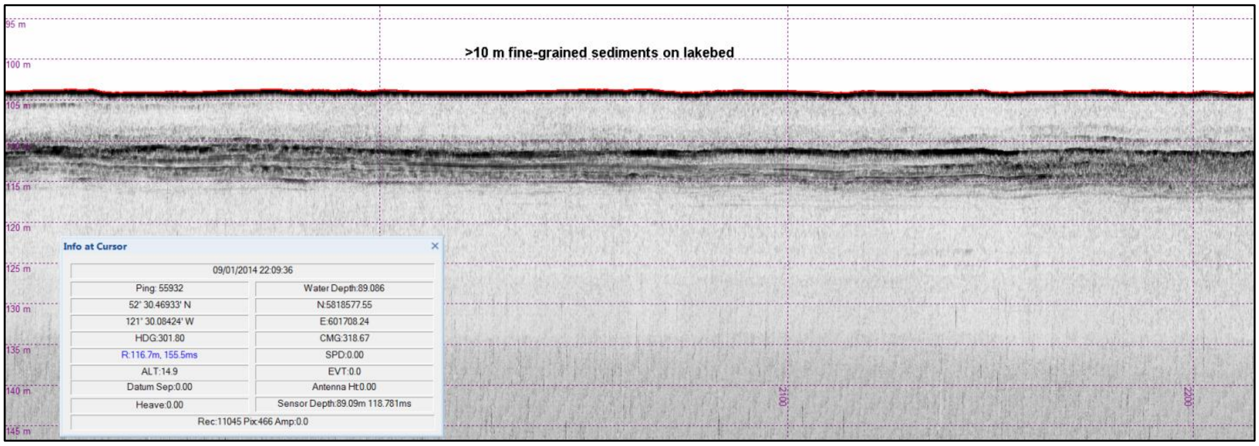


Figure 6 – Sub-bottom Profile Showing Fine-grained Sediments on the Lakebed at Location 4-3 (refer to Figure 3).

In the tailings entry area very little to no sub-surface penetration was observed (refer to Figure 7), indicating that sediments in this area are primarily coarse grained and likely include a large portion of the coarse-grained tailings that entered the lake. Because of the lack of sub-bottom penetration in the tailings deposition area an estimate of the volume of material that had been deposited (thickness of the coarse-grained material over pre-incident sediments) could not be made. In some places a very thin layer of fine-grained material over the coarse-grained material was observed on the lakebed surface and the relatively low-reflectivity of the side-scan data in this area suggests that a thin layer of fine grained material on the sediment surface is widespread.

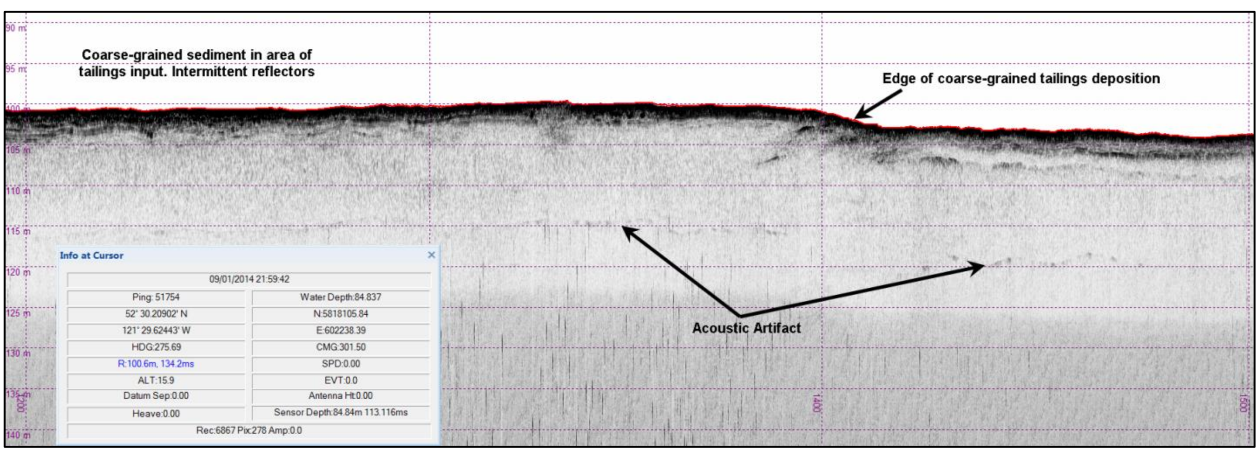


Figure 7 – Sub-bottom Profile Crossing the Tailings Deposition Area; location 4-2 on Line 4 (refer to Figure 3).

Three channels were mapped on the southern edge of the lake. The floor of the westernmost channel is relatively smooth and slightly mounded in the center (Figure 8) and sediments associated with this channel are distributed on the lakebed in a well-developed, not highly reflective, depositional fan (refer to Figure 2).

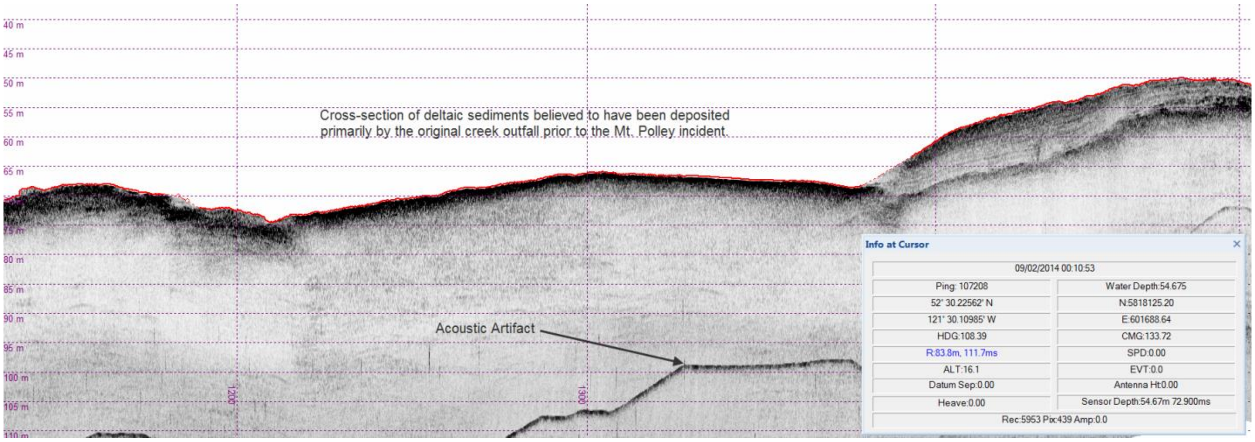


Figure 8 – Sub-bottom Profile Crossing the Location Where the Pre-Incident Creek Entered the Lake Prior to the Tailings Pond Breach; location 10-1 on Figure 3.

Pre-incident satellite imagery shows that Hazeltine Creek entered the lake at this location and the deltaic sediments are most likely associated with the creek (Figure 9).

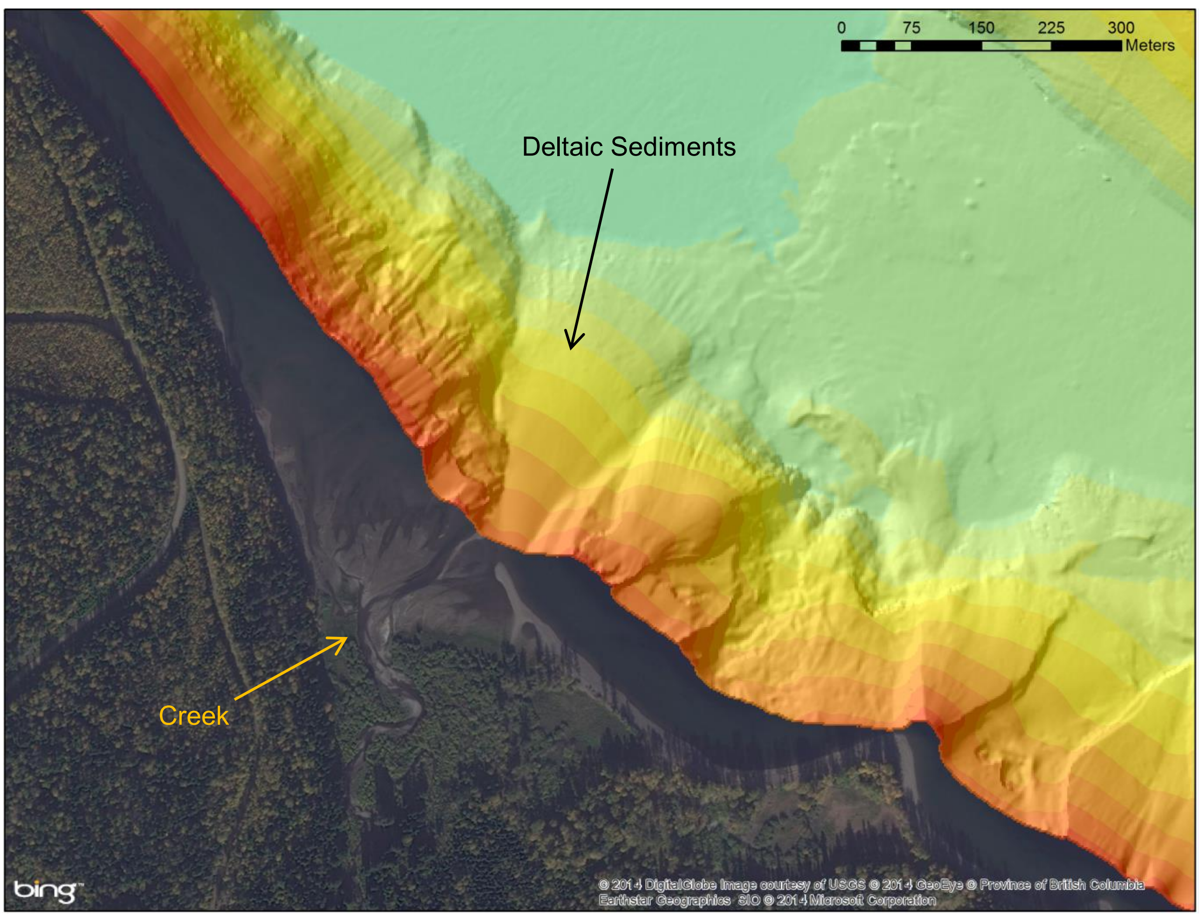


Figure 9 – Pre-Pond Breach Hazeltine Creek Flowing into Lake Quesnel with Associated Deltaic Deposit

To the east, two new channels have been carved out by the influx of material from the tailings pond breach and these appear to be the two primary pathways for tailings into the lake. The walls of these channels are steep and the floors are irregular and highly reflective (refer to Figures 10 and 11). Reflective material is evident in fan-shaped patterns across the lakebed and shoaling towards the northern shore of the lake opposite the channels suggests at least a meter of material was deposited on the lake bed in the vicinity of the tailings entry area.

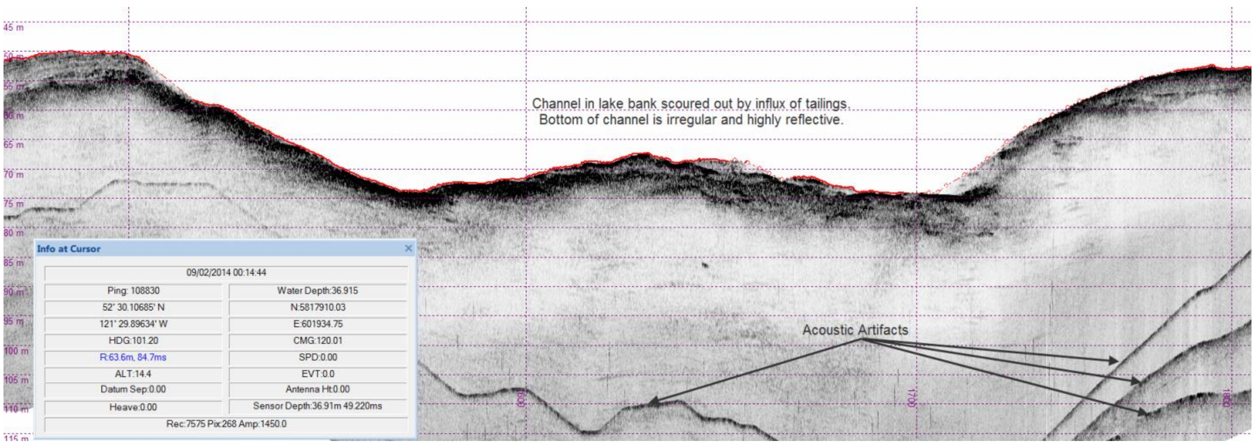


Figure 10 – Sub-bottom Profile Where the Profiler Crossed a Channel Formed by Influx of Material into the Lake; location 10-2 on Figure 3.

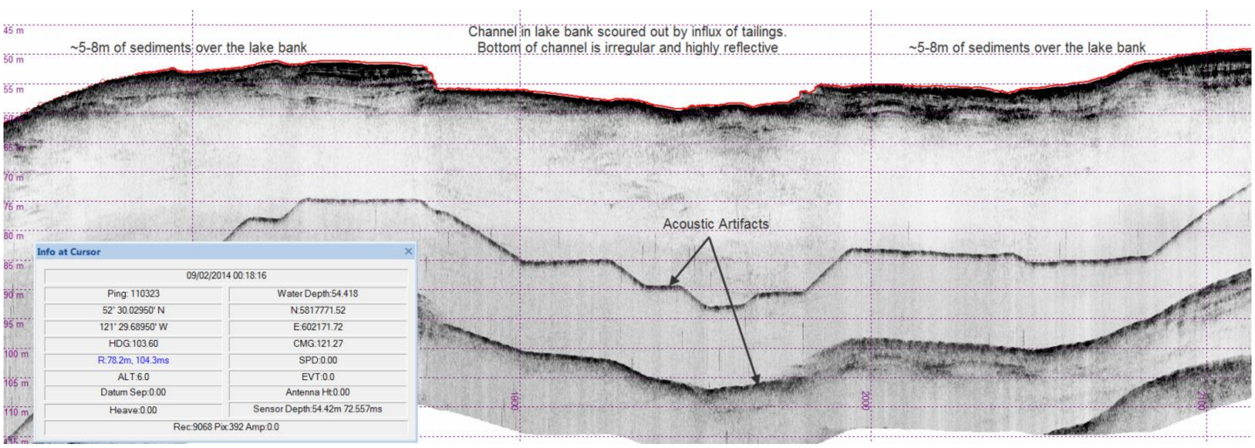


Figure 11 – Sub-bottom Profile Where the Profiler Crossed a Channel Formed by the Influx of Material into the Lake; location 10-3 on Figure 3.

The aerial photography collected after the tailings pond breach shown in Figure 12 and data from the various geophysical sensors indicated that a large portion of the tailings were deposited along the flow path to the lake and adjacent to the point where the material entered the lake through the two primary channels. The aerial photography also shows that the entry area into the lake extends across all three channels mapped in the bathymetry and therefore tailings material should not be expected to be contained by the channels. Once the tailings entered the lake, fine-grained material was likely entrained in the water column and slowly deposited further afield from the tailings deposition area. Grab samples collected along the lake confirm that the deposition of fines was much more widespread (Figure 12). Suspended sediment in the water column was observed during side-scan and sub-bottom profiler data collection but will be better mapped following analysis of the CTD casts.

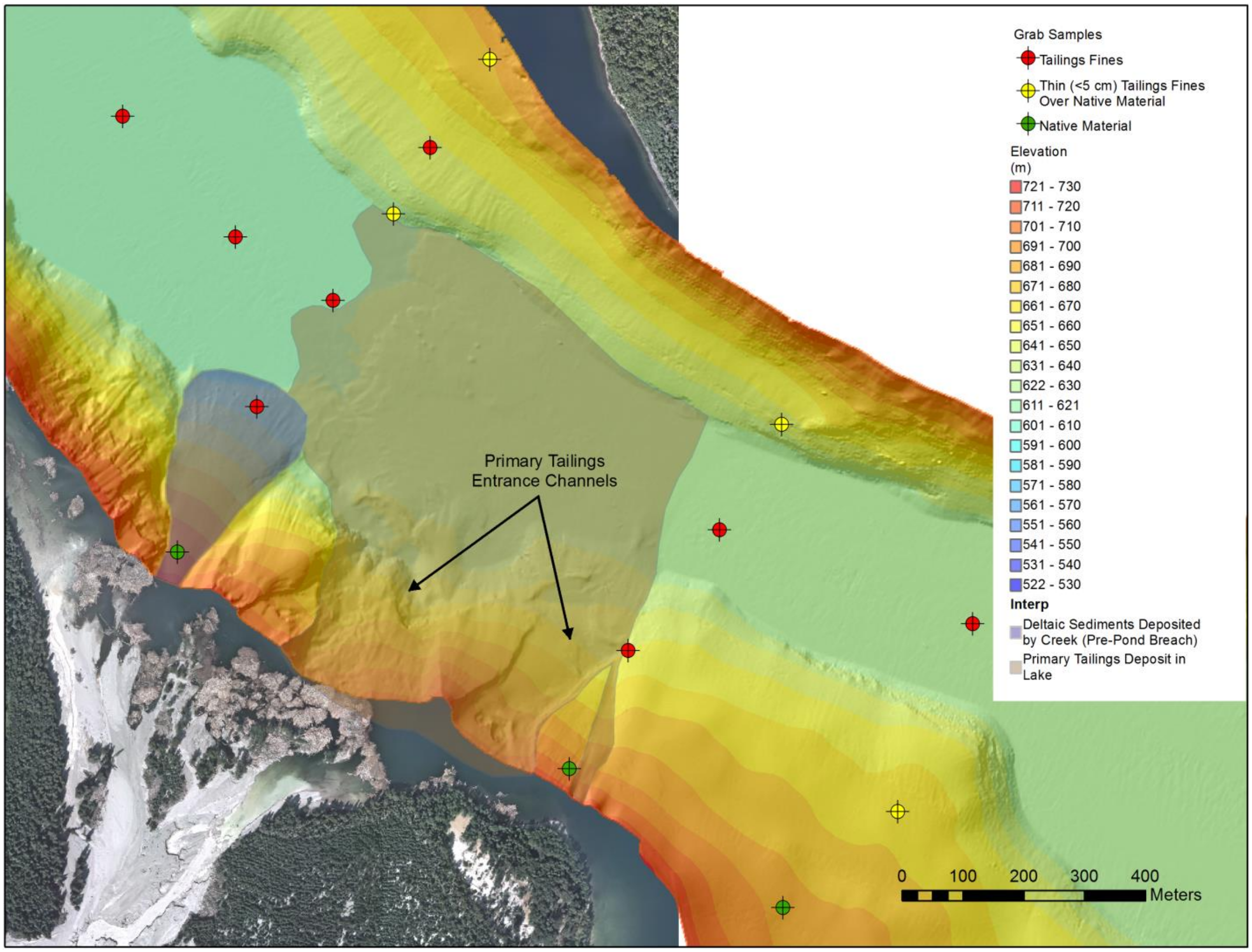


Figure 12 - Interpretation of Geophysical Data

6. Deliverables

Project deliverables include:

1. Summary Report – describes methods and equipment used to conduct the geophysical and summarizes results.
2. Charts (Appendix A)
   a. Chart 1 - Bathymetry map – Shaded relief bathymetry for Project area.
   b. Chart 2 - Side-scan sonar mosaic
3. Digital Files (Appendix B)
   a. XYZ grid of processed bathymetry
   b. Side-scan sonar mosaic

APPENDIX A

CHARTS

APPENDIX B

DIGITAL DELIVERABLES
(PROVIDED SEPARATELY)

QUESNEL LAKE WATER COLUMN OBSERVATIONS AND MODELLING

PRESENTED TO
Mount Polley Mining Corporation

MAY 2015
ISSUED FOR USE
FILE: 704-V13203212-01

Tetra Tech EBA Inc.
Suite 1000 – 10th Floor, 885 Dunsmuir Street
Vancouver, BC V6C 1N5 CANADA
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LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Imperial Metals Corporation and their agents. Tetra Tech EBA Inc. (Tetra Tech EBA) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Imperial Metals Corporation, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Tetra Tech EBA's General Conditions are provided in Appendix B of this report.

1.0 INTRODUCTION AND BACKGROUND

Mount Polley mine is adjacent to Polley Lake, whose outflow forms Hazeltine Creek. About 8 km downstream of Polley Lake and Mount Polley mine, Hazeltine Creek enters the West Basin of Quesnel Lake. Quesnel Lake is a long, narrow fjord lake reaching from the Cariboo Mountains into the Interior Plateau of BC. Its average and maximum depths are 157 and 511 metres, respectively, making it the deepest fjord-type lake in the world (Laval et al, 2008). It has a surface area of about 266 km^2 and a volume of 42 km^3. With a mean annual outflow of 128 m^3/s through the Quesnel River, the lake has an average bulk residence time of 10 years. At the west end of the lake, a contraction and sill at Cariboo Island partially separates the main body of the lake from the West Basin, which represents 8.6% and 2.3% of Quesnel Lake's surface area and volume, respectively.

Subsequent to an August 4, 2014 breach of the Tailings Storage Facility (TSF) at the Mount Polley Mine and a debris flow along Hazeltine Creek, suspended particulate material entered Quesnel Lake. Tetra Tech EBA Inc. (Tetra Tech EBA) was retained by Imperial Metals Corporation to perform both field measurements and numerical analyses to develop a predictive model that would evaluate the fate of the suspended particulate material in Quesnel Lake and the turbidity resulting from that material.

1.1 Objectives

This report describes and discusses Tetra Tech EBA's field measurements, numerical analyses and hydrodynamic modelling. The objectives of this report are to:

1. Present and discuss the water column observations made by Tetra Tech EBA in 2014.
2. Develop and demonstrate an understanding of the lake's hydrodynamics.
3. Synthesize 1 and 2 to describe and predict the fate of the suspended material observed in the water column as a result of the TSF breach incident.

1.2 Lake Dynamics and Literature Review

In temperate lakes, the temperature of the surface water passes through 4°C, the temperature of maximum density, twice annually in a well-understood cycle. Summer warming produces a layer of warm, buoyant water at the surface of a lake. The temperature difference, and thus density difference, between this layer and the cooler water beneath creates a resistance to mixing which stabilizes or stratifies the lake. In the fall, the surface layer cools, reducing the density difference between surface and deeper waters, until the stratification is overcome by wind-induced mixing. This mixing typically involves the entire water column and is commonly referred to as "fall overturn." If the winter climate is sufficiently cold, cooling of the entire lake then continues until the surface is less than 4°C, at which point a reverse winter stratification appears: a cold, buoyant surface layer overlies a warmer (closer to 4°C) deep layer. In the spring, warming of the surface layer leads up to "spring overturn" when, again, the stratification is overcome by wind-induced mixing. Continued warming of the surface layer re-forms the summer stratification and completes the annual cycle. These mixing episodes have previously been observed in Quesnel Lake in December and April. See, for example, thermistor data presented in Potts (2004) and in Laval et al (2012).

In temperate lakes deeper than about 100-200 metres, the seasonal overturn cycle is complicated by high-pressure effects. The temperature of maximum density decreases with pressure, to approximately 3°C at a depth of 500 metres. This means that seasonal overturn events can only involve the upper 100-200 metres of the water column and deeper water is only renewed or displaced by subtle three-dimensional dynamics. For more discussion and numerous references, refer to Potts (2004) and Laval et al (2012). The main body of Quesnel Lake is subject to these effects. The West Basin of Quesnel Lake, however, with a maximum depth of just over 100 metres, follows the normal seasonal overturn cycle for temperate lakes.

The three largest inflows to the lake are east of the sill, whereas Quesnel River flows out of the western tip of the West Basin, meaning that nearly all of the hydraulic throughput of the lake must pass through the West Basin. Based on an average annual outflow of 128 m^3/s, the West Basin's average residence time is about 90 days.

The sill separating the West Basin and the main body of the lake has a maximum depth of 35 metres and forks around Cariboo Island (Figure 1.1). Internal waves, or seiches, between the upper and lower layers in the water column cause two-layer exchange flow over the sill following strong wind events. Using temperature measurements, Potts (2004) estimated the rate of exchange flow to be on the order of 1500 m^3/s, which dwarfs the river outflow by an order of magnitude. This exchange is frequent enough and large enough to fully replace the water in the cool, deeper layer in 6-8 weeks (Laval et al, 2008).

The key physical drivers of the lake are meteorological fluxes, wind, and rivers. Meteorological fluxes create the seasonal stratification and are dominated by shortwave and longwave radiation and evaporative heat transfer (Potts, 2004; Laval et al, 2012). Wind events are responsible for the seiche activity which can result in upwelling of cold water at the western tip of the lake and exchange flows across the sill (Laval et al, 2008) as well as episodic deep water renewal (Laval et al, 2012). Rivers also influence circulation and deep water renewal, but to a lesser degree (Laval et al, 2012).

1.3 2014 Tailings Dam Breach

The turbid water entering Quesnel Lake was denser than the lake water and therefore descended below the lake's surface, forming a submerged plume. After an initial turbulent inflow of unknown duration, the plume was constrained on the east by the sill separating the West Basin from the main lake body, and on the northwest by the shelf at the Quesnel River. Measurements throughout fall 2014 consistently located the plume extending vertically from a depth of approximately 30 metres to the lake bed, with occasional patchy outbreaks to the surface. The plume had elevated temperature, conductivity and suspended solids. The plume was mainly confined to the deep waters of the lake below the thermocline by density stratification caused by both the weight of the dissolved material and suspended sediment in the plume and the buoyancy of the warm surface layer persisting from the summer heating cycle of the lake. On occasion, the force of wind on the water surface can cause the interface between the upper and lower layers of a lake to tilt. This process brought the top of the turbid layer close to the surface periodically in the months following the event. Once the wind dies down, the event, known as an internal seiche, relaxes. Sufficient wind can also mix the two layers, either partially or completely. As the surface waters of the West Basin cool with the onset of fall, this stratification weakens and further wind energy resulted in complete mixing near the start of winter. The behaviour and fate of the turbid water in the West Basin was investigated using field methods and numerical modelling.

2.0 FIELD METHODS

Field observations in Quesnel Lake involved water column profiling by multiple organizations, bathymetric and geophysical data collection by Tetra Tech EBA, and sediment sampling carried out by Minnow, supported by Tetra Tech EBA's research vessels. This report presents data collected by Tetra Tech EBA during a field program from August 28 to September 6, 2014, where the research vessels R/V Storm and R/V Ugly Duckling were mobilized from Tetra Tech's Bothell, WA marine mapping group. Data collected by a joint MPMC/SNC water sampling and profiling program are also referenced. The water column profile data are described in detail in this report. Bathymetric, sidescan and sub-bottom profiling, and ADCP reflectivity measurements are discussed briefly in this report.

2.1 Water Column Profiling

Water column profiles are the primary method of gathering physical limnological data. Conductivity, temperature, and depth (CTD) casts measure three parameters essential for understanding the vertical density structure of a water body. Temperature is generally the dominant factor affecting circulation and water column stability in freshwater lakes. Section 1.2 above contains a discussion of the relevant temperature and density dynamics in Quesnel Lake. Electrical conductivity is the inverse of electrical resistance, and is correlated with the quantity of ionic material, usually salts and metals, dissolved in the water. Conductivity changes with temperature, so is generally normalized to a specific temperature and called specific conductivity. Depth is measured using a pressure sensor and integrating the water column density based on the temperature and conductivity measurements.

A key water column parameter for describing post-event Quesnel Lake is turbidity. Turbidity is an optical measure of water cloudiness – low-turbidity water would have high clarity. Turbidity is caused by a variety of factors, including sediment particles suspended in the water and biomass. The relationships between sediment concentration (by mass of suspended particles) and turbidity can be complex. Variability in particle size, shape, and mineralogy can result in different turbidity readings for the same concentration of material. Instrumentation is also a source of variability, as the measurement of light scattered off particles can be performed in different ways.

The BC Ministry of Environment (MoE) conducted CTD and turbidity (CTD+Tu) casts in the West Basin of Quesnel Lake on August 12 and 13, 2014 using a YSI 6600 sonde. The field sheets were hand-digitized and used for Tetra Tech EBA's initial analysis and modelling work. CTD and turbidity casts collected by MPMC using a YSI EXO2 sonde started to become available on August 19, with increasing coverage and frequency over time.

Tetra Tech EBA's research vessel R/V Storm began an intensive program of water column profiling on August 28, 2014, continuing through September 6, 2014. Tetra Tech EBA used a RBR Concerto CTD+Tu instrument on a hydrographic winch designed for rapid profiling.

Tetra Tech EBA staff joined the MPMC sampling program for two days in October 2014, and a key series of observations were made with both the YSI and RBR instruments on October 24, 2014. The instruments were compared in the field for quality control purposes, and a linear calibration coefficient was found between the two instruments. The Tetra Tech EBA measurements were then corrected to the MPMC measurements. Tetra Tech EBA reviewed the MPMC YSI calibration procedures during this visit and found them to be correct. There are differences in instrument design that likely explain the offset. Throughout this report the RBR turbidity readings are calibrated to match MPMC's instrumentation. Despite the natural and inherent uncertainty, turbidity provides the most useful rapid measurement of suspended material in the Quesnel Lake water column.

A quality-controlled up-cast and down-cast averaging procedure was used to post-process all Tetra Tech EBA CTD casts.

2.2 Multibeam Bathymetry

The primary equipment mobilized onto the survey vessels included a multibeam echosounder sonar, side-scan sonar, sub-bottom profiler, acoustic Doppler current profiler (ADCP), CTD/turbidity sensor systems, and towfish and vessel positioning equipment. These systems and the ancillary positioning systems that were used to conduct the seabed mapping are listed in Table 2.1 and discussed in more detail in future reporting.

Table 2.1. Survey Equipment

Primary Equipment	Make/Model
Multibeam	RESON SeaBat 7125
Side-scan Sonar	EdgeTech 2000-DSS 100/600kHz chirp
Sub-bottom Profiler	EdgeTech 2000-DSS 2-16kHz chirp
ADCP	Teledyne RDI Workhorse Sentinel 600 kHz
USBL	IXBLUE GAPS (Global acoustic positioning system; ultra-short baseline)
Positioning Systems	Applanix POS/MV 320, Trimble SPS65x with OmniStar
Heading, and Motion Reference Systems	Applanix POS/MV 320, IXBLUE GAPS
CTD with Turbidity	Seabird 19 Plus, YSI CastAway
Grab Sampler	WILDCO Standard Ponar (or similar)

The collected bathymetry data were processed with CARIS HIPS software to generate three dimensional maps in the survey coordinate system and units. Data quality control and assurance was also performed in CARIS HIPS 2D and 3D editing software to eliminate outliers typically produced by noise in the sensor system or the acoustic environment. Quality-controlled sounding data were used to create 2 meter-gridded Combined Uncertainty and Bathymetric Estimator (CUBE) and uncertainty surfaces. Both types of surfaces were calculated by computing the uncertainty budgets for each sounding, based on beam geometry and the accuracies of the position system(s), motion sensor, and sonar devices, and applying a weight to each sounding based on an estimate of quality. The bathymetric chart produced by the multibeam survey is reproduced in Figure 2.1.

2.3 Sidescan Sonar

Additional data collected during the project included side-scan imagery sonar and sub-bottom profiler data from the towed EdgeTech 2000-DSS system. This system, referred to as a towfish, is connected to the vessel by a cable and allows measurements to be made closer to the lake bottom. These data provided detailed images of features and textures on the lake bed, and information on the subsurface stratigraphy below the profiler.

Side-scan sonar imagery were acquired in proprietary EdgeTech format (JSF) using EdgeTech's Discover acquisition software and then imported into Chesapeake SonarWiz 5 for post-processing. Towfish position from the GAPS USBL was recorded directly into the raw data file and/or HYPACK for geo-referencing all raw data. The SonarWiz processing package was used to remove erroneous navigation points, apply gains and conduct other signal processing, bottom track the data to remove the water column, and prepare the sonar data for final export. The imagery was exported from SonarWiz as 0.25-meter resolution geotiffs and is displayed on the Figure 2.2.

2.4 Sub-Bottom Profiling

Sub-bottom profiler data were also processed using the SonarWiz software. As with the side-scan sonar files, towfish position was acquired with the GAPS USBL and embedded in the raw data files acquired in the EdgeTech Discover and/or HYPACK programs. The files were recorded in the proprietary EdgeTech JSF format. The sub-bottom profile data were bottom-tracked and gains were applied where appropriate to distinguish different sediment layers on the lake bed where sediment layering was observed.

2.5 Acoustic Doppler Current Meter (ADCP)

ADCP data were collected and processed using the Teledyne-RDI WinRiver software. The ADCP transmits a set of four beams at different angles from vertical and measures the Doppler shift vs time from each beam to derive current directions and magnitudes at closely-spaced depths through the water column. It also tracks the return signal from the bottom to measure water depths and provides measurements of reflectivity vs. depth in the water column that can be used to detect and delineate plumes of suspended sediment in the water column.

The current data at the surveyed positions within the lake and depths in the water column were used to help develop the hydrodynamic model. The water column imagery was used to provide snapshots and, through the use of multiple surveys over time, information on the dynamics of the suspended sediment plumes. While some reflectivity data did indicate the plume's presence in the West Basin of the lake, the frequency of the instrument did not measure the small grain sizes present in the plume very well. The CTD and turbidity data were more useful than the ADCP for plume tracking, and data processing effort was focused therefore on the CTD data.

2.6 Water and Sediment Sampling

MPMC conducted an extensive water column sampling program, discussed in detail in Golder (2015). Comparisons between observed and laboratory-derived conductivity is discussed in relationship to water density in Section 3.2 below. The relationships between turbidity and the laboratory Total Suspended Solids (TSS) measurements are discussed in Section 3 alongside estimates of the total mass of suspended material in Quesnel Lake.

Tetra Tech EBA's R/V Ugly Duckling supported Minnow Environmental staff in collecting grab samples from locations in Quesnel Lake. The grab sample results are discussed in Minnow (2015).

3.0 DATA ANALYSIS AND INTERPRETATION

3.1 Water Column Data

The digitized MoE CTD and turbidity profiles are the first full-depth measurements available in the post-event West Basin of Quesnel Lake. Two profiles, collected August 12 (blue) and August 13 (green) are shown in Figure 3.1. The turbidity profiles in Figure 3.1 show two distinct features, a nearly clear epilimnion (surface layer) above 35 metres and an increasingly turbid hypolimnion (deep layer) below 35 metres. The two profiles were collected on subsequent days approximately 3.5 km apart, and show similar patterns. The increasing turbidity with depth indicates settling of different grain sizes, for example with water from 40 to 80 metres depth being depleted of coarser particles such as silts, but retaining clay-sized particles in suspension.

The temperature profile in Figure 3.1 shows an atypical feature. As is typical of summer lakes, a thermocline exists from 0 to 20 metres with warmer, less dense water on top of cooler water. However, at the boundary between clear and turbid water at 35 metres, the profile is inverted with warmer water below cool. If temperature alone is considered in calculating density, the water column would be unstable and would immediately begin to mix and equalize. This turbid water consists of lake water mixed with water which originated in the shallow, warm tailing storage facility (TSF), and is kept below cooler water by the weight of suspended material. These issues of the effects of turbidity (representing suspended material), conductivity and temperature on water density are described further in Section 3.3 below.

The profile of specific conductivity shows a similar pattern, with a conductivity increase indicating increased dissolved solids below 35 metres.

The CTD and turbidity casts from Tetra Tech EBA's August 29 – September 5 field program are plotted by location in Figure 3.2 through 3.8, with data from different days plotted as lines of different colour. The figure locations start at the north end of the West Basin, near Cedar Point, and continue south and east past Plato Island. The lake was too rough for safe small boat work on September 3 so only some stations were visited with the larger vessel.

Figures 3.2, 3.3 and 3.4 have similar water column profiles at comparable depths. The thermocline was well-established on August 29, with a constant 18°C temperature in the top 15 metres, decreasing to a temperature minimum of 5°C at 25 metres, and increasing again within the turbid deep water to 7°C. Temperatures at depth were stable across the week, while temperatures at the surface indicate that wind mixing and surface cooling occurred during the September 3 storm event.

Figure 3.5 and 3.6 represent water on the west and east side of the Cariboo Island sill. This bathymetric feature is a barrier with maximum depth of approximately 35 metres, restricting the flow of bottom water in or out of the West Basin. Note the change for readability in the turbidity axis scale between Figures 3.5 and 3.6.

The casts near and beyond Plato Island (Figures 3.7 and 3.8) indicate the cold bottom waters typical of the main body of Quesnel Lake.

Quesnel Lake in fall 2014 can be considered as three distinct water masses defined by their location, temperature, and suspended sediment content, represented by turbidity. The coldest and largest water mass is found below the thermocline in the main body of the lake, seen on Figures 3.7 and 3.8 as 4°C water with turbidity near zero. The second water mass is warm surface water, also with low turbidity, seen on all of the above figures at depths less than 20 metres. The third water mass is the turbid bottom water in the West Basin, containing material and warm water introduced during the August 4 TSF breach. Quantifying the development, behaviour and fate of this turbid bottom water was the goal of the observations and modelling described in this report.

A layer of water between 20 and 35 metres in the West Basin contains cold and clear water that appears to have originated at a similar depth in the main lake body. Since the depth of the sill is 35 metres, there is an open path for exchange driven by either wind-induced currents or density differences. The mechanisms of exchange will be further examined in the modelling sections below, but it is inevitable that any transfer of water from the main lake body to the West Basin above the rate of the Quesnel River outflow must be matched by a return flow of water from the West Basin to the main lake body. Figures 3.6 and 3.7 show increased turbidity at depth, with a smooth and consistent spike near 20 metres and a less consistent signal near the bottom of each figure's casts.

Data collected on October 24, 2014 is presented in Figure 3.9. On this figure the casts in the West Basin are averaged into one profile, plotted in blue, and those in the main lake body are averaged into a profile plotted in green. The temperature inversion in the West Basin is much weaker, with a single thermocline at 35 metres below which is the turbid water mass, still near 7°C. Temperatures at the bottom are slightly higher than those at 50 metres depth. Surface water (above 15 metres) temperature and turbidity are the same in both basins, while in the main body of the lake a weak turbidity plume exists at depths between 20 and 50 metres. This figure represents the last synoptic (near-simultaneous) set of casts from which initial conditions were generated for the hydrodynamic model, and therefore the predictions of the plume's eventual fate depend on these data.

3.2 Sediment and Temperature Effects on Density

The temperature inversions in the West Basin described above indicate an anomalous density condition that must be explained by factors other than temperature because temperature alone would result in warmer water at the surface and cooler, denser water at depth. An increase of temperature in bottom water is not explained by normal physical limnological processes. The inflow of water that is warm but dense as a result of dissolved solids and suspended sediment provides a plausible explanation that fits with the event, safely assuming that water in the shallow Mount Polley TSF, in August, was relatively warm. Any material suspended in water results in an apparent change in the density of the water mass proportional to the volume percentage of material and its density relative to water. Dissolved material, like salt in the ocean, also increases the density of water and the results of analytical laboratory analysis of Quesnel Lake water are considered below.

MPMC has collected an extensive set of water samples from locations throughout Quesnel Lake, which were then analyzed for physical parameters such as hardness and nutrient content, as well as numerous other analytes. Using a limnology toolbox 'LIM' described in Pawlowicz (2008) and these laboratory results, a theoretical conductivity and density can be determined based on the concentration of each dissolved element or ion. The results of this comparison for 69 samples collected in the lake are shown in Figure 3.10. The x-axis in all the figures is the observed specific conductivity using a calibrated conductivity meter – the same reading that is made in each in-situ CTD cast.

The left-hand plot in Figure 3.10 indicates that the analytical determination of conductivity from laboratory data closely follows the observed value, though the predicted conductivity does appear to produce a slight underestimate compared with the measured. The LIM toolbox suggests that a match within 5% is considered quite good. The close correlation over a wide range of values indicates that specific conductivity, while not unique to any specific assemblage of material, is a candidate method, supplementing turbidity, for tracking water masses in Quesnel Lake over short periods of time, such as the fall and possibly winter of 2014. The centre plot shows the relationship between calculated density and observed conductivity, indicating that the amount of dissolved matter is sufficiently important to affect the behaviour of the water masses. The observed range of 0.04 kg/m^3 appears small, but represents the same density change as between 4°C and 6.25°C water. The right-hand plot indicates the corresponding salinity, in oceanographic salinity units, to the density and specific conductivity of the Quesnel Lake samples. As H3D is historically an oceanographic model, relating conductivity to salinity units allows use of the existing density subroutine. The differences in dissolved material content is important to the lake's hydrodynamics; however, this should not be correlated with any particular chemical parameter. Consideration of the composition of this water, including total and dissolved metals is addressed in greater detail in the Water Quality report.

3.3 Analytical and Modelled Suspended Sediment Mass

Once the above relationships between dissolved material and density in Quesnel Lake were generated, the effect of suspended material on density and stability of the observed temperature inversion in the West Basin was revisited. Figure 3.11 shows the results of a method to determine the minimum required suspended sediment mass based on water column stability. The left-hand plot shows seven quality-controlled and averaged temperature profiles collected between August 29 and September 5 by Tetra Tech EBA in the West Basin of Quesnel Lake. As described in Section 3.1, warmer water is observed below cold water, at depths greater than approximately 35 metres. The green lines on the right-hand plot show what the density of this water would be if only temperature were considered. It is not physically possible for the theoretical green density profile to exist over any length of time; heavier water floating on lighter water is not stable, and the bottom water would rise and mix, producing a more homogenous temperature and density profile.

The measurement of suspended material in the water column is Total Suspended Solids, or TSS. For modelling purposes we have assumed that TSS can be linearly related to turbidity. The red line shows density calculated using temperature as well as a turbidity to TSS relationship of 1 mg/L to 1.5 NTU (or TSS [mg/L] = 0.66 * Turbidity [NTU]). The density profile is still irregular. Increasing the sediment mass per turbidity unit can produce what appears to be a stable profile at lower depths, but the profile at 20-40 metres does not, in this observation, converge to a smoothly increasing density with depth.

The black lines on Figure 3.11 are calculated considering laboratory-derived dissolved solids with the conductivity/salinity/density relationship discussed above, and suspended solids with the same 1 mg/L: 1.5 NTU turbidity to TSS relationship. The calculated density increases over the thermocline, is nearly constant between 30 and 80 metres depth, and increases again below 80 metres where the turbidity increases faster than the temperature. This profile represents the minimum quantity of suspended solids required to maintain water column stability on the date of the observations, and from these relationships and the volume of the lake an estimate can be made of the total mass of suspended material present.

Figure 3.12 shows the mean, minimum and maximum observed turbidity profiles from the August 29-September 5 observations, and the inferred corresponding TSS profiles in the West Basin. The right-hand panel shows a hypsometric curve for the West Basin of Quesnel Lake. Lakes are wider at the surface than they are near the bottom; the area at depth zero is the surface area of the lake, the area at 110 metres depth is nearly zero as that is the maximum depth in the West Basin. Multiplying the TSS value at each depth interval by the area at that depth produces a profile of sediment mass, and integrating the profile gives a total.

The above calculations were repeated for the August 12 and 13 MoE observations, and for the October 24 observations discussed in Section 3.1. The results from this analysis are shown in Table 3.1, with the Lower Bound column representing the minimum mass required to explain the inverted temperature profile on each date. The mass is also presented as a percentage of the published loss of material from the TSF of 7.9 million cubic metres, using an assumed suspended sediment density of 2650 kg/m^3 to convert suspended mass to volume. The values decrease as time goes on, indicating either settling or export of the suspended material in the West Basin.

Table 3.1. Suspended Sediment Mass

	Lower Bound (kg)	% of Total Material	Model Initial Condition (kg)	% of Total Material
August 13	*28.8 - 37.8 x 10^6*	*0.15 – 0.20*	65.5 x 10^6	0.34
September 1	23.7 x 10^6	0.12	41.8 x 10^6	0.22
October 24	7.7 x 10^6	0.040	12.4 x 10^6	0.064

Initial laboratory analysis of Quesnel Lake water column samples provided input to the turbidity to TSS relationship used in the model. A more complete set of laboratory data is now available, discussed in detail in Golder (2015). Successful modelling of the turbidity and dynamics of Quesnel Lake requires an understanding, however approximate, of the density changes caused by both dissolved and suspended material.

Certain parameters necessary for modelling turbidity are summarized and discussed here. The total suspended solids, and the total dissolved solids excursion above background are plotted against observed turbidity in Figure 3.13. Simulation of lake dynamics is more sensitive to the relative properties of water masses, so subtracting the background TDS value to produce a TDS excursion was more useful given the initial limited number of samples available.

The scatter plots show great variability in the TSS to turbidity relationship, and there is valid technical reason, as noted below, to believe that the laboratory measured TSS is missing some fine-grained material. The TSS points in Figure 3.13 lie below the line representing the minimum TSS:turbidity relationship required for the stability of the observed temperature inversion.

The laboratory analytical technique for TSS measures material above a 1.5 micron grain size. According to detailed grain size distributions conducted by Minnow Environmental (Minnow 2015) the median grain size of samples within the turbid deep water is 1.0 microns. This material contributes to the bulk density of the water, but was not measured by the TSS laboratory method. Some colloidal sediment, or particulate material smaller than 0.45 microns, was likely measured as part of the total dissolved solids laboratory method. Adding the TDS excursion (difference from background) to the TSS values results in points more realistically above the line of minimum water column stability on Figure 3.13.

A variety of TSS:turbidity relationships were tested in the model based on earlier scatter plots of turbidity and dissolved and suspended solids. The production model runs were simulated using a TSS:turbidity relationship of 1 mg/L: 0.8 NTU (or TSS [mg/L] = 1.18 * Turbidity [NTU]), nearly double the material per turbidity unit than the minimum. The regression line representing the modelled TSS:turbidity relationship lies within the TSS + TDS excursion points on Figure 3.13, indicating that the semi-empirically derived model relationship is sufficiently reliable for prediction of turbidity relative to observations.

In summary, while there is uncertainty in the relationship between TSS and turbidity, as is the case in nearly all comparisons of these two different measures, there are minimum quantities of material necessary to maintain the inverted temperature profile in Quesnel Lake for the months which it persisted. Uncertainty resulting from analytical techniques was minimized by a series of model sensitivity tests, and subsequent laboratory data confirmed the assumptions regarding water mass composition and density that were necessary for predictions of turbidity dynamics, transport and fate.

4.0 MODELLING METHODS, DATA SOURCES AND ASSUMPTIONS

4.1 Model Description

A numerical model of Quesnel Lake was developed using H3D, a proprietary three-dimensional hydrodynamic model maintained by Tetra Tech EBA. The model is derived from GF8 (Stronach et al. 1993) developed for Fisheries and Oceans Canada. H3D has been successfully implemented on several extensive studies along the B.C. coast and inland waters.

A more comprehensive description of H3D is located in Appendix A, along with descriptions of the adjustable model parameters and their values for the Quesnel Lake simulations. One implementation relevant to lake and sill dynamics is the simulation of internal waves in Okanagan Lake, whose model validation figure is reproduced in Appendix B.

A curvilinear model grid was created for Quesnel Lake with higher resolution (70m cell size) in the West Basin of the lake (Figure 4.1). Model resolution indicates the smallest feature which can be resolved in the numerical simulation. Since the features of interest for this model are the large-scale behaviour of the lake, the horizontal resolution was chosen based on the minimum necessary to represent the sill at Cariboo Island. The vertical resolution was chosen to provide detailed coverage in the West Basin, which is approximately 100 metres deep, and less detail in the 500+ metre main body of the lake. The depth of the lake and resolution desired resulted in 90 vertical layers being used for the simulations.

Models must be calibrated based on available data, and subsequently validated with an independent dataset. The year 2003 was used for calibration due to the availability of thermistor data in the lake that year (Laval et al., 2008 & 2012). The calibrated model then was applied to simulate the fate of material in 2014 using the same numerical parameters as in 2003. The details of the model calibration are discussed in Section 5 below.

Initial conditions, meteorological inputs, and hydrologic inputs are described in the following sections. Figure 4.2 shows the locations of river inputs and calibration data.

4.2 Initial Conditions

The model must be started from an initial condition, which is a three-dimensional set of data representing all of the simulated parameters throughout the entire lake on a particular date or season. In the absence of a comprehensive survey, the model can be initialized with a small number of vertical profiles which are assumed to represent entire basins.

A good time to initialize a model of a dimictic lake is during the spring overturn where the water column is a constant temperature. The initial condition for temperature in the 2003 model was a constant 3.4°C throughout the lake based on historical thermistor data. No suspended sediment was simulated in 2003. The model was initiated from rest on April 15, 2003.

The 2014 models were initialized at three different times based on available data. One early model was initialized on August 12, using the post-event MoE casts to represent the West Basin and historical temperature profiles from the same month in the main lake body. A model was initialized on September 1, 2014 using casts from the Tetra Tech EBA field program which covered much of the western portion of the lake. A final model was initialized on October 24 using a series of casts from the joint Tetra Tech EBA / MPMC / SNC field visit.

4.3 Meteorological Inputs

Lake dynamics depend on local meteorology, with air temperature, sunlight and cloudiness, and humidity controlling the heat fluxes into and out of the lake, and wind providing energy for generating waves, currents, transfer across the air-water interface and vertical mixing in the water column. Wind is the most important driving force for lake hydrodynamics, transport and mixing processes. The wind field over Quesnel Lake is quite complex due to pronounced topography, as the orientation of the valley changes along the lake (Figure 4.2). The mountainous terrain which surrounds Quesnel Lake results in wind being steered along valley orientation, and either slowed, or funneled, depending on the regional wind directions. A number of current and historical meteorological stations, mapped in Figure 4.3, were investigated in order to understand wind patterns over the lake.

A representative comparison of wind speed and magnitude for some of these stations is presented in Figure 4.4 for the month of September 2003. The plot shows large variability in the wind field over the lake and region. Many of the wind stations were operational for short portions of the year or otherwise unreliable due to obstruction, poor placement, or data quality, such as forest fire stations which only reported wind quadrants for a portion of the summer.

In order to better understand wind patterns, we obtained a hindcast from the meteorological model MM5, which reproduces three-dimensional regional wind patterns. Since the 5 kilometre resolution of the MM5 hindcast was coarse compared to the valley topography, we downscaled the MM5 wind field over the lake using CALMET software which empirically represents the effects of topography. This meteorological model and downscaling system resulted in good performance in terms of event timing, however the wind velocities were much lower than coincident observations and it was not able to resolve the topography-following nature of the winds. Figure 4.5 demonstrates the discrepancies between observations and the MM5 prediction at Goose Spit and Niagara wind stations.

Over the course of successive model runs with varying wind assumptions, and based on previous work focused on the lake's heat balance (Potts, 2004), we came to conclusion that the most reliable source for wind, air temperature, cloud cover, and humidity data is the long-term time series available from the Williams Lake Airport (YWL). We therefore used this YWL wind time series, artificially rotated to be steered by valley topography, as in Figure 4.6. This wind steering assumption produced the best results during model calibration. Further changes were made in the wind steering assumption in response to greater than observed mixing behaviour in the West Basin. Model runs with reduced wind velocity in the West Basin of the lake produced improved results. This change, is physically based on the reduced width and wave-generating fetch in the West Basin that should result in less wind-driven vertical mixing than the open ocean mixing coefficients otherwise produced.

The remaining meteorological parameters are applied over Quesnel Lake directly from the YWL time series. Small time offsets likely exist between events at YWL and events at the lake, but are not significant to the weekly to seasonal time scales of concern.

4.4 Lake and River Hydrology

The Horsefly, Niagara and Mitchell Rivers are included in the model, with monthly average flows and temperatures taken from data available in Potts (2004).

The lake level is in balance between inflow and Quesnel River outflow. Inflows from the three rivers cause the lake level to increase. Higher lake levels cause increased flow out the Quesnel River, which is implemented in the model as a weir boundary condition. The WSC gauge at Likely and historical Quesnel River flows were combined to generate a simplified rating curve based on lake level. Year-to-year variability in inflow and outflow hydrology was not considered in the modelling. The average flows in the inflowing and Quesnel Rivers, as modelled, are shown in the top panel of Figure 4.7. The actual modelled Quesnel River flow is plotted against ten years of observed Quesnel River flows in Figure 4.7; the modelled line is time-shifted for comparison purposes. The modelled flows appear to be a good approximation of actual flows and are deemed sufficient for predicting lake and river processes.

5.0 MODEL VALIDATION

The hydrodynamic model of Quesnel Lake was validated in a variety of ways against available temperature observations in the lake:

- Temperature profile time series from 2003-2004 thermistor chains.
- Timing of fall overturn.
- Exchange flows over the sill.
- Temperature profiles from 2014 casts.
- Quesnel River temperatures.

Time series and profile comparisons provide visual evidence of model validity. In addition, each validation section presents the statistics for the skill of the numerical model in reproducing observations. The statistical methods used to measure model performance are based on calculation of the root-mean-square error (RMSE; Equation 1) and a comprehensive 'model skill' equation (Equation 2). RMSE is presented in the same units as the original data and represents the magnitude of the differences between observations and predictions over the model duration. Model skill (MS), as defined by Wilmott et al. (1981), is a dimensionless measure of the agreement between predicted and observed data, with a skill of one representing a perfect match.

Equation 1: Root-Mean-Square Error (RMSE)

$$\mathrm{RMSE} = \sqrt{\frac{1}{N}\sum_{N}|\mathrm{X_{Model}} - \mathrm{X_{Data}}|^2}$$

Equation 2: Model Skill (MS)

$$\mathrm{MS} = 1 - \frac{\sum|\mathrm{X_{Model}} - \mathrm{X_{Data}}|^2}{\sum(|\mathrm{X_{Model}} - \overline{\mathrm{X_{Data}}}| + |\mathrm{X_{Data}} - \overline{\mathrm{X_{Data}}}|)^2}$$

5.1 Temperature Profiles – 2003 Thermistor Data

Temperature profile time series were available from an observational program in 2003-2004 (Potts, 2004; Laval et al, 2012) in the West Basin and the main lake body (M2 and M8, respectively, in Figure 4.2). The M2 thermistor chain was anchored close to Hazeltine Creek, and represents temperatures in the West Basin. Digital data from M2 were available through the Institute of Ocean Sciences, Sidney, from July 31, 2002 through September 24, 2003. The M8 thermistor chain was anchored at the junction of the lake's three arms, and represents temperatures in the main body of the lake. Data from M8 were available through the University of British Columbia, from July 30, 2003 through June 22, 2004.

The modelled vertical profiles of temperature compared well with measurements at M2. A series of dated profiles are shown in panels on Figures 5.1 through 5.5, covering the period from April 15 to September 23, 2003. The overall RMSE on these profiles is 1.9°C and the model skill is 0.80. A review of these profile comparisons indicates that seasonal variation of temperature, the degree of stratification in the West Basin, and the location of thermocline were captured by the model.

Comparisons of daily modelled and observed temperature profiles at the M8 thermistor are shown in Figures 5.6 through 5.8. The model predicted the vertical variation of temperatures at this location with somewhat better overall accuracy than at the West Basin location, with an overall RMSE of 1.80°C and a model skill of 0.97.

A section through time, referred to here as a scroll plot, provides long-term information at all depths at a single location using colours to represent the quantity of interest. Figure 5.9 presents scroll plots of M2 (upper panel) and M8 (lower panel) temperatures from May 15 to September 24, 2003. Observed temperatures are shown with coloured dots, superimposed over the model-predicted temperatures on the same colour scale. If a dot is invisible it indicates a close match – nearly identical temperatures. The lake stays stratified from early June to the end of the plotted data in September.

Figure 5.10 presents the same plot, but with the time axis zoomed to highlight the upwelling events in the West Basin (M2; upper panel). Here, the thermocline fluctuations indicate wind-driven seiche activity, with distinct mixing, upwelling and downwelling effects. At the junction (M8; lower panel) the lake remains more stably stratified with less fluctuation of the thermocline. Since M8 is at or near the node of the first mode internal seiche, like a rider on the fulcrum of a seesaw, the observed temperatures show little sign of the fluctuations seen at M2. The model captured these seiche events reasonably well. The lower model skill at M2 is a result of the wind-driven seiche activity, with much of the difference between observations and predictions due to the lack of local wind data.

5.2 Fall Destratification in the West Basin

Fall cooling of the warm upper layer weakens the thermal stratification, ultimately leading to complete mixing of the water column. The model indicates that during mid-November the stratification disappears in the West Basin and water column turns homogenous (Figure 5.9). This is generally consistent with the observations at M2 in 2003 (Figure 5.11; reproduced from Laval et al, 2012), where the upper mixed layer gradually deepened through the water column from late September (20 m depth) to mid-November (98 m depth). Therefore, the mixing does not happen instantaneously as the common word "overturn" suggests. This gradual mixing inhibits the sudden resurfacing of deposited bottom sediment.

Note that the M2 data after September 24, 2003, were only available in graphical form, from Laval et al (2012), and therefore could not be displayed on Figure 5.9. This reduces the total length of record over which validation statistics are calculated, but does not change the conclusions regarding model skill.

5.3 Exchange Flows Over Sill

As mentioned in Section 1.2, the wind-induced seiche in Quesnel Lake often causes a two-layer exchange flow over the sill between the West Basin and the main lake body. This exchange flow has been has been captured in the model (Figure 5.12). During sustained winds from the west, warmer surface water leaves the West Basin and cold, deep water from the main lake body enters the West Basin. When the wind stops or changes direction, the warm surface water returns to the West Basin and the colder deep water returns to the main body of the lake. The magnitude of this flux over the sill was estimated by Potts (2004) using a heat conservation method based on the M2 thermistor representing heat content in the West Basin, and the M8 thermistor representing heat content in the main body of the lake. The root-mean-square (RMS) of the estimated flows was 1530 m^3/s. The RMS flows predicted by the model are about 1/3 lower: 960 m^3/s across the sill. This differs somewhat from the Potts (2004) estimates of 960 m^3/s; however, Potts' method, which relies on a single observation point to represent a large basin has considerable uncertainty. The heat conservation method may result in amplified peak flows which then overestimates RMS flow.

The difference of the fluxes entering and leaving the West Basin is equal to the Quesnel River flow which is shown for comparison in Figure 5.12. The instantaneous magnitude of the exchange flow is on the order of ten times greater than the river outflow, and it is proposed in Laval et al (2008) that it could take as little as 6-8 weeks for internal seiche processes to completely exchange the cool, deep West Basin water mass with water from the main lake body. The amount of deep water exchanged between the West Basin and the main body of the lake will be explored further in the modelled characterization of the 2014 event in Section 6 below.

5.4 Quesnel Lake Profiles - 2014 CTD Cast Data

Comparison of observed and modelled temperature profiles is an important method for validating a lake model. Various organizations began measuring water column properties in Quesnel Lake after the TSF breach. The earliest available data were from casts performed by the British Columbia Ministry of Environment (MoE) on August 13, 2014. Tetra Tech EBA collected data in a series of profiles throughout the lake during a field campaign from August 28 to September 6, 2014. MPMC field crews also conducted water column profiling, as discussed in Section 2.1, and a joint observations were conducted by MPMC and Tetra Tech EBA on October 24, 2014, including a comparison of the two different profiling instruments.

Tetra Tech EBA used the most recent data sets to initialize the Quesnel Lake model as they became available. Initial modelling efforts used only one MoE cast for the West Basin and historical data for the main body of the lake. The late-August Tetra Tech EBA field program yielded a large quantity of data suitable for generating initial conditions, and the October 24 field sampling included ten synoptic casts between Likely and Plato.

It is not straightforward to initialize a model of a large lake, as temperature profiles can vary from one part of the lake to another. Models can also drift over time, especially considering that the TSS:turbidity relationship was expected to change over the course of fall 2014. The latest set of synoptic casts, on October 24, was used to initialize the models predicting winter, and future, conditions in the lake. However, the earlier datasets provide a useful validation tool. Two models were run, one with initial conditions from August 13 MoE casts, and another initialized with data from Tetra Tech EBA's September 1 field observations. The August initialization assumed a single MoE cast was representative of the entire West Basin, and that the remainder of Quesnel Lake had a temperature profile identical to an observation in August 2003.

The predicted temperature profiles from the model initialized on August 13 are compared with September 1 and October 24 CTD observations near Hazeltine in Figures 5.13 and 5.14. Figure 5.13 shows scroll plots of modelled temperature and turbidity at a station offshore of Hazeltine Creek. Data from CTD and turbidity casts are shown as superimposed circles; a circle which blends into the background indicates good agreement between model and observation. The surface and bottom temperatures match the observations well in both September and October. The turbidity scroll plot shows qualitative agreement in surface turbidity, but little was known regarding the composition of bottom water when this model was initialized so the bottom predictions diverge from observations.

Figure 5.14 shows line plot comparisons of specific CTD casts and model profiles at the exact time of the observation. The model has some difficulty simulating the lower-temperature water between 20 and 30 metres depth in September, although the model does reproduce the presence of warmer water below cooler water. The October profile is well-matched at the surface and bottom, with the observations showing a somewhat sharper thermocline than modelled.

The Tetra Tech EBA observations in late August and early September were used to improve the model's initial conditions, and a new simulation was started from this date. Casts from a number of consecutive days were averaged to produce a three-dimensional dataset of temperature and suspended sediment. The predictions from the model initialized September 1 are compared with October 24 observations in Figures 5.15 and 5.16. The model does better at reproducing the cool intermediate water at 20 to 40 metres depth, and the match to the October 24 profile is accurate.

Both models predict the future temperature profiles well, with surface and bottom temperatures within 0.6°C of observations and the thermocline depth matched within observation variability. Furthermore, the August initial condition appears adequate with respect to temperature, as the predicted temperatures during the months of September and October are very similar to the more accurate initial conditions of September 1.

5.5 Quesnel River Temperature – 2014 Sonde Data

A validation of the model's predicted Quesnel River temperature is shown in Figure 5.17 for the August 12 initial conditions and Figure 5.18 for the September 1 initial conditions. There are two features to the comparison – the seasonal cooling of the lake's surface waters and therefore Quesnel River outflow, and the event-scale changes in temperature due to upwelling of bottom water. Both initial conditions resulted in a model that accurately reproduced the temperature dips on August 22, September 5 and September 12, with small temporal offsets likely due to the uncertainty in wind and meteorology over the lake compared with YWL. The wind speeds in the West Basin and the air temperature are plotted in the lower panels on both figures. The upwelling events correspond to winds from the west, which push warm surface water out of the West Basin and cause cold water to rise to the surface to replace it.

The August model (Figure 5.17) diverges somewhat from the observed temperature during September, but the accurate fit otherwise supports the assumption that one profile can represent an entire basin. The model skill for the August temperature comparison is 0.99 and the RMS error is 0.93 °C. The September 1 initial condition appears to have started somewhat 'cool' near the surface, likely due to the averaging of multiple days of casts over the entire Tetra Tech EBA field program, some of which were after the September 3 storm event that cooled the lake surface. Despite this early inaccuracy, the total heat content of the lake appears better represented after the first two weeks of the model run, converging well to the observed river temperature from September 13 to the end of the plot. The model skill for the September comparison is 0.99 and the RMS error is 1.02 °C.

The prediction of observed river temperatures within 1 °C throughout the fall of 2014, including a 10 °C change over a four day upwelling event, indicates that the model is skillfully reproducing the physics of the lake. Further adjustment of model parameters cannot produce a better result without a more complete understanding of over-lake meteorology.

6.0 MODEL RESULTS – 2014 EVENT TURBIDITY PLUME

The Quesnel Lake hydrodynamic model, validated against 2003 thermistor data, 2014 river temperature data, and regular CTD casts throughout fall 2014, was run with initial conditions based on both the September 1 and October 24 profiles (described in Section 3.1) to describe the long-term fate of whatever suspended material remained in the water column in the months after the breach event. Historical meteorological data from YWL was used for all models up to a mid-February 2015 reporting cutoff, after which point winds from another year (2010) were substituted.

The models initialized on September 1 are used to discuss fluxes of suspended material between the river, West Basin, and main body of the lake. The September 1 model starts with 41.8 x10^6 kg of suspended sediment (0.22% of estimated total sediment loss from the TSF) distributed throughout the West Basin and main body of the lake based on observed turbidity.

The October 24 profiles represent the last synoptic, or near-real-time, set of turbidity data throughout the West Basin and the main body of the lake up to Plato Island. The October 24 model starts with 12.4 x10^6 kg of suspended sediment (0.064% of estimated total sediment input) distributed throughout the lake. This model is the basis for over-winter and future 2015 turbidity predictions in the Quesnel River and throughout Quesnel Lake.

There exists considerable uncertainty about the total quantity of material suspended in the lake, and its grain size distribution and settling rate. The suspended material in both models is represented as a 2-micron clay which would sink 10 metres in approximately 40 days in the absence of vertical mixing energy. Sensitivity tests indicate that the behaviour of the modelled lake is similar once a certain minimum quantity of suspended sediment is included.

6.1 Temperature and Turbidity Sections

A series of maps and sections present the initial and modelled distribution of turbidity in the West Basin of Quesnel Lake. The model was initialized on October 24, 2014 and run to the end of 2015. All maps show the turbidity in the surface layer of the model. The colour scale represents turbidity and is constant across the six maps and sections. Temperature is contoured as lines at 1 °C intervals. The map and section are both cut off at the same location somewhat east of Plato Island to better show detail in the West Basin and Cariboo Island region.

- Figure 6.1 – October 25, 2014. The model's initial condition based on ten casts on October 24, 2014; the model was initialized at the subsequent midnight. Conditions were calm during observations and the thermocline is at a constant depth of 25-30 m. Turbidity gradually increases with depth in the West Basin to a maximum near 50 NTU, although the colour scale cuts off at a lower value.

- Figure 6.2 – October 31, 2014. Approximately a week after model initialization, a wind event from the southeast deepens the thermocline near Likely, pushing turbid bottom water up and over the sill. The thermocline deepens in the main lake body as not all of the pooling water can fit into the West Basin.

- Figure 6.3 – November 10, 2014. Winds reverse, moving surface waters away from Likely and drawing turbid water closer to the surface. Some mixing may be occurring near Cariboo Island as surface water 'deepens' to cover the entire water column. Stratification is weaker (fewer temperature contour lines) than previously.

- Figure 6.4 – November 30, 2014. There is no evidence of temperature stratification in the West Basin, and a split between turbid material at the bottom and material mixed to the surface near Likely. This is a snapshot in the middle of what is termed the fall overturn, or progression to complete mixing.

- Figure 6.5 – January 15, 2015. Reverse temperature stratification has set in, with surface waters cooler than the bottom water near 4 °C. Some residual turbidity is predicted in the bottom water, with clear upper water connected to the main body of the lake.
- Figure 6.6 – August 17, 2015. The model includes no additional turbidity fluxes, such as from Hazeltine Creek or other rivers, so any turbidity remaining is only due to the original event. The model predicts some residual turbidity below the thermocline. The surface turbidity is below 0.1 NTU where the colour scale on the section plot is cut off.

The model run described in the previous maps and sections is summarized below in scroll plots and time series of river turbidity, focussed on locations just offshore of Hazeltine Creek and just east of Cariboo Island.

6.2 Turbidity Time Series

The modelled turbidity regime from October 24, 2014 through the end of 2015 is summarized in Figures 6.7 and 6.8 for three locations of interest. The figures are identical in content except Figure 6.7 shows the data from October 2014 to March 2015 in finer detail and Figure 6.8 shows the entire year of 2015.

The modelled and observed turbidity in the Quesnel River outflow is plotted in the top panel of both figures. The observed turbidity data was obtained from MPMC and comes from two sources, a water quality sonde at site QUR-1 (black lines), and laboratory analyses of water samples from the same site (black points). The observations and model show turbidity starting to increase above background levels on November 10. The model generally tracks the observed turbidity, with two brief (4-8 day, ~5 NTU) overestimates in mid- and late November. There are short-term spikes in the turbidity sonde time series that are not replicated in either the model or the laboratory samples; these are therefore interpreted as instrument noise or malfunction.

A number of model sensitivity tests were conducted in an effort to best match observations. The model parameters adjusted include the ratio between vertical mixing of velocity and scalars, and a factor decreasing the wind speeds in the West Basin relative to the rest of the lake. The Quesnel River turbidity time series from these alternate models are shown as blue lines. It is possible, by adjusting these parameters, to change the time at which complete vertical mixing occurred in the West Basin. The best-matching model results used a vertical diffusivity / viscosity ratio of 0.5, somewhat larger than the 0.1 used in the 2003 validation. Numerical details on this and other model parameters are discussed in Appendix B. The 2003 model, when rerun with a 0.5 ratio, performed with acceptable, but slightly lesser model skill. The goal of using the same numerical parameters in the calibration, validation, and production model runs is valid, but there is also a physical basis for using a different number in the mixing parameterization in years with and without a sediment-driven density interface.

Previously-published Tetra Tech EBA model predictions of winter 2015 water quality are shown in light blue. These predictions were presented in an initial MPMC memo "Quesnel Lake Cloudiness at Lake Overturn" on November 14, 2014. These models were superseded once model calibration was complete and the volume of sediment in the October 23 initial condition was refined based on observations and laboratory water quality analyses.

A scroll plot of turbidity at QUL-66a is shown in the centre panel for Figures 6.7 and 6.8, with a style similar to Figure 5.15 but for the October 24 initial conditions. The bottom panel of both figures contains a scroll plot from QUL-79, just east of Cariboo Island. Both scroll plots show MPMC turbidity casts as coloured boxes corresponding to the model's turbidity scale.

The scroll plots show evidence of episodic fluxes of material from the West Basin to the main body of the lake. These occur during or after wind events as the interface between clear surface water and turbid deep water tilts.

The flux of material over the sill was calculated from model results, combining the transport of water over the sill (as in Figure 5.12) with a sediment concentrations to produce a comparison of the rates of transport. The flux of water and suspended material from the September 1 model initial condition through February 2015 is shown in Figure 6.9. The third panel shows episodic transport of material from the West Basin to the main body of the lake. A smaller amount of material can briefly flow back into the West Basin as the seiche reverses phase and therefore transport direction. For much of the fall, transport is dominated by seiche dynamics and the river concentration of material is nearly zero. After the fall overturn the river flux increases and the seiche-induced transport decreases. The transport of material out the Quesnel River peaks in November 2014, and then decreases as both river flow and concentration drop over the remainder of the winter.

Quesnel Lake can be coarsely characterized as having a ten-year residence time based on its volume and the flow of rivers. Similarly, the residence time of the West Basin is on the order of three months considering the same river flow and a smaller volume. The reduction in West Basin turbidity on the time scale of a single residence time cannot be explained by average residence time, and the exchange over the sill provides a stronger explanation. As noted in Laval et al. (2008), a single large seiche and upwelling event can exchange 50-60% of the West Basin's bottom water, and multiple such events can continue to dilute and exchange bottom water.

The fluxes of West Basin bottom water over the sill help to explain why river turbidity at overturn was not as high as initially expected. The modelled behaviour of the turbid bottom waters in the West Basin support the interpretation that the bulk of observed suspended material either settled or was transported, much diluted, to the main body of the lake over the fall of 2014.

7.0 CONCLUSION

Observations, analysis, and modelling of Quesnel Lake after the August 4 TSF breach indicate that the suspended material introduced by the debris flow persisted in the water column at depth in the West Basin of the lake for a number of months before mixing either with surface waters or with the main body of the lake.

A series of field observations by MPMC and Tetra Tech EBA staff tracked a water mass containing suspended material and water originating in the TSF. The water mass had a distinct signature of elevated temperature, conductivity, and turbidity. Density calculations based on these three parameters allowed a characterization of the minimum mass of material present, and informed the setup of a hydrodynamic model of the lake.

The hydrodynamic model H3D was implemented in Quesnel Lake and validated to an existing dataset of temperature in 2003. A series of models were then run in 2014 based on specific observations in an iterative modelling process. Uncertainties in the data required for modelling include sparse wind observations and the changing composition of the material suspended in the lake due to settling and exchange processes. The uncertainties are of low impact on predictions, demonstrated by the model's successful reproduction of events such as observed seiches, where internal responses to wind events brought material and cold water close to the surface at Likely. The long-term evolution of Quesnel River turbidity was also well-characterized by the model.

The model predicts that, barring new sources of material, minor (1-2 NTU) residual turbidity may be found in bottom waters in the remainder of 2015. MPMC is currently executing a program of turbidity observations, to monitor the recovery of the lake. Analysis of sediment flux indicates that residence time of material in the West Basin was reduced by exchange processes over the sill at Cariboo Island, and much of the suspended material mixed with the main body of the lake instead of being transported out the Quesnel River.

8.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
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JR/DP/AO/JS/ml

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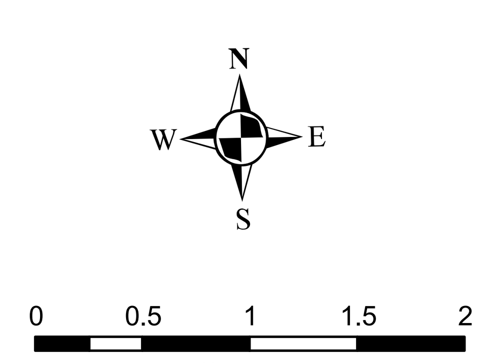
FIGURES



Geodetic Settings		Survey Equipment	
Horizontal Datum	WGS84	**Bathymetry Sensor**	RESON SeaBat 7125
Projection	UTM Zone 10N, Meters	**Positioning System**	Trimble SPS65x with Omnistar
Horizontal Units	Meters	**Heading and Motion Sensors**	Applanix POS MV 320, IXBLUE GAPS
Vertical Units	Meters	**USBL**	IXBLUE GAPS
Vertical Datum	CGVD28 (HT2_0 geoid)	**Sound Speed Profilers**	YSI Castaway, SeaBird SBE-19plus
GPS L1/L2 Corrections	Trimble SPS650 with MarineStar	**Dates Surveyed**	08/30/14 - 09/06/14

Multibeam Bathymetry

Tetra Tech EBA
Oceanic Plaza, 9th Fl.
1066 W. Hastings St.
Vancouver, BC V6E 3X2

TETRA TECH

Crew Chief:	Richard Funk	
Drafted by:	Burr Bridge	FIGURE
Reviewed by:	Robert Feldpausch	2.1

Notes:
1. Survey period: 08/30/14 - 09/06/14

Geodetic Settings	
Horizontal Datum	WGS84
Projection	UTM Zone 10N, Meters
Horizontal Units	Meters
Vertical Units	Meters
Vertical Datum	CGVD28 (HT2_0 geoid)
GPS L1/L2 Corrections	Trimble SPS650 with MarineStar

Survey Equipment	
Bathymetry Sensor	RESON SeaBat 7125
Positioning System	Trimble SPS65x with Omnistar
Heading and Motion Sensors	Applanix POS MV 320, IXBLUE GAPS
USBL	IXBLUE GAPS
Sound Speed Profilers	YSI Castaway, SeaBird SBE-19plus
SideScan/Sub-Bottom Profiler	Edgetech 2000DSS

Multibeam Bathymetry / Side Scan Imagery

Tetra Tech EBA
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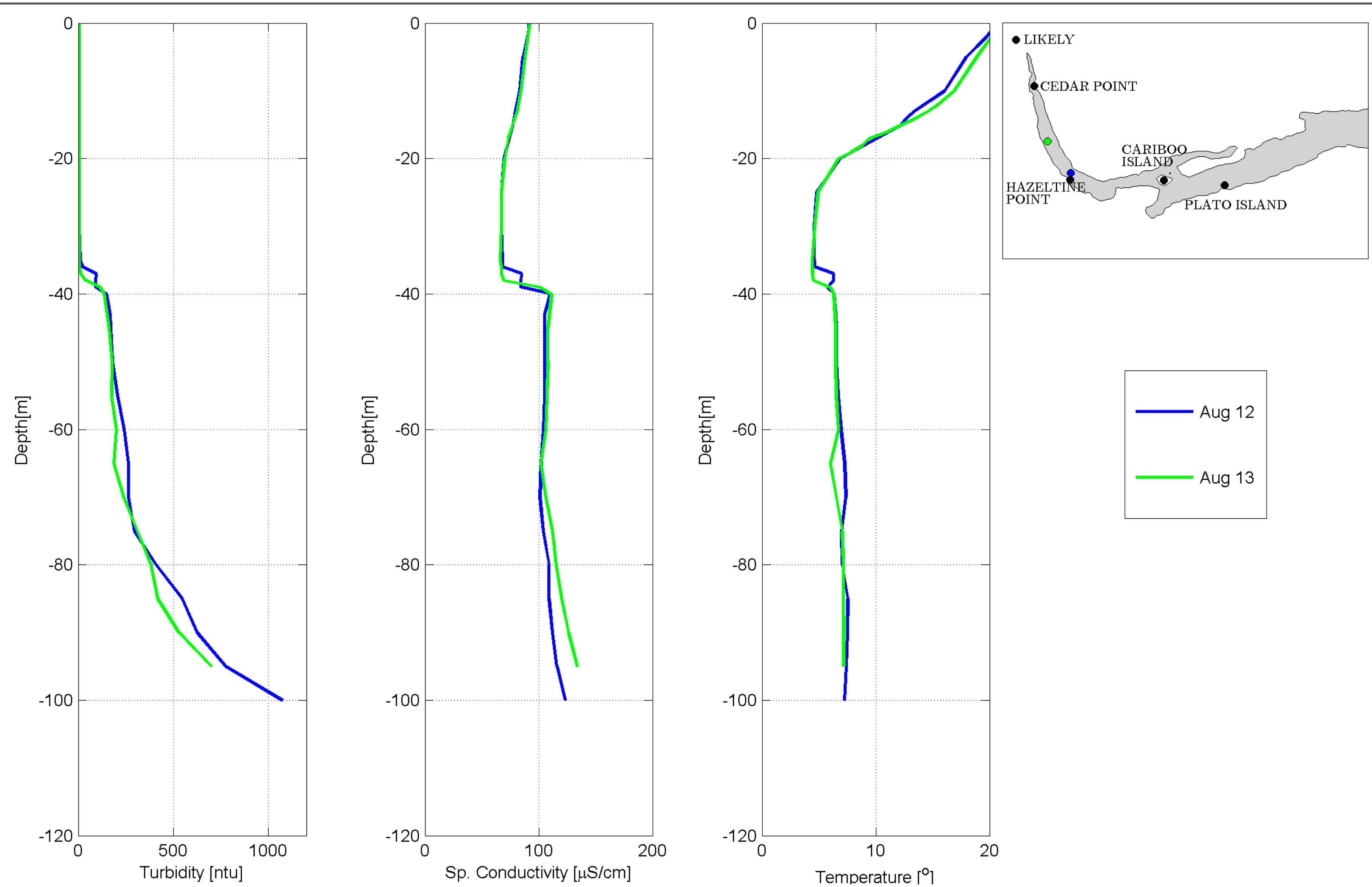
Crew Chief:	Richard Funk	
Drafted by:	Burr Bridge	Figure
Reviewed by:	Robert Feldpausch	2.2



NOTES

Data hand-digitized from MoE field sheets

Turbidity units at unknown calibration, YSI 6600 instrument

STATUS
ISSUED FOR USE

CLIENT
MPMC

TETRA TECH EBA

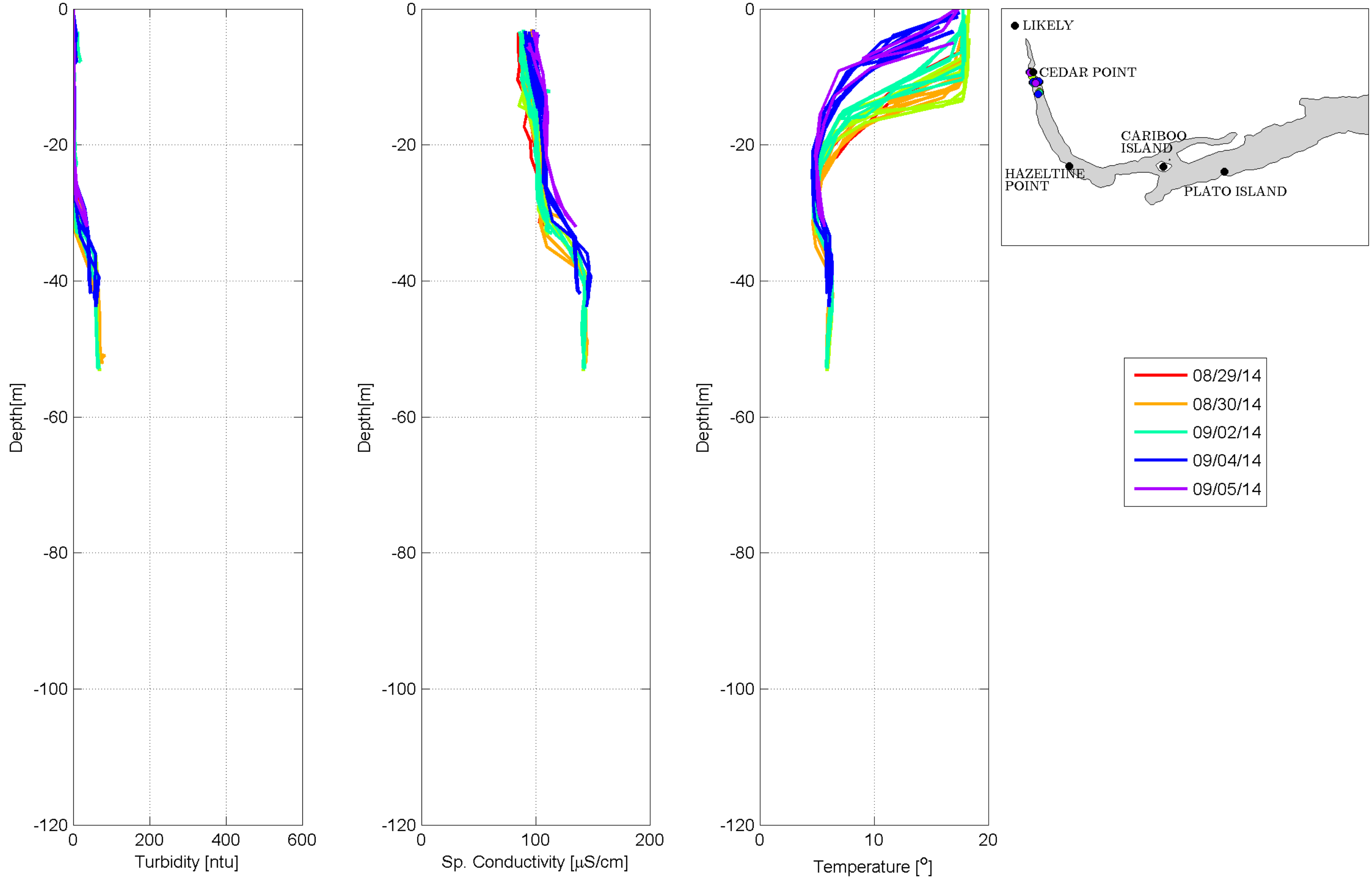
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

August 12 and 13 BC MoE Temperature, Turbidity and Conductivity Casts

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 3.1



NOTES

Data collected by Tetra Tech with RBR Concerto CTD+Tu

Turbidity units converted to match YSI calibration

STATUS
ISSUED FOR USE

CLIENT
MPMC

TETRA TECH EBA

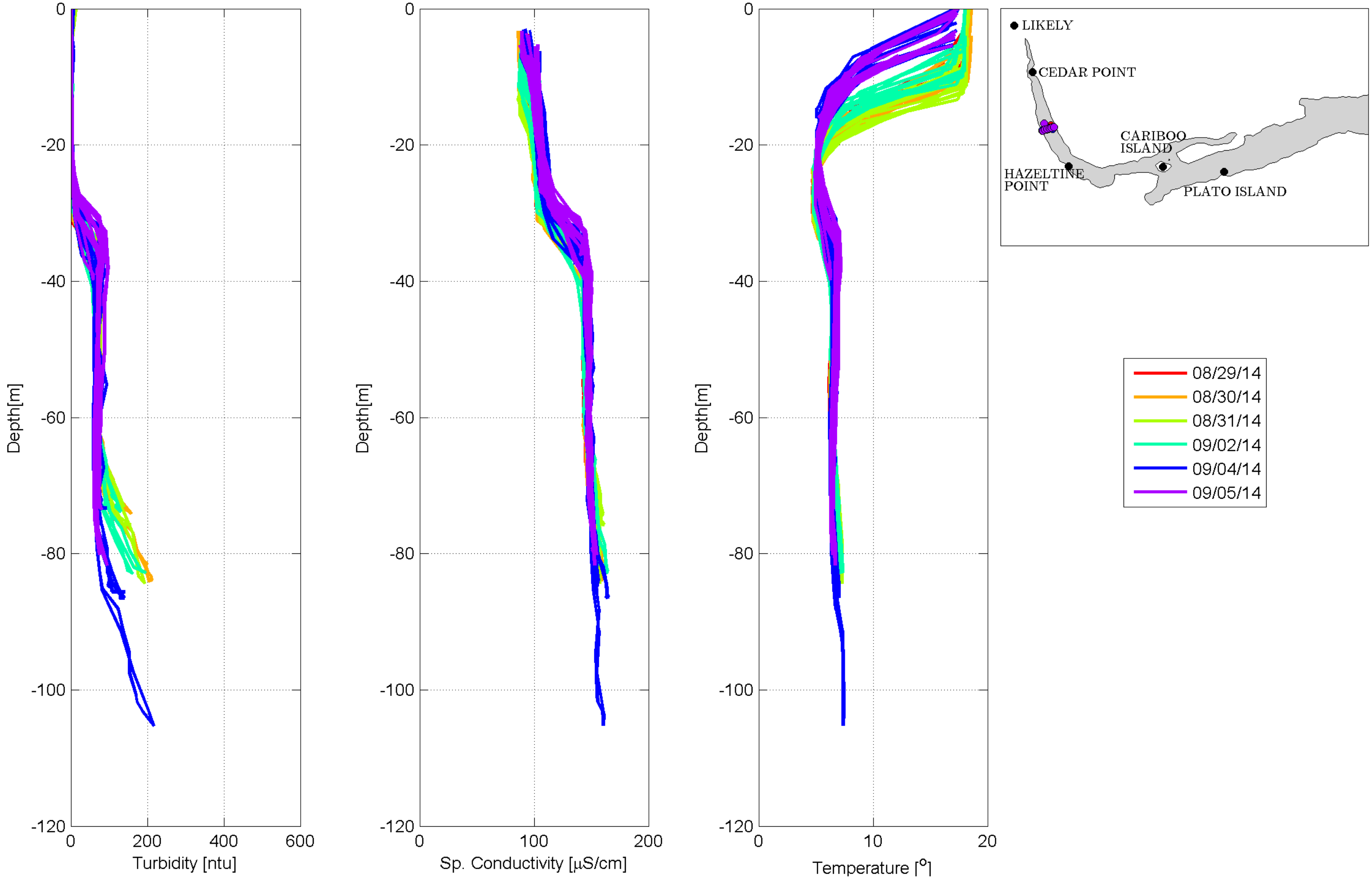
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Temperature, Conductivity and Turbidity Casts - Aug 29 - Sep 5, 2014, Cedar Point

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 3.2



NOTES

Data collected by Tetra Tech with RBR Concerto CTD+Tu

Turbidity units converted to match YSI calibration

STATUS
ISSUED FOR USE

CLIENT
MPMC

TETRA TECH EBA

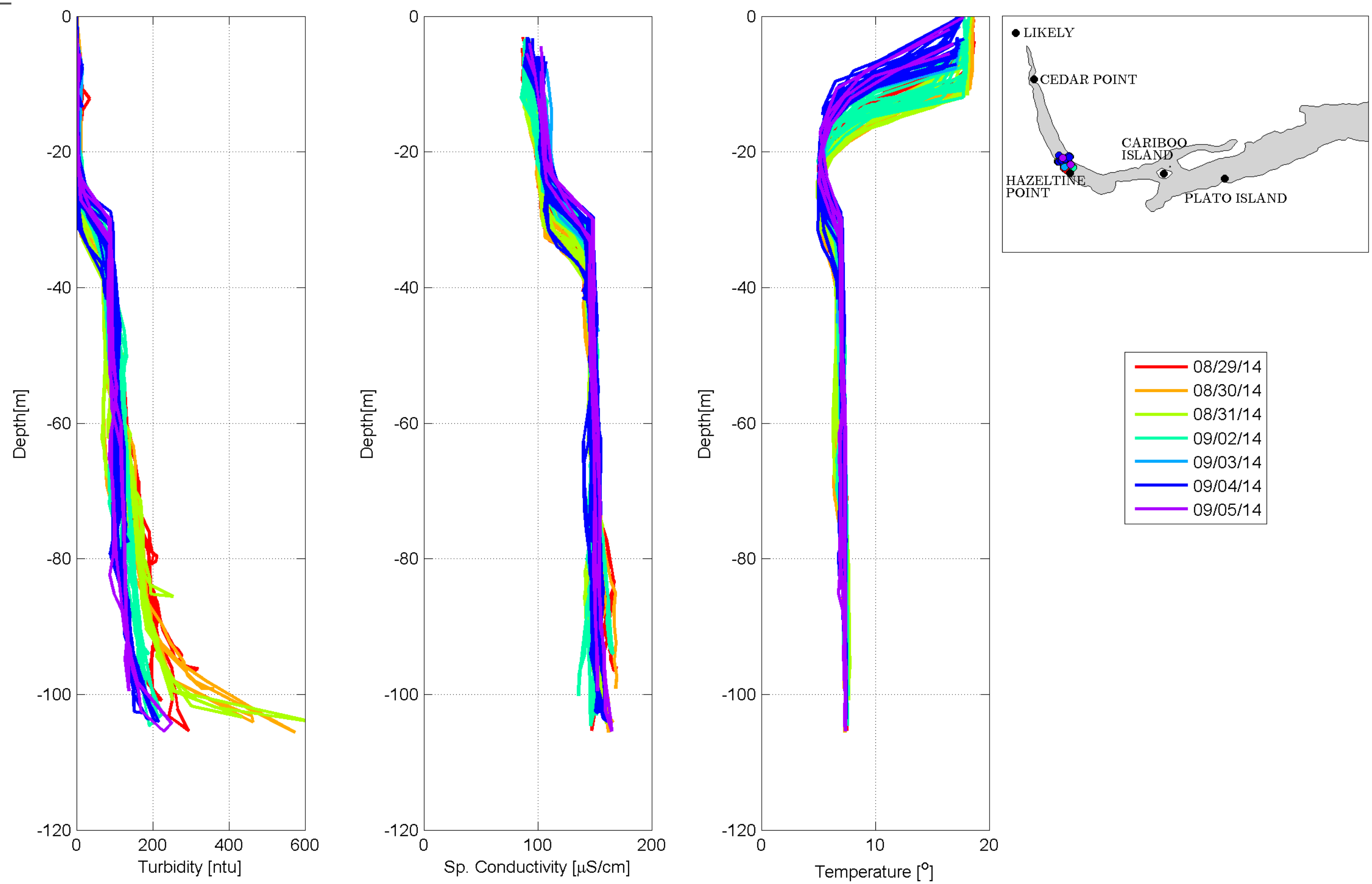
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Temperature, Conductivity and Turbidity Casts - Aug 29 - Sep 5, 2014, Green Buoy

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 3.3



NOTES

Data collected by Tetra Tech with RBR Concerto CTD+Tu

Turbidity units converted to match YSI calibration

STATUS
ISSUED FOR USE

CLIENT
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TETRA TECH EBA

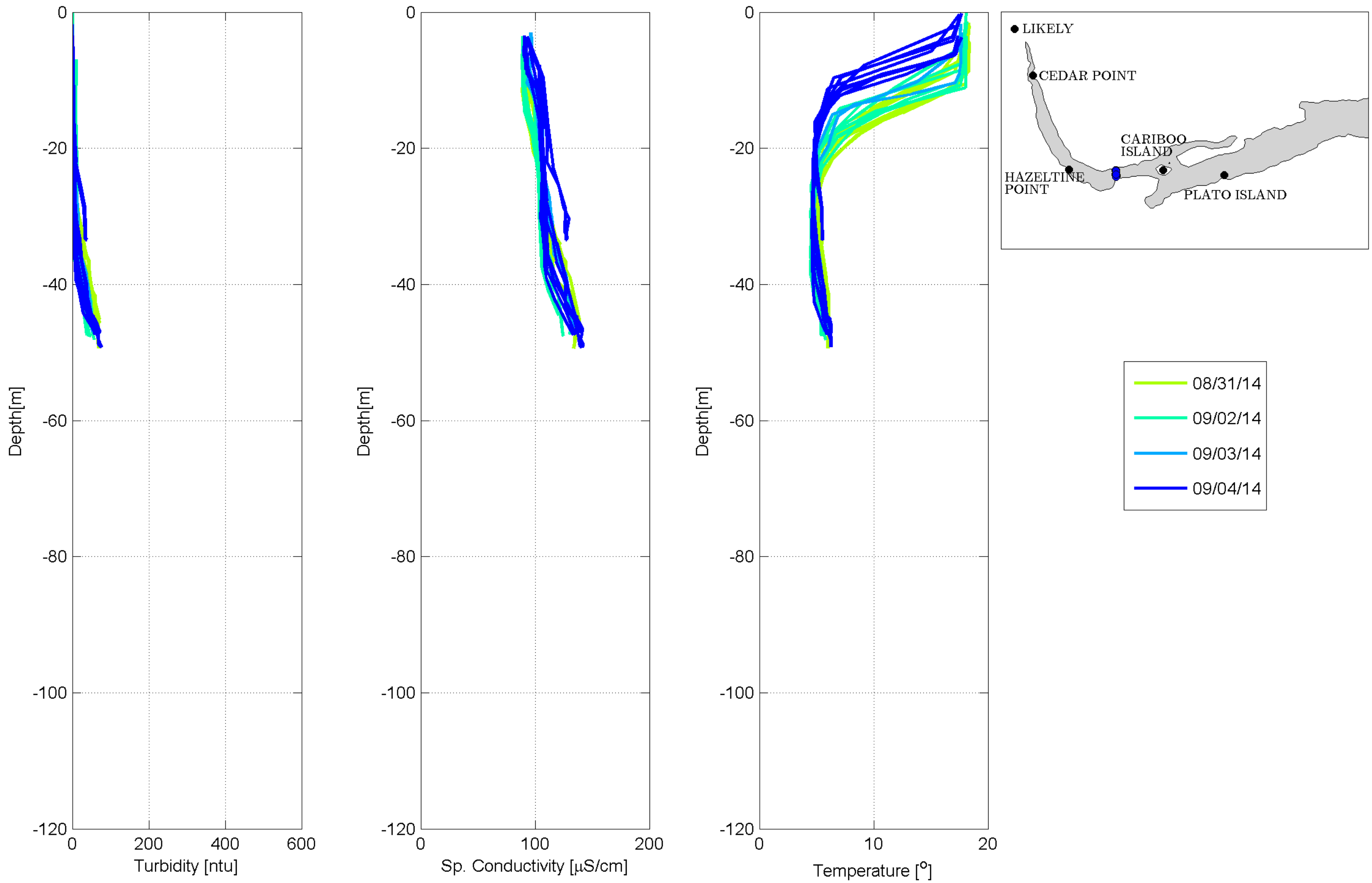
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Temperature, Conductivity and Turbidity Casts - Aug 29 - Sep 5, 2014, Hazeltine

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 3.4



NOTES

Data collected by Tetra Tech with RBR Concerto CTD+Tu

Turbidity units converted to match YSI calibration

STATUS
ISSUED FOR USE

CLIENT

MPMC

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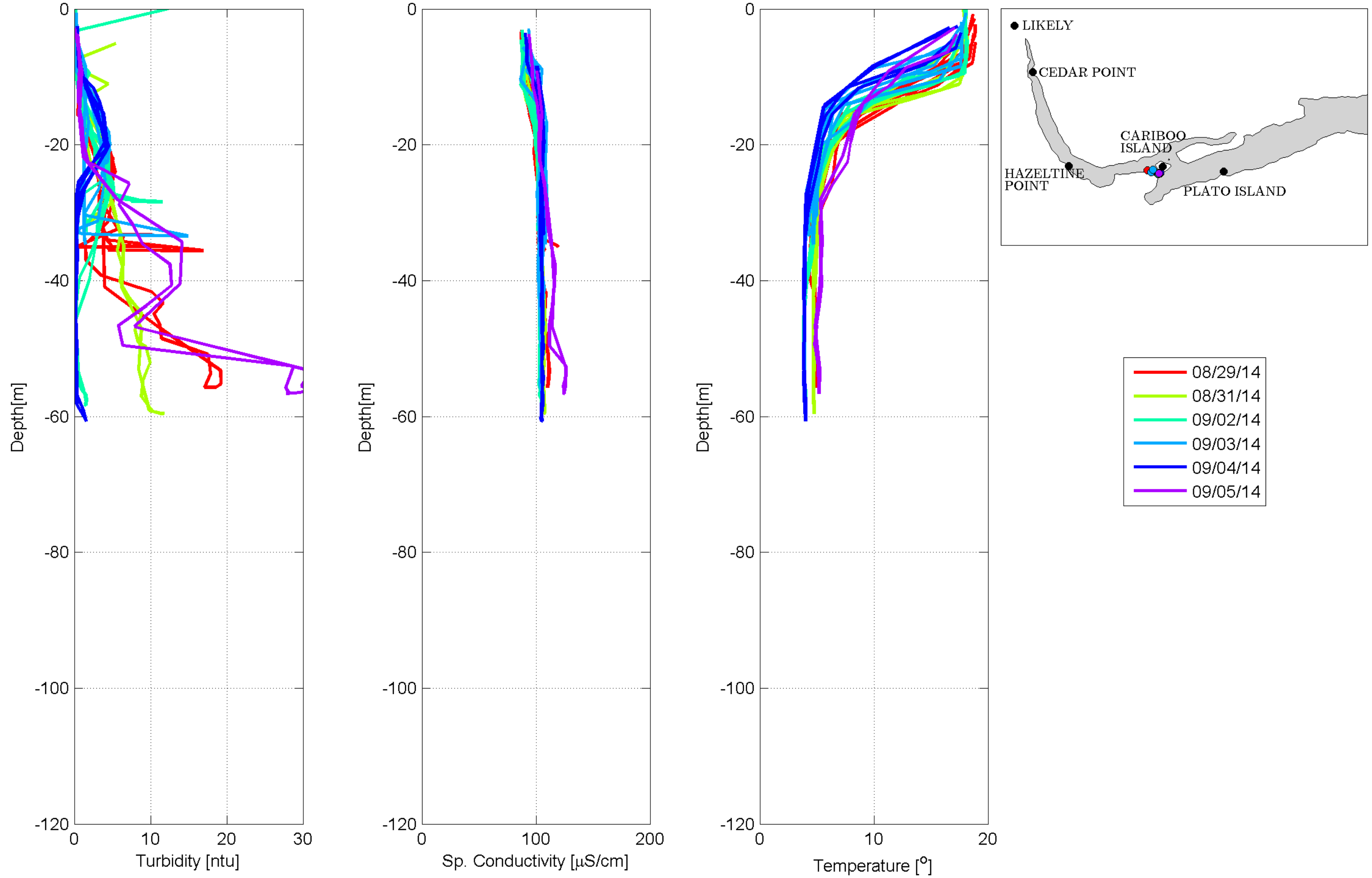
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Temperature, Conductivity and Turbidity Casts - Aug 31 - Sep 4, 2014, Mitchell

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 3.5



NOTES

Data collected by Tetra Tech with RBR Concerto CTD+Tu

Turbidity units converted to match YSI calibration

STATUS
ISSUED FOR USE

CLIENT
MPMC

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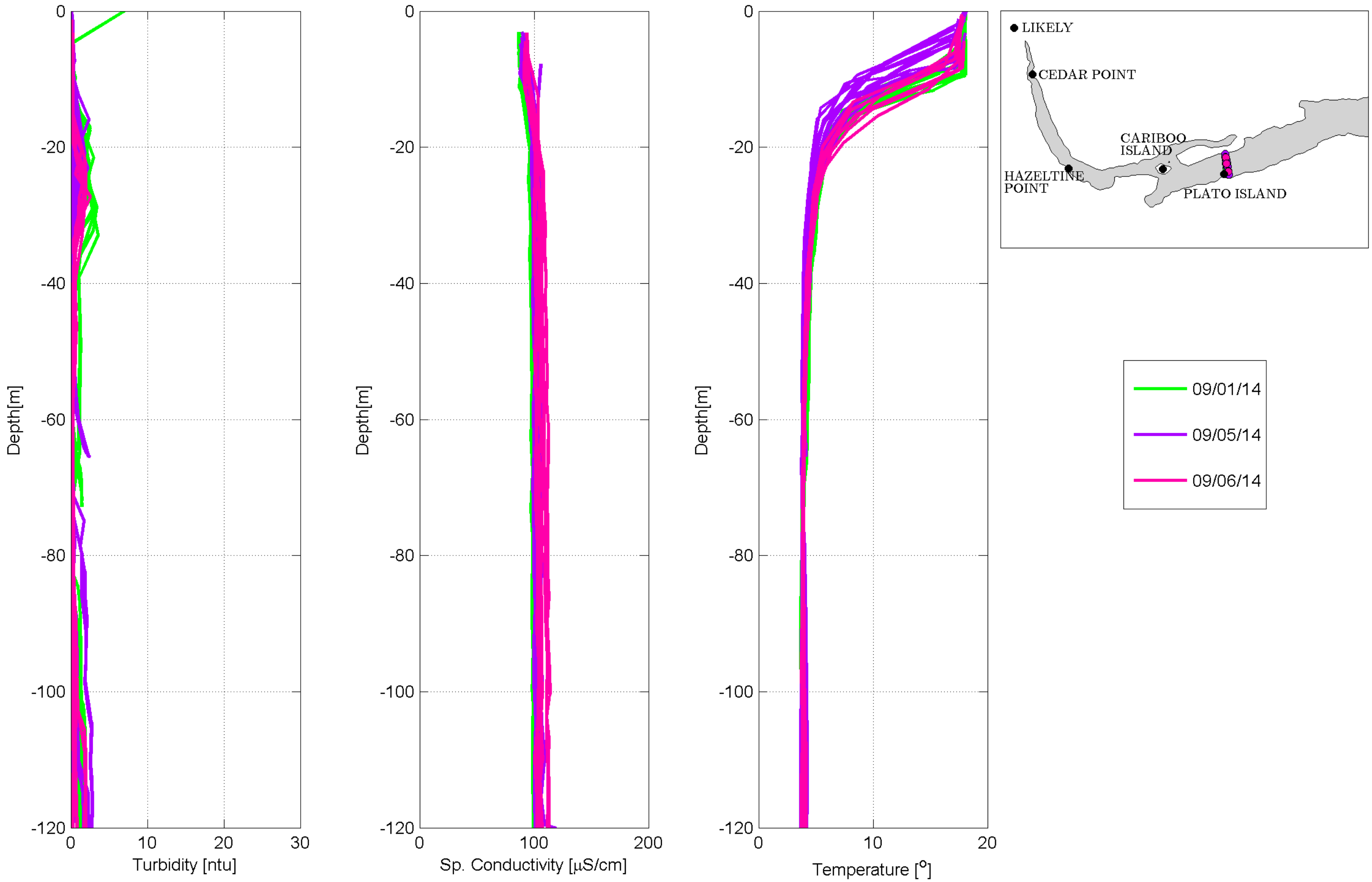
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Temperature, Conductivity and Turbidity Casts - Aug 29 - Sep5, 2014, Cariboo

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 3.6



NOTES

Data collected by Tetra Tech with RBR Concerto CTD+Tu

Turbidity units converted to match YSI calibration

STATUS
ISSUED FOR USE

CLIENT
MPMC

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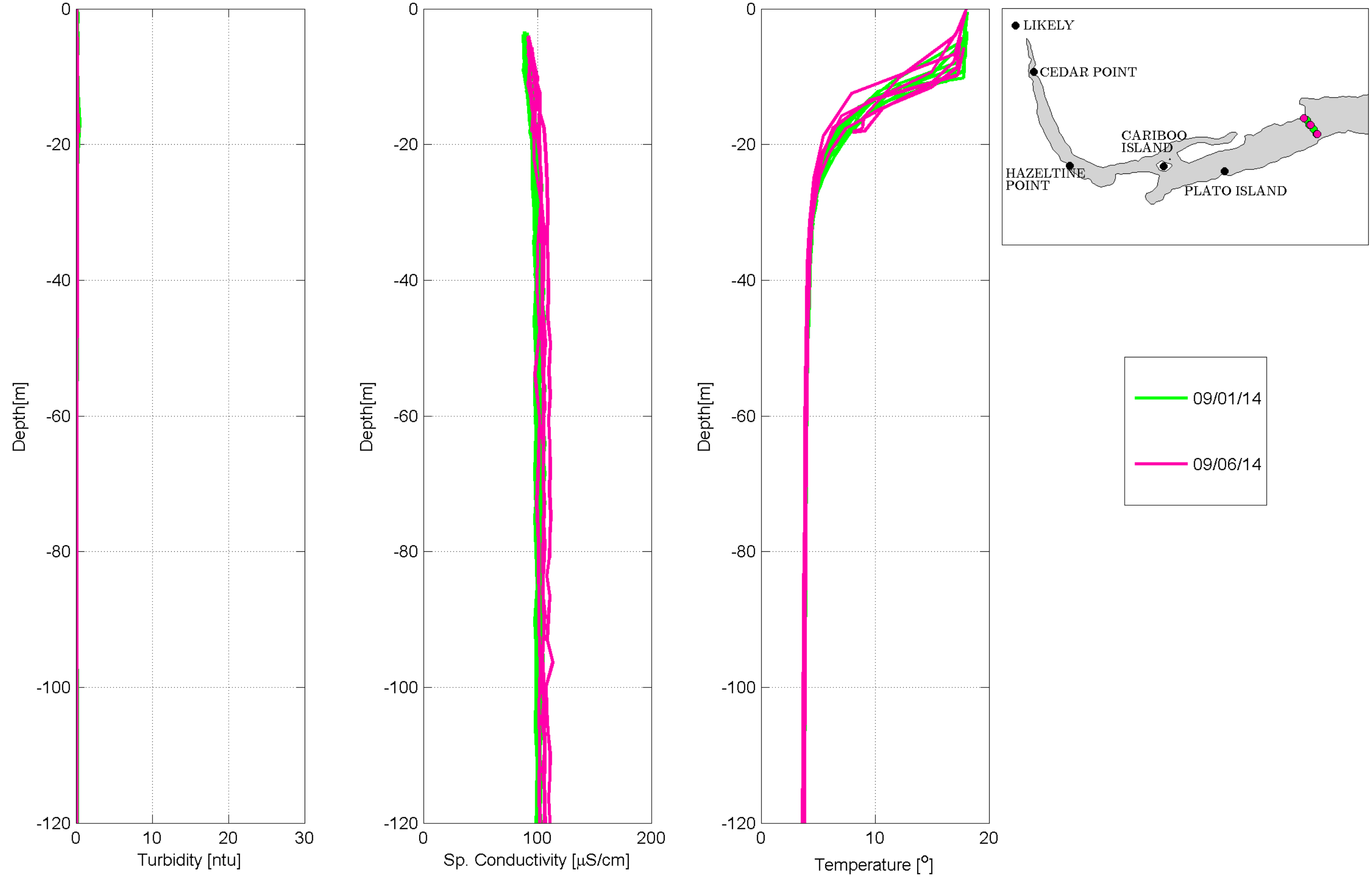
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Temperature, Conductivity and Turbidity Casts - September 1, 5, and 6 - Plato

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0
OFFICE	DATE			
Tetra Tech EBA - VANC	May 2015			

Figure 3.7



NOTES

Data collected by Tetra Tech with RBR Concerto CTD+Tu

Turbidity units converted to match YSI calibration

STATUS
ISSUED FOR USE

CLIENT

MPMC

TETRA TECH EBA

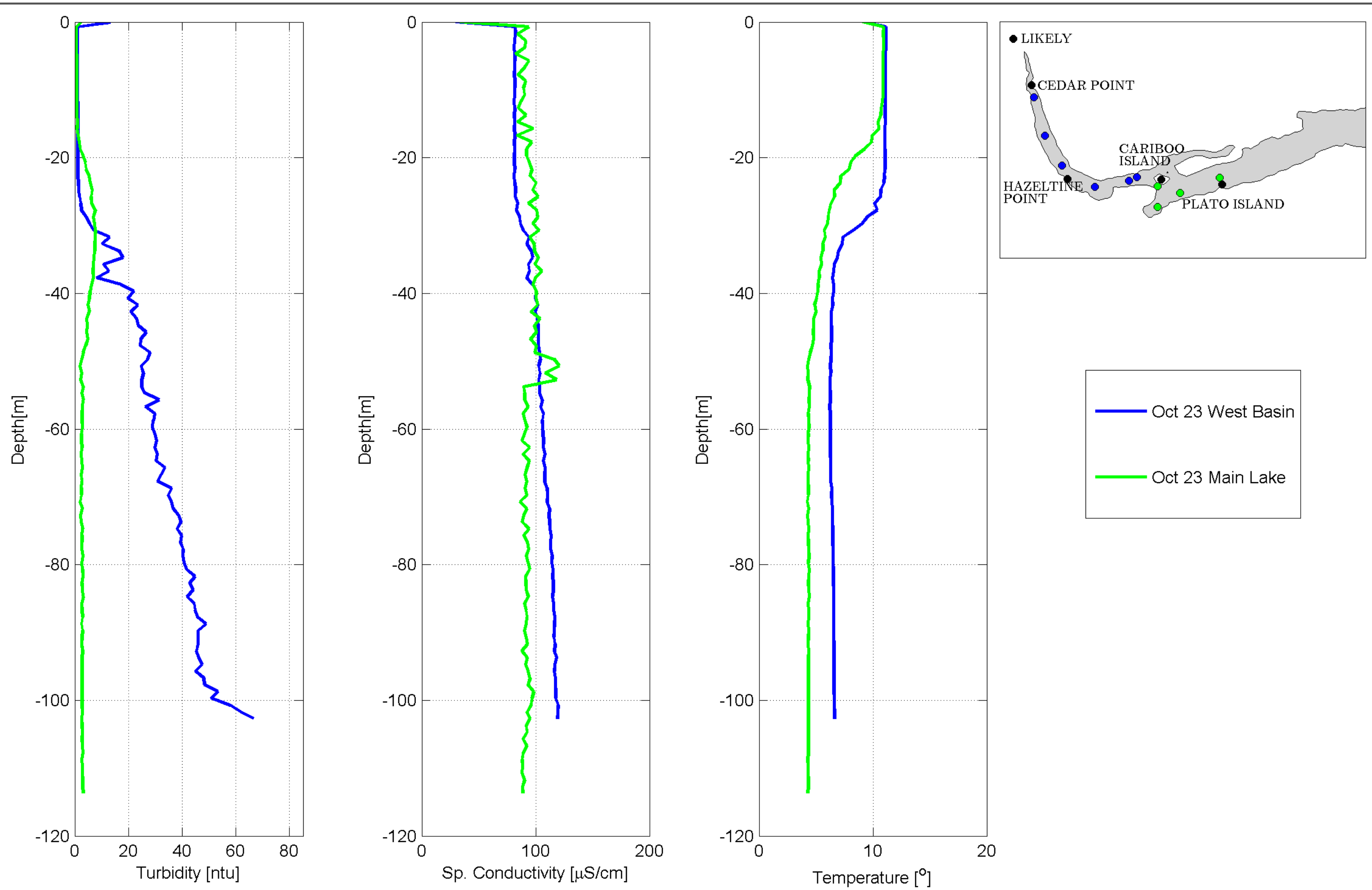
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Temperature, Conductivity and Turbidity Casts - Sep 1 and 6, 2014, Bean Point

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 3.8



NOTES

Data collected by Tetra Tech with RBR Concerto CTD+Tu

Turbidity units converted to match YSI calibration

STATUS
ISSUED FOR USE

CLIENT
MPMC

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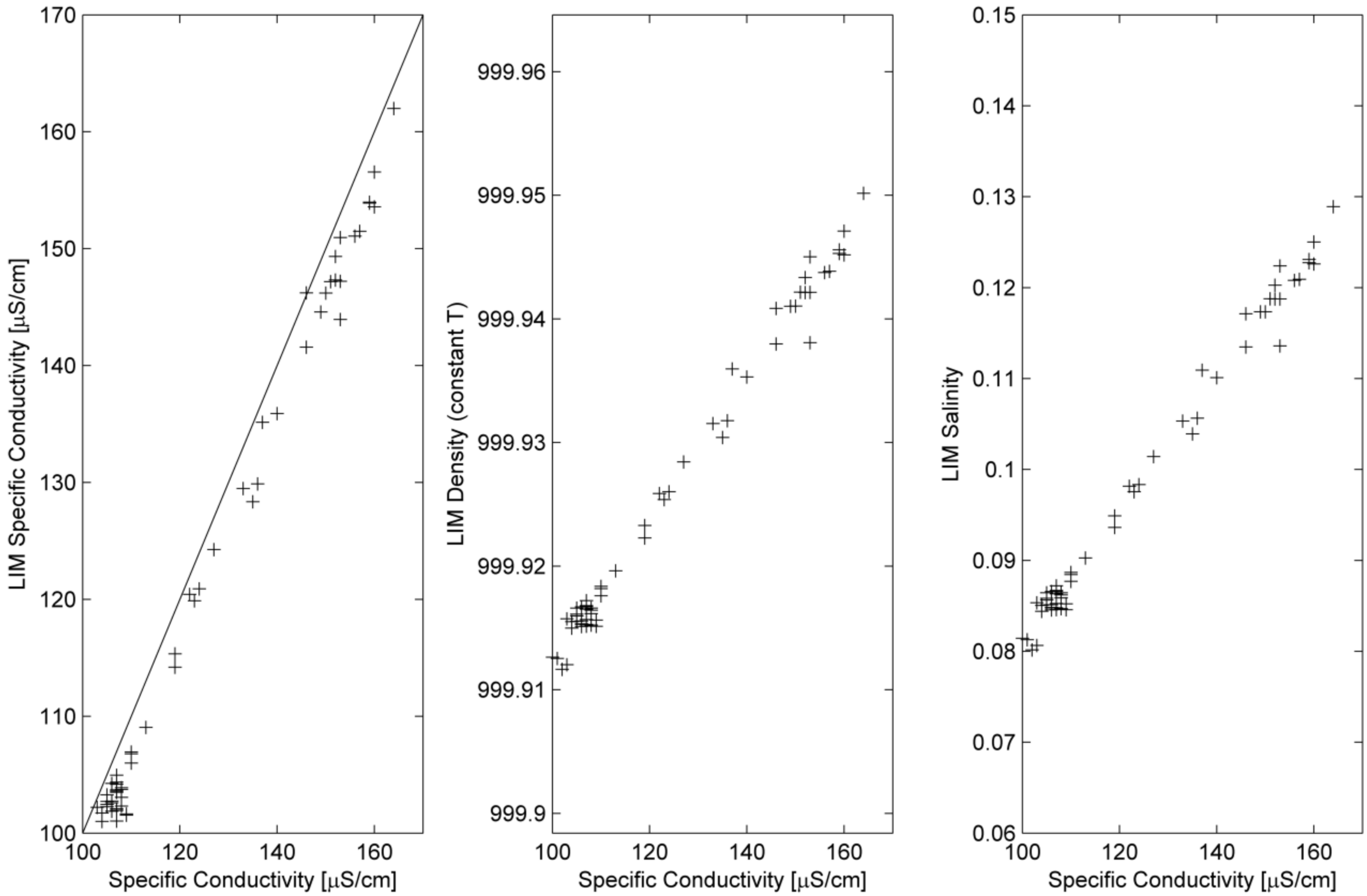
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Temperature, Conductivity and Turbidity Casts - October 24, 2014

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 3.9



NOTES

Specific Conductivity from 69 deep Quesnel Lake (>40 m) water samples taken between August 7 and September 3, 2014 analyzed for physical parameters and metals.

Derived parameters computed using LIM toolbox (Pawlowicz 2008)

STATUS
ISSUED FOR USE

CLIENT
MPMC

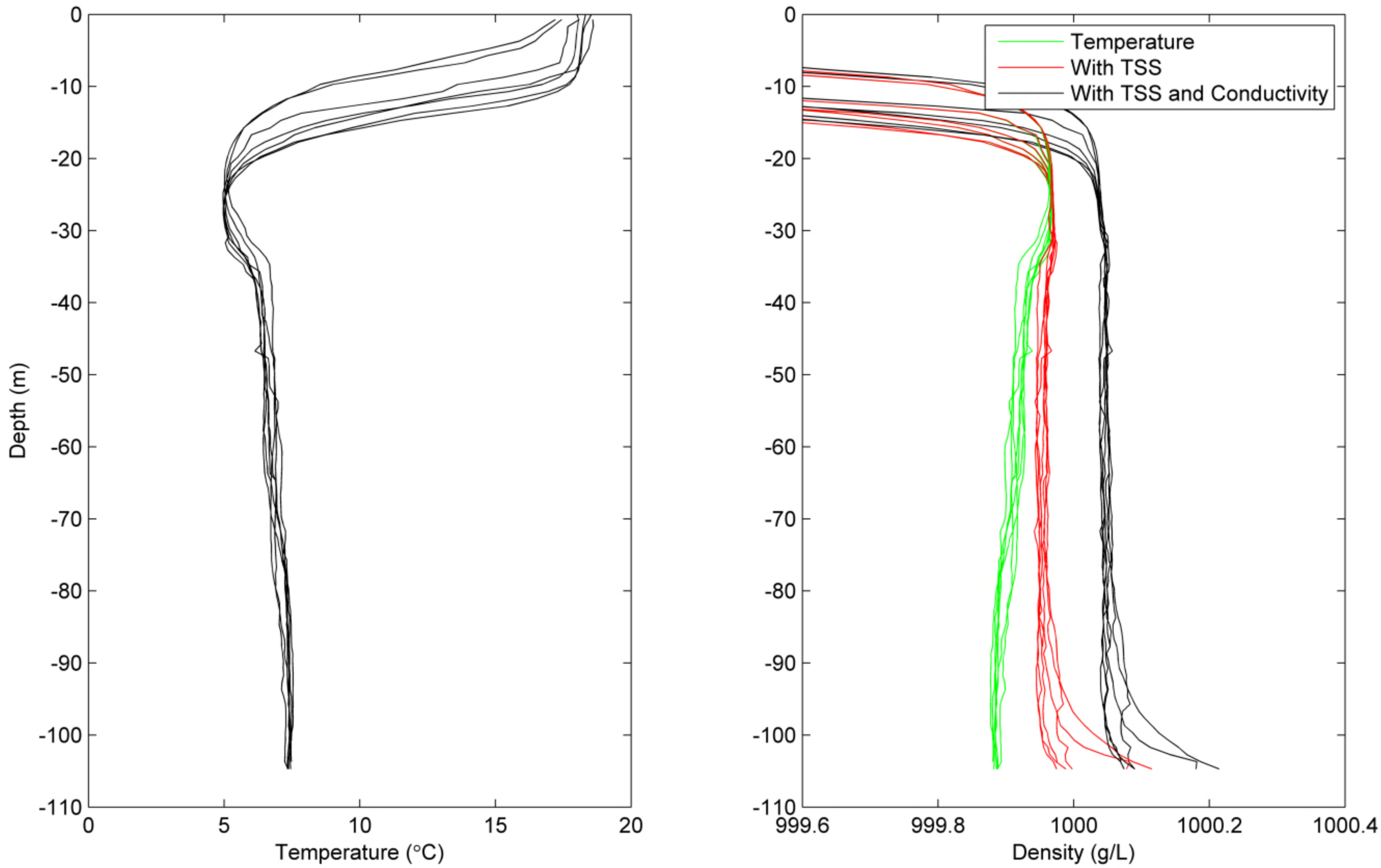
TETRA TECH EBA

QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Conductivity / Density Relationships

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0
OFFICE	DATE			
Tetra Tech EBA - VANC	May 2015			

Figure 3.10



NOTES

A linear relationship between observed turbidity and actual total suspended solids (TSS) is assumed for this calculation.

The minimum Turbidity : TSS relationship required for water column stability was calculated as a ratio of 1 mg/L to 1.5 NTU based on casts in the West Basin between August 28 and September 1, 2014.

Turbidity units were corrected to match YSI calibration

STATUS
ISSUED FOR USE

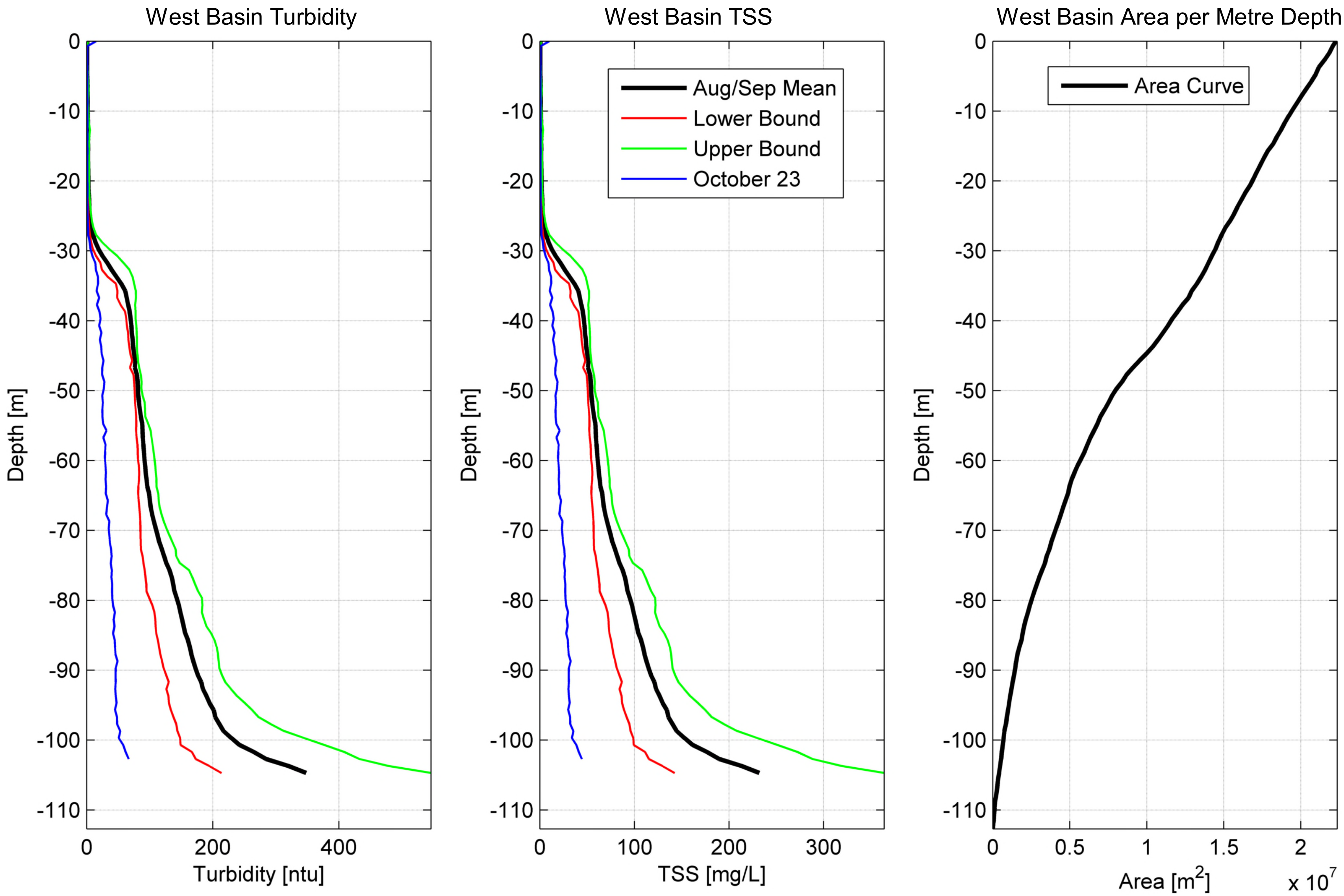
CLIENT
MPMC

TETRA TECH EBA

QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Water Column Stability Determination of TSS using Tt Casts

PROJECT NO.	DWN	CKD	APVD	REV	
V13203212	JMR	JAS	JAS	0	Figure 3.11
OFFICE	DATE				
Tetra Tech EBA - VANC	May 2015				



NOTES

TSS: Turbidity relationships of 1 mg/L to 1.5 NTU based on minimum stability method

Turbidity units were corrected to match YSI calibration

STATUS
ISSUED FOR USE

CLIENT
MPMC

TETRA TECH EBA

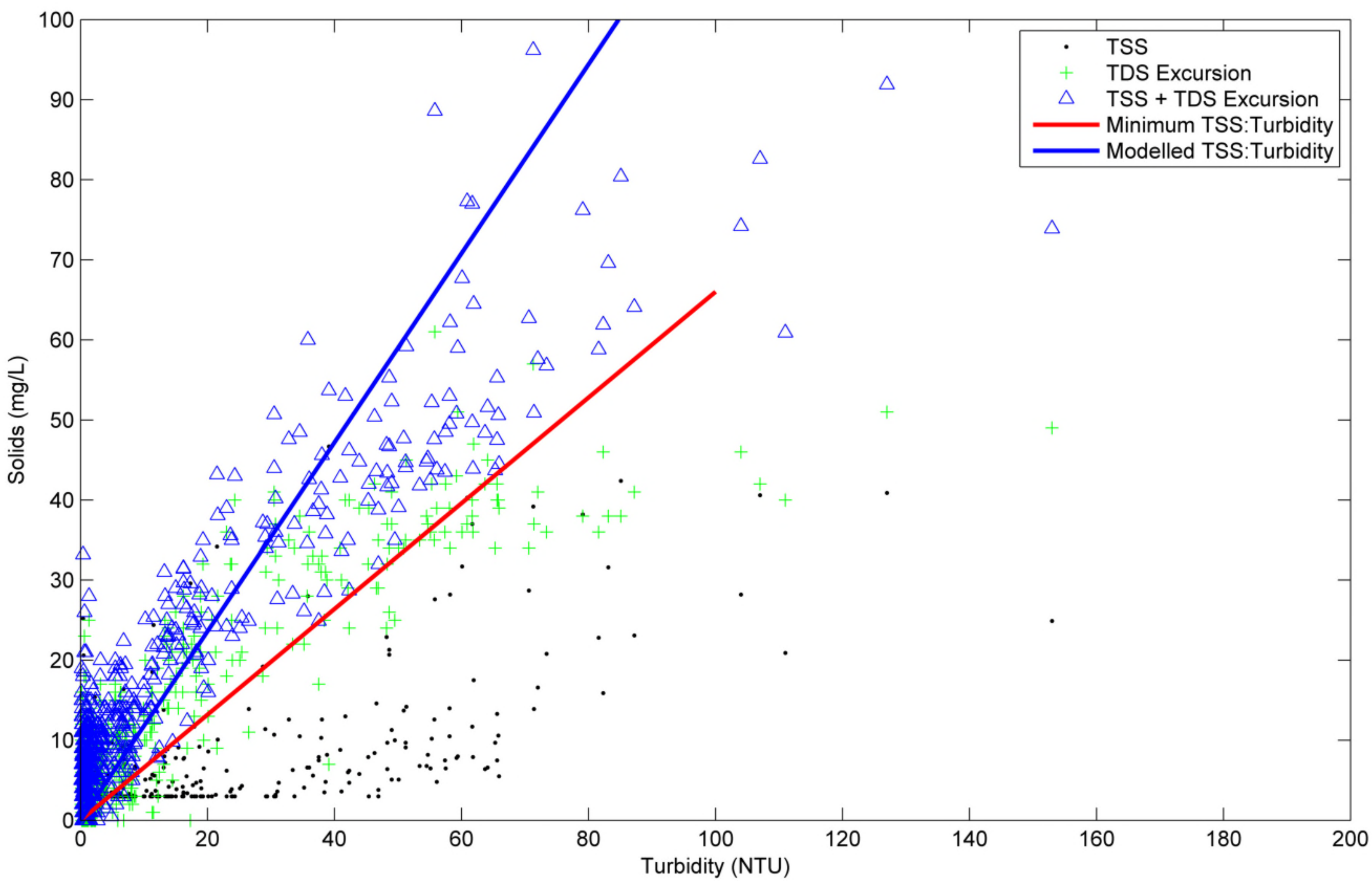
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Stability Determination of Minimum Suspended Sediment Mass

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 3.12



NOTES

Data from 1,106 samples collected at various locations in Quesnel Lake, August 2014 - January 2015

TSS (Total Suspended Solids) represents material greater than 1.5 microns in size
TDS includes both dissolved and colloidal material (grain size smaller than 0.45 microns)
The TDS excursion is defined as the measured TDS minus the background TDS of 66 mg/L.
Background is defined solely for the purpose of modelling as the mean of samples from the lake surface

STATUS
ISSUED FOR USE

CLIENT
MPMC

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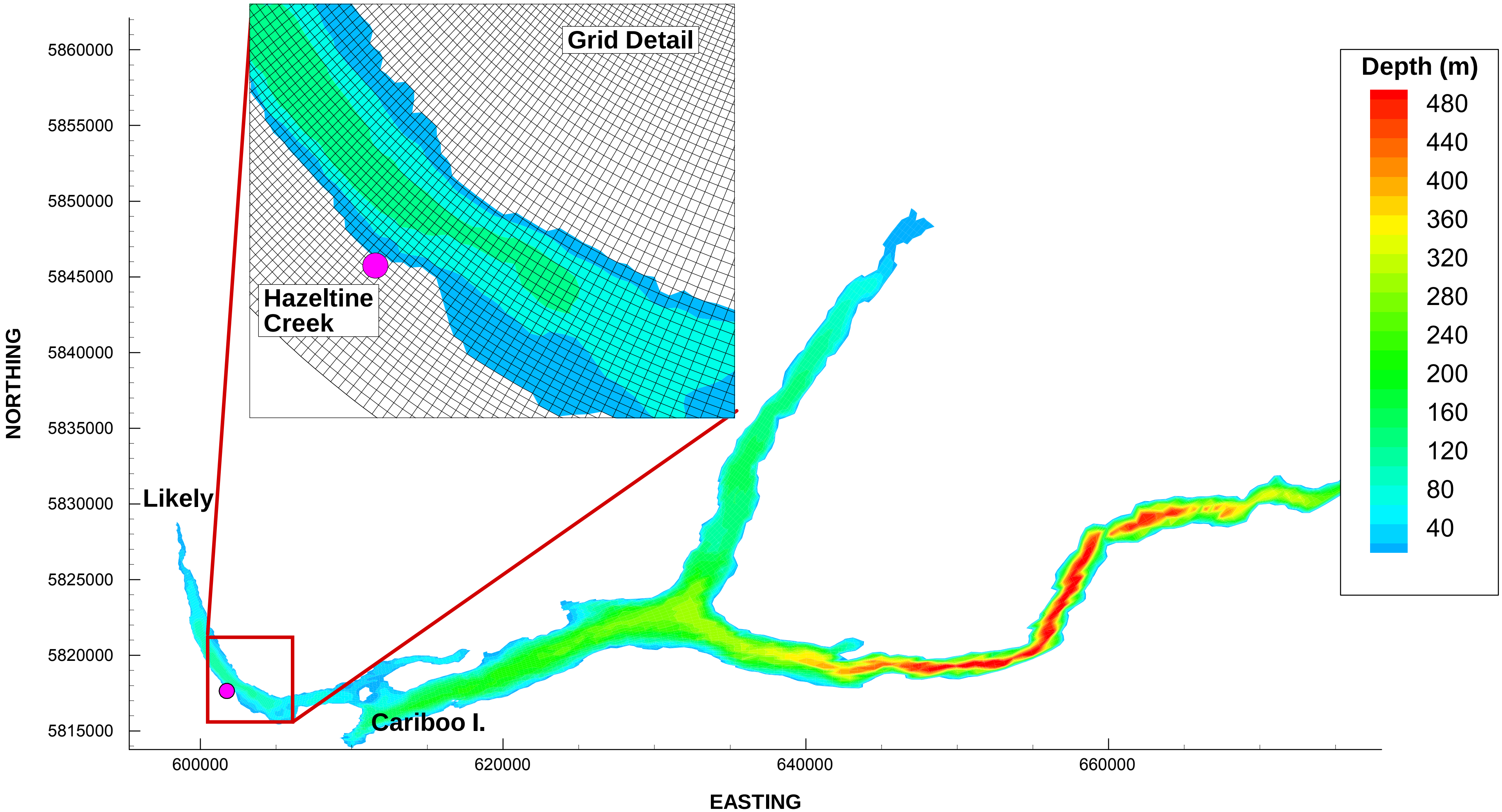
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Turbidity, TSS and TDS Relationships from Quesnel Lake Samples

PROJECT NO.	DWN	CKD	APVD	REV	
V13203212	JMR	JAS	JAS	0	**Figure 3.13**
OFFICE	DATE				
Tetra Tech EBA - VANC	May 2015				



NOTES

Bathymetric data from 2001 Coast Pilot survey and 2014 Tetra Tech multibeam survey, where available

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QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Model Grid and Bathymetry

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	AO	JMR	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 4.1

NOTES

Thermistor chains, M2 and M8, operational in 2003-2004.

Significant inflows to Quesnel Lake are Horsefly River, Mitchell River and Niagara Creek. The sole outflow is Quesnel River.

Although it is a minor inflow, Hazeltine Creek is labelled because of its relevance to the TSF breach incident.

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QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Rivers and Thermistor Chain Locations

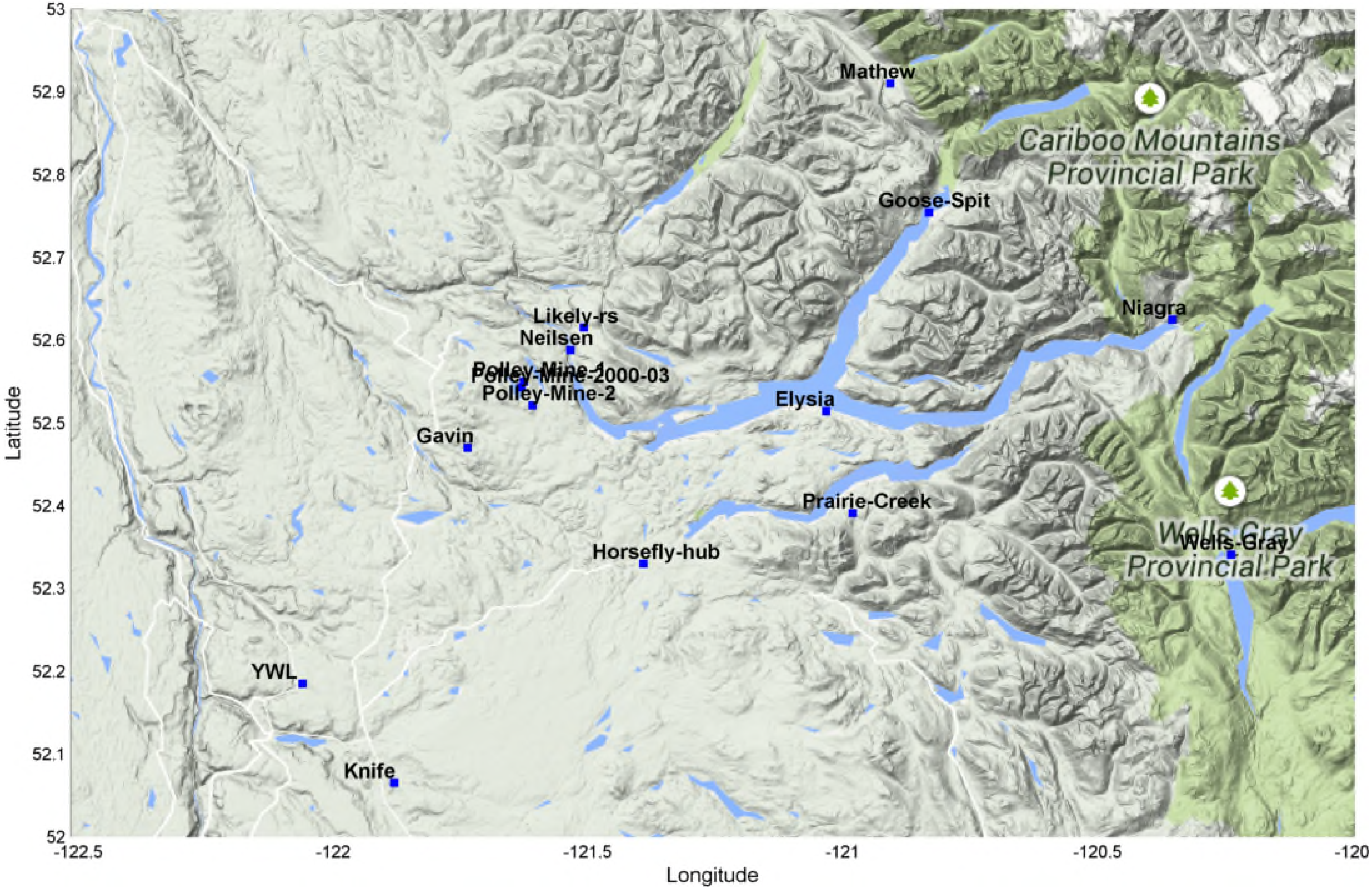
PROJECT NO.	DWN	CKD	APVD	REV
V13203212	AO	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 4.2

V:\privileged_and_confidential__V13203206 Mount Polley\reporting\March Technical Report\Figs\Validation\4p2_Rivers_M2_M8.lay

04 May 2015 11:25:19



NOTES

Notes

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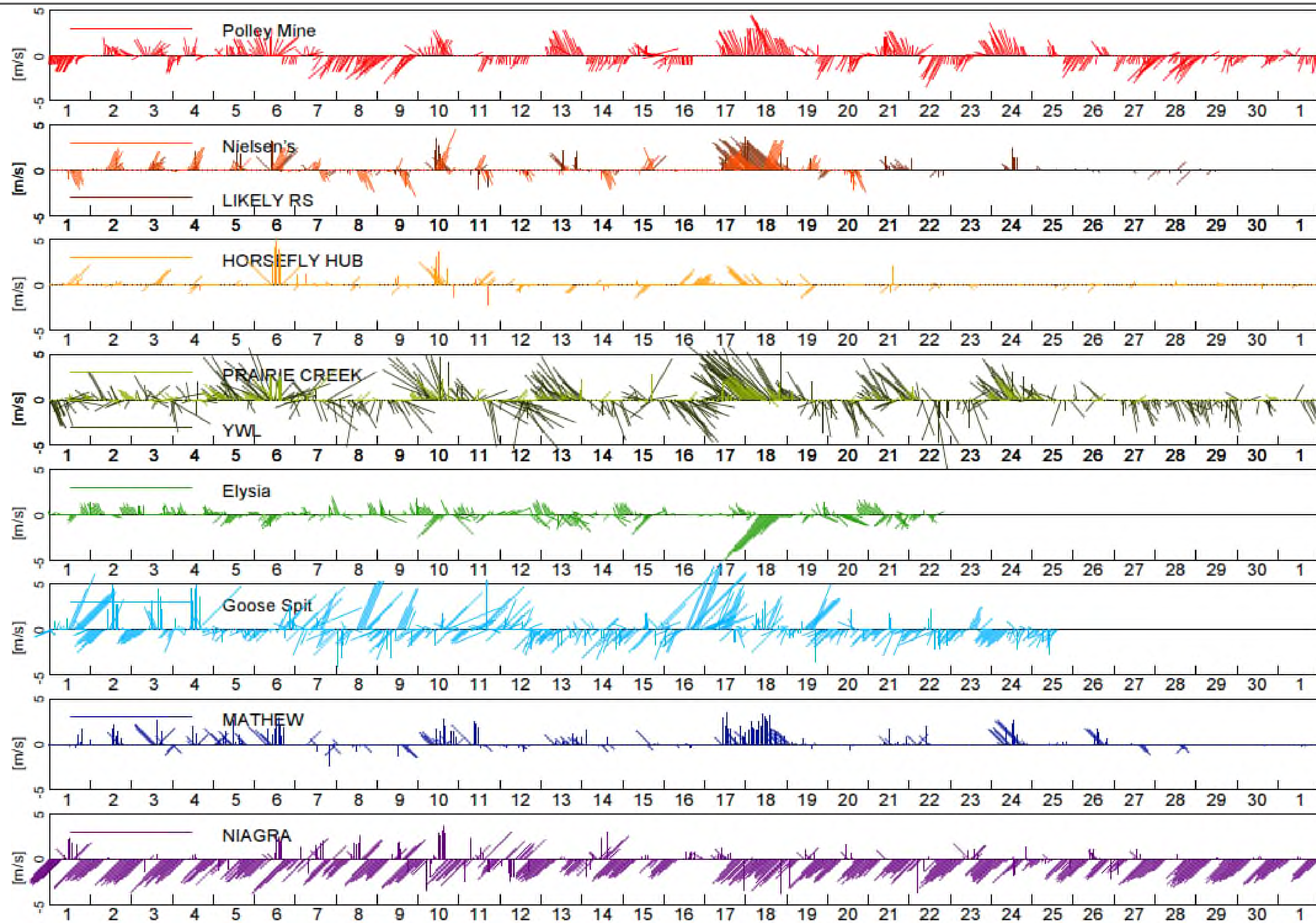
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Location of Wind Observations near Quesnel Lake

PROJECT NO.	DWN	CKD	APVD	REV	
V13203212	AO	JAS	JAS	0	**Figure 4.3**
OFFICE: Tetra Tech EBA - VANC	DATE: May 2015				

V:\privileged_and_confidential__V13203206 Mount Polley\reporting\March Technical Report\Figs\Validation\4p3_windstation.lay

04 May 2015 11:25:02



NOTES

Prairie Creek and YWL ploted on one axis.

Nielsen's and Likely RS ploted on one axis.

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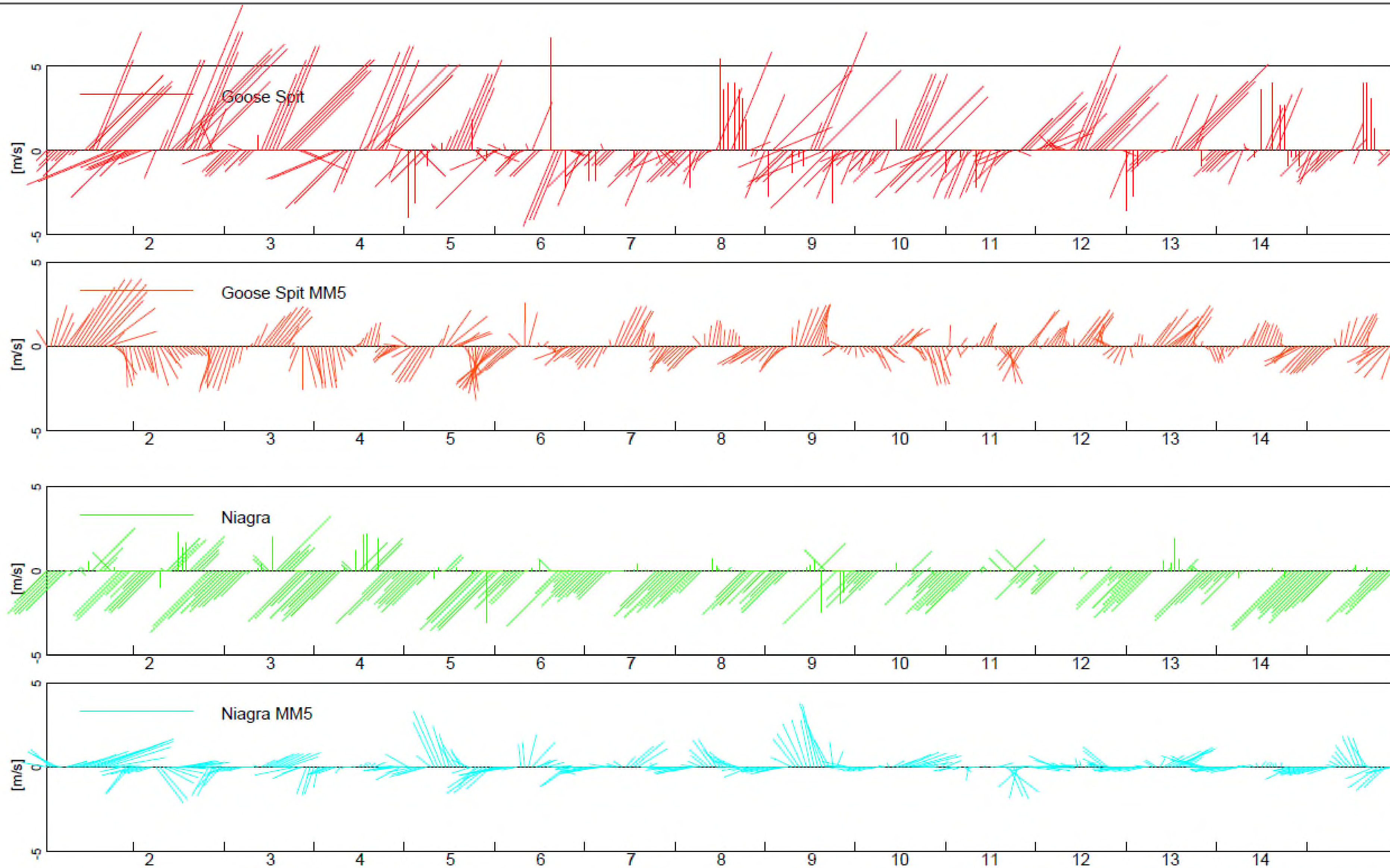
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Wind Observations near Quesnel Lake September 2003

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	AO	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 4.4



NOTES

Notes:

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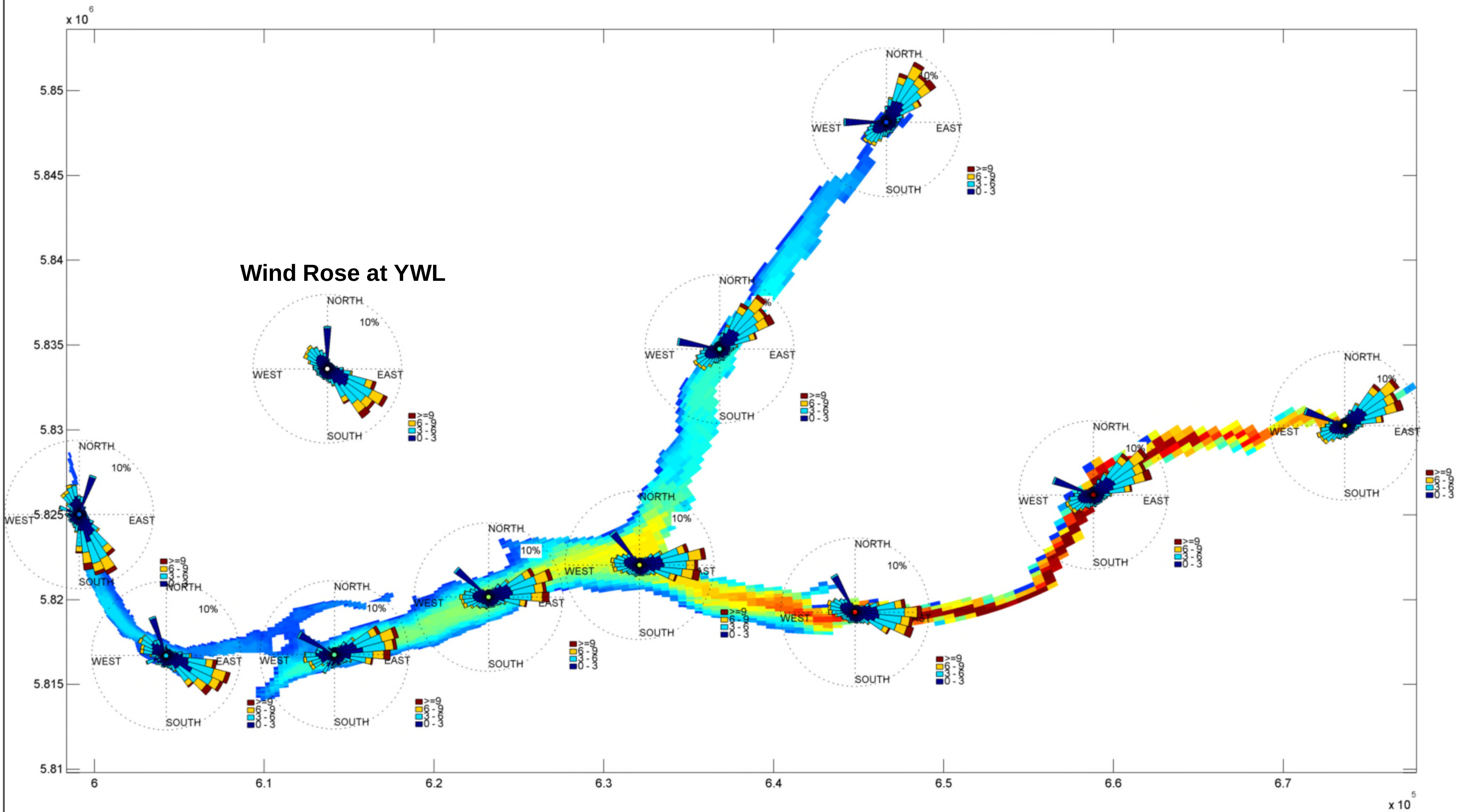
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Comparison of MM5 Winds to to Niagara and Goose Spit Observations, 1-15 Aug 2003

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	AO	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 4.5



NOTES

Wind roses indicate how Williams Lake (YWL) winds were rotated to represent conditions over the lake.

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QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Steered YWL Wind Roses

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PROJECT NO.	DWN	CKD	APVD	REV
V13203212	AO	JMR	JAS	0

OFFICE: Tetra Tech EBA - VANC

DATE: May 2015

Figure 4.6

STATUS
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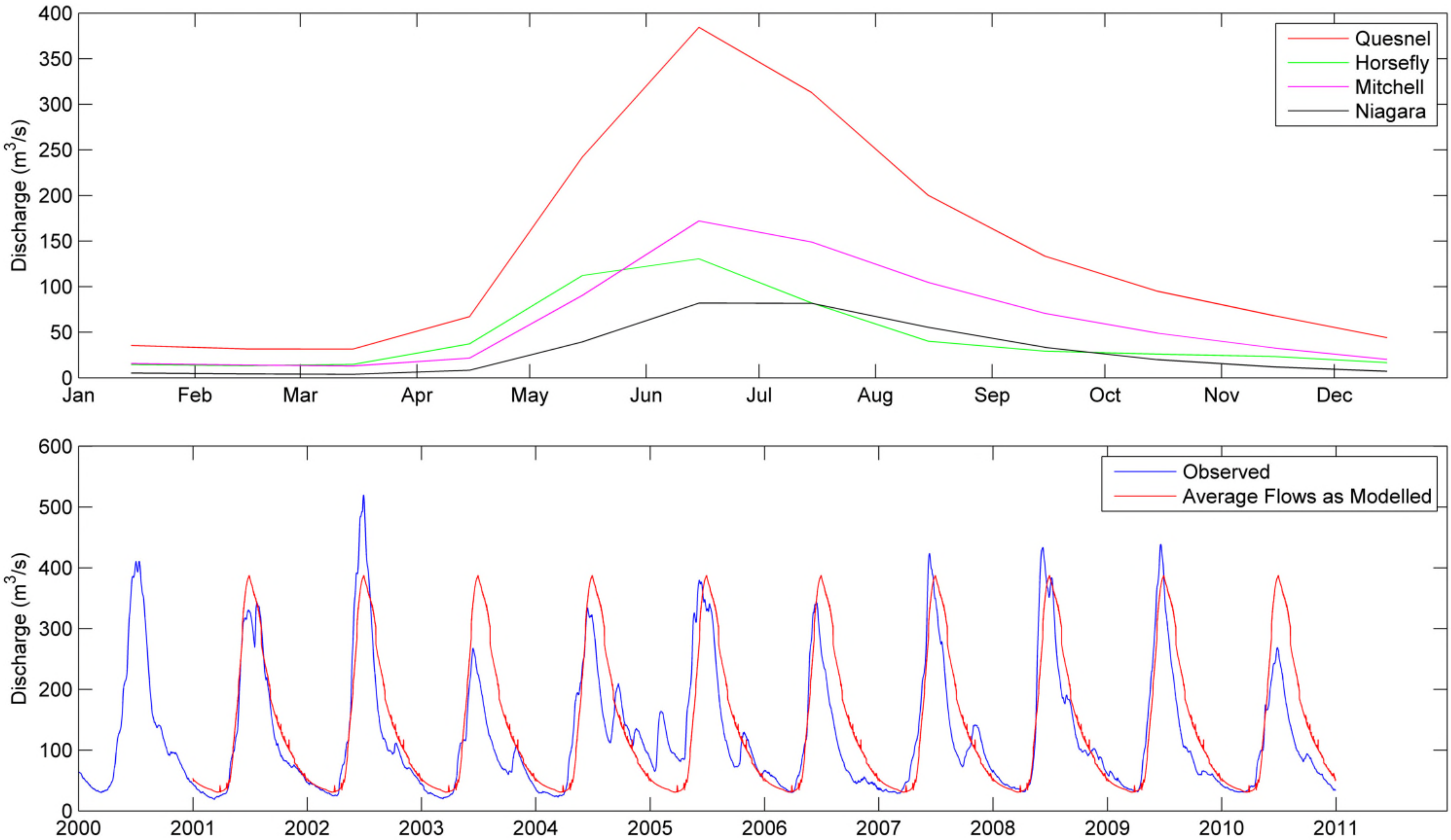

NOTES

Observed flows from WSC Station #08KH001

Monthly average flows from Potts (2004)

STATUS
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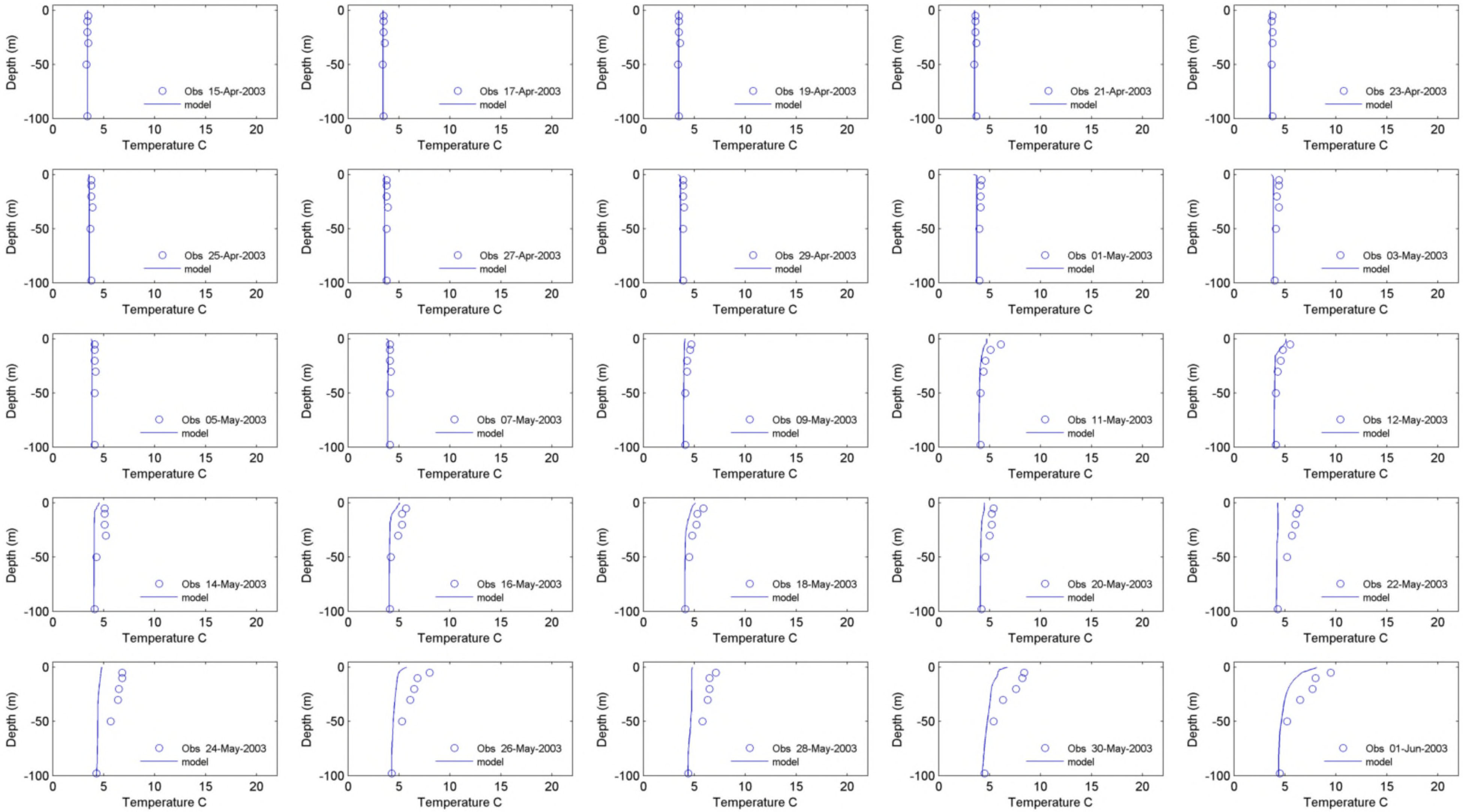
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Modelled and Observed River Flows

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 4.7



NOTES

Circles are thermistor measurements; lines are model temperature vs depth.

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QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Modelled and Observed Temperature Profiles at M2 April - June 2003

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	AO	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

STATUS
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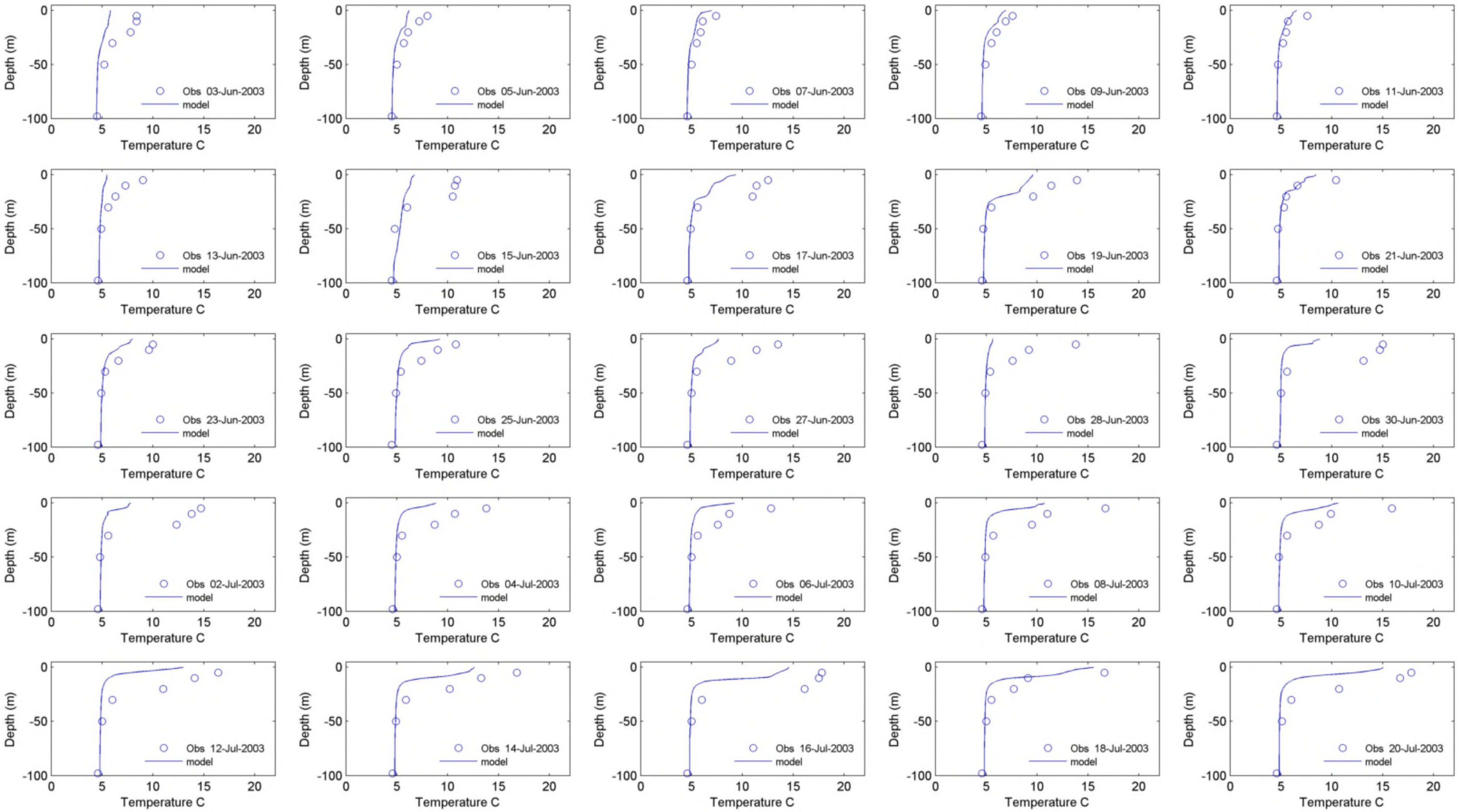
Figure 5.1



NOTES

Circles are thermistor measurements; lines are model temperature vs depth.

STATUS
ISSUED FOR USE

CLIENT

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TETRA TECH EBA

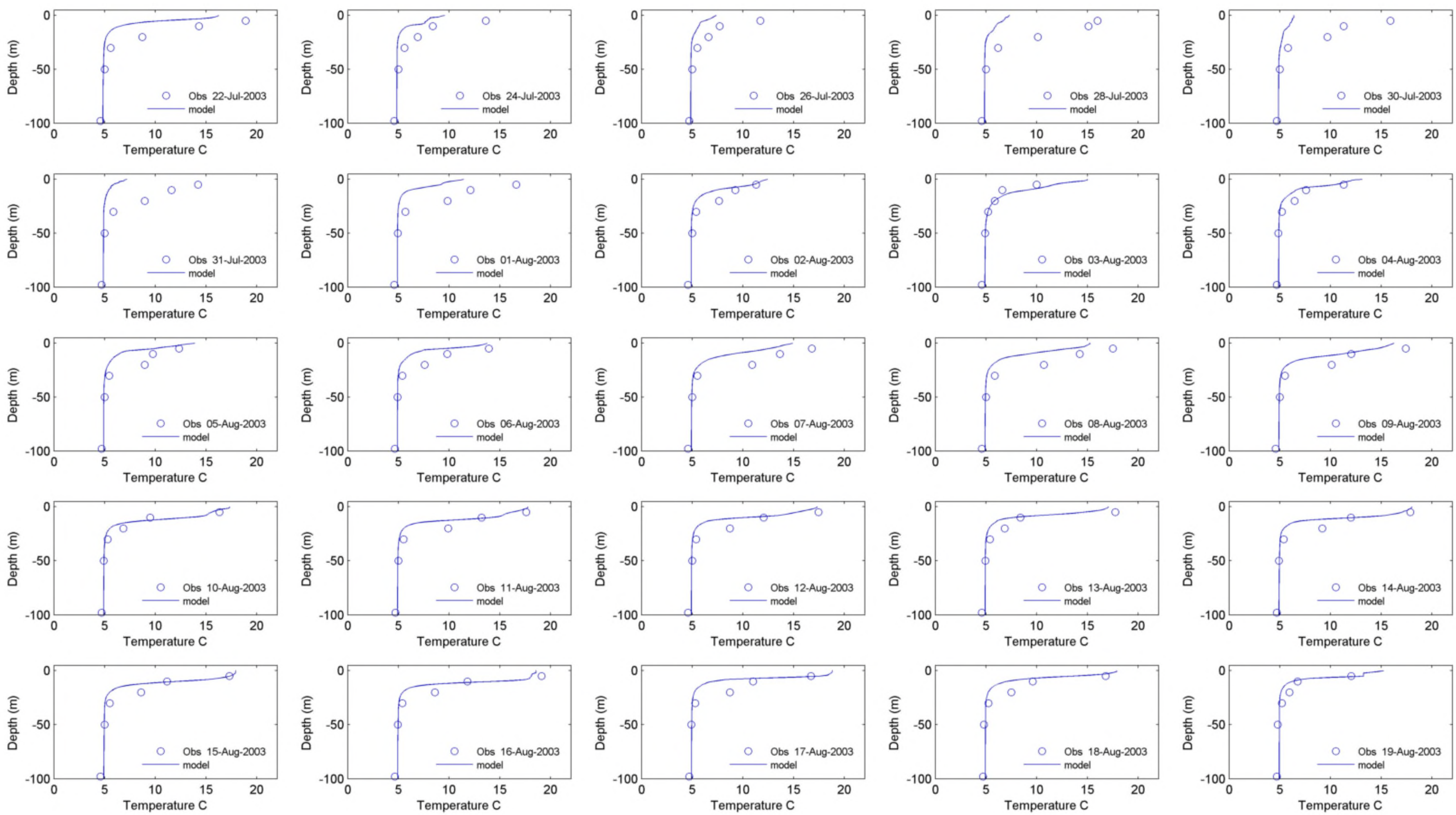
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Modelled and Observed Temperature Profiles at M2 June-July 2003

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	AO	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 5.2



NOTES

Circles are thermistor measurements; lines are model temperature vs depth.

STATUS
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QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

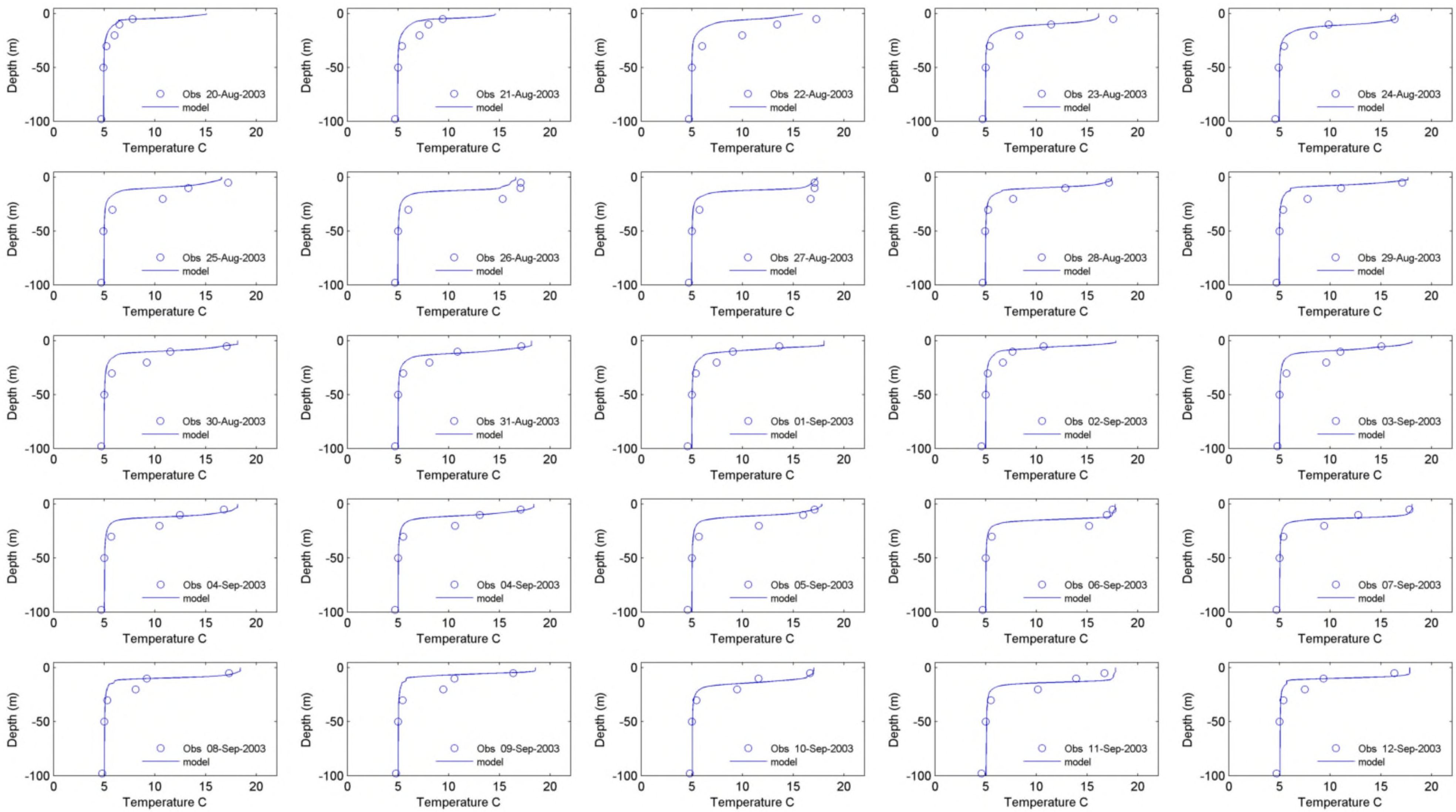
Modelled and Observed Temperature Profiles at M2 July-August 2003

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	AO	JAS	JAS	0

OFFICE
Tetra Tech EBA - VANC

DATE
May 2015

Figure 5.3



NOTES

Circles are thermistor measurements; lines are model temperature vs depth.

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QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Modelled and Observed Temperature Profiles at M2 August-September 2003

TETRA TECH EBA

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	AO	JAS	JAS	0

Figure 5.4

OFFICE: Tetra Tech EBA - VANC

DATE: May 2015

STATUS
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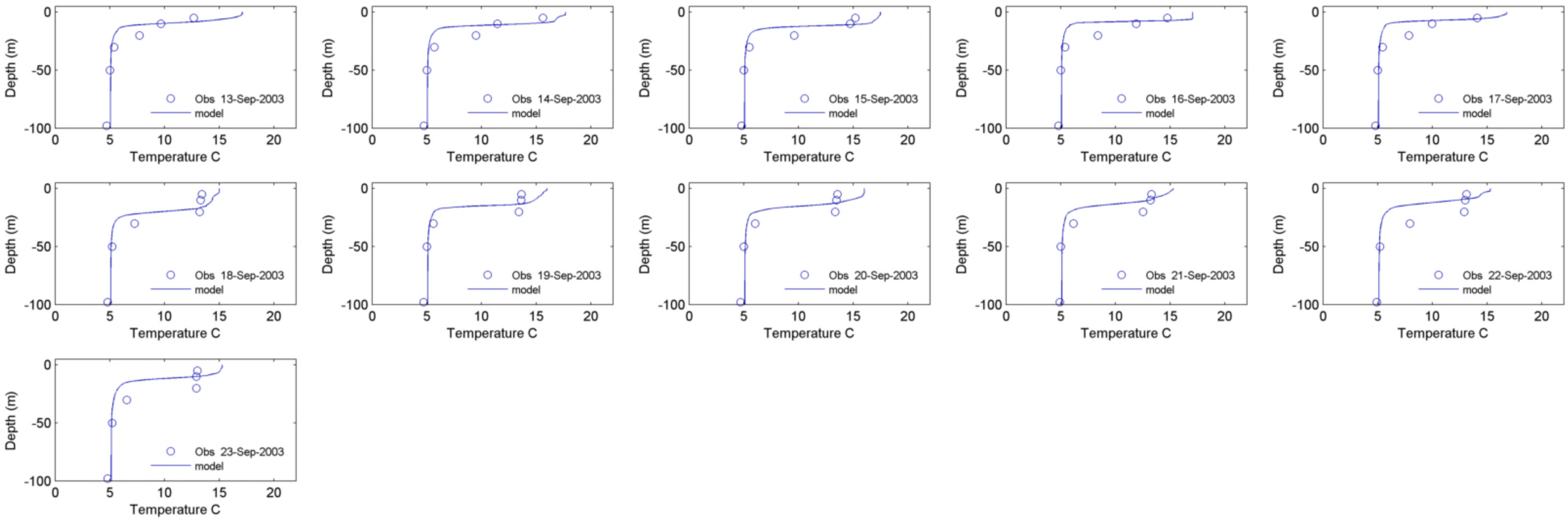
V:\privileged_and_confidential__V13203206 Mount Polley\reporting\March Technical Report\Figs\Validation\5p4_VerProM2_4lay.lay

04 May 2015 11:24:51



NOTES

Circles are thermistor measurements; lines are model temperature vs depth.

CLIENT

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QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

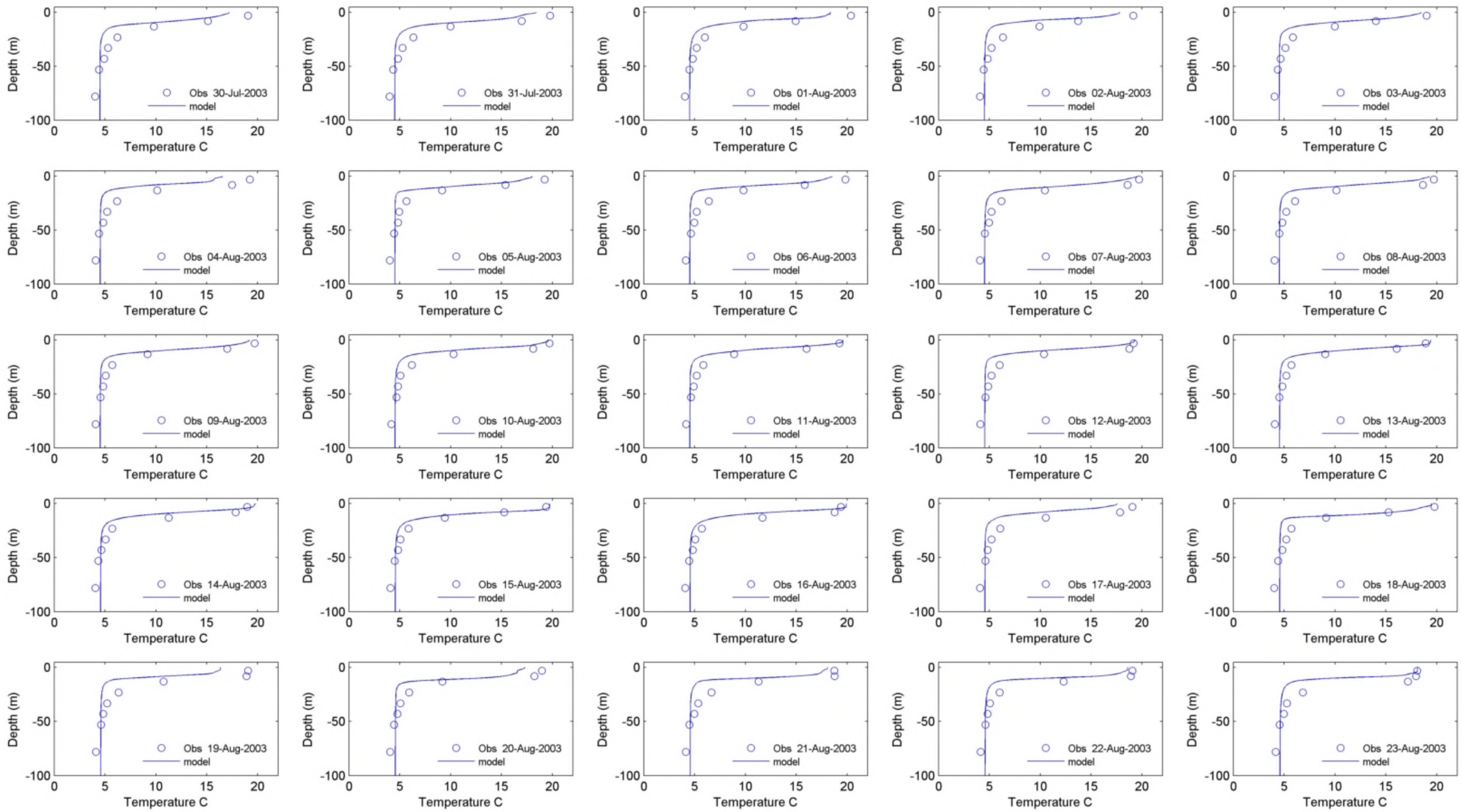
Modelled and Observed Temperature Profiles at M2 September 2003

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	AO	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 5.5

STATUS
ISSUED FOR USE



NOTES

Circles are thermistor measurements; lines are model temperature vs depth.

STATUS
ISSUED FOR USE

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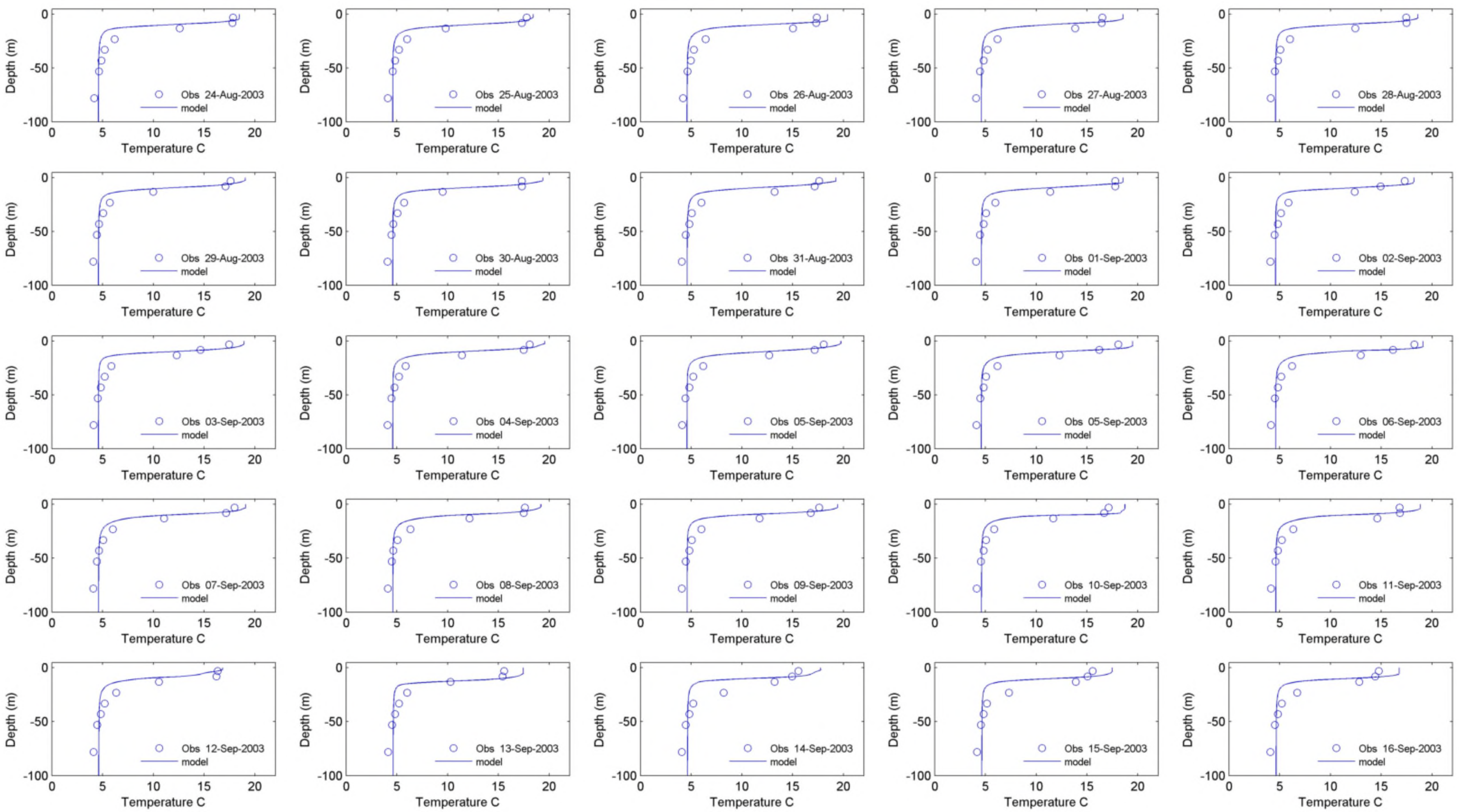
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Modelled and Observed Temperature Profiles at M8 July-August 2003

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	AO	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 5.6



NOTES

Circles are thermistor measurements; lines are model temperature vs depth.

STATUS
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QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

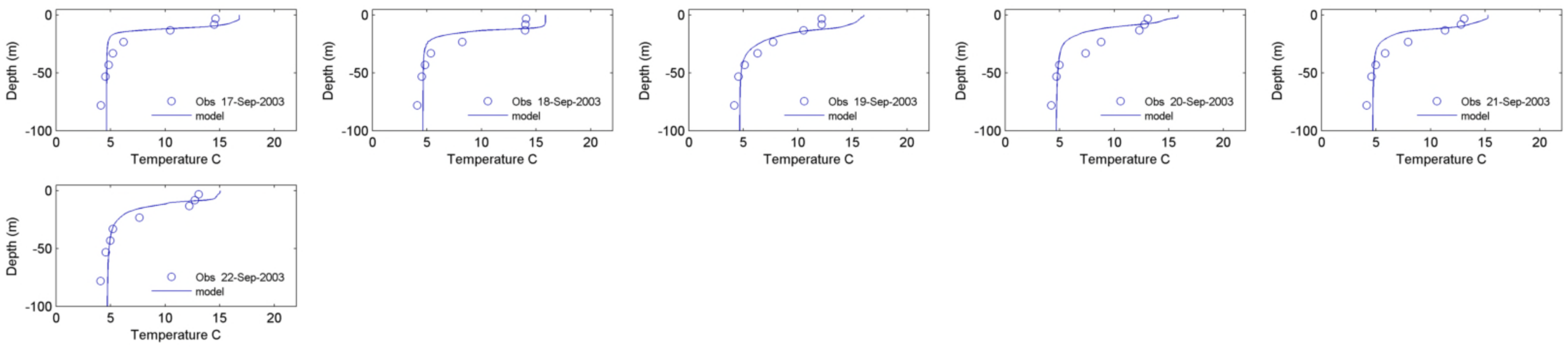
Modelled and Observed Temperature Profiles at M8 August-September 2003

TETRA TECH EBA

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	AO	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 5.7



NOTES

Circles are thermistor measurements; lines are model temperature vs depth.

STATUS
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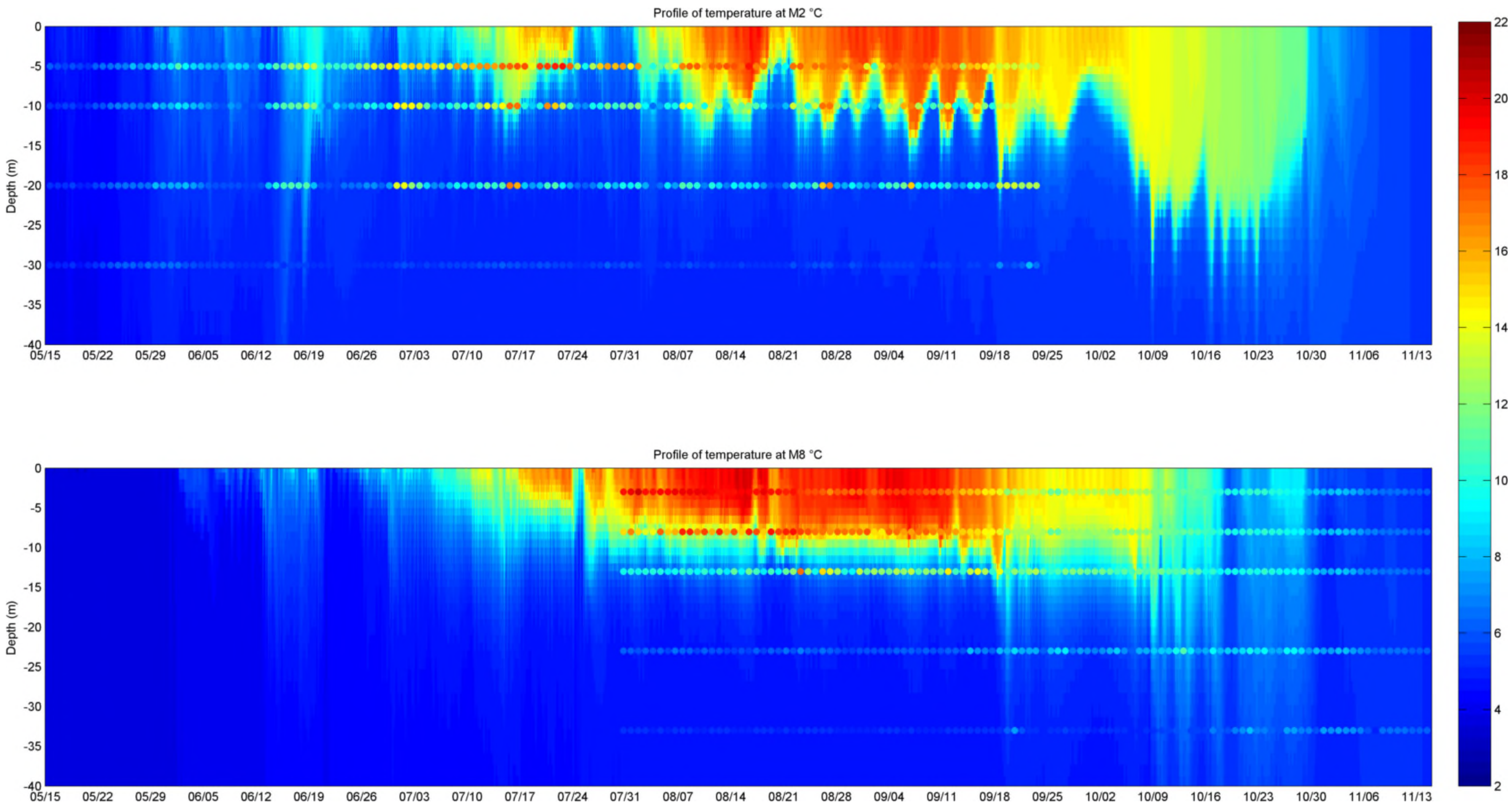
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Modelled and Observed Temperature Profiles at M8 September 2003

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	AO	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 5.8



NOTES

Circles are thermistor measurements; the contour map shows model temperature vs depth.

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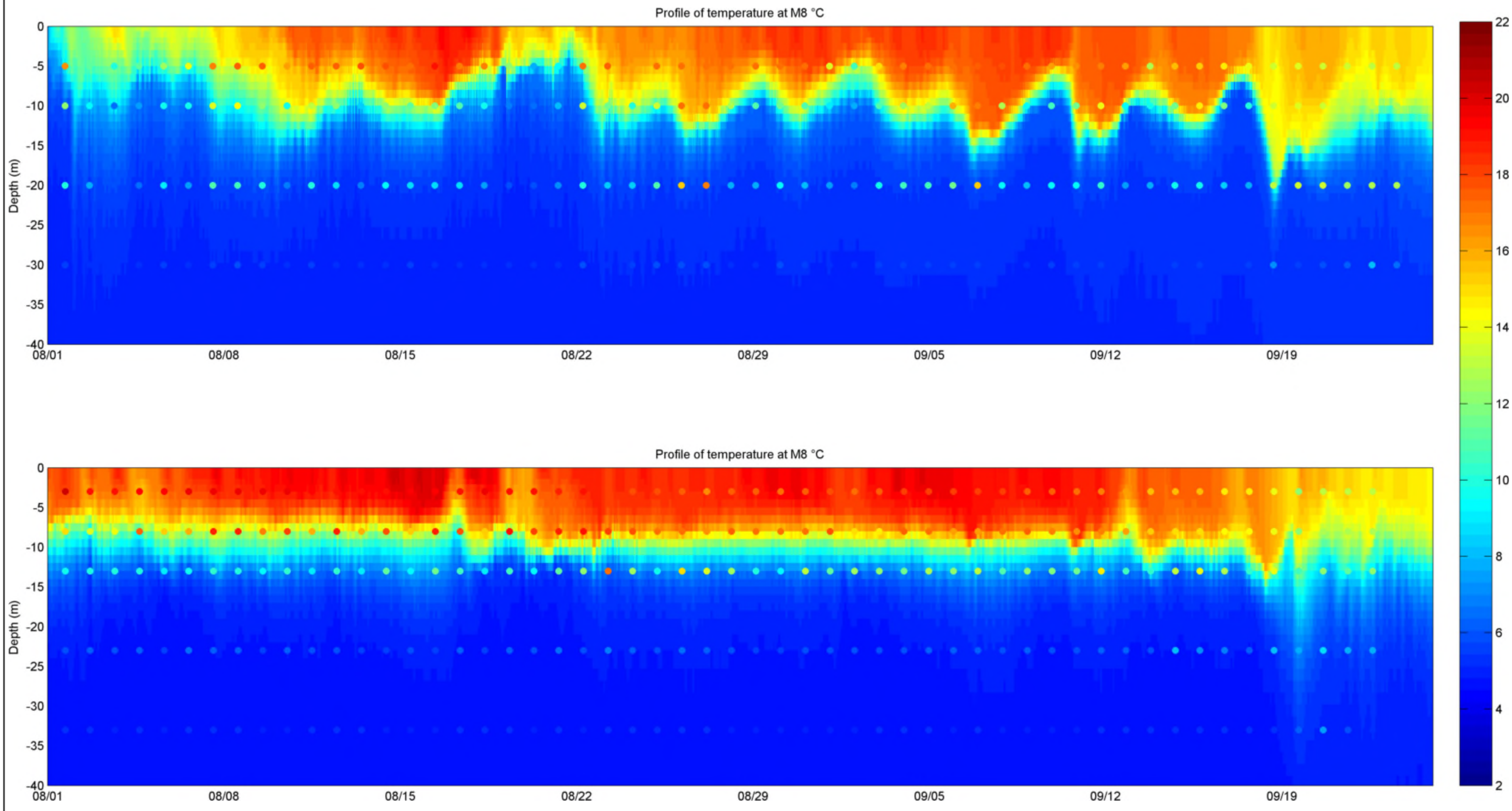
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Modelled and Observed Temperature Time Series at M2 and M8 May - September 2003

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	AO	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 5.9



NOTES

Circles are thermistor measurements; the contour map shows model temperature vs depth.

STATUS
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QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

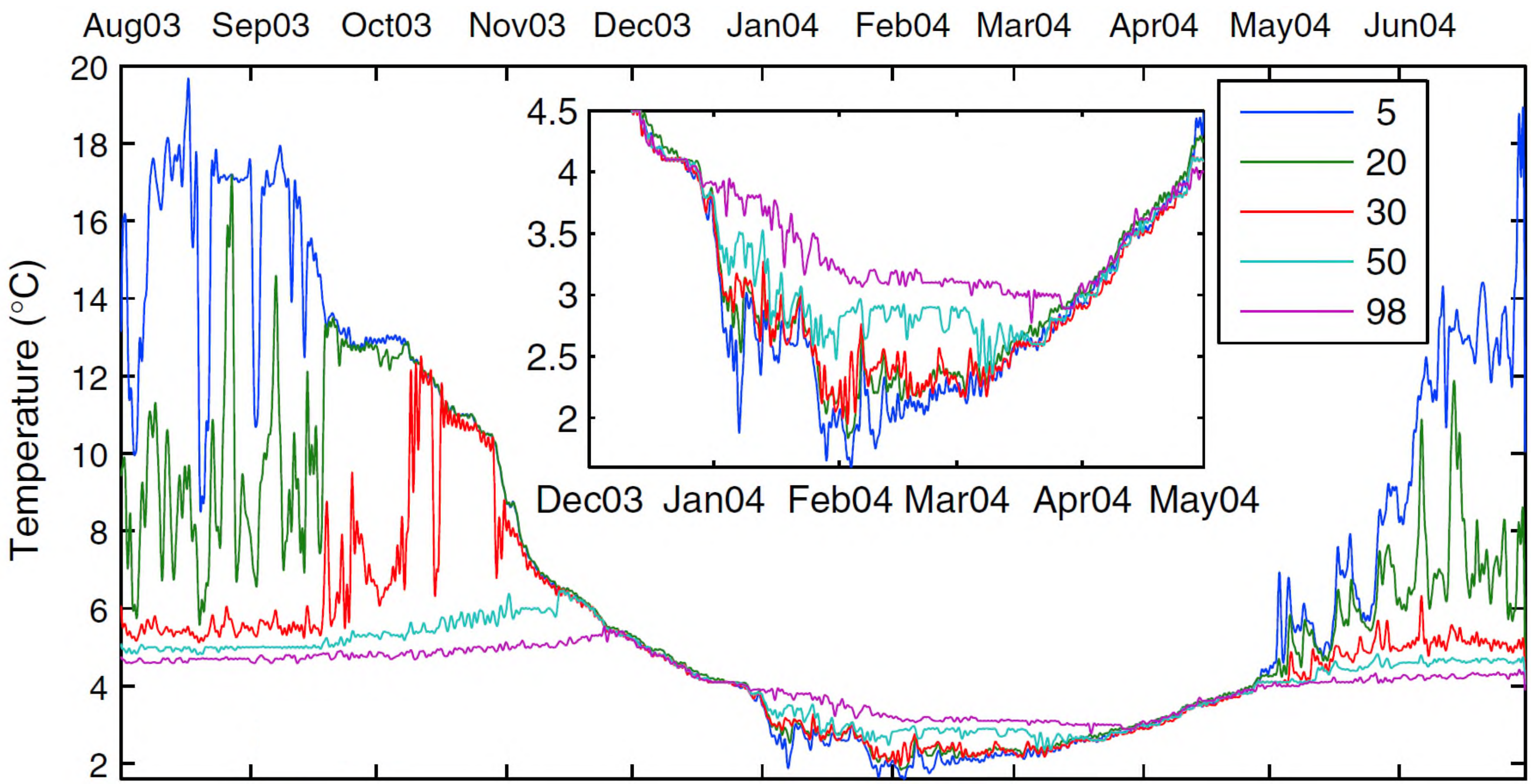
Modelled and Observed Temperature Time Series at M2 and M8 August - September 2003

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	AO	JAS	JAS	0

OFFICE: Tetra Tech EBA - VANC

DATE: May 2015

Figure 5.10



NOTES

Reproduced, with permission, from Laval et al (2012).

Temperature records from selected thermistors in the West Basin (M2). The legend indicates nominal thermistor depth in metres. Temperatures have been averaged over 24hours to remove noise from high-frequency internal waves, and diurnal heating and cooling at the water surface. The inset highlights subtle wintertime variations with an exaggerated temperature scale.

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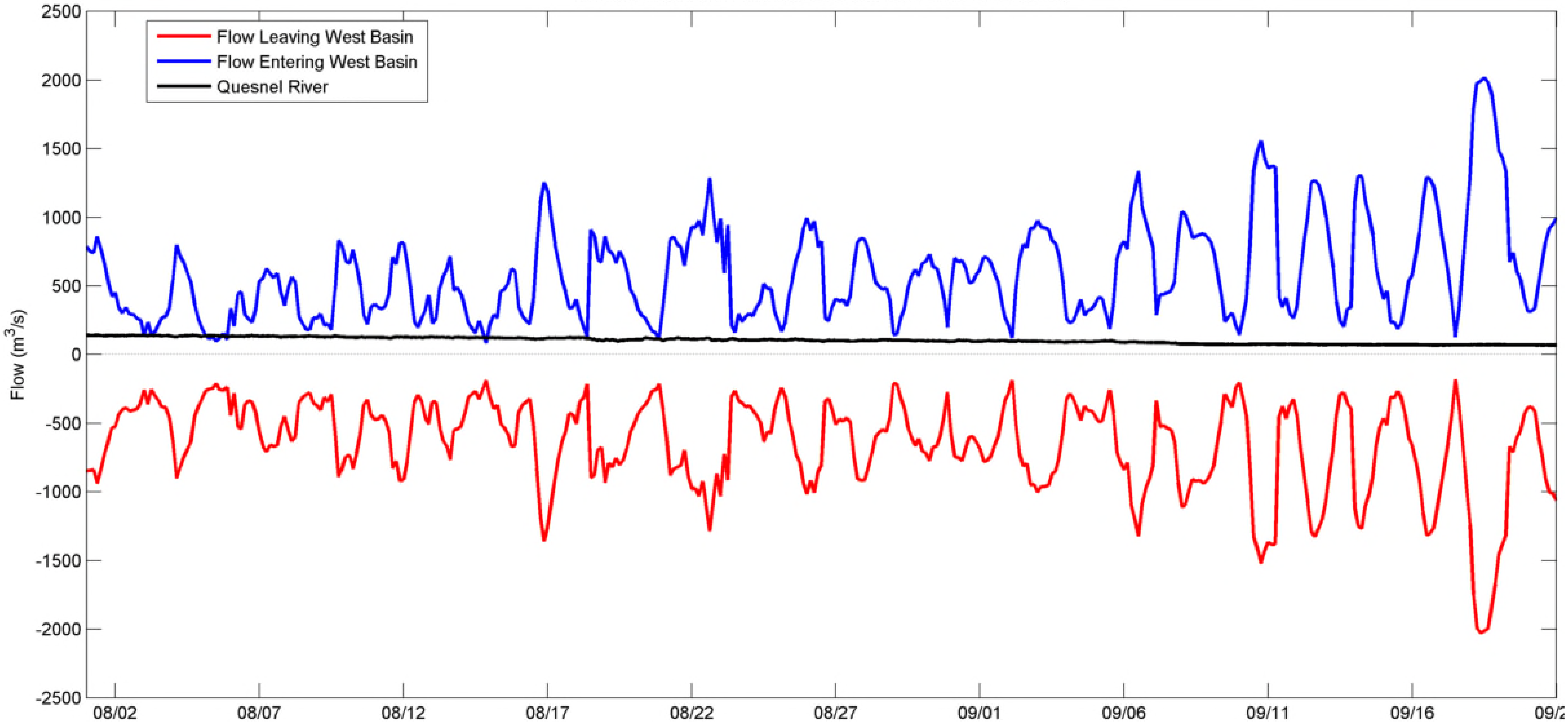
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Time Series of Observed Vertical Temperature Profile at M2 (Laval et al, 2012)

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	DP	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 5.11



NOTES

The difference between the negative and positive flux is equal to the river flow.

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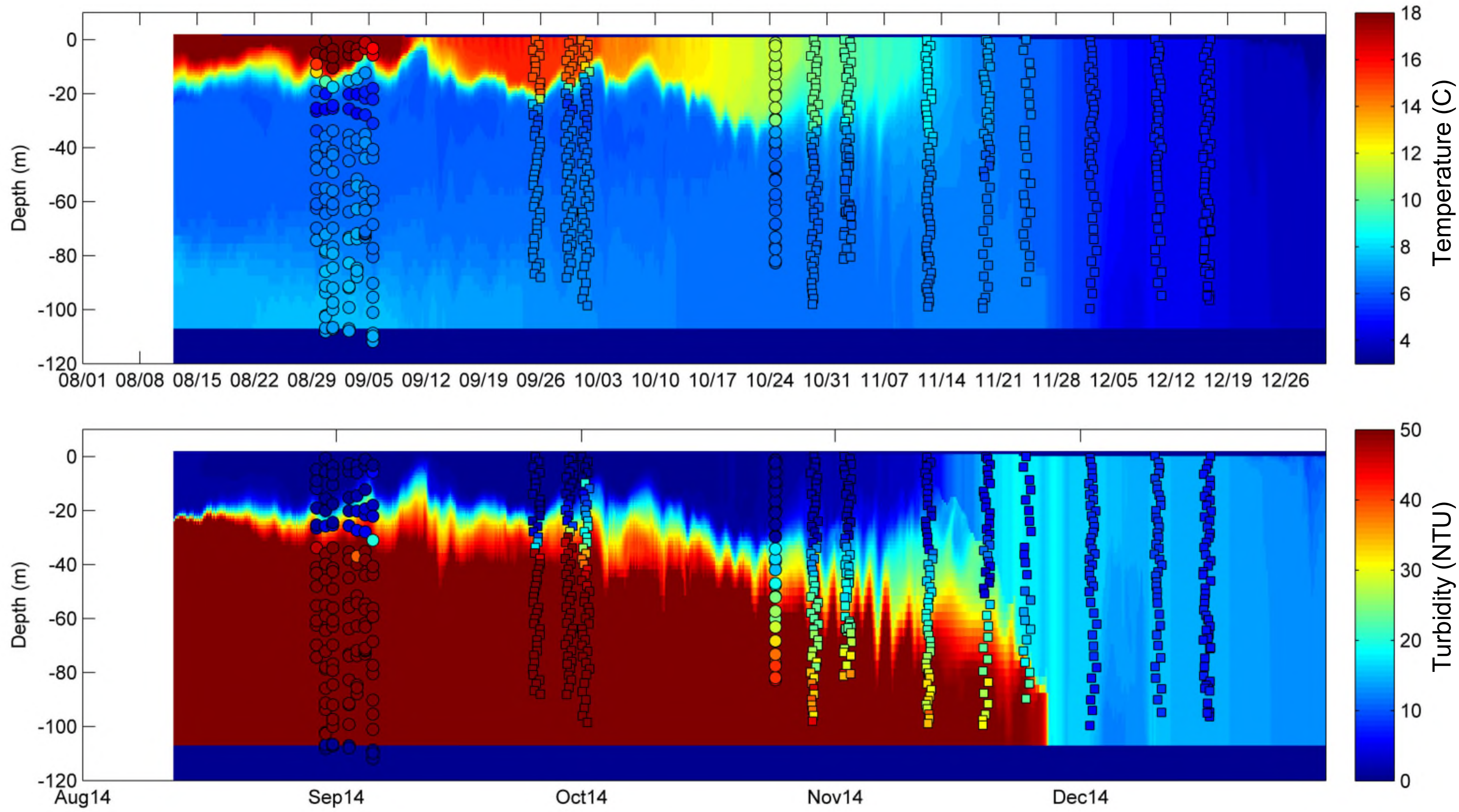
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Fluxes Over Cariboo Island Sill and Quesnel River Flow.

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	AO	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 5.12



NOTES

Turbidity units converted to match YSI calibration

September 1 and October 23 data collected by Tetra Tech

Data collected by MPMC

STATUS
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QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

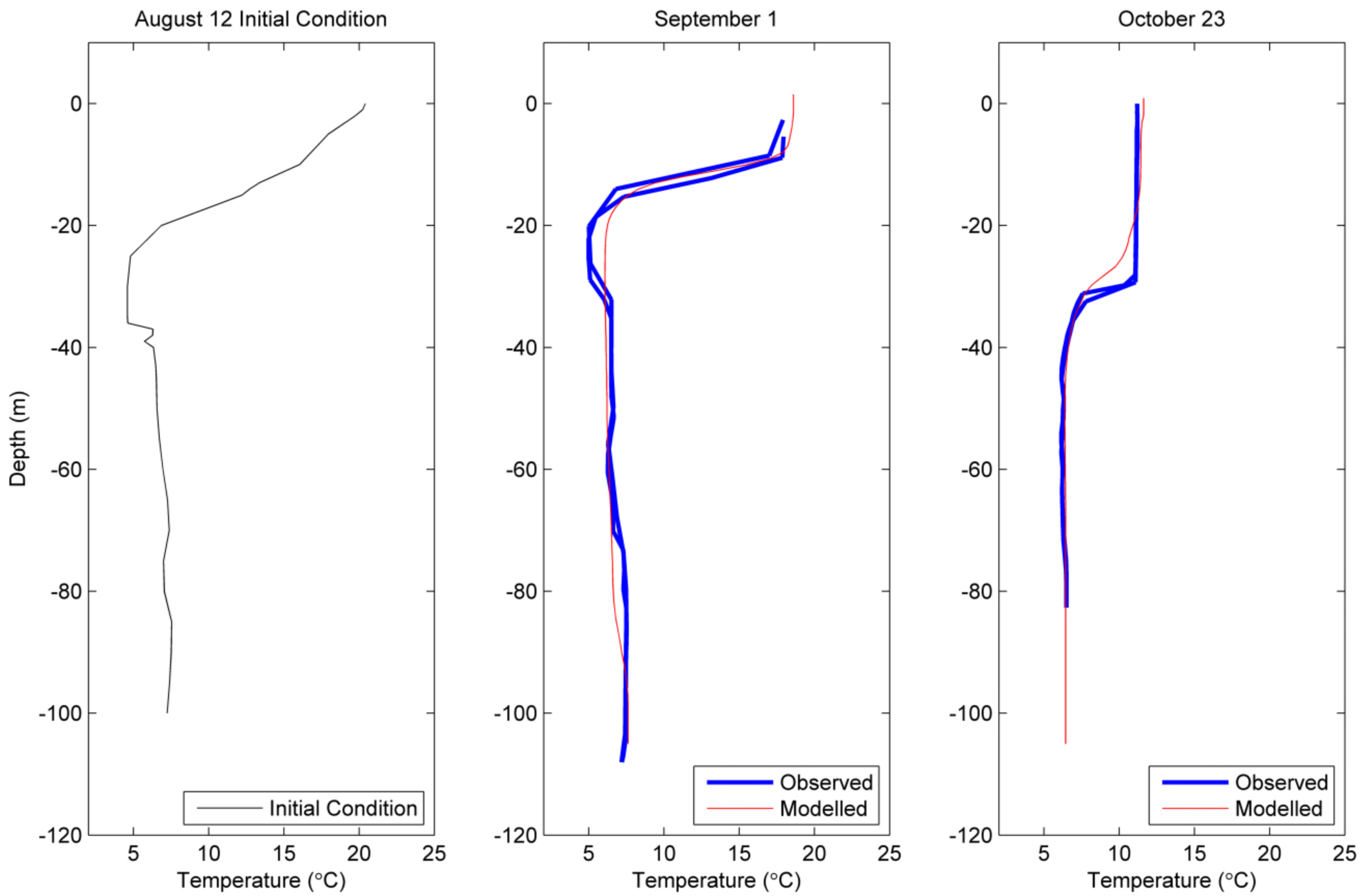
Modelled and Observed Temperature and Turbidity Time Series August 13 Initial Conditions

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE: Tetra Tech EBA - VANC

DATE: May 2015

Figure 5.13



NOTES

August 13 data hand-digitized from MoE field sheet
September 1 and October 23 data collected by Tetra Tech

STATUS
ISSUED FOR USE

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TETRA TECH EBA

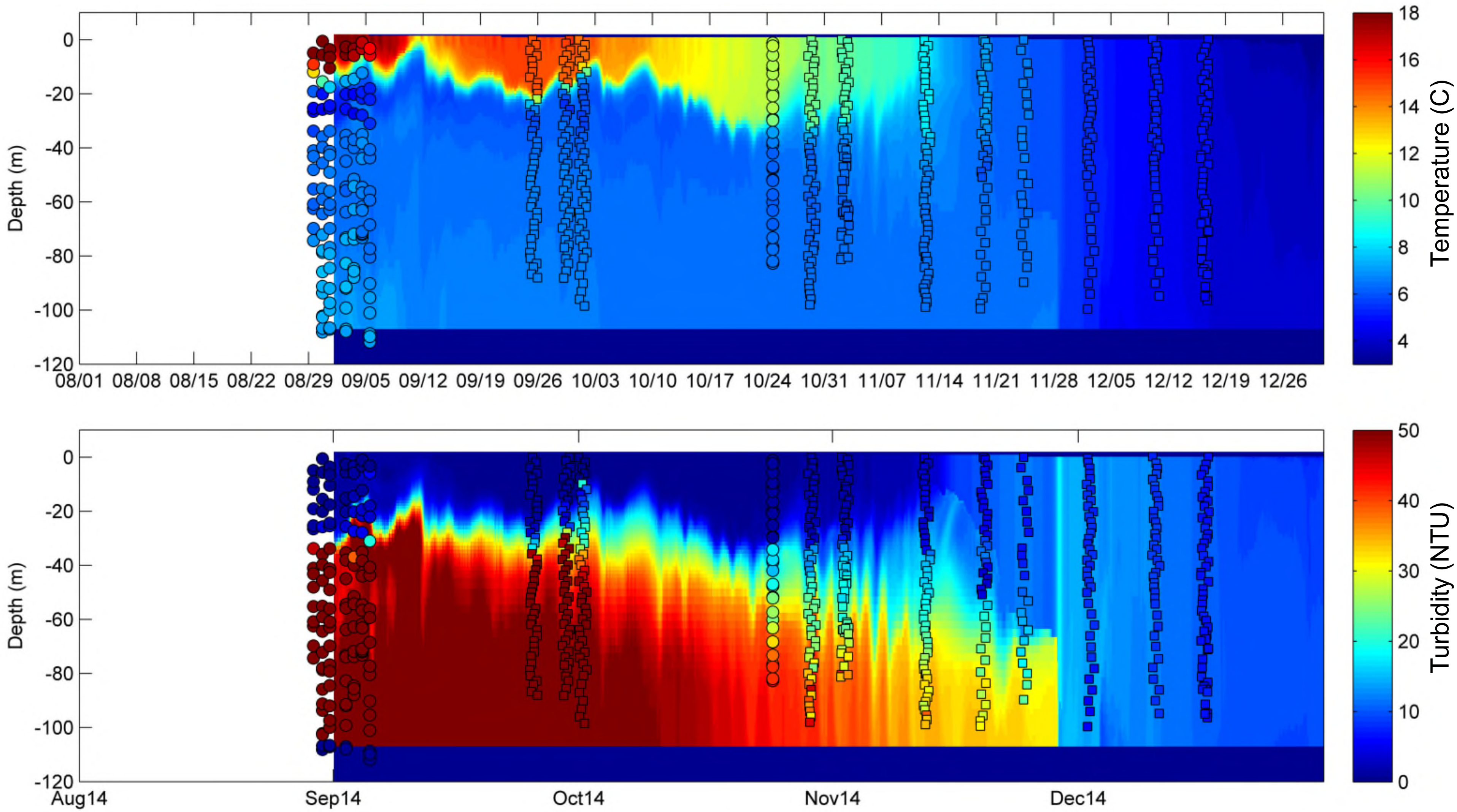
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Modelled and Observed Temperature Profiles
August 13 Initial Conditions

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE: Tetra Tech EBA - VANC
DATE: May 2015

Figure 5.14



NOTES

Turbidity units converted to match YSI calibration

September 1 and October 23 data collected by Tetra Tech

Data collected by MPMC

STATUS
ISSUED FOR USE

CLIENT

MPMC

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QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Modelled and Observed Temperature and Turbidity Time Series September 1 Initial Conditions

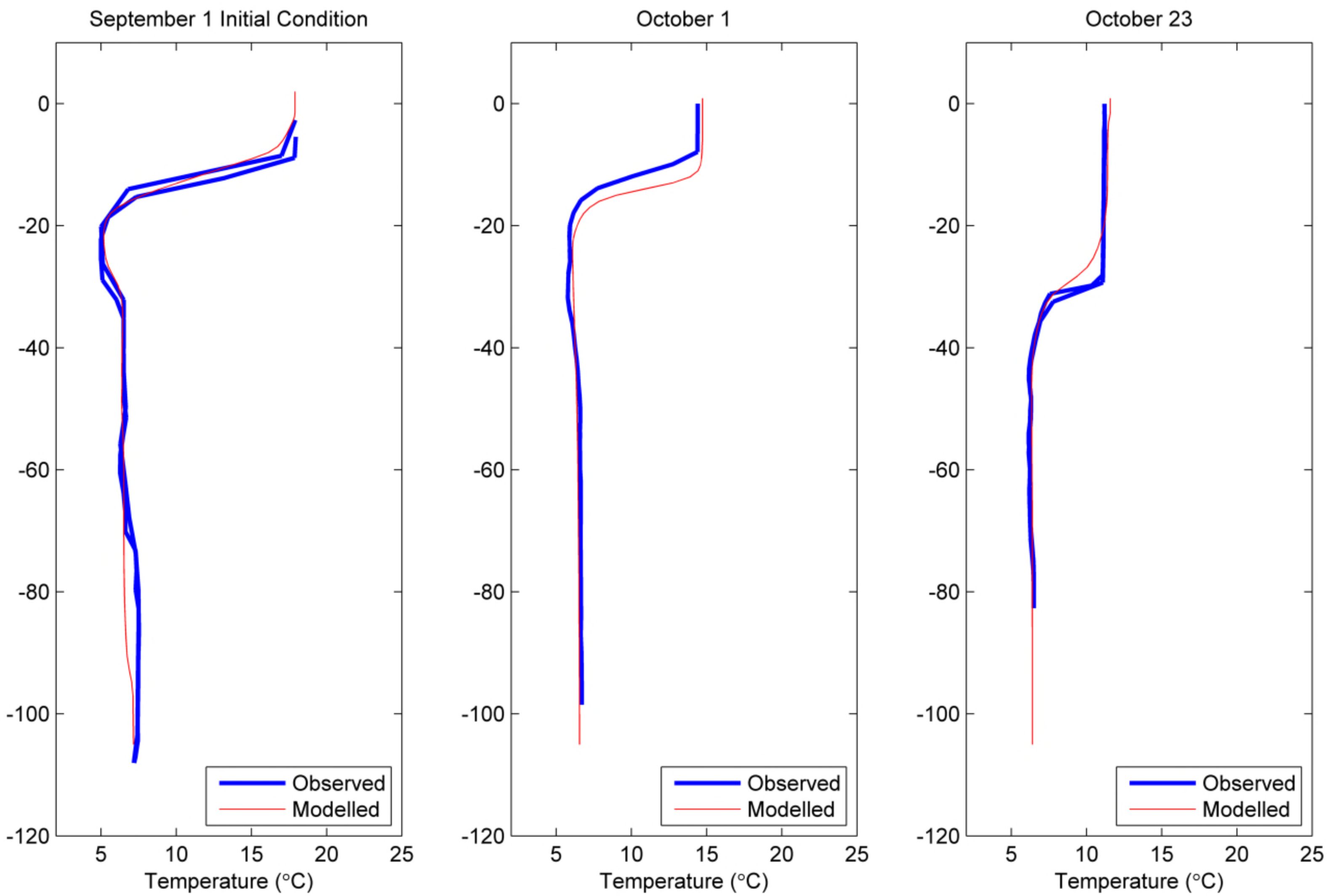
PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 5.15

V:\privileged_and_confidential__V13203206 Mount Polley\reporting\March Technical Report\Figs\JR\Figure5_15_SepIC-Scroll.lay

04 May 2015 13:08:02



NOTES

September 1 and October 23 data collected by Tetra Tech

STATUS
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QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

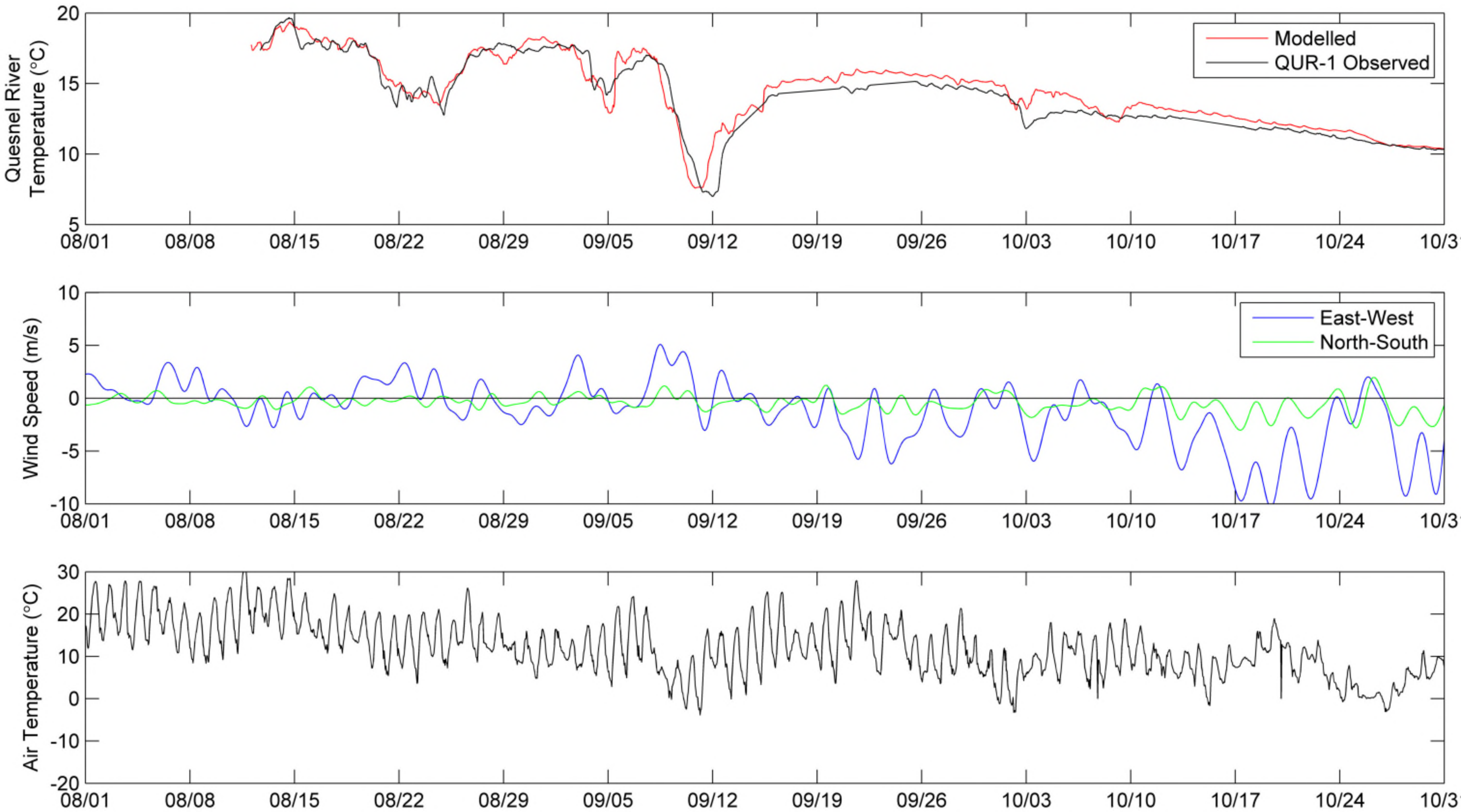
Modelled and Observed Temperature Profiles September 1 Initial Conditions

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE: Tetra Tech EBA - VANC

DATE: May 2015

Figure 5.16



NOTES

August 13 data hand-digitized from MoE field sheet
September 1 and October 23 data collected by Tetra Tech

Wind speeds presented from rotated YWL time series - a positive East-West wind is blowing towards the east at Cariboo Island

Air temperature from YWL

STATUS
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QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

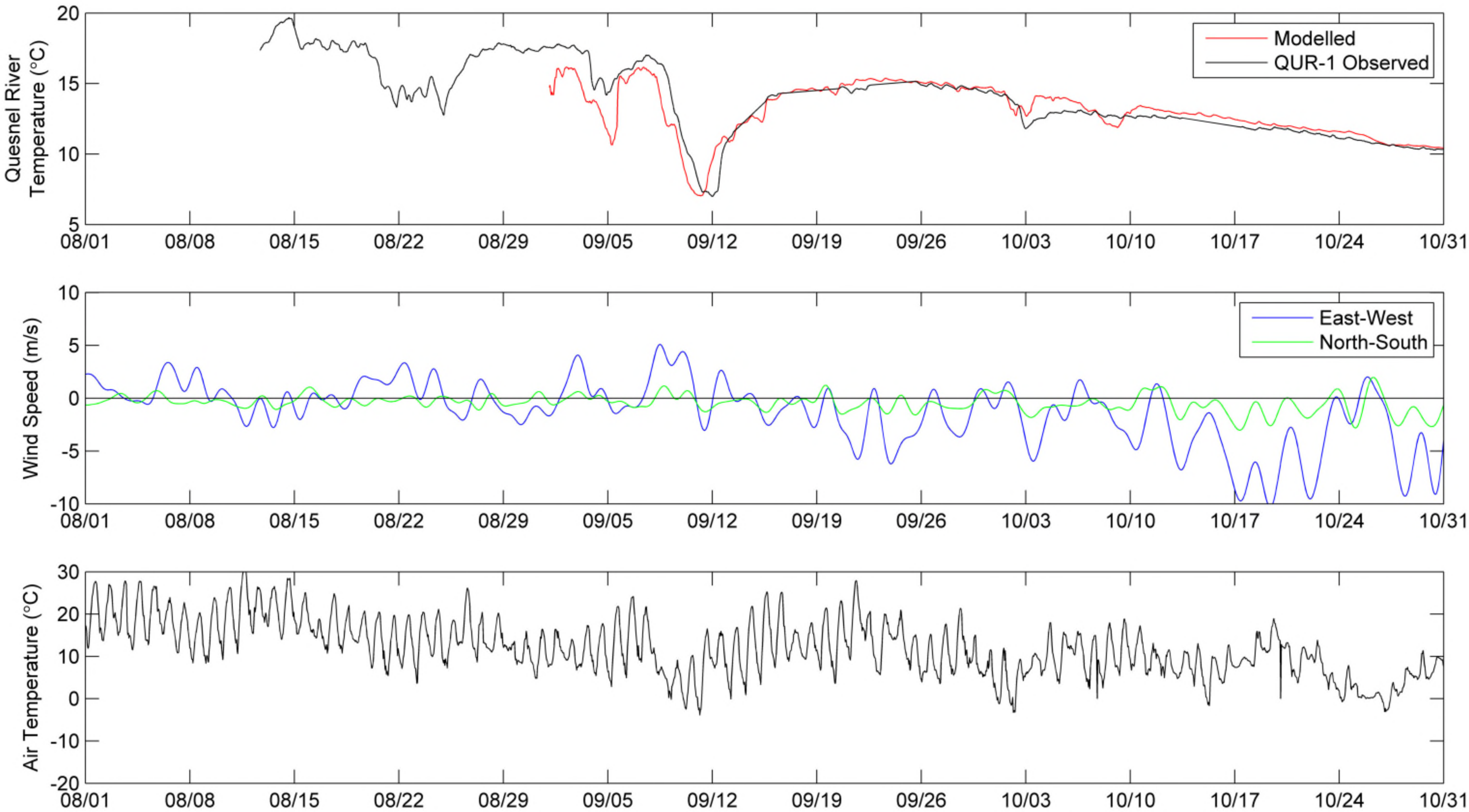
Modelled and Observed Quesnel River Temperature Time Series August 13 Initial Conditions

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE: Tetra Tech EBA - VANC

DATE: May 2015

Figure 5.17



NOTES

September 1 and October 23 data collected by Tetra Tech

Wind speeds presented from rotated YWL time series - a positive East-West wind is blowing towards the east at Cariboo Island

Air temperature from YWL

STATUS
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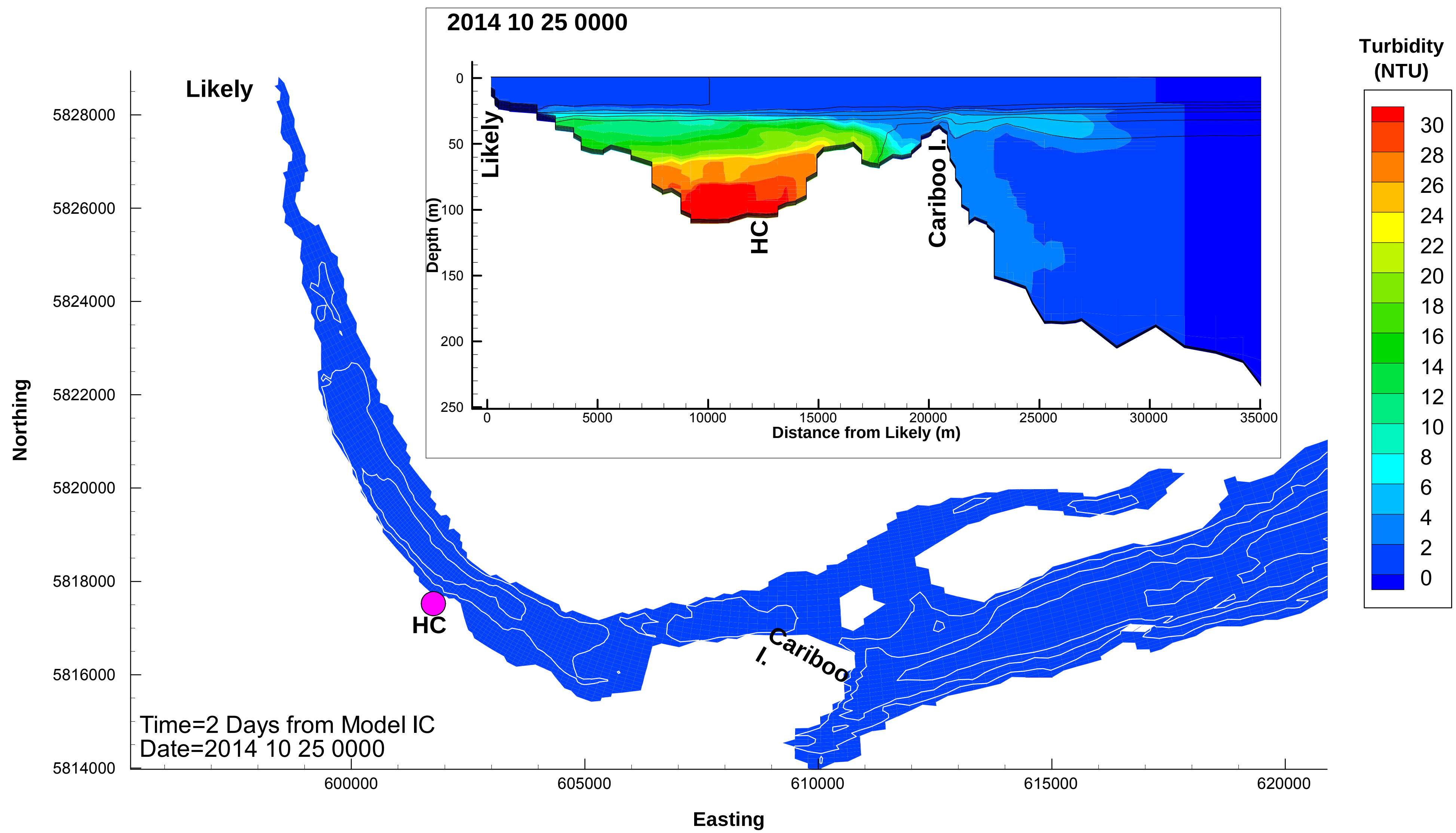
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Modelled and Observed Quesnel River Temperature Time Series September 1 Initial Conditions

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 5.18



NOTES

Turbidity [NTU] = 1.18 * TSS (mg/L)

STATUS
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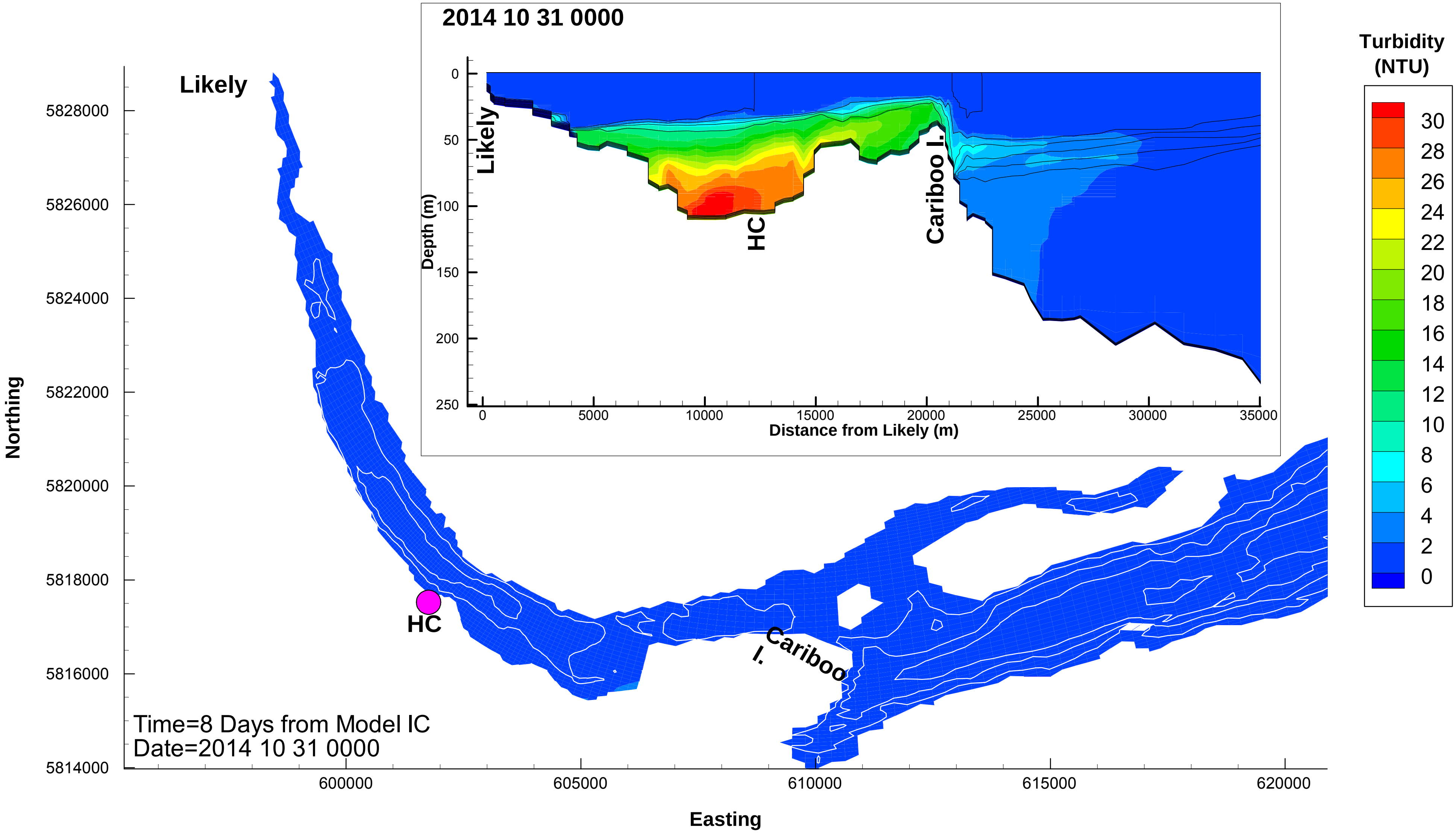
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Turbidity Map and Section Plot
October 25, 2014
Model Initial Condition

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2014

Figure 6.1



NOTES

Turbidity [NTU] = 1.18 * TSS (mg/L)

STATUS
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TETRA TECH EBA

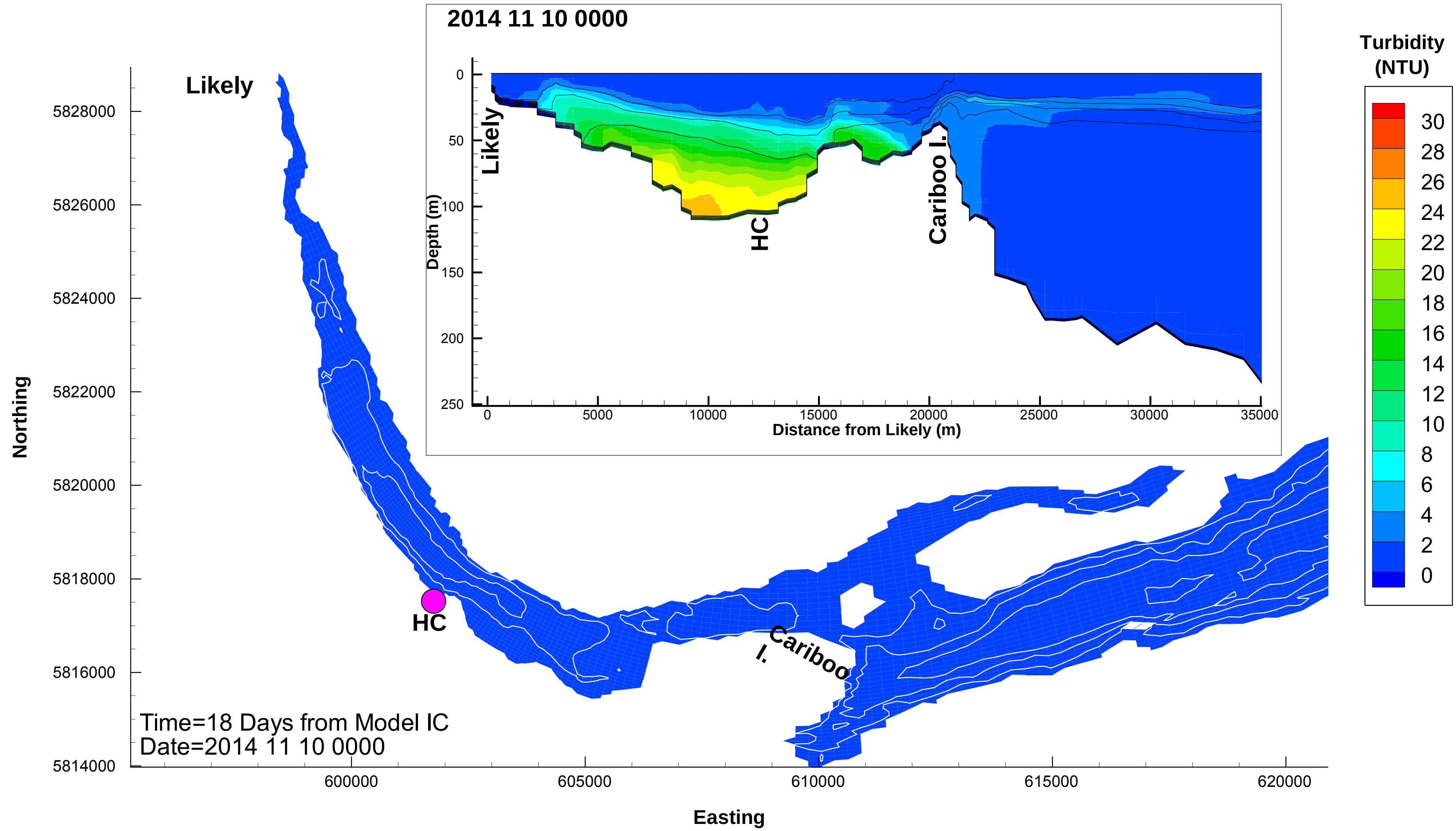
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Turbidity Map and Section Plot
Seiche Event

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2014

Figure 6.2



NOTES

Turbidity [NTU] = 1.18 * TSS (mg/L)

STATUS
ISSUED FOR USE

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MPMC

TETRA TECH EBA

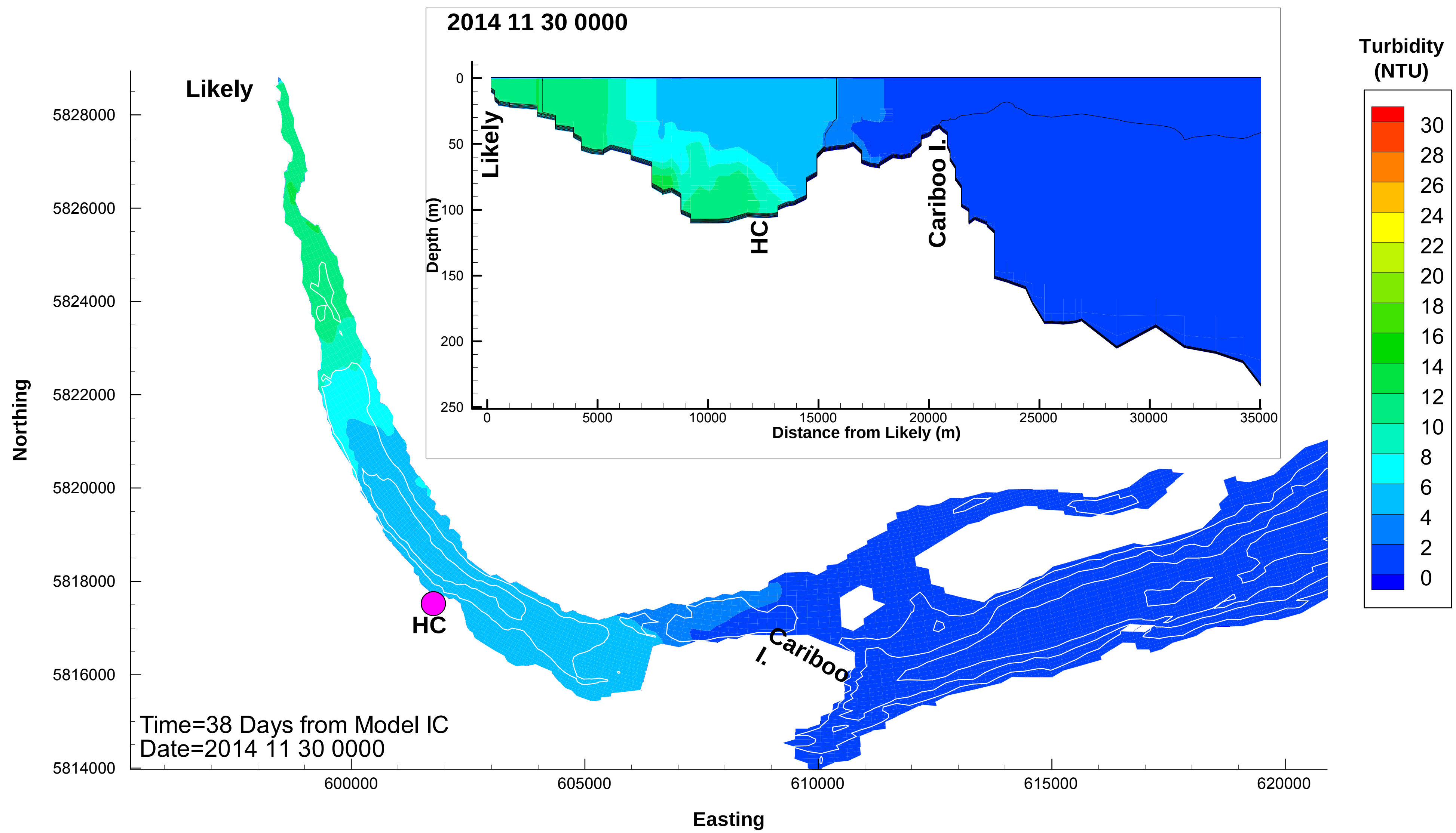
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Turbidity Map and Section Plot Likely Seiche Event

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE: Tetra Tech EBA - VANC
DATE: May 2014

Figure 6.3



NOTES

Turbidity [NTU] = 1.18 * TSS (mg/L)

STATUS
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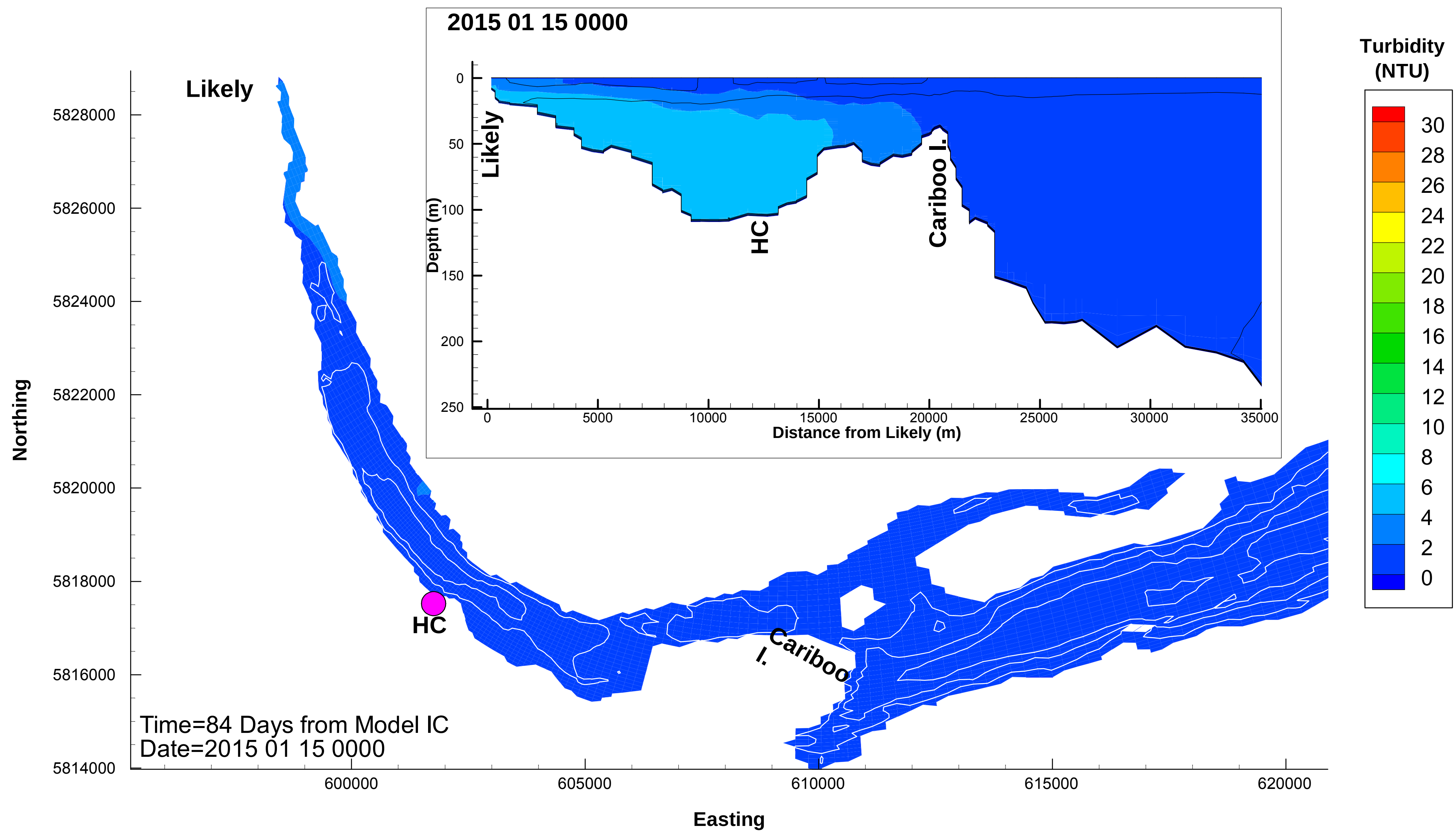
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Turbidity Map and Section Plot
Vertical Mixing

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2014

Figure 6.4



NOTES

Turbidity [NTU] = 1.18 * TSS (mg/L)

STATUS
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TETRA TECH EBA

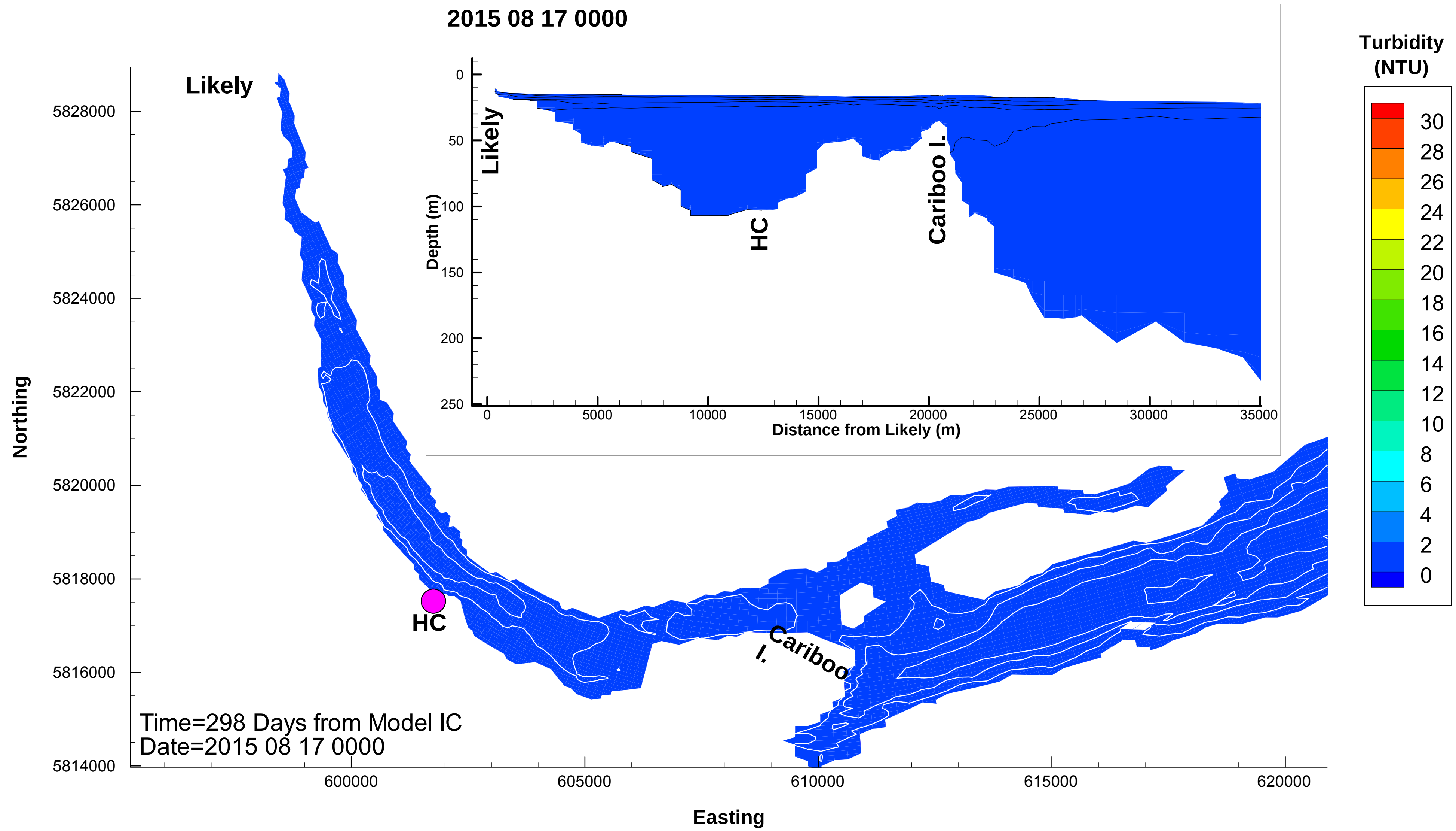
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Turbidity Map and Section Plot
Winter 2015

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2014

Figure 6.5



NOTES

Turbidity [NTU] = 1.18 * TSS (mg/L)

Colour scale on section view blanked below 0.1 NTU

STATUS
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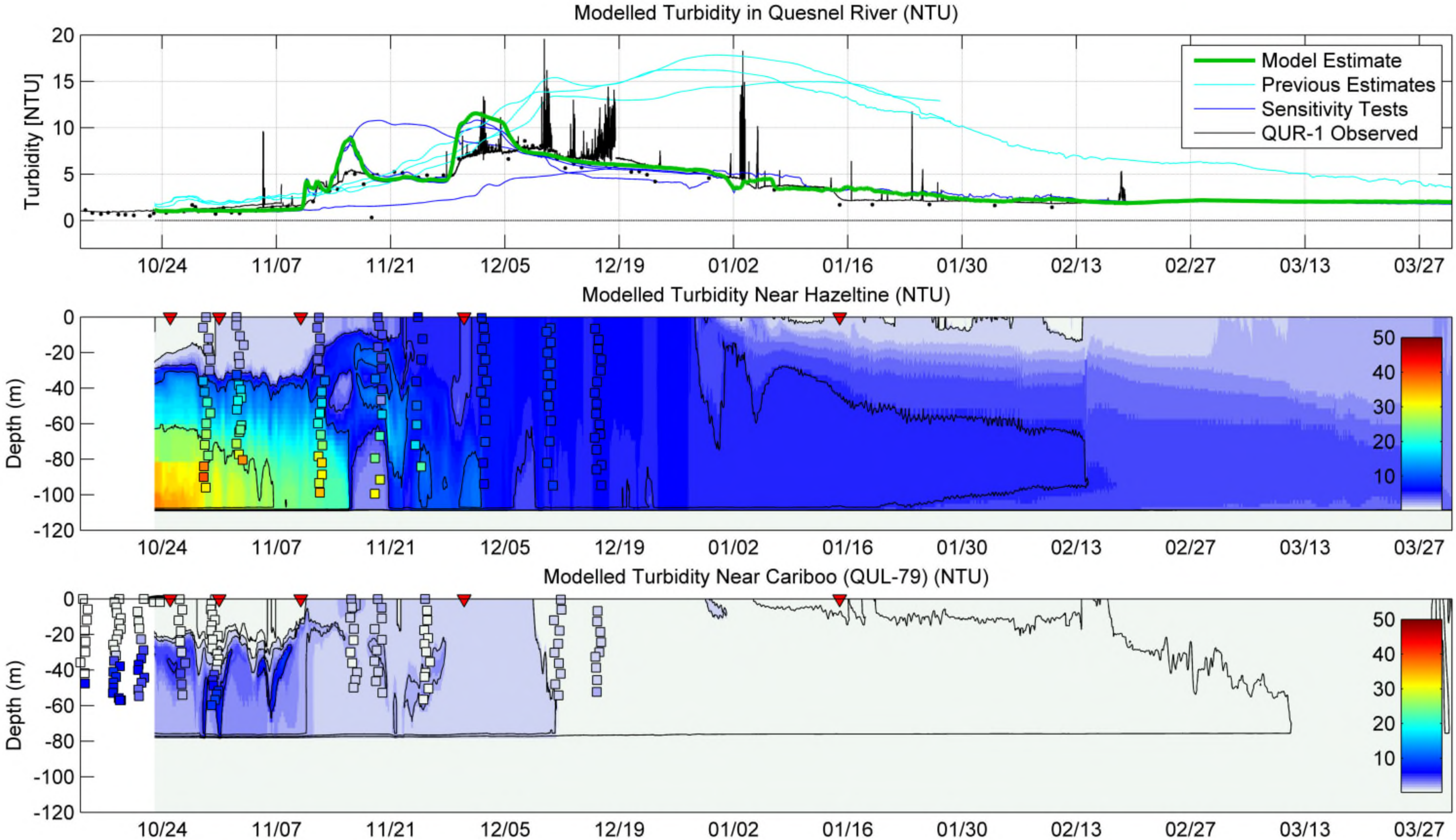
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Turbidity Map and Section Plot Summer 2015

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2014

Figure 6.6



NOTES

QUR-1 Observations collected by MPMC. Lines are YSI sonde, dots are laboratory turbidity measurements

Turbidity [NTU] = 1.18 * TSS (mg/L)

Contour lines at 0.5, 1.0, 2.0, 5.0, 10, 25, and 50 NTU
Colours cut off at 1.0 NTU

Red triangles mark dates of Figures 6.1 - 6.6

STATUS
ISSUED FOR USE

CLIENT
MPMC

TETRA TECH EBA

QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Modelled and Observed Turbidity
Quesnel River and Lake
October 2014 - May 2015

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	AO	JAS	JAS	0

OFFICE: Tetra Tech EBA - VANC
DATE: May 2015

Figure 6.7

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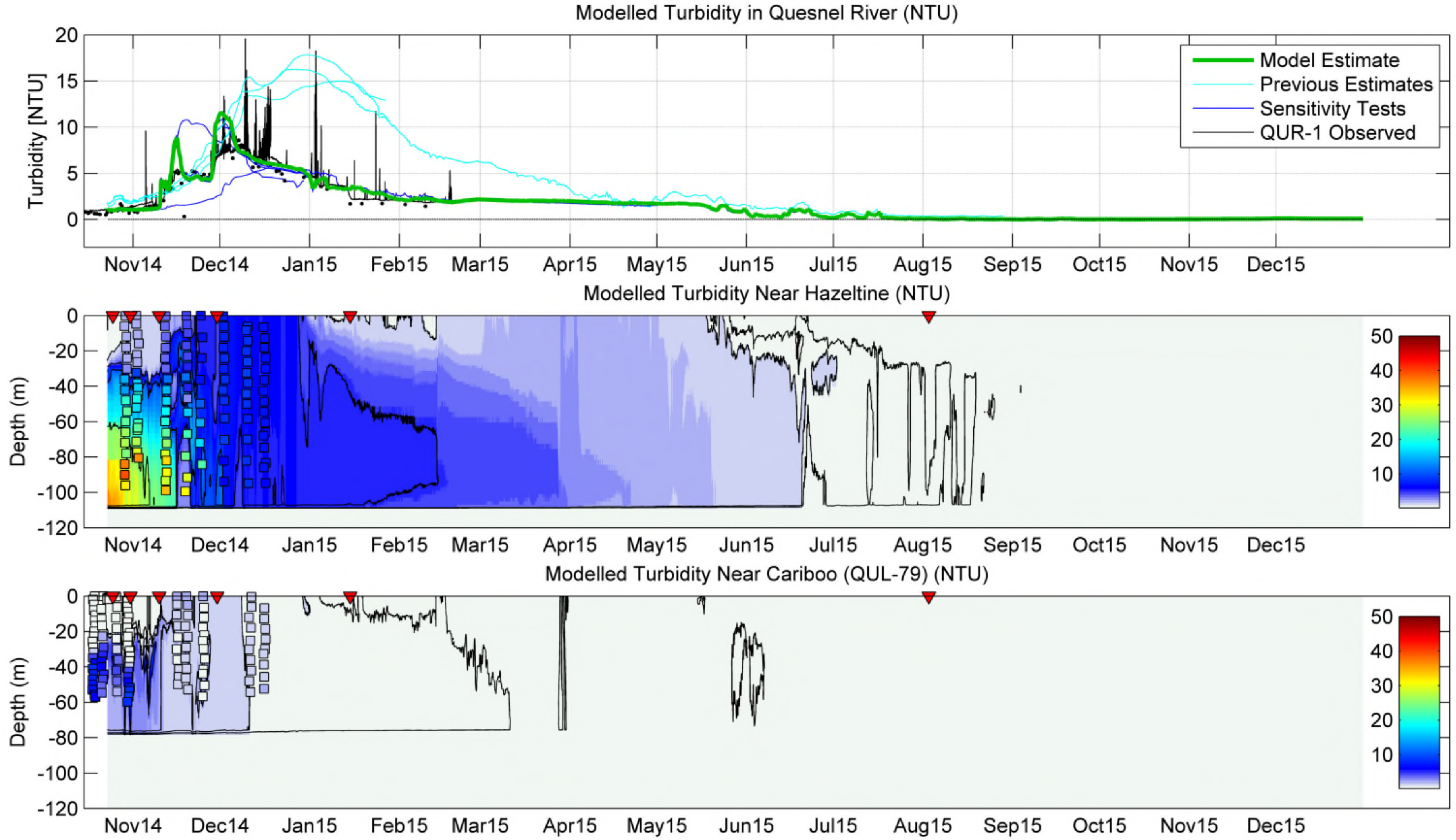

NOTES

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Turbidity [NTU] = 1.18 * TSS (mg/L)

Contour lines at 0.5, 1.0, 2.0, 5.0, 10, 25, and 50 NTU
Colours cut off at 1.0 NTU

Red triangles mark dates of Figures 6.1 - 6.6

STATUS
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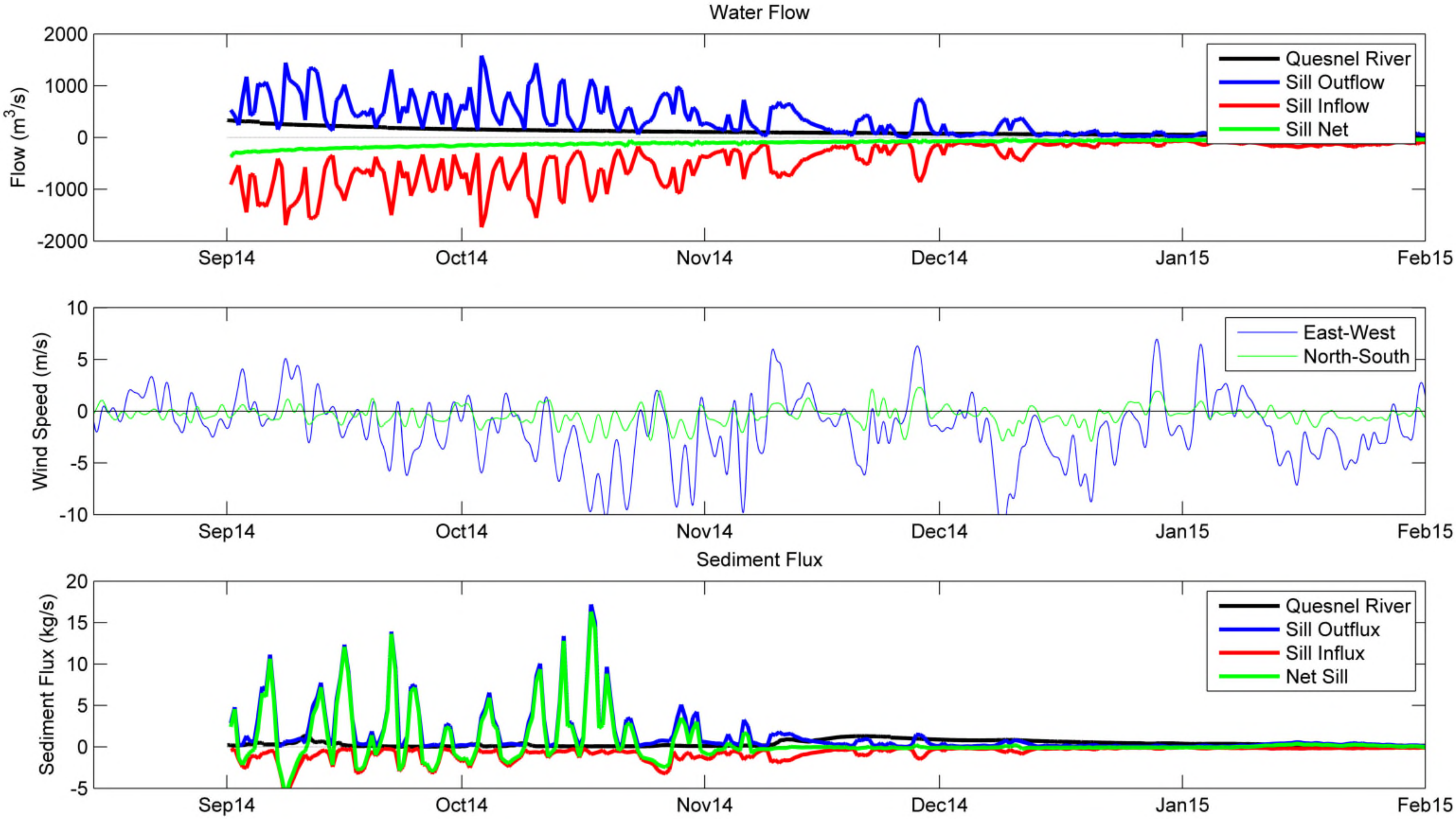
QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Modelled and Observed Turbidity Quesnel River and Lake October 2014 - December 2015

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE: Tetra Tech EBA - VANC
DATE: May 2015

Figure 6.8



NOTES

The top panel shows the instantaneous flux of water into and out of the West Basin over the Cariboo Island Sill. The sum of the fluxes over the sill are equal and opposite to the net outflow to the Quesnel River.

The centre panel shows modelled wind near Cariboo Island.

The bottom panel takes the sediment concentration of the water into account, representing the flux of suspended material.

STATUS
ISSUED FOR USE

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QUESNEL LAKE OBSERVATIONS AND HYDRODYNAMIC MODELLING

Modelled Transport and Sediment Flux September IC

PROJECT NO.	DWN	CKD	APVD	REV
V13203212	JMR	JAS	JAS	0

OFFICE	DATE
Tetra Tech EBA - VANC	May 2015

Figure 6.9

APPENDIX A
H3D TECHNICAL DESCRIPTION

APPENDIX A: H3D TECHNICAL DESCRIPTION
ISSUED FOR REVIEW: APRIL 22, 2015

1.0 INTRODUCTION

H3D is an implementation of the numerical model developed by Backhaus (1983; 1985) which has had numerous applications to the European continental shelf, (Duwe et al., 1983; Backhaus and Meir Reimer, 1983), Arctic waters (Kampf and Backhaus, 1999; Backhaus and Kampf, 1999) and deep estuarine waters, (Stronach et al., 1993). Locally, H3D has been used to model the temperature structure of Okanagan Lake (Stronach et al., 2002), the transport of scalar contaminants in Okanagan Lake, (Wang and Stronach, 2005), sediment movement and scour / deposition in the Fraser River, circulation and wave propagation in Seymour and Capilano dams, and salinity movement in the lower Fraser River. H3D forms the basis of the model developed by Saucier and co-workers for the Gulf of St. Lawrence (Saucier et al., 2003), and has been applied to the Gulf of Mexico (Rego et al., 2010).

2.0 THEORETICAL BASIS

H3D is a three-dimensional time-stepping numerical model which computes the three components of velocity (u,v,w) on a regular grid in three dimensions (x,y,z), as well as scalar fields such as temperature and contaminant concentrations. The model uses the Arakawa C-grid (Arakawa and Lamb, 1977) in space, and uses a two level semi-implicit scheme in the time domain. H3D bears many similarities to the well-known Princeton Ocean Model (POM) (Blumberg and Mellor, 1987) in terms of the equations it solves, but differs in how the time-domain aspects are implemented. H3D uses a semi-implicit scheme, allowing relatively large time steps, and does not separately solve the internal and external models as POM does. It also uses a considerably simpler turbulence scheme in the vertical. These considerations combined allow H3D to execute complex problems relatively quickly.

The equations to be solved are:

Mass Conservation:

(A1)

$$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}+\frac{\partial w}{\partial z}=0$$

At the end of each timestep equation, (A1) is used to diagnostically determine the vertical component of velocity *(w)* once the two horizontal components of velocity (*u* and v) have been calculated by the model.

X-directed momentum:

$$\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}+w\frac{\partial u}{\partial z}+g\frac{\partial \eta}{\partial x}+\frac{1}{\rho_o}\frac{\partial}{\partial x}\int_z^{\eta}(\rho_w-\rho_o)g\,dz-fv-\frac{\partial}{\partial x}A_H\frac{\partial u}{\partial x}-\frac{\partial}{\partial y}A_H\frac{\partial u}{\partial y}-\frac{\partial}{\partial z}A_V\frac{\partial u}{\partial z}=0. \quad \text{(A2)}$$

Y-directed momentum:

$$\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}+w\frac{\partial v}{\partial z}+g\frac{\partial \eta}{\partial y}+\frac{1}{\rho_o}\frac{\partial}{\partial y}\int_z^{\eta}(\rho_w-\rho_o)g\,dz+fu-\frac{\partial}{\partial x}A_H\frac{\partial v}{\partial x}-\frac{\partial}{\partial y}A_H\frac{\partial v}{\partial y}-\frac{\partial}{\partial z}A_V\frac{\partial v}{\partial z}=0. \quad \text{(A3)}$$

Water surface elevation determined from the vertically-integrated continuity equation:

$$\frac{\partial \eta}{\partial t} = -\frac{\partial}{\partial x}\int_{-H}^{\eta} u dz - \frac{\partial}{\partial y}\int_{-H}^{\eta} v dz. \qquad \text{(A4)}$$

The effect of wind forcing introduced by means of the surface wind-stress boundary condition:

$$\left(A_V \frac{\partial u}{\partial z}, A_V \frac{\partial v}{\partial z} \right)_{z=\eta} = \frac{\rho_a}{\rho_w} C_{D,air} \vec{U}_{wind} \left| \vec{U}_{wind} \right|. \qquad \text{(A5)}$$

The effect of bottom friction introduced by the bottom boundary condition:

$$\left(A_V \frac{\partial u}{\partial z}, A_V \frac{\partial v}{\partial z} \right)_{z=-H} = K_{bottom} \vec{U}_{bottom} \left| \vec{U}_{bottom} \right|. \qquad \text{(A6)}$$

The bottom friction coefficient is usually understood to apply to currents at an elevation of one metre above the bottom. The bottom-most vector in H3D will, in general, be at a different elevation, i.e., at the midpoint of the lowest computational cell. H3D uses the ‘law of the wall’ to estimate the flow velocity at one metre above the bottom from the modelled near-bottom velocity.

The evolution of scalars, such as salinity, temperature, or suspended sediment, is given by the scalar transport/diffusion equation:

$$\frac{\partial S}{\partial t} + u\frac{\partial S}{\partial x} + v\frac{\partial S}{\partial y} + w\frac{\partial S}{\partial z} - \frac{\partial}{\partial x} N_H \frac{\partial S}{\partial x} - \frac{\partial}{\partial y} N_H \frac{\partial S}{\partial y} - \frac{\partial}{\partial z} N_V \frac{\partial S}{\partial z} = Q\,. \qquad \text{(A7)}$$

In the above equations:

u(x,y,z,t): component of velocity in the *x* direction;

v(x,y,z,t): component of velocity in the *y* direction;

w(x,y,z,t): component of velocity in the *z* direction;

S(x,y,z,t): scalar concentration;

Q(x,y,z,t): source term for each scalar species

f: Coriolis parameter, determined by the earth’s rotation and the local latitude;

$A_H \left(\partial u / \partial x, \partial u / \partial y, \partial v / \partial x, \partial v / \partial y \right)$: horizontal eddy viscosity;

$A_V \left(\partial u / \partial z, \partial v / \partial z, \partial \rho_{water} / \partial z \right)$: vertical eddy viscosity;

N_H: horizontal eddy diffusivity;

$N_V \left(\partial u / \partial z, \partial v / \partial z, \partial \rho_{water} / \partial z \right)$: vertical eddy diffusivity;

$C_{D,air}$: drag coefficient at the air-water interface;

$C_{D,bottom}$: drag coefficient at the water/sea bottom interface;

ρ_a: density of air;

$\rho_w(x,y,z,t)$: density of water;

ρ_o : reference density of water;

$\eta(x,y,t)$: water surface elevation;

H(x,y) : local depth of water.

The above equations are formally integrated over the small volumes defined by the computational grid, and a set of algebraic equations results, for which an appropriate time-stepping methodology must be found. Backhaus (1983, 1985) presents such a procedure, referred to as a semi-implicit method. The spatially-discretized version of the continuity equation is written as:

$$\eta^{(1)} = \eta^{(0)} - \alpha \frac{\Delta t}{\Delta l}(\delta_x U^{(1)} + \delta_y V^{(1)}) - (1-\alpha)\frac{\Delta t}{\Delta l}(\delta_x U^{(0)} + \delta_y V^{(0)}) \quad \text{(A8)}$$

where superscript *(0)* and *(1)* refer to the present and the advanced time, δ_x and δ_y are spatial differencing operators, and *U* and *V* are vertically integrated velocities. The factor α represents an implicit weighting, which must be greater than 0.5 for numerical stability. $U^{(0)}$ and $V^{(0)}$ are known at the start of each computational cycle. $U^{(1)}$, and similarly $V^{(1)}$, can be expressed as:

$$U^{(1)} = U^{(0)} - g\alpha\Delta t\eta_x^{(1)} - g(1-\alpha)\Delta t\eta_x^{(0)} + \Delta t X^{(0)} \quad \text{(A9)}$$

where $X^{(0)}$ symbolically represents all other terms in the equation of motion for the u- or v-component, which are evaluated at time level *(0)*: Coriolis force, internal pressure gradients, non-linear terms, and top and bottom stresses,*)*. When these expressions are substituted into the continuity equation (A4), after some further manipulations, there results an elliptic equation for $\delta_{i,k}$, the change in water level over one timestep at grid cell *i,k* (respectively the *y* and *x* directions):

$$\delta_{i,k} - (ce\delta_{i,k+1} + cw\delta_{i,k-1} + cn\delta_{i-1,k} + cs\delta_{i+1,k}) = Z_{i,k} \quad \text{(A10)}$$

where *ce*, *cw*, *cn*, and *cs* are coefficients depending on local depths and the weighting factor (α), and $Z_{i,k}$ represents the sum of the divergence formed from velocities at time level *(0)* plus a weighted sum of adjacent water levels at time level *(0).*

Once equation (A10) is solved for $\delta_{i,k}$, the water level can be updated:

$$\eta_{i,k}^{(1)} = \eta_{i,k}^{(0)} + \delta_{i,k} \quad \text{(A11)}$$

and equation (A9) can be completed.

At the end of each timestep, volume conservation is used to diagnostically compute the vertical velocity *w(j,i,k)* from the two horizontal components *u* and *v*.

2.1 Vertical Grid Geometry

In the vertical, the levels near the surface are typically closely spaced to assist with resolving near-surface dynamics. In addition, the model is capable of dealing with relatively large excursions in overall water level as the water level rises and falls in response to varying inflows and outflows, by allowing the number of near-surface layers to change as the water level varies. That is, as water levels rise in a particular cell, successive layers above the original layer are turned on and become part of the computational mesh. Similarly, as water levels fall, layers are turned off. This procedure has proven to be quite robust, and allows for any reasonable vertical resolution in near-surface waters. When modelling thin river plumes in areas of large tidal range, the variable number of layers approach allows for much better control over vertical resolution than does the σ-coordinate method.

In addition to tides, the model is able to capture the important response, in terms of enhanced currents and vertical mixing, to wind-driven events. This is achieved by applying wind stress to each surface grid point on each time step. Vertical mixing in the model then re-distributes this horizontal momentum throughout the water column. Similarly, heat flux through the water surface is re-distributed by turbulence and currents in temperature simulations.

2.2 Turbulence Closure

Turbulence modelling is important in determining the correct distribution of velocity and scalars in the model. The diffusion coefficients for momentum (A_H and A_V) and scalars (N_H and N_V) at each computational cell are dependent on the level of turbulence at that point. H3D uses a shear-dependent turbulence formulation in the horizontal, (Smagorinsky, 1963). The basic form is:

$$A_H = A_{Ho}\, dx\, dy \sqrt{\left(\frac{du}{dx}\right)^2 + \left(\frac{dv}{dy}\right)^2 + \frac{1}{2}\left(\frac{\partial v}{\partial x} + \frac{\partial u}{\partial y}\right)^2} \qquad \text{(A12)}$$

The parameter A_{H0} is a dimensionless tuning variable, and experience has shown it to lie in the range of 0.1 to 1.0 for most water bodies such as rivers, lakes and estuaries.

A shear and stratification dependent formulation, the Level 2 model of Mellor and Yamada (1982), is used for the vertical eddy diffusivity. The basic theory for the vertical viscosity formulation is taken from an early paper, Mellor and Durbin (1975). The evaluation of length scale is based on a methodology presented in Mellor and Yamada (1982).

For scalars, both horizontal and vertical eddy diffusivity are taken to be similar to their eddy viscosity counterparts, but scaled by a fixed ratio from the eddy viscosity values. Different ratios are used for the horizontal and vertical diffusivities. If data is available for calibration, these ratios can be adjusted based on comparisons between modelled and observed data. Otherwise, standard values based on experience with similar previously modelled water bodies are used. For the Quesnel Lake model, the ratio of vertical eddy diffusivity to vertical eddy viscosity was 0.1 for models with only temperature (2003) and 0.5 for models with temperature and suspended material (2014). The ratio between horizontal eddy diffusivity and horizontal eddy viscosity was 1.0.

2.3 Scalar Transport

The scalar transport equation implements a form of the flux-corrected algorithm (Zalesak, 1979), in which all fluxes through the sides of each computational cell are first calculated using a second-order method. Although generally more accurate than a first order method, second order flux calculations can sometimes lead to unwanted high frequency oscillations in the numerical solution. To determine if such a situation is developing, the model examines each cell to see if the computed second order flux would cause a local minimum or maximum to develop. If so, then all fluxes into or out of that cell are replaced by first order fluxes, and the calculation is completed. As noted, the method is not a strict implementation of the Zalesak method, but is much faster and achieves very good performance with respect to propagation of a Gaussian distribution through a computational mesh. It does not propagate box-car distributions as well as the full Zalesak method, but achieves realistic simulations of the advection of scalars in lakes, rivers and estuaries, which is the goal of the model. This scheme as implemented is thus a good tradeoff between precision and execution time, important since in many situations, where more than one scalar is involved, the transport-diffusion algorithm can take up more than half the execution time.

2.4 Heat Flux at the Air-Water Interface

The contribution of heat flux to the evolution of the water temperature field can be schematized as:

$$\frac{dT}{dt} = \frac{\Delta Q}{\rho * c_p * h}$$

where ΔQ is the net heat flux per unit area retained in a particular layer, ρ is the density of water, c_p is the heat capacity of water and *h* is the layer thickness.

Heat flux at the air-water interface incorporates the following terms:

Q_{in}: incident short wave radiation. Generally, this is not known from direct observations. For Quesnel Lake, it was estimated from the cloud cover and opacity observations at Williams Lake Airport, a theoretical calculation of radiation at the top of the atmosphere based on the geometry of the earth/sun system, and an empirical adjustment based on radiation measurements at Vancouver Airport and UBC respectively for the period 1974-1977. This procedure has worked well for other water bodies, notably Okanagan Lake and the waters of the north coast of British Columbia, in terms of allowing H3D to reproduce the observed temperature distributions in space and time. Values for albedo as a function of solar height are taken from Kondratyev (1972).

Q_{back}: net long wave radiation, calculated according to Gill (1982), involving the usual fourth power dependence on temperature, a factor of 0.985 to allow for the non-black body behaviour of the ocean, a factor depending on vapor pressure to allow for losses due to back radiation from moisture in the air, and a factor representing backscatter from clouds.

Q_L and Q_H: latent and sensible heat flux. Latent heat flux (Q_L) is the heat carried away by the process of evaporation of water. Sensible heat flux (Q_S) is driven by the air-water temperature difference and is similar to conduction, but assisted by turbulence in the air. Latent and sensible heat flux is described by:

$$Q_L = 1.32e^{-3} * L * windspeed * (q_{obs} - q_{sat}) * latent\_factor$$

$$Q_S = 1.46e^{-3} * \rho_{air} * c_p * windspeed * (T_{air} - T_{water}) * sensible\_factor$$

Where q_{obs} and q_{sat} are the observed and saturated specific humidities, T_{air} and T_{water} are the air and water temperatures, *L* is the latent heat of evaporation of water, and c_p is the heat capacity of water. '*latent_factor*' and '*sensible_factor*' are scaling factors introduced to account for local factors, and can be adjusted, when needed, to achieve better calibration of the model. Typically, the only adjustment is that *Sensible_factor* is doubled when the air temperature is less than the water or ice surface temperature to account for increased turbulence in an unstable air column.

Light absorption in the water column. As light passes through the water column it is absorbed and the absorbed energy is a component of the energy balance that drives water temperature. H3D assumes that light attenuation follows an exponential decay law:

$$E(z) = E(z_0) * e^{-k*(z-z_0)}$$

The model computes the energy at the top and bottom of each layer and the difference is applied to the general heat equation in that layer. The extinction coefficient (*k*) is related to the Secci depth (D_s) by

$$k = \frac{2.1}{D_s}$$

Temperature is treated like any other scalar as far as advection and diffusion are concerned. Heat flux at the water-sediment interface is not currently included in H3D.

3.0 VALIDATION

Three validations, outside of those presented in the Quesnel Lake report, are discussed below.

3.1 Strait of Georgia/Point Atkinson Tide: Wave Propagation

A fundamental concern with a circulation model such as H3D is how well it propagates waves, the carriers of information through the system. Figure A-1 presents results of a simulation of tides in the Strait of Georgia and Juan de Fuca Strait, with tidal elevations prescribed at the entrance to Juan de Fuca Strait and at a section north of Texada Island in the Strait of Georgia. The complex dynamics of the northern passes, such as Discovery Passage and Seymour Narrows, are thus avoided, allowing a test of H3D's wave propagation capabilities. The figure plots the modelled water level at Point Atkinson in red, and the observed water level in black. There is nearly perfect agreement, with the slight difference resulting from small storm surge events. This validation demonstrates that the selection of grid schematization (Arakawa C-grid) and the semi-implicit time-stepping approach have produced a system than can accurately propagate information through a water body.

3.2 Okanagan Lake Temperature Profiles

Obtaining good reproduction of the seasonally–evolving temperate structure of a lake indicates that the heat flux across the air-water interface is accurately parameterized and that the transport-diffusive processes operating in the water column are also accurately reproduced by the model. Figure A-2 presents a comparison of observed and computed temperature profiles at the northern end of Okanagan Lake near Vernon, in April, August, October and December of 1997. The agreement is very good as the model reproduced the transition from a well-mixed condition in the spring to the development of a strong thermocline in the summer, the deepening of the upper layer during the fall cooling period, and a return to isothermal conditions in winter. There is little doubt that H3D can compute accurate temperature distributions in water bodies, as long as adequate meteorological data is available. For this simulation, the meteorological data was obtained from Penticton Airport: winds, rotated to follow the thalweg of the valley; cloud cover, air temperature and relative humidity.

3.3 Thermistor Response: Okanagan Lake

Okanagan Lake is subject to significant fluctuations in the vertical thermal structure during the summer stratified period. Figure A-3 shows a temperature time-series at a site on the north side of the William R. Bennett Bridge which exhibits significant temperature excursions at periods of about 60 hours, or 2.5 days. Figure A-4 shows the modelled time series of temperature at three selected depths, 51 m, 21 m and 9 m. The occurrence and magnitude of the temperature fluctuations is generally predicted by the model, but the reproduction is not perfect: the occurrence and timing of the temperature events is quite good, but the modelled peaks appear to be generally somewhat broader in time. It was found that there were considerable differences in the simulated behaviour depending on whether winds at Kelowna Airport, which is situated in a side-valley, were included in the model or not. It is also clear that H3D can generally reproduce internal seiches in a lake, as long as adequate spatial resolution is used. This is particularly apparent when the coherent internal waves that propagate up and down the lake are examined in a longitudinal section, illustrated in two snapshots from a model simulation of such an event in Figure A-5.

4.0 COEFFICIENTS USED IN THE QUESNEL LAKE SIMULATION

Model Coefficients

Coefficient	Value	Comment
Vertical levels	-2.25, -1.75, -1.25, -0.5, 0.25, 1, 1.75, 2.5, 3.5, 4.5, 5.5, 6.5, 7.5, 8.5, 9.5, 10.5, 11.5, 12.5, 13.5, 14.5, 15.5, 16.5, 17.5, 18.5, 19.5, 20.5, 21.5, 22.5, 23.5, 24.5, 26, 27.5, 29, 30.5, 32, 33.5, 35, 36.5, 38, 39.5, 41, 42.5, 44, 45.5, 47, 50, 53, 56, 59, 62, 65, 68, 71, 74, 77, 80, 83, 86, 89, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 117, 120, 123, 126.66, 131.13, 136.6, 143.2, 151.3, 161.2, 173.3, 188.0, 206.0, 227.9, 254.6, 287.2, 327.0, 375.6, 434.8, 507.1, 600	In depth coordinates, not elevations.
Horizontal grid size	Variable, ranging from 77 x 78 m near Hazeltine Creek to 400 x 700 m at the tip of the East Arm	
Δt	20-22 s, varied according to water velocity	Timestep
A	0.75	Weighting for implicit/explicit solution, more implicit than explicit in this case
Bottom friction coefficient	0.003	
Wind drag coefficient at water surface	1.5×10^{-3}	
A_{Ho}	0.5	Horizontal eddy viscosity coefficient in Smagorinsky formulation
Ah_floor	0.1	Horizontal eddy viscosity minimum (m^2/s)
Kh_factor	1	Ratio between horizontal scalar and velocity mixing
Ratio	0.1 (2003 model), 0.5 (2014 model)	Ratio between vertical scalar and velocity mixing
Av_min	1×10^{-5}	Vertical eddy viscosity minimum (m^2/s)
latent_factor	1.0 if water colder than air, 0.75 if water warmer than air	Latent heat coefficient
sensible_factor	1.0 if water colder than air, 0.75 if water warmer than air	Sensible heat coefficient
Secci	4	Secci disk depth (m)

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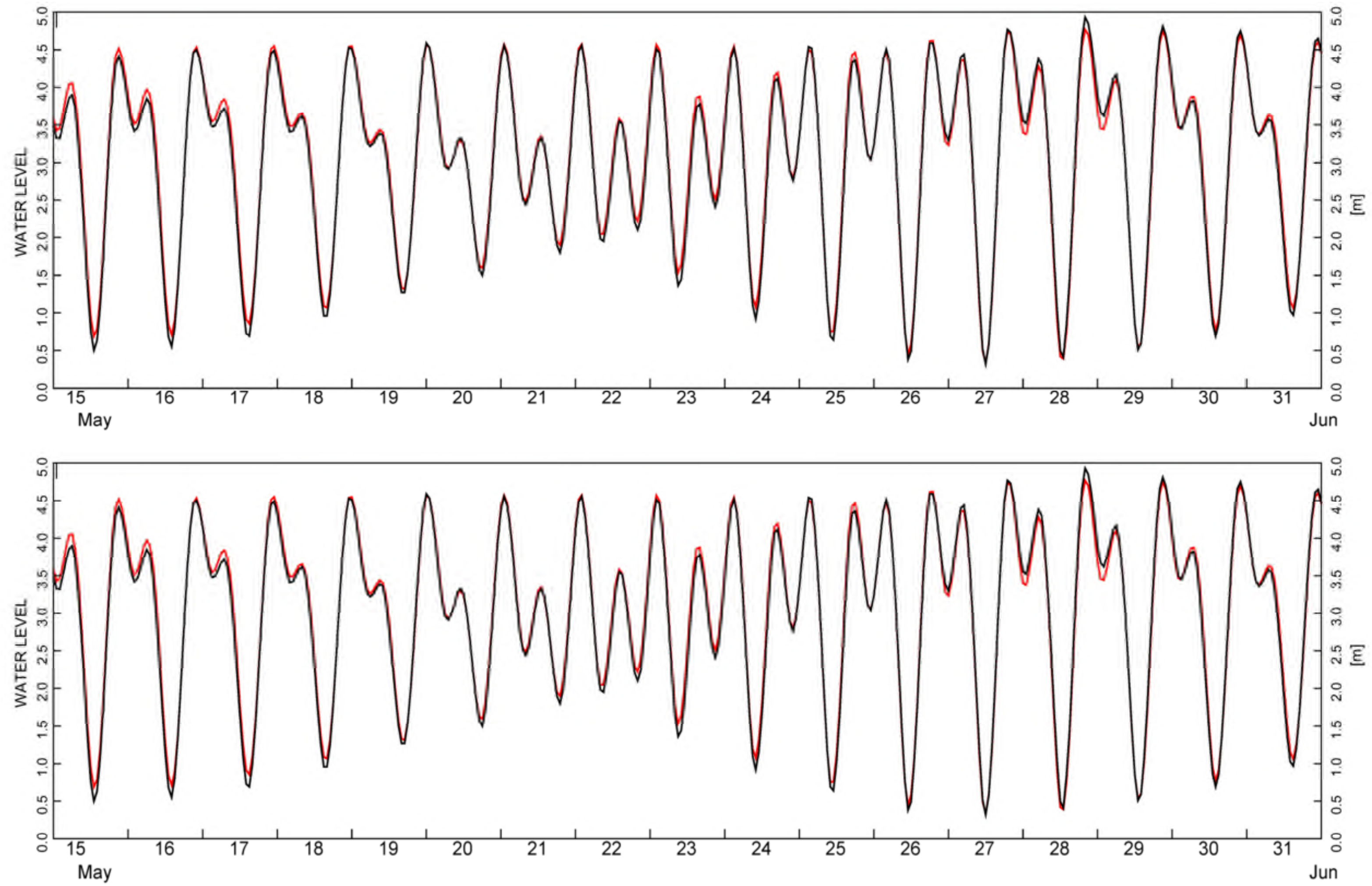

LEGEND

- Black lines represent observed profiles
- Red lines represent modelled profiles

NOTES

STATUS

CLIENT

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H3D TECHNICAL DESCRIPTION

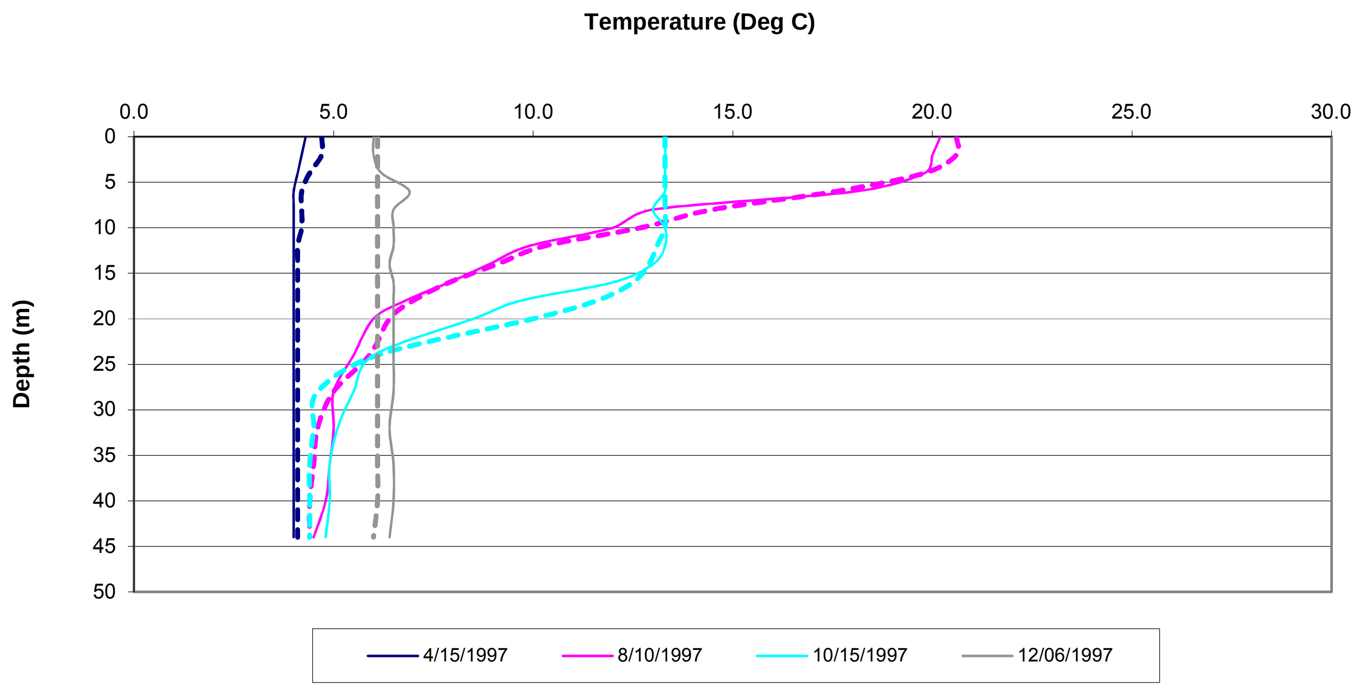
H3D Validation
Tidal Reproduction

TETRA TECH EBA

PROJECT NO.	DWN	CKD	APVD	REV
V132	JMR	JAS	JAS	001

OFFICE	DATE
EBA-VANC	March 2015

Figure A-1



LEGEND

- Solid lines represent observed profiles
- Dashed lines represent modelled profiles

NOTES

STATUS

CLIENT

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TETRA TECH EBA

H3D TECHNICAL DESCRIPTION

H3D Validation
Comparison of Observed and Modelled Temperature Profiles at Vernon

PROJECT NO.	DWN	CKD	APVD	REV
V132	JMR	JAS	JAS	001

OFFICE	DATE
EBA-VANC	March 2015

Figure A-2

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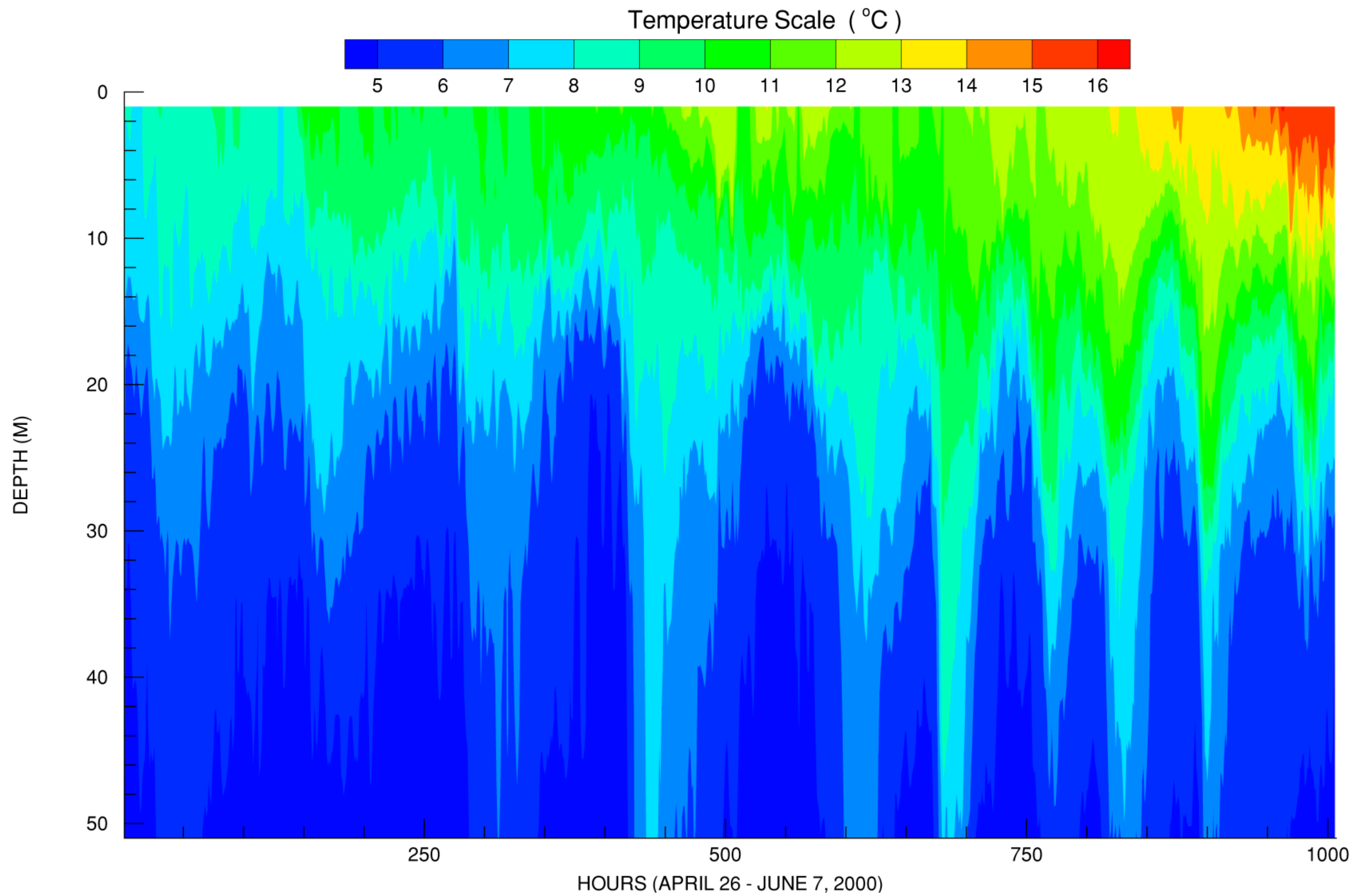


LEGEND

NOTES

STATUS
ISSUED FOR REVIEW

CLIENT

-

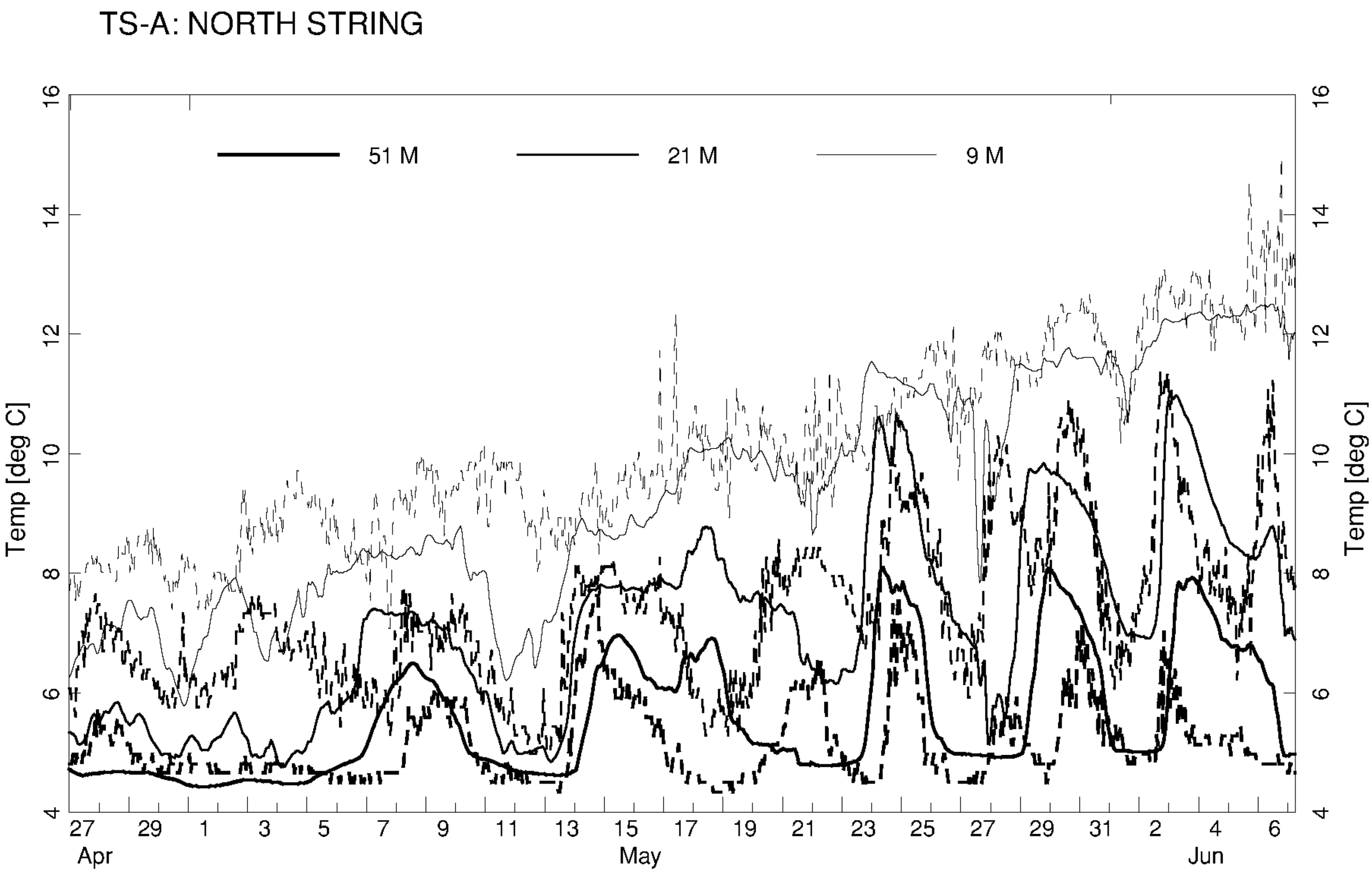
TETRA TECH EBA

H3D TECHNICAL DESCRIPTION

H3D VALIDATION
SEICHES IN OKANAGAN LAKE
(OBSERVED DATA)

PROJECT NO.	DWN	CKD	APVD	REV
V132	JMR	JAS	JAS	0
OFFICE	DATE			
EBA-VANC	March 2015			

Figure A-3



LEGEND

Dashed Lines: Observed Temperature
Solid Lines: Modelled Temperature

NOTES

STATUS
ISSUED FOR REVIEW

CLIENT
-

TETRA TECH EBA

H3D TECHNICAL DESCRIPTION

H3D VALIDATION INTERNAL SEICHE DYNAMICS OKANAGAN LAKE

PROJECT NO.	DWN	CKD	APVD	REV
V132	JMR	JAS	JAS	0

OFFICE	DATE
EBA-VANC	Marhc 2015

Figure A-4

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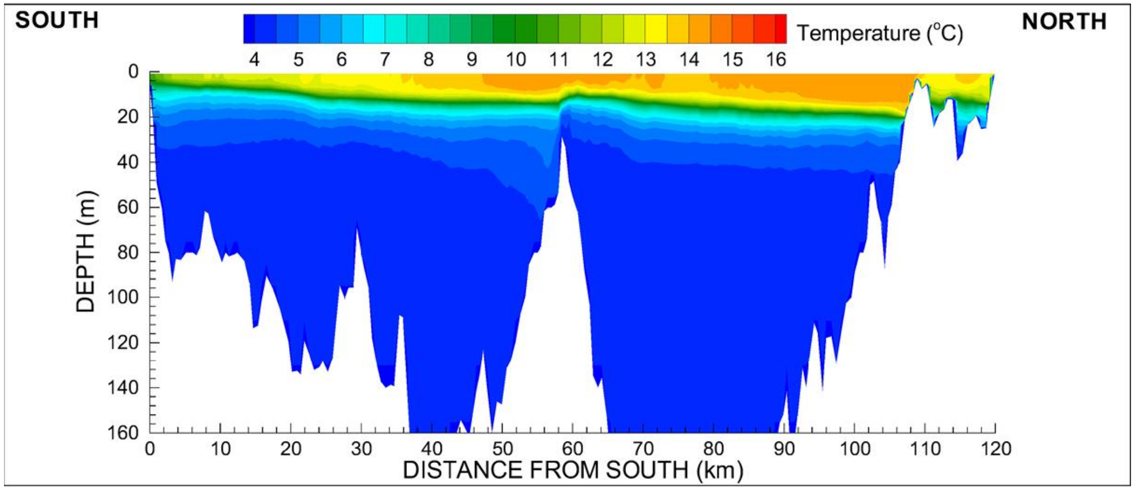

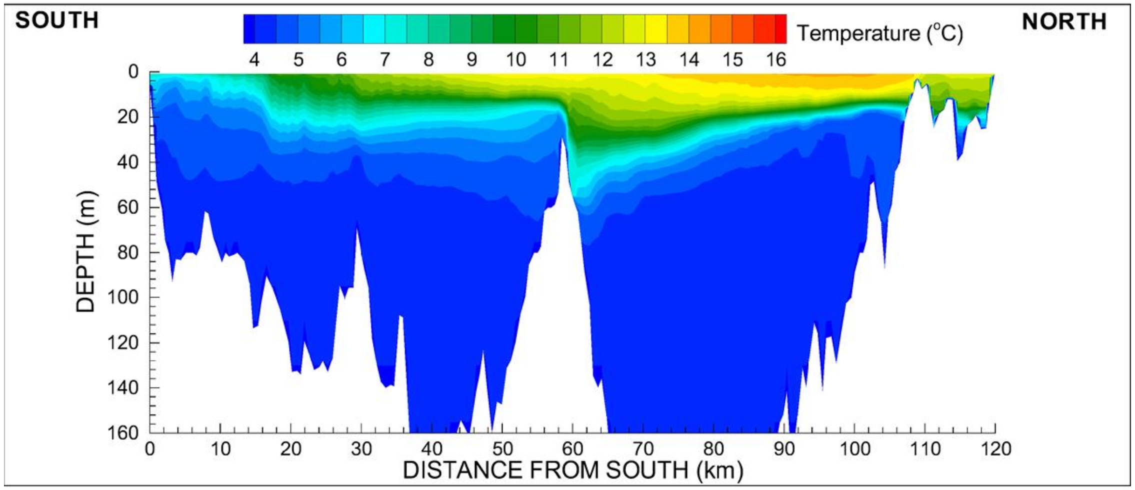

LEGEND

NOTES

STATUS
ISSUED FOR REVIEW

CLIENT
-

TETRA TECH EBA

H3D TECHNICAL DESCRIPTION

H3D VALIDATION INTERNAL SEICHE DYNAMICS OKANAGAN LAKE

PROJECT NO.	DWN	CKD	APVD	REV
V132	JMR	JAS	JAS	JAS

OFFICE	DATE
EBA-VANC	March 2015

Figure A-5

APPENDIX B
TETRA TECH EBA'S GENERAL CONDITIONS

GENERAL CONDITIONS

DESIGN REPORT

This report incorporates and is subject to these “General Conditions”.

1.0 USE OF REPORT AND OWNERSHIP

This Design Report pertains to a specific site, a specific development, and a specific scope of work. The Design Report may include plans, drawings, profiles and other support documents that collectively constitute the Design Report. The Report and all supporting documents are intended for the sole use of Tetra Tech EBA’s Client. Tetra Tech EBA does not accept any responsibility for the accuracy of any of the data, analyses or other contents of the Design Report when it is used or relied upon by any party other than Tetra Tech EBA’s Client, unless authorized in writing by Tetra Tech EBA. Any unauthorized use of the Design Report is at the sole risk of the user.

All reports, plans, and data generated by Tetra Tech EBA during the performance of the work and other documents prepared by Tetra Tech EBA are considered its professional work product and shall remain the copyright property of Tetra Tech EBA.

2.0 ALTERNATIVE REPORT FORMAT

Where Tetra Tech EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed Tetra Tech EBA’s instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by Tetra Tech EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of Tetra Tech EBA’s instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except Tetra Tech EBA. Tetra Tech EBA’s instruments of professional service will be used only and exactly as submitted by Tetra Tech EBA.

Electronic files submitted by Tetra Tech EBA have been prepared and submitted using specific software and hardware systems. Tetra Tech EBA makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

3.0 ENVIRONMENTAL AND REGULATORY ISSUES

Unless so stipulated in the Design Report, Tetra Tech EBA was not retained to investigate, address or consider, and has not investigated, addressed or considered any environmental or regulatory issues associated with the project specific design.

4.0 CALCULATIONS AND DESIGNS

Tetra Tech EBA has undertaken design calculations and has prepared project specific designs in accordance with terms of reference that were previously set out in consultation with, and agreement of, Tetra Tech EBA’s client. These designs have been prepared to a standard that is consistent with industry practice. Notwithstanding, if any error or omission is detected by Tetra Tech EBA’s Client or any party that is authorized to use the Design Report, the error or omission should be immediately drawn to the attention of Tetra Tech EBA.

5.0 GEOTECHNICAL CONDITIONS

A Geotechnical Report is commonly the basis upon which the specific project design has been completed. It is incumbent upon Tetra Tech EBA’s Client, and any other authorized party, to be knowledgeable of the level of risk that has been incorporated into the project design, in consideration of the level of the geotechnical information that was reasonably acquired to facilitate completion of the design.

If a Geotechnical Report was prepared for the project by Tetra Tech EBA, it will be included in the Design Report. The Geotechnical Report contains General Conditions that should be read in conjunction with these General Conditions for the Design Report.

6.0 INFORMATION PROVIDED TO TETRA TECH EBA BY OTHERS

During the performance of the work and the preparation of the report, Tetra Tech EBA may rely on information provided by persons other than the Client. While Tetra Tech EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, Tetra Tech EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

APPENDIX C: MOUNT POLLEY MINE TAILINGS DAM FAILURE: GEOCHEMICAL CHARACTERIZATION OF SPILLED TAILINGS

Chris Kennedy, Ph.D., P.Geo and Stephen Day, M.Sc., P.Geo

SRK Consulting (Canada) Inc.

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Mount Polley Mine Tailings Dam Failure: Geochemical Characterization of Spilled Tailings

Prepared for

Mount Polley Mining Corporation

Prepared by

srk consulting 1974 40 2014

SRK Consulting (Canada) Inc.
1CI008.003
June 2015

Mount Polley Mine Tailings Dam Failure: Geochemical Characterization of Spilled Tailings

June 2015

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Project No: 1CI008.003

File Name: SRK_PEEIAR_Section_MtPolley_TailingsDamBreach_Geochem_1CI008 003_FINAL_20150601_CBK

Executive Summary

A tailings dam failure occurred at the Mount Polley Mine (MPM), located approximately 55 km north-east of Williams Lake, BC, on August 4, 2014. The dam failure resulted in spillage of tailings and other materials into Polley Lake, Hazeltine Creek, and Quesnel Lake. SRK developed and carried out a geochemical characterization program to assess the metal leaching and acid rock drainage (ML/ARD) potential of the spilled tailings that included a review of existing data, a geochemical conceptual model to guide sampling design, and a sampling and analysis plan. Results of the program are provided herein, although at the time of this report certain tests were on-going and the interpretations provided in this report are therefore considered interim.

The geochemical conceptual model developed indicated that ML/ARD potential needed to be assessed for two main storage conditions: (1) subaerial tailings along the banks of Hazeltine Creek and (2) subaqueous tailings along the stream bed of Hazeltine Creek and in Polley and Quesnel Lakes. The spilled tailings likely mixed to varying degrees with native sediments during and after the dam failure and during deposition. Therefore, geochemical characterization and reference to ‘spilled tailings’ herein is inclusive of any co-mingled native sediments.

Sampling was conducted along Hazeltine Creek by SRK and SNC-Lavalin. Minnow Environmental Inc. also sampled tailings from along the creek and from the bottom of Quesnel and Polley Lake. Characterization tests were designed to provide information on acid-base accounting, tailings composition, mineralogy, and leaching potential characteristics of the tailings under subaerial (i.e. humidity cell and column tests) and sub-aqueous (i.e. sequential extractions) storage configurations.

Sampling results were such that acid rock drainage potential of the spilled tailings is considered to be negligible owing to low sulphur content (ranging from 0.1 to 0.3%) and high buffering potential from calcite. As a result, leaching from the spilled tailings needs to be considered only as under non-acidic conditions (i.e. typical conditions in natural streams and lakes) rather than acidic conditions.

Element screening tests, which were based on an industry standard technique of comparing solid phase concentrations in the spilled tailings to average concentrations in similar rock types, found that the only enriched elements in the spilled tailings were copper and selenium. Screening the elements on the basis of enrichment is a common approach to identifying elements for further consideration in a geochemistry program. However, screening on its own does not preclude elimination of considerations for element leaching under particular environmental conditions. On-going geochemical testing and site specific application will be needed to further evaluate element leaching.

The association of these enriched elements (copper and selenium) is with sulphides, which is a typical mineralogical relationship. A portion of copper (approximately 20%) was also found to be associated with relatively insoluble, slow weathering silicates. Copper solubility at neutral pH is also low due to oxide formation as compared to much higher solubility under acidic conditions and, as a result, leaching of copper from the tailings is expected to be low. Selenium is more

soluble than copper at neutral pH and does not appear to be associated with silicates. However, given the relatively thin deposition of tailings along the creek and high dilution potential from precipitation and other sources, selenium concentrations are likely to be low. Kinetic testing is underway to confirm this expectation and MPMC's ongoing environmental monitoring program will detect if selenium concentrations begin to change.

Tailings that settled in Quesnel and Polley Lakes are expected to be geochemically stable and not readily soluble. Only a small proportion of mineral forms that could be susceptible to reductive dissolution were found in the samples, and neither copper nor selenium were significantly associated with these forms. Water saturation will effectively inhibit oxidation of the sulphides in the tailings; therefore, leaching of elements like copper and selenium that require oxidation to be released will effectively be inhibited.

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List of Abbreviations

AP	acid potential
HCT	humidity cell test
HDPE	high-density polyethylene
ICP-MS	inductively coupled plasma mass spectrometry
LOD	limit of detection
MPM	Mount Polley Mine
MPMC	Mount Polley Mining Corporation
MOE	British Columbia Ministry of Environment
ML/ARD	metal leaching and acid rock drainage
NP	neutralization potential
PAO	Pollution Abatement Order
RPD	relative percent difference
TIC	total inorganic carbon
TSF	tailings storage facility
QA/QC	quality assurance and quality control
QEMSCAN	Quantitative Evaluation of Minerals by Scanning Electron Microscopy

1 Introduction

A tailings dam failure occurred at the Mount Polley Mine (MPM), located approximately 55 km north-east of Williams Lake, BC, on August 4, 2014. The dam failure resulted in the release of tailings and water contained within the tailings dam into Polley Lake, Hazeltine Creek, and Quesnel Lake. Production at the MPM ceased after the dam failure and the mill was placed on care and maintenance.

SRK was retained to develop and execute a plan and to characterize the geochemical characteristics of the tailings materials released from the Tailings Storage Facility (TSF). The plan included a review of existing data, a geochemical conceptual model to guide sampling design, and a sampling and analysis plan.

Geochemical characterization results are presented and discussed herein, although certain tests, described below, are on-going and the results are considered interim. Conclusions based on currently available data of the metal leaching and acid rock drainage (MLARD) potential of exposed tailings along Hazeltine Creek and the tailings deposited in Quesnel and Polley Lakes are provided.

2 Background

2.1 Geological Setting

The Mount Polley deposit is classified as an alkalic porphyry copper gold deposit (BC MINFILE No. 093A 008). It has been mined from several different mineralized zones, which have the following common features:

- The host rocks for porphyry mineralization are intrusions into the Nicola Volcanics varying in composition from diorite to syenite.
- Alteration is potassic (secondary biotite and pink orthoclase) and propylitic (calcite-epidote-chlorite-pyrite).
- Sulphide mineralization consists mainly of chalcopyrite ($CuFeS_2$) and pyrite (FeS_2), with lesser bornite (Cu_5FeS_4), covellite (CuS), and digenite (Cu_9S_5).
- Carbonate mineralization is principally calcite, with occurrences of malachite ($Cu_2CO_3(OH)_2$); Iron carbonates have not been reported.
- A significant portion of the copper at the MPM is not associated with sulphides (upwards of 50% in the upper portions of each pit). This fraction has been termed ‘copper oxide’ by MPM personnel and is associated primarily with chrysocolla ($(Cu,Al)_2H_2Si_2O_5(OH)_4 \cdot nH_2O$) and malachite ($Cu_2CO_3(OH)_2$) in equal proportions (Henry 2009). The term ‘copper oxide’ is not used hereafter in this report; however, other reports produced by MPMC do use this term to describe non-sulphide associated copper.

2.2 Ore Processing History

Understanding the ore processing history at the MPM is important because it may help identify processing changes over time that could have altered the geochemical reactivity of the tailings. Potential differences in reactivity can then be assessed in terms of potential quantity and also possible storage conditions after the dam failure (i.e. subaerial versus subaqueous).

Flow-sheets for the entirety of operations at the MPM were provided to SRK, along with records of ore and tailings production, and percentage of non-sulphide associated copper in the ore and tailings. Composition of the tailings produced in the mill prior to the dam failure is provided in Section 5.6.4. Processing history information was provided to SRK by the MPMC. SRK Principal Metallurgist, Adrian Dance, reviewed the flow sheets to identify processing changes that may have altered the composition of the tailings. A summary of the ore processing history and grinding and flotation circuit changes over the years of operation is provided in Table 2-1. The flow sheet for the flotation circuit in 2014 is provided in Appendix A as an example for processing steps at the mine.

The main product produced from mining the Mount Polley ore body is a copper sulphide concentrate. In general terms, the concentrate is produced by blasting the ore, primary and secondary crushing, grinding, rougher flotation and cleaner flotation. The majority of the plant feed is disposed of as tailings following the flotation separation stage. As the goal of flotation is to concentrate sulphides, the tailings are lower in sulphide minerals compared to the original ore feed.

Mill process reagents that were added to the mill are typical of sites that float copper sulphides and included methyl isobutyl carbinol (MIBC), xanthates and lime (calcium oxide). Sodium hydrogen sulphide (NaHS) was added to the crushed ore slurry to bind to the surface of the non-sulphide copper containing minerals and enable them to be recovered in the same manner as the copper sulphide minerals. While sulphides are the predominant economic mineral in the ore, the near surface portions of the ore body have naturally oxidized prior to mining, and as a result, a varying amount of non-sulphide copper needed to be processed. The non-sulphide component generally decreased as mining progressed in each pit. With the exception of lime, the process reagents are not expected to be present with the spilled tailings as they would either have remained with the concentrate (chemically bound to mineral surfaces) or degraded quickly in the environment. This was confirmed by testing of tailings along Hazeltine Creek by MPMC and the BC Ministry of the Environment as results for MIBC and xanthates (and their degradation products) showed that concentrations were below detection in all samples tested (MPMC 2014a).

The main processing phases over the life of mine are provided in Table 2-1. The mine was shut down from the end of 2001 until the beginning of 2005 due to low metal prices. The three most significant processing changes were (1) incorporation of an oxide recovery unit, (2) addition of ‘flash’ flotation, and (3) addition of a magnetite separation unit. These changes are relatively minor in terms of altering the geochemical reactivity of the tailings; consequently, the tailings geochemistry can be considered in aggregate.

Changing relative abundance of non-sulphide copper ore appears to be the most significant variable for geochemical reactivity of the tailings. Non-sulphide copper has accounted for as much as 67% of the total copper in the tailings (Figure 2-1); although, copper is a relatively minor component of the tailings (i.e. 67% non-sulphide copper of 0.3% total copper). The two downward trends observed in Figure 2-1 represent mining progressing to depth in the Springer and Cariboo open pits (the most weathered ore is near the surface of each pit).

Table 2-1: Ore processing summary for the Mount Polley Mine.

Year of Production	Ore Processed (tonnes)	Tailings Produced (tonnes)	Grinding Circuit	Sources of Tailings	Changes and Geochemical Considerations
Mine Start in 1997	2,346,829	2,333,186	2 rod, 2 ball, 3 pebble mills	Three tailings streams: (1) sand scavenger; (2) oxide; and (3) cleaner tails from cyclone overflow. All streams combined for disposal in the impoundment.	NaHS used to float non-sulphide copper minerals.
1998	5,828,358	5,788,498			
1999	7,051,212	6,986,932			
2000	6,948,339	6,883,317			
2001	5,385,796	5,328,581			
5 year shutdown					Consolidation of the tailings in the impoundment
2005	4,814,083	4,758,757	2 rod, 2 ball, 3 pebble mills	Two streams; rougher and scavenger tails. Both streams combined for disposal in the impoundment	Higher proportion of sulphide ore and lower NaHS addition
2006	6,235,221	6,133,088			
2007	6,444,112	6,346,640	2 rod, 3 ball, 3 pebble mills		Addition of third ball mill to increase production from 6.4 to 7 million tonnes per annum (Mtpa)
2008	6,848,983	6,735,444			
2009	7,045,737	6,977,681			
2010	7,894,596	7,825,178	2 rod, 3 ball, 3 pebble mills and flash flotation		Addition of flash flotation for remainder of operations to date with the potential to lower sulphide content in the tailings
2011	7,716,856	7,663,577		One stream combined	More weathered ore and higher NaHS addition
2012	8,121,878	8,056,496		One flotation stream and addition of circuit to remove magnetite	Addition of magnetite removal circuit. Tailings produced after 2012 would contain lower amounts of magnetite.
2013	7,956,738	7,882,625			
2014	4,548,182	4,502,145			

Source: Z:\01_SITES\Mt_Polley\1CI008.003_Privileged_and_Confidential\500_Reporting\Interpretations\Processing_History\[Processed Ore Data (1997-2014)_add.xlsx]

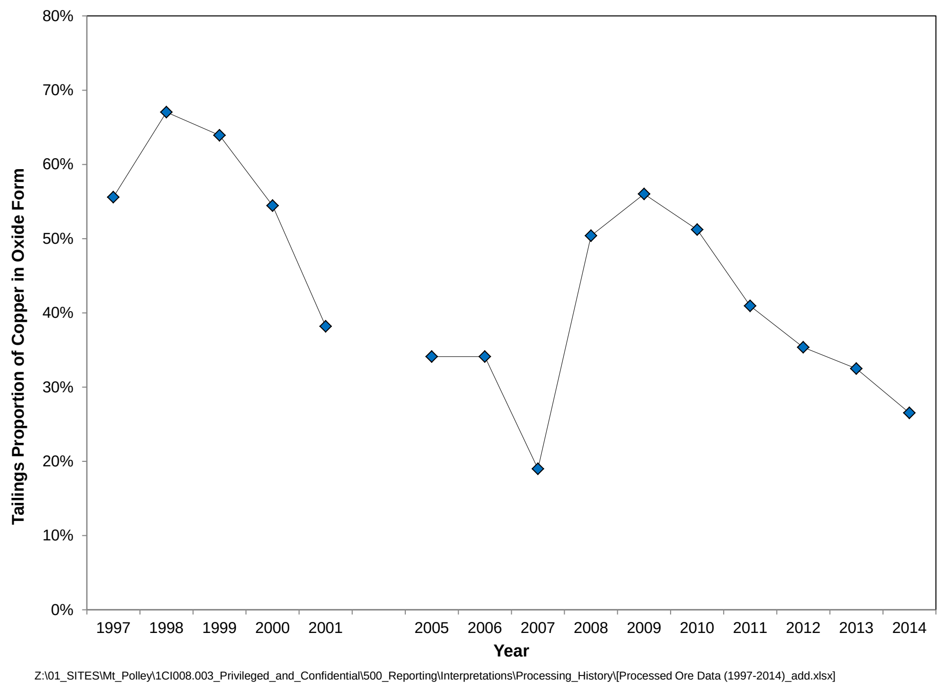


Figure 2-1: Average percentage of non-sulphide copper in MPM tailings during life of mine.

2.3 Tailings Deposition History

Understanding tailings deposition history at the MPM is important because it may help identify deposition changes over time that could have resulted in varying geochemical characteristics of tailings that spilled from the TSF.

The following summary of the tailings deposition history at the MPM is based on input from the MPMC.

Tailings slurry produced in the mill is gravity-fed to the TSF with deposition by single-point discharge and using “sand cell” construction. The sand cell method was used to the maximum extent possible to encourage drainage of the tailings and to keep the piezometric surface as far from the embankment as possible. During operations, the discharge point was sequentially rotated along the entire length of the three embankments (i.e. the Perimeter, Main, and South Embankments) on the upstream face, allowing inactive areas of the tailings beach to partially dry and consolidate. The goal of rotating deposition was so that beaches would form around the entire upstream perimeter of the TSF and supernatant water containing fines would centralize around the TSF supernatant reclaim barge.

Sand cells were built in 100 m lengths, 25 to 30 m wide and varied in height with the beach management requirements (height versus advancement around dam). They were constructed by creating a “cell” out of existing tailings and waste rock with a decant structure at the end of the cell. Tailings were introduced into the cell by single-point discharge from the tailings line, and allowed to flow through the cell, the coarser layer being contained in the cell. A modified bulldozer was used to “work” the material in order to optimize material retention. The fine or “slimes” fraction reported to the tailings pond by means of the decant structure and formed beaches.

Based on the tailings deposition history provided by MPMC, the tailings produced during operations would have been well mixed and there appears to have been limited potential to create anomalous zones in the impoundment.

3 Initial Geochemical Conceptual Model

3.1 Basis

An initial geochemical conceptual model (IGCM) was formulated in September 2014 to guide the design of the characterization approach for the spilled tailings. It was based on current understanding of the site geology, ore processing, tailings deposition, and SRK’s experience at other sites prior to gathering the data presented subsequently in the report. The IGCM effectively represents hypotheses about tailings characteristics and reactivity which are subsequently evaluated through observations, sampling, testwork and interpretation.

The two main configurations of the spilled tailings are:

- Subaerial tailings along the banks of Hazeltine Creek.
- Subaqueous tailings along the stream bed of Hazeltine Creek, and in Polley Lake and Quesnel Lake.

The above two storage configurations are discussed in Section 3.2 and 3.3.

3.2 Subaerial Tailings

The tailings that spilled from the TSF and were deposited along the banks of Hazeltine Creek above the water table will be exposed to atmospheric conditions. MPM tailings contain sulphide and carbonate minerals, which will react in the presence of atmospheric oxygen to yield water soluble components. The rate at which these reactions occur and significance for impacts to water quality depends on the chemical and physical characteristics of the tailings, as well as their final deposition configuration. Physical characteristics are important as fine grained material is less likely to allow gas diffusion and weathering of the tailings can be depth limited, as compared to coarser sand like tailings where gas diffusion is not as limited and weathering can proceed relatively unimpeded.

Based on the review of ore processing, tailings composition and tailings deposition history provided by the MPMC, the composition and physical characteristics of the spilled tailings is expected to be fairly homogeneous. However, some degree of tailings mixing with natural sediments likely occurred, so the materials along the banks of Hazeltine Creek may be a heterogeneous mixture of tailings and natural sediments. The pre-existing sediments likely have low sulphide content and as a result, the tailings will dominate reactivity of the mixture. As a result, any reference to the term ‘spilled tailings’ herein is inclusive of co-mingled native sediments.

On the basis of the composition of the tailings in the TSF, ARD is not expected and element leaching needs to be considered only under neutral drainage conditions. While elements like copper would be expected to be enriched in the tailings, leaching of this element would likely be low due to metal oxide formation at neutral pH.

The goal of sampling is to confirm that the compositional variability of tailings and any co-mingled natural sediments is low, and to confirm that mineral weathering only needs to be considered under neutral pH conditions. This is important to note as mineral and element specific solubility is often much lower under neutral pH conditions than acidic pH conditions.

3.3 Subaqueous Tailings

The majority of tailings that were contained within the TSF prior to the dam failure were stored underwater. Sulphide oxidation, and any element leaching from sulphide oxidation, would have effectively been inhibited due to the solubility of oxygen in water being orders of magnitude lower than the atmosphere (i.e. 21% atmospheric versus 0.001% in water at 10°C). Secondary mineral formation from weathering (e.g. iron oxyhydroxides) would also have been limited, although the unsaturated portions of the beaches may have formed secondary minerals that could have sequestered certain elements. The potential water quality impacts from re-deposition of tailings in a new subaqueous environment is expected to be mainly dependent on pH and oxidation reduction potential (redox). The aerobic portions of Hazeltine Creek, Polley Lake and Quesnel Lake would likely be geochemically similar to the TSF conditions, as these waters are not acidic and therefore leaching potential is expected to be limited. The main consideration for water quality impacts is from any secondary minerals formed (e.g. iron oxyhydroxides) that are deposited in an anaerobic environment and susceptible to reductive dissolution. Secondary minerals may have formed in the unsaturated portions of the tailings before the dam failure, or during in-situ weathering of the ore deposit before mining.

Additional sampling would not be required to address this question, but geochemical characterization would need to consider leachable mineral forms under varying subaqueous redox conditions. Geochemical characterization tests were designed to consider leachable mineral forms as outlined in Section 4.3.

4 Geochemical Characterization Methods

4.1 Overview

The geochemical characterization data provided in this report were obtained through implementation of SRK's Characterization Plan (SRK 2014). The plan was developed to address assumptions made in the conceptual model, with the overall goal of assessing how the reactivity of the spilled tailings may impact water quality.

In brief, the plan consisted of field sampling along Hazeltine Creek and a series of geochemical tests to understand the composition, mineralogy and leaching characteristics under various storage configurations. SRK focused on the spilled tailings along Hazeltine Creek because weathering under sub-aerial conditions should represent the most likely scenario for leaching based on the IGCM. In addition, Minnow Environmental's scope included sampling of spilled tailings that settled in Polley and Quesnel Lakes. Between the historical data, and two independent sampling campaigns, the assumption was that geochemical variability would be characterized.

The following sections provide specific details of how the plan was implemented. The plan also included considerations for sampling tailings remaining within the impoundment, but due to safety considerations at the time of the field program and results for tailings available from historical mill sampling, sampling of material within the TSF was precluded.

4.2 Field Sampling

Representatives of SRK and SNC Lavalin collected samples from the banks of Hazeltine Creek between September 8, 2014 and September 19, 2014 as described in a letter dated November 10, 2014 and posted on MPMC's website (MPMC 2014b). For ease of reference, the main components of the field sampling program are summarized in Section 4.2.1.

4.2.1 Hazeltine Creek Sample Collection

Samples of exposed spilled tailings in Hazeltine Creek were collected along 18 parallel transects, oriented roughly perpendicular to the course of Hazeltine Creek, spaced approximately 500 m apart beginning with transect ST17/18 in the area of the dam dam failure and ending with transect ST01 near the mouth of Hazeltine Creek at Quesnel Lake (Figure 4-1). At each transect, major physical/depositional features were sampled, with up to five samples per transect. Physical/depositional features were determined in the field based on particle size (fine grained versus coarse), colour, or depositional area (e.g. high on a bank or shoulder versus adjacent to the creek). In total, 108 samples were collected, of which 68 were identified as spilled tailings samples. The remainder of samples consisted of native sediments beneath tailings and soils outside of the impacted area.

A site-specific methodology for sampling along Hazeltine Creek was developed by SRK and SNC representatives based on professional experience using best practice to ensure sampling was un-biased and properly characterized geochemical variability. Since the spilled tailings had not been sampled previously, the program allowed for the possibility that additional sampling would be needed to understand variability of critical geochemical characteristics of the spilled tailings but in practice the program provided sufficient data with a second field program. Details of the sampling method are provided below.

Sample locations at each transect were determined by multiplying the length of the field identified feature by a random decimal number (from a list of random decimals generated in Excel). The result of this random number multiplication was the distance (along the transect) within the feature where the sample was to be taken. For each transect, zero distance was the location of the background sample, which alternated between the east and west side of Hazeltine Creek. As an example, a feature 10 m long and a random number of 0.2, the sample would be taken 2 m from the start of the transect. Additionally, special interest samples could be taken for discrete material types that did not comprise an entire depositional feature.

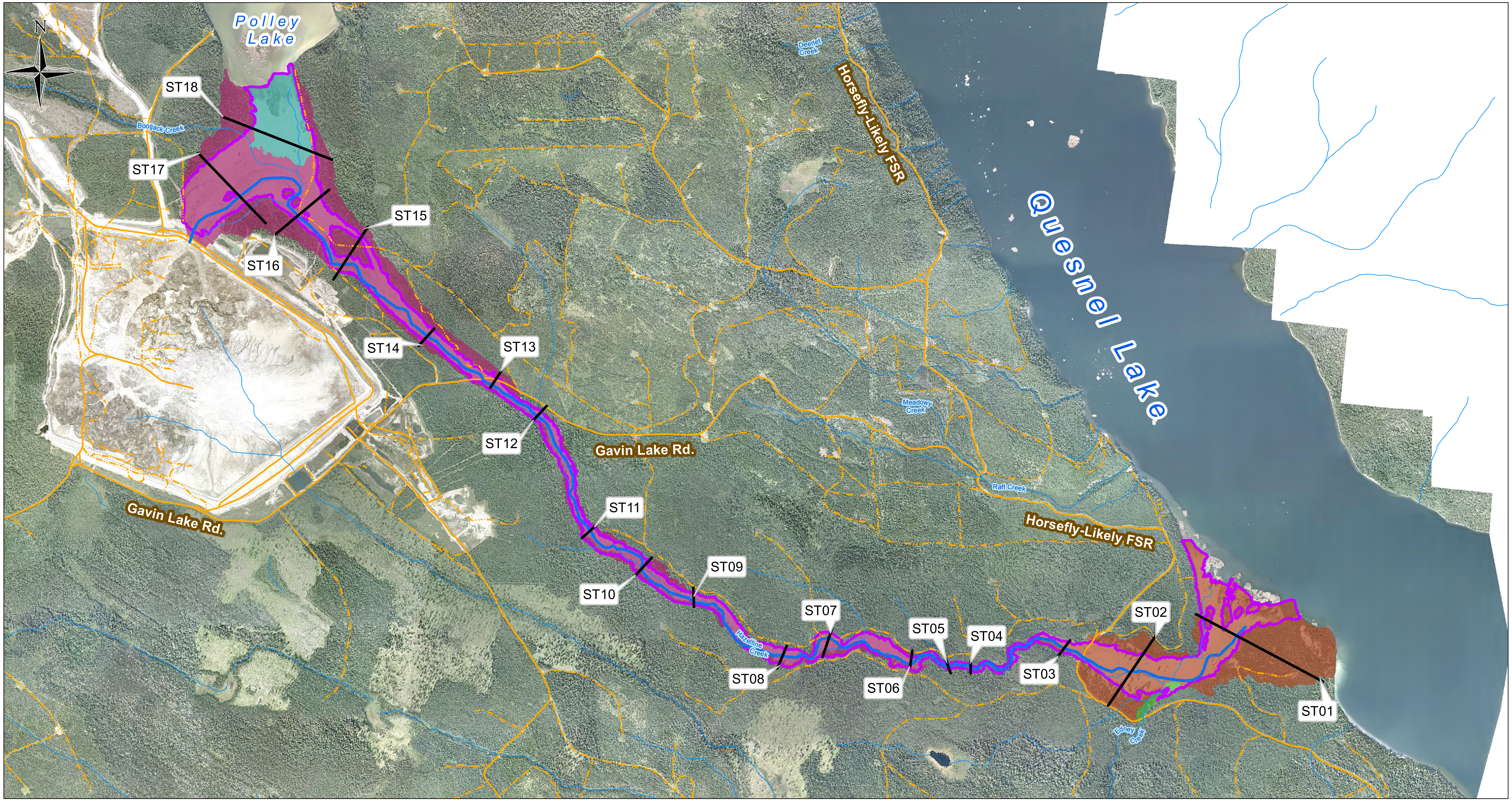
Samples were collected from test-pits that were hand-dug using a clean shovel. Material was collected at depth within the test-pits using a clean trowel. Plant roots and other organics were excluded as much as possible. Detailed logs of each sample test-pit are provided in SNC (2015).

Duplicates and replicates of approximately 10% of the samples were collected for quality assurance and quality control (QA/QC) and assessment of sample variability. For duplicate sample collection, material was split evenly among two sampling containers each time it was brought up from depth. Replicate sample collection to assess variability was performed by multiplying a random number by 360 degrees to determine a bearing from the location of the initial sample. The replicate sample was collected 1 m away from the initial sample along the determined bearing.

Three silica sand blanks were also submitted as ‘blind’ samples to the laboratory as part of QA/QC procedures. They were placed into the same sample bags using field equipment to evaluate potential contamination sources during sampling, in transport, and in the laboratory.

4.2.2 Sequential Extraction Sample Collection

A total of 78 additional samples were collected from the study area for sequential extraction analyses by Minnow Environmental between August 13 and October 24, 2014. Specific details of the sample collection procedures and locations are provided in Minnow (2015). Of the samples collected, 18 were from the profundal zone in Quesnel Lake (6 lake sediment samples and 12 spilled tailings), 18 were from the littoral zone in Quesnel Lake (2 lake sediment samples and 16 spilled tailings), and 15 were spilled tailings from along Hazeltine Creek. Fifteen samples from the bottom of Polley Lake were also collected by Minnow Environmental. The Hazeltine Creek samples were collected along the same transects as described in Section 4.2.1, but collected by Minnow Environmental on different dates and distances along each transect.

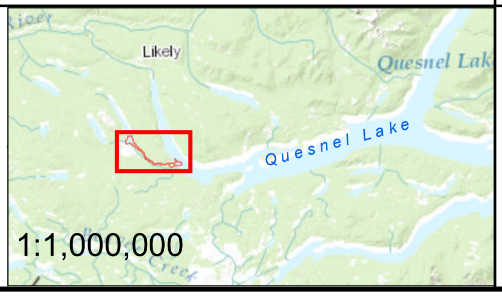


LEGEND

- Soil Sampling Transects
- New Hazeltine Creek Channel (Approximate)
- Streams
- Gravel Roads
- Rough Roads
- Scour Area

Affected Areas

- Canyon
- Edney Creek Mouth
- Lower Hazeltine Creek
- Polley Plug
- Upper Hazeltine Creek



NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 125 250 500 750 1,000 Meters

1. TRIM data provided by Mount Polley Mining Corporation
2. Orthophoto collected by McElhanney on August 5, 2014
3. Service Layer Credits: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation	PROJECT LOCATION: Mount Polley Mine, Likely, BC

Fig. 4-1:Site Overview and Transect Plan

BY: AO	SCALE: 1:25,000	DATE: 2015/06/04	REF No: REV: 0
CHK'D: DS	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-4-2

MXD Path: \\Proj_srv\projects\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\4.0 Execution\4.5 GIS and Drawings\GIS\PEEIAR Figures\621717-4-2_SiteOverviewTransects.mxd

Project Path: P:\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Mount Polley Mine\

4.3 Laboratory Analyses for Hazeltine Creek Samples

A two-phase testing approach was used for geochemical characterization in order to constrain composition variability and understand specific acid-base accounting (ABA) and mineralogical characteristics of the Hazeltine Creek samples as previously outlined in SRK's Characterization Plan (SRK 2014).

4.3.1 Phase 1

Phase one testing included the following analyses on samples from Hazeltine Creek:

- Moisture content.
- Multi-element analysis, including sulphur content by aqua regia digestion with an inductively coupled plasma mass spectrometry (ICP-MS) finish (ALS code ME-MS41).
- Total inorganic carbon (TIC).

Particle size distribution by sieving was also performed on approximately 25 % of the samples. The analyses were conducted by ALS Environmental in Burnaby, British Columbia.

4.3.2 Phase 2

Approximately 25% (19) of the Hazeltine Creek samples were submitted for a second phase of testing to confirm ABA assumptions and define mineralogical characteristics of the samples and rates of weathering. Samples were selected to capture the range of sulphur, TIC, copper, and selenium content in the Hazeltine Creek samples based on the results of the phase 1 analyses (Table 4-1). Copper and selenium were part of the considerations for sample selection due to their enrichment in the samples. The rationale for 'tailings type' (i.e. magnetite sand and grey tailings) is provided in Section 5.1.

Prior to any analytical testing, some samples were composited as outlined in Table 4-2. For samples that were composited, new sample identifications were provided. Prior to compositing, 200 grams (g) of material from each sample was retained for archiving purposes. Composited samples were well mixed by the analytical laboratory and splits of the homogenised composites were taken for the various Phase 2 tests.

Table 4-1: Hazeltine Creek Tailings Samples Selected for Phase 2 Analyses

Sample ID	Tailings Type	S (%)	TIC (kg $CaCO_3$/t)	Cu (mg/kg)	Se (mg/kg)
ST01-03	Magnetite Sand	0.17	14.6	805	1.8
ST01-05-02	Grey Tailings	0.09	13.8	317	0.9
ST02-02-01	Grey Tailings	0.12	17.4	571	0.9
ST02-05-02	Magnetite Sand	0.13	14.5	715	1.2
ST03-04	Grey Tailings	0.17	26.1	934	1.1
ST05-02-01	Magnetite/Grey Tailings Mix	0.10	25.9	652	1.3
ST08-02-01	Grey Tailings	0.15	38.9	911	1.7
ST08-03	Magnetite Sand	0.28	27.6	1055	1.6
ST11-02-01	Magnetite Sand	0.24	24.8	1205	1.4
ST11-02-02	Magnetite Sand	0.25	24.1	1465	1.7
ST12-02	Magnetite Sand	0.24	25.8	1410	1.7
ST12-04	Grey Tailings	0.12	25.6	870	1.7
ST13-03	Grey Tailings	0.15	26.5	934	1.5
ST14-04	Grey Tailings	0.11	23.1	768	1.2
ST16-02	Magnetite Sand	0.15	23.0	1030	1.5
ST17-08-01	Grey Tailings	0.23	32.0	1310	1.8
ST18-02-01	Grey Tailings/Magnetite Mix	0.09	20.9	954	1.6
ST18-03-02	Grey Tailings/Magnetite Mix	0.18	37.8	1475	1.2
ST18-05-01	Grey Tailings	0.16	21.6	899	1.6

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Table 4-2: Composite Sample Labelling

Sample ID	Composite ID	Tailings Type
ST11-02-02, ST12-02, ST11-02-1	HC-1/COL-1	Magnetite Sand
ST16-02, ST01-03	HC-2/COL2	Magnetite Sand
ST08-02-01, ST13-03	HC-3/COL-3; HC-3D	Grey Tailings
ST01-05-02	Not composited.	Grey Tailings
ST02-05-02		Magnetite Sand
ST17-08-01		Grey Tailings
ST02-02-01		Grey Tailings
ST03-04		Grey Tailings
ST05-02-01		Magnetite/Grey Tailings Mix
ST08-03		Magnetite Sand
ST12-04		Grey Tailings
ST14-04		Grey Tailings
ST18-02-01		Grey Tailings/Magnetite Mix
ST18-03-02		Grey Tailings/Magnetite Mix
ST18-05-01		Grey Tailings

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The 15 samples listed in Table 4-2 were submitted for the following additional tests at ALS:

- Paste pH and conductivity.
- Modified Sobek Neutralization Potential determination (MEND 1991).

- Total sulphur (by LECO furnace) and sulphate sulphur (by hydrochloric acid (HCl) leach).
- Non-sulphide copper analysis using a method developed by the MPM, as follows
  - Dried samples were leached using 2.5% sulphuric acid (H_2SO_4). The acidic slurry was mixed using a vortex shaker and then placed on a shaker table for 90 minutes. The sample was allowed to settle and leachate was filtered and submitted for ICP-MS multi-element scans (35 elements including sulphur and low level selenium).
- Two samples were randomly selected by ALS to serve as duplicates for QA/QC purposes.

4.3.3 Kinetic Testing Program

The kinetic testing program consists of six standard laboratory humidity cells (HCs), three column leach tests, two blanks (a HC and a column), and one HC duplicate (Table 4-3). The intent of the program is to establish weathering rates under oxygen unlimited conditions using humidity cell testing and then use column tests to evaluate the effect of reduced leaching rates. As a result, composites were prepared to represent the range of geochemical variability identified during phase one testing, but to also be of sufficient volume that splits of each sample could be taken for testing in humidity cells and columns.

Table 4-3: Composite preparation requirements and sample labelling.

Kinetic Test ID	Tailings Type	Original Sample IDs
HC-1/COL-1	Magnetite Sand	Composite of ST11-02-02, ST12-02 and ST11-02-1
HC-2/COL2	Magnetite Sand	Composite of ST16-02 and ST01-03
HC-3/COL-3; HC-3D	Grey Tailings	Composite of ST08-02-01 and ST13-03
HC-4	Grey Tailings	ST01-05-02
HC-5	Magnetite Sand	ST02-05-02
HC-6	Grey Tailings	ST17-08-01
HC-7	Blank	
COL-4		

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The HCs were set up according to the methods described in the 1991 Mine Environment Neutral Drainage Program's Acid Rock Drainage Prediction Manual (MEND 1991). The two major sample mixture/tailings types identified in the field, (1) magnetite sands tailings and (2) grey tailings, were both tested. The duplicate cell (HC-3D) is a split from HC-3. The blank cell (HC-7) was constructed using the exact same material and adhesives as the other cells and is running according to the same procedures.

The column tests, including the blank, were constructed from plexiglass (acrylic) with a 10 cm inner diameter and a perforated base supporting two layers of nylon screen (400 mesh). The columns were filled with 500 g of tailings and are being trickle leached with 500 mL of water per week.

Weekly leachate analyses were performed for the first month of the kinetic testing program. The analysis frequency will then change to bi-weekly analyses for all parameters except pH, conductivity, and volume of leachate recovered, which will continue to be recorded weekly.

At the time of this report, three cycles of data had been received from the humidity cells and only one cycle had been recovered from the columns. Typically these tests run for a minimum of 40 weeks and meaningful results are usually not available until after 20 weeks.

4.3.4 Mineralogy

Mineralogical characterization using Quantitative Evaluation of Minerals by Scanning Electron Microscopy (QEMSCAN) was conducted on 100 g splits from all of the kinetic test program samples (Table 4-1), including the duplicate. Analysis was performed by SGS Canada Inc. in Burnaby, BC.

QEMSCAN is a relatively new mineralogical method being used for environmental geochemistry applications and it provides modal mineralogy based on mineral grain chemistry. The method is advantageous over optical petrography methods as many more mineral grains can be analyzed and quantitative information on particle size and degree of mineral liberation/exposure can also be obtained.

As part of the QEMSCAN characterization of the samples, Rietveld X-ray diffraction (XRD) and electron microprobe were selectively used to refine and confirm modal abundances, mineral form (e.g. the different iron oxides present) and element deportment for low concentrations that could not be resolved by QEMSCAN.

4.3.5 Sequential Extractions

Sequential extractions involve a progressive series of chemical extractions applied to the same sample in order to divide the total metal content into geochemical ‘fractions’. Each fraction is the result of dissolution of certain types of minerals using specific reagents. The sequential extractions conducted for the MPM tailings were performed by ALS Minerals in Burnaby, BC as designed and directed by Minnow Environmental (Minnow 2015) and based on the Tessier procedure (Tessier et al. 1979).

The design targeted elements that were exchangeable and adsorbed, associated with carbonates, reducible minerals (i.e. iron oxides), organically-bound metals and residual metals. Water soluble constituents were also determined on splits of the same sample using the shake flask extraction (SFE) method (MEND 2009).

The reagents used for the sequential extractions and noted modifications to the procedure are provided in Table 4-4. The procedure as intended by Tessier and the modifications applied by Minnow were designed for soils, and as a result, some of the reagents used would likely target different mineral fractions in tailings than they would in soils. The three main deviations identified include:

- Easily reducible iron oxides - the reagents used likely result in dissolution of other mineral groups in addition to the easily reducible iron oxides.
- Organically bound metals – as there are expected to be limited amounts of organic materials in the tailings due to the nature of the ore, the reagents and temperatures used likely oxidize some of the sulphide and may also leach more resistant oxide minerals. Tessier et al. (1979)

also noted some alteration of the minerals smectite, chlorite and mica in this digestion step. These minerals are present in the MPM tailings.

- Residual metals – a four acid digestion was not performed and instead replaced by aqua regia which will not completely dissolve silicates and is likely most representative of metals associated with sulphides. In addition, aqua regia digestion was performed on the minus 2 mm fraction, not pulverized samples, which can result in incomplete digestion.

In order to avoid confusion in comparison of results from different programs, the naming of each fraction from the sequential leaching has not changed, but results will be discussed in the context of the above differences.

Table 4-4: Description of Sequential Extraction Method (modified after Tessier et al. 1979)

Step	Mineral Fraction	Reagent	Procedure	Deviation from Tessier et al. 1979
I	Exchangeable & Adsorbed	magnesium chloride (1 M $MgCl_2 \cdot 6H_2O$)	1. Add 16 mL of reagent	ALS doubled the method to ensure that there was enough sample for analysis.
			2. Place on shaker table (1 hour)	
			3. Centrifuge on high (30 minutes)	
			4. Pipette the supernatant into a centrifuge tube for analysis	
			5. Add 16 mL of deionized water to the tube with the sediment, hand shake (1 minute)	
			6. Pipette supernatant	
			7. Discard supernatant	
II	Carbonate Metal	sodium acetate (1 M NaOAc)	1. Add 16 mL of reagent, adjust pH to 5 using acetic acid (HOAc) if necessary	Tessier states to shake for 5 hours. 2.5 hours applied.
			2. Place on shaker table (2.5 hours)	
			3. Repeat steps 4-7 as in Step I	
III	Easily Reducible and Iron Oxides	hydroxylamine hydrochloride in acetic acid (0.1 M NH_2OH-HCl (25% V/V in HOAc))	1. Add 40 mL of reagent	--
			2. Hand shake (1 minute)	
			3. Place in oven at 96 ± 3 ºC (6 hours), hand shake every hour and after 6 hours	
			4. Repeat steps 4-7 as in Step I	
IV	Organic Bound Metal	nitric acid followed by ammonium acetate (0.02 M HNO_3 then 3.2 M NH_4OAc)	1. Add 6 ml of 0.02 M HNO_3	--
			2. Add 10 mL of 30% H_2O_2 and adjust to pH 2 with HNO_3	
			3. Hand shake (1 minute)	
			4. Place in the oven at 85 ± 2 ºC (2 hours), shake at the end of 1 and 2 hours	
			5. Add 6 mL of H_2O_2 (adjust to pH 2 with HNO_3 if necessary) and hand shake	
			6. Heat to 85 ± 2 ºC (3 hour), shake every hour	
			7. Cool sample	
			8. Add 10 mL of 3.2 M NH_4OAc in 20% V/V HNO_3	
			9. Add 8 mL H_2O (dilute to 40mL)	
			10. Shake with a wrist shaker (30 minutes)	
			11. Repeat step 4-7 as in Step I	
V	Residual Metal	Aqua regia (CSR (EPA 200.2))	1. Add 10 mL of deionized water, 5 mL of HNO_3 and 5 mL of HCl	Tessier states digestion using $HF/HClO_4$.
			2. Cold digest (60 minutes)	
			3. Digest for 2 hours ± 15 minutes at sub-boiling reflux temperature	
			4. Cool	
			5. Bulk to 50 mL with deionized water, cap and shake.	

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5 Results

5.1 Hazeltine Creek Field Observations

Photographs from field sampling are provided in Appendix B. A sample list and descriptions of the Hazeltine Creek samples used in this geochemical characterization study are provided in Appendix C1.

Two types of tailings-bearing samples were observed along Hazeltine Creek. They were classified in the field as ‘grey tailings’ and ‘magnetite sands’. This classification was based on physical and mineralogical characteristics as follows:

- Grey tailings were dominantly grey in colour and had a finer texture (silty sand) than the magnetite sands. They had a strong reaction (referred to as “fizz”) with 10% HCl and did not contain sulphide minerals that were visible by examination with a hand lens. Mineral identification was difficult due to small grain size, but the dominant minerals included potassium feldspar and plagioclase, with minor biotite mica and quartz.
- Magnetite sands were speckled pinkish-orange and black. They were strongly magnetic and coarser (sand) than the grey tailings. They had weak fizz and trace (less than 1%) sulphide minerals were infrequently noted. The dominant minerals identified included plagioclase feldspar and magnetite. Biotite mica and quartz appeared more abundant than in the grey tailings.

The grey tailings tended to be most abundant along the embankments and upper benches of the creek, whereas the magnetite sands were commonly present in low-lying areas near the creek. With the exception of the area near the tailings dam failure and Polley Lake, the tailings were deposited in relatively thin ‘skiffs’ (e.g. 10 to 20 cm deep). The thickest observed tailings deposits (e.g. 1 to 1.5 m deep) were in the immediate vicinity of the tailings dam failure and Polley Lake (SNC-Lavalin 2015).

5.2 Quality Assurance and Quality Control

5.2.1 Overview

In addition to the normal laboratory QA/QC procedures, field duplicates and field blanks were assessed for QA/QC. Results of the assessment are provided in Appendix C2. Based on the QA/QC measures taken for this program, SRK’s overall conclusion is that the data quality is acceptable. A summary of the procedures for duplicates and blanks is provided below.

5.2.2 Duplicates

The duplicates were assessed with respect to a relative percent difference (RPD) target of 25%. RPD was calculated using the equation below, where ‘x’ is the concentration of the original sample and ‘y’ is the concentration from the duplicate sample:

$$\mathrm{RPD}\,(\%) = \frac{x - y}{(x + y)/2} \times 100$$

Reproducibility was excellent at concentrations greater than ten times the limit of detection (LOD) for the ICP scans and greater than 1% for the QEMSCAN duplicate. The RPD criterion does not apply at concentrations near the LOD because RPD is expected to frequently be greater than 25% due to reduced analytical accuracy at very low concentrations. The only exceedances of the 25% RPD criteria were for the ST18-02-01 and ST18-02-02 duplicate set: vanadium was 224 and 292 mg/kg, respectively (RPD 26%), and the ST05-02-01 and ST05-02-02 duplicate set: moisture content was 19 and 28%, respectively (RPD 39%).

5.2.3 Blanks

Silica sand blanks submitted as ‘blind’ samples were assessed with respect to ten times the limit of analytical detection. Based on this criterion, the majority of elements for all three samples were below this level. A few elements exceeded this criterion (Ce, Cu, Fe, La, Pb, Mn, Ni, Rb, Ag, Sr, and Y), but only marginally so by ten to fifteen times detection limits. Concentrations were orders of magnitude lower than the concentrations in the samples.

5.3 Assessment of Sampling Spatial Variability

Spatial variability was assessed for the Hazeltine Creek tailings samples based on 5 replicates taken 1 m away from the original samples (Appendix C3). Generally, the replicates were very similar to the original samples with average RPDs of less than 10%. However, some local variability was discovered as the ST06-04-01 and ST06-04-02 replicate set had an average RPD of 29% with 30 out of 55 parameters having RPDs greater than 25%. This higher variability may reflect various degrees of mixing between the tailings and native sediments during deposition.

SRK’s overall conclusion based on the above results was that the composites collected as part of this study captured the range of variability in the near vicinity (i.e. metres) of where they were collected. Variability of the samples collected downstream and generally as part of this study is discussed in Sections 5.3.

5.4 Particle Size Distribution

Particle size data for the Hazeltine Creek tailings samples are provided in Appendix C4 and illustrated in (Figure 5-1). Particle size distributions were largely bi-modal, consistent with textural observations in the field. The magnetite sands tailings samples generally contained less silts and clay-sized particles than the grey tailings samples, with the exception of one sample (ST18-05-03).

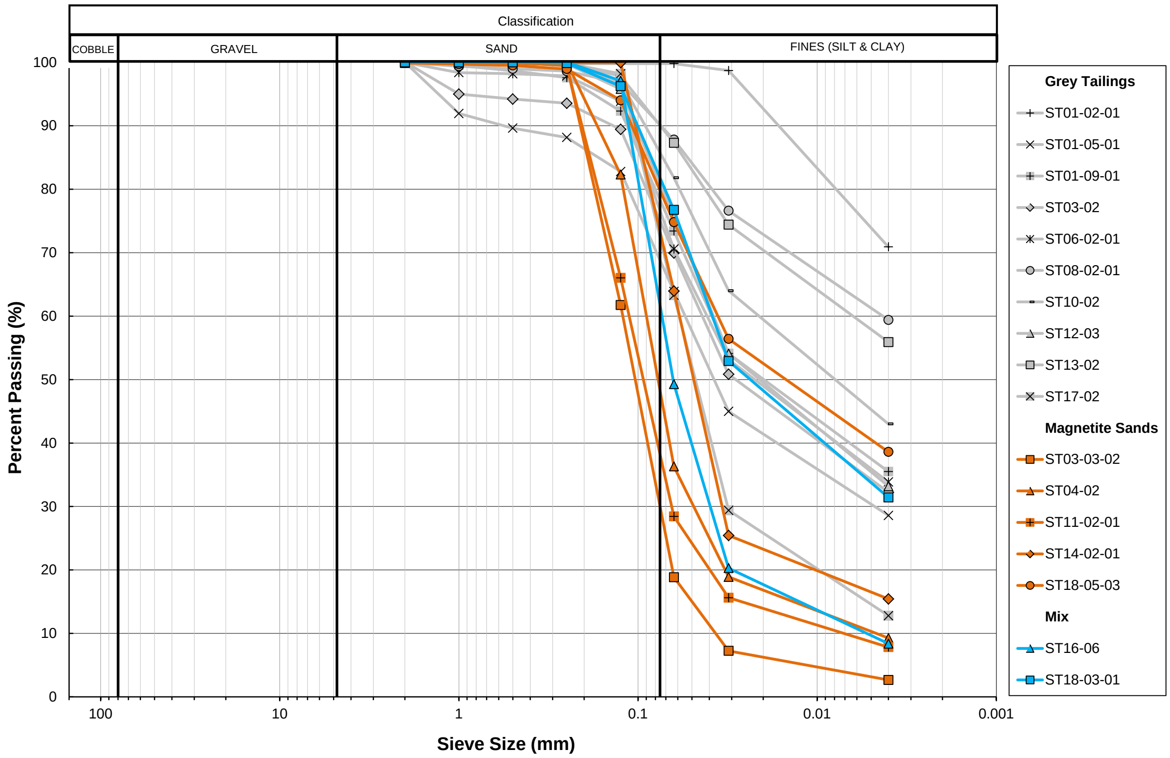

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Figure 5-1: Hazeltine Creek tailings particle size distribution results.

5.5 Acid Base Accounting

Acid-base accounting data for the Hazeltine Creek tailings samples are provided in Appendix C5. A summary of findings is provided in the following sections.

5.5.1 Sulphur Forms and Acid Potential

A statistical summary of total sulphur results determined by aqua regia digestion and ICP-MS is provided in Table 5-1. Sulphur ranged from 0.1 to 0.3%, with an average of 0.2% for all samples. These values are considered relatively low compared to other mine sites and consistent with the geological setting (MEND 2009). The results were fairly consistent by material type, with the magnetite sands containing more sulphur than the grey tailings with average values of 0.2 and 0.1%, respectively (significant difference based on a one-tailed t-test, $p < 0.05$).

Total sulphur content was also determined by the LECO furnace method for all of the samples that were selected for Phase 2 analyses. The LECO sulphur and ICP-MS sulphur results were similar (Figure 5-2). The concentration of sulphur in many of the samples was within ten times the limit of detection (i.e. 0.1%) and variability in the results is attributed to analytical uncertainty. Sulphate sulphur analysis by HCl leach also indicate that sulphate results were near or below the LOD (0.01%) and as organic sulphur in tailings is expected to be negligible, sulphide sulphur from ICP-MS analysis was set to equal total sulphur for the basis of acid potential (AP) calculations.

Acid potential was calculated using total sulphur content from ICP-MS as:

$$AP = \text{Total Sulphur} \times 31.25$$

where AP is expressed in kg $CaCO_3$/t and total sulphur is expressed in %.

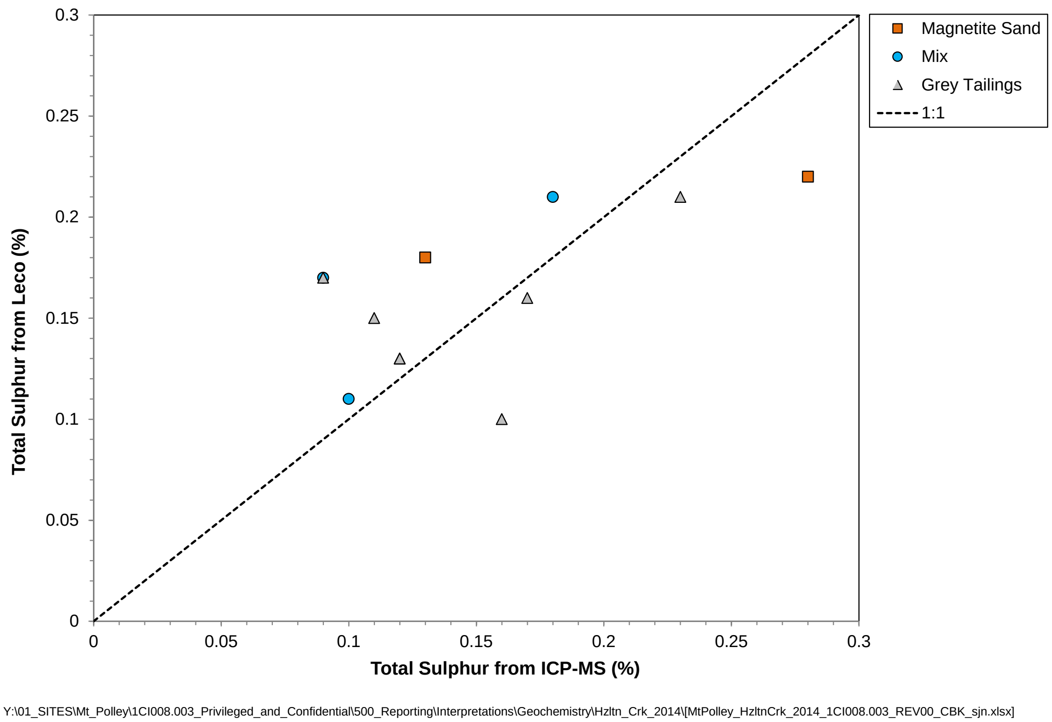

Figure 5-2: Hazeltine Creek tailings LECO vs. ICP-MS Sulphur

5.5.2 Neutralization Potential

A statistical summary of carbonate neutralization potential (NP) results is provided in Table 5-1. Carbonate NP, measured as total inorganic carbon (TIC), ranged from 8.7 to 40 kg $CaCO_3$/t with an average value of 27 kg $CaCO_3$/t for all Hazeltine Creek tailings samples. The results were fairly consistent by material type, with average TIC reported for the grey tailings being greater than for the magnetite sands tailings, although the averages were not statistically different based on a two-tailed t-test ($p < 0.08$). The grey tailings contained an average of 28 kg $CaCO_3$/t, whereas the magnetite sands contained 24 kg $CaCO_3$/t.

Modified Sobek NP results are available for all samples that were selected for Phase 2 analyses. Modified NP was generally greater than carbonate NP (Figure 5-3), which may indicate the presence of reactive silicate minerals in the test, or residual lime in the samples (a processing reagent added in the mill), or both. Silicates provide neutralization under the conditions created for the Modified Sobek NP analysis, but their reactivity is low and they generally do not contribute to neutralization under field conditions. Lime would also react in the modified NP titration test but not contribute to carbonate content. Consequently, carbonate is a better measurement of NP for the Hazeltine Creek tailings and was used for the ARD assessment.

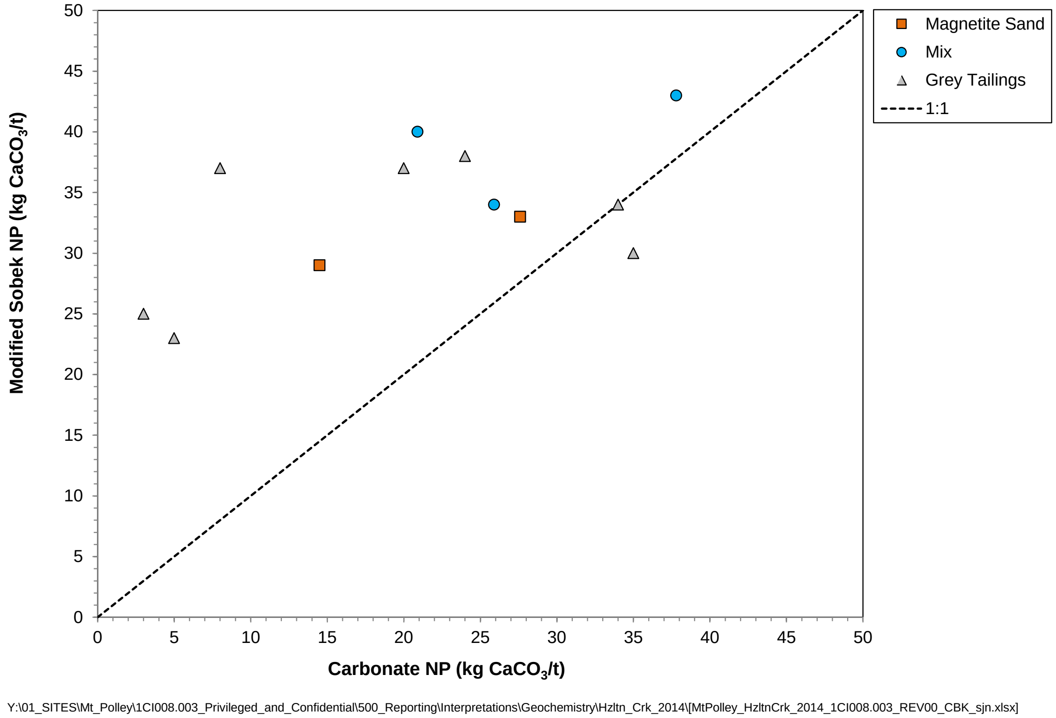

Figure 5-3: Hazeltine Creek tailings Modified NP vs. Carbonate NP

Table 5-1: Statistical summary of tailings samples geochemistry results from Phase 1.

Sample Type	Statistic	TIC kg $CaCO_3$/t	S %	AP kg $CaCO_3$/t	NPR ratio	As mg/kg	Cd mg/kg	Cr mg/kg	Cu mg/kg	Fe %	Pb mg/kg	Mn mg/kg	Hg mg/kg	Mo mg/kg	Ni mg/kg	Se mg/kg	U mg/kg	V mg/kg	Zn mg/kg
All Samples	Min	8.7	0.01	0.31	2.7	7.2	0.08	8	29	3.0	4.0	360	0.03	0.57	4.5	0.3	0.52	86	40
n=69	P5	15	0.09	2.8	3.2	8.7	0.12	9	360	3.8	4.4	460	0.06	1.9	6.5	0.74	0.67	120	45
	P25	24	0.12	3.8	4.6	10	0.14	10	800	4.3	4.9	520	0.08	3.9	7.3	1.2	0.78	160	52
	Mean	27	0.15	4.6	5.9	11	0.16	13	880	4.9	5.7	580	0.091	4.3	9.5	1.4	0.9	180	57
	Median	27	0.14	4.4	5.9	11	0.15	10	910	4.9	5.4	570	0.08	4.6	8.3	1.5	0.9	180	56
	P75	32	0.16	5.0	7.1	12	0.17	13	990	5.3	6.0	610	0.10	5.0	9.9	1.6	0.99	200	61
	P95	38	0.25	7.7	10	13	0.23	27	1300	6.5	8.5	740	0.13	5.5	16	1.8	1.2	250	74
	Max	40	0.30	9.4	59	13	0.31	55	1500	7.7	12	850	0.28	6.5	36	1.9	1.4	300	82
Grey Tailings	P5	17	0.087	2.7	3.7	8.8	0.12	9	270	3.8	4.7	510	0.06	1.7	7.3	0.5	0.7	110	48
n = 40	Mean	28	0.14	4.2	6.7	11	0.15	14	810	4.8	5.8	600	0.088	4.1	10	1.4	0.93	170	59
	P95	38	0.22	6.9	11	13	0.23	29	1200	5.5	8.4	780	0.13	5.2	20	1.8	1.2	200	74
Magnetite Sands	P5	15	0.09	2.8	3.1	8.8	0.13	9	470	3.7	4.3	470	0.07	2.8	6.3	0.8	0.72	140	43
n = 21	Mean	24	0.17	5.4	4.5	11	0.16	12	990	5.1	5.8	530	0.098	4.5	8.4	1.4	0.83	190	53
	P95	33	0.25	7.8	7.1	12	0.21	20	1400	7.6	9.0	640	0.13	5.6	13	1.7	1.1	290	61
Mix	P5	19	0.094	2.9	4.1	8.3	0.12	8.4	720	4.4	4.5	450	0.054	3.2	5.2	1.2	0.65	160	45
n = 8	Mean	28	0.15	4.5	6.1	11	0.15	10	970	5.3	5.1	560	0.091	4.8	7.8	1.4	0.92	200	56
	P95	36	0.23	7.0	8.0	13	0.19	14	1300	6.6	6.3	720	0.16	6.2	11	1.6	1.2	250	74

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Note: Results have been rounded to two significant figures.

5.5.3 Acid Rock Drainage Potential

Acid rock drainage (ARD) potential was assessed based on neutralization potential ratios (NPRs) calculated as:

$$NPR = \frac{\text{Carbonate NP}}{AP}$$

Carbonate NP in the above equation is based on TIC as described in Section 5.5.2.

In this ARD assessment, NPR below 1 indicates potential for ARD (PAG – potentially ARD generating), NPR above 2 indicates low potential for ARD (non-PAG), and NPR between 1 and 2 indicates uncertainty. The NPR value of 2 was used to define non-PAG as calcite (refer to Section 5.8.1), which was found to be the predominant carbonate present (MEND 2009). A statistical summary of the NPRs for the Hazeltine Creek tailings samples is provided in Table 5-1.

All of the samples were classified as non-PAG, with NPRs as high as 59 (Figure 5-4). By material type the magnetite sands had slightly lower NPRs, mainly due to marginally lower carbonate content. Overall, the potential for ARD from the tailings in Hazeltine Creek is very low.

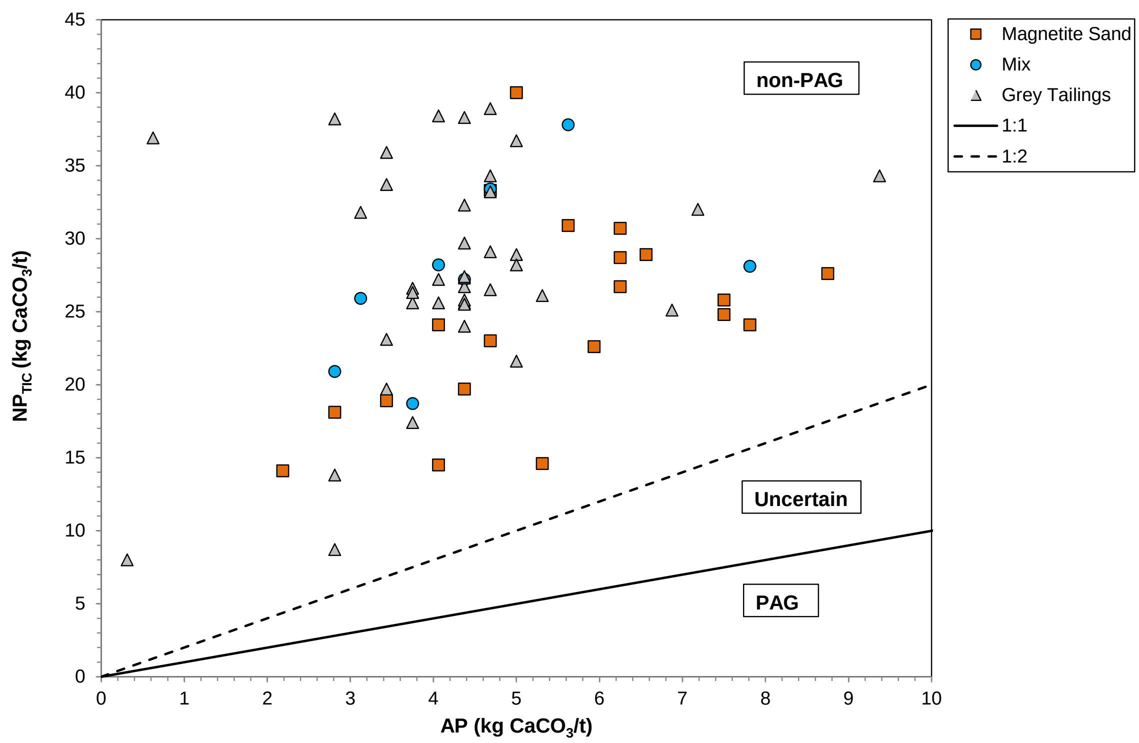

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Figure 5-4: ARD potential of Hazeltine Creek tailings.

5.5.4 ARD Comparison to Operational Tailings

Historical data provided by MPMC to the BC MOE (http://www.env.gov.bc.ca/eemp/incidents/2014/mount-polley.htm) provides a basis to compare ARD characterization results obtained from this study to characteristics from operational/historical tailings collected over the life of mine from the mill. Results of the comparison are provided in Figure 5-5 and show that none of the samples collected to date are PAG and only one sample in the dataset was on the boundary between non-PAG and uncertain. The samples containing higher NP and AP are all predominantly from mining between 2006 and 2008, whereas samples after this time contain very similar NP and AP values to the samples collected from Hazeltine Creek. The lower AP and NP values in samples from along Hazeltine Creek may also reflect tailings that have been mixed with native sediments that contain lower amounts of sulphur and carbonate than the tailings.

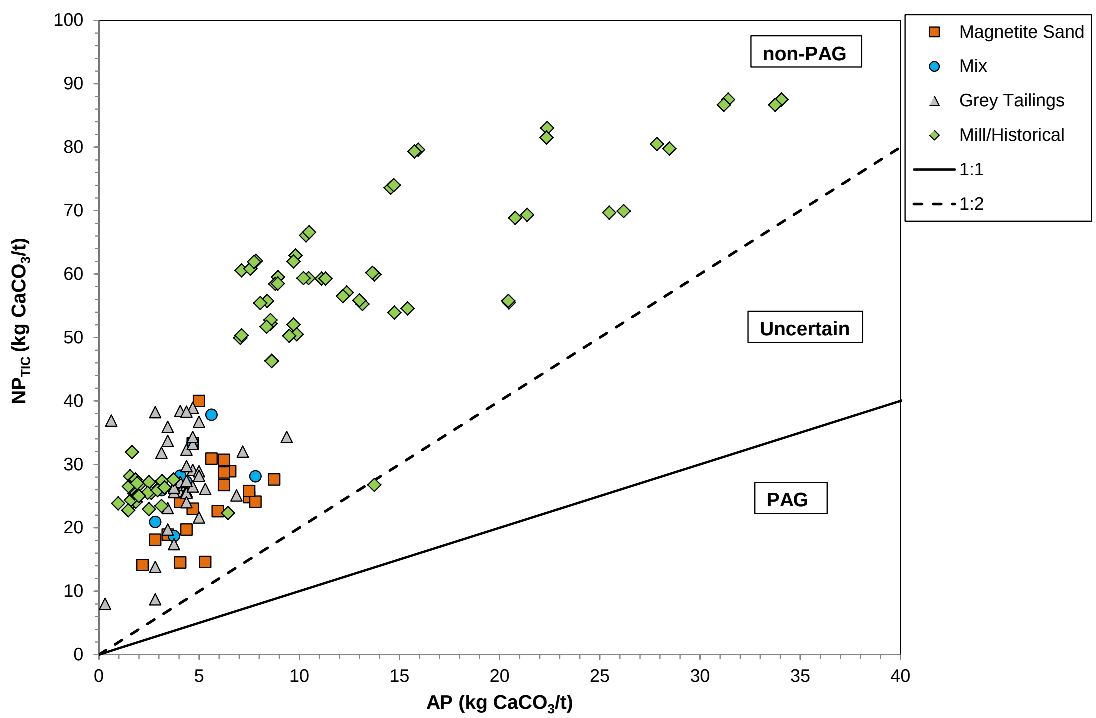

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Figure 5-5: Comparison of spilled tailings and MPM mill/historical tailings.

5.6 Trace Element Occurrence

5.6.1 Element Enrichment

Complete analytical composition results from a 35 element scan are provided in Appendix C6. For ease of reference a shortened list of element concentrations that have guidelines for the protection of freshwater aquatic life in British Columbia is provided in Table 5-1.

To provide an indication of trace element enrichment in the spilled tailings samples, concentrations were compared to typical global average concentrations for basalt (Price 1997). This comparison approach is a standard element leaching screening practice as outlined by MEND (2009).

Concentrations present at more than an order-of-magnitude above global average values were considered enriched for the purpose of screening and enrichment ratios are shown in Figure 5-6. The ratios were calculated by dividing the concentration of copper (for example) in the sample by the typical concentration of copper in basalt. Ratios greater than 10 are considered enriched. Ratios less than one indicate lower concentrations in the Hazeltine Creek samples than in average basalt. ‘Box and whisker’ plots were used to illustrate the results, with the boxes representing the 25th to 75th percentile ranges. The solid horizontal line represents equivalence with typical basalt, whereas the dashed line represents ten times the concentration of basalt.

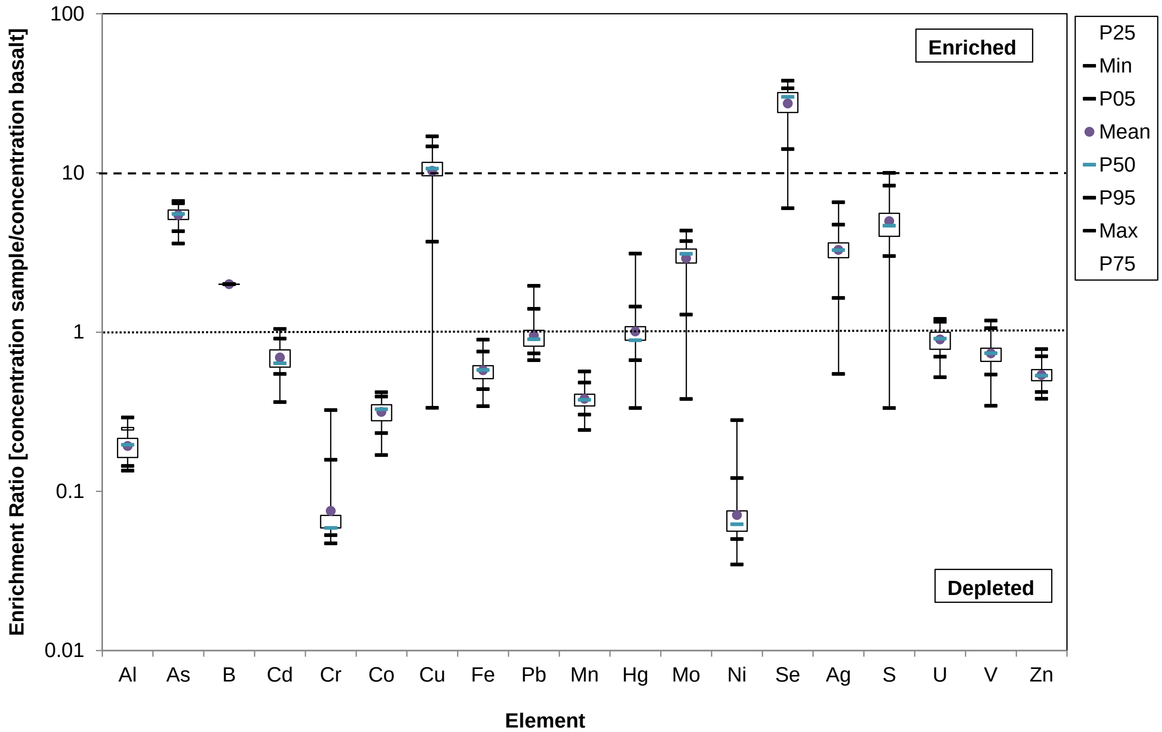

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Figure 5-6: Element enrichment assessment for Hazeltine Creek tailings samples.

By this method, copper and selenium are considered to be enriched in the tailings. The magnetite sands contain more copper than the grey tailings, with average values of 985 and 812 mg/kg, respectively. The difference between the averages is statistically significant based on a one-tailed t-test ($p < 0.05$). The average selenium concentrations for both tailings types were statistically the same at 1.4 mg/kg.

Despite the ‘enrichment’ noted in the spilled materials, the average concentration of selenium in operational tailings from within the TSF is lower (1.1 mg/kg) than the spilled materials and similar to the average of 137 regional stream sediment samples from the region surrounding Mount Polley (average 1.0 ppm, range 0.1 to 9.1 ppm)(GSC 1981; Jackman 2008). This is important to note as the screening was done for the purposes of geochemical characterization, which concerns itself with the likelihood of chemical release mechanisms. However, the presence of a possible release mechanism should not be inferred to mean that a release of metals or others elements would give rise to adverse environmental effects. The human and ecological risk assessment, planned for the summer of 2015, will evaluate this potential. This is a relevant distinction in the present case because selenium is identified to be enriched in this geochemical evaluation but is present in the tailings at concentrations that are less than the Urban Park Land Use standard (PL; 3 mg/kg), which is used as a soil quality benchmark as it is considered appropriate as a screening tool for sites in a wildlands land use setting.

5.6.2 Element-Mineral Correlations

The correlations between copper and sulphur, selenium and sulphur, and selenium and copper are provided in Figure 5-7, Figure 5-8, and Figure 5-9, respectively. Correlation of copper and sulphur ($r = 0.78$) indicate that copper is likely associated with chalcopyrite and bornite, although it could also be copper-enriched pyrite. The chalcopyrite and bornite correlation is consistent with previous estimations of ore mineralogy (Henry, 2009). With regards to selenium, there is a better correlation between selenium and copper ($r = 0.68$) than between selenium and sulphur ($r = 0.54$), which may indicate that selenium is preferentially associated with the copper sulphide rather than pyrite. All of the correlations were significant at the 99% confidence level indicating that both copper and selenium are probably associated with sulphur (sulphide) which is expected from the elemental properties of selenium.

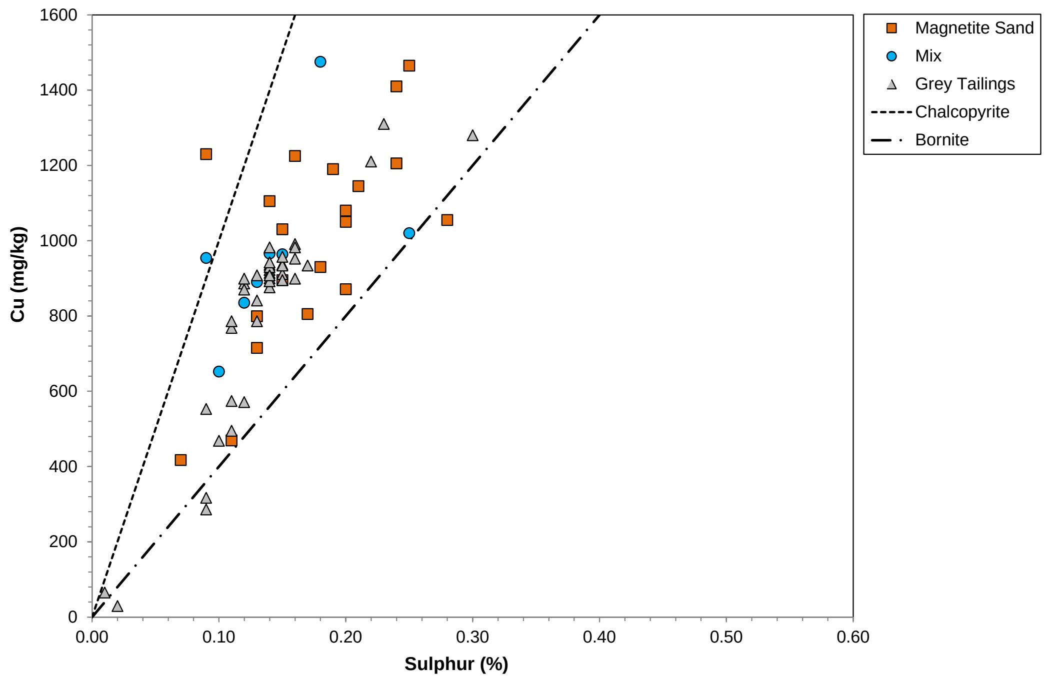

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Figure 5-7: Comparison of copper and sulphur for Hazeltine Creek tailings samples.

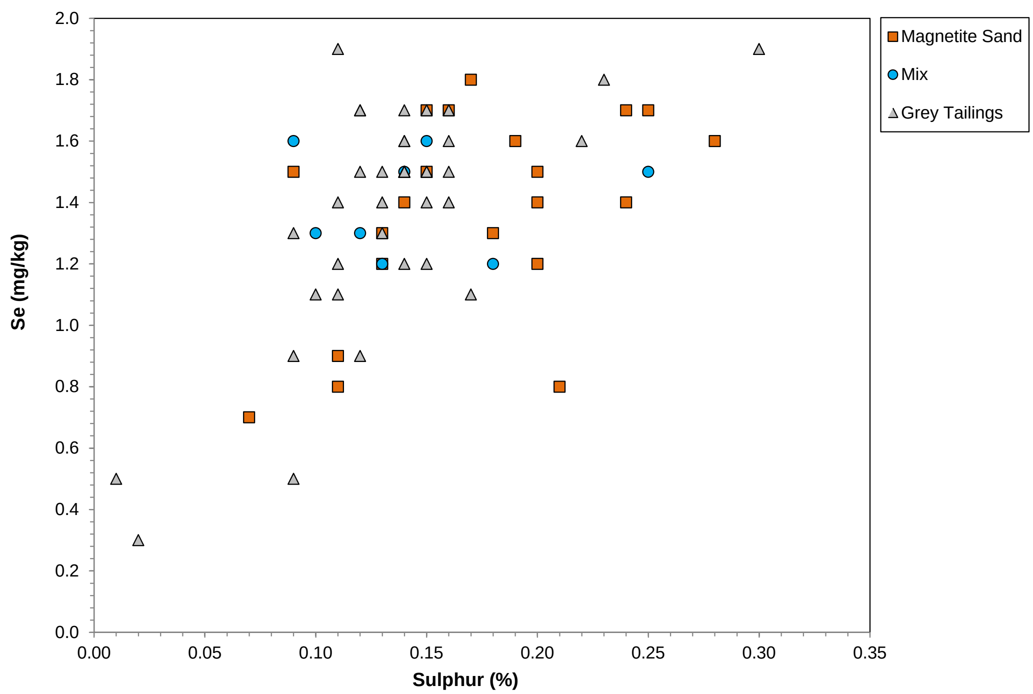

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Figure 5-8: Comparison of selenium and sulphur for Hazeltine Creek tailings samples.

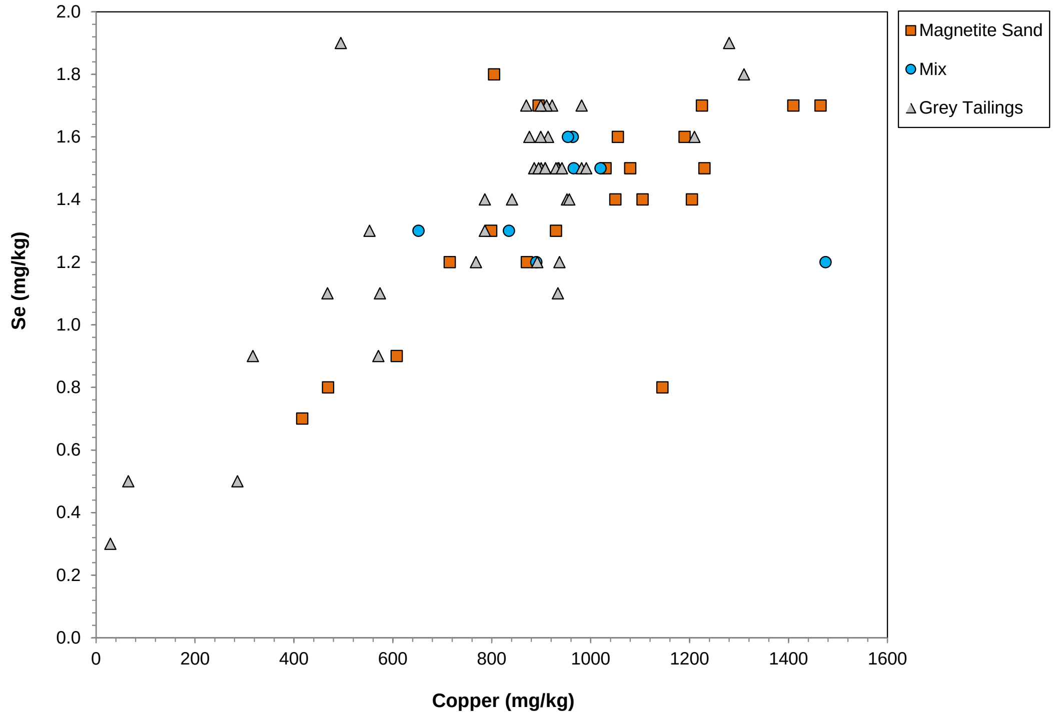

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Figure 5-9: Comparison of selenium and copper for Hazeltine Creek tailings samples.

5.6.3 Element Trends in Hazeltine Creek Tailings Deposits

Trace element concentrations were also evaluated in terms of distance from the tailings dam failure in order to determine if spatial considerations for element leaching needed to be evaluated. Concentrations were correlated with distance down Hazeltine Creek, with transect ST17/18 serving as the starting location and distance calculated by the shortest distance downstream between each transect. For each transect (see Figure 4-1), results were averaged and Pearson's correlation coefficient was determined to evaluate the degree of linear dependence between concentration and distance.

Results for copper and selenium indicated that there was a statistically significant correlation at the 90% confidence limit (r = -0.45 and -0.41 for Cu and Se, respectively), indicating that concentrations decreased downstream. Results are provided in Figure 5-10 and Figure 5-11. Error bars on the graphs represent the range of concentrations measured in the samples along each transect. The sample at 6.5 km (ST4) only had one sample and so does not contain error bars, whereas at 2.5 km (ST12), error bars are smaller than the data point for selenium.

Only copper and selenium are presented as they were the only elements identified as exceeding the enrichment criteria (i.e. ten times crustal basalt concentration). When compared to the criteria downstream, copper fluctuated above and below the enrichment criteria, but remained below for the last three transects closest to Quesnel Lake. Selenium was always above the enrichment criterion.

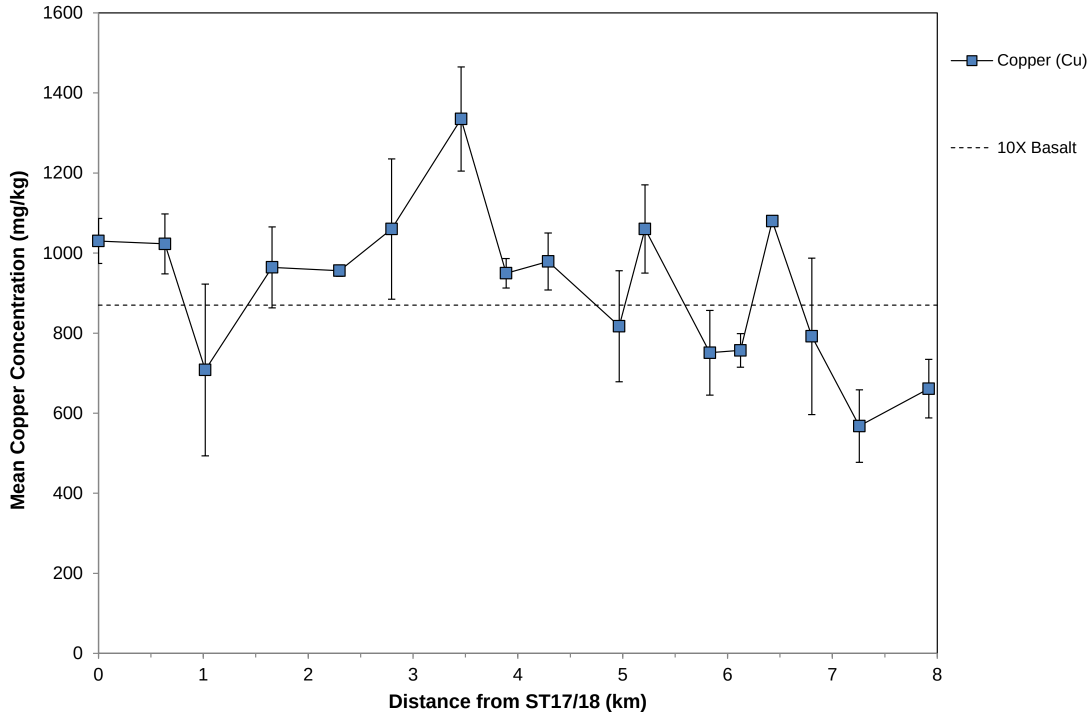

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Figure 5-10: Comparison of tailings copper concentration by distance downstream.

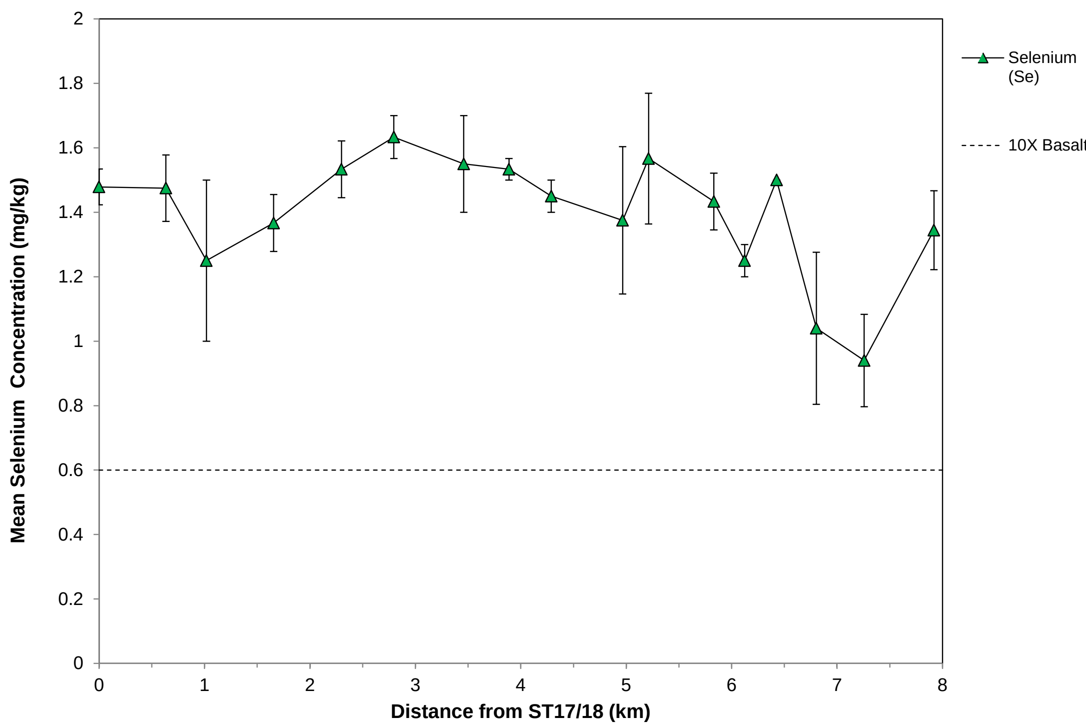

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Figure 5-11: Comparison of tailings selenium concentration by distance downstream.

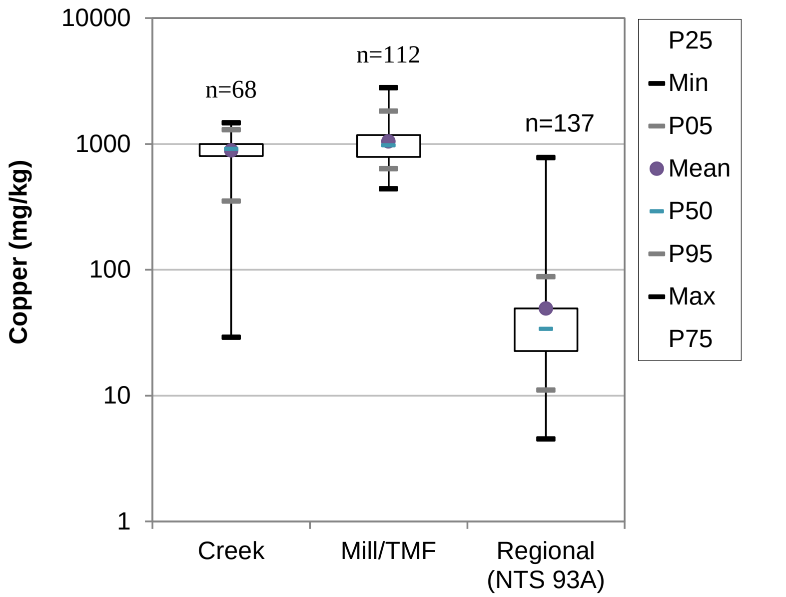
Based on the results of the comparison from available results to date, the element concentration changes observed downstream are not significant enough that consideration of element leaching potential by distance from the dam failure is warranted.

5.6.4 Trace Element Comparison to Operational Tailings and Regional Sediments

Historical data provided by MPMC to the BC MOE (http://www.env.gov.bc.ca/eemp/incidents/2014/mount-polley.htm), in addition to previous studies by the Geological Survey of Canada and Geoscience BC, provides a basis to compare element concentrations determined in this study to characteristics from operational/historical tailings collected over the life of mine from the mill and regional sediments collected in the 1980s prior to mining the Mount Polley deposit. Carbonate (NP) and sulphur (AP) were compared in Section 5.5.4, so copper and selenium are the only elements compared here given that it is only these two elements that were found to be enriched in the tailings.

The average copper concentrations were similar for the spilled tailings and the operational tailings at 890 mg/kg versus 1050 mg/kg, respectively (Figure 5-12). However, based on a one-tailed t-test the means were statistically different (p level equal to 0.01). The spilled tailings also had a lower range reported, although copper concentrations in the tailings during the first few years of mining were reported as being nearly double the last ten years (Figure 5-12), which has likely biased the average high. Mixing with native sediments during deposition would also likely lower the concentration of the materials sampled from along the creek as the native sediments had an average copper concentration of 50 mg/kg and ranged from 4.5 to 780 mg/kg (GSC 1981; Jackman 2008) (Figure 5-12). As a result, the difference between the two datasets is attributed to an averaging effect and potentially mixing rather than non-homogeneity or “hot spot” phenomena.

The average selenium concentrations were also similar, but slightly higher in the spilled tailings as compared to the operational mill tailings at 1.4 mg/kg and 1.0 mg/kg, respectively (Figure 5-12). The means were statistically different based on a one-tailed t-test and while the range was higher in the mill tailings (Figure 5-12), overall the concentration of selenium appears to be well represented in the creek samples. The slightly higher average in the creek samples could be due to a number of selenium concentrations not being reported in earlier mill tailings samples as detection limits have decreased over time, but could also be due to the native sediments that have mixed with the tailings during deposition having higher selenium concentrations than the tailings (Figure 5-12)(Jackman 2008).



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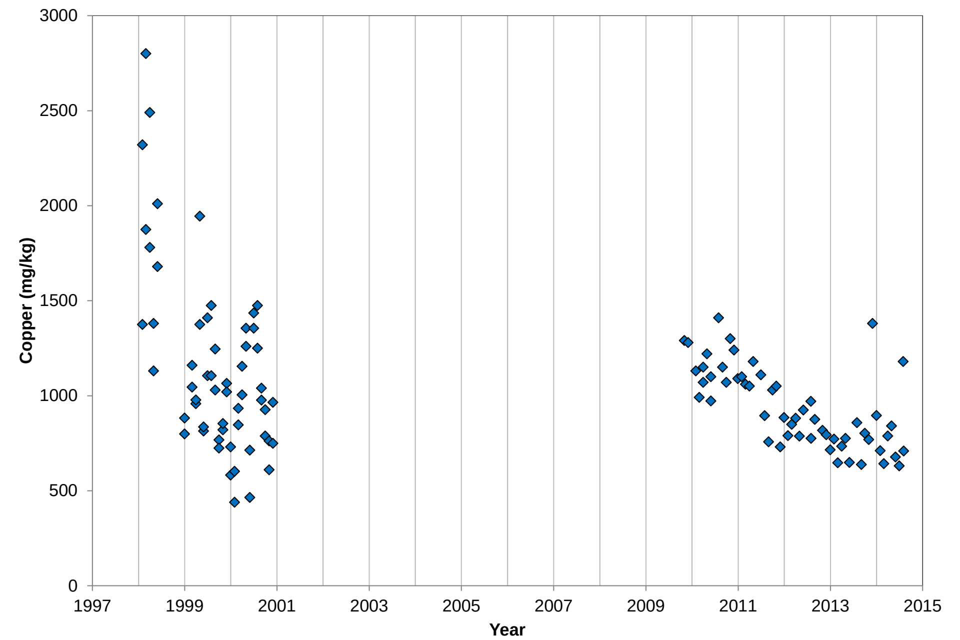
(a) Copper comparison



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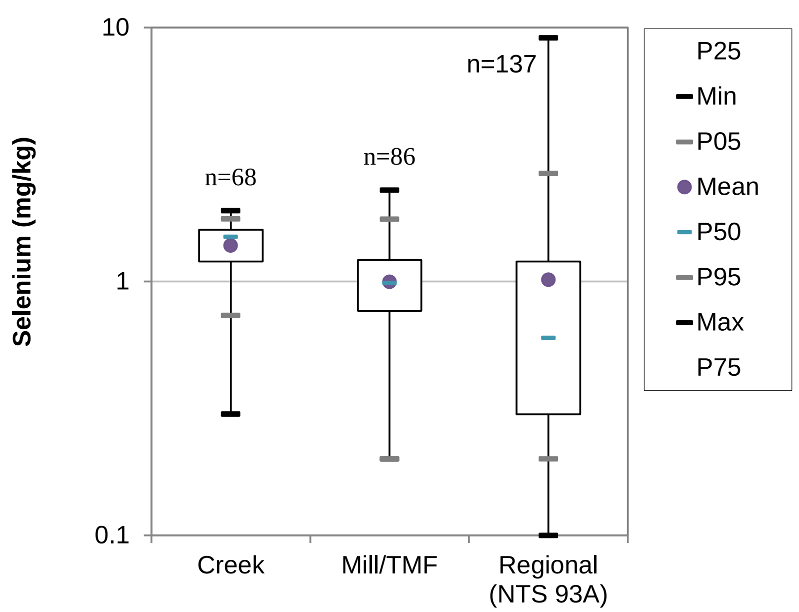
(b) Operational mill tailings copper concentrations.



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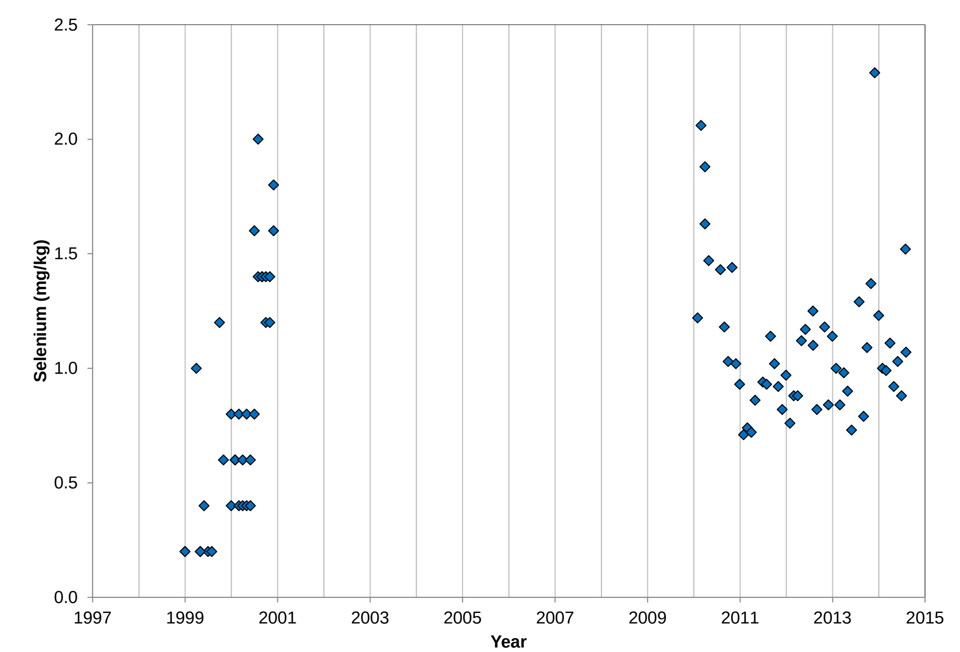
(c) Selenium comparison



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(d) Operational mill tailings selenium concentrations.

Figure 5-12: Comparison of copper (a, b) and selenium (c, d) concentrations in Hazeltine Creek spilled tailings, operational mill tailings and regional sediments.

5.7 Kinetic Testing and Copper Oxide Analysis

Kinetic testing is being performed to assess empirical weathering rates of the spilled tailings along Hazeltine Creek, which will also help refine element leaching potential beyond the initial screening test. At the time of preparation of this report, only three cycles of results (representing 6 weeks of testing) for the humidity cells had been received and no data for the columns were available. As mentioned previously, these tests are typically run for a minimum of 40 weeks and meaningful results are usually not available until after at least 20 weeks. Kinetic testing results will be provided in an update report once the tests have stabilized and a more substantial number of cycles have been completed.

Non-sulphide copper analyses (also referred to as copper oxide) were also not available at the time of this report and will also be reported subsequently. These results will help confirm the amount of copper and other trace elements that are associated with this marginally soluble mineral fraction.

5.8 Mineralogy

5.8.1 General Composition

Minerals detected by QEMSCAN and electron microprobe are shown in Table 5-2 and X-ray diffraction results are provided in Table 5-3. Complete mineralogy results are provided in Appendix C7 and Appendix C8.

The samples are dominated by silicates, including feldspars, chlorite and quartz. Chrysocolla was noted, although only at trace levels. Iron oxides (magnetite and hematite) were frequently the next most abundant minerals after the silicates, followed by carbonates and the minor amounts of sulphides. The presence of quartz at concentrations greater than 1% is a good indication that the tailings are intermixed with native sediments as the deposit is syenitic to monzonitic and the tailings should contain very little to no quartz (BC MINFILE No. 093A 008).

Sulphide mineralogy is consistent with the ore mineralogy previously described for the project, including pyrite and chalcopyrite as the two main sulphide minerals in approximately equal proportions (approximately 0.2% for each mineral), followed by bornite (less than 0.1%) and other copper sulphides (likely covellite). Typically XRD has higher detection limits than QEMSCAN, which is why the sulphides have not been reported by XRD.

The main carbonate present was calcite, ranging from 0.7% to 4.5%. Dolomite was also present, although typically less than 0.1% with the exception of one sample (HC-4) at 0.4%. Malachite was also present, although at near detection levels and at much lower concentrations than expected based on previous understanding of the ore (Section 2.1).

Iron oxides present ranged from approximately 3 to 7%. QEMSCAN is a composition based technique (i.e. all iron oxides will be noted together) and differentiation of individual iron oxides was performed on three samples using XRD, which identifies minerals based on structure. Magnetite was found to be the main iron oxide present, which is consistent with visual observations in the field and sequential leaching results (Section 5.9). Hematite was also present, but at less than 50% of the total iron oxide abundance in the samples tested. In the 'Magnetite Sand' sample, magnetite comprised approximately 75% of the iron oxide detected.

Table 5-2: Mineral Composition of Selected Hazeltine Creek Tailings as Determined by QEMSCAN

		Sample ID					
Sample ID		**HC-1/COL-1**	**HC-2/COL-2**	**HC-3/COL-3**	**HC-4**	**HC-5**	**HC-6**
Sampling Transect ID		**ST-11 & ST-12**	**ST-16 & ST-01**	**ST-08 & ST-13**	**ST-01**	**ST-02**	**ST-17**
Sample Type		**Magnetite Sand**	**Magnetite Sand**	**Grey Tailings**	**Grey Tailings**	**Magnetite Sand**	**Grey Tailings**
Mineral Form		**Modal Abundance %**					
Silicates	K-Feldspar	43	43	39	24	31	39
	Plagioclase	24	29	27	19	21	27
	Chlorite	3.8	3.6	6.9	5.2	4.1	3.8
	Quartz	3.8	1.3	1.1	27	21	3.0
	Clinopyroxene	4.3	5.1	5	3.9	3.9	4.6
	Sericite/Muscovite	1.5	1.1	1.5	1.7	1.1	1.8
	Biotite	1.7	2.2	3.2	1.2	1.3	1.6
	Garnet	2.2	1.8	1.3	3.4	2.5	1.8
	Clays	1.8	1.9	2.3	5.3	4.3	2.8
	Epidote Group	0.87	0.47	0.28	1.1	0.89	0.4
	Chrysocolla	0.0022	0.0048	0.0014	0.000061	0.0014	0.0026
	Other Silicates	1.9	1.9	3.1	2.9	1.9	2.2
Sulphides	Pyrite	0.24	0.19	0.33	0.08	0.16	0.4
	Chalcopyrite	0.24	0.18	0.024	0.021	0.16	0.23
	Bornite	0.035	0.019	0.0	0.00029	0.015	0.016
	Other Cu Sulphides	0.00041	0.00024	0.0017	0.00029	0.00017	0.0006
	Other Sulphides	0.0014	0.00045	0.0009	0.0032	0.0053	0.0028
Carbonates, Oxides, Phosphates	Calcite	2.2	2.3	2.6	0.72	1.3	4.5
	Dolomite (Fe)	0.11	0.037	0.018	0.43	0.15	0.048
	Malachite	0.0081	0.00048	0.0	0.0	0.0028	0.013
	Fe-Oxides	7.0	5.3	4.9	2.8	3.8	4.9
	Ti (Fe) Oxides	0.29	0.24	0.11	0.64	0.73	0.28
	Apatite	0.7	0.68	0.88	0.44	0.51	0.81
	Other	0.027	0.027	0.054	0.036	0.032	0.021

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Table 5-3: Mineral Composition of Selected Hazeltine Creek Tailings as Determined by XRD.

		HC-1/COL-1	HC-4	HC-6
Sampling Transect ID		**ST-11 & ST-12**	**ST-01**	**ST-17**
Sample Type		**Magnetite Sand**	**Grey Tailings**	**Grey Tailings**
Mineral Form		**Modal Abundance %**		
Silicates	Microcline (K-feldspar)	35	16	36
	Albite (Plagioclase)	25	24	25
	Anorthite (Plagioclase)	7.6	4.6	5.0
	Chlorite	5.4	7.0	6.8
	Quartz	1.8	27	1.7
	Diopside (pyroxene)	6.4	7.2	5.5
	Muscovite	2.1	0.61	1.5
	Andradite (garnet)	1.7	0.18	0.56
	Grossular (garnet)	0.51	0.3	0.53
	Almandine (garnet)	-	2.1	0.94
	Epidote	2.1	2.6	3.7
	Kaolinite (clay)	0.4	0.89	0.72
	Titanite	2.7	1.7	2.4
Carbonates, Oxides and Phosphates	Magnetite	4.8	2.3	4.2
	Calcite	2.4	0.82	2.9
	Hematite	1.7	2.2	1.7
	Fluorapatite	-	-	0.57

Source: Z:\01_SITES\Mt_Polley\1CI008.003_Privileged_and_Confidential\500_Reporting\Interpretations\Geochemistry\Mineralogy\[QEMSCAN_interp_Mount Polley_1CI008.003_REV00_CBK.xlsx]

Note: '-' denotes that the mineral was not detected.

5.8.2 Mineral Exposure

The degree of mineral exposure (also referred to as liberation) was measured by QEMSCAN for the sulphides and carbonates. This is a useful characteristic to understand as the more a mineral is exposed to its surrounding environment (e.g. the atmosphere and precipitation), the more susceptible it likely is to weathering. Conversely, the less exposed a mineral, the less likely it is susceptible to weathering.

Analytical results are provided in Appendix C7. As tailings are the product of grinding activities, mineral liberation is expected to be high. This was true for the carbonate minerals, ranging from approximately 30% to 80% of the carbonates fully exposed. However, the iron sulphides were variably less exposed. With the exception of HC-3 (a grey tailings sample), sulphides were predominantly locked, with over 50% of the minerals less than 10% exposed. It is noted that quantification for the sulphides is expected to be somewhat uncertain due to the relatively low amounts of sulphide present (i.e. < 1%).

5.8.3 Mineral Deportment of Copper and Selenium

Deportment can be considered assignment of which mineral 'hosts' a particular element. This is important for understanding reactivity of the tailings, as if an element is 'deported' entirely to a water soluble mineral, then dissolution processes will control its release. However, if an element is deported to sulphide mineral, then oxidation will be the mechanism that controls release.

The deportment of copper and selenium was investigated. However, the concentration of selenium was too low to be detected by QEMSCAN or electron microprobe (typically around 0.1%, whereas the concentration in the samples is only 0.0001%). Consequently, only the results for copper are discussed below.

Copper mineral deportment results are provided in Figure 5-13 and complete analytical results are provided in Appendix C7. Chalcopyrite contained approximately half of the copper when total copper concentrations were above 0.05%. Chlorite was the next most abundant mineral to host copper, followed by bornite and covellite/chalcocite. Malachite was not detected as a significant mineral host for copper. The deportment in chlorite was unexpected as previous investigations have indicated that chrysocolla was the non-sulphide mineral phase hosting copper. However, other studies have also noted the same finding (Chanquıa et al, 2010) and the overall implication is likely insignificant as previous work by MPMC has shown copper in the non-sulphide phase extremely resistant to leaching by acidic solutions (Taplin 2002; Henry 2009).

Based on the mineral characterization and element deportment work, the copper mineral inventory in the spilled tailings samples is composed of a mixture of sulphides with a significant portion in slowly weathering silicates. Given the correlation identified between selenium and copper (Section 5.6.2), selenium can also be reasonably assumed to be present in at least the sulphide mineral forms. While some variation among the samples exists, based on the mineralogy results, leaching of copper and selenium will require oxidation in a subaerial environment. This is discussed further in Section 6.1.

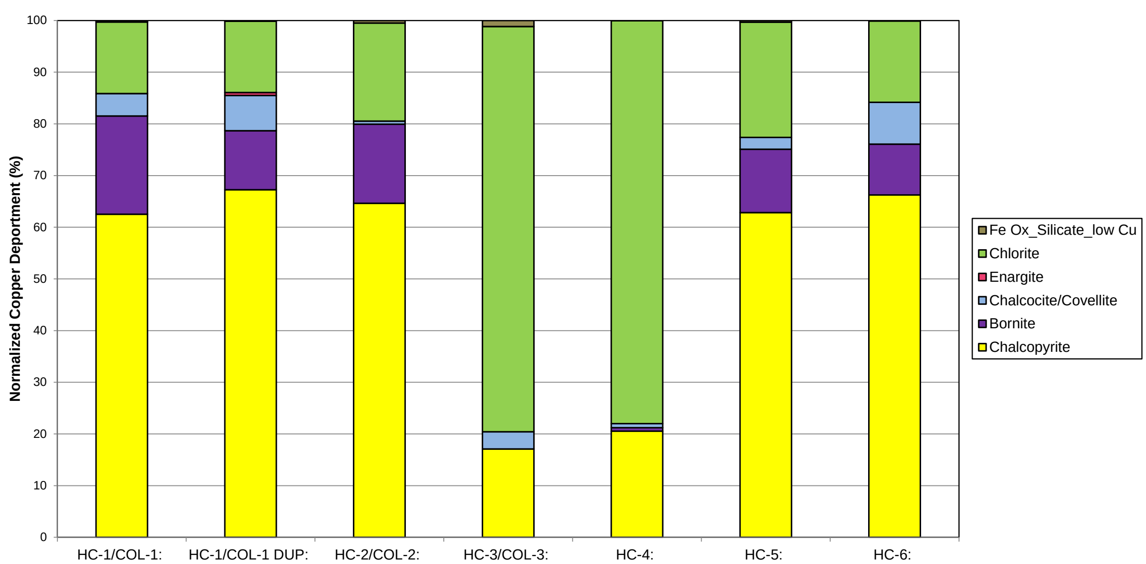


Figure 5-13: Mineral deportment of copper.

5.9 Sequential Extraction Results

5.9.1 Minnow Environmental Results

Complete results from sequential extraction testing are provided in Appendix D.

Results from the extractions were grouped together to represent spilled tailings from Hazeltine Creek, from the bottom of Quesnel and Polley Lake, and also lake sediments that were not impacted by the tailings discharge (i.e. a background lake reference). The groupings also provide the context to compare and discuss implications of the new depositional environment of the tailings in terms of the profundal zone (i.e. the deepest part of the lake) where reducing conditions could develop.

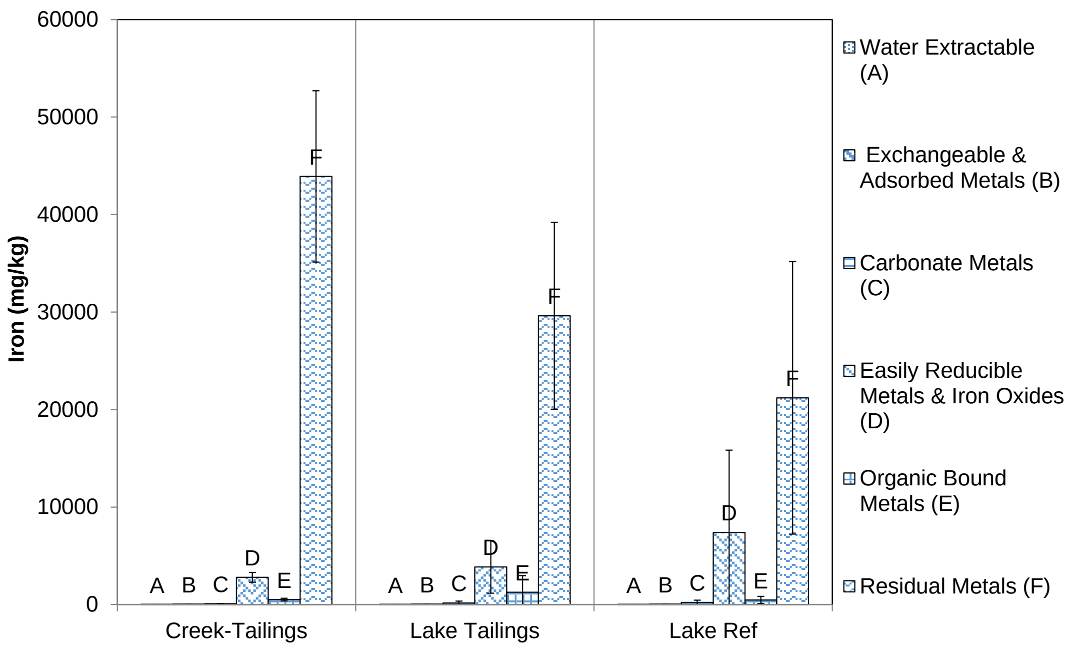
Sulphur results were not included in the analysis, and so iron was used to help understand major mineralogy, followed by copper and selenium on account of their enrichment as compared to global basalt averages. Arsenic is also presented as it is often an element that is sequestered by iron oxides and susceptible to reductive dissolution, although it should be noted that arsenic was not considered enriched in the MPM tailings samples.

Iron was predominantly associated with the ‘residual metals’ fraction (e.g. 85% of total iron extracted in lake tailings) in all samples tested, which as described in Section 4.3.5, is likely comprised of mainly sulphides due to the use of an aqua regia digest (Figure 5-14). Magnetite, hematite and some silicates may also be partially digested in this fraction, but only marginally as aqua regia on sieved, not pulverized, samples will not result in a complete digestion. Iron oxides are likely a small portion of the samples as only a minor portion of the iron was present in the reducible fraction (12% of total) and at lower average concentrations than present in the lake reference sample. When compared to the lake reference sample, the average ‘reducible’ iron fraction was greater in the lake reference than the tailings samples and a statistical analysis (t-test) showed that the reducible iron oxide concentrations in Quesnel Lake tailings were not significantly different than the background samples.

Arsenic was also predominantly associated with the ‘residual’ fraction and not with reducible iron oxides (71% versus 17%, respectively) (Figure 5-14). This is consistent with arsenic being present in a sulphide mineral phase. When compared to the lake reference sample, arsenic was also predominantly associated with the ‘residual’ fraction at 71% in the lake reference sample. The lake tailings ‘reducible’ phase had slightly higher arsenic content than the lake reference sample that was statistically different based on a t-test, although results were relatively low for both samples when compared to the total available arsenic in these samples.

Copper was primarily associated with the ‘organic bound’ metal fraction in the tailings, ranging from 63% to 56% in the creek and lake tailings, respectively (Figure 5-14). As discussed in Section 4.3.5, this is likely partially associated with sulphide minerals and also chlorite due to the reagents and temperatures used in the extraction step (Tessier 1979). Mineralogy results presented in Section 5.8 also support this with the deportment of copper partially in chlorite. The ‘residual’ fraction contained the next highest amount, but also notable for copper was the presence of 4% in the ‘carbonate metal’, likely reflecting the presence of malachite. When compared to the lake reference sample, total copper was two orders of magnitude lower and the highest proportion of copper was in the ‘residual’ fraction for the lake reference samples.

Selenium was similar to copper in that it was also primarily associated with the ‘organic bound’ metal fraction, ranging from 33% to 46% in the creek and lake tailings, which as noted above likely represents sulphide minerals and also the copper silicate. This is consistent with element scan correlations in that selenium appears to be associated with the copper sulphides. Selenium was below detection in the other fractions as 0.2 mg/kg is the calculated detection limit based on aqueous concentrations in the sequential extraction tests (does not include water extractable). The one exception was the creek tailings ‘residual metals’ fraction as this sample was slightly above analytical detection limits. When compared to the lake reference sample, selenium was also highest in the ‘organic’ fraction, at 27% of the total. Statistical analysis (t-test assuming unequal variances) showed that the ‘organic’ fraction of selenium was not different between the tailings and lake reference sample.



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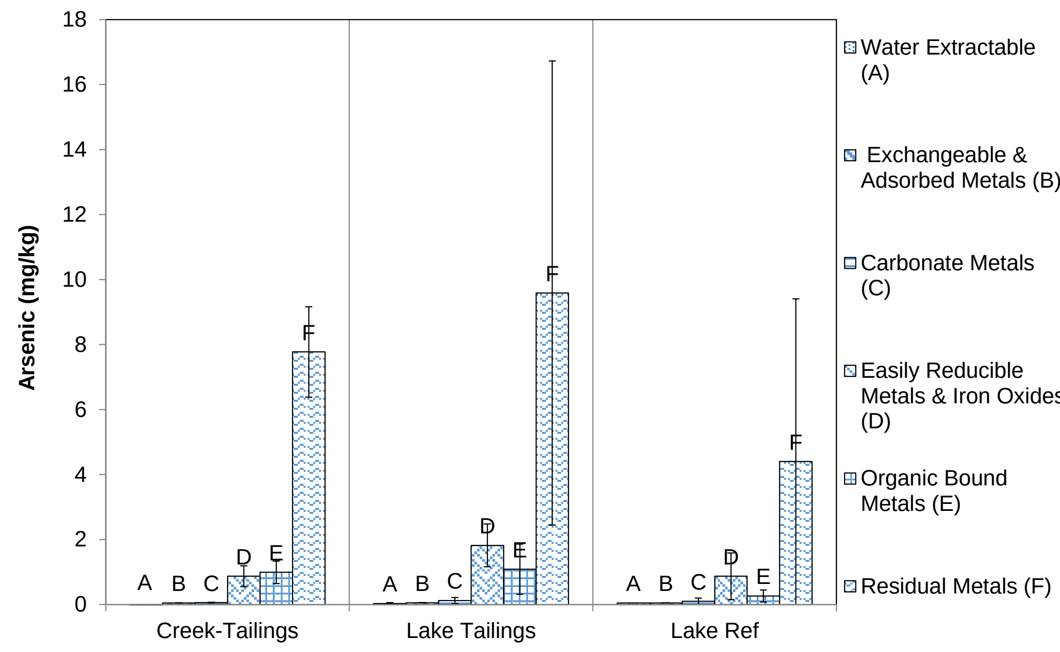

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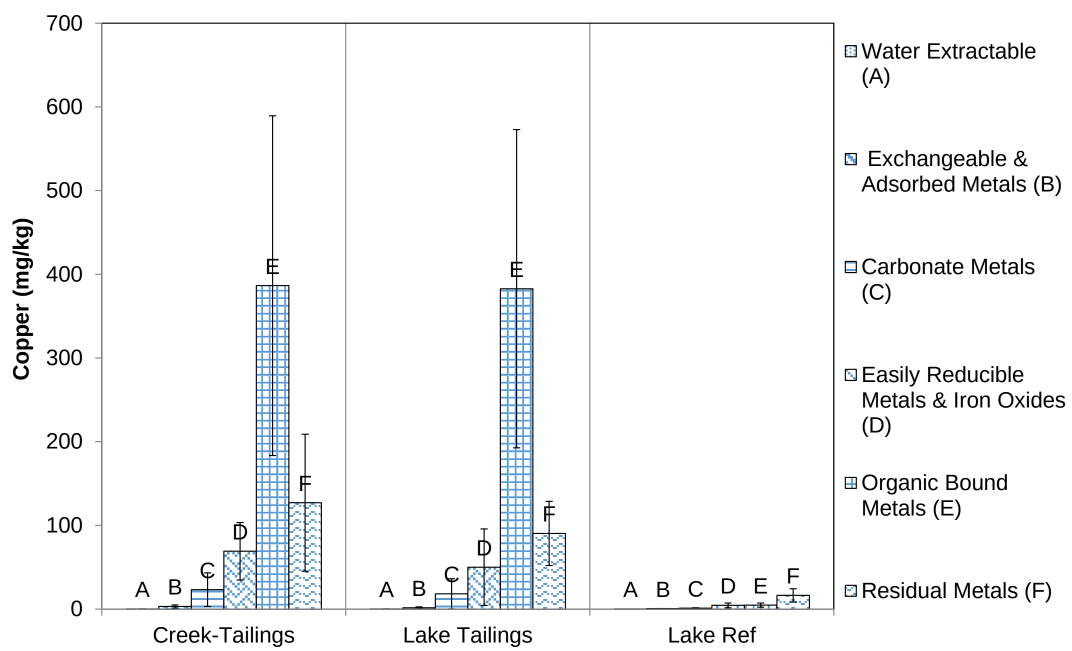

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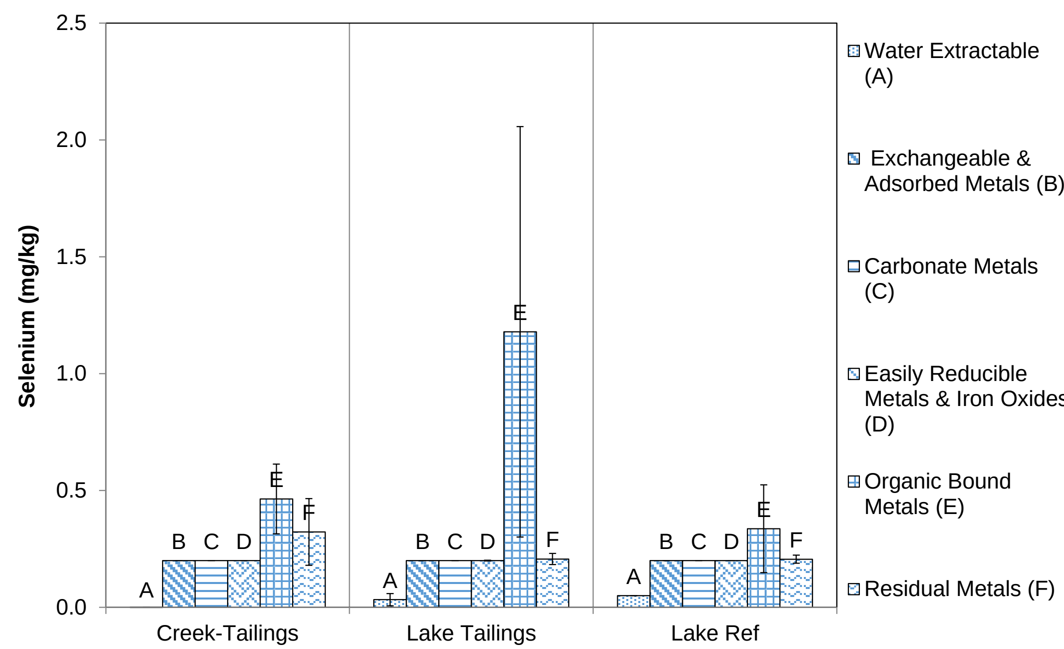

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Figure 5-14: Sequential extraction results for iron, arsenic, copper and selenium.

5.9.2 Comparison between Datasets

Copper and selenium concentrations in the samples collected by SRK and SNC-Lavalin with Minnow Environmental data were compared to check that the element partitioning interpretations based on the Minnow Environmental results were broadly applicable.

Results of the comparison are provided in Figure 5-15 and Figure 5-16, and show that the SRK/SNC averages were higher for copper and lower for selenium, with significant overlap between the majority of samples. The differences for copper and selenium are likely a result of greater mixing with native sediments than the samples along Hazeltine Creek. This is because the selenium concentrations in native sediments are similar or higher when compared to the tailings, whereas copper concentrations are lower in the sediments (Figure 5-12; GSC 1981; Jackaman 2008; Minnow 2014). Thus, the higher selenium and lower copper contents of the Lake Polley samples indicates that there could have been more mixing in Polley Lake as compared to the spilled tailings collected along Hazeltine Creek and Quesnel Lake.

The difference in selenium between the samples collected by SRK and Minnow Environmental may also be partially attributed to the manner in which concentrations for the Minnow Environmental samples were calculated. For each of the sequential extraction steps, the total amount of selenium was summed, including detection limits at the level of detection (0.2 mg/kg). As a result, up to an additional 0.8 mg/kg (from four below detection limit results) of selenium could have been added to the total, or approximately 25% of the total amount of selenium reported.

Based on the comparison of the available data, SRK's conclusion is that the sequential extractions were performed on a range of sample compositions and are broadly applicable for making interpretations in this study. There is also nothing in the dataset or understanding of ore mineralogy to indicate that higher copper or selenium concentrations would be in mineral forms not identified in this study.

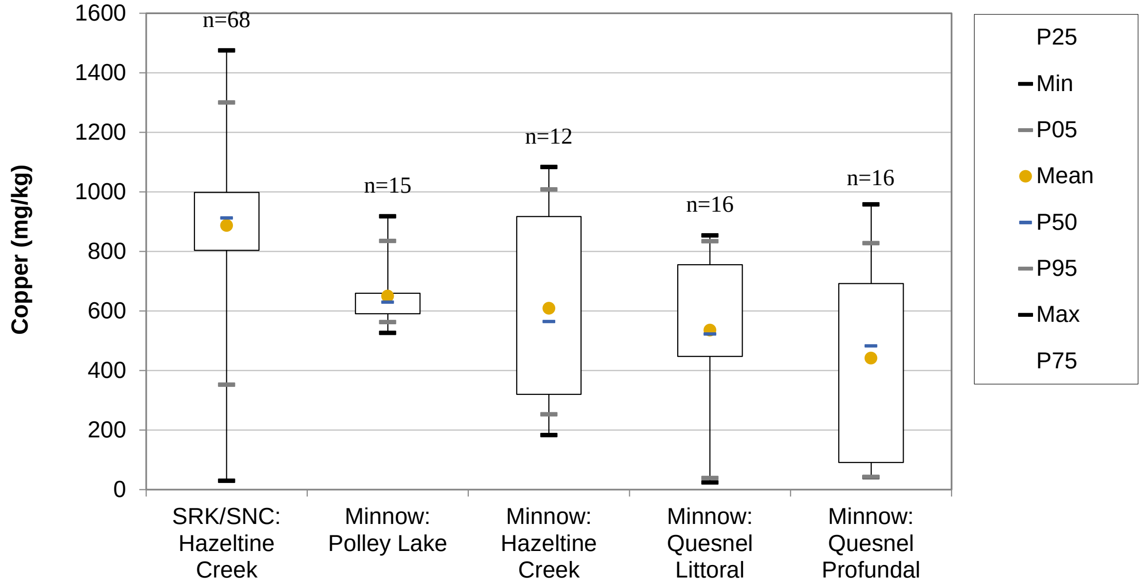

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Figure 5-15: Comparison of copper datasets for sequential extractions.

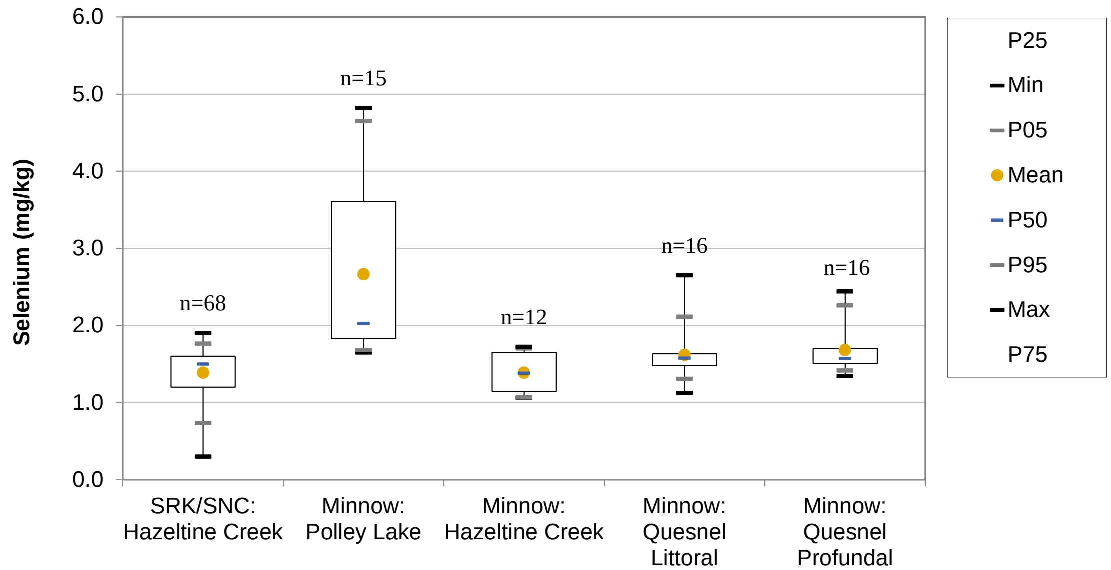

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Figure 5-16: Comparison of selenium datasets for sequential extractions.

6 Discussion

6.1 General Element Leaching Concepts

6.1.1 Overview

The geochemical characterization program outlined here was developed to provide information on the potential for release of metals or other elements from the spilled tailings. The initial geochemical conceptual model provided the framework to evaluate spilled tailings reactivity impacts as follows:

- Representative sample collection.
- Subaerial weathering of tailings along Hazeltine Creek.
- Subaqueous dissolution in the profundal zones of Polley Lake and Quesnel Lakes.

The main pathway for water quality impacts on the Hazeltine Creek tailings is neutral pH weathering. ARD has not been identified as a concern for tailings historically and the results of this program confirm the previous findings. As a result, leaching considerations are focused on neutral pH conditions.

Considerations for leaching of water-saturated tailings along the bottom of Hazeltine Creek are also not considered further. This is because this region of the stream likely remains aerobic and leaching from the spilled tailings would effectively be inhibited.

6.1.2 Representative Sample Collection

Tailings were deposited along an approximately 8 km reach down Hazeltine Creek. Therefore, it was appropriate to understand the range of variability in tailings chemistry along the Creek to determine if conclusions regarding geochemistry in one area of the Creek could be applied to other areas of the Creek.

Based on: i) the TSF deposition history of the tailings, ii) comparisons of ML/ARD potential between the creek tailings and operational mill tailings, and (iii) the distribution of samples analyzed, it is likely that the possible range of geochemical characteristics of the spilled tailings were suitably characterized by this program. All of the highest sulphur, carbonate and copper concentrations appear to be from the initial years of mining and do not appear to have left the impoundment. SRK concludes that the interpretations and implications based on the samples collected for this study are applicable to the entire impacted area.

6.1.3 Subaerial Weathering of Tailings

The spilled tailings and mixed in sediment materials stored along the banks of Hazeltine Creek and any other subaerial setting will weather in the presence of oxygen. However, leaching is expected to be slow because sulphides containing copper and selenium leach at relatively slow rates under neutral pH conditions. On-going geochemical testing is establishing these rates. Silicates will also weather, but at even slower rates that are dependent on mildly acidic rainwater (the dissolved carbon dioxide equilibrium pH of rainwater is ~5.5). Given the carbonates present in the MPM tailings, mildly acidic rainwater will be neutralized upon contact and leaching of silicates would be slower than could occur by rainwater. Specific leaching rates for the tailings collected are currently being established through kinetic testing and will be reported subsequently.

Copper was identified as an enriched element, but this is consistent with the nature of the copper porphyry deposit that the MPM was mining. A significant portion of the copper has previously been reported in two site specific studies to be locked up in a non-sulphide mineral that required extremely acidic conditions (i.e. 25% HCl solution) to leach (Taplin 2002; Henry 2009). This study has found that the non-sulphide associate mineral is chlorite and likely ranges from 20% to nearly 70% (Figure 2-1) of the total copper in the spilled tailings, which effectively lowers the total leachable copper content. For example, if only 20% of the copper is locked up in silicates, then this would bring the sulphide associated oxidizable copper down from the average of approximately 1,000 mg/kg to 800 mg/kg, which is below the enrichment criteria.

Thermodynamic first principles and the equilibrium modelling software package PHREEQC (version 2.17.4137) (Parkhurst and Appelo, 1999) predicts low solubility of copper at neutral pH as compared to concentrations that are associated with copper porphyries under acidic pH (Day and Rees, 2006). This is because secondary copper oxide minerals that would form after oxidative dissolution from a copper sulphide are only sparingly soluble. The prediction by PHREEQC under aerobic conditions and carbonate buffered rainwater is an upper limit of 0.02 mg/L due to copper oxide solubility limits. This is consistent with other copper concentrations measured under neutral pH at the MPM and other copper porphyry sites (Day and Rees, 2006).

Selenium was shown to be correlated with copper and likely is present as an accessory element in the copper sulphides as this element often replaces sulphur owing to similar geochemical properties (Ralston et al, 2008; MEND 2015). However, the methods used in this study could not detect selenium co-precipitated with silicate minerals and so selenium release should be conservatively assumed to be associated only with oxidative dissolution of sulphides. Once selenium has been leached, it is also relatively soluble under oxidizing and neutral pH conditions and is unlikely to be controlled by mineral solubility (MEND 2015).

6.1.4 Subaqueous Dissolution of Tailings

For any of the spilled tailings that ended up in Quesnel or Polley Lake, water saturation is the best way to inhibit oxidation of sulphides (INAP 2010). Therefore, leaching of any elements hosted in sulphides (i.e. copper and selenium) that would be released by oxidation is effectively inhibited for tailings present in Quesnel and Polley Lakes.

The settling of spilled tailings deep in Quesnel or Polley Lake could be susceptible to reductive dissolution processes. This is because certain minerals like iron oxyhydroxides (i.e. ferrihydrite) contain ferric iron that is only sparingly soluble under aerobic neutral pH conditions, but becomes much more soluble if converted to ferrous iron by iron reducing bacteria in anaerobic environments (Lovely 1991). Ferrihydrite is a well-known mineral for sorbing other elements and if it undergoes reduction dissolution, then those elements could also potentially become soluble.

Based on the results of the mineralogical characterization work and sequential extractions, the risk for mobilization of elements under reducing conditions is very low. Easily reducible iron oxides were minor components of the tailings samples tested and neither copper nor selenium were associated with a mineral phase that would be susceptible to reductive dissolution. Arsenic was also evaluated as it is often sorbed to iron oxyhydroxides, but it was primarily associated with sulphides.

It should also be noted that selenium behaves quite differently under reducing conditions and will either sorb to mineral surfaces if it is speciated as selenite, or precipitate as elemental selenium (Ralston et al, 2008; MEND 2015). In either event, even if selenium was released from reductive dissolution processes, its geochemical behaviour under reducing conditions would result in it being removed from the water column and it is not considered a water quality risk under subaqueous reducing conditions.

7 Conclusions and Next Steps

Geochemical characterization, including ABA tests, trace element analyses, mineralogical analyses, and sequential extractions have been undertaken on representative tailings samples that spilled into Hazeltine Creek, and Quesnel and Polley Lakes from the MPM.

The results indicate that the MPM tailings are not potentially acid generating, which is consistent with historical understanding of the tailings and the low sulphur nature of the ore deposit. Leaching considerations are under neutral pH only, which tends to support low mineral and element specific solubility. The only elements that were noted to be enriched when compared to typical crustal rocks (basalt) were copper and selenium. Both of these elements were primarily associated with sulphide minerals and require oxidation to be leached. The potential for reductive dissolution processes to leach elements from the spilled tailings that have settled in Quesnel and Polley Lakes was assessed and found to be low.

Copper is partially deported to silicate minerals and is also relatively insoluble at neutral pH. Therefore, it is not considered to be readily leachable from the spilled tailings. Selenium appears to only be associated with the sulphide fraction, is soluble at neutral pH, and will be leached to a small degree from the tailings when located in a subaerial environment. However, given the relatively thin deposition of tailings along the creek and high dilution potential from precipitation and other sources, selenium concentrations are likely to be low.

Kinetic testing of the samples using humidity cells and columns is on-going and will establish empirical weathering rates in the laboratory. The rates will need to be adjusted (geochemically ‘scaled’) to account for site temperature differences between the lab and field, but will provide a basis to further refine understanding of potential for water quality impacts from the spilled tailings. An update will be provided once stable leaching rates from the lab tests are available.

This report, Mount Polley Mine Tailings Dam Failure: Geochemical Characterization of Spilled Tailings, was prepared by

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All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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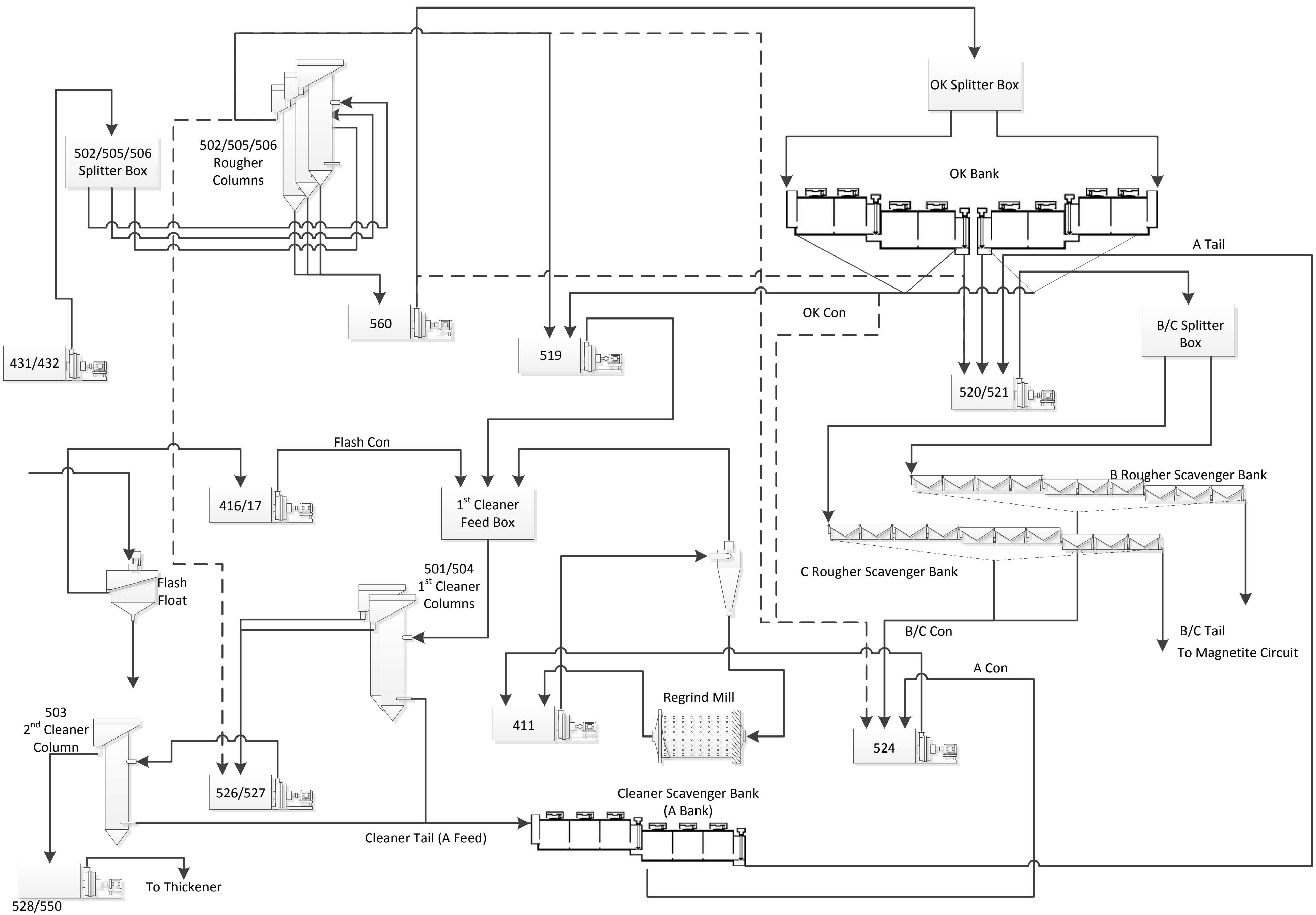
Appendix A – MPM Operations Flow-Sheet & Ore Processing Information

Appendix A1 – MPM Flotation Circuit Flow-Sheet from 2014



OK Splitter Box
502/505/506
Splitter Box
502/505/506
Rougher
Columns
OK Bank
A Tail
560
519
OK Con
B/C Splitter
Box
431/432
520/521
Flash Con
B Rougher Scavenger Bank
416/17
1st Cleaner
Feed Box
C Rougher Scavenger Bank
501/504
1st Cleaner
Columns
Flash
Float
B/C Con
B/C Tail
To Magnetite Circuit
A Con
Regrind Mill
503
2nd Cleaner
Column
411
524
526/527
Cleaner Scavenger Bank
(A Bank)
Cleaner Tail (A Feed)
To Thickener
528/550

Appendix A2 – MPM Ore Processing Information

Year of Production	Production Period	Ore Processed (tonnes)	Head Grade					Tails Produced (tonnes)	*% to Tailings*	Tailings Grade					Grinding Circuit	Flotation Circuit	Main Changes and Geochemical Considerations
			CuT	CuNS	CuS	Au	Oxide Ratio (%)			CuT	CuNS	CuS	Au	Oxide Ratio (%)			
1997	10 July to 31 Dec	2,346,829	0.266	0.074	0.193	0.36	27.6%	2,333,186	*99.4%*	0.102	0.057	0.045	0.12	55.6%	2 rod, 2 ball, 3 pebble mills	tailings = sand scav tails + oxide scav tails + cleaner scav tails cyc OF	High sodium sulphide content to flot copper oxide.
1998	1 Jan to 31 Dec	5,828,358	0.370	0.151	0.219	0.79	40.9%	5,788,498	*99.3%*	0.179	0.120	0.059	0.22	67.0%			
1999	1 Jan to 31 Dec	7,051,212	0.335	0.098	0.237	0.57	29.1%	6,986,932	*99.1%*	0.105	0.067	0.038	0.13	63.9%			
2000	1 Jan to 31 Dec	6,948,339	0.330	0.076	0.254	0.51	23.0%	6,883,317	*99.1%*	0.095	0.052	0.043	0.12	54.5%			
2001	1 Jan to 14 Oct	5,385,796	0.335	0.052	0.283	0.52	15.5%	5,328,581	*98.9%*	0.083	0.032	0.051	0.14	38.2%			
5 year shutdown																	Consolidation
2005	8 Mar to 31 Dec	4,814,083	0.391	0.043	0.349	0.30	10.9%	4,758,757	*98.9%*	0.106	0.036	0.070	0.10	34.1%	2 rod, 2 ball, 3 pebble mills	tailings = B, C rougher scav tails	Higher proportion of sulphide ore and lower NaS
2006	1 Jan to 31 Dec	6,235,221	0.474	0.035	0.439	0.26	7.4%	6,133,088	*98.4%*	0.071	0.024	0.047	0.08	34.1%			
2007	1 Jan to 31 Dec	6,444,112	0.461	0.028	0.433	0.24	6.1%	6,346,640	*98.5%*	0.100	0.019	0.081	0.08	19.0%	2 rod, 3 ball, 3 pebble mills		addition of 3rd ball mill 6.4 to 7Mtpa
2008	1 Jan to 31 Dec	6,848,983	0.552	0.093	0.459	0.31	16.9%	6,735,444	*98.3%*	0.155	0.078	0.077	0.09	50.4%			
2009	1 Jan to 31 Dec	7,045,737	0.371	0.095	0.276	0.32	25.5%	6,977,681	*99.0%*	0.154	0.086	0.068	0.11	56.0%			
2010	1 Jan to 31 Dec	7,894,596	0.322	0.071	0.251	0.28	22.0%	7,825,178	*99.1%*	0.123	0.063	0.060	0.10	51.2%	2 rod, 3 ball, 3 pebble mills + flash flot		addition of flash flotation and lower Cu grade
2011	1 Jan to 31 Dec	7,716,856	0.265	0.051	0.214	0.27	19.1%	7,663,577	*99.3%*	0.110	0.045	0.065	0.10	40.9%		tailings = C rougher scav tails	only C scav tails; more oxidized ore and higher NaS
2012	1 Jan to 31 Dec	8,121,878	0.280	0.039	0.242	0.30	13.7%	8,056,496	*99.2%*	0.093	0.033	0.060	0.11	35.4%		B, C rougher scav tails to magnetite circuit	Addition of magnetite remvoal circuit. Possible reduction in pyrrhotite content in tailings.
2013	1 Jan to 31 Dec	7,956,738	0.295	0.032	0.263	0.26	10.9%	7,882,625	*99.1%*	0.076	0.025	0.051	0.08	32.5%			
2014	1 Jan to 3 Aug	4,548,182	0.321	0.027	0.294	0.26	8.5%	4,502,145	*99.0%*	0.078	0.021	0.057	0.08	26.5%			

Note: From October 15, 2001 to March 7, 2005 Mount Polley Mine was shut down due to low metal price.

Appendix B – Sampling Photos

Photo 1. View of TMF breach from Hazeltine Creek.

Photo 2. Eastward view from TMF breach.

Photo 3. View of TMF breach from Transect ST17 (General Section: Polley Lake Plug).

Photo 4. Southward view from Transect ST17 (General Section: Polley Lake Plug).

Photo 5. Sample material from ST18-03, mixture of grey tailings and magnetite sands (General Section: Polley Lake Plug).

Photo 6. ST16 sample location, view upstream showing magnetite sands (General Section: Polley Lake Plug)

Photo 7. Close-up view of magnetite sands from ST15 (General Section: Upper Valley).

Photo 8. View upstream showing iron oxide seep at ST14 (General Section: Upper Valley).

Photo 9. Sample location for ST14-03 (General Section: Upper Valley).

Photo 10. View of magnetite sands near ST11 (General Section: Middle Canyon).

Photo 11. View upstream above ST11 (General Section: Middle Canyon)

Photo 12. View downstream from ST10 (General Section: Middle Canyon).

Photo 13. Eroded bank showing glacial sediments at ST09 (General Section: Middle Canyon).

Photo 14. Upstream view showing bedrock near ST06 (General Section: Lower Canyon).

Photo 15. Downstream view from ST06 (General Section: Lower Canyon).

Photo 16. View downstream from just above ST03 (General Section: Delta).

Photo 17. View downstream from just below ST03 (General Section: Delta).

Photo 18. Example of sample location on ST02 showing grey tailings on top (General Section: Delta).

Photo 19. Upstream view from ST01 (General Section: Delta).

Photo 20. View of Quesnel Lake near ST01 (General Section: Delta).

Appendix C – Analytical Data for 2014 Hazeltine Creek Tailings Samples

Appendix C1 – Hazeltine Creek Tailings Sample Descriptions

Soil Transect Identification	Sample Identification	Sample Date	UTM Coordinates		General Section of Hazeltine Creek	Major Soil Type	Minor Soil Type Grouping	Primary Colour(s)
			Easting	Northing				
ST01	ST01-02-01	2014-09-22	5817130.75	602234.88	Delta	Grey Tailings	Silt with some Fine Sand	Grey
	ST01-03	2014-09-11	5817404.55	601747.117	Delta	Magnetite Sand	Fine Silt with Suspect --tive	Grey
	ST01-04	2014-09-11	5817422.836	601707.532	Delta	Grey Tailings	Fine Sand and Magnetite Sand	Grey - Orange - Brown - Black
	ST01-05-01	2014-09-11	5817493.807	601586.262	Delta	Grey Tailings	Fine Sand and Silt	Grey
	ST01-05-02	2014-09-11	5817493.807	601586.262	Delta	Grey Tailings	Fine Sand	Grey
	ST01-06	2014-09-11	5817523.571	601546.503	Delta	Grey Tailings	Fine Sand and Silt	Grey
	ST01-09-01	2014-09-22	5817160.19	602135.48	Delta	Grey Tailings	Silt with some Fine Sand	Grey
	ST01-09-02	2014-09-22	5817160.19	602135.48	Delta	Grey Tailings	Fine Sand	Grey
ST02	ST02-02-01	2014-09-10	5817356.593	601226.145	Delta	Grey Tailings	Fine Sand and Silt	Grey
	ST02-03	2014-09-10	5817256.555	601154.188	Delta	Grey Tailings	Fine Sand	Grey
	ST02-05-01	2014-09-10	5817088.83	601055.707	Delta	Magnetite Sand	Fine Sand and Silt	Grey
	ST02-05-02	2014-09-10	5817088.83	601055.707	Delta	Magnetite Sand	Fine Sand and Silt	Grey-Brown-Orange
	ST02-06	2014-09-10	5817028.016	601023.605	Delta	Magnetite Sand	Medium Sand	Grey-Brown
ST03	ST03-02	2014-09-15	5817300.938	600669.337	Delta	Grey Tailings	Sand and Silt	Grey
	ST03-03-01	2014-09-09	5817334.75	600693.39	Delta	Magnetite Sand	Silt and Sand	Grey - Brown
	ST03-03-02	2014-09-09	5817334.75	600693.39	Delta	Magnetite Sand	Fine Sand	Light Brown
	ST03-04	2014-09-09	5817338.682	600696.871	Delta	Grey Tailings	Silt and Fine Sand	Grey
	ST03-05-02	2014-09-10	5817353.974	600712.729	Delta	Grey Tailings	Sand and Silt	Brown
ST04	ST04-02	2014-09-15	5817200.553	600035.593	Lower Canyon	Magnetite Sand	Medium Sand	Black-Brown-Orange
ST05	ST05-02-01	2014-09-15	5817235.024	599912.392	Lower Canyon	Magnetite/Grey Tailings Mix	Magnetite/Grey Tailings Sand and Silt Mix	Black-Brown-Orange
ST06	ST06-02-01	2014-09-15	5817227.551	599692.508	Lower Canyon	Grey Tailings	Grey Sand, with Silt/Clay	Grey - Pale Green
	ST06-03	2014-09-22	5817198.7	599688.2	Middle Canyon	Grey Tailings	Clay and Silt	Grey
	ST06-04-01	2014-09-22	5817180.959	599691.994	Middle Canyon	Grey Tailings	Clay and Silt with Trace Sand	Grey
ST07	ST07-02	2014-09-11	5817297.063	599135.545	Lower Canyon	Grey Tailings/Magneitite Mix	Grey Tailings Silt/Trace Magnetite	Grey with Trace Orange
	ST07-03-01	2014-09-11	5817326.107	599150.328	Lower Canyon	Grey Tailings	Fine Sand and SIlt	Grey with Trace Orange
	ST07-03-02	2014-09-11	5817326.107	599150.328	Lower Canyon	Grey Tailings	Grey Tailings with S. --tive Sand & Gravel	Grey with Trace Yellow-Orange
ST08	ST08-02-01	2014-09-15	5817291.42	598870.794	Middle Canyon	Grey Tailings	Clay and Silt	Grey
	ST08-03	2014-09-15	5817268.019	598863.406	Middle Canyon	Magnetite Sand	Fine to Medium Sand	Black-Brown-Orange
	ST08-04	2014-09-15	5817245.54	598858.472	Middle Canyon	Grey Tailings	Fine Sand	Grey
	ST08-05-01	2014-09-15	5817207.801	598850.824	Middle Canyon	Magnetite Sand	Medium Sand	Black-Brown-Orange
ST09	ST09-02-01	2014-09-15	5817621.615	598273.313	Middle Canyon	Magnetite Sand	Medium Sand	Black-Brown-Orange
	ST09-03	2014-09-15	5817647.98	598279.641	Middle Canyon	Grey Tailings	Fine Sand	Grey
ST10	ST10-02	2014-09-14	5817857.907	597948.48	Middle Canyon	Grey Tailings	Fine Sand	Grey
	ST10-03	2014-09-14	5817829.396	597919.025	Middle Canyon	Grey Tailings	Fine Sand and SIlt	Grey
	ST10-04	2014-09-14	5817849.253	597937.763	Middle Canyon	Grey Tailings	Silt and Clay	Grey
ST11	ST11-02-01	2014-09-14	5818075.518	597644.167	Middle Canyon	Magnetite Sand	Medium Sand	Black-Brown-Orange
	ST11-02-02	2014-09-14	5818075.518	597644.167	Middle Canyon	Magnetite Sand	Medium Sand	Black-Brown-Orange
ST12	ST12-02	2014-09-14	5818796.68	597284.097	Upper Valley	Magnetite Sand	Medium Sand	Black-Brown-Orange
	ST12-03	2014-09-14	5818820.642	597305.462	Upper Valley	Grey Tailings	Fine Sand	Grey
	ST12-04	2014-09-14	5818828.967	597314.189	Upper Valley	Grey Tailings	Silt and Fine Sand	Grey
ST13	ST13-02	2014-09-14	5819036.409	597015.857	Upper Valley	Grey Tailings	Silt and Clay	Grey
	ST13-03	2014-09-14	5819017.274	596999.606	Upper Valley	Grey Tailings	Silt and Fine to Medium Sand	Grey
	ST13-04-01	2014-09-14	5819006.256	596982.731	Upper Valley	Grey Tailings	Fine Sand and Some Silt	Grey
ST14	ST14-02-01	2014-09-14	5819277.606	596543.899	Upper Valley	Magnetite Sand	Fine and Medium Sand;Trace Silt	Black-Brown-Orange
	ST14-03	2014-09-14	5819319.038	596575.358	Upper Valley	Grey Tailings/Magneitite Mix	Fine and Medium Sand;Trace Silt	Grey and Black-Brown-Orange
	ST14-04	2014-09-14	5819354.908	596610.52	Upper Valley	Grey Tailings	Clay and Silt; Trace Medium Sand	Grey; Trace Orange-Light Brown
ST15	ST15-02-01	2014-09-13	5819897.723	596190.574	Upper Valley	Grey Tailings	Clay and Fine Sand	Grey
	ST15-02-02	2014-09-13	5819897.723	596190.574	Upper Valley	Grey Tailings	Silt Trace Sand	Brown-Light Brown
	ST15-03	2014-09-13	5819824.912	596071.578	Upper Valley	Grey Tailings	Silt and Clay	Grey
	ST15-04	2014-09-13	5819805.498	596068.195	Upper Valley	Grey Tailings	Clay and Sand	Grey

Soil Transect Identification	Sample Identification	Sample Date	UTM Coordinates		General Section of Hazeltine Creek	Major Soil Type	Minor Soil Type Grouping	Primary Colour(s)
			Easting	Northing				
ST16	ST16-02	2014-09-13	5819999.969	595639.055	Polley Lake Plug	Magnetite Sand	Fine and Medium Sand	Grey-Brown-Orange
	ST16-03	2014-09-13	5820073.331	595763.053	Polley Lake Plug	Magnetite Sand	Fine Sand	Black - Dark Orange
	ST16-05	2014-09-13	5820151.172	595855.364	Polley Lake Plug	Magnetite Sand	Fine Sand	Grey
	ST16-06	2014-09-13	5820192.22	595977.103	Polley Lake Plug	Grey Tailings/Magneitite Mix	Fine and Medium Sand	Grey and Orange-Brown-Black
ST17	ST17-02	2014-09-12	5820501.207	595171.521	Polley Lake Plug	Grey Tailings	Fine Sand	Grey - Light Brown
	ST17-04	2014-09-12	5820360.931	595294.281	Polley Lake Plug	Grey Tailings	Fine Sand and Silt	Grey
	ST17-05	2014-09-12	5820268.51	595363.733	Polley Lake Plug	Grey Tailings	Fine Sand and Silt	Grey
	ST17-06	2014-09-12	5820212.327	595394.606	Polley Lake Plug	Grey Tailings	Fine Sand and Silt	Grey
	ST17-07	2014-09-12	5820164.538	595429.356	Polley Lake Plug	Grey Tailings	Silt and Clay	Grey
	ST17-08-01	2014-09-12	5820142.757	595443.325	Polley Lake Plug	Grey Tailings	Medium Sand	Dark Grey
	ST17-08-02	2014-09-12	5820142.757	595443.325	Polley Lake Plug	Magnetite Sand	Medium Sand	Orange - Brown
ST18	ST18-02-01	2014-09-17	5820653.41	595765.34	Polley Lake Plug	Grey Tailings/Magneitite Mix	Fine and Medium Sand; and Silt	Grey and Orange-Black
	ST18-02-03	2014-09-17	5820653.41	595765.34	Polley Lake Plug	Magnetite Sand	Medium Sand	Grey and Orange-Brown-Black
	ST18-03-01	2014-09-13	5820589.698	595608.743	Polley Lake Plug	Grey Tailings/Magneitite Mix	Fine and Medium Sand	Grey and Orange-Brown-Black
	ST18-03-02	2014-09-13	5820589.698	595608.743	Polley Lake Plug	Grey Tailings/Magneitite Mix	Medium Sand; Trace Fine Sand	Orange-Brown-Black; Trace Grey
	ST18-04	2014-09-13	5820592.608	595596.141	Polley Lake Plug	Grey Tailings/Magneitite Mix	Medium Sand with some Clay	Orange and Brown; with Grey Clay
	ST18-05-01	2014-09-17	5820429.37	595927.35	Polley Lake Plug	Grey Tailings	Silt with some Fine Sand	Grey
	ST18-05-03	2014-09-17	5820429.37	595927.35	Polley Lake Plug	Magnetite Sand	Medium Sand	Grey and Orange-Black

Duplicate Samples

ST01	ST01-02-03	2014-09-22	5817130.75	602234.88	Delta	Grey Tailings	Silt with some Fine Sand	Grey
	ST01-09-03	2014-09-22	5817160.19	602135.48	Delta	Grey Tailings	Silt with some Fine Sand	Grey
ST05	ST05-02-02	2014-09-15	5817235.024	599912.392	Lower Canyon	Magnetite/Grey Tailings Mix	Magnetite/Grey Tailings Sand and Silt Mix	Black-Brown-Orange
ST07	ST07-03-03	2014-09-11	5817326.107	599150.328	Lower Canyon	Grey Tailings	Fine Sand and SIlt	Grey with Trace Orange
ST09	ST09-02-02	2014-09-15	5817621.615	598273.313	Middle Canyon	Magnetite Sand	Medium Sand	Black-Brown-Orange
ST14	ST14-02-02	2014-09-14	5819277.606	596543.899	Upper Valley	Magnetite Sand	Fine and Medium Sand;Trace Silt	Black-Brown-Orange
ST18	ST18-02-02	2014-09-17	5820653.41	595765.34	Polley Lake Plug	Grey Tailings/Magneitite Mix	Fine and Medium Sand; and Silt	Grey and Orange-Black
	ST18-05-02	2014-09-17	5820429.37	595927.35	Polley Lake Plug	Grey Tailings	Silt with some Fine Sand	Grey

Replicate Samples

ST01	ST01-07	2014-09-11	5817526.259	601543.75	Delta	Grey Tailings	Fine - Medium Sand	Grey and Light Brown
	ST01-09-04	2014-09-22	5817159.381	602134.892	Delta	Grey Tailings	--	--
ST06	ST06-02-02	2014-09-15	5817226.6	599692.199	Lower Canyon	Grey Tailings	Grey Sand	Grey
	ST06-04-02	2014-09-22	5817180.959	599692.994	Middle Canyon	Grey Tailings	--	--
ST13	ST13-04-02	2014-09-14	5819005.98	596981.77	Upper Valley	Grey Tailings	Replicate	--

Field Blank Samples

ST01	ST01-08	2014-09-16	-	-	Delta	Field Blank	Silica Sand	--
ST10	ST10-05	2014-09-14	-	-	Middle Canyon	Field Blank	Silica Sand	--
ST18	ST18-06	2014-09-16	-	-	Polley Lake Plug	Field Blank	Silica Sand	--

Soil Transect Identification	Sample Identification	Sample Date	Moisture Content (Field)	Sectoin of Hazeltine Creek	Distance from TSF via Hazeltine Creek (m)	Depth to Suspected Native Ground	Sample Depth (		Field Rinse Tests		Duplicate and Replicate Information
							start	end	pH	Cond. (µS/cm)	
ST01	ST01-02-01	2014-09-22	Wet	Delta	9500	8	0	8	7.4	76.1	--
	ST01-03	2014-09-11	Wet	Delta	9500	20	0	15	8.56	399	--
	ST01-04	2014-09-11	Damp	Delta	9500	25	0	15	8.42	402	--
	ST01-05-01	2014-09-11	Wet	Delta	9500	23	0	10	8.32	361	--
	ST01-05-02	2014-09-11	Damp	Delta	9500	23	10	18	8.48	100	--
	ST01-06	2014-09-11	Damp	Delta	9500	60	0	20	8.25	293	--
	ST01-09-01	2014-09-22	Wet	Delta	9500	45	0	20	9	194	--
	ST01-09-02	2014-09-22	Wet	Delta	9500	45	0	20	7	410	--
ST02	ST02-02-01	2014-09-10	Wet	Delta	8660	14	3	20	7.15	13	--
	ST02-03	2014-09-10	Damp	Delta	8660	12	15	25	8.49	158	--
	ST02-05-01	2014-09-10	Moist	Delta	8660	38	0	20	8.32	412	--
	ST02-05-02	2014-09-10	Damp	Delta	8660	38	20	38	8.21	312	--
	ST02-06	2014-09-10	Damp	Delta	8660	80	0	20	8.17	155	--
ST03	ST03-02	2014-09-15	Moist	Delta	8300	5	0	5	8.31	383	--
	ST03-03-01	2014-09-09	Damp	Delta	8300	60	0	12	8.51	178	--
	ST03-03-02	2014-09-09	Damp	Delta	8300	60	12	27	8.63	95	--
	ST03-04	2014-09-09	Damp	Delta	8300	20	0	20	8.06	65	--
	ST03-05-02	2014-09-10	Damp	Delta	8300	50	55	70	6.24	119	--
ST04	ST04-02	2014-09-15	Wet	Canyon	7420	1.15	0	10	8.59	107	--
ST05	ST05-02-01	2014-09-15	Wet	Canyon	7270	20	0	20	7.85	113	--
ST06	ST06-02-01	2014-09-15	Damp	Canyon	6980	20	0	10	8.19	604	--
	ST06-03	2014-09-22	Wet	Canyon	6980	--	0	20	8.48	335	--
	ST06-04-01	2014-09-22	Wet	Canyon	6980	15	0	20	9.08	270	--
ST07	ST07-02	2014-09-11	Damp	Canyon	6370	3	0	3	8.38	297	--
	ST07-03-01	2014-09-11	Moist	Canyon	6370	50	0	12	8.04	637	--
	ST07-03-02	2014-09-11	Wet	Canyon	6370	50	15	45	8.05	251	--
ST08	ST08-02-01	2014-09-15	Wet	Middle	5970	35	0	20	9.12	300	--
	ST08-03	2014-09-15	Wet	Middle	5970	--	0	8	8.93	191	--
	ST08-04	2014-09-15	Damp	Middle	5970	5	0	5	8.58	478	--
	ST08-05-01	2014-09-15	Damp	Middle	5970	24	5	20	8.44	175	--
ST09	ST09-02-01	2014-09-15	Very Wet	Middle	5200	20	0	20	8.33	281	--
	ST09-03	2014-09-15	Dry	Middle	5200	12	0	12	8.31	461	--
ST10	ST10-02	2014-09-14	Moist	Middle	4780	12	0	12	8.44	701	--
	ST10-03	2014-09-14	Damp	Middle	4780	10	0	10	8.15	491	--
	ST10-04	2014-09-14	Wet	Middle	4780	--	0	20	9.07	355	--
ST11	ST11-02-01	2014-09-14	Wet	Middle	4350	1.75	0	15	8.88	152	--
	ST11-02-02	2014-09-14	Very Wet	Middle	4350	1.75	20	40	8.94	190	--
ST12	ST12-02	2014-09-14	Very Wet	Upper	3500	20	0	15	9.03	90	--
	ST12-03	2014-09-14	Damp	Upper	3500	14	0	13	8.54	508	--
	ST12-04	2014-09-14	Dry	Upper	3500	5	0	5	8.68	507	--
ST13	ST13-02	2014-09-14	Wet	Upper	3125	70	0	20	9.31	395	--
	ST13-03	2014-09-14	Dry	Upper	3125	15	0	5	8.41	876	--
	ST13-04-01	2014-09-14	Damp	Upper	3125	8	0	8	8.76	326	--
ST14	ST14-02-01	2014-09-14	Moist	Upper	2600	50	0	20	9.06	114	--
	ST14-03	2014-09-14	Moist	Upper	2600	16	0	15	8.42	316	--
	ST14-04	2014-09-14	Moist	Upper	2600	20	0	20	8.84	485	--
ST15	ST15-02-01	2014-09-13	Damp	Upper	1850	30	0	10	8.75	444	--
	ST15-02-02	2014-09-13	Moist	Upper	1850	30	20	30	6.61	23	--
	ST15-03	2014-09-13	Damp	Upper	1850	10	0	10	8.45	640	--
	ST15-04	2014-09-13	Wet	Upper	1850	18	0	10	8.57	385	--

Soil Transect Identification	Sample Identification	Sample Date	Moisture Content (Field)	Sectoin of Hazeltine Creek	Distance from TSF via Hazeltine Creek (m)	Depth to Suspected Native Ground	Sample Depth (		Field Rinse Tests		Duplicate and Replicate Information
							start	end	pH	Cond. (μS/cm)	
ST16	ST16-02	2014-09-13	Very Wet	Polley Lake Plug	1400	--	0	10	8.66	233	--
	ST16-03	2014-09-13	Wet	Polley Lake Plug	1400	10	0	4	8.61	715	--
	ST16-05	2014-09-13	Wet	Polley Lake Plug	1400	>80	35	55	9.21	273	--
	ST16-06	2014-09-13	Wet	Polley Lake Plug	1400	40	0	15	8.07	348	--
ST17	ST17-02	2014-09-12	Wet	Polley Lake Plug	800	25	5	20	7.69	289	--
	ST17-04	2014-09-12	Wet	Polley Lake Plug	800	1.5	0	15	9.13	293	--
	ST17-05	2014-09-12	Damp	Polley Lake Plug	800	22	0	20	8.65	519	--
	ST17-06	2014-09-12	Very Wet	Polley Lake Plug	800	--	0	10	8.58	307	--
	ST17-07	2014-09-12	Very Wet	Polley Lake Plug	800	40	0	20	9.27	252	--
	ST17-08-01	2014-09-12	Moist	Polley Lake Plug	800	60	0	10	8.10	130	--
	ST17-08-02	2014-09-12	Moist	Polley Lake Plug	800	60	15	30	8.16	296	--
ST18	ST18-02-01	2014-09-17	Wet	Polley Lake Plug	1100	80	0	30	9.09	262	--
	ST18-02-03	2014-09-17	Wet	Polley Lake Plug	1100	80	30	60	8.57	265	--
	ST18-03-01	2014-09-13	Wet	Polley Lake Plug	1100	1.55	5	20	9.09	378	--
	ST18-03-02	2014-09-13	Moist	Polley Lake Plug	1100	1.55	50	65	8.98	458	--
	ST18-04	2014-09-13	Wet	Polley Lake Plug	1100	1	25	45	9.44	281	--
	ST18-05-01	2014-09-17	Wet	Polley Lake Plug	1100	90	0	30	8.93	290	--
	ST18-05-03	2014-09-17	Wet	Polley Lake Plug	1100	90	30	60	8.26	303	--

Duplicate Samples

ST01	ST01-02-03	2014-09-22	Wet	Delta	9500	8	--	--	--	--	Duplicate of ST01-02-01
	ST01-09-03	2014-09-22	Wet	Delta	9500	45	0	20	8.5	186	Duplicate of ST01-09-01
ST05	ST05-02-02	2014-09-15	Wet	Canyon	7270	20	0	20	--	--	Duplicate of ST05-02-01
ST07	ST07-03-03	2014-09-11	Moist	Canyon	6370	50	15	45	8.09	561	Duplicate of ST07-03-01
ST09	ST09-02-02	2014-09-15	Very Wet	Middle	5200	20	0	20	--	--	Duplicate of ST09-02-01
ST14	ST14-02-02	2014-09-14	Moist	Upper	2600	50	0	20	--	--	Duplicate of ST14-02-01
ST18	ST18-02-02	2014-09-17	Wet	Polley Lake Plug	1100	80	0	30	--	--	Duplicate of ST18-02-1
	ST18-05-02	2014-09-17	Wet	Polley Lake Plug	1100	90	0	30	--	--	Duplicate of ST18-05-01

Replicate Samples

ST01	ST01-07	2014-09-11	Damp	Delta	9500	60	0	20	8.56	160	Replicate of ST01-06
	ST01-09-04	2014-09-22	--	Delta	9500	45	0	20	--	--	Replicate of ST01-09-01
ST06	ST06-02-02	2014-09-15	Damp	Canyon	6980	20	0	10	--	--	Replicate of ST06-02-01
	ST06-04-02	2014-09-22	--	Canyon	6980	15	0	20	8.85	243	Replicate of ST06-04-1
ST13	ST13-04-02	2014-09-14	--	Upper	3125	--	0	8	--	--	Replicate of ST13-04-01

Field Blank Samples

ST01	ST01-08	2014-09-16	--	--	--	--	--	--	--	--	--
ST10	ST10-05	2014-09-14	--	--	--	--	--	--	--	--	--
ST18	ST18-06	2014-09-16	--	--	--	--	--	--	--	--	--

Appendix C2 – Hazeltine Creek Tailings Samples Duplicate and Blank Data

	Sample Identification	Major Soil Type	Moisture %	pH (1:2 soil:water) -	TIC kg $CaCO_3$/t	ICP S %	AP kg $CaCO_3$/t	NP/AP ratio	Al %	Sb mg/kg	As mg/kg	Ba mg/kg	Be mg/kg	Bi mg/kg	B mg/kg	Cd mg/kg	Ca %	Ce mg/kg	Cs mg/kg	Cr mg/kg	Co mg/kg	Cu mg/kg
	Limit of Detection (LOD)	**--**	-	-	**8**	**0.01**	**0.3**	**--**	**0.01**	**0.05**	**0.1**	**10**	**0.05**	**0.01**	**10**	**0.01**	**0.01**	**0.02**	**0.05**	**1**	**0.1**	**0.2**
Duplicates	ST01-02-01	Grey Tailings	47	7.7	35.9	0.11	3.4	10.4	2.12	0.5	12.7	230	0.71	0.12	10	0.31	2.17	26.5	1.71	27	18.6	495
	ST01-02-03	Duplicate	42	7.7	35.5	0.11	3.4	10.3	2	0.45	12	230	0.59	0.12	10	0.32	2.17	24.2	1.65	26	17.8	485
	RPD (%)		10%	0%	1%	0%	0%	1%	6%	11%	6%	0%	18%	0%	0%	-3%	0%	9%	4%	4%	4%	2%
	ST01-09-01	Grey Tailings	18	8.7	38.3	0.14	4.4	8.8	1.57	0.34	10.5	180	0.6	0.07	10	0.16	2.37	16.65	2.08	11	16.3	908
	ST01-09-03	Duplicate	21	8.8	50.9	0.14	4.4	11.6	1.55	0.33	10.4	170	0.58	0.07	10	0.15	2.35	16.3	2.13	11	16.1	888
	RPD (%)		-13%	-1%	-28%	0%	0%	-28%	1%	3%	1%	6%	3%	0%	0%	6%	1%	2%	-2%	0%	1%	2%
	ST05-02-01	Magnetite/Grey Tailings Mix	19	8.6	25.9	0.1	3.1	8.3	1.38	0.35	9.3	160	0.44	0.07	***10***	0.14	2.03	16.55	1.8	14	13.6	652
	ST05-02-02	Duplicate	28	8.5	23.9	0.1	3.1	7.6	1.3	0.32	8.5	150	0.46	0.06	***10***	0.13	1.8	15.35	1.77	13	12.1	634
	RPD (%)		-39%	0%	8%	0%	0%	8%	6%	9%	9%	6%	-4%	15%	0%	7%	12%	8%	2%	7%	12%	3%
	ST09-02-01	Magnetite Sand	24	8.6	28.7	0.2	6.3	4.6	1.19	0.33	10.2	140	0.38	0.07	10	0.15	2.08	14.3	1.71	11	12.1	1050
	ST09-02-02	Duplicate	18	8.7	26.4	0.19	5.9	4.4	1.19	0.31	10.2	140	0.45	0.07	10	0.19	1.95	13.7	1.94	9	11.6	1120
	RPD (%)		25%	-1%	8%	5%	5%	3%	0%	6%	0%	0%	-17%	0%	0%	-24%	6%	4%	-13%	20%	4%	-6%
	ST14-02-01	Magnetite Sand	10	8.8	19.7	0.14	4.4	4.5	1.35	0.35	10.2	170	0.51	0.07	10	0.14	2.05	14.05	2.13	9	12.9	1105
	ST14-02-02	Duplicate	10	8.9	18.7	0.14	4.4	4.3	1.34	0.34	10.6	170	0.53	0.07	***10***	0.17	2.06	14.05	2.14	9	13.4	1090
	RPD (%)		-3%	-1%	5%	0%	0%	5%	1%	3%	-4%	0%	-4%	0%	0%	-19%	0%	0%	0%	0%	-4%	1%
	ST18-02-01	Grey Tailings/Magneitite Mix	19	7.5	20.9	0.09	2.8	7.4	1.71	0.37	11.4	200	0.6	0.06	10	0.15	2.15	18.25	3.1	11	15.5	954
	ST18-02-02	Duplicate	23	8.9	21.9	0.09	2.8	7.8	1.69	0.34	12.3	180	0.66	0.08	10	0.14	2.11	20.2	3.15	11	17.4	1230
	RPD (%)		-18%	-17%	-5%	0%	0%	-5%	1%	8%	-8%	11%	-10%	-29%	0%	7%	2%	-10%	-2%	0%	-12%	-25%
	ST18-05-01	Grey Tailings	24	8.7	21.6	0.16	5.0	4.3	1.57	0.35	11.1	180	0.57	0.07	10	0.14	2.39	16.7	2.02	10	16.2	899
	ST18-05-02	Duplicate	25	8.7	33.3	0.16	5.0	6.7	1.6	0.36	11.4	180	0.63	0.07	10	0.14	2.41	17	2.03	10	16.6	895
	RPD (%)		-7%	-1%	-43%	0%	0%	-43%	-2%	-3%	-3%	0%	-10%	0%	0%	0%	-1%	-2%	0%	0%	-2%	0%
Field Blanks	ST01-08	Silica Sand	***0.25***	7.8	--	0.04	1.3	--	0.06	0.06	0.6	10	0.08	0.02	***10***	0.03	0.07	5.76	0.1	2	0.4	7.1
	ST10-05	Silica Sand	***0.25***	7.6	--	0.04	1.3	--	0.05	0.06	0.6	***10***	***0.05***	0.02	***10***	0.02	0.06	5.93	0.09	2	0.4	8.3
	ST18-06	Silica Sand	***0.25***	7.7	--	0.05	1.6	--	0.08	0.07	0.7	10	0.07	0.02	***10***	0.03	0.09	6.02	0.1	4	0.5	3.3

red italic text indicates result was below the limit of detection

Note: RPDs > 25% are highlighted red

Note: field blank concentrations greater than 10 x LOD are highlighted orange

	Sample Identification	Major Soil Type	Ga mg/kg	Ge mg/kg	Hf mg/kg	In mg/kg	Fe %	La mg/kg	Pb mg/kg	Li mg/kg	Mg %	Mn mg/kg	Hg mg/kg	Mo mg/kg	Ni mg/kg	Nb mg/kg	P mg/kg	K %	Re mg/kg	Rb mg/kg	Sc mg/kg	Se mg/kg	Ag mg/kg	Na %
	Limit of Detection (LOD)	**--**	**0.05**	**0.05**	**0.02**	**0.005**	**0.01**	**0.2**	**0.2**	**0.1**	**0.01**	**5**	**0.01**	**0.05**	**0.2**	**0.05**	**10**	**0.01**	**0.001**	**0.1**	**0.1**	**0.2**	**0.01**	**0.01**
Duplicates	ST01-02-01	Grey Tailings	8.05	0.13	0.06	0.078	3.8	14.7	8.6	22.5	1.12	844	0.11	3.56	23.6	1.05	1160	0.21	0.018	12.5	7.1	1.9	0.31	0.08
	ST01-02-03	Duplicate	7.52	0.14	0.06	0.074	4	13.7	8.2	20.2	1.1	818	0.11	3.28	21.9	0.94	1230	0.18	0.016	11.1	6.2	1.4	0.3	0.08
	RPD (%)		7%	-7%	0%	5%	-5%	7%	5%	11%	2%	3%	0%	8%	7%	11%	-6%	15%	12%	12%	14%	30%	3%	0%
	ST01-09-01	Grey Tailings	7.73	0.32	0.25	0.089	4.8	9.6	5	14.9	0.98	570	0.08	4.15	9.5	0.15	1310	0.17	0.018	8.2	4.6	1.5	0.35	0.11
	ST01-09-03	Duplicate	7.71	0.33	0.25	0.089	4.73	9.5	4.8	14.6	0.98	562	0.08	3.95	9.2	0.15	1290	0.15	0.017	7.6	4.6	1.5	0.35	0.11
	RPD (%)		0%	-3%	0%	0%	1%	1%	4%	2%	0%	1%	0%	5%	3%	0%	2%	13%	6%	8%	0%	0%	0%	0%
	ST05-02-01	Magnetite/Grey Tailings Mix	6.63	0.23	0.13	0.062	4.24	9.2	5.2	12.9	0.78	510	0.07	3.14	11	0.29	1130	0.15	0.012	8	4.1	1.3	0.29	0.09
	ST05-02-02	Duplicate	5.78	0.21	0.12	0.053	3.79	8.5	4.7	11.4	0.67	475	0.07	3.36	10.3	0.33	1010	0.14	0.013	7.3	3.5	1.1	0.28	0.1
	RPD (%)		14%	9%	8%	16%	11%	8%	10%	12%	15%	7%	0%	-7%	7%	-13%	11%	7%	-8%	9%	16%	17%	4%	-11%
	ST09-02-01	Magnetite Sand	6.44	0.24	0.25	0.056	4.99	8.2	4.7	11	0.69	513	0.11	4.31	6.2	0.12	1140	0.15	0.018	6.7	3.4	1.4	0.4	0.1
	ST09-02-02	Duplicate	6.25	0.25	0.23	0.057	3.99	7.9	4.9	11.4	0.7	487	0.11	5.16	6.3	0.11	1000	0.14	0.019	6.6	3.5	1.4	0.47	0.11
	RPD (%)		3%	-4%	8%	-2%	22%	4%	-4%	-4%	-1%	5%	0%	-18%	-2%	9%	13%	7%	-5%	2%	-3%	0%	-16%	-10%
	ST14-02-01	Magnetite Sand	7.22	0.29	0.26	0.07	4.65	8	4.5	12.1	0.72	467	0.09	5.3	6.5	0.13	1030	0.15	0.017	7.6	3.7	1.4	0.41	0.11
	ST14-02-02	Duplicate	7.29	0.3	0.26	0.072	4.78	8.2	4.6	12.1	0.72	469	0.08	5.83	6.5	0.14	1060	0.15	0.019	7.7	3.7	1.5	0.41	0.11
	RPD (%)		-1%	-3%	0%	-3%	-3%	-2%	-2%	0%	0%	0%	12%	-10%	0%	-7%	-3%	0%	-11%	-1%	0%	-7%	0%	0%
	ST18-02-01	Grey Tailings/Magneitite Mix	8.62	0.37	0.26	0.082	6.39	10.5	4.4	12.8	0.84	499	0.06	5.66	9.8	0.13	1330	0.22	0.023	9	4.5	1.6	0.36	0.2
	ST18-02-02	Duplicate	9.51	0.43	0.24	0.08	7.74	11.4	5.5	12.9	0.89	481	0.07	5.44	11.1	0.11	1470	0.19	0.024	8	4.8	1.5	0.4	0.2
	RPD (%)		-10%	-15%	8%	2%	-19%	-8%	-22%	-1%	-6%	4%	-15%	4%	-12%	17%	-10%	15%	-4%	12%	-6%	6%	-11%	0%
	ST18-05-01	Grey Tailings	7.98	0.33	0.3	0.093	4.86	9.6	4.8	14.6	0.98	568	0.08	4.21	8	0.13	1300	0.18	0.021	8.7	4.6	1.6	0.38	0.12
	ST18-05-02	Duplicate	8.11	0.32	0.29	0.093	4.81	9.8	4.8	15	0.99	577	0.09	4.62	8.4	0.13	1290	0.19	0.018	9	4.8	1.7	0.38	0.12
	RPD (%)		-2%	3%	3%	0%	1%	-2%	0%	-3%	-1%	-2%	-12%	-9%	-5%	0%	1%	-5%	15%	-3%	-4%	-6%	0%	0%
Field Blanks	ST01-08	Silica Sand	0.21	*0.05*	0.08	0.008	0.29	3	2.2	0.4	0.03	30	*0.01*	0.34	1.2	*0.05*	20	0.04	*0.001*	1.4	0.1	*0.2*	0.06	*0.01*
	ST10-05	Silica Sand	0.18	*0.05*	0.07	0.005	0.25	3	2	0.4	0.03	25	0.01	0.36	1.2	*0.05*	20	0.03	*0.001*	1	0.1	*0.2*	0.05	*0.01*
	ST18-06	Silica Sand	0.27	*0.05*	0.1	*0.005*	0.59	3.1	2.6	0.4	0.03	57	0.01	0.5	2.2	*0.05*	10	0.06	*0.001*	2	0.1	*0.2*	0.33	*0.01*

red italic text indicates result was below the limit of detection

Note: RPDs > 25% are highlighted red

Note: field blank concentrations greater than 10 x LOD are highlighted orange

	Sample Identification	Major Soil Type	Sr mg/kg	Ta mg/kg	Te mg/kg	Tl mg/kg	Th mg/kg	Sn mg/kg	Ti %	W mg/kg	U mg/kg	V mg/kg	Y mg/kg	Zn mg/kg	Zr mg/kg
	Limit of Detection (LOD)	**--**	**0.2**	**0.01**	**0.01**	**0.02**	**0.2**	**0.2**	**0.005**	**0.05**	**0.05**	**1**	**0.05**	**2**	**0.5**
Duplicates	ST01-02-01	Grey Tailings	175.5	***0.01***	0.08	0.07	1.9	1.1	0.116	0.44	1.42	111	13.3	78	2.1
	ST01-02-03	Duplicate	173.5	***0.01***	0.06	0.07	1.9	0.9	0.113	0.43	1.35	119	12.4	77	1.9
	RPD (%)		1%	0%	29%	0%	0%	20%	3%	2%	5%	-7%	7%	1%	10%
	ST01-09-01	Grey Tailings	173	***0.01***	0.06	0.02	1	1.3	0.141	0.48	0.9	174	10.75	56	8
	ST01-09-03	Duplicate	172.5	***0.01***	0.07	0.02	1	1.3	0.138	0.49	0.89	173	10.65	58	7.9
	RPD (%)		0%	0%	-15%	0%	0%	0%	2%	-2%	1%	1%	1%	-4%	1%
	ST05-02-01	Magnetite/Grey Tailings Mix	150.5	***0.01***	0.05	0.03	1.5	1	0.121	0.43	0.8	150	9.77	49	5.6
	ST05-02-02	Duplicate	152	***0.01***	0.05	0.03	1.3	0.9	0.108	0.36	0.7	130	8.6	45	5
	RPD (%)		-1%	0%	0%	0%	14%	11%	11%	18%	13%	14%	13%	9%	11%
	ST09-02-01	Magnetite Sand	99.9	***0.01***	0.05	0.02	0.9	0.9	0.12	0.44	0.77	192	9.14	52	7.2
	ST09-02-02	Duplicate	109	***0.01***	0.05	0.02	0.8	0.9	0.107	0.42	0.68	151	8.74	50	7
	RPD (%)		-9%	0%	0%	0%	12%	0%	11%	5%	12%	24%	4%	4%	3%
	ST14-02-01	Magnetite Sand	149.5	***0.01***	0.06	***0.02***	0.8	1.2	0.131	0.51	0.77	175	9.31	47	7.2
	ST14-02-02	Duplicate	148.5	***0.01***	0.05	0.02	0.8	1.2	0.131	0.53	0.76	181	9.44	48	7.4
	RPD (%)		1%	0%	18%	0%	0%	0%	0%	-4%	1%	-3%	-1%	-2%	-3%
	ST18-02-01	Grey Tailings/Magneitite Mix	186.5	***0.01***	0.07	0.02	1	1.7	0.167	0.71	1.16	224	12.7	44	7.8
	ST18-02-02	Duplicate	163.5	***0.01***	0.07	0.02	1	1.6	0.164	0.65	1.19	292	13.6	46	7
	RPD (%)		13%	0%	0%	0%	0%	6%	2%	9%	-3%	-26%	-7%	-4%	11%
	ST18-05-01	Grey Tailings	171.5	***0.01***	0.07	0.02	0.9	1.4	0.148	0.48	0.92	182	11.15	55	8.8
	ST18-05-02	Duplicate	177	***0.01***	0.07	0.02	0.9	1.4	0.148	0.53	0.92	179	11.5	56	9.1
	RPD (%)		-3%	0%	0%	0%	0%	0%	0%	-10%	0%	2%	-3%	-2%	-3%
Field Blanks	ST01-08	Silica Sand	7	***0.01***	0.01	0.02	1.4	***0.2***	***0.005***	***0.05***	0.3	1	0.73	11	2.4
	ST10-05	Silica Sand	5.8	***0.01***	***0.01***	0.02	1.4	***0.2***	***0.005***	***0.05***	0.24	1	0.62	11	1.7
	ST18-06	Silica Sand	6.5	***0.01***	0.01	0.03	1.3	***0.2***	***0.005***	0.05	0.31	1	0.77	10	2.6

red italic text indicates result was below the limit of detection

Note: RPDs > 25% are highlighted red

Note: field blank concentrations greater than 10 x LOD are highlighted orange

Appendix C3 – Hazeltine Creek Tailings Samples Replicates Data

	Sample Identification	Major Soil Type	Moisture	pH (1:2 soil:water)	TIC	ICP S	AP	NP/AP	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Ce	Cs	Cr
			%	-	kg $CaCO_3$/t	%	kg $CaCO_3$/t	ratio	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg
	Limit of Detection	**--**	**-**	**-**	**8**	**0.01**	**0.3**	**--**	**0.01**	**0.05**	**0.1**	**10**	**0.05**	**0.01**	**10**	**0.01**	**0.01**	**0.02**	**0.05**	**1**
Replicates	ST01-06	Grey Tailings	25	8.1	19.7	0.11	3.4	5.7	1.26	0.34	8.8	150	0.45	0.06	10	0.16	1.79	15.85	1.68	15
	ST01-07	Replicate	12	8.2	19.8	0.11	3.4	5.8	1.24	0.34	9.1	140	0.41	0.06	10	0.14	1.76	15.4	1.69	15
	RPD (%)		70%	-1%	-1%	0%	0%	-1%	2%	0%	-3%	7%	9%	0%	0%	13%	2%	3%	-1%	0%
	ST01-09-01	Grey Tailings	18	8.7	38.3	0.14	4.4	8.8	1.57	0.34	10.5	180	0.6	0.07	10	0.16	2.37	16.65	2.08	11
	ST01-09-04	Replicate	20	8.7	33.1	0.14	4.4	7.6	1.53	0.3	10.6	170	0.56	0.07	10	0.12	2.33	16	2.11	10
	RPD (%)		-9%	0%	15%	0%	0%	15%	3%	13%	-1%	6%	7%	0%	0%	29%	2%	4%	-1%	10%
	ST06-02-01	Grey Tailings	15	8.5	27.3	0.14	4.4	6.2	1.52	0.34	10.9	190	0.59	0.06	10	0.13	2.37	16.05	2.1	9
	ST06-02-02	Replicate	11	8.4	27.5	0.14	4.4	6.3	1.56	0.34	11.2	200	0.55	0.07	10	0.12	2.41	16.55	2.14	10
	RPD (%)		27%	1%	-1%	0%	0%	-1%	-3%	0%	-3%	-5%	7%	-15%	0%	8%	-2%	-3%	-2%	-11%
	ST06-04-01	Grey Tailings	19	8.6	38.2	0.09	2.8	13.6	1.18	0.26	8.9	140	0.43	0.05	***10***	0.23	2.28	13.85	1.38	17
	ST06-04-02	Replicate	19	8.6	40	0.14	4.4	9.1	1.68	0.34	11.2	190	0.63	0.1	10	0.12	2.51	16.5	2.21	9
	RPD (%)		2%	0%	-5%	-43%	-43%	39%	-35%	-27%	-23%	-30%	-38%	-67%	0%	63%	-10%	-17%	-46%	62%
	ST13-04-01	Grey Tailings	10	8.5	28.2	0.16	5.0	5.6	1.64	0.37	12.2	200	0.61	0.07	10	0.13	2.53	17.6	2.21	10
	ST13-04-02	Replicate	12	8.6	28.8	0.16	5.0	5.8	1.69	0.39	12.5	200	0.7	0.07	10	0.16	2.6	18.05	2.29	10
	RPD (%)		-14%	-1%	-2%	0%	0%	-2%	-3%	-5%	-2%	0%	-14%	0%	0%	-21%	-3%	-3%	-4%	0%

red italic text indicates result was below the limit of detection

Note: RPDs > 25% are highlighted red

	Sample Identification	Major Soil Type	Co	Cu	Ga	Ge	Hf	In	Fe	La	Pb	Li	Mg	Mn	Hg	Mo	Ni	Nb	P	K	Re	Rb
			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg
	Limit of Detection	**--**	**0.1**	**0.2**	**0.05**	**0.05**	**0.02**	**0.005**	**0.01**	**0.2**	**0.2**	**0.1**	**0.01**	**5**	**0.01**	**0.05**	**0.2**	**0.05**	**10**	**0.01**	**0.001**	**0.1**
Replicates	ST01-06	Grey Tailings	11.8	574	5.82	0.19	0.12	0.049	4.15	8.9	4.7	10.9	0.63	517	0.08	3.29	10.3	0.33	980	0.15	0.014	7.2
	ST01-07	Replicate	11.6	608	5.72	0.18	0.15	0.051	3.87	8.5	4.9	10.8	0.62	494	0.08	3.6	10.3	0.27	940	0.14	0.016	7
	RPD (%)		2%	-6%	2%	5%	-22%	-4%	7%	5%	-4%	1%	2%	5%	0%	-9%	0%	20%	4%	7%	-13%	3%
	ST01-09-01	Grey Tailings	16.3	908	7.73	0.32	0.25	0.089	4.8	9.6	5	14.9	0.98	570	0.08	4.15	9.5	0.15	1310	0.17	0.018	8.2
	ST01-09-04	Replicate	16	854	7.66	0.32	0.24	0.088	4.67	9.3	5.1	14.5	0.98	547	0.09	4.19	9	0.14	1300	0.14	0.018	7.6
	RPD (%)		2%	6%	1%	0%	4%	1%	3%	3%	-2%	3%	0%	4%	-12%	-1%	5%	7%	1%	19%	0%	8%
	ST06-02-01	Grey Tailings	16.3	914	8.14	0.31	0.27	0.091	5.17	9.5	4.7	14.4	0.96	545	0.08	4.3	7.4	0.1	1340	0.16	0.018	8.1
	ST06-02-02	Replicate	16.6	928	8.25	0.33	0.3	0.1	5.28	9.6	5.1	15.1	0.96	565	0.07	4.79	7.5	0.11	1330	0.17	0.023	8.6
	RPD (%)		-2%	-2%	-1%	-6%	-11%	-9%	-2%	-1%	-8%	-5%	0%	-4%	13%	-11%	-1%	-10%	1%	-6%	-24%	-6%
	ST06-04-01	Grey Tailings	14.9	553	5.76	0.23	0.25	0.068	3.99	8.1	4.4	12.2	0.99	573	0.14	2.73	14.9	0.1	1100	0.12	0.011	6.5
	ST06-04-02	Replicate	17.5	931	8.54	0.32	0.29	0.1	4.85	9.7	5.7	16.5	1.1	603	0.08	4.4	8.3	0.09	1370	0.17	0.022	8.4
	RPD (%)		-16%	-51%	-39%	-33%	-15%	-38%	-19%	-18%	-26%	-30%	-11%	-5%	55%	-47%	57%	11%	-22%	-34%	-67%	-26%
	ST13-04-01	Grey Tailings	17.1	952	8.81	0.31	0.33	0.096	5.32	10.4	5.8	17	1.03	613	0.09	5	8.1	0.09	1390	0.18	0.019	9
	ST13-04-02	Replicate	17.5	986	9.02	0.33	0.37	0.106	5.34	10.6	5.9	17.5	1.04	630	0.09	4.89	7.9	0.1	1410	0.18	0.019	9.1
	RPD (%)		-2%	-4%	-2%	-6%	-11%	-10%	0%	-2%	-2%	-3%	-1%	-3%	0%	2%	2%	-11%	-1%	0%	0%	-1%

red italic text indicates result was below the limit of detection

Note: RPDs > 25% are highlighted red

	Sample Identification	Major Soil Type	Sc	Se	Ag	Na	Sr	Ta	Te	Tl	Th	Sn	Ti	W	U	V	Y	Zn	Zr
			mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
	Limit of Detection	**--**	**0.1**	**0.2**	**0.01**	**0.01**	**0.2**	**0.01**	**0.01**	**0.02**	**0.2**	**0.2**	**0.005**	**0.05**	**0.05**	**1**	**0.05**	**2**	**0.5**
Replicates	ST01-06	Grey Tailings	3.7	1.1	0.26	0.1	142.5	0.01	0.05	0.04	1.4	0.9	0.118	0.39	0.74	147	8.85	43	5
	ST01-07	Replicate	3.7	0.9	0.25	0.1	139.5	0.01	0.03	0.03	1.5	0.9	0.117	0.38	0.73	138	8.72	43	5.8
	RPD (%)		0%	20%	4%	0%	2%	0%	50%	29%	-7%	0%	1%	3%	1%	6%	1%	0%	-15%
	ST01-09-01	Grey Tailings	4.6	1.5	0.35	0.11	173	*0.01*	0.06	0.02	1	1.3	0.141	0.48	0.9	174	10.75	56	8
	ST01-09-04	Replicate	4.5	1.8	0.33	0.11	171.5	*0.01*	0.07	0.02	1	1.2	0.131	0.47	0.86	170	10.45	56	7.4
	RPD (%)		2%	-18%	6%	0%	1%	0%	-15%	0%	0%	8%	7%	2%	5%	2%	3%	0%	8%
	ST06-02-01	Grey Tailings	4.6	1.6	0.32	0.11	156.5	*0.01*	0.07	0.02	0.8	1.3	0.14	0.54	0.9	187	10.9	55	8
	ST06-02-02	Replicate	4.7	1.5	0.34	0.12	161.5	*0.01*	0.07	0.02	0.9	1.5	0.151	0.56	0.96	194	11.35	57	8.9
	RPD (%)		-2%	6%	-6%	-9%	-3%	0%	0%	0%	-12%	-14%	-8%	-4%	-6%	-4%	-4%	-4%	-11%
	ST06-04-01	Grey Tailings	6.4	1.3	0.22	0.07	148.5	*0.01*	0.05	0.02	1	0.9	0.107	0.36	0.65	135	10.2	58	7.2
	ST06-04-02	Replicate	5.1	1.6	0.35	0.12	168	*0.01*	0.06	0.02	0.9	1.4	0.146	0.55	0.95	178	11.35	62	8.9
	RPD (%)		23%	-21%	-46%	-53%	-12%	0%	-18%	0%	11%	-43%	-31%	-42%	-38%	-27%	-11%	-7%	-21%
	ST13-04-01	Grey Tailings	5.1	1.4	0.37	0.12	166.5	*0.01*	0.06	0.02	0.9	1.5	0.154	0.62	0.95	196	12	61	9.6
	ST13-04-02	Replicate	5.2	1.7	0.39	0.12	172.5	*0.01*	0.07	0.02	0.9	1.6	0.166	0.67	1.03	199	12.35	63	10
	RPD (%)		-2%	-19%	-5%	0%	-4%	0%	-15%	0%	0%	-6%	-8%	-8%	-8%	-2%	-3%	-3%	-4%

red italic text indicates result was below the limit of detection

Note: RPDs > 25% are highlighted red

Appendix C4 – Hazeltine Creek Tailings Samples Physical Data

					Abundances									Percent Passing								
Sample Identification	Major Soil Type	Moisture	pH (1:2 soil:water)	Texture	% Gravel (>2mm)	% Sand (2.00mm - 1.00mm)	% Sand (1.00mm - 0.50mm)	% Sand (0.50mm - 0.25mm)	% Sand (0.25mm - 0.125mm)	% Sand (0.125mm - 0.063mm)	% Silt (0.063mm - 0.0312mm)	% Silt (0.0312mm - 0.004mm)	% Clay (<4um)	% Gravel (>2mm)	% Sand (2.00mm - 1.00mm)	% Sand (1.00mm - 0.50mm)	% Sand (0.50mm - 0.25mm)	% Sand (0.25mm - 0.125mm)	% Sand (0.125mm - 0.063mm)	% Silt (0.063mm - 0.0312mm)	% Silt (0.0312mm - 0.004mm)	% Clay (<4um)
ST01-02-01	Grey Tailings	46.5	7.66	Silt loam	<0.10	<0.10	<0.10	<0.10	<0.10	1.09	27.8	52.2	18.7	99.79	99.79	99.79	99.79	99.79	99.79	98.7	70.9	18.7
ST01-03	Magnetite Sand	16.4	8.57	-	-	-	-	-	-	-	-	-	-									
ST01-04	Grey Tailings	16	8.28	-	-	-	-	-	-	-	-	-	-									
ST01-05-01	Grey Tailings	15.1	8.72	Sandy loam	8.19	2.32	1.46	5.37	18.9	18.9	16.4	21.3	7.28	100	91.93	89.61	88.15	82.78	63.88	44.98	28.58	7.28
ST01-05-02	Grey Tailings	13.4	7.99	-	-	-	-	-	-	-	-	-	-									
ST01-06	Grey Tailings	24.9	8.1	-	-	-	-	-	-	-	-	-	-									
ST01-09-01	Grey Tailings	18.3	8.72	Sandy loam	0.49	0.85	1.07	5.28	18.9	19.3	18.6	26.2	9.3	99.99	99.5	98.65	97.58	92.3	73.4	54.1	35.5	9.3
ST01-09-02	Grey Tailings	26.5	7.9	-	-	-	-	-	-	-	-	-	-									
ST02-02-01	Grey Tailings	24.8	8.07	-	-	-	-	-	-	-	-	-	-									
ST02-03	Grey Tailings	6.12	8.45	-	-	-	-	-	-	-	-	-	-									
ST02-05-01	Magnetite Sand	16.8	8.24	-	-	-	-	-	-	-	-	-	-									
ST02-05-02	Magnetite Sand	6.77	8.23	-	-	-	-	-	-	-	-	-	-									
ST02-06	Magnetite Sand	8.88	8.31	-	-	-	-	-	-	-	-	-	-									
ST03-02	Grey Tailings	15.6	8.59	Sandy loam	5.08	0.78	0.66	4.11	19.5	19.1	18.6	23.8	8.43	100.06	94.98	94.2	93.54	89.43	69.93	50.83	32.23	8.43
ST03-03-01	Magnetite Sand	18	8.44	-	-	-	-	-	-	-	-	-	-									
ST03-03-02	Magnetite Sand	8.38	8.58	Sand	<0.10	<0.10	0.31	37.8	42.9	11.6	4.59	2.19	0.47	99.86	99.86	99.86	99.55	61.75	18.85	7.25	2.66	0.47
ST03-04	Grey Tailings	15.5	8.24	-	-	-	-	-	-	-	-	-	-									
ST03-05-02	Grey Tailings	14.2	6.41	-	-	-	-	-	-	-	-	-	-									
ST04-02	Magnetite Sand	19	9.09	Loamy sand	<0.10	<0.10	<0.10	17.7	46	17.4	9.64	7.49	1.77	100	100	100	100	82.3	36.3	18.9	9.26	1.77
ST05-02-01	Magnetite/Grey Tailings Mix	19.2	8.56	-	-	-	-	-	-	-	-	-	-									
ST06-02-01	Grey Tailings	14.5	8.5	Sandy loam	1.61	0.18	0.35	3.98	23.3	17.4	19.3	25.4	8.46	99.98	98.37	98.19	97.84	93.86	70.56	53.16	33.86	8.46
ST06-03	Grey Tailings	20.8	8.51	-	-	-	-	-	-	-	-	-	-									
ST06-04-01	Grey Tailings	19.4	8.59	-	-	-	-	-	-	-	-	-	-									
ST07-02	Grey Tailings/Magneitite Mix	15.5	8.31	-	-	-	-	-	-	-	-	-	-									
ST07-03-01	Grey Tailings	-	-	-	-	-	-	-	-	-	-	-	-									
ST07-03-02	Grey Tailings	-	-	-	-	-	-	-	-	-	-	-	-									
ST08-02-01	Grey Tailings	20.5	8.49	Silt loam	0.58	0.4	0.37	1.83	8.97	11.2	17.2	39	20.4	99.95	99.37	98.97	98.6	96.77	87.8	76.6	59.4	20.4
ST08-03	Magnetite Sand	24.3	8.77	-	-	-	-	-	-	-	-	-	-									
ST08-04	Grey Tailings	12.1	8.52	-	-	-	-	-	-	-	-	-	-									
ST08-05-01	Magnetite Sand	-	-	-	-	-	-	-	-	-	-	-	-									
ST09-02-01	Magnetite Sand	23.6	8.58	-	-	-	-	-	-	-	-	-	-									
ST09-03	Grey Tailings	12.5	8.42	-	-	-	-	-	-	-	-	-	-									
ST10-02	Grey Tailings	13.6	8.42	Silt loam	0.11	<0.10	0.12	2.64	15.2	17.8	21	31.1	11.9	99.87	99.76	99.76	99.64	97	81.8	64	43	11.9
ST10-03	Grey Tailings	17.9	8.34	-	-	-	-	-	-	-	-	-	-									
ST10-04	Grey Tailings	17.2	8.54	-	-	-	-	-	-	-	-	-	-									
ST11-02-01	Magnetite Sand	17.4	8.81	Sand	<0.10	<0.10	0.55	33.4	37.6	12.8	7.79	6.47	1.37	99.98	99.98	99.98	99.43	66.03	28.43	15.63	7.84	1.37
ST11-02-02	Magnetite Sand	17.9	8.73	-	-	-	-	-	-	-	-	-	-									
ST12-02	Magnetite Sand	23.2	8.99	-	-	-	-	-	-	-	-	-	-									
ST12-03	Grey Tailings	13.7	8.42	Sandy loam	0.1	<0.10	0.13	3.97	20.2	21.5	20.9	25.5	7.68	99.98	99.88	99.88	99.75	95.78	75.58	54.08	33.18	7.68
ST12-04	Grey Tailings	4.2	8.51	-	-	-	-	-	-	-	-	-	-									
ST13-02	Grey Tailings	24.5	8.6	Silt loam	<0.10	<0.10	0.14	2.01	10.5	12.9	18.5	37.3	18.6	99.95	99.95	99.95	99.81	97.8	87.3	74.4	55.9	18.6
ST13-03	Grey Tailings	6.59	8.3	-	-	-	-	-	-	-	-	-	-									
ST13-04-01	Grey Tailings	10.3	8.5	-	-	-	-	-	-	-	-	-	-									
ST14-02-01	Magnetite Sand	9.72	8.8	Sand	<0.10	<0.10	<0.10	36	38.5	10	7.16	6.44	1.83	99.93	99.93	99.93	99.93	63.93	25.43	15.43	8.27	1.83
ST14-03	Grey Tailings/Magneitite Mix	20.7	8.82	-	-	-	-	-	-	-	-	-	-									
ST14-04	Grey Tailings	18.8	8.42	-	-	-	-	-	-	-	-	-	-									
ST15-02-01	Grey Tailings	-	-	-	-	-	-	-	-	-	-	-	-									
ST15-02-02	Grey Tailings	-	-	-	-	-	-	-	-	-	-	-	-									
ST15-03	Grey Tailings	-	-	-	-	-	-	-	-	-	-	-	-									
ST15-04	Grey Tailings	-	-	-	-	-	-	-	-	-	-	-	-									
ST16-02	Magnetite Sand	21.4	8.9	-	-	-	-	-	-	-	-	-	-									
ST16-03	Magnetite Sand	20.2	8.4	-	-	-	-	-	-	-	-	-	-									
ST16-05	Magnetite Sand	18.7	8.54	-	-	-	-	-	-	-	-	-	-									
ST16-06	Grey Tailings/Magneitite Mix	17.5	8.35	Sand / Loamy sand	<0.10	<0.10	<0.10	2.91	47.8	29	11.9	7.15	1.23	99.99	99.99	99.99	99.99	97.08	49.28	20.28	8.38	1.23
ST17-02	Grey Tailings	49	8.42	Loamy sand	<0.10	<0.10	0.1	1.63	34.9	33.9	16.6	11.2	1.59	99.92	99.92	99.92	99.82	98.19	63.29	29.39	12.79	1.59
ST17-04	Grey Tailings	16.6	8.88	-	-	-	-	-	-	-	-	-	-									
ST17-05	Grey Tailings	11.1	8.3	-	-	-	-	-	-	-	-	-	-									
ST17-06	Grey Tailings	17.4	8.46	-	-	-	-	-	-	-	-	-	-									
ST17-07	Grey Tailings	18.4	8.76	-	-	-	-	-	-	-	-	-	-									
ST17-08-01	Grey Tailings	9.65	8.66	-	-	-	-	-	-	-	-	-	-									
ST17-08-02	Magnetite Sand	16.2	8.61	-	-	-	-	-	-	-	-	-	-									
ST18-02-01	Grey Tailings/Magneitite Mix	19.2	7.51	-	-	-	-	-	-	-	-	-	-									
ST18-02-03	Magnetite Sand	17.5	8.8	-	-	-	-	-	-	-	-	-	-									
ST18-03-01	Grey Tailings/Magneitite Mix	19.2	8.88	Sandy loam	<0.10	<0.10	0.12	3.65	19.5	23.8	21.5	25.3	6.12	99.99	99.99	99.99	99.87	96.22	76.72	52.92	31.42	6.12
ST18-03-02	Grey Tailings/Magneitite Mix	21.7	8.5	-	-	-	-	-	-	-	-	-	-									
ST18-04	Grey Tailings/Magneitite Mix	20.6	8.85	-	-	-	-	-	-	-	-	-	-									
ST18-05-01	Grey Tailings	23.5	8.66	-	-	-	-	-	-	-	-	-	-									
ST18-05-03	Magnetite Sand	24.7	8.54	Loam	0.2	0.2	0.57	4.93	19.2	18.4	17.8	27.3	11.3	99.9	99.7	99.5	98.93	94	74.8	56.4	38.6	11.3

Appendix C5 – Hazeltine Creek Tailings Samples ABA Data

Sample Identification	Kinetic Test Identification	Major Soil Type	Phase 1 Results				
			Total Carbon by Combustion	Total Inorganic Carbon (TIC)	Sulphur (ICP-MS)	AP	NP/AP
			%	kg $CaCO_3$/t	%	kg $CaCO_3$/t	ratio
ST01-02-01		Grey Tailings	0.5	35.9	0.11	3.4	10.4
ST01-03		Magnetite Sand	-	14.6	0.17	5.3	2.7
ST01-04		Grey Tailings	-	25.6	0.14	4.4	5.9
ST01-05-01		Grey Tailings	0.5	25.6	0.13	4.1	6.3
ST01-05-02	HC-4	Grey Tailings	-	13.8	0.09	2.8	4.9
ST01-06		Grey Tailings	-	19.7	0.11	3.4	5.7
ST01-09-01		Grey Tailings	0.6	38.3	0.14	4.4	8.8
ST01-09-02		Grey Tailings	-	31.8	0.10	3.1	10.2
ST02-02-01		Grey Tailings	0.7	17.4	0.12	3.8	4.6
ST02-03		Grey Tailings	-	8.7	0.09	2.8	3.1
ST02-05-01		Magnetite Sand	-	24.1	0.13	4.1	5.9
ST02-05-02	HC-5	Magnetite Sand	-	14.5	0.13	4.1	3.6
ST02-06		Magnetite Sand	-	18.9	0.11	3.4	5.5
ST03-02		Grey Tailings	0.4	26.7	0.14	4.4	6.1
ST03-03-01		Magnetite Sand	-	30.9	0.18	5.6	5.5
ST03-03-02		Magnetite Sand	0.5	28.9	0.21	6.6	4.4
ST03-04		Grey Tailings	-	26.1	0.17	5.3	4.9
ST03-05-02		Grey Tailings	-	36.9	0.02	0.6	59.0
ST04-02		Magnetite Sand	0.4	30.7	0.20	6.3	4.9
ST05-02-01		Magnetite/Grey Tailings Mix	0.7	25.9	0.10	3.1	8.3
ST06-02-01		Grey Tailings	0.4	27.3	0.14	4.4	6.2
ST06-03		Grey Tailings	-	33.7	0.11	3.4	9.8
ST06-04-01		Grey Tailings	-	38.2	0.09	2.8	13.6
ST07-02		Grey Tailings/Magneitite Mix	0.5	33.4	0.15	4.7	7.1
ST07-03-01		Grey Tailings	-	29.1	0.15	4.7	6.2
ST07-03-02		Grey Tailings	0.5	34.3	0.30	9.4	3.7
ST08-02-01		Grey Tailings	0.5	38.9	0.15	4.7	8.3
ST08-03		Magnetite Sand	-	27.6	0.28	8.8	3.2
ST08-04		Grey Tailings	-	26.6	0.12	3.8	7.1
ST08-05-01		Magnetite Sand	-	14.1	0.07	2.2	6.4
ST09-02-01		Magnetite Sand	-	28.7	0.20	6.3	4.6
ST09-03		Grey Tailings	-	27.2	0.13	4.1	6.7
ST10-02		Grey Tailings	0.4	25.8	0.14	4.4	5.9
ST10-03		Grey Tailings	-	29.7	0.14	4.4	6.8
ST10-04		Grey Tailings	-	28.9	0.16	5.0	5.8
ST11-02-01		Magnetite Sand	0.3	24.8	0.24	7.5	3.3
ST11-02-02		Magnetite Sand	-	24.1	0.25	7.8	3.1
ST12-02		Magnetite Sand	-	25.8	0.24	7.5	3.4
ST12-03		Grey Tailings	0.3	25.5	0.14	4.4	5.8
ST12-04		Grey Tailings	-	25.6	0.12	3.8	6.8
ST13-02		Grey Tailings	0.5	36.7	0.16	5.0	7.3
ST13-03		Grey Tailings	-	26.5	0.15	4.7	5.7
ST13-04-01		Grey Tailings	-	28.2	0.16	5.0	5.6
ST14-02-01		Magnetite Sand	0.3	19.7	0.14	4.4	4.5
ST14-03		Grey Tailings/Magneitite Mix	-	28.1	0.25	7.8	3.6
ST14-04		Grey Tailings	-	23.1	0.11	3.4	6.7
ST15-02-01		Grey Tailings	-	32.3	0.14	4.4	7.4
ST15-02-02		Grey Tailings	-	<8	0.01	0.3	-
ST15-03		Grey Tailings	-	33.2	0.15	4.7	7.1
ST15-04		Grey Tailings	-	27.4	0.14	4.4	6.3
ST16-02		Magnetite Sand	-	23.0	0.15	4.7	4.9
ST16-03		Magnetite Sand	-	26.7	0.20	6.3	4.3
ST16-05		Magnetite Sand	-	40.0	0.16	5.0	8.0
ST16-06		Grey Tailings/Magneitite Mix	0.4	27.2	0.14	4.4	6.2
ST17-02		Grey Tailings	0.6	38.4	0.13	4.1	9.5
ST17-04		Grey Tailings	-	26.3	0.12	3.8	7.0
ST17-05		Grey Tailings	-	24.0	0.14	4.4	5.5
ST17-06		Grey Tailings	-	25.1	0.22	6.9	3.7
ST17-07		Grey Tailings	-	34.3	0.15	4.7	7.3
ST17-08-01	HC-6	Grey Tailings	-	32.0	0.23	7.2	4.5
ST17-08-02		Magnetite Sand	-	22.6	0.19	5.9	3.8
ST18-02-01		Grey Tailings/Magneitite Mix	-	20.9	0.09	2.8	7.4
ST18-02-03		Magnetite Sand	-	18.1	0.09	2.8	6.4
ST18-03-01		Grey Tailings/Magneitite Mix	0.4	28.2	0.13	4.1	6.9
ST18-03-02		Grey Tailings/Magneitite Mix	-	37.8	0.18	5.6	6.7
ST18-04		Grey Tailings/Magneitite Mix	-	18.7	0.12	3.8	5.0
ST18-05-01		Grey Tailings	-	21.6	0.16	5.0	4.3
ST18-05-03		Magnetite Sand	0.5	33.3	0.15	4.7	7.1
L1519001-38 COMP (22-24)	HC-1 / COL-1	Magnetite Sand	-	-	-	-	-
L1519001-39 COMP (22-24) DUP	Duplicate	Magnetite Sand	-	-	-	-	-
L1518225-74 COMP (41+58)	HC-2 / COL-2	Magnetite Sand	-	-	-	-	-
L1519001-40 COMP (7+29)	HC-3 / HC-3D / COL-3	Grey Tailings	-	-	-	-	-

Sample Identification	Kinetic Test Identification	Major Soil Type	Phase 2 Results							
			pH	Conductivity	Fizz Rating	NP	AP	NP/AP	Total S	Sulphate S
			-	uS/cm	-	kg $CaCO_3$/t	kg $CaCO_3$/t	-	%	%
ST01-02-01		Grey Tailings	-	-	-	-	-	-	-	-
ST01-03		Magnetite Sand	-	-	-	-	-	-	-	-
ST01-04		Grey Tailings	-	-	-	-	-	-	-	-
ST01-05-01		Grey Tailings	-	-	-	-	-	-	-	-
ST01-05-02	HC-4	Grey Tailings	7.1	587	1	25	5.3	4.71	0.17	<0.01
ST01-06		Grey Tailings	-	-	-	-	-	-	-	-
ST01-09-01		Grey Tailings	-	-	-	-	-	-	-	-
ST01-09-02		Grey Tailings	-	-	-	-	-	-	-	-
ST02-02-01		Grey Tailings	7.3	265	1	23	4.1	5.66	0.13	<0.01
ST02-03		Grey Tailings	-	-	-	-	-	-	-	-
ST02-05-01		Magnetite Sand	-	-	-	-	-	-	-	-
ST02-05-02	HC-5	Magnetite Sand	7.5	922	2	29	5.6	5.16	0.18	<0.01
ST02-06		Magnetite Sand	-	-	-	-	-	-	-	-
ST03-02		Grey Tailings	-	-	-	-	-	-	-	-
ST03-03-01		Magnetite Sand	-	-	-	-	-	-	-	-
ST03-03-02		Magnetite Sand	-	-	-	-	-	-	-	-
ST03-04		Grey Tailings	7.7	839	2	37	5	7.4	0.16	0.03
ST03-05-02		Grey Tailings	-	-	-	-	-	-	-	-
ST04-02		Magnetite Sand	-	-	-	-	-	-	-	-
ST05-02-01		Magnetite/Grey Tailings Mix	7.6	338	2	34	3.4	9.89	0.11	<0.01
ST06-02-01		Grey Tailings	-	-	-	-	-	-	-	-
ST06-03		Grey Tailings	-	-	-	-	-	-	-	-
ST06-04-01		Grey Tailings	-	-	-	-	-	-	-	-
ST07-02		Grey Tailings/Magneitite Mix	-	-	-	-	-	-	-	-
ST07-03-01		Grey Tailings	-	-	-	-	-	-	-	-
ST07-03-02		Grey Tailings	-	-	-	-	-	-	-	-
ST08-02-01		Grey Tailings	-	-	-	-	-	-	-	-
ST08-03		Magnetite Sand	7.7	514	1	33	6.9	4.8	0.22	<0.01
ST08-04		Grey Tailings	-	-	-	-	-	-	-	-
ST08-05-01		Magnetite Sand	-	-	-	-	-	-	-	-
ST09-02-01		Magnetite Sand	-	-	-	-	-	-	-	-
ST09-03		Grey Tailings	-	-	-	-	-	-	-	-
ST10-02		Grey Tailings	-	-	-	-	-	-	-	-
ST10-03		Grey Tailings	-	-	-	-	-	-	-	-
ST10-04		Grey Tailings	-	-	-	-	-	-	-	-
ST11-02-01		Magnetite Sand	-	-	-	-	-	-	-	-
ST11-02-02		Magnetite Sand	-	-	-	-	-	-	-	-
ST12-02		Magnetite Sand	-	-	-	-	-	-	-	-
ST12-03		Grey Tailings	-	-	-	-	-	-	-	-
ST12-04		Grey Tailings	7.7	706	2	37	4.1	9.11	0.13	<0.01
ST13-02		Grey Tailings	-	-	-	-	-	-	-	-
ST13-03		Grey Tailings	-	-	-	-	-	-	-	-
ST13-04-01		Grey Tailings	-	-	-	-	-	-	-	-
ST14-02-01		Magnetite Sand	-	-	-	-	-	-	-	-
ST14-03		Grey Tailings/Magneitite Mix	-	-	-	-	-	-	-	-
ST14-04		Grey Tailings	7.5	1020	2	38	4.7	8.11	0.15	<0.01
ST15-02-01		Grey Tailings	-	-	-	-	-	-	-	-
ST15-02-02		Grey Tailings	-	-	-	-	-	-	-	-
ST15-03		Grey Tailings	-	-	-	-	-	-	-	-
ST15-04		Grey Tailings	-	-	-	-	-	-	-	-
ST16-02		Magnetite Sand	-	-	-	-	-	-	-	-
ST16-03		Magnetite Sand	-	-	-	-	-	-	-	-
ST16-05		Magnetite Sand	-	-	-	-	-	-	-	-
ST16-06		Grey Tailings/Magneitite Mix	-	-	-	-	-	-	-	-
ST17-02		Grey Tailings	-	-	-	-	-	-	-	-
ST17-04		Grey Tailings	-	-	-	-	-	-	-	-
ST17-05		Grey Tailings	-	-	-	-	-	-	-	-
ST17-06		Grey Tailings	-	-	-	-	-	-	-	-
ST17-07		Grey Tailings	-	-	-	-	-	-	-	-
ST17-08-01	HC-6	Grey Tailings	7.7	658	2	34	6.6	5.18	0.21	<0.01
ST17-08-02		Magnetite Sand	-	-	-	-	-	-	-	-
ST18-02-01		Grey Tailings/Magneitite Mix	7.8	726	2	40	5.3	7.53	0.17	<0.01
ST18-02-03		Magnetite Sand	-	-	-	-	-	-	-	-
ST18-03-01		Grey Tailings/Magneitite Mix	-	-	-	-	-	-	-	-
ST18-03-02		Grey Tailings/Magneitite Mix	7.6	902	2	43	6.6	6.55	0.21	<0.01
ST18-04		Grey Tailings/Magneitite Mix	-	-	-	-	-	-	-	-
ST18-05-01		Grey Tailings	7.9	662	2	30	3.1	9.6	0.1	0.01
ST18-05-03		Magnetite Sand	-	-	-	-	-	-	-	-
L1519001-38 COMP (22-24)	HC-1 / COL-1	Magnetite Sand	7.7	397	1	33	8.1	4.06	0.26	<0.01
L1519001-39 COMP (22-24) DUP	Duplicate	Magnetite Sand	7.7	386	1	32	8.4	3.79	0.27	<0.01
L1518225-74 COMP (41+58)	HC-2 / COL-2	Magnetite Sand	7.7	543	2	34	5	6.8	0.16	<0.01
L1519001-40 COMP (7+29)	HC-3 / HC-3D / COL-3	Grey Tailings	7.3	1040	2	40	5	8	0.16	<0.01

Appendix C6 – Hazeltine Creek Tailings Samples Trace Element Data

Sample Identification	Major Soil Type	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Ce	Cs	Cr	Co	Cu	Ga	Ge	Hf
		%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
ST01-02-01	Grey Tailings	2.12	0.5	12.7	230	0.71	0.12	10	0.31	2.17	26.5	1.71	27	18.6	495	8.05	0.13	0.06
ST01-03	Magnetite Sand	1.83	0.43	10.6	210	0.6	0.06	10	0.17	2.65	18.6	1.97	11	16.3	805	8.75	0.37	0.48
ST01-04	Grey Tailings	1.84	0.42	12.2	220	0.67	0.08	10	0.14	2.59	19.35	2.27	11	17.8	936	8.93	0.36	0.37
ST01-05-01	Grey Tailings	1.52	0.36	10.5	170	0.6	0.07	10	0.14	2.24	17	2.05	12	15.5	841	7.81	0.36	0.29
ST01-05-02	Grey Tailings	1.25	0.44	9.6	140	0.42	0.07	10	0.16	1.55	16.25	1.11	29	12.2	317	5.65	0.17	0.15
ST01-06	Grey Tailings	1.26	0.34	8.8	150	0.45	0.06	10	0.16	1.79	15.85	1.68	15	11.8	574	5.82	0.19	0.12
ST01-09-01	Grey Tailings	1.57	0.34	10.5	180	0.6	0.07	10	0.16	2.37	16.65	2.08	11	16.3	908	7.73	0.32	0.25
ST01-09-02	Grey Tailings	1.32	0.31	9.6	160	0.49	0.07	<10	0.17	1.78	18.05	1.58	17	13.2	468	6	0.19	0.05
ST02-02-01	Grey Tailings	1.28	0.33	8.6	160	0.44	0.07	10	0.15	1.73	16.15	1.61	16	11.5	571	5.7	0.19	0.06
ST02-03	Grey Tailings	1.6	0.54	11.7	150	0.48	0.06	10	0.23	1.4	16.9	1.21	27	12.5	286	6.29	0.1	0.26
ST02-05-01	Magnetite Sand	1.91	0.34	11.7	170	0.65	0.07	10	0.16	2.97	17.45	1.86	10	15.4	799	9.85	0.32	0.35
ST02-05-02	Magnetite Sand	1.38	0.43	10.2	170	0.52	0.07	10	0.16	1.72	16.3	1.53	20	12	715	6.18	0.19	0.27
ST02-06	Magnetite Sand	1.22	0.44	8.8	140	0.41	0.06	10	0.13	1.64	16.05	1.26	22	11.1	469	5.51	0.17	0.25
ST03-02	Grey Tailings	1.59	0.4	11.5	200	0.58	0.07	10	0.18	2.39	16.7	2.05	11	16.7	922	8.33	0.3	0.31
ST03-03-01	Magnetite Sand	1.67	0.37	12	240	0.64	0.09	10	0.23	2.57	18.25	2.08	12	15.4	930	8.03	0.23	0.27
ST03-03-02	Magnetite Sand	1.21	0.34	10.9	150	0.54	0.07	10	0.19	2.13	14.25	1.76	9	10.4	1145	6.28	0.22	0.26
ST03-04	Grey Tailings	1.65	0.36	11.1	210	0.62	0.08	10	0.12	2.52	16.85	2.08	10	16.1	934	8.3	0.32	0.28
ST03-05-02	Grey Tailings	1.31	0.28	8.3	80	0.37	0.08	10	0.17	0.47	22.1	0.9	33	8.1	29.1	4.44	0.05	0.02
ST04-02	Magnetite Sand	1.12	0.34	10.6	130	0.45	0.07	10	0.17	1.98	14	1.71	10	12.7	1080	6.48	0.28	0.24
ST05-02-01	Magnetite/Grey Tailings Mix	1.38	0.35	9.3	160	0.44	0.07	<10	0.14	2.03	16.55	1.8	14	13.6	652	6.63	0.23	0.13
ST06-02-01	Grey Tailings	1.52	0.34	10.9	190	0.59	0.06	10	0.13	2.37	16.05	2.1	9	16.3	914	8.14	0.31	0.27
ST06-03	Grey Tailings	1.75	0.35	10	170	0.55	0.07	10	0.14	2.3	16.1	2.06	10	17	786	8.2	0.34	0.3
ST06-04-01	Grey Tailings	1.18	0.26	8.9	140	0.43	0.05	<10	0.23	2.28	13.85	1.38	17	14.9	553	5.76	0.23	0.25
ST07-02	Grey Tailings/Magneitite Mix	1.92	0.41	12.9	220	0.66	0.08	10	0.16	2.8	18.85	2.35	10	18.9	964	9.36	0.34	0.35
ST07-03-01	Grey Tailings	1.55	0.35	11.4	200	0.55	0.07	10	0.13	2.46	16.75	2.12	10	16.2	937	8.2	0.32	0.31
ST07-03-02	Grey Tailings	1.68	0.33	10.7	160	0.52	0.08	10	0.12	2.21	17.55	1.93	9	16.8	1280	7.82	0.29	0.33
ST08-02-01	Grey Tailings	1.95	0.36	12.7	210	0.74	0.08	10	0.18	2.81	18.45	2.27	10	20.1	911	9.46	0.32	0.35
ST08-03	Magnetite Sand	1.11	0.33	11.8	120	0.42	0.09	10	0.2	2.15	16.65	1.55	17	17	1055	7.94	0.29	0.23
ST08-04	Grey Tailings	1.55	0.32	10.2	180	0.55	0.07	10	0.12	2.34	15.35	2.13	9	16.6	886	8.05	0.36	0.28
ST08-05-01	Magnetite Sand	1.05	0.28	7.2	100	0.29	0.05	<10	0.1	1.15	12.75	1.03	17	9.3	417	4.34	0.14	0.08
ST09-02-01	Magnetite Sand	1.19	0.33	10.2	140	0.38	0.07	10	0.15	2.08	14.3	1.71	11	12.1	1050	6.44	0.24	0.25
ST09-03	Grey Tailings	1.57	0.33	10.2	180	0.51	0.06	10	0.13	2.35	15.65	2.15	10	17.1	908	8.19	0.33	0.29
ST10-02	Grey Tailings	1.78	0.38	13	210	0.64	0.07	10	0.14	2.65	17.55	2.28	10	18.4	982	8.89	0.34	0.33
ST10-03	Grey Tailings	1.72	0.35	11.1	190	0.63	0.07	10	0.14	2.54	17.9	2.19	10	17.8	876	8.63	0.33	0.31
ST10-04	Grey Tailings	1.63	0.35	12	200	0.63	0.06	10	0.13	2.55	17	2.18	10	17.3	991	8.76	0.34	0.32
ST11-02-01	Magnetite Sand	1.21	0.35	11.9	140	0.52	0.08	10	0.17	2.21	15.15	1.79	11	14.2	1205	7.48	0.28	0.29
ST11-02-02	Magnetite Sand	1.21	0.4	12	120	0.51	0.09	10	0.21	2.13	14.85	1.8	13	13.4	1465	6.94	0.22	0.31
ST12-02	Magnetite Sand	1.24	0.36	12.4	140	0.57	0.08	10	0.2	2.15	15.1	1.98	10	14	1410	7.53	0.25	0.29
ST12-03	Grey Tailings	1.53	0.37	11.6	190	0.63	0.06	10	0.14	2.38	16.65	2.09	10	16.3	900	8.4	0.33	0.35
ST12-04	Grey Tailings	1.63	0.36	11.1	190	0.59	0.06	10	0.14	2.4	16.15	2.16	9	16.8	870	8.61	0.34	0.28
ST13-02	Grey Tailings	1.97	0.4	13.3	220	0.74	0.08	10	0.17	2.84	18.95	2.36	10	20.1	982	9.68	0.36	0.37
ST13-03	Grey Tailings	1.56	0.36	11.5	190	0.58	0.06	10	0.14	2.45	16.6	2.15	9	16.5	934	8.41	0.33	0.33
ST13-04-01	Grey Tailings	1.64	0.37	12.2	200	0.61	0.07	10	0.13	2.53	17.6	2.21	10	17.1	952	8.81	0.31	0.33
ST14-02-01	Magnetite Sand	1.35	0.35	10.2	170	0.51	0.07	10	0.14	2.05	14.05	2.13	9	12.9	1105	7.22	0.29	0.26
ST14-03	Grey Tailings/Magneitite Mix	1.27	0.38	13.1	170	0.55	0.08	10	0.2	2.35	18.15	1.82	13	15.9	1020	8.36	0.3	0.32
ST14-04	Grey Tailings	1.75	0.48	11.3	170	0.68	0.07	10	0.18	2.29	17.65	2.02	14	16.6	768	8.69	0.27	0.37
ST15-02-01	Grey Tailings	1.74	0.36	11.5	200	0.59	0.07	10	0.14	2.61	17.9	2.27	10	17.9	930	8.9	0.34	0.33
ST15-02-02	Grey Tailings	2.27	0.48	9.2	210	0.59	0.13	10	0.08	0.64	34.9	1.85	55	15.3	65.2	6.75	0.07	0.24
ST15-03	Grey Tailings	1.93	0.4	12.6	210	0.72	0.08	10	0.17	2.85	20.4	2.31	11	19	895	9.56	0.34	0.37
ST15-04	Grey Tailings	1.6	0.37	11.3	200	0.59	0.06	10	0.15	2.53	17.4	2.19	10	16.4	942	8.27	0.31	0.32
ST16-02	Magnetite Sand	1.35	0.34	10	170	0.49	0.06	10	0.14	2.1	14.9	2.09	10	13.3	1030	7.16	0.27	0.24
ST16-03	Magnetite Sand	1.24	0.33	11	160	0.5	0.07	10	0.15	2.27	16.45	1.8	11	13.5	871	7.11	0.26	0.26
ST16-05	Magnetite Sand	1.29	0.33	10.7	210	0.55	0.09	10	0.18	1.99	17.1	1.93	12	16	1225	7.91	0.36	0.26

Sample Identification	Major Soil Type	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Ce	Cs	Cr	Co	Cu	Ga	Ge	Hf
		%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
ST16-06	Grey Tailings/Magneitite Mix	1.28	0.33	9.7	160	0.51	0.06	10	0.17	1.98	14.55	2.19	9	13.1	966	7	0.3	0.19
ST17-02	Grey Tailings	1.27	0.31	9.5	160	0.47	0.06	10	0.14	2.1	15.15	2	10	14.6	786	7.42	0.31	0.21
ST17-04	Grey Tailings	1.51	0.34	11	190	0.59	0.06	10	0.11	2.41	16.95	2.21	10	16.8	899	8.3	0.33	0.31
ST17-05	Grey Tailings	1.63	0.36	10.7	200	0.54	0.05	10	0.13	2.57	17.15	2.14	11	16.4	892	8.41	0.29	0.32
ST17-06	Grey Tailings	1.35	0.4	11.7	160	0.54	0.07	10	0.16	2.35	15.75	2.04	10	14	1210	7.47	0.28	0.28
ST17-07	Grey Tailings	1.68	0.37	11.2	190	0.61	0.07	10	0.14	2.6	17.9	2.29	9	17.5	957	8.67	0.35	0.32
ST17-08-01	Grey Tailings	1.36	0.4	11.3	170	0.55	0.07	10	0.24	2.37	15.6	2.03	11	14.5	1310	7.35	0.26	0.27
ST17-08-02	Magnetite Sand	1.23	0.34	10.4	150	0.52	0.06	10	0.17	2.07	13.75	1.81	10	14	1190	7.11	0.31	0.24
ST18-02-01	Grey Tailings/Magneitite Mix	1.71	0.37	11.4	200	0.6	0.06	10	0.15	2.15	18.25	3.1	11	15.5	954	8.62	0.37	0.26
ST18-02-03	Magnetite Sand	1.69	0.34	12.3	180	0.66	0.08	10	0.14	2.11	20.2	3.15	11	17.4	1230	9.51	0.43	0.24
ST18-03-01	Grey Tailings/Magneitite Mix	1.41	0.33	10	180	0.5	0.06	10	0.12	2.27	15.7	2.03	9	15.1	890	7.62	0.31	0.26
ST18-03-02	Grey Tailings/Magneitite Mix	1.33	0.27	10	140	0.5	0.07	10	0.13	2.84	17.7	1.12	9	14.2	1475	8.09	0.24	0.4
ST18-04	Grey Tailings/Magneitite Mix	1.09	0.29	7.8	230	0.38	0.04	10	0.13	1.96	11.9	1.2	8	12.5	835	6.66	0.29	0.29
ST18-05-01	Grey Tailings	1.57	0.35	11.1	180	0.57	0.07	10	0.14	2.39	16.7	2.02	10	16.2	899	7.98	0.33	0.3
ST18-05-03	Magnetite Sand	1.6	0.36	11.4	180	0.63	0.07	10	0.14	2.41	17	2.03	10	16.6	895	8.11	0.32	0.29

Sample Identification	Major Soil Type	In	Fe	La	Pb	Li	Mg	Mn	Hg	Mo	Ni	Nb	P	K	Re	Rb
		mg/kg	%	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg
ST01-02-01	Grey Tailings	0.078	3.8	14.7	8.6	22.5	1.12	844	0.11	3.56	23.6	1.05	1160	0.21	0.018	12.5
ST01-03	Magnetite Sand	0.095	5.33	10.4	5.7	16.1	0.98	638	0.1	4.8	8.6	0.14	1330	0.21	0.02	9.3
ST01-04	Grey Tailings	0.112	5.11	11.3	6.2	17.9	1.08	659	0.07	4.94	9	0.11	1350	0.24	0.022	10.9
ST01-05-01	Grey Tailings	0.087	4.76	9.6	5.1	14.4	0.9	566	0.09	4.58	9.8	0.15	1230	0.15	0.021	7.8
ST01-05-02	Grey Tailings	0.032	4.2	8.6	5.4	11.2	0.71	600	0.08	1.79	15.9	0.67	970	0.12	0.007	6.2
ST01-06	Grey Tailings	0.049	4.15	8.9	4.7	10.9	0.63	517	0.08	3.29	10.3	0.33	980	0.15	0.014	7.2
ST01-09-01	Grey Tailings	0.089	4.8	9.6	5	14.9	0.98	570	0.08	4.15	9.5	0.15	1310	0.17	0.018	8.2
ST01-09-02	Grey Tailings	0.054	4.08	10.1	5.2	12.7	0.7	554	0.08	2.78	13	0.65	1180	0.12	0.011	7.7
ST02-02-01	Grey Tailings	0.047	3.99	8.2	7.6	11.6	0.64	535	0.07	2.99	11	0.56	1020	0.12	0.012	6.6
ST02-03	Grey Tailings	0.042	4.05	8.2	8.7	13.9	0.84	774	0.06	1.93	19.7	0.15	1030	0.15	0.005	6.5
ST02-05-01	Magnetite Sand	0.085	4.8	9.9	6.4	16	0.9	576	0.08	4.21	8.6	0.1	1290	0.16	0.016	7.8
ST02-05-02	Magnetite Sand	0.049	4.31	8.9	9	12.6	0.68	555	0.1	3.56	12.8	0.19	930	0.2	0.012	8.7
ST02-06	Magnetite Sand	0.038	4.08	8.7	5.6	10.6	0.62	515	0.08	2.76	12.6	0.21	880	0.15	0.01	6.7
ST03-02	Grey Tailings	0.094	5.32	9.9	5.2	15.3	0.94	576	0.08	4.79	8	0.12	1300	0.2	0.019	9.2
ST03-03-01	Magnetite Sand	0.086	4.36	9.9	11.7	17.6	1.08	673	0.09	4.04	9.9	0.1	1310	0.18	0.017	8.6
ST03-03-02	Magnetite Sand	0.055	3.71	7.6	8.1	12.4	0.68	515	0.11	4.93	6.3	0.11	990	0.15	0.017	6.8
ST03-04	Grey Tailings	0.101	5.12	9.1	6.7	16.6	1.03	613	0.07	4.93	8	0.1	1370	0.17	0.019	7.9
ST03-05-02	Grey Tailings	0.02	2.96	10.3	6.9	12.6	0.45	364	0.03	0.57	16.7	0.69	730	0.09	0.002	6.9
ST04-02	Magnetite Sand	0.056	4.77	8.1	4.8	11.6	0.68	499	0.1	4.64	6.7	0.12	1070	0.13	0.016	6.4
ST05-02-01	Magnetite/Grey Tailings Mix	0.062	4.24	9.2	5.2	12.9	0.78	510	0.07	3.14	11	0.29	1130	0.15	0.012	8
ST06-02-01	Grey Tailings	0.091	5.17	9.5	4.7	14.4	0.96	545	0.08	4.3	7.4	0.1	1340	0.16	0.018	8.1
ST06-03	Grey Tailings	0.092	4.81	9.3	5.2	17	1.08	585	0.07	4.46	9.2	0.11	1260	0.15	0.018	8.3
ST06-04-01	Grey Tailings	0.068	3.99	8.1	4.4	12.2	0.99	573	0.14	2.73	14.9	0.1	1100	0.12	0.011	6.5
ST07-02	Grey Tailings/Magneitite Mix	0.115	4.9	11.1	6.4	19.3	1.25	723	0.09	4.37	9.3	0.12	1400	0.2	0.02	9.6
ST07-03-01	Grey Tailings	0.091	5.3	9.6	5.4	15.1	0.96	574	0.09	4.89	7.4	0.12	1330	0.17	0.02	8.3
ST07-03-02	Grey Tailings	0.086	4.26	9.3	6.2	16.8	1.03	572	0.28	3.48	8.6	0.13	1160	0.16	0.016	7.9
ST08-02-01	Grey Tailings	0.117	4.32	10.8	6.4	20.7	1.38	722	0.08	4.46	10.3	0.1	1400	0.18	0.02	9
ST08-03	Magnetite Sand	0.066	7.55	9.7	5.6	12.1	0.71	565	0.11	4.71	9	0.13	1370	0.12	0.018	6.1
ST08-04	Grey Tailings	0.101	4.93	8.9	4.9	14.4	0.96	522	0.08	5.03	7.4	0.1	1270	0.16	0.021	8.1
ST08-05-01	Magnetite Sand	0.031	3.14	6.8	4	9	0.56	433	0.07	1.97	10.2	0.4	770	0.09	0.006	4.8
ST09-02-01	Magnetite Sand	0.056	4.99	8.2	4.7	11	0.69	513	0.11	4.31	6.2	0.12	1140	0.15	0.018	6.7
ST09-03	Grey Tailings	0.098	5.01	9	4.5	14.1	0.97	533	0.08	4.71	7.9	0.1	1250	0.16	0.023	8.3
ST10-02	Grey Tailings	0.114	5.19	10.4	5.7	17	1.12	646	0.08	5.15	8.4	0.1	1420	0.19	0.027	9.4
ST10-03	Grey Tailings	0.105	4.78	10.6	5	15.6	1.09	606	0.08	4.51	8.8	0.13	1350	0.17	0.022	8.7
ST10-04	Grey Tailings	0.098	5.39	10	5.8	17.9	1.02	605	0.09	5.3	8	0.1	1410	0.17	0.024	8.2
ST11-02-01	Magnetite Sand	0.064	5.76	8.9	5.2	13.1	0.73	559	0.11	4.81	6.8	0.12	1220	0.14	0.018	6.8
ST11-02-02	Magnetite Sand	0.06	4.72	8.5	5.6	14	0.75	559	0.13	5.72	8.6	0.12	1000	0.13	0.022	6.8
ST12-02	Magnetite Sand	0.067	5.21	8.8	5.7	13.8	0.76	556	0.13	5.6	6.7	0.1	1140	0.14	0.019	7
ST12-03	Grey Tailings	0.094	5.26	9.8	5.1	15.1	0.92	550	0.08	4.75	7.3	0.11	1290	0.18	0.021	8.5
ST12-04	Grey Tailings	0.105	4.88	9.3	5	16.5	1	561	0.06	4.88	7.6	0.13	1250	0.18	0.02	8.7
ST13-02	Grey Tailings	0.12	4.55	11.1	6.6	21.7	1.36	748	0.08	4.65	9.7	0.09	1420	0.19	0.019	9.3
ST13-03	Grey Tailings	0.097	5.1	9.5	5.2	16	0.98	563	0.09	5.2	7.2	0.1	1320	0.17	0.026	8.1
ST13-04-01	Grey Tailings	0.096	5.32	10.4	5.8	17	1.03	613	0.09	5	8.1	0.09	1390	0.18	0.019	9
ST14-02-01	Magnetite Sand	0.07	4.65	8	4.5	12.1	0.72	467	0.09	5.3	6.5	0.13	1030	0.15	0.017	7.6
ST14-03	Grey Tailings/Magneitite Mix	0.072	6.77	10.6	6.2	13.5	0.75	581	0.11	6.5	7.6	0.13	1470	0.16	0.018	7.7
ST14-04	Grey Tailings	0.086	4.16	10.3	5.5	18.7	1.15	848	0.09	3.86	10.8	0.1	1220	0.18	0.015	9.1
ST15-02-01	Grey Tailings	0.109	5.13	10.5	5.7	16.4	1.08	616	0.09	4.88	8.3	0.1	1360	0.18	0.022	9.1
ST15-02-02	Grey Tailings	0.028	3.78	18.8	8.4	16.6	0.79	665	0.08	0.6	36.4	0.11	780	0.2	0.001	13.1
ST15-03	Grey Tailings	0.114	4.86	11.8	6.5	18.8	1.23	708	0.09	4.48	9.8	0.1	1440	0.19	0.021	9.4
ST15-04	Grey Tailings	0.102	5.45	10.1	5.1	14.7	0.97	578	0.08	4.76	7.3	0.12	1380	0.18	0.024	8.6
ST16-02	Magnetite Sand	0.073	5.06	8.5	5.3	11.7	0.71	492	0.1	4.98	6.6	0.15	1110	0.16	0.022	7.7
ST16-03	Magnetite Sand	0.067	5.51	9.4	5.4	12.2	0.72	531	0.11	4.42	6.6	0.14	1310	0.16	0.023	7.5
ST16-05	Magnetite Sand	0.065	6.54	9.8	4.3	12.8	0.86	512	0.1	4.5	7.4	0.13	1390	0.21	0.014	11.2

Sample Identification	Major Soil Type	In	Fe	La	Pb	Li	Mg	Mn	Hg	Mo	Ni	Nb	P	K	Re	Rb
		mg/kg	%	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg
ST16-06	Grey Tailings/Magneitite Mix	0.069	4.69	8.2	4.7	11.3	0.67	441	0.09	5.18	6.8	0.19	1060	0.14	0.023	7.5
ST17-02	Grey Tailings	0.074	6.06	8.8	5.3	11.7	0.71	455	0.08	3.93	7.5	0.24	1280	0.14	0.018	7.5
ST17-04	Grey Tailings	0.097	5.35	9.9	5.6	14.6	0.92	532	0.08	4.99	7.3	0.13	1310	0.16	0.025	8.5
ST17-05	Grey Tailings	0.099	5.45	9.8	5.1	15.6	0.95	584	0.08	4.48	7.6	0.12	1330	0.18	0.019	9
ST17-06	Grey Tailings	0.068	5.38	9.2	6	13.2	0.78	592	0.13	5.28	6.5	0.12	1210	0.16	0.019	7.2
ST17-07	Grey Tailings	0.107	5.07	10.3	5.4	16	1.04	621	0.08	4.51	7.9	0.11	1390	0.17	0.02	8.8
ST17-08-01	Grey Tailings	0.066	4.92	9	6	12.9	0.8	617	0.11	5.07	8.2	0.11	1150	0.14	0.017	7.1
ST17-08-02	Magnetite Sand	0.069	5.57	7.8	4.3	12.1	0.69	481	0.09	5.34	6.6	0.1	1120	0.15	0.02	6.9
ST18-02-01	Grey Tailings/Magneitite Mix	0.082	6.39	10.5	4.4	12.8	0.84	499	0.06	5.66	9.8	0.13	1330	0.22	0.023	9
ST18-02-03	Magnetite Sand	0.08	7.74	11.4	5.5	12.9	0.89	481	0.07	5.44	11.1	0.11	1470	0.19	0.024	8
ST18-03-01	Grey Tailings/Magneitite Mix	0.085	5.15	9.2	4.7	13.3	0.84	520	0.08	5.12	6.6	0.1	1260	0.15	0.023	7.4
ST18-03-02	Grey Tailings/Magneitite Mix	0.07	5.18	10.6	4.8	16.2	0.81	720	0.18	3.45	6.7	0.1	1500	0.14	0.016	6.4
ST18-04	Grey Tailings/Magneitite Mix	0.063	4.85	6.6	4.6	10.8	0.6	456	0.05	4.65	4.5	0.12	1150	0.15	0.018	6.4
ST18-05-01	Grey Tailings	0.093	4.86	9.6	4.8	14.6	0.98	568	0.08	4.21	8	0.13	1300	0.18	0.021	8.7
ST18-05-03	Magnetite Sand	0.093	4.81	9.8	4.8	15	0.99	577	0.09	4.62	8.4	0.13	1290	0.19	0.018	9

Sample Identification	Major Soil Type	Sc	Se	Ag	Na	Sr	Ta	Te	Tl	Th	Sn	Ti	W	U	V	Y	Zn	Zr
		mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
ST01-02-01	Grey Tailings	7.1	1.9	0.31	0.08	175.5	<0.01	0.08	0.07	1.9	1.1	0.116	0.44	1.42	111	13.3	78	2.1
ST01-03	Magnetite Sand	5.9	1.8	0.4	0.13	151	0.01	0.05	0.05	1.1	1.6	0.192	0.59	1.08	188	13.65	60	14.6
ST01-04	Grey Tailings	5.7	1.5	0.34	0.14	178	0.01	0.05	0.03	1.2	1.8	0.179	0.65	1.15	181	12.9	62	11.2
ST01-05-01	Grey Tailings	4.7	1.4	0.35	0.11	163.5	0.01	0.06	0.03	1.1	1.5	0.145	0.55	0.93	173	10.9	57	8.8
ST01-05-02	Grey Tailings	4.3	0.9	0.18	0.08	100.5	0.01	0.02	0.04	1.7	0.6	0.13	0.34	0.7	144	8.74	55	6
ST01-06	Grey Tailings	3.7	1.1	0.26	0.1	142.5	0.01	0.05	0.04	1.4	0.9	0.118	0.39	0.74	147	8.85	43	5
ST01-09-01	Grey Tailings	4.6	1.5	0.35	0.11	173	<0.01	0.06	0.02	1	1.3	0.141	0.48	0.9	174	10.75	56	8
ST01-09-02	Grey Tailings	4.1	1.1	0.24	0.08	138	<0.01	0.05	0.03	1.5	0.8	0.1	0.37	0.82	140	9.63	50	2
ST02-02-01	Grey Tailings	3.8	0.9	0.24	0.08	131.5	0.01	0.03	0.03	1.4	0.9	0.116	0.39	0.74	140	8.07	48	2.5
ST02-03	Grey Tailings	6.1	0.5	0.16	0.08	94.1	0.01	0.03	0.07	1.9	0.6	0.141	0.31	0.7	135	9.13	61	9.7
ST02-05-01	Magnetite Sand	4.8	1.3	0.35	0.11	157.5	0.01	0.04	0.02	1.1	1.3	0.15	0.61	0.96	177	11.6	55	11.2
ST02-05-02	Magnetite Sand	4.3	1.2	0.34	0.12	116.5	0.01	0.03	0.04	1.5	0.9	0.137	0.38	0.83	147	9.55	53	9.4
ST02-06	Magnetite Sand	4	0.8	0.23	0.09	115	0.01	0.03	0.04	1.7	0.8	0.127	0.38	0.73	139	8.62	47	8.6
ST03-02	Grey Tailings	4.8	1.7	0.36	0.13	157.5	<0.01	0.06	0.02	0.9	1.5	0.153	0.58	0.97	189	12	56	9.7
ST03-03-01	Magnetite Sand	5.2	1.3	0.4	0.11	154.5	0.01	0.06	0.03	1.2	1.3	0.155	0.57	0.9	163	10.8	69	8.9
ST03-03-02	Magnetite Sand	3.7	0.8	0.49	0.1	98.1	0.01	0.05	0.02	0.9	0.9	0.119	0.46	0.73	142	8.79	53	7.8
ST03-04	Grey Tailings	5	1.1	0.36	0.12	157.5	0.01	0.05	0.03	0.9	1.5	0.163	0.66	0.99	186	11	61	8.9
ST03-05-02	Grey Tailings	3.2	0.3	0.07	0.02	48.1	0.01	0.01	0.05	2.4	0.3	0.098	0.25	0.54	86	4.49	53	1.1
ST04-02	Magnetite Sand	3.5	1.5	0.44	0.09	94.1	<0.01	0.06	0.02	0.9	0.9	0.112	0.44	0.74	182	9.15	52	7
ST05-02-01	Magnetite/Grey Tailings Mix	4.1	1.3	0.29	0.09	150.5	<0.01	0.05	0.03	1.5	1	0.121	0.43	0.8	150	9.77	49	5.6
ST06-02-01	Grey Tailings	4.6	1.6	0.32	0.11	156.5	<0.01	0.07	0.02	0.8	1.3	0.14	0.54	0.9	187	10.9	55	8
ST06-03	Grey Tailings	5.4	1.4	0.3	0.1	152.5	<0.01	0.06	0.03	1	1.3	0.154	0.48	0.86	165	11.15	59	8.7
ST06-04-01	Grey Tailings	6.4	1.3	0.22	0.07	148.5	<0.01	0.05	0.02	1	0.9	0.107	0.36	0.65	135	10.2	58	7.2
ST07-02	Grey Tailings/Magneitite Mix	6	1.6	0.38	0.13	183	0.01	0.07	0.03	1	1.7	0.181	0.71	1.21	179	12.95	71	11.1
ST07-03-01	Grey Tailings	4.7	1.2	0.36	0.11	154	0.01	0.06	0.02	1	1.5	0.154	0.63	1.05	194	11.55	59	9.1
ST07-03-02	Grey Tailings	5.6	1.9	0.32	0.1	138	0.01	0.08	0.02	1.7	1.3	0.145	0.5	0.88	148	11.25	58	9.5
ST08-02-01	Grey Tailings	6.2	1.7	0.36	0.12	186.5	<0.01	0.06	0.02	1	1.7	0.17	0.6	1.09	157	12.75	74	10.8
ST08-03	Magnetite Sand	3.8	1.6	0.52	0.08	85.1	<0.01	0.06	0.02	1	1.1	0.12	0.45	0.83	295	10.6	61	7.2
ST08-04	Grey Tailings	4.7	1.5	0.32	0.11	155	<0.01	0.07	0.02	0.9	1.4	0.147	0.56	0.88	181	10.8	52	8.3
ST08-05-01	Magnetite Sand	2.9	0.7	0.18	0.06	82.2	<0.01	0.03	0.02	1.4	0.5	0.095	0.28	0.52	105	6.28	40	3.4
ST09-02-01	Magnetite Sand	3.4	1.4	0.4	0.1	99.9	<0.01	0.05	0.02	0.9	0.9	0.12	0.44	0.77	192	9.14	52	7.2
ST09-03	Grey Tailings	4.6	1.5	0.35	0.12	163	<0.01	0.06	0.02	0.9	1.4	0.147	0.53	0.89	181	11	51	8.4
ST10-02	Grey Tailings	5.5	1.5	0.34	0.13	172	<0.01	0.05	0.02	0.9	1.6	0.167	0.63	1.06	188	12.6	63	10.3
ST10-03	Grey Tailings	5.1	1.6	0.34	0.12	197.5	<0.01	0.07	0.02	1	1.6	0.158	0.57	1.05	173	12.05	60	9.6
ST10-04	Grey Tailings	5	1.5	0.37	0.12	158	<0.01	0.06	0.02	0.9	1.5	0.152	0.63	0.95	196	11.55	61	8.9
ST11-02-01	Magnetite Sand	3.8	1.4	0.52	0.1	97.8	<0.01	0.05	<0.02	0.8	1.1	0.124	0.53	0.81	227	9.94	56	7.7
ST11-02-02	Magnetite Sand	3.9	1.7	0.72	0.09	106.5	<0.01	0.08	0.03	1.1	0.9	0.114	0.49	0.78	179	9.22	58	8.4
ST12-02	Magnetite Sand	3.9	1.7	0.6	0.1	103	<0.01	0.06	0.02	0.8	1.1	0.122	0.55	0.83	202	9.89	57	7.9
ST12-03	Grey Tailings	4.7	1.5	0.35	0.12	155.5	<0.01	0.06	0.02	0.9	1.5	0.156	0.64	1	190	11.4	54	9.2
ST12-04	Grey Tailings	5	1.7	0.32	0.12	155	<0.01	0.06	0.02	0.9	1.6	0.158	0.63	0.92	177	11.35	56	8.6
ST13-02	Grey Tailings	6.3	1.7	0.37	0.12	193	<0.01	0.06	0.02	1	1.7	0.171	0.68	1.14	165	12.95	74	10.8
ST13-03	Grey Tailings	4.8	1.5	0.37	0.12	149.5	<0.01	0.07	0.02	0.9	1.5	0.152	0.64	0.95	187	11.15	57	8.9
ST13-04-01	Grey Tailings	5.1	1.4	0.37	0.12	166.5	<0.01	0.06	0.02	0.9	1.5	0.154	0.62	0.95	196	12	61	9.6
ST14-02-01	Magnetite Sand	3.7	1.4	0.41	0.11	149.5	<0.01	0.06	<0.02	0.8	1.2	0.131	0.51	0.77	175	9.31	47	7.2
ST14-03	Grey Tailings/Magneitite Mix	4.2	1.5	0.47	0.1	108.5	<0.01	0.06	0.02	0.9	1.2	0.145	0.62	0.91	266	11.95	59	8.8
ST14-04	Grey Tailings	5.9	1.2	0.32	0.11	176.5	<0.01	0.06	0.05	1.2	1.4	0.156	0.58	0.95	147	11.45	82	11
ST15-02-01	Grey Tailings	5.4	1.5	0.36	0.12	174.5	0.01	0.07	0.02	1	1.7	0.166	0.67	1.09	188	12.3	61	9.8
ST15-02-02	Grey Tailings	10.2	0.5	0.06	0.04	93.4	0.01	0.02	0.12	5.6	0.5	0.107	0.18	0.74	92	12.6	64	11.2
ST15-03	Grey Tailings	6.3	1.5	0.37	0.12	188.5	0.01	0.07	0.02	1.1	1.7	0.177	0.66	1.2	180	13.65	71	11.7
ST15-04	Grey Tailings	4.8	1.5	0.37	0.12	161.5	0.01	0.05	0.02	0.9	1.6	0.163	0.64	1.06	202	11.95	57	9.5
ST16-02	Magnetite Sand	3.8	1.5	0.41	0.11	146	0.01	0.04	0.02	0.8	1.2	0.13	0.51	0.82	191	10	47	7.2
ST16-03	Magnetite Sand	3.9	1.2	0.4	0.11	105	0.01	0.04	0.02	0.9	1.2	0.135	0.55	0.85	216	10.8	52	7.9
ST16-05	Magnetite Sand	4.5	1.7	0.35	0.11	112.5	0.01	0.06	0.02	0.9	1.2	0.156	0.53	0.94	290	11.75	54	7.4

Sample Identification	Major Soil Type	Sc	Se	Ag	Na	Sr	Ta	Te	Tl	Th	Sn	Ti	W	U	V	Y	Zn	Zr
		mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
ST16-06	Grey Tailings/Magneitite Mix	3.6	1.5	0.43	0.12	159	0.01	0.05	0.02	0.9	1.3	0.122	0.49	0.78	179	9.61	46	6.3
ST17-02	Grey Tailings	3.7	1.3	0.33	0.1	160	0.01	0.05	0.02	0.9	1.2	0.124	0.52	0.84	229	9.87	47	5.9
ST17-04	Grey Tailings	4.7	1.7	0.34	0.11	160	0.01	0.06	0.02	0.9	1.6	0.158	0.63	1	199	11.85	52	8.8
ST17-05	Grey Tailings	5	1.2	0.33	0.12	146.5	0.01	0.06	0.02	1	1.6	0.167	0.63	0.97	202	11.85	57	9.6
ST17-06	Grey Tailings	4.1	1.6	0.49	0.11	114.5	0.01	0.06	0.02	0.9	1.2	0.141	0.58	0.91	207	10.6	61	8.5
ST17-07	Grey Tailings	5.2	1.4	0.38	0.12	177	0.01	0.06	0.02	1	1.6	0.16	0.62	1.07	187	12.25	61	9.7
ST17-08-01	Grey Tailings	4.1	1.8	0.53	0.1	139	0.01	0.09	0.02	0.9	1.1	0.125	0.54	0.81	185	10.5	59	8.2
ST17-08-02	Magnetite Sand	3.6	1.6	0.44	0.1	124	0.01	0.07	0.02	0.8	1.1	0.119	0.46	0.72	214	9.32	48	7
ST18-02-01	Grey Tailings/Magneitite Mix	4.5	1.6	0.36	0.2	186.5	<0.01	0.07	0.02	1	1.7	0.167	0.71	1.16	224	12.7	44	7.8
ST18-02-03	Magnetite Sand	4.8	1.5	0.4	0.2	163.5	<0.01	0.07	0.02	1	1.6	0.164	0.65	1.19	292	13.6	46	7
ST18-03-01	Grey Tailings/Magneitite Mix	4.3	1.2	0.33	0.11	145.5	0.01	0.07	0.02	0.9	1.4	0.141	0.54	0.94	190	10.6	53	7.9
ST18-03-02	Grey Tailings/Magneitite Mix	4.6	1.2	0.67	0.05	92.6	0.01	0.06	0.02	1	1.1	0.134	0.7	0.94	220	10.5	75	12.3
ST18-04	Grey Tailings/Magneitite Mix	3.2	1.3	0.29	0.07	78	0.01	0.02	0.02	0.7	1.1	0.138	0.6	0.58	216	9.18	48	7.8
ST18-05-01	Grey Tailings	4.6	1.6	0.38	0.12	171.5	<0.01	0.07	0.02	0.9	1.4	0.148	0.48	0.92	182	11.15	55	8.8
ST18-05-03	Magnetite Sand	4.8	1.7	0.38	0.12	177	<0.01	0.07	0.02	0.9	1.4	0.148	0.53	0.92	179	11.5	56	9.1

Appendix C7 – QEMSCAN

An Investigation into

THE MINERALOGICAL CHARACTERISTICS OF SEVEN SAMPLES COLLECTED ALONG HAZELTINE CREEK

prepared for

IMPERIAL METALS CORPORATION

Project 50220-103 – Final Report
May 8, 2015

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Executive Summary

Seven samples (six samples and one duplicate) collected from along Hazeltine Creek downstream of the tailings dam breach at the Mount Polley Mine, were submitted to the Advanced Mineralogy Facility by SRK on behalf of Imperial Metals Corporation. A mineralogical test program was conducted using QEMSCAN technology (Quantitative Evaluation of Materials by Scanning Electron Microscopy), X-ray Diffraction (XRD), Electron Microprobe Analysis (EMPA) and chemical analysis. The objective of this investigation was to determine the overall mineralogical characteristics with an emphasis on the sulphide and carbonate mineralization and to identify the mineral hosts of copper and selenium.

The as-received samples were wet screened at 2 mm. The work was conducted on the -2mm material while the +2 mm fraction was stored.

Sample Characteristics

The modal mineral abundances, sulphide and carbonate exposure along with size data of the samples are summarized in Table 1. Note that the exposure and size data is based on the as-received -2 mm fraction.

The sulphides (pyrite, chalcopyrite and bornite) range in abundance from 0.10% in HC-4 to 0.64% in HC-6, the carbonates (calcite and dolomite) from 1.15% in HC-4 to 4.50% in HC-6. Iron-oxides range from 2.84% in HC-4 to 6.97% in HC-1/COL-1. From the Rietveld XRD analysis, the iron oxides in HC-1/COL-1, HC-4 and HC-6 have been identified as magnetite (4.8%, 2.3% and 4.2% respectively) and hematite (1.7%, 2.2% and 1.7% respectively). The samples are primarily comprised of potassium-feldspar (24-43%), plagioclase (19-29%) and quartz ranging from 27% in HC-4 to 21% in HC-5.

Sulphides that have >20% exposure range from 12% in HC-6 to 66% in HC-3/COL-3, carbonates (>20% exposure) range from 62% in HC-6 to 93% in HC-3/COL-3.

The majority of the sulphides are <75 µm in size. Approximately 82% of the sulphide mass is <75 µm in size in HC-4 and 100% (88% are <30 µm) in HC-3/COL-3. The carbonates range in size. Thus, HC-3/COL-3 contains the finest in size carbonates with 100% at <75 µm, and HC-4 the coarsest with the majority (68%) of the carbonates at >75 µm and 32% at <75 µm.

Table 1: Summary Table of Sample Characteristics

Sample		HC-1/COL-1	HC-1/COL-1 DUP	HC-2/COL-2	HC-3/COL-3	HC-4	HC-5	HC-6
Calculated ESD Particle Size		106	110	67	17	247	180	189
QEMSCAN Modal Mineral Mass (%)	Pyrite	0.24	0.32	0.19	0.33	0.08	0.16	0.40
	Chalcopyrite	0.24	0.24	0.18	0.02	0.02	0.16	0.23
	Bornite	0.03	0.02	0.02	0.00	0.00	0.01	0.02
	Calcite	2.23	2.50	2.29	2.64	0.72	1.27	4.45
	Dolomite (Fe)	0.11	0.05	0.04	0.02	0.43	0.15	0.05
	Fe Oxides	6.97	6.51	5.26	4.93	2.84	3.82	4.95
	K-Feldspar	43.0	40.5	42.8	39.5	23.7	30.6	39.5
	Plagioclase	24.2	24.9	29.0	26.9	19.4	21.3	27.4
	Quartz	3.85	5.02	1.26	1.09	27.1	21.3	2.96
	Other Minerals	26.1	26.4	24.2	29.6	28.5	25.1	25.1
Sulphides Exposure (wt%)	**Exposed**	**9.34**	**28.4**	**25.4**	**47.0**	**29.4**	**3.37**	**9.13**
	20-80%	29.8	30.0	6.17	19.3	4.46	28.0	3.11
	<20% Exposed	54.4	33.1	58.8	26.5	40.9	59.8	81.8
	Locked	6.43	8.45	9.64	7.19	25.3	8.88	5.94
Sulphides Size (wt%)	>75 µm	3.32	14.4	9.32	0.00	17.6	7.82	7.41
	30-75 µm	41.3	43.8	25.4	11.6	21.7	53.8	54.7
	<30 µm	55.4	41.8	65.3	88.4	60.7	38.4	37.9
Carbonates Exposure (wt%)	**Exposed**	**30.9**	**31.5**	**44.9**	**78.9**	**45.8**	**55.1**	**27.9**
	20-80% Exposed	39.3	41.3	36.4	14.3	30.8	22.0	34.0
	<20% Exposed	27.5	25.7	17.2	6.40	20.5	19.7	37.1
	Locked	2.21	1.48	1.52	0.46	2.93	3.20	0.96
Carbonates Size (wt%)	>75 µm	39.0	37.1	32.2	0.00	68.4	54.0	61.3
	30-75 µm	37.4	40.2	42.4	34.7	20.6	33.1	30.3
	<30 µm	23.6	22.7	25.4	65.3	11.0	12.9	8.43

Elemental Deportment

The elemental deportment for copper (Cu) was calculated using EMPA averages and the QEMSCAN mineral distribution. The results are summarized in Table 2 (normalized values).

Selenium (Se) was found in four grains of bornite and could possibly be present in other minerals, but is below the detection limit of the electron microprobe.

Table 2: Elemental Deportment Summary (Normalized)

Element	Mineral Name	HC-1/COL-1	HC-1/COL-1 DUP	HC-2/COL-2	HC-3/COL-3	HC-4	HC-5	HC-6
Cu Deportment	Chalcopyrite	62.5	67.2	64.6	17.1	20.5	62.8	66.3
	Bornite	19.0	11.4	15.3	0.00	0.67	12.3	9.82
	Chalcocite/Covellite	4.36	6.85	0.59	3.30	0.80	2.29	8.09
	Enargite	0.00	0.55	0.00	0.00	0.00	0.00	0.00
	Chlorite	13.8	13.8	19.0	78.4	78.0	22.3	15.7
	Fe Ox_Silicate_low	0.29	0.14	0.50	1.17	0.03	0.33	0.11

Introduction

This report describes a mineralogical test program using QEMSCAN technology (Quantitative Evaluation of Materials by Scanning Electron Microscopy), X-ray Diffraction (XRD), Electron Microprobe Analysis (EMPA), and chemical analysis on seven samples (six samples and one duplicate) submitted by SRK on behalf of Imperial Metals Corporation. The samples were collected along Hazeltine Creek, downstream of the tailings dam breach at the Mount Polley Mine. The objective of the test program was to determine the overall mineral assemblage with emphasis on the mineral exposure, particle size of the sulphides and carbonates, and the elemental deportment of copper and selenium.

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Data Processing by: Sarah Prout
Report preparation by: Morgan Gibson-Wright
Report reviewed by: Sarah Prout, Cheryl Mina, Tassos Grammatikopoulos, Jake Lang

Testwork Summary

1. Sample Receipt, Preparation, and Analysis

Seven samples collected from along Hazeltine Creek, downstream of the tailings dam breach at the Mount Polley Mine, were submitted to the Advanced Mineralogy Facility by SRK on behalf of Imperial Metals Corporation. The shipment was assigned an internal sample receipt number of 0270-FEB15 and the project number CAVM-50220-103 was assigned to the testwork.

The as-received samples were inventoried (Table 3). Each sample was wet screened at 2 mm, with the mineralogical work carried out on the -2 mm fraction and the +2 mm fraction stored.

Table 3: Sample Inventory

Sample ID	-2 mm Wt (g)	QEMSCAN Analysis Mode
HC-1/COL-1	87.0	PMA and SMS
HC-1/COL-1 DUP	100.1	
HC-2/COL-2	81.0	
HC-3/COL-3	97.2	
HC-4	83.5	Field Scan (FS)
HC-5	98.3	
HC-6	97.1	

An assay cut was riffled and pulverized from each -2 mm sample, and submitted for whole rock analysis (WRA) by X-ray fluorescence (XRF). Additional chemical analysis data were provided by SRK on behalf of Imperial Metals Corporation including sulphur and copper. Approximately 10 g was riffled and pulverized from three of the samples (HC-1/COL-1, HC-4 and HC-6) and submitted for Rietveld X-Ray Diffraction (XRD).

Approximately 1 g sub-samples were micro-riffled from each -2 mm sample for polished section preparation. One graphite impregnated polished epoxy grain mount was prepared for each sample. Note: due to the coarse particle size, one polished section may not be representative of the whole sample, especially due to the low grade sulphide mineral occurrence; caution must be taken with interpretation of the data.

The polished sections were carbon coated and submitted for QEMSCAN analysis by Particle Mineral Analysis (PMA) and Specific Mineral Search (SMS) or the Field Scan (FS) mode of operation depending on the particle size, where the coarser samples (HC-4, HC-5 and HC-6) a FS analysis was used and for the finer (HC-1/COL-1, HC-COL-1 DUP, HC-2/COL-2 and HC-3/COL-3) samples a combination of PMA and SMS was used. Following the QEMSCAN analysis, the polished sections from samples HC-1/COL-1, HC-5 and HC-6 were submitted for Electron Microprobe Analysis (EMPA).

The certificates of chemical analysis are presented in Appendix A, the XRD report is presented in Appendix B, EMPA data is presented in Appendix C and additional QEMSCAN data is presented in Appendix D.

2. Operational Modes and Quality Control

Particle Mineral Analysis (PMA) mode of analysis is a two-dimensional mapping analysis where a pre-defined number of particles are mapped at a point spacing selected in order to spatially resolve and describe mineral textures and associations. The data is processed offline using the iDiscover software to calibrate the mineral database and to categorize the minerals.

The Specific Mineral Search (SMS) mode of analysis is a modified PMA routine. However, in an SMS routine, a phase reports as a low-grade constituent and can be located by setting a threshold limit of the back-scattered electron intensity (or mineral brightness depending upon the atomic weight of the elements present), with any particles above this value being mapped in two dimensions. Any accompanying phases of a lower brightness within the composite particle are also mapped. For example, this mode of measurement would be selected in ores of low sulphide grade, searching specifically for particles containing sulphide minerals.

Field Scan (FS) mode of measurement maps a core sample (or coarse size particulate sample) that has been mounted in the polished section. It collects a chemical spectrum at a set interval within the field of view. Each field of view is then processed offline and a pseudo image of the core sample is produced. For particulate samples, the data is further processed in order to produce individual particles for exposure and size calculations.

A comparison of the mode of analysis and the number of particles scanned for each sample is presented in Table 4. The modal mineralogy data is based on the analysis of over 9,000 particles per sample.

Table 4: Number of Particles Scanned

Sample ID	QEMSCAN Analysis Mode	No. of Particles Scanned
HC-1/COL-1	PMA	15,670
	SMS	2,044
HC-1/COL-1 DUP	PMA	13,431
	SMS	1,737
HC-2/COL-2	PMA	51,571
	SMS	1,904
HC-3/COL-3	PMA	37,793
	SMS	5,421
HC-4	FS	11,931
HC-5	FS	9,970
HC-6	FS	12,290

*SMS mode only maps sulphides and their associations

It should be noted that the energy dispersive X-ray characteristics for magnetite and hematite are nearly identical and these two minerals have a lower confidence level than the other minerals distinguished by QEMSCAN; light elements such as Li, B, C, Be, O and H also cannot be discriminated.

2.1. X-Ray Diffraction Analysis

Rietveld XRD analysis was performed on samples HC-1/COL-1, HC-4 and HC-6 for QEMSCAN calibration and quality control purposes. The XRD results are summarized in Table 5 and the complete XRD report with the patterns are presented in Appendix B. In general, the XRD results are consistent with the QEMSCAN analysis.

Table 5: Summary of XRD Analysis

Mineral/Compound	HC-1/COL-1 MAR4504-01 (wt %)	HC-4 MAR4504-02 (wt %)	HC-6 MAR4504-03 (wt %)
Quartz	1.8	27.0	1.7
Albite	25.3	24.2	25.3
Anorthite	7.6	4.6	5.0
Microcline	35.1	16.4	35.9
Magnetite	4.8	2.3	4.2
Calcite	2.4	0.8	2.9
Muscovite	2.1	0.6	1.5
Diopside	6.4	7.2	5.5
Hematite	1.7	2.2	1.7
Chlorite	5.4	7.0	6.8
Kaolinite	0.4	0.9	0.7
Epidote	2.1	2.6	3.7
Andradite	1.7	0.2	0.6
Titanite	2.7	1.7	2.4
Grossular	0.5	0.3	0.5
Almandine	-	2.1	0.9
Fluorapatite	-	-	0.6
TOTAL	100	100	100

2.2. QEMSCAN Assay Reconciliation

The QEMSCAN mineralogical assays were regressed with the chemical assays (Figure 1) and are based on the PMA and FS data. The certificate of analysis is presented in Appendix A. The QEMSCAN calculated assays show good correlation with the chemical assays with the overall correlation as measured by the R-squared criteria of 0.99 and a slope (m) of 0.97.

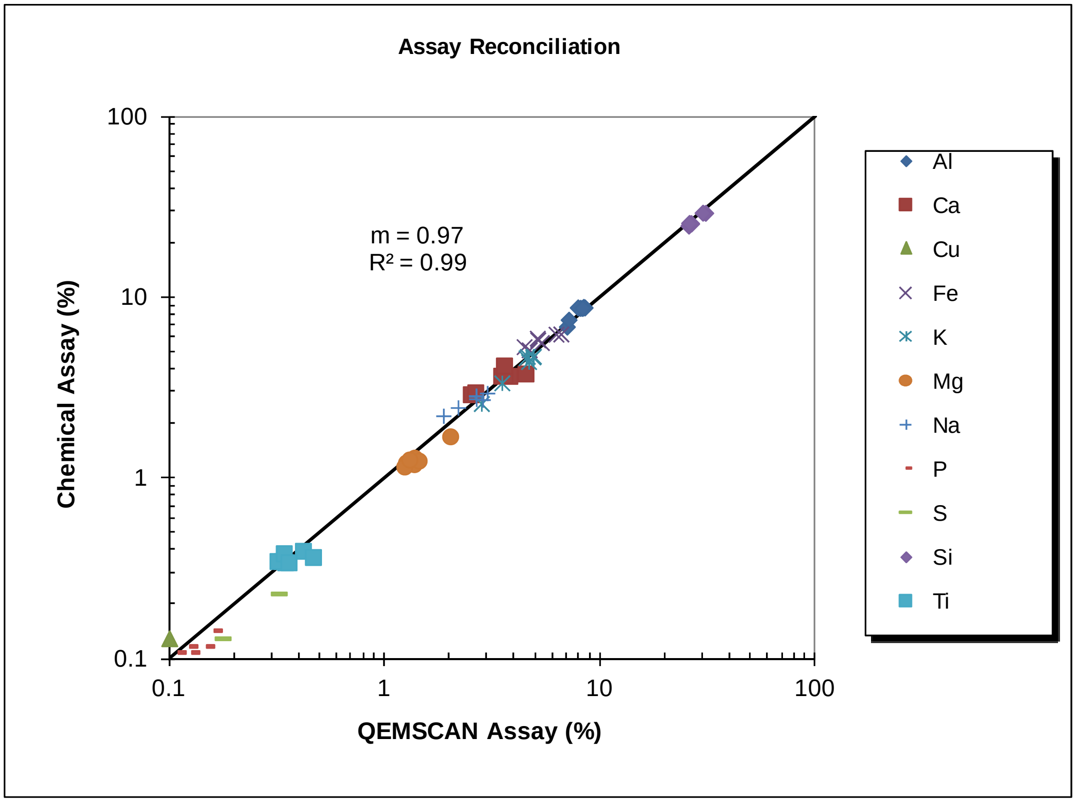


Figure 1: Quality Control – QEMSCAN Calculated vs. Direct Assay Reconciliation

2.3. Bulk Mineral Characterization

The modal abundances (wt%) of the minerals measured by QEMSCAN are presented in Table 6 and graphically illustrated in Figure 2.

The main sulphides present in the samples are pyrite, chalcopyrite and bornite ranging from 0.10% in HC-4 (0.08%, 0.02% and nil, respectively) to 0.64% in HC-6 (0.40%, 0.23% and 0.02%, respectively). The main carbonates are calcite and iron-rich dolomite ranging from 1.15% in HC-4 (0.72% and 0.43%, respectively) to 4.50% in HC-6 (4.45% and 0.05%, respectively). All of the samples are primarily comprised of potassium-feldspar (23.7% to 43.0%) and plagioclase (19.4% to 29.0%), with moderate amounts of quartz in HC-4 (27.1%) and HC-5 (21.3%).

Using the XRD results for samples HC-1/COL-1, HC-4 and HC-6 show that the Fe-oxides consist of magnetite (4.8%, 2.3% and 4.2%, respectively) and hematite (1.7%, 2.2% and 1.7%, respectively).

Table 6: Modal Mineral Abundances by QEMSCAN

Survey		CAVM-50220-103 / MI7008-FEB15						
Project		Mount Polley						
Sample		HC-1/COL-1	HC-1/COL-1 DUP	HC-2/COL-2	HC-3/COL-3	HC-4	HC-5	HC-6
Fraction		-2mm	-2mm	-2mm	-2mm	-2mm	-2mm	-2mm
Mass Size Distribution (%)		100.0	100.0	100.0	100.0	100.0	100.0	100.0
Calculated ESD Particle Size		106	110	67	17	247	180	189
Mineral Mass (%)	Pyrite	0.24	0.32	0.19	0.33	0.08	0.16	0.40
	Chalcopyrite	0.24	0.24	0.18	0.02	0.02	0.16	0.23
	Bornite	0.03	0.02	0.02	0.00	0.00	0.01	0.02
	Other Cu Sulphides	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Other Sulphides	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	Quartz	3.85	5.02	1.26	1.09	27.1	21.3	2.96
	Plagioclase	24.2	24.9	29.0	26.9	19.4	21.3	27.4
	K-Feldspar	43.0	40.5	42.8	39.5	23.7	30.6	39.5
	Sericite/Muscovite	1.52	1.41	1.07	1.46	1.69	1.12	1.82
	Biotite	1.72	1.39	2.16	3.22	1.19	1.34	1.56
	Clinopyroxene	4.33	5.85	5.12	5.03	3.87	3.86	4.62
	Epidote Group	0.87	0.49	0.47	0.28	1.10	0.89	0.40
	Garnet	2.18	2.50	1.81	1.26	3.39	2.46	1.80
	Chlorite	3.81	3.67	3.61	6.91	5.16	4.13	3.84
	Clays	1.77	1.75	1.87	2.27	5.25	4.29	2.76
	Chrysocolla	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Other Silicates	1.86	1.95	1.87	3.15	2.86	1.92	2.16
	Fe-Oxides	6.97	6.51	5.26	4.93	2.84	3.82	4.95
	Ti (Fe) Oxides	0.29	0.23	0.24	0.11	0.64	0.73	0.28
	Calcite	2.23	2.50	2.29	2.64	0.72	1.27	4.45
	Dolomite (Fe)	0.11	0.05	0.04	0.02	0.43	0.15	0.05
	Malachite	0.01	0.01	0.00	0.00	0.00	0.00	0.01
	Apatite	0.70	0.60	0.68	0.88	0.44	0.51	0.81
	Other	0.03	0.05	0.03	0.05	0.04	0.03	0.02
	Total	100	100	100	100	100	100	100

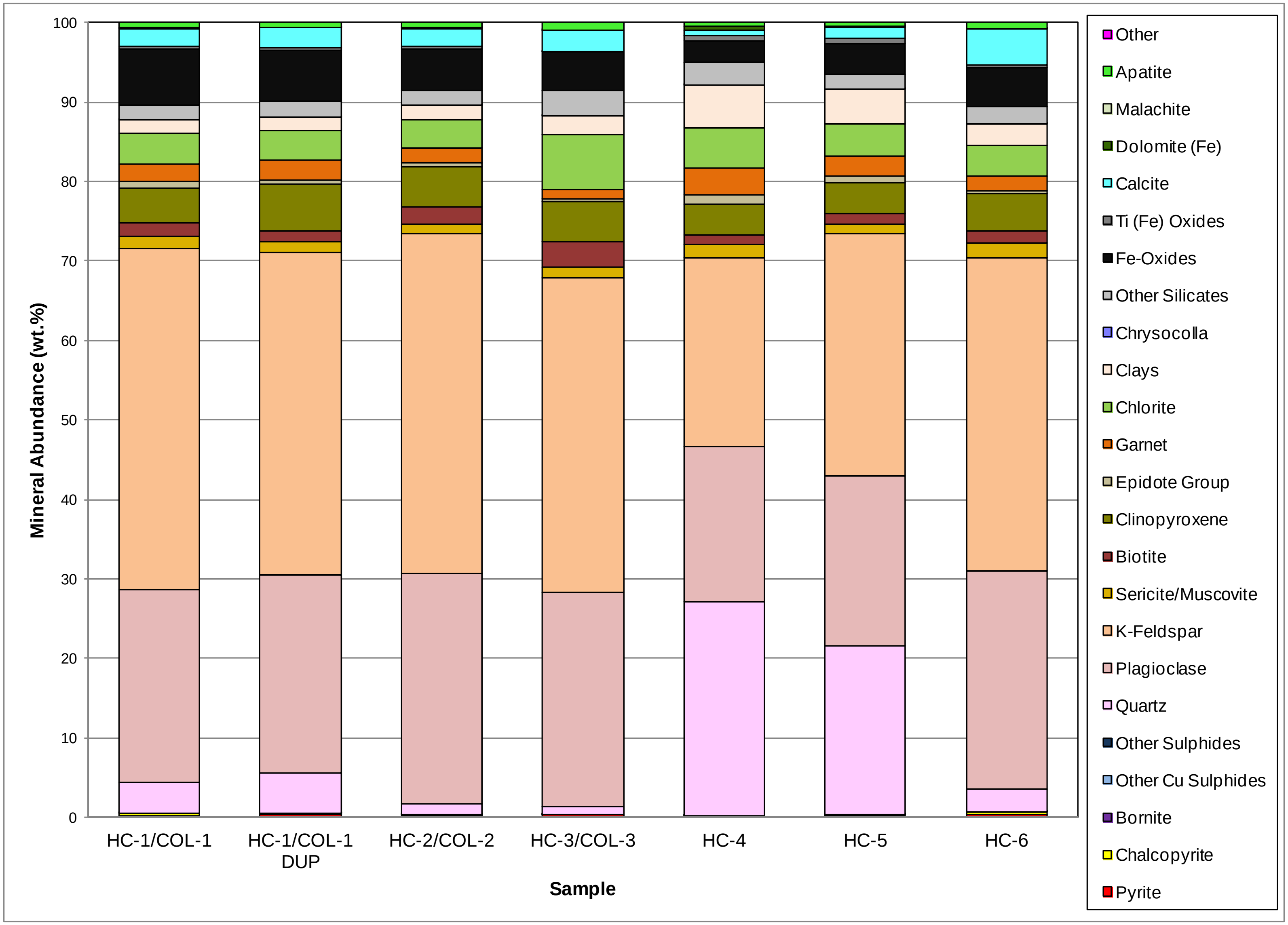


Figure 2: Modal Mineral Abundances by QEMSCAN

3. Elemental Deportment

Electron Microprobe Analysis was carried out on the main sulphides, silicates and carbonate minerals to determine their chemical compositions and to define the possible carriers of copper and selenium. The average elemental compositions (in weight percent) are summarized below and the complete EMPA report is presented in Appendix C.

The elemental distribution data are given in weight percent. The deportment calculations are based on the average elemental composition from the EMPA analysis and QEMSCAN modal distributions. The absolute data is presented in Appendix D.

3.1. Electron Microprobe Analysis

The average elemental compositions are below from Table 7 to Table 9. Copper (Cu) is carried in the silicate minerals by an Al-Fe silicate phase (which possibly resembles a chlorite texture) and chlorite with an average of 1.85% and 0.41%, respectively. The value of 1.85% copper within the Al-Fe silicate could fine grained copper oxide within the silicates which shows possible copper remobilisation. Images from the electron microprobe can be seen in Appendix C (Figure 2 within the appendix), which shows higher copper zoning around holes within the particle (this was also seen under the QEMSCAN SEM). Further work is needed in order to fully understand this copper occurrence within these altered particles.

All of the silicates have selenium (Se) below detection limits of the EMPA.

The average copper content in bornite and chalcopyrite is 62.2% and 34.3%, respectively. Pyrite contains an average of 0.02% copper, which is at the detection limit of the electron microprobe. Bornite carries 0.06% of the selenium which is based only on four particles analysed and thus the result must be interpreted with caution. Chalcopyrite and pyrite have selenium below the detection limits of the electron microprobe. It is recommended that Laser Ablation be carried out on the other sulphides as it has a lower detection limit than the electron microprobe to further understand the deportment of selenium.

The average concentration of iron (Fe) in dolomite is 6.44% and in calcite 0.13%. Dolomite is referred to as dolomite (Fe) within the report due to its iron content.

Table 7: Average Elemental Composition of the Silicate Minerals and Fe-Oxides

EMPA Average		Na	Se	Ca	K	Fe	Si	Mg	Ti	Cl	Mn	Al	Cr	P	Cu	V	No. of Analyses
Chlorite	*Detection Limit*	*0.02*	*0.02*	*0.01*	*0.01*	*0.01*	*0.02*	*0.02*	*0.02*	*0.01*	*0.02*	*0.01*	*0.02*	*0.02*	*0.02*	*0.02*	31
	Element (wt%)	**0.02**	**0.01**	**0.39**	**0.50**	**14.0**	**14.8**	**11.3**	**0.47**	**0.03**	**0.40**	**8.68**	**0.01**	**0.01**	**0.41**	**0.03**	
SiAlFe	*Detection Limit*	*0.02*	*0.02*	*0.01*	*0.01*	*0.02*	*0.02*	*0.02*	*0.02*	*0.01*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	4
	Element (wt%)	**0.07**	**0.01**	**1.49**	**0.81**	**12.3**	**24.1**	**0.47**	**0.00**	**0.01**	**0.04**	**9.39**	**0.00**	**0.01**	**1.85**	**0.00**	
Fe Oxide	*Detection Limit*	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.01	0.03	0.02	0.03	0.02	8
	Element (wt%)	***0.00***	***0.01***	***0.02***	***0.01***	***70.9***	***0.12***	***0.07***	***0.27***	***0.00***	***0.18***	***0.23***	***0.15***	***0.00***	***0.00***	***0.38***	
Orthoclase	*Detection Limit*	*0.02*	*0.02*	*0.01*	*0.01*	*0.01*	*0.02*	*0.02*	*0.02*	*0.01*	*0.01*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	17
	Element (wt%)	**0.33**	**0.01**	**0.04**	**13.9**	**0.20**	**30.1**	**0.01**	**0.01**	**0.01**	**0.01**	**9.69**	**0.00**	**0.00**	**0.00**	**0.00**	
Albite	*Detection Limit*	*0.02*	*0.02*	*0.01*	*0.01*	*0.01*	*0.02*	*0.02*	*0.02*	*0.01*	*0.01*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	10
	Element (wt%)	**8.01**	**0.01**	**0.49**	**0.59**	**0.13**	**31.4**	**0.03**	**0.00**	**0.01**	**0.01**	**11.2**	**0.00**	**0.00**	**0.00**	**0.00**	
Mica	*Detection Limit*	*0.02*	*0.02*	*0.01*	*0.01*	*0.01*	*0.02*	*0.02*	*0.02*	*0.01*	*0.02*	*0.01*	*0.02*	*0.02*	*0.02*	*0.02*	6
	Element (wt%)	**0.17**	**0.00**	**0.07**	**7.32**	**8.83**	**17.4**	**11.4**	**2.51**	**0.13**	**0.20**	**7.41**	**0.00**	**0.00**	**0.00**	**0.02**	
Pyroxene	*Detection Limit*	*0.02*	*0.02*	*0.01*	*0.01*	*0.02*	*0.02*	*0.02*	*0.02*	*0.01*	*0.02*	*0.01*	*0.02*	*0.02*	*0.02*	*0.02*	3
	Element (wt%)	**0.38**	**0.00**	**16.7**	**0.00**	**5.08**	**24.3**	**9.03**	**0.21**	**0.01**	**0.24**	**1.23**	**0.10**	**0.00**	**0.00**	**0.02**	
Sphene	*Detection Limit*	*0.02*	*0.02*	*0.01*	*0.01*	*0.02*	*0.02*	*0.02*	*0.03*	*0.02*	*0.02*	*0.01*	*0.02*	*0.02*	*0.02*	*0.02*	3
	Element (wt%)	**0.01**	**0.01**	**20.5**	**0.03**	**1.27**	**14.4**	**0.01**	**22.3**	**0.01**	**0.05**	**0.50**	**0.00**	**0.04**	**0.00**	**0.07**	
Epidote	*Detection Limit*	*0.02*	*0.02*	*0.01*	*0.01*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.03*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	2
	Element (wt%)	**0.00**	**0.01**	**20.8**	**0.02**	**9.68**	**17.7**	**0.09**	**0.13**	**0.00**	**0.52**	**9.31**	**0.01**	**0.01**	**0.00**	**0.01**	

Table 8: Average Elemental Composition of the Sulphide Minerals

EMPA Average		As	Se	Cu	S	Fe	Co	Sb	Ni	Zn	No. of Analyses
Chalcopyrite	*Detection Limit*	*0.03*	*0.04*	*0.03*	*0.01*	*0.02*	*0.02*	*0.10*	*0.02*	*0.03*	29
	Element (wt%)	**0.01**	**0.03**	**34.3**	**35.0**	**30.2**	**0.00**	**0.00**	**0.00**	**0.00**	
Pyrite	*Detection Limit*	*0.03*	*0.04*	*0.02*	*0.01*	*0.02*	*0.02*	*0.09*	*0.01*	*0.03*	8
	Element (wt%)	**0.03**	**0.01**	**0.02**	**53.7**	**46.2**	**0.12**	**0.00**	**0.01**	**0.00**	
Bornite	*Detection Limit*	*0.03*	*0.04*	*0.03*	*0.01*	*0.02*	*0.02*	*0.10*	*0.02*	*0.03*	4
	Element (wt%)	**0.01**	**0.06**	**62.2**	**26.5**	**11.5**	**0.00**	**0.00**	**0.00**	**0.00**	

Table 9: Average Elemental Composition of the Carbonate Minerals

EMPA Average		Ca	Mg	Sr	Fe	Mn	C	No. of Analyses
Calcite	*Detection Limit*	*0.03*	*0.03*	*0.05*	*0.04*	*0.04*	*N/A*	31
	Element (wt%)	**39.2**	**0.03**	**0.03**	**0.13**	**0.28**	**12.1**	
Dolomite	*Detection Limit*	*0.03*	*0.03*	*0.05*	*0.04*	*0.04*	*N/A*	2
	Element (wt%)	**19.9**	**10.1**	**0.03**	**6.44**	**0.48**	**12.7**	

3.2. Selenium Deportment

Based on the EMPA data all of the selenium (Se) in the samples is carried by bornite. However, the presence of selenides as micrometric inclusions within the sulphides cannot be excluded which are impossible to identify with the QEMSCAN. Note that this is only based on four bornite particles, and must be taken into context of the overall grade of the selenium within the samples.

3.3. Copper Deportment

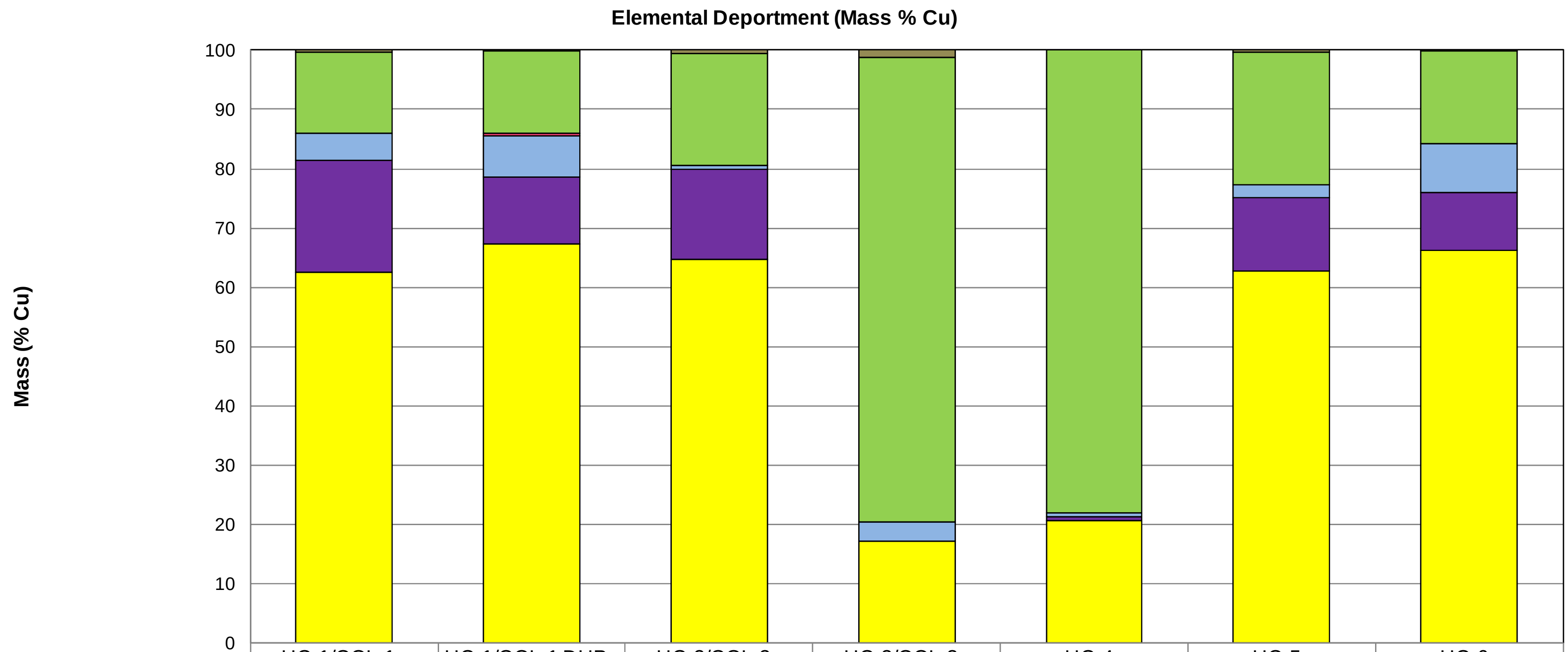
The elemental distribution of copper (Cu) in the seven samples is presented below in Figure 3. Pyrite was not included in the deportment data due to the amount (0.02%) being at the detection limit of the electron microprobe and only eight grains being analysed. The Al-Fe silicate that contains 1.85% copper has also not been included in the copper deportment because there were only four analyses taken.

In samples HC-1/COL-1, HC-1-COL-1 DUP, HC-2/COL-2, HC-5, and HC-6, copper is predominantly carried in the chalcopyrite (62-67%), followed by chlorite (14-22%), bornite (10-19%), and chalcocite/covellite (1-8%) accounting for the majority of the remainder.

In samples HC-3/COL-3 and HC-4, copper is predominantly carried by chlorite (78%), followed by chalcopyrite (17-20%) and chalcocite/covellite (1-3%).

From the QEMSCAN data an iron oxide/silicate was defined that contained copper (2% copper was used as a tentative value for the deportment analysis), but as this was not found during the probe work, so the exact chemistry is unknown at this time. Further work is recommended on defining this phase.

Note that the copper value (0.41%) assigned to chlorite. However, this value can vary widely, due to the copper present being very fine grained (micrometric) and/or present within the crystal structure which cannot be defined properly by the QEMSCAN. Thus, caution must be taken when using this data as there could be an overestimation of the amount of copper that is contributed by chlorite.



	HC-1/COL-1:	HC-1/COL-1 DUP:	HC-2/COL-2:	HC-3/COL-3:	HC-4:	HC-5:	HC-6:
Fe Ox_Silicate_low Cu	0.29	0.14	0.50	1.17	0.03	0.33	0.11
Chlorite	13.8	13.8	19.0	78.4	78.0	22.3	15.7
Enargite	0.00	0.55	0.00	0.00	0.00	0.00	0.00
Chalcocite/Covellite	4.36	6.85	0.59	3.30	0.80	2.29	8.09
Bornite	19.0	11.4	15.3	0.00	0.67	12.3	9.82
Chalcopyrite	62.5	67.2	64.6	17.1	20.5	62.8	66.3

Figure 3: Copper Deportment (Normalized)

4. Mineral Characteristics

4.1. Mineral Exposure

Mineral exposure measures the surface exposure of the mineral or minerals of interest which could correlate with the ARD potential of a sample. For example, if the phases are well exposed the potential for reactivity is greater; but if the carbonate exposure is also high, then the ability of these particles to neutralize acid is more significant.

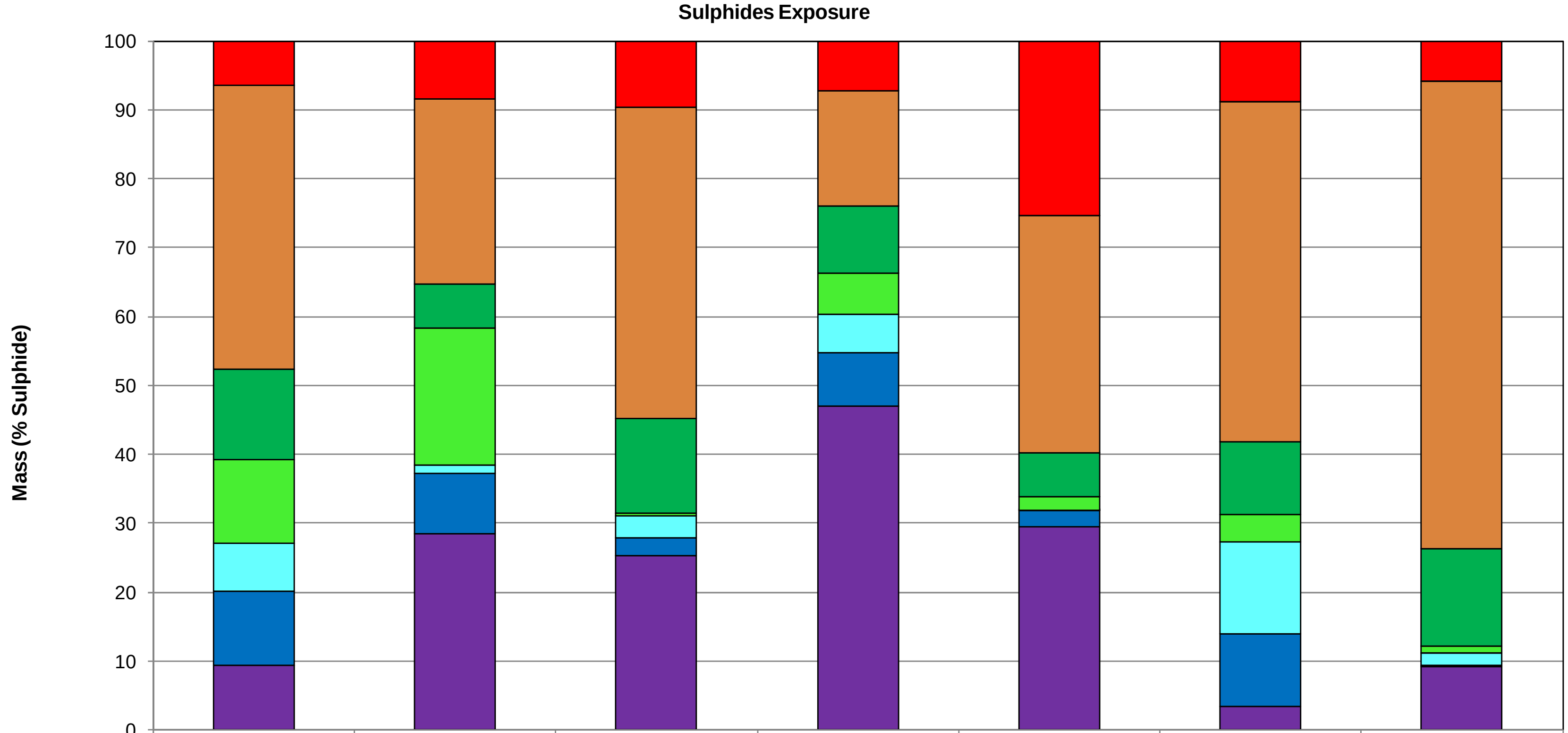
Exposure measures the surface exposure of the mineral or minerals of interest, with exposed minerals containing a surface exposure greater than 80%. Both the mineral exposure for the sulphide and carbonate minerals is presented below in weight percent and is based on the as received -2 mm fraction.

4.1.1. Sulphide Exposure

The sulphide exposure data are presented in Figure 4. Sulphides are defined as the combination all of the sulphides as one mineral group (pyrite, chalcopyrite, bornite etc.). An image grid and particle maps, which visually illustrates the sulphide exposure within the particles are presented

Figure 5Figure 5 and Figure 6, respectively. The absolute data are presented in Appendix D.

Sample HC-3/COL-3 shows the highest exposure with 47.0% exposed (>80% exposed), and 19.3% between 20-80% exposed. The remainder is less than 20% exposed (26.5%) and locked (7.2%). HC-6 shows the lowest exposure with 81.8% less than 20% exposed, 9.1% exposed, and 3.1% between 20-80% exposed. The remainder (5.9%) is locked. HC-4 has the highest percentage of locked sulphides at 25.3%.



	HC-1/COL-1	HC-1/COL-1 DUP	HC-2/COL-2	HC-3/COL-3	HC-4	HC-5	HC-6
Locked	6.43	8.45	9.64	7.19	25.3	8.88	5.94
0-10% Exposed	41.2	26.7	45.1	16.7	34.4	49.4	67.7
10-20% Exposed	13.2	6.37	13.7	9.85	6.45	10.4	14.2
20-30% Exposed	12.1	20.1	0.51	5.90	1.93	3.98	1.11
30-50% Exposed	6.90	1.18	3.10	5.57	0.14	13.4	1.71
50-80% Exposed	10.8	8.77	2.56	7.86	2.40	10.6	0.30
Exposed	9.34	28.4	25.4	47.0	29.4	3.37	9.13

Figure 4: Sulphide Exposure (Normalized)

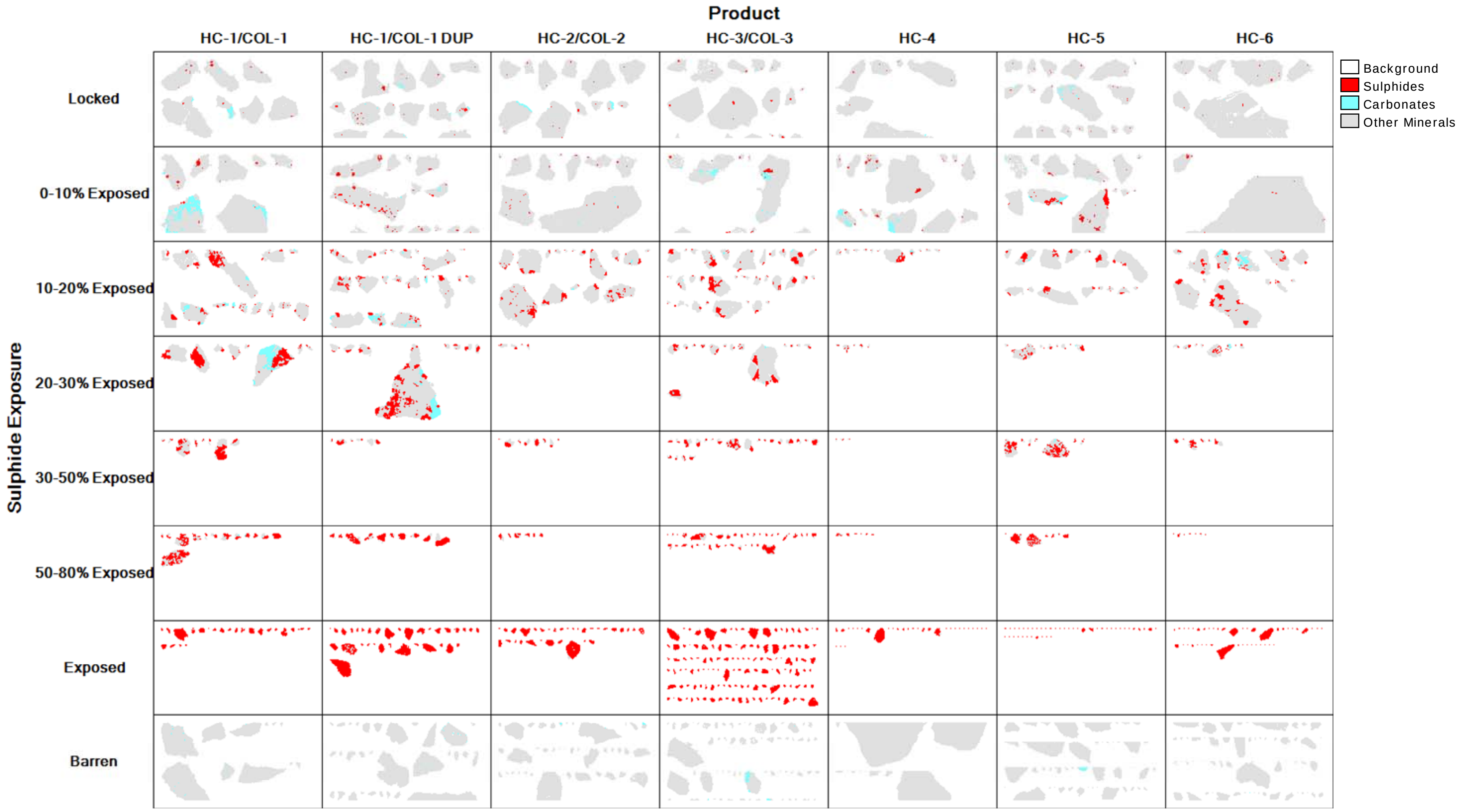
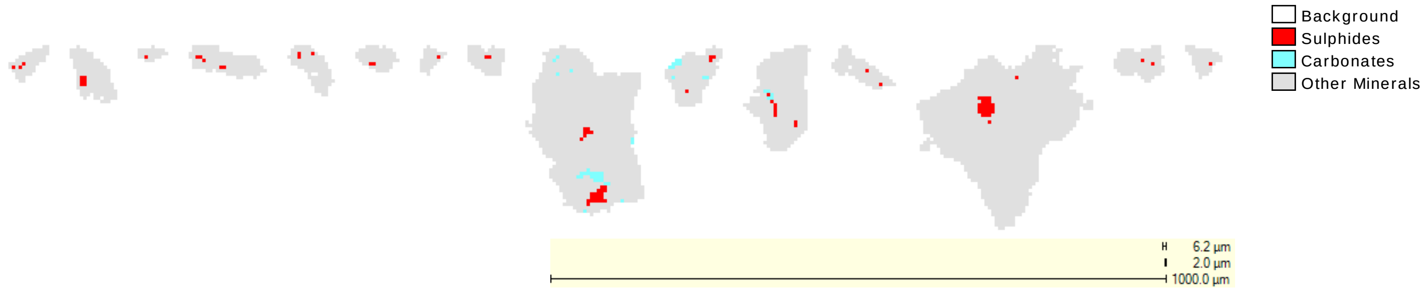
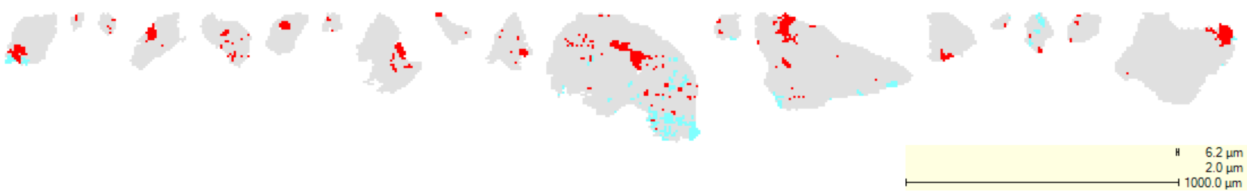


Figure 5: Image Grid of Sulphide Exposure

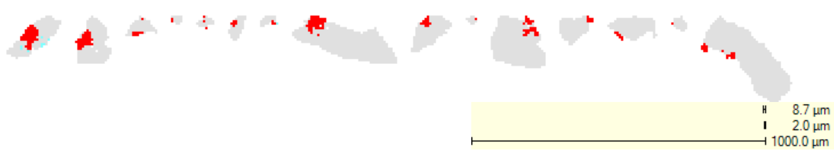
HC-2/COL-2: Sulphides Locked



HC-1/COL-1: Sulphides 0-10% Exposed



HC-5: Sulphides 10-20% Exposed



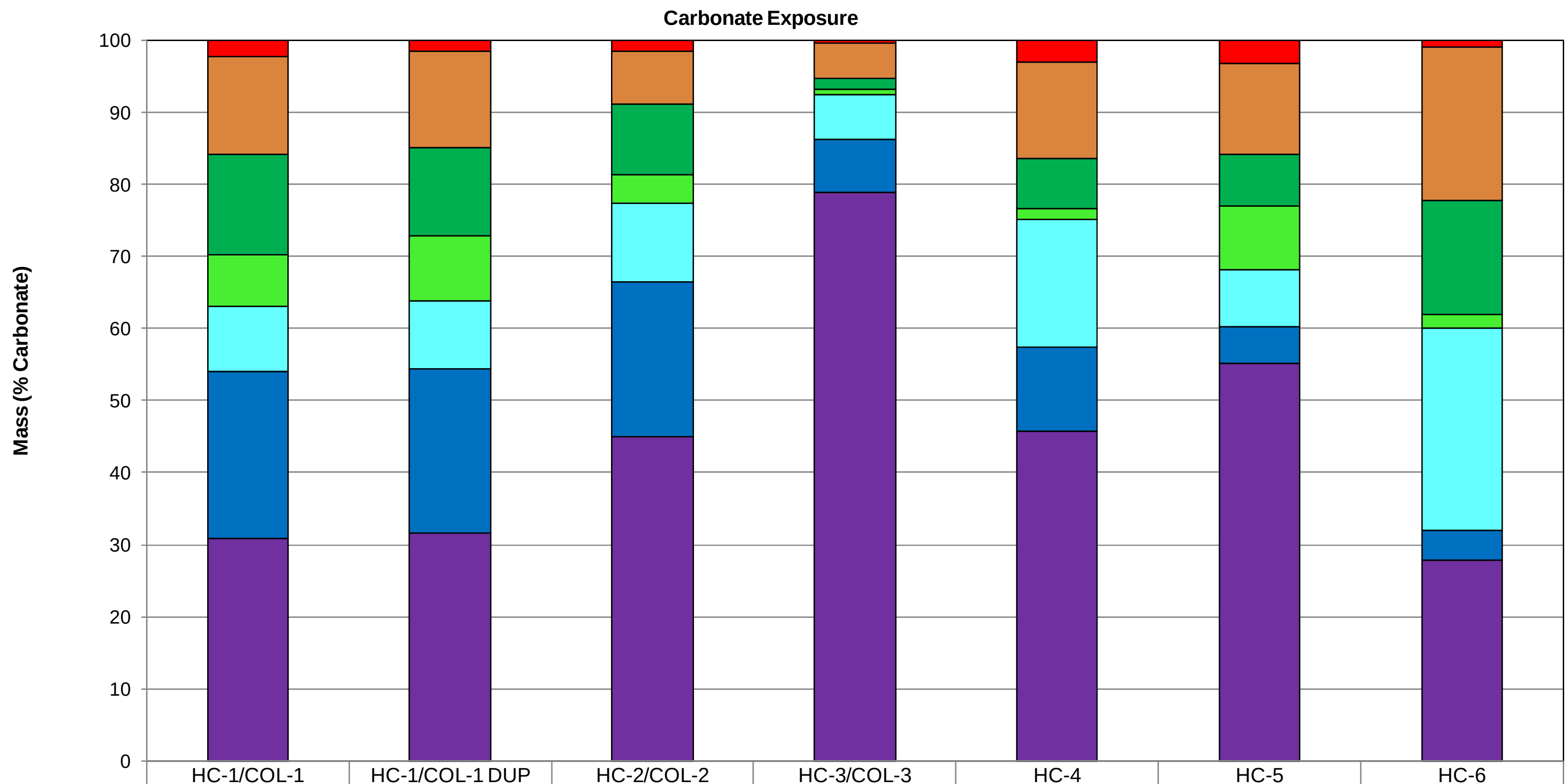
HC-6: Sulphides 20-30% Exposed

Figure 6: Selected Particle Maps of Sulphide Exposure

4.1.2. Carbonate Exposure

The carbonate exposure data are presented in Figure 7. The carbonates group is defined as a combination of calcite and dolomite. An image grid and particle maps, which visually illustrates the carbonate exposure within the particles are presented in Figure 8 and Figure 9, respectively. The absolute data are presented in Appendix D.

Sample HC-3/COL-3 shows the highest exposure with 78.9% exposed (>80% exposed) and 14.3% between 20-80% exposed. The remainder is less than 20% exposed (6.4%) and locked (<1%). HC-6 shows the lowest exposure with 27.9% exposed, 34.0% between 20-80% exposed, 37.1% less than 20% exposed and (<1%) locked.



	HC-1/COL-1	HC-1/COL-1 DUP	HC-2/COL-2	HC-3/COL-3	HC-4	HC-5	HC-6
Locked	2.21	1.48	1.52	0.46	2.93	3.20	0.96
0-10% Exposed	13.6	13.4	7.35	4.89	13.5	12.6	21.3
10-20% Exposed	13.9	12.3	9.85	1.51	7.04	7.14	15.8
20-30% Exposed	7.27	8.89	3.93	0.59	1.47	8.82	1.82
30-50% Exposed	8.93	9.51	10.9	6.30	17.6	7.94	28.2
50-80% Exposed	23.1	22.9	21.5	7.40	11.7	5.24	4.06
Exposed	30.9	31.5	44.9	78.9	45.8	55.1	27.9

Figure 7: Carbonate Exposure (Normalized)

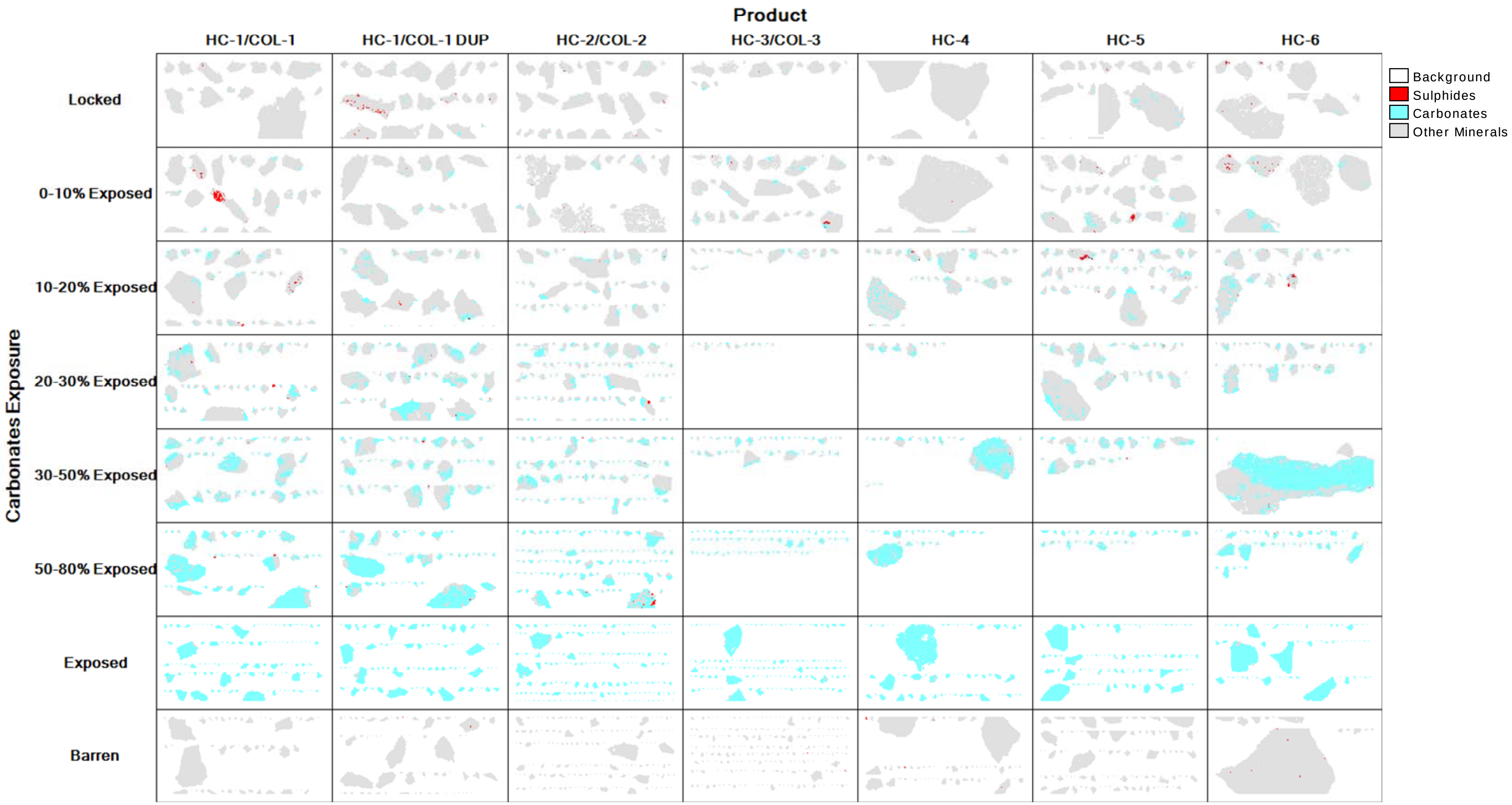
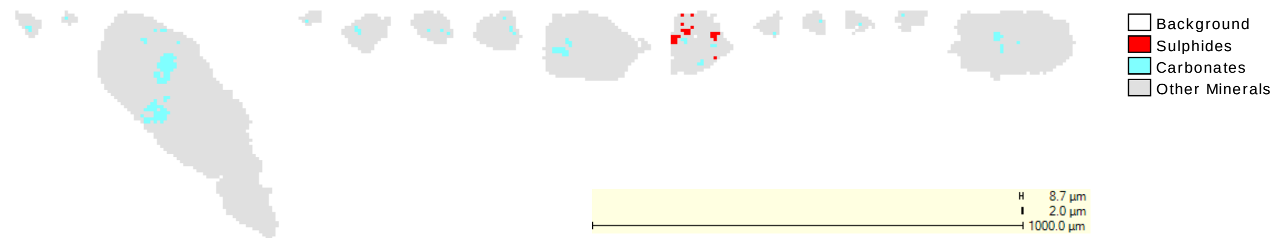
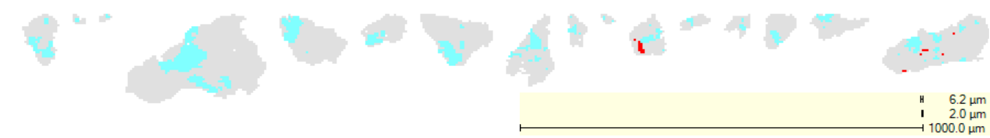


Figure 8: Image Grid of Carbonate Exposure

<u>HC-4: Carbonates Locked</u>



<u>HC-1/COL-1 DUP: Carbonates 0-10% Exposed</u>



<u>HC-6: Carbonates 10-20% Exposed</u>

<u>HC-2/COL-2: Carbonates 20-30% Exposed</u>

Figure 9: Selected Particle Maps of Carbonate Exposure

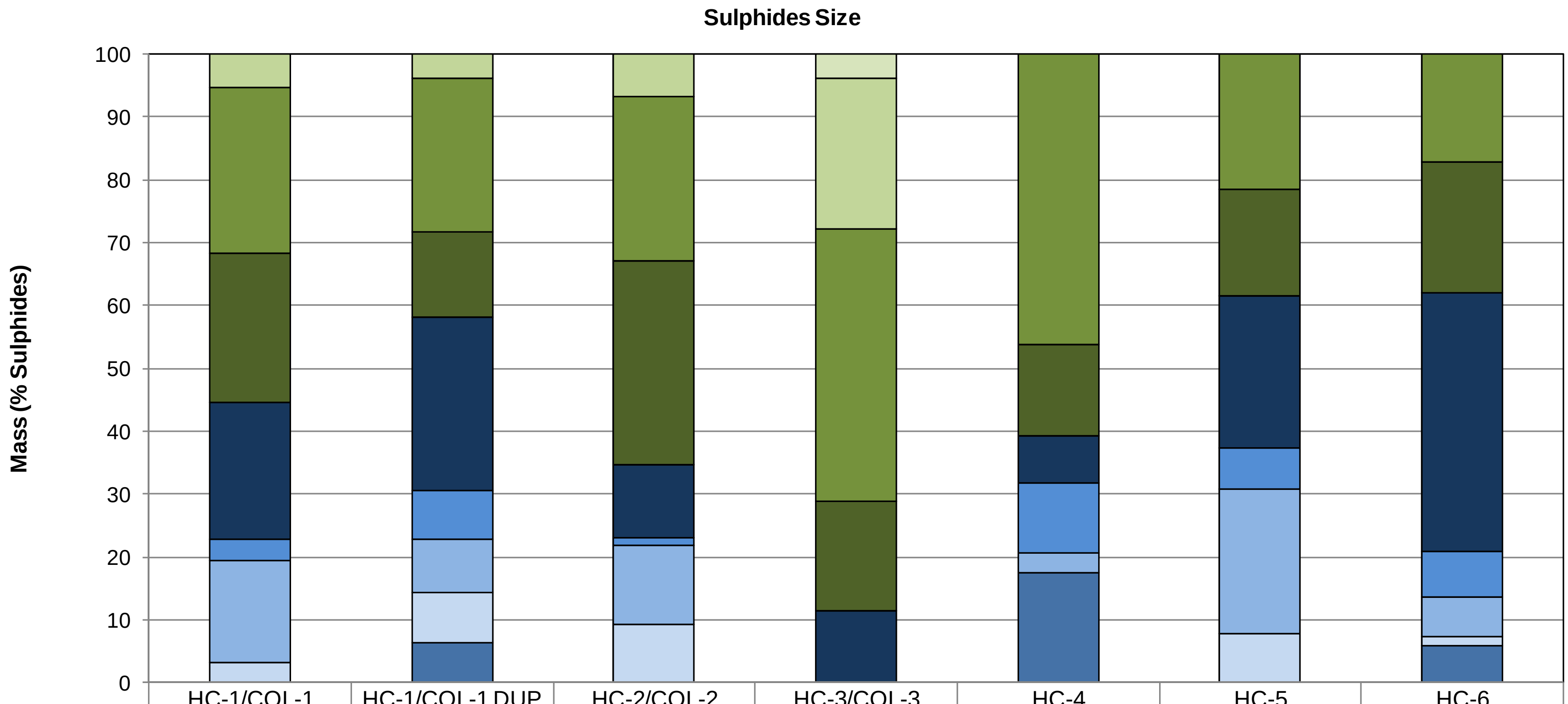
4.2. Particle Size

Particle size is calculated for the sulphide and carbonate minerals.

4.2.1. Sulphide Size

The data of the sulphide size is presented in Figure 10. The absolute data is presented in Appendix D.

Sample HC-3/COL-3 contains the finest sulphides with 88.4% of the mass at less than 30 µm, and the remainder (11.6%) between 30-40 µm; whereas sample HC-4 contains the coarsest sulphides with 17.6% greater than 75 µm, 21.7% between 30-75 µm and 60.7% less than 30 µm in size.



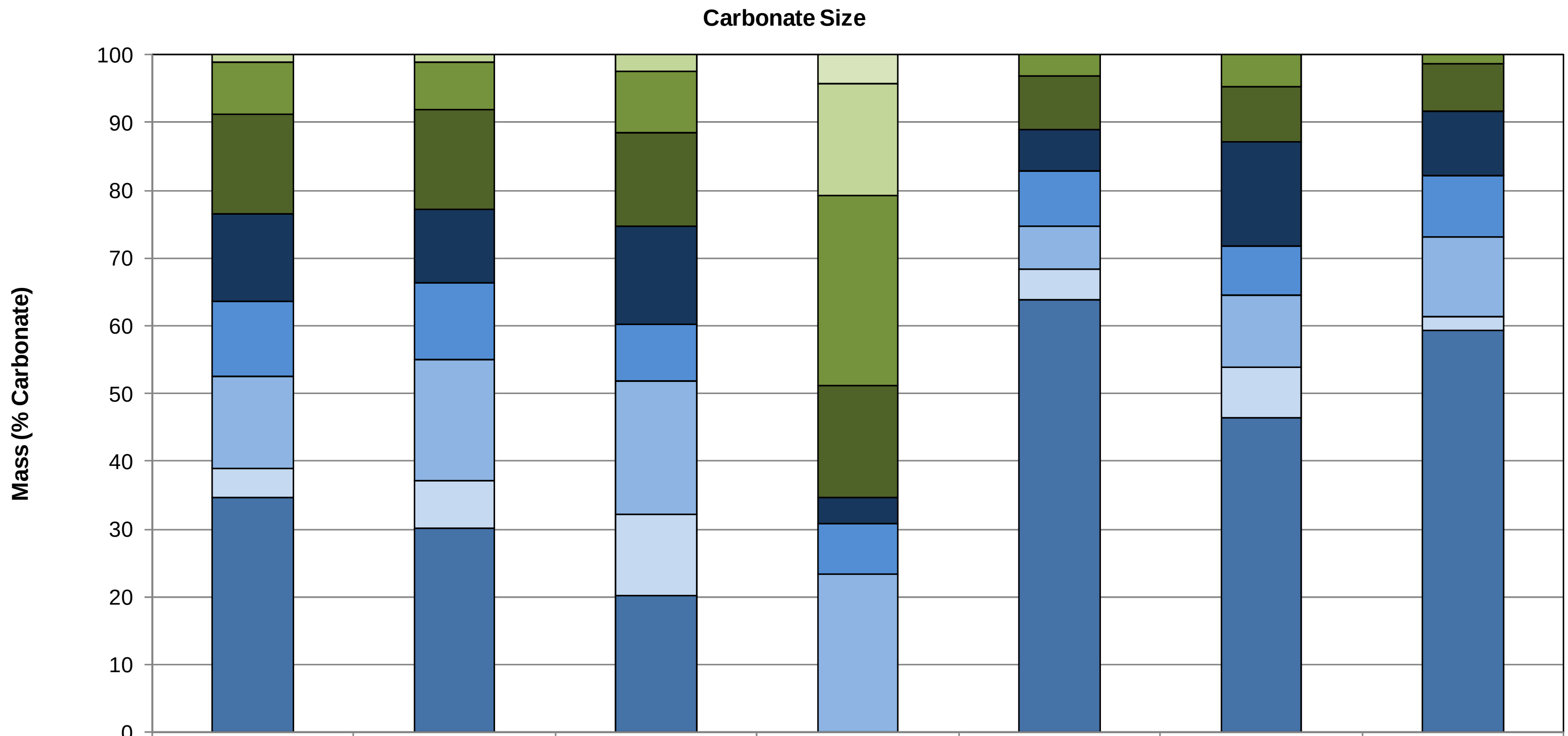
	HC-1/COL-1	HC-1/COL-1 DUP	HC-2/COL-2	HC-3/COL-3	HC-4	HC-5	HC-6
<5 µm	0.00	0.00	0.00	3.92	0.00	0.00	0.00
5-10 µm	5.41	3.78	6.69	23.8	0.00	0.00	0.00
10-20 µm	26.3	24.6	26.3	43.4	46.2	21.6	17.2
20-30 µm	23.7	13.4	32.3	17.3	14.5	16.8	20.7
30-40 µm	21.8	27.6	11.7	11.6	7.59	24.3	41.1
40-50 µm	3.29	7.64	1.07	0.00	11.0	6.47	7.33
50-75 µm	16.2	8.52	12.6	0.00	3.11	23.0	6.28
75-100 µm	3.32	7.94	9.32	0.00	0.00	7.82	1.39
>100 µm	0.00	6.46	0.00	0.00	17.6	0.00	6.02

Figure 10: Sulphide Particle Size (Normalized)

4.2.2. Carbonate Size

The carbonate minerals size data is presented in Figure 11. The absolute data is presented in Appendix E.

Sample HC-3/COL-3 contains the finest carbonates with 65.3% of the mass at less than 30 µm in size, and 34.7% between 30-75 µm; whereas sample HC-6 contains the coarsest carbonates with 59.3% greater than 100 µm, 32.3% between 30-75 µm, and 8.4% at less than 30 µm in size.



	HC-1/COL-1	HC-1/COL-1 DUP	HC-2/COL-2	HC-3/COL-3	HC-4	HC-5	HC-6
<5 µm	0.00	0.00	0.00	4.25	0.00	0.00	0.00
5-10 µm	1.19	1.18	2.46	16.5	0.00	0.00	0.00
10-20 µm	7.59	6.99	9.08	27.9	3.09	4.68	1.36
20-30 µm	14.8	14.5	13.8	16.5	7.93	8.20	7.06
30-40 µm	12.8	10.9	14.4	4.00	6.24	15.3	9.35
40-50 µm	11.1	11.4	8.27	7.30	8.03	7.29	9.05
50-75 µm	13.5	18.0	19.7	23.4	6.29	10.5	11.9
75-100 µm	4.42	6.98	12.0	0.00	4.64	7.44	1.95
>100 µm	34.6	30.1	20.2	0.00	63.8	46.5	59.3

Figure 11: Carbonate Particle Size (Normalized)

Conclusions and Recommendations

- The main sulphides present are pyrite, chalcopyrite and bornite.
- Carbonates have been identified as calcite and iron bearing dolomite (from EMPA data).
- Iron-oxides consist of magnetite and hematite, as identified by Rietveld XRD.
- The main carriers of copper have been identified as chalcopyrite, bornite, chalcocite/covellite, enargite and silicates such as chlorite and an iron oxide/silicate phase.
- Selenium was identified in four bornite grains that were above the detection limit of the EMPA. However, the presence of selenides as micrometric inclusions within the sulphides cannot be excluded which are impossible to identify with the QEMSCAN. It is recommended that additional work like SEM and Laser Ablation be carried out to further investigate this, which is beyond the scope of this project.
- HC-3/COL-3 contains the highest exposed sulphides (>20% exposure) at 66% and HC-6 the lowest at 12%.
- HC-3/COL-3 contains the highest exposed carbonates (>20% exposure) at 93% and HC-6 the lowest at 62%.
- The majority of the sulphides are <75 µm in size.
- The carbonates range in size with HC-3/COL-3 containing the finest carbonates at 65.3% of the mass less than 30 µm in size and sample HC-6 with the coarsest carbonates at 59.3% greater than 100 µm.

Appendix A – Certificate of Analysis

Certificate of Analysis

Work Order : VC150553

[Report File No.: 0000010617]

To: **Morgan Gibson-Wright**
F400101 SGS CANADA INC
3260 PRODUCTION WAY
BURNABY BC V5A 4W4

Date: Mar 09, 2015

P.O. No.	:	MI7008-FEB15
Project No.	:	CAVM-50220-103
No. Of Samples	:	7
Date Submitted	:	Mar 03, 2015
Report Comprises	:	Pages 1 to 3 (Inclusive of Cover Sheet)

Distribution of unused material:
Active files:

Certified By : ____________________
Cam Chiang
Assistant Operations Manager

SGS Minerals Services Geochemistry Vancouver conforms to the requirements of ISO/IEC 17025 for specific tests as listed on their scope of accreditation which can be found at http://www.scc.ca/en/search/palcan/sgs

Report Footer:

L.N.R.	= Listed not received	I.S.	= Insufficient Sample
n.a.	= Not applicable	--	= No result

*INF = Composition of this sample makes detection impossible by this method

M after a result denotes ppb to ppm conversion, % denotes ppm to % conversion

Methods marked with an asterisk (e.g. *NAA08V) were subcontracted
Elements marked with the **@** symbol (e.g. @Cu) denote assays performed using accredited test methods

Final : VC150553 Order: MI7008-FEB15

Report File No.: 0000010617

Element	LOI	SiO2	Al2O3	Fe2O3	MgO	CaO	K2O	Na2O
Method	GO_XRF76V	GO_XRF76V	GO_XRF76V	GO_XRF76V	GO_XRF76V	GO_XRF76V	GO_XRF76V	GO_XRF76V
Det.Lim.	-10.000	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Units	%	%	%	%	%	%	%	%
HC-1/COL-1	2.38	54.7	16.5	8.96	2.02	5.15	5.69	3.85
HC-1/COL-1 DUP	2.47	55.0	16.6	8.93	1.98	5.14	5.67	3.82
HC-2/COL-2	2.74	54.7	16.6	8.49	2.15	5.20	5.63	3.98
HC-3/COL-3	4.20	53.3	16.7	8.03	2.82	5.87	5.31	3.66
HC-4	4.17	62.7	13.0	7.62	2.07	4.07	3.11	2.98
HC-5	2.56	62.8	14.2	7.32	1.92	4.17	4.05	3.31
HC-6	2.90	55.1	16.5	8.31	2.10	5.30	5.57	3.70

Element	TiO2	MnO	P2O5	Cr2O3	V2O5	Sum
Method	GO_XRF76V	GO_XRF76V	GO_XRF76V	GO_XRF76V	GO_XRF76V	GO_XRF76V
Det.Lim.	0.01	0.01	0.01	0.01	0.01	0
Units	%	%	%	%	%	%
HC-1/COL-1	0.57	0.12	0.25	0.02	0.04	100.3
HC-1/COL-1 DUP	0.58	0.13	0.25	0.02	0.04	100.6
HC-2/COL-2	0.58	0.12	0.27	0.02	0.05	100.5
HC-3/COL-3	0.64	0.14	0.33	0.02	0.04	101.0
HC-4	0.66	0.13	0.22	0.04	0.04	100.8
HC-5	0.61	0.11	0.22	0.03	0.04	101.3
HC-6	0.57	0.13	0.27	0.02	0.04	100.5

Appendix B – XRD Analysis

Provided on CD

Appendix C – EMPA Data

Provided on CD

Appendix D – Additional QEMSCAN Data

Provided on CD

Appendix C8 : Quantitative X-Ray Diffraction by Rietveld Refinement

Provided on CD

Appendix D – Sequential Extraction Results

Provided on CD

APPENDIX D: SOIL QUALITY IMPACT ASSESSMENT

Trevor McConkey, M.Sc., P.Ag. and Daniel Schneider, R.P. Bio. P.Ag.

SNC-Lavalin Inc.

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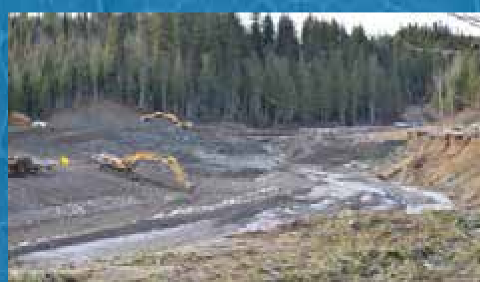
SNC·LAVALIN

SOIL QUALITY IMPACT ASSESSMENT

Hazeltine Creek Study Area
Mount Polley Mine, BC

Prepared for: Mount Polley Mining Corporation




SNC-LAVALIN INC.

June 3, 2015

FINAL REPORT / V-01
621717

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List of Abbreviations

ALR – Agricultural Land Reserve

ALS – ALS Laboratory Group

ASTM – American Society for Testing Materials

Avg. – Average

BC – British Columbia

bgs – Below Ground Surface

CALA – Canadian Association for Laboratory Accreditation

C - Carbon

CCME – Canadian Council of Minister of the Environment

CEC – Cation Exchange Capacity

CEIA – Comprehensive Environmental Impact Assessment

COC – Contaminant of Concern

COPC – Contaminants of Potential Concern

CSR – *Contaminated Sites Regulation* (CSR), B.C. Reg. 375/96, including amendments up to B.C. Reg. 4/2014, January 31, 2014.

CSR PL – Contaminated Site Regulation – Park Land

CSR WL – Contaminated Site Regulation – Wildlands

CSSC – Canadian System of Soil Classification

CSST – Contaminated Sites Soil Task Group

EC – Electrical Conductivity

EPH – Extractable Petroleum Hydrocarbons

ESP –Extractable Sodium Percentage

FSR – Forest Service Road

GIS – Geographic Information System

List of Abbreviations (Cont'd)

GLBD – Growth Limiting Bulk Density

Golder – Golder Associates Ltd.

GPS – Global Positioning System

HEPH – Heavy Extractable Petroleum Hydrocarbon

HIA – Hydrotechnical and Geomorphological Impact Assessment

ID – Identification Number

LEPH – Light Extractable Petroleum Hydrocarbon

LFH – Forest Floor (Litter, Fermented, Humus)

LiDAR – Light Detection and Ranging

Max – Maximum

MEM – Ministry of Energy and Mines

MIBC – Methyl Isobutyl Carbinol

MIBK – Methyl Isobutyl Ketone

Min – Minimum

Mine – Mount Polley Mine

MoE – Ministry of Environment

MPMC – Mount Polley Mining Company

MSDS – Material Safety Data Sheet N – Sample size (number of samples)

PAH – Polycyclic Aromatic Hydrocarbons

PEEIAR – Post-Event Environmental Impact Assessment Report

POPs – Preferred Operating Procedures

QA/QC – Quality Assurance/ Quality Control

R^2 Value – Coefficient of Determination

List of Abbreviations (Cont'd)

RPD – Relative Percent Difference

SALM – Strong Acid Leachable Method

SAR – Sodium Adsorption Ratio

study area – Hazeltine Creek Study Area

SQIA – Soil Quality Impact Assessment

SRC – Sample Receipt Confirmation

SRK – SRK Consulting (Canada) Inc

ST – Soil Transect

TIA – Terrestrial Impact Assessment

TDS – Total Dissolved Solids

TP – Test Pit

TSF – Tailings Storage Facility

UCLM – Upper Confidence Limit of the Mean

USCS – Unified Soil Classification System

UTM – Universal Transverse Mercator

VOC – Volatile Organic Compounds

VO_2^+ – Vanadyl Cation

Units

% - percentage

°C – degrees celsius

µg/g – microgram per gram

µm – micrometre

µs/cm – microsiemens per centimetre

List of Abbreviations (Cont'd)

cm – centimetre

cmol – The SI base unit for amount of substance is the mole. 1 mole is equal to 100 cmol.

g – grams

g/cm^3 – gram per cubic centimetre

ha – hectare

km – kilometres

km^2 – square kilometres

m – metres

m^3 – cubic metre

meq – milliequivalents

mg/kg – milligram per kilogram

mg/kg lwt – milligram per kilogram based on lipid adjusted weight of sample

mg/kg wwt – milligram per kilogram based on wet weight of sample

mg/L – milligram per litre

mg/m^3 – milligram per cubic metre

Mg/m^3 – megagram per cubic metre

mL – millilitre

mm – millimetre

1 INTRODUCTION

On behalf of Mount Polley Mining Company (MPMC), the Environment & Water business unit of SNC-Lavalin Inc. (SNC-Lavalin) has completed this Soil Quality Impact Assessment (SQIA) for the Hazeltine Creek study area (study area) near the Mount Polley Mine (Mine) near Likely, British Columbia (BC). The SQIA was completed as part of an assessment of impacts associated with the tailings dam failure of August 4, 2014.

1.1 Scope and Objectives

The work described herein was conducted in general accordance with Chapter IV of the SNC-Lavalin proposal submitted to MPMC titled *Mount Polley Comprehensive Environmental Impact Assessment Work Plan* dated August 29, 2014 (SNC-Lavalin 2014). The primary objective of the SQIA was to characterize tailings and native soils in the receiving environment to assess potential impacts associated with the tailings release event. The SQIA provides data for understanding the human health and environmental health risks associated with the impacts, including information to identify potential plant growth limiting soil conditions for consideration during immediate and long term reclamation efforts. The assessment included efforts to support estimating the physical distribution of tailings from below the Tailings Storage Facility (TSF) to the shore of Quesnel Lake through both lateral and vertical delineation sampling and use of aerial photograph imagery. Limitations, including with respect to delineation, are summarized in Section 1.4 with details provided as appropriate throughout the document. SNC-Lavalin worked cooperatively with SRK Consulting (Canada) Inc. (SRK) in the execution of the field sampling. As a result of shared sampling methods and soil samples, the data for the SQIA and the geochemical characterization work undertaken by SRK are complementary.

For the purposes of the SQIA, "soil" refers collectively to the various material classes that were sampled and includes native *in situ* soils, tailings, and/or mixtures of tailings and native soil and/or sediments translocated as a result of the TSF breach, except where specified. The term "tailings" refers to material representative of tailings alone, and more often a mixture of tailings and translocated native soils and/or sediments. Subaqueous sediments (including tailings) within Quesnel Lake, Polley Lake, and from the Hazeltine Creek channel were sampled as part of the Sediment Quality Impact Characterization, results of which are provided in the associated report (Minnow 2015).

Findings related to sediment and tailings geochemistry, including with respect to leachability, are provided in the Sediment Quality Impact Characterization report (Minnow 2015), and the Geochemical Characterization of Spilled Tailings report (SRK 2015). Findings related to hydrotechnical and geomorphological impacts are provided in SNC-Lavalin's Hydrotechnical and Geomorphological Impact Assessment (HIA) Report (SNC-Lavalin 2015).

1.2 Study Area

The SQIA characterized soils within the Hazeltine Creek study area, defined as the area affected by the TSF breach, within the Hazeltine Creek channel that extends from the former dam wall and Polley Lake (Upper Hazeltine Creek) through to its confluence with Quesnel Lake. The study area is approximately 9 kilometres (km) long and up to 1 km at its widest point (in the area of Lower Hazeltine Creek near Quesnel Lake). The study area, as defined in this SQIA, is further divided into nine smaller Study Areas based on position along the Hazeltine Creek Channel. References to these specific Study Areas are consistent with those defined in the Post-Event Environmental Impact Assessment Summary Report (PEEIAR) authored by Golder Associates Ltd. (Golder) on behalf of MPMC (refer to Figure 1, Golder 2015).

An area referred to as the Hazeltine Canyon is located approximately two-thirds of the distance between the TSF and Quesnel Lake. This area presented unique access and safety considerations due to the presence of steep and potentially unstable slopes and specific limitations with respect to sampling in this area are provided in Section 1.4 and Section 3.2.1. A detailed description of the physical setting of the study area, including with respect to pre-disturbance conditions, are provided in the HIA (SNC-Lavalin 2015b).

1.3 Report Structure

This SQIA report is a technical appendix to the PEEIAR (Golder 2015). The reader should refer to the Glossary of Terms within the PEEIAR for definitions and abbreviations.

The following outlines the structure of this report:

- Introduction
- Background Review
- Soil Quality Assessment Methodology
- Impact Assessment Methodology
- Assessment Results
- Discussion
- Conclusion

1.4 Limitations

The study was limited by access constraints and geotechnical safety (instability) issues. These limitations influenced access to soil sampling transects, sampling equipment selection, and sampling locations within specific transects. Details on the sampling limitations are provided in Section 3.2.1. Based on a preliminary review of environmental soil quality data (i.e., total metals), batch leachability testing of native and background soils was not carried out as proposed in the SQIA Workplan (SNC-Lavalin 2014).

2 BACKGROUND REVIEW

SNC-Lavalin reviewed background information (aerial photographs) on the physical distribution of tailings following the TSF breach, reclamation reports for the Mine including with respect to pre-disturbance soil conditions, historical soil, landform and reclamation reports, and existing tailings inventory chemistry and mine processing reagent records. The background review was carried out to inform the design of the field program with respect to sampling locations and selection of soil analytical parameters for study.

2.1 Aerial Photographs and Topographic Survey Data

SNC-Lavalin estimated the physical extents of the tailings in the Hazeltine channel using the 20 centimetre (cm) resolution orthophotos and light detection and ranging (LiDAR) topographic survey data provided by MPMC that was collected by airplane on August 5, 2014. The aerial survey extent included the TSF, south end of Polley Lake, Hazeltine Creek and a portion of Quesnel Lake. SNC-Lavalin used the orthophotos and topographic survey data to develop base drawings for use during the field program and to assist in field sampling design. Roads and trails were added to the drawings, to assist in field navigation.

Using base drawings, SNC-Lavalin measured the Hazeltine Creek channel from Quesnel Lake to the TSF and established 18 soil sampling transects (approximately 1 transect per 500 metre [m] reach) along the Hazeltine Creek channel which would serve as the basis for the soil quality assessment. Details on the soil sampling methodology are provided in Section 3.2. In total, 11 base drawings were developed for the field investigation. These drawings were later updated with sample locations (Drawings 621717-4-3-P1 to 621717-4-3-P11, attached).

2.2 Surficial Geology and Soil Survey Information

As part of the SQIA, historical soil and surficial geology survey information was reviewed (Imperial Metals 1990; Lord 1984; Bicheler and Bobrowsky 2003). As outlined by these historical reports, large parts of the Canadian Cordillera were covered by interconnecting valley and piedmont glaciers at several different times during the Pleistocene. This glacial mass is known as the Cordilleran Ice Sheet. Most of the Interior Plateau features prominent land forms that are the results of glacial and glaciofluvial processes. Morainal tills are the most extensive sediments in the vicinity of the Mine. These are sediments laid down by glacial ice with little or no re-working by melt-water. As a result, these tills tend to be massive or crudely stratified and poorly sorted with a wide range of particle sizes.

Table A summarizes surficial geology as identified by Bicheler and Bobrowsky (2003) in the study area. A detailed interpretation of surficial geological information is provided in the Hydrotechnical and Geomorphological Impact Assessment Report (SNC-Lavalin 2015b).

Table A: Summary of Surficial Geology in the Hazeltine Creek Study Area

Area	Type	Quarternary Geology	Surface Expression
Upper Hazeltine Creek	Pleistocene Morainal / Glaciofluvial	• Pleistocene Morainal described as poorly sorted, moderate to well compacted, clayey to silty diamicton. Clasts are subrounded to subangular, range from pebbles to boulders and may be faceted and/or striated. Interpreted as lodgement till. Irregular sand and gravel lenses may be present where till was deposited subaqueously or in association with flowing water.	Rolling; blanket
		• Morainal was more extensive than Glaciofluvial. Glaciofluvial was described as typically moderately sorted, weak to moderately compacted, cobble or boulder cobble gravel with a sand matrix. Clasts are rounded to subrounded. They are found as well-defined terraces in the major valleys up to approximately 70 m above river level or as irregular deposits at higher elevations on valley slopes or on plateaus. They are associated with melt-water channels or drainage courses.	Blanket
Lower Hazeltine Creek	Pleistocene Morainal / Glaciofluvial	• Occurrences are similar to Upper Hazeltine Creek, however Pleistocene Morainal was indicated to be more extensive than Glaciofluvial deposits, and found overtop of hummocky bedrock.	Blanket; hummocky

Soils are formed from the parent materials interacting over time with topography, climate and biota. Soil mapping was undertaken by the British Columbia Soil Survey in 1984 and shows that the area impacted by the tailings release was covered by Mesisol, Luvisol and Brunisol soil orders, which are noted as being derived from morainal tills, glaciolacustrine sediments and colluvium. Organic soils (Meisols) and Gelsols with poor drainage characteristics were described for areas at both ends of Polley Lake. Drawing 621717-4-1 (attached) and Table B provide an overview of the soil types found within the study area (Lord 1984).

Table B: Summary of Soils in the Hazeltine Creek Study Area

Area	Soil Type	Material	Surface Expression	Water Regime of Dominant Soil	Classification of Dominate Soil
Polley Plug; Upper Hazeltine Creek	Catfish Creek – Spakwaniko (CC-SW/2)	Moderately decomposed sedge fen peat and loamy morainal and colluvial materials	Level, undulating	Aquic, very poorly drained, moderately pervious	Typical Mesisol
Upper Hazeltine Creek	Lanezi – Deserters (LZ-D/3-4)	Loamy morainal, and sandy and loamy morainal and colluvial materials	Inclined, ridged, blanket and veneer	Perhumid to humid, moderately well drained, moderately pervious	Luvisolic-Humo-Ferric Podzol
Lower Hazeltine Creek	Moffat Lakes – Lanezi (MF-LZ)	Gravelly, sandy and loamy skeletal and loamy morainal materials	Undulating, rolling	Humid to subhumid, well drained, moderately to rapidly pervious	Eluviated Dystric Brunisol

2.3 Stage I Environmental and Socioeconomic Impact Assessment Report

Information from baseline environmental and socioeconomic impact studies conducted for the Mount Polley Project in 1989 and 1990 as part of Mine permitting (Imperial Metals 1990) was reviewed. This section summarizes the relevant information SNC-Lavalin obtained from the review with respect to baseline information on the metallurgical process and mine processing reagents, tailings characteristics, surficial geology and soils survey information, and on the conceptual reclamation plan.

At the Mine, the report described the copper-gold ore process to crush, grind and subject materials to a flotation circuit to concentrate target minerals, before discharging tailings to the TSF. Information on the mine processing reagents is provided in Section 2.4. Within the Stage I Environmental and Socioeconomic Impact Assessment Report (Imperial Metals 1990), tailings material was described as a non-plastic, yellow-grey, fine grained material with 6% clay, 64% silt and 30% fine sand. The report described acid base account testing which determined that the tailings were a net acid consumer. It also concluded that leachate testing determined that tailings would not be considered special waste under the BC Waste Management Branch regulations (now the *Hazardous Waste Regulation* [BC Ministry of Environment, 2009a]*)* and humidity cell testing demonstrated that the tailings exhibited low reactivity. SNC-Lavalin used this information as a basis for anticipating soil and total metals concentrations and establishing contaminants of potential concern (COPC). Historical tailings inventory and pre-release chemistry data is further discussed in Section 2.4.

Imperial Metals assessed surficial geology and soil as part of determining impacts to terrestrial resources. Surficial Geology and Soil is further discussed in Section 2.2. The stated reclamation objective in the conceptual reclamation plan was to return lands affected by the Mine to their original use and capability to the extent practical. Imperial Metals proposed a phased reclamation strategy for exploration and construction, mine operation and mine closure and decommissioning project phases which would incorporate results of an ongoing reclamation research and planning program. The reclamation research and planning program resulted in a number of reports that are summarized in Section 2.6.

2.4 Mine Processing Reagent Records

Mine processing reagents are introduced in the extraction process, primarily to extract target metals and to clarify process water. SNC-Lavalin completed a review of MPMC mine processing reagent records provided by MPMC that were known to have been used at the mill between 2009 and 2014 (MPMC 2014). SNC-Lavalin carried out an examination of MPMC-provided Material Safety Data Sheet (MSDS) and supplier-provided chemical information related to the mine processing reagents to identify key chemical constituents. A preliminary review of readily available toxicological information was carried out for chemical constituents considered indicator parameters and discussions were had with several Canadian commercial environmental laboratories to confirm the feasibility of laboratory analysis. Table C provides a summary of mine processing reagents MPMC used at Mount Polley between 2009 and 2014 (MPMC 2014).

Table C: Summary of Mine Processing Reagents used at Mount Polley 2009 to 2014

Process Reagent (in kilograms)	2009	2010	2011	2012	2013	2014
Potassium amyl xanthate	120,045	116,450	140,250	98,750	91,800	45,900
Methyl isobutyl carbinol (MIBC) Frother	136,493	-	-	-	-	-
Sodium hydrosulphide	186,093	246,927	82,962	6,239	1,133	-
Flocculant	474	673	479	672	1,053	498

Table C (Cont'd): Summary of Mine Processing Reagents used at Mount Polley 2009 to 2014

Process Reagent (in kilograms)	2009	2010	2011	2012	2013	2014
Aero 208 / Danaflot 468	19,115	3,944	-	-	-	-
R200M	2,250	-	-	-	-	-
Lime (Calcium Hydroxide)	2,564,726	2,870,676	2,120,114	1,394,798	1,403,483	351,680
Nalco	4,692	-	-	-	-	-
W22 Frother	27,851	93,323	86,076	104,852	139,424	55,475
TNC 312 / R200M	-	2,000	-	-	-	-
Eliminice	-	7,872	-	-	-	-
IPAC 6832 (dust/de-icer)	-	-	85,434	22,086	49,753	-
3180M	-	-	9,553	6,804	908	-
A208 / A7048	-	-	1,786	-	-	-
Promoters (O68)	-	-	-	225	515	-

Although the addition of diesel and oils to the flotation circuit was confirmed to not be current practice at the Mine, extractable petroleum hydrocarbons (EPH) were included as COPC as diesel and oils are constituents of W22C Frother. Similarly, methyl isobutyl ketone (MIBK) was included as a COPC in relation to historical practices at mine that pre-date 2009, and may be associated with degradation products of methyl isobutyl carbinol (MIBC) or may be present in residual quantities due to its potential use in the manufacturing of MIBC.

Specific indicator parameters for inorganic agents quicklime, IPAC 6832 (de-icer) and sodium hydrosulfide do not exist, and thus a review of effects upon inorganic parameters (pH, salinity / sodium, alkalinity, etc.) was undertaken to identify any general effects that may be attributable to these agents in the receiving environment. Chemicals such as phosphorodithioic acid (associated with the Aerofloat 208) and polyoxyalkylene alkyl ether (associated with W22C Frother) could not be analyzed by the Canadian commercial environmental laboratories that were contacted by SNC-Lavalin (AGAT Laboratories based in Mississauga, Ontario and ALS Environmental of Vancouver, BC). Chemical product information and/or MSDS information for 3190M, TNC312/R200M, Nalco and Eliminice was not available for review.

Based on the review of mine processing reagents, the following inorganic parameters were considered potential indicators and were included in the analytical program of the SQIA:

- Total xanthates: indicator for presence of potassium amyl xanthate.
- Carbon disulphide: a trace constituent and possible degradation byproduct in relation to potassium amyl xanthate.
- Total glycols: indicator for Promoter O68.
- MIBC and MIBK: indicators for W22C Frother and MIBC Frother.

2.5 Tailings Composition Records

The chemical composition of the Mine tailings in the TSF was characterized by MPMC as part of mine operations support and ongoing geochemical characterization studies. Tailings chemistry reflects the mineralogy and composition of the mined ore, which is primarily potassium feldspar and albite-altered breccias (Imperial Metals 1990). Trace minerals that are recovered as ore also include chalcopyrite with minor amounts of bornite, covellite, chalcocite, magnetite and digenite. MPMC has provided tailings inventory data in Annual Environmental and Reclamation Reports submitted to the Ministry of Energy and Mines (MEM) and Ministry of Environment (MoE). Table D provides a summary of the total metals concentrations (MPMC 2014) from pre-release chemistry data provided by MPMC in August 2014 (MPMC 2014). As such, the primary COPC associated with the tailings are metals, which may be present in elevated concentrations relative to natural conditions in the area.

Table D: Summary of Average Tailings Composition Between 2010 to 2014

Element	Average Total Concentration of Tailings Solids (mg/kg)
Aluminum (Al)	19,139
Antimony (Sb)	0.43
Arsenic (As)	12.32
Barium (Ba)	222
Beryllium (Be)	0.63
Bismuth (Bi)	1.85
Cadmium (Cd)	0.16
Calcium (Ca)	28,122
Chromium (Cr)	20.3
Cobalt (Co)	17.4

Table D (Cont'd): Summary of Average Tailings Composition Between 2010 to 2014

Element	Average Total Concentration of Tailings Solids (mg/kg)
Copper (Cu)	931
Iron (Fe)	49,651
Lead (Pb)	5.35
Lithium (Li)	17
Magnesium (Mg)	10,969
Manganese (Mn)	652
Mercury (Hg)	0.49
Molybdenum (Mo)	5.37
Nickel (Ni)	104.61
Phosphorus (P)	1405
Potassium (K)	2121
Selenium (Se)	1.04
Silver (Ag)	116.01
Sodium (Na)	1,438
Strontium (Sr)	192.12
Thallium (Tl)	0.025
Tin (Sn)	1.5
Titanium (Ti)	1525
Uranium (U)	15.61
Vanadium (V)	180.54
Zinc (Zn)	59.44

2.6 Historical Soils, Landforms and Reclamation Reports

As part of the background review, SNC-Lavalin reviewed historical soil, landform and reclamation reports in order to identify pre-release chemistry and soil physical properties relevant to contaminant chemistry (e.g., texture, particle size, consistency, colour, etc.) for soil in the study area. Reports reviewed as part of the SQIA are referenced in Section 9, and relevant information is summarized below.

In 1995, a pre-development soil survey was completed to assess native soil quality prior to mine site construction (Hallam Knight Piésold Ltd. 1995a) which assessed texture, particle size, rooting depth/size, consistency, colour, available nutrients and soil metals concentrations at the mine and mill areas, and the TSF. As part of the study, summary descriptions for 29 test pit locations were provided along with the analysis of 32 mineral soil samples collected from shallow mineral soil. Analytical results are presented in Table E for the mine and mill areas, and the TSF.

Table E: Summary of Pre-Disturbance Mineral Soil Quality

Parameter	Proposed Mine and Mill Areas (n=18)			Proposed TSF Area (n=14)		
	Minimum	Maximum	Average	Minimum	Maximum	Average
pH	4.9	6.2	5.4	5.0	6.6	6.0
Copper (mg/kg)	86	1980	521	17	59	31
Vanadium (mg/kg)	65	165	120	29	91	66
Organic Matter (%)	0.33	11.2	3.57	0.24	3.70	1.05
Total Nitrogen (mg/kg)	0.02	0.34	0.11	0.02	1.50	0.15

As part of the soil survey completed in 1995, soils and landforms and agricultural capability of the mill, mine and TSF were assessed (Hallam Knight Piésold Ltd. 1995b). Soils in the area of the TSF were found to be developed on morainal deposits, underlain occasionally by lacustrine parent materials, with depth to bedrock measured up to 20 m below ground surface (bgs) (Hallam Knight Piésold Ltd. 1995b).

Following development of the Mine, a number of soil inventories and reclamation research reports were completed (Forestmeister Services 2006, 2007a, 2007b, 2014a, 2014b; Inland Timber Management Ltd. 2004) to support final reclamation at the Mine. Reclamation research included establishing vegetation and tree survey plots with various amendment combinations of overburden, fertilizer, biosolids, tailings and waste rock and then assessing metals content in vegetation tissue (Forestmeister Services 2007a). Reclamation research is reportedly ongoing to monitor tree growth overtime in soil with tailings and biosolids amendments (Forestmeister Services 2014b). During the review of reclamation research reports, SNC-Lavalin did not identify total copper and vanadium concentrations for tailings amended into vegetation and tree survey plot soils.

2.7 Summary of COPC

Based on the background review, the following COPC were identified and assessed as part of the SQIA. A list of COPC and their associated regulated analytical parameters are presented in Table F.

Table F: Summary of COPC and Analytical Parameters in Tailings and Mine Processing Reagents

Source	COPC	Soil Analytical Parameters
Tailings	Metals, pH	Total metals, pH
Mine Processing Reagents	Xanthates, VOCs (including carbon disulphide, 2-hexanone, MIBC, MIBK), glycols, LEPH, HEPH, PAHs	Xanthates, VOCs (including carbon disulphide, 2-hexanone, MIBC, MIBK), glycols, LEPH, HEPH, PAHs

HEPH – heavy extractable petroleum hydrocarbon
LEPH – light extractable petroleum hydrocarbon
MIBC – methyl isobutyl carbinol
MIBK – methyl isobutyl ketone
PAH – polycyclic aromatic hydrocarbons
VOCs – Volatile Organic Compounds

3 SOIL QUALITY ASSESSMENT METHODOLOGY

The following sections present the methodology for the SQIA. The sampling personnel followed SNC-Lavalin's preferred operating procedures (POPs) which are consistent with MoE requirements and industry standards. The SQIA methodology included a review of background information, completion of preliminary field observations and a soil investigation.

Select photographs taken during the field investigation, organized by site setting and sampling (Photographs 1 to 18) and background sample locations (Photographs 19 to 36) have been provided in Appendix I. Analytical laboratory methods used by ALS Environmental of Vancouver, BC (ALS) and affiliate laboratories are summarized in Appendix II. Quality Assurance/ Quality Control (QA/QC) methods are described in Section 3.6 and Appendix III.

3.1 Preliminary Field Observations

SNC-Lavalin and SRK completed preliminary field observations in order to develop the sampling methodology for the SQIA. SNC-Lavalin was able to complete initial field observations while assessing site access and completing background soil sampling between September 2 and September 7, 2014. On September 8 and 9, 2014, SNC-Lavalin and SRK visited the various areas of the study area to observe the distribution of tailings and their depositional environments along Hazeltine Creek to refine the sampling design. Tailings were observed to be deposited within the scoured channel of Hazeltine Creek (Photograph 2) and within the forest adjacent to Hazeltine Creek (Photograph 6 and 9). Within the affected area, tailings were observed in what appeared to be different depositional environments based on surface characteristics including texture, colour, and/or apparent moisture content and degree of saturation. These apparent depositional environments were mapped, in part using aerial photographs in the field. These observations formed the basis for developing the approach for their sampling and characterization (refer to Section 3.2.1).

Two primary tailings types were identified based on visually apparent properties such as colour, texture, and field observable geochemical properties (i.e., magnetism, field carbonate effervescence class, and visible mineralogy). Various parent materials were observed below a layer of tailings of variable thickness. Tailings appeared to be mixed with native soils to varying degrees.

Bedrock was observed within the Hazeltine Canyon above the Horsefly-Likely Forest Service Road (FSR), also locally referred to locally as the Ditch Road (Photograph 5). In places within the Hazeltine Canyon, the bedrock was exposed at surface and visible along channel sidewalls (Photograph 8). A clear boundary was apparent at soil transects as evidenced by the presence of tailings and high water marks on soil and/or vegetation. Soils beyond this boundary appeared unaffected by the TSF breach and these observations supported selection of background sampling locations approximately 10 m beyond the boundary.

As a result of these observations three material classes were identified and targeted in the sampling program: tailings, native within channel soil, and background soils. Details on the sampling methodology are provided in Section 3.2.

3.2 Soil Investigation

Field soil sampling activities related to the SQIA were carried out between September 3, 2014 and October 29, 2014 and were led by SNC-Lavalin personnel. Soil sampling activities between September 8 and September 16, 2014 were carried out in conjunction with SRK personnel.

During the soil investigation, soil samples were collected from three material classes, and these are referred to throughout the report. These material classes include tailings, native within channel soils, and background soils. Tailings samples were collected from material inferred to be representative of tailings alone, or mixed with other soils and/or sediments translocated as a result of the TSF breach. Native within channel soil samples were collected from within the boundaries of the tailings affected area. Lastly, samples considered representative of background conditions were collected at locations approximately 10 m outside the area affected by the tailings release with the exception of locations that were shifted due to the presence of native soil disturbance from existing or historical roads or trails. The extent of tailings deposition was based on visual observations. The methods relating to the assessment of soil physical properties are described in Section 3.3.

3.2.1 General Soil Sampling Methodology and Field Limitations

The soil sampling design involved establishing transects approximately every 500 m along the affected areas of Hazeltine Creek. Factors such as access and inferred soil variability, observed from high resolution aerial photo imagery were taken into account. A total of 18 transects were established as shown on Drawing 621717-4-2 (attached).

In order to obtain soil samples representative of the various apparent depositional environments across each transect, SNC-Lavalin developed transect specific sampling maps using high resolution aerial photographs to map the dominant soil units. Within each transect, units representing various depositional environments were established based on aerial photographs and field observations (e.g., suspect tailings depths, grain size, apparent moisture, etc.), and their width estimated. The field personnel then selected up to five dominant soil units across each transect to target for sampling. In the areas of Lower Hazeltine Creek and Upper Hazeltine Creek near the Polley Plug, five locations were established across the affected areas to account for higher observed variability in depositional environments. Additional tailings samples were occasionally collected, based on observed field variability within soil transects. In order to remove possible bias in selecting sampling locations within a unit, the horizontal position within each unit was selected at random.

Within each transect, one or more test pit sample locations were selected for stratigraphic observation or sampling from multiple depths to understand the vertical variability within the tailings and to characterize underlying native *in situ* soils. The selected test pit locations typically were those that exhibited increased apparent variability in material type. Native within channel soil samples were also occasionally collected from channel sidewalls along the scour path. This method was used opportunistically and did not require the excavation of test pits.

Various access and safety concerns were identified during the site visits. Steep ground and potentially unstable channel sidewalls (Photograph 4) forced the shifting of entire transects to accommodate access or to maintain safe working conditions. In addition, during the course of sampling individual transects, the above mentioned conditions as well as soft and saturated ground conditions occasionally required sampling locations to be adjusted. Specifically, loose unconsolidated wet tailings, unstable ground, unsafe channel sidewalls and changing water levels caused by changes to pump operations at Polley Lake affected where and how samples could be collected for the study. When deemed necessary, sample locations were field adjusted by selecting a new random horizontal position until a safe sampling location could be established. In some cases, the horizontal transect azimuth was adjusted slightly to avoid areas of safety concern.

At tailings sample locations, test pits were advanced using hand tools (i.e., spade shovel, post-hole shovel, soil auger) until native soils were encountered. At locations where tailings deposits were thick enough that their depth could not be ascertained, the underlying soil resources were not assessed. Probing with a spade shovel handle was done until refusal, and the shovel probe depths were recorded as an estimate of tailings depth. Native within channel soils were uncovered undisturbed soils along channel side walls or in native soil below tailings. Photographs were collected before and after sampling and field notes were taken to document relevant observations. Locations were recorded using both a Trimble GeoExplorer 6000 Geo-XH global positioning system (GPS) unit and on field sketches. SNC-Lavalin then used the Trimble GPS Pathfinder Office software program to correct GPS locations relative to a known GPS base station and this increased the accuracy of coordinates to between 0.5 m to 1.5 m. Sample locations were also verified by field personnel on drawings as part of QA/QC measures. Additional detail on QA/QC measures is provided in Appendix III.

Samples were collected of tailings and native within channel material types using a clean (de-contaminated) hand trowel, placed into two labelled 500 millilitre (mL) lab supplied glass jars and into one or more labelled clean Ziploc® or Poly-Ore bags (Photograph 16). To minimize the potential for cross-contamination, sampling tools were cleaned using de-ionized water and paper towel between each sample location.

Sample descriptions were logged in the field, including particle size, colour using the Unified Soil Classification System (USCS) (American Society for Testing and Materials [ASTM] D2487-11) and any evidence of contamination (i.e., suspected tailings, etc.) was recorded. The jars and bags were labeled and stored in ice-filled coolers and submitted to ALS for analysis under chain-of-custody documentation. A detailed summary of the analytical methods used by ALS and the associated references is provided in Appendix II.

Soil quality was not assessed beneath tailings between the Polley Plug and the TSF in upper Hazeltine Creek, due to the thickness of soft, saturated tailings sampling conditions and safety considerations noted above. Additional assessment would be necessary to characterize underlying native soils in this area. At the time of writing, results had become available for soils at two sample locations in the Polley Lake Plug area through sampling efforts carried out by MPMC staff; however, they have not been included in the scope of the SQIA. Further sampling of this area will be conducted as part of the planned ecological and human health risk assessment program (Golder 2015), and the recent MPMC results will be included in the associated reports.

3.2.2 Soil Contaminant Chemistry

To assess soil contaminant chemistry, SNC-Lavalin collected 71 tailings samples and 14 within channel native samples from 68 separate locations. Samples were submitted samples to ALS for analysis of total metals, pH, moisture, light and heavy extractable petroleum hydrocarbons (LEPH/HEPH), PAH, glycols, volatile organic compounds (VOC) (including carbon disulphide, 2-hexanone, MIBC, MIBK) and xanthates. SNC-Lavalin placed soil samples directly into clean laboratory provided 500 mL glass containers for LEPH/HEPH, PAH and VOC analysis. Other analyses were carried out on samples from either bags or jars, as described above.

3.2.3 Soil Nutrients and Salinity

The sample collection and handling for soil nutrient and salinity parameters followed general methods described above. The soil analyzed for nutrient and salinity parameters was subsampled at the laboratory from the same jarred and/or bagged soils submitted as described above. Samples selected for analysis of these parameters were chosen to provide representative data for the various material classes (i.e., tailings, native within channel soils, and background soils) and spatial representation of the study area.

A total of 57 samples were submitted for analysis of nutrient parameters (available nitrate and nitrite, phosphorus, potassium, sulphate, mineralizable nitrogen, total carbon, total nitrogen, total organic carbon, anions, cation exchange capacity [CEC], and ammonium acetate extractable cations). Of these samples, 26 were considered representative of tailings material, 14 of native within channel soils, and 17 of native soil from background locations.

Samples were collected from mineral soil horizons and, where present, the forest floor (Litter, Fermented, Humus [LFH] layers) was carefully removed prior to sampling. Nutrients in the 26 tailings and 14 native within channel samples were selected to represent a diverse range of tailings and native soil types, and depositional environments.

At total of 60 samples were submitted for analysis of salinity parameters (i.e., pH, electrical conductivity, sodium, chloride, sodium adsorption ratio (SAR), exchangeable sodium percentage (ESP), theoretical gypsum requirement, and alkalinity). Of these samples, 26 were considered representative of tailings material, 17 of native within channel soils, and 17 of native soil from background locations.

3.2.4 Contact Tests

Soil pH and electrical conductivity were determined on soil water slurries (Hendershot *et al*. 1993; Janzen 1993) prepared by SNC-Lavalin following sample collection. Approximately 100 mL of distilled water was mixed with 50 grams (g) of lightly packed soil (i.e., 2:1 ratio by volume) in clean glass jars. The slurry was then agitated and let to stand for a minimum of 10 minutes, after which, the pH and conductivity were measured and recorded. Contact test data were then used to inform sample selection for laboratory analysis, as described in Section 3.4. Samples submitted to ALS were also analyzed for pH and electrical conductivity and methods are described in Appendix II.

3.3 Soil Physical Properties

3.3.1 Particle Size Determination and Soil Texture

The particle size distribution of soil samples was determined on laboratory prepared subsamples from jarred and/or bagged soil samples collected along soil transects. Soil particle size estimation in the field followed the USCS (Test Pit Logs, Appendix IV). Samples were analyzed using sieve and hydrometer methods described by ALS in Appendix II. The associated laboratory reports (Appendix V) describe the measured relative proportions of the various particle size fractions (gravel, sand, silt, clay) of the whole soil sample submitted for analysis (i.e., including gravel fractions). The laboratory used methods for particle size determination which considers soils passing the 0.063 micrometer (µm) sieve as silts and clays (fines) and gravel as anything retained on a 2 mm sieve.

SNC-Lavalin used the particles size results to estimate soil texture in general accordance with the Canadian System of Soil Classification (CSSC) (National Research Council of Canada 1998) which is determined based on the relative proportions of sand, silt, and clay fractions in soil passing a 2 mm sieve (i.e., soil fractions excluding gravel). To reflect this methodology, laboratory particle size results were “adjusted” for the purpose of determining soil texture and these data are reported only in Tables M and N (Section 5.5).

3.3.2 Bulk Density Sampling

The *in situ* bulk density assessment involved sampling the various material classes encountered throughout the SQIA, specifically the tailings, native within channel soils, and background soils. The surficial geologic origin of parent material was also interpreted for the within channel native soils (e.g., till, lacustrine deposits, etc.), as these units were specifically targeted for bulk density determination.

These units were targeted opportunistically and to achieve spatial representation along the channel. Due to the small sample size, the results are not intended to provide a thorough characterization of the units, but to provide an initial screening. Detailed descriptions of the surficial geology of the study area are provided in the HIA (SNC-Lavalin 2015b).

Where present, the forest floor and/or coarse woody debris were carefully removed to expose the underlying mineral soil. Soil at each location was excavated from a cylinder shaped hole (10 cm in diameter) to a depth of approximately 15 cm bgs (Photograph 18). Once the excavation was complete, the volume of the hole was measured to the nearest 5 mL with a graduated cylinder using density sand specified in the ASTM Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method (ASTM D1556 / D1556M-15). The sample ID and measured volume of the excavated material was recorded in the field. Sample locations were shifted approximately 30 cm in a random direction if the excavation was impeded due to the presence of cobbles or boulders. Sample location coordinates were recorded following the same method described for soil samples above.

The excavated soil for each sample was bagged, labelled, and shipped to SNC-Lavalin's geotechnical laboratory in Fort St. John, BC for analysis.

Upon receipt at the laboratory, the bulk density samples were analyzed using the ASTM D1556 test method. As required by ASTM D1556, samples were air dried following oven drying at 105 °C for 48 hours to achieve a constant dry mass. Samples were sieved through #10 sieve (2.00 mm mesh) to separate coarse fragments (i.e., coarse mineral and coarse organic material >2.00 mm in diameter) from the fine material. To calculate the bulk density of the fine material (i.e., <2.00 mm in diameter), mass and volume of coarse fragments were subtracted, respectively, from the mass and volume of the bulk sample. A particle density value of 2.65 megagrams per cubic metre (Mg/m^3) was used to determine the volume of coarse mineral material and a particle density value of 0.5 Mg/m^3 was used to determine the volume of any coarse organic material, using equation [1]:

$$Vol\ (m^3) = \frac{Mass\ (Mg)}{Particle\ density\ (Mg/m^3)} \quad [1]$$

Fine material bulk density was calculated as the mass of dry, coarse fragment-free soil per field measured volume of soil, where volume was also calculated on a coarse fragment-free basis, by using equation (2):

$$\text{Bulk Density } (Mg/m^3) = \frac{\text{Total Mass } (Mg) - (\text{Mass of Coarse Mineral } (Mg) + \text{Mass of Coarse Organic Material}) \ (Mg)}{\text{Total Volume } (m^3) - (\text{Volume of Coarse Mineral} + \text{Volume of Coarse Organic Material})(m^3)} \quad [2]$$

Laboratory reports for bulk density have been included in Appendix V.

3.3.3 Background Soil Sampling

Between September 3, 2014 and October 29, 2014, 19 background sample locations were established approximately 10 m beyond the lateral limit of the tailings affected area at alternating ends of each transect to assess soil background conditions with respect to total metals concentrations, nutrients, salinity, bulk density, particle size and rooting depth/size.

At background soil sample locations, test pits were advanced using hand tools (e.g., spade shovel, post-hole shovel, pick mattock, etc). Soil horizons (e.g., LFH, A, B, etc.) were identified in general accordance with the CSSC (National Research Council of Canada 1998). Soil samples were generally collected at discrete intervals from within the A horizon and also from underlying B horizons. If more than one B horizon was observed, suggesting varying underlying parent materials, additional samples were collected and the horizon (BII horizon) described independently. The dominant species of herbaceous, shrub, and tree communities, along with any evidence of contamination or stressed vegetation was documented and photographed.

Samples were collected using a clean hand trowel, placed into a clean, labelled polyethylene (Ziploc®) bag or laboratory supplied jars. Sample descriptions were logged in the field, including, particle size, colour using the USCS. Locations were recorded using both a GPS unit and on field sketches. The same sample collection, handling, and shipping procedures described in Section 3.2.1 were used for samples collected from background locations. Soil profiles are provided in the test pits logs (Appendix IV) and photographs of each soil profile are provided in Appendix I (Photographs 19 through 36).

The sampling locations were recorded in the field and were used in conjunction with aerial photograph imagery to support determination of the lateral extent of tailings. Refer to the HIA for detailed methods used to estimate the extent of the tailings affected area (SNC-Lavalin 2015b).

3.4 Summary of Sample Analysis Selection

SNC-Lavalin selected samples for laboratory analysis based on material class (tailings, native within channel, background) to identify physical and chemical composition anomalies in the receiving environment that may be associated with the tailings release event. Initial selections for analysis were based on field observations and contact test results. Some additional follow-up analyses were selected based on interim laboratory results.

Table G below provides a summary of sample selection rationale and number of sample selected for analysis by material type.

Table G: Summary of Soil Quality Analyses

<table>
<tr><th rowspan="2">Parameter</th><th rowspan="2">Sample Selection Rationale</th><th colspan="3">Number of Samples Analyzed (excluding QA/QC samples)</th></tr>
<tr><th>Tailings</th><th>Native Within Channel</th><th>Background</th></tr>
<tr><td>Total Metals + pH</td><td>• To represent the various soil types observed during sampling.</td><td>71</td><td>17</td><td>23</td></tr>
<tr><td>Nutrients</td><td rowspan="2">• To represent a diverse range of tailings and native soil types, and the more prevalent physical environments observed during the SQIA.</td><td>27</td><td>14</td><td>19</td></tr>
<tr><td>Salinity</td><td>27</td><td>14</td><td>18</td></tr>
<tr><td>Mine Processing Reagents</td><td>• To represent tailings (magnetite sands and grey tailings) from areas throughout the study area.
• To characterize native soil immediately below the tailings.</td><td>7</td><td>1</td><td>0</td></tr>
<tr><td>Particle Size</td><td>• To represent a range of tailings and native within channel soil types.</td><td>19</td><td>13</td><td>0</td></tr>
<tr><td>Bulk Density</td><td>• To represent a range of tailings and native soil types, and the various depositional environments observed during the SQIA.</td><td>9</td><td>8</td><td>4</td></tr>
</table>

Notes:

- Mine Processing Reagents included LEPH/HEPH, PAH, VOCs (carbon disulphide, 2-hexanone, MIBC, MIBK), glycols, xanthates.
- Salinity analysis includes paste pH, Conductivity, Nitrate, Chloride, Metals, SAR, Saturation Percentage, Theoretical Gypsum Requirement and Alkalinity.
- Nutrients analysis included Available Nitrate and Nitrite, Phosphorus, Potassium, Sulphate; Mineralizable Nitrogen, Total Carbon, Total Nitrogen, Total Organic Carbon, Anions, CEC and Ammonium Acetate Extractable Cations).

3.5 Statistical Evaluation

Simple statistics for minimum, maximum and average parameter concentrations were calculated in Microsoft Excel. Where data were less than their laboratory detection limit, a value of half the detection limit was used when calculating the average values of a given parameter. SNC-Lavalin used ProUCL 5.0 to estimate the 90th percentile concentrations, 95% upper confidence limits of the mean (95% Upper Confidence Limit of the Mean [UCLM]), and standard deviation. It was also used to generate histograms for data visualization purposes and to assess the data normality. Information on the statistical methodology used by ProUCL 5.0 is provided in the technical guide (US Environmental Protection Agency [EPA], 2013).

SNC-Lavalin estimated the distance in metres along Hazeltine Creek channel to the TSF of each soil transect, and then plotted chemical concentration versus distance from TSF. Relationships were assessed through regression analysis. Similarly copper and vanadium concentrations were plotted against the percent silt and clay and also assessed through regression analysis.

T-tests were also used to compare the differences between averages of material sample groups, for a number of analytical parameters, with significance assessed at P=<0.05.

Results of samples collected for QA/QC purposes were not included in the calculation of statistical parameters relating to soil quality data.

3.6 Quality Assurance / Quality Control

Sample collection and analysis were subject to QA/QC measures. Samples were collected in accordance with written POPs by trained field staff under the direction of senior project staff. SNC-Lavalin led all aspects of the SQIA. Blind field duplicate samples were collected at a frequency of approximately 1 in 10. QA/QC information, including a flowchart illustrating the document control methodology, and a data quality review is provided in Appendix III. The results of the data quality review are provided in the appropriate results and/or discussion sections. Laboratory QA/QC procedures and results are provided in analytical laboratory reports (Appendix V).

Five replicate samples and three silica sand field blank samples were also submitted for QA/QC purposes in support of SRK's tailings geochemical assessment (SRK 2015). Clean (blank) silica sand was filled into two clean 500 mL glass jars and one clean Ziploc® bag and submitted to ALS for analysis. Although provided in attached tables, the results related to replicates and silica sand field blanks are discussed in the SRK report. Field replicate sample locations were collected approximately 1 m in a random direction from their original sample location. Test pit logs are provided for replicate sample locations; however, the locations are not shown on the attached drawings given their small scale.

4 IMPACT ASSESSMENT METHODOLOGY

The methodology provided in the following sections outline types of information and data collected and how it was used to describe and discuss the potential soil quality impacts related to the TSF breach.

4.1 Lateral and Vertical Extents of Tailings

Field observations and aerial photograph imagery were used to interpret the spatial distribution of the tailings and deposited material along Hazeltine Creek. Test pit logs (Appendix IV) were used to record stratigraphic information observed in the field. Soil analytical results and contact testing were used to verify inferences regarding tailings distribution. Discussion on this is provided in Section 5.1.

The vertical extent of tailings deposition was determined through advancing a number test pits to a depth where native *in situ* soils were encountered. The stratigraphic information recorded on test pit logs was used to discuss the distribution of tailings, including their depth in relation to underlying native soils where these were intersected. The estimates of tailings depth and depth to native soils are provided in the context of limitations which affect the accuracy of the estimates, including the avoidance of certain unstable areas, and where native underlying soils were not intersected. The SQIA background sample locations, native depth measurements, and field observations supported the HIA estimate of the native within channel soil scour and tailings volume estimates. Further information on HIA methods used to estimate native within channel soil scour volumes and deposition volumes is provided in the HIA (SNC-Lavalin 2015b).

Semi-quantitative methods were used for estimating the lateral distribution of the tailings and provided an estimate of the surface area of the tailings-affected area. This was achieved through aerial photograph and topography interpretation coupled with field observations made during the SQIA and HIA field programs (SNC-Lavalin 2015b). The affected area boundary was further validated using GPS coordinates of background test pit locations collected approximately 10 m outside the affected area. Further information on HIA methods to determine the extent of the tailings affected area is provided in the HIA. Laboratory analytical results were also used to confirm the estimated lateral extent of tailings through comparison of tailings data versus soil quality data at background locations.

4.2 Soil Physical Impacts

A summary of the range of potential soil physical impacts is provided in relation to topsoil removal and/or their inundation with tailings. The results are based largely on field observations, including test pit logs (Appendix IV) to support the interpretations. The interpretation of the spatial extent of the physical impacts are reported in the context of the tailings affected area and the scour zone described in detail in the HIA (SNC-Lavalin 2015b) and shown on Drawings 621717-4-3-P1 to 621717-4-3-P11 (attached).

Stratigraphic data regarding forest floor and A horizon thickness and presence / absence are provided on test pit logs (Appendix IV) for the tailings affected areas both within and outside of the scour zone, along with comparisons to observed background conditions. The comparisons help to understand the conditions and potential impacts within the affected areas as they relate to the physical integrity of topsoil resources. The observed differences are discussed as they relate to soil nutrient availability, soil physical condition, and habitat for soil fauna and flora (i.e., microbial communities).

4.3 Soil Contaminant Chemistry

4.3.1 Regulatory Framework

In BC, soil standards exist, against which, comparison is possible to evaluate the human health and environmental health risk associated with a wide variety of parameters. As such, to screen for potential impacts, COPC identified to be associated with tailings and mine processing reagents (Section 2.7) were compared against the applicable standards, where available, contained within the *Contaminated Sites Regulation* (CSR), B.C. Reg. 375/96, including amendments up to B.C. Reg. 4/2014. The CSR includes generic, matrix, and site-specific comparative numerical standards for the concentrations of those substances in soil. For the purposes of determining applicable soil matrix numeric standards contained in Schedule 5 of the CSR, the following site-specific factors were determined to apply to the study area:

- Human Health Protection: Intake of contaminated soil (mandatory at all sites).
- Environmental Protection: Toxicity to soil invertebrates and plants (mandatory at all sites); and Groundwater flow to surface water used by freshwater aquatic life.

Considering the land use definitions contained in the CSR and the observed land use in the study area, CSR Wildlands (WL) was considered applicable to the study area. Since CSR standards for Wildlands are not available, the CSR specifies that Urban Park land use (PL) standards are appropriate comparison standards for soils within the depth of investigation for this report.

Although portions of the Study Area fall within the boundaries of the Agricultural Land Reserve (ALR) and BC Range Tenures 077614 and 077615, no signs of agricultural land use or evidence of grazing (animal sightings, feces, etc.) by domestic animals were observed during the field program. MPMC has confirmed that grazing is active along the Gavin Lake FSR. Grazing patterns and ranges of livestock in the area will be considered during the planned ecological and human health risk assessment program (Golder 2015).

As described in Section 3.5, SNC-Lavalin followed MoE Technical Guidance 2 titled *Statistical Criteria for Characterizing a Volume of Contaminated Material* (BC MoE 2009b) to characterize tailings and the statistical summary of results is included in Appendix VI. The resulting statistical parameters were considered in evaluating the distribution of various COPC in soil against CSR PL standards. In the Cariboo region of BC, regional background soil quality estimates are available for a number of the COPC and these are discussed, where appropriate. For instance, the regional background estimate for copper is 65 mg/kg and for vanadium it is 100 mg/kg (BC MoE 2010).

Concentrations of mine processing reagents including LEPH/HEPH, PAH, VOC, glycols and xanthates were compared against CSR PL standards, where available. Other soil chemical parameters analyzed for (e.g., pH, CEC, total carbon and inorganic carbon) are potentially important factors in determining the mobility and leachability of some of the COPC associated with the tailings (i.e., total metals). A detailed discussion on the metal mobility and leachability of sediments and tailings within the study area is provided in the Sediment Quality Impact Characterization report (Minnow 2015) and the Geochemical Characterization of Spilled Tailings report (SRK 2015), respectively.

4.3.2 Nutrients

Soil nutrient parameters were assessed to understand if the tailings or exposed mineral soils in areas of scour may be nutrient deficient posing potential challenges to soil productivity and site reclamation. Soil nutrients such as total nitrogen, total carbon, and mineralizable nitrogen are considered key indicators of soil productivity and are closely associated with soil organic matter content. Mineralizable soil nitrogen has been shown to be a useful indicator of soil productivity in forestry related studies (Powers 1980; Doran and Parkin 1994). It is a measure of the active fraction of soil organic nitrogen, which is largely responsible for the release of mineralizable nitrogen by the microbial community and its subsequent uptake by plants. Mineralizable nitrogen often correlates well with plant-available nitrogen and can be used to ascertain the presence of nutrient limiting conditions that could affect tree and other plant growth.

Total carbon, total nitrogen, available phosphorus, available potassium, mineralizable nitrogen, and CEC were specifically evaluated and compared between material classes to understand the potential impacts related to changes in soil nutrient status. The results of the nutrient assessment work are also discussed in the context of soil conditions at background locations and pre-disturbance soil data available for the areas of the Mine site and TSF area (Hallam Knight Piésold Ltd. 1995a).

The influence of soil pH on plant nutrient availability is also discussed. Specific impacts to terrestrial communities related to changes in soil chemistry are provided in the Terrestrial Wildlife and Vegetation Impact Assessment (TIA) (SNC-Lavalin 2015c).

4.3.3 Soil Salinity

Soil salinity can adversely affect performance of certain plant species through changes in nutrient availability and uptake, impacts to soil structure, and through osmotic imbalance (Brady and Weil 1996; McBride 1994). Tailings and subsoil salinity was assessed in two ways: 1) by comparison of chloride and sodium results to CSR PL standards; and 2) comparison of data for SAR, ESP, and electrical conductivity to literature values for evaluating soil sodicity.

4.4 Soil Physical Properties

4.4.1 Bulk Density

Although there are other factors that can influence site productivity, soil physical condition is considered to be an important indicator of soil quality. Measures such as bulk density are often used to assess soil physical condition (Schoenholtz *et al*. 2000) and it is also accepted as an important indicator in relation to forest productivity (Burger and Kelting 1999).

In the Hazard Assessment Keys for Evaluating Site Sensitivity to Soil Degrading Processes Guidebook, *soil compaction* is defined as an increase in soil bulk density that results from the rearrangement of soil particles in response to applied external forces (BC Ministry of Forests, 1999). Unweathered parent materials, largely free from soil forming processes, often lack soil structure and low organic matter content which influence soil-air-water-plant interactions. To assess potential impacts, the bulk density of the tailings and also of exposed or shallow parent materials within the Hazeltine channel was characterized for direct comparison to conditions at background locations and to literature values for potentially plant growth limiting bulk density.

Information regarding the physical condition of soil was also recorded on test pit logs (Appendix IV) as it relates to the density or consistency of the soil. This was a subjective measure that reflects the resistance of the soil to deformation, its relative cohesiveness, and the difficulty experienced during excavation. This information is discussed specifically in relation to the tailings material.

4.4.2 Particle Size and Soil Texture

The particle size distribution of a soil can influence the behavior and bioavailability of contaminants that may be present. It is also an important factor when considering the fate and transport of the COPC as it relates to soil permeability, erodibility, transport, and behaviour in aquatic systems (i.e., settling and dispersion).

When considering the effects of the bulk density on soil productivity, soil texture is an important consideration as it has been used successfully to estimate potentially growth limiting thresholds for a variety of plants (Daddow and Warrington 1983). Soil texture and coarse fragment content are often used to determine the potential susceptibility to compaction of a given soil, which can be important during soil handling and reclamation activities. For the purposes of the SQIA, the implications of the particle size results and soil texture are primarily discussed in the context of the soil bulk density results.

In relation to susceptibility to erosion, as well as potential terrestrial and aquatic impacts, particle size results are discussed in the HIA (SNC-Lavalin 2015b), TIA (SNC-Lavalin 2015c), and the Fish and Fish Habitat Impact Assessment (SNC-Lavalin 2015a), respectively.

5 ASSESSMENT RESULTS

Soil sample locations are shown on Drawings 621717-4-3-P1 to 621717-4-3-P11 (attached). Where applicable, the results are presented below by tailings, native within channel soil, and background material classes. Details on the corresponding tables, drawings and appendices are provided in each section.

5.1 *Lateral and Vertical Extents of Tailings*

The estimated lateral limits of the tailings affected area and of the scour zone are shown on Drawings 621717-4-3-P1 to 621717-4-3-P11 (attached). In total, approximately 2.34 square kilometres were affected by tailings as a result of the TSF breach. Approximately 42% of the area covered by tailings was found within standing forest, while the remaining 58% was found in areas where the forest and portions of native soils were removed (i.e., the scour zone).

The depth of tailings, where present, was measured at assessment locations, and the depth to native underlying soils was also recorded on test pit logs (Appendix IV). Native soil was intersected at 16 of the 18 soil transects completed within the tailings affected area, and at a total of 44 of the 68 test pits excavations. The average measured thickness of tailings was 0.25 m at assessment locations within the affected area; but, as noted below, the deposition was thicker in some areas. This estimate includes results that represent minimum tailings thicknesses at locations where native soils or bedrock were not intersected. Tailings were overlying variable mineral soils within the scour zone (Photograph 13), and somewhat intact forest soils outside of it (Photograph 12).

At a number of locations, tailings were probed below the base of test pit excavations in an effort to estimate the vertical extent of tailings. These results are described in the notes of test pit logs (Appendix IV). Areas where deeper tailings thicknesses were estimated included: 1) Polley Lake Plug in Upper Hazeltine Creek (0.8 m at ST18-02, 1.55 m at ST18-03); 2) Upper Hazeltine Creek (0.7 m at ST13-02, 1.3 m at ST11-02); and 3) Lower Hazeltine Creek (1.15 m at ST04-02, 0.8 m ST02-06). Photographs of select locations where deeper deposits of tailings were observed are provided in Appendix I (Photograph 10).

The observations from the SQIA regarding the lateral and vertical distribution of tailings were incorporated into the HIA estimate of tailings volume remaining in Hazeltine Creek (SNC-Lavalin 2015b). Results relating to the loss and/or inundation of topsoil resources in the tailings affected area are provided in Section 5.2, along with relevant tailings related observations.

5.2 Soil Physical Impacts

Soil resources were physically impacted by the breach in terms of loss of topsoil resources by erosion or their inundation with tailings. Observations relating to soil physical impacts were made during the SQIA and recorded on test pit logs (Appendix IV). This information was used to support estimating the zone of the tailings affected area, and the scour zone. The boundaries of these areas are shown on Drawings 621717-4-3-P1 to 621717-4-3-P11 (attached).

Within the scour zone, tailings were observed as surficial deposits over a range of substrates (e.g., parent materials) where forest floor and shallow soil horizons (e.g., topsoil) had been mostly removed, sometimes exposing parent mineral soil and/or bedrock (Photographs 13 and 15). Tailings thicknesses were on average 0.23 m thick, with less than a few cm measured covering parent materials at many locations, and up to and exceeding 1.55 m at others (maximum depth of tailings measured). No clear evidence of forest floor materials (LFH) were observed in these areas, and inferred A horizon soil material was only observed at four of 32 assessment locations where native soil was intersected, with variable tailings overburden thickness at these respective locations.

Tailings were also observed in areas outside of the scour zone, but still within what is considered the tailings affected area. A total of 16 soil sample test pits were advanced from outside of the scour zone yet within the boundary of the tailings affected area. Soil resources in these areas appeared to have been subjected to less erosion and at many of the locations, much of the topsoil and vegetation community appeared intact (Photographs 3). This type of environment represents approximately 136 hectares (ha) or 42% of the tailings affected area. Drawings 621717-4-3-P1 to 621717-4-3-P11 (attached) show the interpreted boundaries of the tailings affected area and interpreted limits of the scour zone. No clear evidence of LFH was observed in these areas, and A horizon material was identified at 11 of the 16 associated assessment locations. A summary of relevant soil stratigraphy data for tailings affected areas outside of the scour zone is provided in Table H. Soil stratigraphy data from background locations has been included for comparison purposes.

Table H: Summary of Soil Stratigraphy Data for Locations Outside of Scour Zone

Soil Stratigraphy	Thickness (m)			
	n	Minimum	Maximum	Average
Deposited Tailings	16	0.08	0.80	0.34
A Horizon	16	0	0.26	0.07
Background LFH	19	0.03	0.20	0.08
Background A Horizon	19	0	0.18	0.07

5.3 Field Screening Contact Tests

Field screening results of contact tests are provided in test pit logs (Appendix IV) and summarized by material class in Table I below.

Table I: Statistical Summary of Contact Testing Results by Material Class

Material Class	pH			Conductivity (µs/cm)		
	Minimum	Maximum	Average	Minimum	Maximum	Average
Tailings	6.98	9.44	8.54	17.5	876	318
Native Within Channel	6.24	8.63	7.23	23	285	99
Background	4.86	7.15	5.76	7.5	116	24.5

Contact testing results indicated tailings had basic pH levels, while native within channel samples were close to pH 7.0 (i.e., circumneutral) and background soils were typically more acidic. Tailings electrical conductivity on average was three to eight times higher than the averages of native within channel soils and background soils. Contact testing provided useful data that supported distinguishing between tailings and native soils, because the pH range of tailings was generally higher (i.e., more basic pH) and were measured with higher conductivity than within native soils at within channel and background locations (Section 3.2.4).

5.4 Soil Contaminant Chemistry

Results from the assessment of COPC identified in Section 2.7 in soil are presented by total metals and mine processing reagents in Table J.

5.4.1 Total Metals

A total of 71 tailings samples, 17 native within channel soil samples, and 23 background soil samples were submitted for laboratory analysis of total metals and pH. The results were screened against applicable CSR PL standards, where available. The results in comparison to the applicable standards are provided in Table 1 (attached). The laboratory analytical reports are included in Appendix V. Table J provides a summary of soil pH values and analytical results for COPC that exceeded the applicable standards in tailings (copper, vanadium, and arsenic) as well as parameters that exceeded CSR PL standards at native within channel soil and background soil assessment locations. Although concentrations of copper, vanadium, and arsenic were less than CSR PL standards at each of the native within channel soil and background soil assessment locations, the results have been included under their respective subheadings for comparison purposes.

Table J: Statistical Summary by Primary Contaminants in Soil

COPC	Number of Exceedances of CSR PL (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)	Average (mg/kg)	90th Percentile (mg/kg)	95% UCLM (mg/kg)	*Applicable CSR PL Standard* (mg/kg)
Tailings							
pH	-	7.51	9.09	8.50	8.88	8.56	n/a
Copper	71/71	**185**	**1,560**	**869**	**1,110**	**917**	150
Vanadium	24/71	106	**289**	187	**218**	194	200
Arsenic	1/71	7.54	16.5	11.2	13.1	11.6	15
Native Within Channel							
pH	-	5.95	8.48	7.30	8.33	7.62	n/a
Copper	0/17	6.28	86.7	36.1	64.3	44.7	150
Vanadium	0/17	2.04	100	59.7	88.5	70.6	200
Arsenic	0/17	0.43	14.7	6.98	10.0	8.43	15
Chromium	1/17	1	**61.7**	33.5	50.4	39.2	60
Background							
pH	-	4.69	7.13	5.62	6.54	5.86	n/a
Copper	0/23	5.98	135	35.6	74.5	49.1	90 - 150
Vanadium	0/23	40.2	133	70.0	103	78.4	200
Arsenic	0/23	3.06	14.2	6.98	11.3	8.10	15
Chromium	3/23	9.59	**108**	41.2	75.0	51.9	60
Manganese	2/23	170	**7,320**	930	1,188	1,418	1,800
Nickel	1/23	4.4	**104**	32.2	59.0	41.4	100
Selenium	1/23	0.2	**4.29**	0.39	0.59	0.80	3

Notes:

- The CSR PL standard for Human and Ecological Health considers the most stringent value.
- The CSR PL standard for Copper is pH dependent however since tailings and native within channel soils were above pH 5.5, the most stringent value is 150 mg/kg. A range is provided for background soils, since pH was measured below 5.5.
- Values exceeding CSR PL standards are shown in bold font.

Soil pH measured by the laboratory was consistent with contact test results where average tailings pH was basic, native within channel samples was circumneutral, and background soils were acidic.

The concentrations of copper and vanadium were consistently measured in tailings samples above their corresponding CSR PL standard (Table J above, Table 1, attached) throughout the study area and depth profile of the tailings. The average copper and vanadium concentrations of a subset of tailings samples representing the two observed tailings types (grey tailings [n=40] and magnetite sands [n=20]) were compared using a two tailed t-test to examine potential differences. The average concentration of copper in grey tailings (837.7 mg/kg) was not significantly different than that of magnetite sands (950.4 mg/kg) when assessed at a significance level of $P<0.05$ ($P=0.077$). Similarly, the average concentration of vanadium in grey tailings (184.6 mg/kg) was not significantly different than that of magnetite sands (190.7 mg/kg) when assessed at a significance level of $P<0.05$ ($P=0.478$). These results suggest that the concentration of copper concentrations may be influenced by differences between the two types of tailings. However, given the lack of statistical significance, and the concentrations of copper and vanadium relative to their CSR PL standards, their grouping is supported. Results and discussion presented herein treat tailings as one population. Analyzed soil samples collected from native within channel soil beneath tailings had concentrations of copper and vanadium below CSR PL standards.

Although the upper 95% UCLM concentration of vanadium in tailings is below CSR PL, the 90th percentile concentration (218 mg/kg) is marginally above the CSR PL standard of 200 mg/kg. In accordance with the MoE Technical Guidance document (No. 2) titled *Statistical Criteria for Characterizing a Volume of Contaminated Material*[1] (MoE TGD No. 2) (BC MoE 2009b), the concentration of vanadium in the tailings is considered above CSR PL standards.

The maximum concentration of arsenic was 16.5 mg/kg, which is slightly above CSR PL standard of 15 mg/kg in one tailings sample (ST17-03). However, following the methods of MoE TGD No. 2 for characterizing a volume of material, the tailings would be classified as meeting CSR PL standards. This interpretation is based on the tailings material being one population, the 90th percentile and upper 95% confidence limit of the average concentration are below the CSR PL standard, and the maximum concentration is less than twice the standard.

The concentrations of chromium, manganese, nickel and/or selenium in native soil were greater than corresponding CSR PL standards (Table J) at a few assessment locations from native within channel soils (ST15-02-02) or at background locations (ST12-01-01, ST12-01-02, ST13-01, and ST16-01-01). The concentration of these metals is attributed to naturally occurring background conditions. Each of the tailings samples analyzed contained concentrations of these metals less than the corresponding CSR PL standards supporting that the results are not associated with the tailings. These results for are not discussed further. The remainder of soil parameters in the samples analyzed contained concentrations of metals less than CSR PL. Consequently, copper and vanadium were the only metals considered contaminants of concern (COCs) in relation to the tailings. As a result, the discussion in Section 6.3 is limited to copper and vanadium.

[1] Technical Guidance Document 2: *Statistical Criteria for Characterizing a Volume of Contaminated Soil*, BC MoE, January 2009.

5.4.2 Mine Processing Reagents

A total of eight samples were analyzed for COPC associated with mine processing reagents. These included seven tailings samples representative of the two tailings types (i.e., grey tailings and magnetite sands). Samples were collected to achieve spatial representation by collecting samples from Upper Hazeltine Creek and Lower Hazeltine Creek. Sample ST15-02-02 was collected from native within channel soil below underlying approximately 0.1 m of tailings. The results in comparison to the applicable CSR PL standards are shown on Table 2 (attached). The laboratory analytical reports are included in Appendix V.

Concentrations of EPH, LEPH/HEPH, PAH, glycols and xanthates, were below laboratory method detection limits, and CSR PL standards where available. The concentrations of VOC compounds carbon disulphide, 2-hexanone, MIBC, and MIBK were also below laboratory method detection limits, and CSR PL standards where available.

5.4.3 Nutrients

The analytical results for soil nutrient parameters are provided in Table 2 (attached). Detailed laboratory results are provided in Appendix V. A summary of the results for key nutrient parameters is provided in Table K. For the purposes of calculating averages presented in Table K, values of half the method detection limit were used when results were non-detect. Results for soil pH are summarized in Table J above.

Table K: Summary by Key Soil Nutrient Results

Analytical Parameter	Tailings (n=27)			Native Within Channel (n=13*)			Background			
	Min	Max	Avg.	Min	Max	Avg.	n	Min	Max	Avg.
Total Carbon (%)	0.3	0.9	0.5	0.1	4.6 (44.2)	1.2 (4.2)	18	0.3	10.5	2.0
Total Nitrogen (%)	<0.02	0.028	0.011	<0.02	0.261 (2.63)	0.061 (0.244)	18	<0.02	0.667	0.117
Mineralizable Nitrogen (micrograms/gram [µg/g])	3	86	9	1.3	95 (350)	21 (44)	19	8	103	26
Cation Exchange Capacity (milliequivalents [meq]/100g)	2.55	30.4	7.28	4.21	28.3 (85.8)	12.2 (17.4)	18	6.1	81.3	18.9
Available Phosphate (µg/g)	<2	3.9	1.30	<2	9.4	2.31	18	1	293	41.17
Available Potassium (µg/g)	36	418	148.3	32	113	63.15	18	32	232	84.27

* Soil sample ST02-02 targeted an organic rich silt unit and is not directly comparable to other samples collected from mineral soil horizons. The maximum and average values presented outside of parentheses do not include the results for sample ST02-02 (n=13). Values inclusive of ST02-02 have been provided in parentheses for comparison (n=14).

Statistical differences in the average concentration of mineralizable nitrogen between and both native within channel soils and background soils were evaluated using one-tailed t-tests. Results indicated that the average concentration of mineralizable nitrogen in tailings was significantly less than both that of the native within channel soils (P=0.046) and background soils (P=0.003).

5.4.4 Salinity

The analytical results for soil salinity parameters are provided in Table 2 (attached). Detailed laboratory results are provided in Appendix V.

A summary of the results for key salinity parameters is provided in Table L.

Table L: Summary of Soil Salinity Results in Soil

Analytical Parameter	Tailings (n=27)			Native Within Channel (n=14)			Background (n=18)		
	Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.
Saturated Paste Sodium (µg/g)	4.8	73.3	25.4	<2.00	16.0	4.05	<3.00	8.10	2.89
Saturated Paste Chloride (µg/g)	<2.0	19.8	7.4	<1.0	24.0	4.3	1.0	29.6	3.9
Electrical Conductivity (µS/cm)	132	2,320	953	71	956	298	35	363	101
Sodium Absorption Ratio	0.73	2.94	1.69	0.25	0.99	0.35	0.43	1.24	0.51
Exchangeable Sodium Percentage (%)	1.92	15.3	7.95	0.67	5.94	3.31	0.31	4.11	2.42

The soil samples from all material classes targeted for analysis of salinity related parameters contained concentrations of sodium and chloride less than their respective CSR PL standards of 200 µg/g and 90 µg/g.

5.5 Soil Physical Properties

5.5.1 Particle Size and Texture

The analytical results for particle size and their "adjusted" values used for estimating soil texture are provided in Table 1 (attached). Photographs of the different material types are provided in Appendix I (Photographs 10 to 13). The associated laboratory analytical reports are provided as Appendix V.

The estimated (adjusted) sand, silt, and clay contents of tailings samples are summarized in Table M, along with a list of associated soil classifications of the various tailings samples analyzed.

Table M: Summary of Tailings Soil Texture

Parameter	Tailings (n =20)		
	Minimum	Maximum	Average
Sand (%)	0.6	92.7	49.0
Silt (%)	6.8	80.2	41.4
Clay (%)	0.5	31.5	9.6
Gravel (%)	0.1	17.1	1.7
Soil Classification*	Loam (7), Silt Loam (5), Loamy Sand (4), Sandy Loam (2), Sand (1), Silty Clay Loam (1)		

* The number of occurrences are provided in parentheses.

A summary of particle size results for the various interpreted native within channel soil units is provided in Table N.

Table N: Summary of Particle Size Results for Native Within Channel Soils

	Till Units (n=9)			Lacustrine Unit (n=1)	Other Units* (n=3)		
	Min	Max	Average	Result	Min	Max	Average
Sand (%)	25.8	61.7	42.2	0.8	50.9	80.8	42.8
Silt (%)	31.5	58.1	42.4	66.7	13.4	42.8	27.0
Clay (%)	6.3	27.1	15.4	32.5	5.8	7.5	6.5
Gravel (%)	0	32.4	9.6	0	0	32.5	10.8
Soil Classifications**	Loam (4), Sandy Loam (3), Silt Loam (2)			Silty Clay Loam (1)	Sandy Loam (2), Loamy Sand (1)		

* The description "Other" refers to units not interpreted to be till or lacustrine parent material (i.e., sands and/or gravels with variable fines content).
** The number of occurrences are provided in parentheses.

5.5.2 Bulk Density

The analytical results for soil bulk density are provided in Table 4 (attached). Detailed laboratory results are provided in Appendix V. The various types of parent materials observed and targeted during the bulk density assessment were described for each of the samples to support interpretation of the bulk density results, and are shown on Table 4.

The bulk density results have been summarized in Figure A for each of the inferred material classes and parent materials assessed.

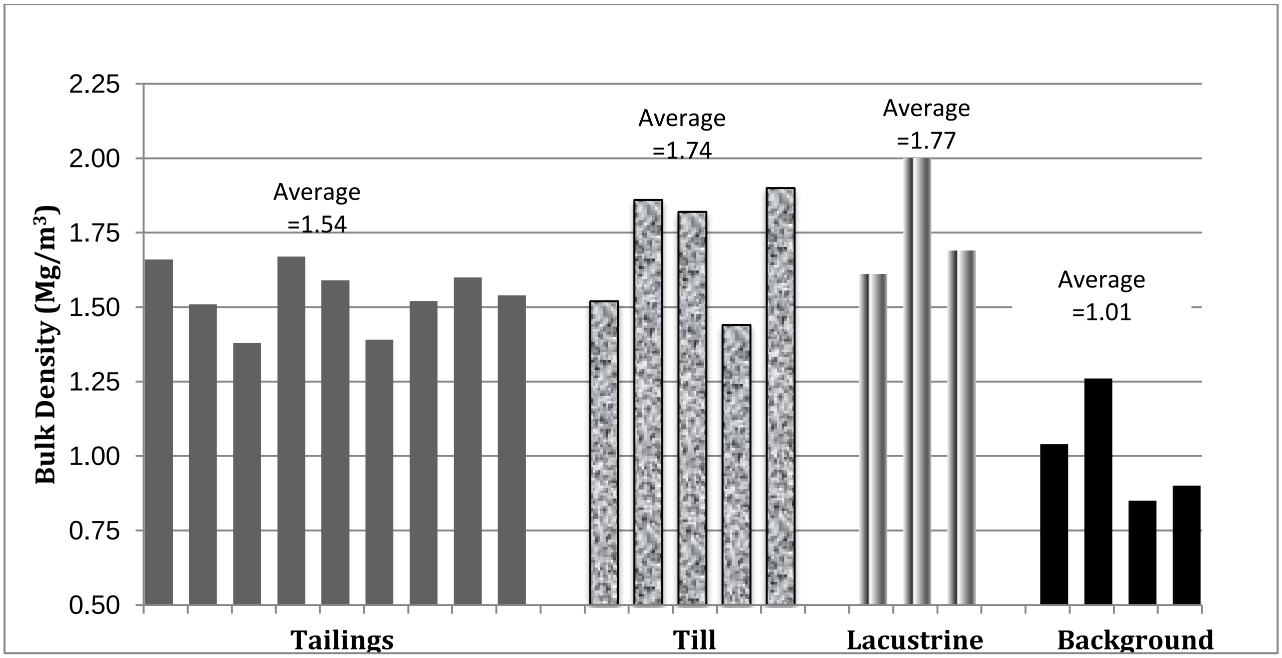

Figure A: Summary of Bulk Density for Tailings, Native Within Channel Soils and Background Soils

5.6 QA/QC

The results of the relative percent difference (RPD) calculations for the soil sampling program are included in Tables 1, 2 and 3 (attached). RPD for duplicate samples were below SNC-Lavalin's accepted RPD values except for sample pairs at locations ST01-09-03 and ST01-02-03, as summarized in Table O below.

Table O: Summary of Duplicate Samples Exceeding RPD Acceptance Criteria

Sample ID	Duplicate ID	Parameter	%RPD of Duplicate Sample
ST01-09-01	ST01-09-03	% Sand (2.00 mm - 1.00 mm)	94
ST01-02-01	ST01-02-03	Total Carbon (%)	162

The observed differences may be attributable to sample heterogeneity, laboratory error, or sampling error. Upon review of the data, and given the lack of comparison standards for these parameters, the differences are not considered to affect the conclusions of the report. Additional details from the QA/QC program can be found in Appendix III.

6 DISCUSSION

6.1 Lateral and Vertical Extents of Tailings

The SQIA measured tailings distribution by determining the lateral limits of tailings at 18 soil transects and by measuring the thickness of tailings at sample locations, where possible. The lateral and vertical extents of tailings were distinguished from native (*in situ*) soils through visually apparent differences in the field. The background samples collected outside of the inferred limits of the tailings affected area contained concentrations of copper and vanadium (COCs) less than CSR PL standards. These data support that at the time of sampling, the background locations had not been affected by the tailings, and further support the spatial estimates of the tailings affected area. Both the laboratory analytical results and contact testing data support the ability to visually discern differences between native soil from tailings in the field, which supports the use of the data set in estimating the extents of the tailings in the study area.

The estimates of tailings thickness indicate that results are variable both laterally across the channel, and along the length of Hazeltine Creek, particularly down gradient of Upper Hazeltine Creek. Our data set was not sufficient in size to analyze trends given the observed and measured variability, and attempts to quantify trends would likely be confounded by the limitations of the assessment. These limitations included the fact that certain areas were not sampled due to their inaccessibility and health and safety concerns (e.g., proximity to steep or cut slopes, saturated and deep tailings deposits, etc.).

Further discussion regarding the distribution of tailings in the study area, including in relation to fluvial geomorphological characteristics of the Hazeltine channel, are provided in the HIA (SNC-Lavalin 2015b), along with the methods and results of the spatial and volumetric estimates of tailings deposition.

6.2 Soil Physical Impacts

Topsoil resources in forested ecosystems are important to ecosystem function, as these horizons are host to the large majority of plant roots and provide habitat for soil flora and fauna. Soil fauna and flora (microbial communities) regulate organic matter turnover, contribute to plant available nutrient pools, and enhance soil structure. Topsoil also plays a role in the regulation of soil temperature and moisture which are important factors in plant performance and ecosystem function.

Within the scour zone, topsoil resources (LFH and/or A horizon) were not evident at all but four of the 32 assessment locations where native soil was intersected. This suggests that the upper portions of the soil horizons were largely eroded as a result of the TSF breach. Although tailings thicknesses were not determined at every assessment location due to limitations related to assessment methodology and site conditions, an average tailings thickness of 23 cm was estimated, although it was observed to range up to 1.55 m. This average value may be low due to the full depth of tailings not being measured at all locations and some depositional environments not being investigated due to safety concerns. These measurements indicate that rooting depths at many locations within the scour zone where tailings are relatively thin, are likely to extend to the underlying mineral soil horizons making their characterization important with respect to indicators of soil productivity (refer to Sections 6.4).

At locations outside of the scour zone within the tailings affected area, native soils were intersected at twelve of 16 assessment locations. The A horizon thickness at the twelve locations ranged between 0 cm and 26 cm, with the maximum thickness measured at ST02-02, an area where thick organic rich soils were observed. Excluding the assessment location ST02-02, the average A horizon thicknesses were similar between the locations outside of the scour zone (8 cm) and those at the background locations (7 cm).

The deposited tailings thickness was variable (0.08 m to 0.8 m) in the areas outside of the scour zone, and was approximately 0.34 m thick on average. Based on the observed depth of topsoil inundation at these locations, the topsoil will likely continue to act as a source of available nutrients for plants and habitat for soil fauna to varying degrees. The contributions of the inundated topsoil to plant available nutrients and habitat for soil fauna would be expected to diminish as tailings thickness increases, and they become physically further from the active rooting zone. The range of potential impacts to plants from tailings inundation of topsoil resources will likely vary depending on the rooting depths of the species.

Where topsoil loss has occurred, the habitat of various soil organisms has been directly impacted by removal or alteration. In relation to soil quality, the changes to topsoil distribution will affect the lower trophic level organisms that are largely responsible for the decomposition of organic matter and nutrient cycling. The changes may have long term impacts related to plant nutrient availability and ecological function. A detailed discussion on potential ecological impacts of the breach related to plant and animal communities is provided in the TIA (SNC-Lavalin 2015c), and will be further assessed in the planned ecological and human health risk assessments (Golder 2015).

Changes to soil thermal and moisture regimes are likely to have resulted through the loss of topsoil and forest floor resources which contribute to their regulation in forested ecosystems. These changes typically have the most pronounced affects during periods of higher or lower than normal precipitation or temperatures when soils conditions become potentially growth limiting (e.g., moisture contents at permanent wilting point, high soil strength, reduced air-filled porosity, etc.). Their study was outside of the scope of the SQIA as one time measurements, particularly at the end of the growing season, would not be expected to yield meaningful results.

Due to the geotechnically unstable nature of the channel at some locations, ongoing changes to soil resources related to slope failure and mass wasting would be expected. Such impacts include further topsoil loss, inundation and/or mixing with subsoil during failure events.

Discussion on the potential impacts related to the loss of topsoil and its inundation in the tailings affected area are provided in Section 6.3.4 in the context of soil nutrient and soil physical properties.

6.3 Soil Contaminant Chemistry

The following discusses the results for COC identified to be associated with the tailings assessed as part of the SQIA.

6.3.1 Copper and Vanadium

The SQIA identified concentrations of copper and vanadium above their corresponding CSR PL standards throughout the study area and these metals are considered to be associated with the entire volume of tailings material based on the distribution of the copper and vanadium data suggesting they are representative of a single population. These COC appeared to be evenly distributed vertically throughout the entire study area. Vertically stratified sampling did not identify spatial trends that would suggesting these contaminants were stratified at the time of the sampling event. The environmental quality of underlying native within channel soils (less than CSR PL) indicates that at the time of sampling, these COC had not affected underlying (*in situ*) soils at the locations targeted for sampling. The potential for metal leaching from tailings over time is discussed in the Geochemical Characterization of Spilled Tailings report (SRK 2015).

Data exists from prior to mine development (Hallam Knight Piésold Ltd. 1995a) that suggests copper in mineral soil horizons in the area of the mine and mill site (copper concentration ranged from 86 mg/kg to 1,980 mg/kg; average of 521 mg/kg) contained concentrations of copper greater than CSR PL standards, and even at concentrations greater than the highest copper values observed in tailings samples (1,560 mg/kg in ST17-03), while samples collected near the TSF contained copper concentrations below CSR PL. These data are likely most relevant to locations near the Mine and mill site, whereas background data collected during the SQIA is more relevant as distance from the Mine and mill increases. The pre-disturbance data (Hallam Knight Piésold Ltd 1995a) does highlight that native soils in the region may contain concentrations of copper within or above the range observed for the tailings, likely when in close proximity to mineralized bedrock or soils that have formed on them.

To assess horizontal spatial trends, the concentrations of copper and vanadium in tailings were plotted against the estimated distance of each sample from the TSF, as illustrated in Figure B below. The coefficients of determination (R^2 value) were approximately 0.25 for both metals suggesting a weak trend of decreasing concentration of copper and vanadium as distance from the TSF increases. This may be a result of increased mixing between tailings and native within channel soils (dilution) as distance from the TSF increases. Field observations of scouring in the Upper Hazeltine Creek and Hazeltine Canyon areas, along with the results of the HIA support this interpretation. The potential changes in copper concentration with distance from the TSF does not affect the interpretation of the results in relation to applicable CSR PL standards.

However, the observed trend for vanadium suggests that it may be occurring in soil at concentrations exceeding CSR PL standards at greater frequencies in Upper Hazeltine Creek compared to the Lower Hazeltine Creek area. This is supported by results which indicated that the concentration of vanadium in tailings samples collected from Upper Hazeltine Creek was above the CSR PL standard in 21 of 46 (46%) samples, while only 3 of 25 (12%) samples contained concentrations above the standard in Lower Hazeltine Creek.

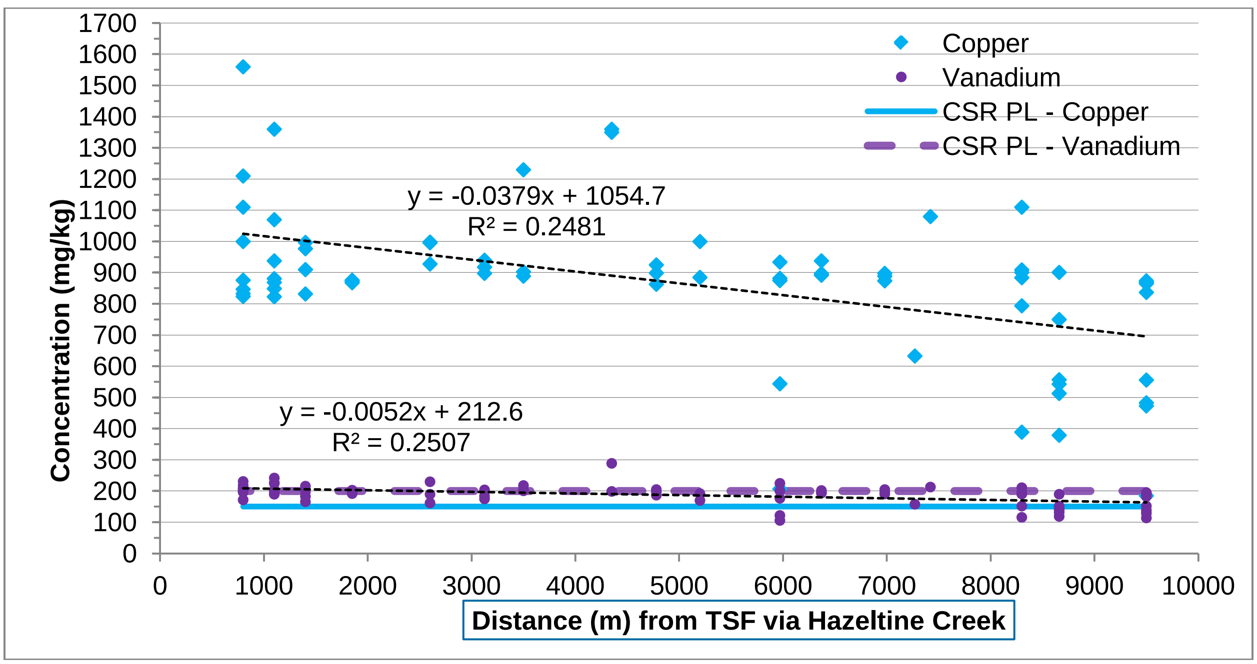

Figure B: Total Copper and Vanadium versus Distance to TSF

To evaluate the potential influence of tailings particle size, copper concentrations were plotted against combined silt and clay contents (% silt + % clay). The effect size of combined silt and clay content on copper and vanadium concentration was low (R^2=0.04 and R^2=0.11, respectively) suggesting the concentration of these COPC are not strongly associated with particle size.

The average depths of tailings samples were also plotted against the concentrations of copper and vanadium in tailings to examine for potential vertical trends in contaminant distribution. The low R^2

values (R^2=0.0005 for copper, R^2=0.0327 for vanadium) support that the contaminants were not stratified vertically.

The distribution of these two metals is generally considered to be consistent with the distribution of tailings throughout the study area. Accordingly, the discussion on the lateral and vertical extents of tailings is considered directly applicable in understanding the distribution of copper and vanadium at the site. Additional relevant information on the distribution of tailings is contained within the HIA (SNC-Lavalin 2015b).

6.3.2 Standards for Environmental Protection

This discussion summarizes how CSR PL standards for copper and vanadium are derived, and also discusses the fate and transport of these contaminants in the environment. Further discussion on the reactivity and mobility (leachability) of metals in the environment was assessed and reported by SRK as part of geochemical studies (SRK 2015).

6.3.2.1 Copper

The BC CSR Schedule 5 Matrix Numerical Soil Standards provide standards for both protection of human health and the environment, specific to the exposure pathway of concern. Since a standard for Wildlands is not available, the Urban Park standard is applicable to soils from 0 m to 3 m bgs, while Commercial standards are applicable to soils at depths greater than 3 m bgs. The most conservative soil standard for copper, applicable to either human health or environmental protection, was determined to be the standard for Toxicity to Soil Invertebrates and Plants at 150 mg/kg; this standard was used for comparison to concentrations of copper in affected soils.

In general, the standards for Toxicity to Soil Invertebrates and Plants were derived by the Contaminated Sites Soil Task Group (CSST) through the use of the sensitive measurement endpoint data from key receptors, considered to act as predictive sentinel species (BC MoE 1996). Primarily, endpoints used in standard derivation included mortality, reproduction and growth, with raw data for these endpoints obtained from the Canadian Council of Minister of the Environment (CCME) Ecological Health Substance Assessment documents. In determining the critical ecological receptors and pathways for use in deriving environmental protection matrix standards, CSST considered the land use and relevant direct exposure pathways. For Agricultural, Residential and Urban Parkland uses, the concentration corresponding to the more stringent of the LC20 (the concentration at which 20% of tested organisms experienced mortality) and EC50-NL (the concentration at which 50% of tested organisms experienced a non-lethal effect) values was chosen as the appropriate Toxicity to Soil Invertebrates and Plants soil quality matrix standard.

6.3.2.2 Vanadium

The BC CSR Schedule 4 Generic Numerical Soils standards provide a generic numerical value considered to be protective of both human health and the environment. Since a standard for Wildlands is not available, the Urban Park standard is applicable to soils from 0 m to 3 m bgs, while Commercial standards are applicable to soils at depths greater than 3 m bgs. The BC CSR Schedule 4 guideline of 200 mg/kg for vanadium was used for comparison to levels of vanadium measured in area of impact soils. Though the BC CSR guideline is considered to be protective of both human and ecological receptors, specific rationale behind the derivation of these standards is not provided.

The BC CSR standard of 200 mg/kg is consistent with the interim remediation criteria for vanadium, proposed by the CCME in 1991. While the rationale for the selection of this CCME guideline is not available, the interim guidelines from 1991, were based on existing guidelines in other jurisdictions (such as BC MoE, Ontario MoE, or Alberta Tier 1 criteria); these guidelines would not take into account any toxicity testing or research developments that occurred after 1991, and are considered potentially outdated.

Considering that the 95% UCLM of vanadium concentration in tailings was less than the CSR PL standard, and that any remedial efforts directed towards managing risks associated with elevated copper would be expected to manage risks posed by vanadium in concurrence, vanadium is considered a secondary COPC.

6.3.3 Mine Processing Reagents

The concentration of EPH, LEPH/HEPH, PAH, glycols and xanthates in tailings samples targeted for analysis were less than laboratory method detection limits and corresponding CSR PL standards. The VOC compounds carbon disulphide, 2-hexanone, MIBC and MIBK were also measured in each of the samples at concentrations below laboratory method detection limits. Results were not unexpected given that these COPC would be expected to have been consumed during mine processing, ending up in the mineral concentrate shipped for smelting, and/or have been biologically degraded to varying degrees within the TSF.

6.3.4 Nutrients

Soil nutrient estimates for pre-disturbance mine and TSF area soils (Table E) and background mineral soils (Table K) were similar within the study area. Although total carbon includes inorganic fractions, the vast majority of background soils studied as part of the SQIA contained low amounts of inorganic carbon making its comparison to the pre-disturbance soil organic matter content data reasonable, and helps to validate the background nutrient data set.

Mineralized nitrogen is typically correlated with total carbon and total nitrogen values and is also considered an appropriate indicator for soil quality in relation to plant available nitrogen. Values of mineralizable nitrogen below 10 µg/g to 17 µg/g have been associated with poor tree performance in some conifer species (Powers 1980). Soil at background locations contained mineralizable nitrogen concentrations between 8 µg/g and 103 µg/g with an average of 26 µg/g. The average concentration of mineralizable nitrogen in tailings samples was 9 µg/g, and values under 10 µg/g were measured at 24 of the 27 locations assessed. The average concentration of mineralizable nitrogen was less in tailings than in soils at both background (P=0.003) and native within channel (P=0.003) assessment locations.

The average concentration of available phosphate was 1.3 µg/g, and was less than laboratory method detection limits (<2 µg/g)[2] at 23 of 27 tailings samples. This is in contrast to an average concentration of 41 µg/g at background locations. The availability of phosphate is influenced by soil pH as it typically becomes increasingly insoluble with a rise in pH. The range in values of available potassium between the material classes were similar, with average values of 148 µg/g measured in the tailings in comparison to 84.3 µg/g measured in background soils. The minimum concentration of available potassium in tailings (36 µg/g) was similar to that measured in native within channel soils and at background locations (32 µg/g). On average, tailings contained approximately double the combined average concentration of available potassium of the native within channel and background soils. These results suggests potassium is not at growth limiting concentrations in the tailings.

In comparison to deeper subsoils, shallow mineral soils are typically enriched with respect to many key plant available soil nutrients originating in upper soil horizons from the decomposition of organic materials present in LFH and A horizon layers. Nutrient conditions appear to be variable for native within channel soils with values of mineralizable nitrogen ranging between 1 µg/g and 95 µg/g. The variability is likely related to the degree of scouring that occurred at a given location which affected the depth from the original ground surface at which samples were collected. In areas where scoured subsoils are exposed or thinly inundated by tailings, they may serve as potential rooting media for plants, and their nutrient status will likely depend largely on the depth from original grades and the degree to which topsoil resources were affected (refer to Section 4.2).

The average pH of the tailings was approximately 8.5 with values ranging between 7.51 and 9.1. The elevated pH of the tailings is likely attributable in part to the use of lime as a mine processing reagent. These values are typically considered indicative of moderately to strongly alkaline soils. In comparison, the average pH at the background locations was 5.62, a value typical for upper soil horizons in forested ecosystems where the yearly addition and decomposition of litter causes acidification. The average pH of the native within channel soil was also variable with an average of 7.29, with differences between native within channel and background soils likely attributable to the degree of scouring and removal of lower pH topsoil.

[2] Concentrations equal to half of the laboratory detection limit was used to calculate the average which explains why the minimum reported value exceeds the average.

The results indicate that for some plant species, growth limiting conditions with respect to nutrients may be encountered within the tailings deposits, and also at some locations of exposed mineral subsoil within the tailings affected area. Many pioneer plant and shrub species, including some conifers such as lodgepole pine, are adapted to nutrient poor soil conditions (Kranabetter *et al.* 2006) and their establishment and performance may not be influenced to the same degree by the nutrient-related conditions. Fertilization and/or addition of nutrient rich or organic amendments are often considered to improve the nutrient status of deficient soils. Measuring foliar concentrations of emergent vegetation allows for a more direct evaluation of the effects of soil nutrient status on vegetation performance.

In addition to the nutrient parameters discussed above, the availability of micronutrients such as boron, cobalt, copper, iron, manganese, and zinc are known to be reduced in soils with elevated pH similar to that of the tailings. Additional investigation would be necessary to ascertain any potential nutrient deficiencies related to these micronutrients; however, this is likely better suited for evaluation upon establishing reclamation objectives and understanding the range of materials on which re-vegetation efforts will be undertaken.

The potential influence of the change in pH on the plant communities in the study area is further discussed in the TIA (SNC-Lavalin 2015c).

6.3.5 Salinity

The concentration of sodium and chloride parameters in the various material classes, including tailings, were less than their respective CSR PL standards indicating they are not considered COCs.

The soil salinity of the tailings, native within channel soils, and background soils was also evaluated against literature values for classifying them as normal, saline, sodic, or saline-sodic soils (Brady and Weil 1996) based on their pH, electrical conductivity, SAR, and ESP. At background and native within channel soil assessment locations, each of the samples targeted for analysis were considered within the range of normal soils.

On average, tailings also fall within the normal range. However, approximately half of the samples have pH values greater than 8.5. Soils with pH values above 8.5 are generally considered moderately to strongly alkaline. However, when values of soil electrical conductivity, SAR, and ESP are within the range of normal soils, soils with pH values over 8.5 are not classified. This is given that the exchange complex of soils with elevated pH is typically dominated by sodium, which is not the case for the vast majority of the tailings materials. The average exchangeable sodium in the tailings was 0.54 meq/100g and was less than method detection limits (<0.5 ceq/100 g) at 12 of the 27 sampling locations.

A discussion on the influence of pH on nutrient availability is provided in Section 6.4 above. A detailed discussion on the importance of pH as it relates to the geochemistry of the tailings and mobility of the metals is provided in the Geochemical Characterization of Spilled Tailings report (SRK 2015).

6.4 Soil Physical Properties

Various studies have focused on identifying growth limiting bulk density (GLBD) thresholds for a variety of plant and tree species and some of these values have been used as criteria in evaluating the quality of soils to support sustainable plant growth (Daddow and Warrington 1983). Daddow and Warrington used the "Average Pore Radius" as the only variable driving GLBD, based on the theory that most soil pore diameters at the GLBD were less than the diameter of growing roots which can restrict their elongation. Daddow and Warrington's model was based on research typically conducted on sites with coarse fragment (>2.00 mm) contents less than 10%, which confined its applicability to similar types of soils.

Some studies suggest root growth and development may become restricted at or above a bulk density values of approximately 1.4 to 1.6 gram per cubic centimetre (g/cm^3) depending on soil texture (Brady and Weil 1996; Bulmer and Krzic 2003). This is a result of elevated soil mechanical resistance or strength often exhibited by soils with high bulk density, particularly when soils are dry; as soil moisture strongly influences soil strength. Zou *et al*. (2000) demonstrated that soils with higher bulk densities experience quicker rates of strength increase during drying. Bulk density also is an indirect measure of the porosity of soil and therefore can indicate differences in soil structure, particularly between similar soils.

The estimated average bulk density of the tailings samples was 1.54 Mg/m^3, which is based on an average assumed particle density of 2.65 Mg/m^3. Based on the range in textures of the tailings, and using GLBD estimates provided by Daddow and Warrington (1983), plant growth may become limited at values of bulk density as low as 1.4 Mg/m^3 (Silty Clay Loam) and at values up to and exceeding 1.75 Mg/m^3 (Loamy Sand, Sands). When considering the average texture of the tailings material, the GLBD would be equal to a value between 1.55 Mg/m^3 and 1.60 Mg/m^3, suggesting that the tailings materials are, on average, not in a potentially growth limiting state.

The assumed particle density used to calculate the tailings bulk density values is likely biased low given it assumes soils are derived from typical parent geologic materials, rather than originating from the processing of mineralized and metal enriched ore bodies being targeted by mining activities. The use of lower than actual particle density values in Equations 1 and 2 (Section 3.3.2) results in overestimates of bulk density being calculated. Although field observations such as resistance experienced during test pit excavation and sampling would have been strongly influenced by field soil moisture conditions, observations suggested tailings were generally loose or soft and not in a compacted state. These observations support the interpretation that bulk density estimates may be biased high for the tailings materials. Additional investigation to determine the particle density of the tailings (e.g., through pycnometry) would be necessary to confirm this interpretation.

Based on the Hazard Assessment Keys for Evaluating Site Sensitivity to Soil Degrading Processes Guidebook, the tailings would be considered to have compaction hazard ratings ranging between low to very high depending on the soil moisture regime. Susceptibility and resiliency to compaction is also influenced by moisture content, soil organic carbon, and texture (Smith *et al*. 1997). This information is provided in the context of possible future reclamation activities and may be important for planning purposes.

Native within channel soils were also targeted for bulk density determination. For soils characterized as till, using GLBD estimates provided by Daddow and Warrington (1983), plant growth may become limited at values of bulk density as low as 1.45 Mg/m^3 and at values up to 1.65 Mg/m^3. This estimate of GLBD thresholds is provided in consideration of the range in soil textures measured for samples representative of till units (Table N). The till units had bulk density values both above and below this range, and have an average bulk density of 1.74 Mg/m^3, which is greater than the estimated GLBD.

For the lacustrine soils, the GLBD estimate is approximately 1.42 Mg/m^3. The bulk density values of the three soil samples collected from lacustrine deposits were greater than the estimated GLBD, and their average was 1.77 Mg/m^3. In comparison, the average bulk density of the four samples collected from background locations was approximately 1.01 Mg/m^3.

The occurrences of morainal tills were expected to be predominant in the Upper Hazeltine Creek study area, and in the Hazeltine Canyon, based on surficial geological survey data (Section 2.2). The results of the SQIA support the distribution of tills in these reaches, but also identified glaciolacustrine deposits in the Hazeltine Canyon, typically observed below the till deposits, and also exposed at surface in the Lower Hazeltine Creek area (near transects ST02 and ST03). The distribution of observed surficial geological deposits is discussed in greater detail in the HIA (SNC-Lavalin 2015b).

Although the study has a relatively small sample size, the results suggest that potentially growth limiting conditions may be experienced by some plant species at locations where tills and lacustrine deposits are exposed, and where, correspondingly, topsoil resources have been eroded. A study evaluating the effects of physical soil rehabilitation identified that lodgepole pine (*Pinus contorta*) performance on fine textured soils with elevated bulk density, in contrast to the white spruce (*Picea glauca*) endemic to the study area, was not affected by improving soil physical condition (McConkey *et al*. 2012). Kranabetter *et al*. (2006) found similar results with respect to lodgepole pine in the interior of BC. These differences highlight that the influence of soil physical condition on plant performance is a function of plant physiology and other factors including climate and soil moisture regime as these influence the complex soil-air-moisture-plant relationships. Various early successional species are adapted to establish on poor substrates with respect to soil physical condition.

Although drainage is not entirely governed by soil texture, the presence of coarse fragments tends to improve drainage and soil gas exchange due to connectivity of pores. Coarse grained soils tend to have higher GLBDs (Daddow and Warrington, 1983) and they exhibit a greater ability to recover from compaction (Page-Dumroese *et al*. 2006), as compared to fine-textured soils. For these reasons, the study focused on soils with lower coarse fragment contents as exhibited by the various till and lacustrine deposits.

Coarse grained soils were described in detail at a number of "observation" points along the channel during the bulk density sampling (Table 4, attached). These locations are shown on Drawings 621717-4-3-P1 to 621717-4-3-P11 (attached) with sample ID prefixes "OBS". These locations were not sampled due to their high estimated volumetric (v/v) coarse fragment content (i.e., greater than 50% v/v). Although locations with elevated estimated volumetric coarse fragment content (>50% v/v) were observed near the Polly Lake Plug (ST16) and above the Hazeltine Canyon (ST08), soil texture and coarse fragment content at native soil assessment locations within the scour zone appeared more variable in the Lower Hazeltine Creek area than in others. Native within channel soils in this area included tills, lacustrine deposits and a range of sand and / or gravel units with variable cobble and boulder content.

7 CONCLUSION

The following summarizes the key conclusions of the SQIA based on findings of the background review and soil sampling and analysis carried out between September 3, 2014 and October 29, 2014:

- Based on background information related to surficial geology, the pre-disturbance conditions of the study area were generally described as being dominated by glacial morainal and glaciofluvial deposits. Field observations and sampling supported these descriptions, but also identified fine textured glaciolacustrine deposits, most often observed in the lower reaches of Hazeltine Creek.
- Tailings were observed to have been deposited in what is referred to as the scour zone (135.9 ha) where topsoil resources had been removed to varying degrees, and outside of the scour zone in areas with standing vegetation (98.5 ha).
- The loss of topsoil has altered the habitat for soil flora and fauna, and related soil ecological functions such as nutrient cycling are likely to have been impacted. An evaluation of available nutrients (i.e., mineralizable N) indicate that tailings and exposed (or shallow) mineral subsoils may present growth limiting conditions for some plant species, and this is likely to be influenced by the degree to which shallow soils (i.e., topsoil) have been scoured and / or inundated by tailings.
- The tailings samples contained concentrations of total metals parameters less than CSR PL standards with the exception of copper, vanadium, and arsenic. Arsenic was measured in a single sample at a concentration marginally greater than the CSR PL standard, and statistical methods (BC MoE 2009b) indicate the tailings, on a statistical basis, are not considered to exceed the CSR PL standard for this parameter. The results were considered generally consistent with pre-release tailings chemistry
- Considering that the 95% UCLM of vanadium concentrations in tailings was less than the CSR PL standard, and that any remedial efforts directed towards managing risks associated with elevated copper would be expected to manage risks posed by vanadium in concurrence, vanadium is considered a secondary COPC.
- The concentrations of targeted analytical parameters associated with mine processing reagents were less than corresponding CSR PL standards and minimum laboratory method detection limits in the seven tailings samples and the single native within channel soil sample submitted for analysis.

- Soil samples collected from native soils beneath the tailings and from background locations outside of the tailings affected area contained concentrations of copper and vanadium less than corresponding CSR PL standards. Pre-disturbance (pre-mine construction, circa 1995) soil chemistry results from samples collected from mineral soil in the area of the Mine and mill site contained concentrations of copper between 86 mg/kg and 1980 mg/kg, which includes values that exceed the maximum observed value in tailings and the corresponding CSR PL standard. These results highlight that in a regional context, soils containing elevated concentrations of copper are present.
- Using regression analysis, copper and vanadium concentrations were determined to not be strongly influenced by sample depth or texture (i.e., combined silt and clay fractions). A weak trend of decreasing concentration of copper and vanadium with distance from the TSF was observed. This trend does not change the interpretation of the results with respect to the CSR PL standard for copper; however, suggests that vanadium may not be present at concentrations greater than CSR PL standards in the Lower Hazeltine Creek area.
- The interpretation of the distribution of tailings within the study area is considered directly applicable to understanding the distribution of the COC associated with the tailings (i.e., copper and vanadium).
- The bulk density values measured for till and lacustrine deposits suggests that where these soils are exposed or shallow, potentially growth limiting conditions with respect to soil physical condition may be present for some plant species.

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10 CLOSURE

This report was prepared based on objectives and available information at the time of writing. Contributions and comments were provided by internal and external biologists, geoscientists, engineers and agrologists.

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TABLES

TABLE 1: Summary of Analytical Results for Physical Parameters, Particle Size and Total Metals in Soil

					Miscellaneous Parameters					Particle Size								
Sample Location	Sample ID	Sample Type	Sample Date (yyyy mm dd)	Depth Interval (m)	pH (pH)	Total Organic Carbon (%)	Total Inorganic Carbon (%)	Inorganic Carbon (as CACO3 Equiv) (%)	Moisture (%)	Gravel (%)	% Sand (0.125mm - 0.063mm) (%)	% Sand (0.25mm - 0.125mm) (%)	% Sand (0.50mm - 0.25mm) (%)	% Sand (1.00mm - 0.50mm) (%)	% Sand (2.00mm - 1.00mm) (%)	% Silt (0.0312mm - 0.004mm) (%)	% Silt (0.063mm - 0.0312mm) (%)	Clay (%)
BC Standards																		
CSR Urban Park Land Use (PL)[a]					n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Background Locations																		
ST01-01	ST01-01-140906	Background	2014 09 06	0.0 - 0.2	6.01	0.45	-	-	6.08	-	-	-	-	-	-	-	-	-
ST02-01	ST02-01-140903	Background	2014 09 03	0.0 - 0.2	6.61	-	-	-	9.10	-	-	-	-	-	-	-	-	-
ST03-01	ST03-01-140907	Background	2014 09 07	0.1 - 0.3	5.36	1.22	-	-	13.8	-	-	-	-	-	-	-	-	-
ST04-01	ST04-01-140905	Background	2014 09 05	0.1 - 0.3	6.02	0.58	-	-	9.35	-	-	-	-	-	-	-	-	-
ST04-03	ST04-03-140906	Background	2014 09 06	0.1 - 0.3	6.03	0.39	-	-	5.44	-	-	-	-	-	-	-	-	-
ST05-03	ST05-03-140922	Background	2014 09 22	0.1 - 0.2	-	1.79	-	-	6.63	-	-	-	-	-	-	-	-	-
ST06-01	ST06-01-01-140905	Background	2014 09 05	0.0 - 0.1	4.97	1.10	-	-	17.8	-	-	-	-	-	-	-	-	-
	ST06-01-02-140905	Background	2014 09 05	0.1 - 0.3	5.55	-	-	-	13.8	-	-	-	-	-	-	-	-	-
	ST06-01-03-140905	Background	DUPLICATE	0.1 - 0.3	5.73	0.81	-	-	12.8	-	-	-	-	-	-	-	-	-
	QA/QC RPD %				3	*	-	-	8	-	-	-	-	-	-	-	-	-
ST07-01	ST07-01-140907	Background	2014 09 07	0.1 - 0.2	4.92	0.74	-	-	10.3	-	-	-	-	-	-	-	-	-
ST08-01	ST08-01-140905	Background	2014 09 05	0.1 - 0.3	5.06	0.55	-	-	9.59	-	-	-	-	-	-	-	-	-
ST09-01	ST09-01-01-140907	Background	2014 09 07	0.0 - 0.2	5.14	0.80	-	-	11.2	-	-	-	-	-	-	-	-	-
	ST09-01-02-140907	Background	2014 09 07	0.2 - 0.4	6.19	-	-	-	10.2	-	-	-	-	-	-	-	-	-
ST10-01	ST10-01-140905	Background	2014 09 05	0.1 - 0.3	5.61	0.35	-	-	11.2	-	-	-	-	-	-	-	-	-
ST11-01	ST11-01-140907	Background	2014 09 07	0.0 - 0.3	5.03	0.67	-	-	9.27	-	-	-	-	-	-	-	-	-
ST12-01	ST12-01-01-140904	Background	2014 09 04	0.0 - 0.0	6.63	-	-	-	59.0	-	-	-	-	-	-	-	-	-
	ST12-01-02-140904	Background	2014 09 04	0.0 - 0.2	7.13	3.28	-	-	25.7	-	-	-	-	-	-	-	-	-
ST13-01	ST13-01-140908	Background	2014 09 08	0.0 - 0.2	6.24	10.5	-	-	39.5	-	-	-	-	-	-	-	-	-
ST14-01	ST14-01-140904	Background	2014 09 04	0.1 - 0.2	5.46	-	-	-	16.7	-	-	-	-	-	-	-	-	-
ST15-01	ST15-01-01-140908	Background	2014 09 08	0.0 - 0.1	4.88	3.40	-	-	24.8	-	-	-	-	-	-	-	-	-
	ST15-01-02-140908	Background	2014 09 08	0.2 - 0.3	5.30	-	-	-	14.4	-	-	-	-	-	-	-	-	-
	ST15-01-03-140908	Background	DUPLICATE	0.2 - 0.3	5.29	0.59	-	-	12.8	-	-	-	-	-	-	-	-	-
	QA/QC RPD %				< 1	*	-	-	12	-	-	-	-	-	-	-	-	-
ST16-01	ST16-01-01-140906	Background	2014 09 06	0.1 - 0.2	4.96	6.53	-	-	45.2	-	-	-	-	-	-	-	-	-
	ST16-01-02-140906	Background	2014 09 06	0.2 - 0.3	5.26	-	-	-	13.0	-	-	-	-	-	-	-	-	-
ST17-01	ST17-01-140912	Background	2014 09 12	0.1 - 0.2	4.69	1.11	-	-	15.9	-	-	-	-	-	-	-	-	-
ST18-01	ST18-01-140917	Background	2014 09 17	0.2 - 0.3	6.20	0.32	-	-	10.1	-	-	-	-	-	-	-	-	-
Within Channel Locations																		
ST01-02	ST01-02-01-140922	Tailings	2014 09 22	0.0 - 0.1	7.66	< 0.10	0.43	3.59	46.5	< 0.10	1.09	< 0.10	< 0.10	< 0.10	< 0.10	52.2	27.8	18.7
	ST01-02-03-140922	Tailings	DUPLICATE	0.0 - 0.1	7.68	4.24	0.43	3.55	41.9	< 0.10	1.0	< 0.10	< 0.10	< 0.10	< 0.10	52.2	27.9	18.6
	QA/QC RPD %				< 1	*	*	*	10	*	9	*	*	*	*	0	< 1	< 1
	ST01-02-02-140922	Native Within Channel	2014 09 22	0.1 - 0.2	6.92	2.45	0.26	2.14	20.0	32.4	7.07	8.7	8.83	6.95	6.28	14.3	8.74	6.71
ST01-03	ST01-03-140911	Tailings	2014 09 11	0.0 - 0.2	8.57	-	0.18	1.46	16.4	-	-	-	-	-	-	-	-	-
ST01-04	ST01-04-140911	Tailings	2014 09 11	0.0 - 0.2	8.28	-	0.31	2.56	16.0	-	-	-	-	-	-	-	-	-
ST01-05	ST01-05-01-140911	Tailings	2014 09 11	0.0 - 0.1	8.72	0.23	0.31	2.56	15.1	8.19	18.9	18.9	5.37	1.46	2.32	21.3	16.4	7.28
	ST01-05-02-140911	Tailings	2014 09 11	0.1 - 0.2	7.99	-	0.17	1.38	13.4	-	-	-	-	-	-	-	-	-
	ST01-05-03-140911	Native Within Channel	2014 09 11	0.2 - 0.3	6.79	4.6	< 0.10	< 0.80	25.5	-	-	-	-	-	-	-	-	-
ST01-06	ST01-06-140911	Tailings	2014 09 11	0.0 - 0.2	8.10	-	0.24	1.97	24.9	-	-	-	-	-	-	-	-	-
ST01-09	ST01-09-01-140922	Tailings	2014 09 22	0.0 - 0.1	8.72	0.11	0.46	3.83	18.3	0.49	19.3	18.9	5.28	1.07	0.85	26.2	18.6	9.3
	ST01-09-03-140922	Tailings	DUPLICATE	0.0 - 0.1	8.77	< 0.10	0.61	5.09	20.8	0.52	19.0	19.2	5.45	1.09	2.36	25.3	17.7	9.39
	QA/QC RPD %				< 1	*	*	*	13	*	2	2	3	2	94	4	5	< 1
	ST01-09-02-140922	Tailings	2014 09 22	0.4 - 0.5	7.90	-	0.38	3.18	26.5	-	-	-	-	-	-	-	-	-
ST02-02	ST02-02-01-140910	Tailings	2014 09 10	0.0 - 0.1	8.07	0.46	0.21	1.74	24.8	-	-	-	-	-	-	-	-	-
	ST02-02-03-140910	Tailings	DUPLICATE	0.0 - 0.1	8.14	-	0.32	2.69	34.6	-	-	-	-	-	-	-	-	-
	QA/QC RPD %				<1	*	*	*	33	-	-	-	-	-	-	-	-	-
	ST02-02-02-140910	Native Within Channel	2014 09 10	0.2 - 0.4	6.76	44.2	< 0.10	< 0.80	83.8	-	-	-	-	-	-	-	-	-
ST02-03	ST02-03-140910	Tailings	2014 09 10	0.2 - 0.3	8.45	-	0.10	0.87	6.12	-	-	-	-	-	-	-	-	-
ST02-04	ST02-04-140910	Native Within Channel	2014 09 10	0.1 - 0.3	8.46	0.32	1.17	9.77	22.5	< 0.10	0.82	< 0.10	< 0.10	< 0.10	< 0.10	52.1	14.5	32.5

	Stong Acid Leachable - Total Metals																					
Sample ID	Antimony (µg/g)	Arsenic (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Cadmium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)	Copper (µg/g)	Lead (µg/g)	Lithium (µg/g)	Manganese (µg/g)	Mercury (µg/g)	Molybdenum (µg/g)	Nickel (µg/g)	Selenium (µg/g)	Silver (µg/g)	Strontium (µg/g)	Tin (µg/g)	Uranium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
BC Standards																					
CSR Urban Park Land Use (PL)[a]	20	15	400	4	1.5 - 35[b]	60	50	90-150[b]	100-400[b]	1,600	1,800	15	10	100	3	20	47,000	50	16	200	150-450[b]
Background Locations																					
ST01-01-140906	0.26	14.2	101	0.34	0.243	29.5	10.5	16.6	5.44	11.9	518	< 0.050	< 0.50	23.5	< 0.20	< 0.10	36.8	< 2.0	0.378	81.3	95.4
ST02-01-140903	0.44	8.69	72.2	0.33	0.127	23.7	8.75	34.2	4.55	8.0	413	0.064	0.65	19.7	< 0.20	< 0.10	47.5	< 2.0	0.462	69.6	40.1
ST03-01-140907	0.36	7.69	88.0	0.30	0.344	38.5	11.1	29.2	5.34	13.1	408	< 0.050	0.51	27.2	< 0.20	0.11	22.5	< 2.0	0.551	53.3	61.7
ST04-01-140905	0.25	5.33	69.7	0.31	0.087	31.2	8.66	20.9	4.25	11.3	252	< 0.050	< 0.50	22.6	< 0.20	< 0.10	33.1	< 2.0	0.507	55.2	44.0
ST04-03-140906	0.38	7.26	128	0.35	0.125	23.9	10.8	28.7	5.37	11.1	410	< 0.050	0.55	25.2	0.20	< 0.10	40.3	< 2.0	0.401	88.2	45.5
ST05-03-140922	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ST06-01-01-140905	0.35	8.10	92.5	< 0.20	< 0.050	9.59	2.51	5.98	5.03	7.1	171	< 0.050	0.58	4.40	< 0.20	< 0.10	16.8	< 2.0	0.424	40.8	32.0
ST06-01-02-140905	0.42	11.2	150	0.25	0.064	15.5	5.22	11.5	4.84	13.6	170	< 0.050	0.65	12.7	< 0.20	0.11	14.8	< 2.0	0.407	54.0	53.7
ST06-01-03-140905	0.44	11.0	144	0.26	0.064	15.0	5.45	10.6	4.76	16.9	154	< 0.050	0.59	12.7	< 0.20	0.11	16.2	< 2.0	0.451	51.7	66.9
QA/QC RPD %	*	2	4	*	*	3	4	8	2	*	10	*	*	0	*	*	9	*	10	4	22
ST07-01-140907	0.21	5.00	101	0.30	0.104	43.2	14.3	18.9	10.5	33.9	385	< 0.050	< 0.50	36.3	< 0.20	< 0.10	16.1	< 2.0	0.512	40.2	79.1
ST08-01-140905	0.30	4.28	62.0	0.35	0.145	35.4	11.7	19.2	7.69	21.4	377	< 0.050	0.65	23.3	< 0.20	< 0.10	25.1	< 2.0	0.534	61.5	53.6
ST09-01-01-140907	0.23	4.09	70.5	0.35	0.192	33.1	10.9	15.3	6.87	19.3	352	< 0.050	< 0.50	20.6	< 0.20	0.14	27.1	< 2.0	0.493	58.3	61.2
ST09-01-02-140907	0.30	5.23	62.2	0.41	0.106	40.1	11.9	22.4	7.43	20.1	398	< 0.050	< 0.50	25.4	< 0.20	< 0.10	37.3	< 2.0	0.578	58.0	51.4
ST10-01-140905	0.27	3.87	49.8	0.31	0.158	29.6	8.48	19.3	5.00	13.2	290	< 0.050	< 0.50	21.2	< 0.20	< 0.10	31.4	< 2.0	0.487	59.4	42.6
ST11-01-140907	0.23	3.94	62.9	0.28	0.221	30.1	10.8	21.7	5.59	16.6	329	< 0.050	0.53	22.9	< 0.20	< 0.10	26.1	< 2.0	0.481	55.1	53.0
ST12-01-01-140904	0.46	4.86	369	0.40	1.98	25.1	14.0	76.1	5.05	5.7	***7,320***	0.170	5.11	53.9	***4.29***	0.66	142	< 2.0	10.5	40.3	46.8
ST12-01-02-140904	0.56	14.0	396	1.37	0.740	***108***	35.0	132	22.0	31.5	***3,630***	0.132	2.33	***104***	1.21	1.15	96.8	< 2.0	4.54	133	149
ST13-01-140908	0.57	11.3	365	1.7	0.718	***94.6***	23.2	135	14.8	36.3	1,240	0.090	1.13	85.5	0.66	0.78	97.7	< 2.0	2.47	114	145
ST14-01-140904	0.36	4.96	92.0	0.48	0.261	46.5	17.2	25.9	9.69	24.1	916	< 0.050	0.99	29.2	0.23	0.12	25.9	< 2.0	0.542	72.1	74.6
ST15-01-01-140908	0.26	6.48	147	0.64	0.359	47.6	13.1	36.3	8.58	19.7	663	0.057	0.67	30.2	< 0.20	0.71	36.4	< 2.0	0.786	81.5	86.1
ST15-01-02-140908	0.26	6.17	89.3	0.37	0.209	38.4	11.1	22.1	6.08	14.1	506	< 0.050	< 0.50	22.1	< 0.20	< 0.10	44.0	< 2.0	0.547	74.1	45.5
ST15-01-03-140908	0.20	5.06	87.0	0.28	0.168	34.0	7.12	20.2	5.44	14.0	299	< 0.050	< 0.50	18.7	< 0.20	< 0.10	48.3	< 2.0	0.527	64.6	40.7
QA/QC RPD %	*	20	3	*	*	12	44	9	11	*	51	*	*	17	*	*	9	*	4	14	11
ST16-01-01-140906	0.37	6.27	248	1.18	0.445	***81.8***	19.8	68.2	15.9	34.7	978	0.087	1.61	60.3	0.31	0.75	43.4	< 2.0	1.23	107	147
ST16-01-02-140906	0.26	6.26	82.1	0.35	0.090	39.5	12.2	21.8	8.08	20.5	552	< 0.050	0.51	27.9	0.25	< 0.10	45.7	< 2.0	0.565	71.2	48.7
ST17-01-140912	0.34	3.06	62.7	0.25	0.290	40.5	8.13	10.6	6.64	19.4	304	< 0.050	0.53	18.0	< 0.20	0.12	23.8	< 2.0	0.500	61.8	93.4
ST18-01-140917	0.36	8.25	100	0.40	0.097	42.2	15.9	26.1	8.01	14.4	808	< 0.050	< 0.50	24.5	0.23	< 0.10	49.2	< 2.0	0.596	80.4	44.5
Within Channel Locations																					
ST01-02-01-140922	0.56	13.3	219	0.74	0.294	29.1	19.0	***473***	8.64	22.6	927	0.111	3.57	23.6	1.16	0.30	180	< 2.0	1.51	129	77.1
ST01-02-03-140922	0.48	11.7	198	0.66	0.280	25.4	17.3	***446***	7.38	20.1	830	0.104	3.26	20.6	1.05	0.28	163	< 2.0	1.25	131	69.3
QA/QC RPD %	*	13	10	*	5	14	9	6	16	*	11	*	9	14	10	*	10	*	19	2	11
ST01-02-02-140922	0.24	6.95	104	0.46	0.365	34.3	9.30	45.8	5.94	22.3	499	< 0.050	< 0.50	26.3	0.4	0.26	58.5	< 2.0	1.08	60.5	52.7
ST01-03-140911	0.38	11.2	179	0.59	0.123	10.4	16.3	***837***	6.57	15.3	614	0.076	4.39	7.89	1.04	0.35	153	< 2.0	0.988	195	53.3
ST01-04-140911	0.5	12.4	191	0.71	0.152	10.2	18.0	***870***	5.70	17.5	688	0.066	4.85	8.55	1.17	0.34	179	< 2.0	1.15	190	62.6
ST01-05-01-140911	0.37	11.0	157	0.62	0.134	10.7	15.7	***865***	4.80	14.1	604	0.071	3.94	9.19	1.07	0.33	165	< 2.0	0.976	183	54.6
ST01-05-02-140911	0.45	8.78	66.1	0.36	0.113	23.1	10.7	***185***	4.42	11.3	513	0.062	1.16	15.7	0.42	< 0.10	85.3	< 2.0	0.571	114	48.2
ST01-05-03-140911	0.34	9.49	100	0.34	0.313	35.4	10.9	34.0	6.07	12.1	686	0.081	0.65	25.2	0.52	0.11	84.0	< 2.0	0.898	61.3	51.1
ST01-06-140911	0.36	10.2	159	0.46	0.188	15.7	12.6	***556***	4.66	10.7	953	0.081	4.27	12.3	0.85	0.24	135	< 2.0	0.778	138	46.3
ST01-09-01-140922	0.36	11.7	168	0.59	0.137	12.1	17.0	***874***	5.34	15.9	598	0.076	4.60	9.30	1.12	0.35	174	< 2.0	0.978	191	56.4
ST01-09-03-140922	0.31	11.0	160	0.60	0.133	11.1	16.1	***851***	4.67	15.0	563	0.081	4.50	8.92	1.16	0.36	164	< 2.0	0.911	179	54.0
QA/QC RPD %	*	6	5	*	*	9	5	3	13	*	6	*	2	4	4	*	6	*	7	7	4
ST01-09-02-140922	0.36	9.93	155	0.50	0.176	18.6	14.0	***483***	5.33	13.9	608	0.079	3.01	13.5	0.82	0.24	140	< 2.0	0.893	152	50.3
ST02-02-01-140910	0.32	8.55	113	0.41	0.118	15.4	11.0	***513***	4.42	10.7	491	0.065	3.26	10.2	0.74	0.23	112	< 2.0	0.692	132	40.9
ST02-02-03-140910	0.37	8.79	127	0.46	0.166	16.8	11.4	***550***	4.13	10.4	514	0.062	3.25	10.6	0.72	0.22	119	< 2.0	0.704	133	43.2
QA/QC RPD %	*	3	12	*	*	9	4	7	7	*	5	*	< 1	4	*	*	6	*	2	< 1	6
ST02-02-02-140910	0.17	0.434	30.8	< 0.20	0.084	1.00	0.20	6.28	< 0.50	< 5.0	7.4	< 0.050	1.95	2.29	1.50	< 0.10	120	< 2.0	3.15	2.04	2.3
ST02-03-140910	0.48	11.4	97.3	0.46	0.193	18.7	12.2	***557***	5.24	11.8	566	0.095	2.80	12.0	0.62	0.27	103	< 2.0	0.674	142	49.7
ST02-04-140910	0.25	8.67	145	0.59	0.159	48.4	16.9	37.4	13.8	42.0	802	< 0.050	0.68	44.9	0.36	< 0.10	223	< 2.0	1.25	45.6	84.7

Associated ALS files: L1518225, L1519001, L1520490, L1522556, L1540219.
All terms defined within the body of SNC-Lavalin's report.
< Denotes concentration less than indicated detection limit or RPD less than indicated value.
- Denotes analysis not conducted.
n/a Denotes no applicable standard.
RPD Denotes relative percent difference.
* RPDs are not normally calculated where one or more concentrations are less than five times MDL.

BOLD Concentration greater than CSR Urban Park Land Use (PL) standard.

[a] The site-specific factors used for determining the matrix standards for this site include: intake of contaminated soil, groundwater used for drinking water, toxicity to soil invertebrates and plants, and groundwater flow to surface water used by freshwater aquatic life (whichever is most stringent).
[b] Standard varies with pH.

TABLE 1 (cont'd): Summary of Analytical Results for Physical Parameters, Particle Size and Total Metals in Soil

Sample Location	Sample ID	Sample Type	Sample Date (yyyy mm dd)	Depth Interval (m)	Miscellaneous Parameters: pH (pH)	Total Organic Carbon (%)	Total Inorganic Carbon (%)	Inorganic Carbon (as CACO3 Equiv) (%)	Moisture (%)	Particle Size: Gravel (%)	% Sand (0.125mm - 0.063mm) (%)	% Sand (0.25mm - 0.125mm) (%)	% Sand (0.50mm - 0.25mm) (%)	% Sand (1.00mm - 0.50mm) (%)	% Sand (2.00mm - 1.00mm) (%)	% Silt (0.0312mm - 0.004mm) (%)	% Silt (0.063mm - 0.0312mm) (%)	Clay (%)	Stong Acid Leachable - Total Metals: Antimony (µg/g)	Arsenic (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Cadmium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)	Copper (µg/g)	Lead (µg/g)	Lithium (µg/g)	Manganese (µg/g)	Mercury (µg/g)	Molybdenum (µg/g)	Nickel (µg/g)	Selenium (µg/g)	Silver (µg/g)	Strontium (µg/g)	Tin (µg/g)	Uranium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
BC Standards																																							
CSR Urban Park Land Use (PL)[a]					n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	20	15	400	4	1.5 - 35[b]	60	50	90-150[b]	100-400[b]	1,600	1,800	15	10	100	3	20	47,000	50	16	200	150-450[b]
Within Channel Locations (Cont'd)																																							
ST02-05	ST02-05-01-140910	Tailings	2014 09 10	0.0 - 0.2	8.24	-	0.29	2.41	16.8	-	-	-	-	-	-	-	-	-	0.35	11.4	160	0.61	0.170	10.8	16.4	**901**	4.97	14.7	632	0.081	4.39	9.02	1.07	0.35	155	< 2.0	0.888	190	60.2
	ST02-05-02-140910	Tailings	2014 09 10	0.2 - 0.4	8.23	-	0.17	1.45	6.77	-	-	-	-	-	-	-	-	-	0.36	9.62	92.4	0.45	0.128	15.5	12.1	**750**	4.30	10.3	514	0.070	2.76	10.2	0.84	0.29	105	< 2.0	0.631	152	46.5
	ST02-05-03-140910	Tailings	2014 09 10	0.4 - 0.6	8.32	0.15	0.23	1.88	8.82	-	-	-	-	-	-	-	-	-	0.42	9.79	97.7	0.42	0.160	19.3	11.8	**543**	5.21	11.1	556	0.078	4.23	13.3	0.64	0.22	98.8	< 2.0	0.709	141	48.7
ST02-06	ST02-06-140910	Tailings	2014 09 10	0.0 - 0.2	8.31	-	0.23	1.89	8.88	-	-	-	-	-	-	-	-	-	0.37	8.65	74.5	0.39	0.105	20.2	10.2	**379**	4.14	9.2	488	0.060	3.06	12.6	0.57	0.17	93.2	< 2.0	0.575	119	42.7
ST02-07	ST02-07-140903	Native Within Channel	2014 09 03	0.3 - 0.8	7.75	0.48	< 0.10	< 0.80	8.94	32.5	4.77	8.91	15.0	15.9	9.98	5.49	3.58	3.89	0.37	9.27	74.4	0.40	0.096	28.5	8.70	32.3	5.08	10.1	370	0.093	1.23	17.2	< 0.20	< 0.10	57.4	< 2.0	0.704	86.8	60.6
ST02-08	ST02-08-140910	Native Within Channel	2014 09 10	0.1 - 0.3	7.74	0.13	< 0.10	< 0.80	14.8	< 0.10	32.9	17.1	0.85	< 0.10	< 0.10	20.7	22.1	6.27	0.27	14.7	68.5	0.28	0.133	32.8	9.43	25.0	5.91	12.9	307	< 0.050	< 0.50	26.0	0.27	< 0.10	42.9	< 2.0	0.647	42.1	42.5
ST03-02	ST03-02-140915	Tailings	2014 09 15	0.0 - 0.1	8.59	0.13	0.32	2.67	15.6	5.08	19.1	19.5	4.11	0.66	0.78	23.8	18.6	8.43	0.43	11.9	185	0.65	0.131	11.0	16.9	**909**	5.16	15.9	635	0.075	4.73	7.98	1.14	0.34	161	< 2.0	1.08	**211**	55.4
ST03-03	ST03-03-01-140909	Tailings	2014 09 09	0.0 - 0.1	8.44	-	0.37	3.09	18.0	-	-	-	-	-	-	-	-	-	0.40	12.1	165	0.54	0.213	12.3	14.8	**794**	5.67	13.4	619	0.086	3.73	8.77	0.94	0.32	129	< 2.0	0.913	191	54.1
	ST03-03-02-140909	Tailings	2014 09 09	0.1 - 0.3	8.58	0.17	0.35	2.89	8.38	< 0.10	11.6	42.9	37.8	0.31	< 0.10	2.19	4.59	0.47	0.33	10.5	90.4	0.48	0.181	8.50	11.2	**1,110**	4.36	11.7	519	0.097	5.27	6.31	1.02	0.43	79.3	< 2.0	0.670	152	52.6
	ST03-03-03-140909	Tailings	2014 09 09	0.3 - 0.6	8.93	0.10	0.66	5.50	23.4	-	-	-	-	-	-	-	-	-	0.40	12.8	173	0.62	0.166	10.1	17.2	**901**	5.49	16.5	632	0.078	4.14	8.03	1.07	0.36	151	< 2.0	0.936	196	60.0
ST03-04	ST03-04-140909	Tailings	2014 09 09	0.0 - 0.2	8.24	-	0.31	2.61	15.5	-	-	-	-	-	-	-	-	-	0.38	11.7	175	0.63	0.167	10.2	17.0	**884**	5.39	15.2	641	0.073	4.31	7.92	1.06	0.31	148	< 2.0	1.01	191	57.3
ST03-05	ST03-05-01-140910	Tailings	2014 09 10	0.0 - 0.5	8.37	0.13	0.22	1.87	9.76	-	-	-	-	-	-	-	-	-	0.36	7.96	87.4	0.38	0.134	18.4	10.9	**389**	4.27	10.6	486	0.061	3.09	12.8	0.51	0.17	104	< 2.0	0.536	116	44.8
	ST03-05-02-140910	Native Within Channel	2014 09 10	0.6 - 0.7	6.41	-	0.44	3.69	14.2	0.61	16.5	21.4	17.2	4.42	1.82	17.9	13.4	6.75	0.28	6.98	82.9	0.32	0.182	32.6	8.82	23.3	5.45	13.0	321	< 0.050	< 0.50	18.6	< 0.20	< 0.10	43.2	< 2.0	0.547	81.1	48.6
ST04-02	ST04-02-140915	Tailings	2014 09 15	0.0 - 0.1	9.09	< 0.10	0.37	3.07	19.0	< 0.10	17.4	46.0	17.7	< 0.10	< 0.10	7.49	9.64	1.77	0.37	11.8	98.0	0.50	0.234	11.7	13.4	**1,080**	4.94	11.9	599	0.095	6.28	7.24	1.21	0.43	97.3	< 2.0	0.854	**213**	52.0
ST05-02	ST05-02-01-140915	Tailings	2014 09 15	0.0 - 0.2	8.56	0.35	0.31	2.59	19.2	-	-	-	-	-	-	-	-	-	0.37	9.51	126	0.52	0.124	14.6	13.0	**633**	4.71	11.7	537	0.063	3.29	11.2	0.84	0.28	138	< 2.0	0.759	158	44.9
	ST05-02-02-140915	Tailings	DUPLICATE	0.0 - 0.2	8.53	0.33	0.29	2.39	28.4	-	-	-	-	-	-	-	-	-	0.38	10.6	175	0.57	0.157	15.1	15.0	**681**	5.85	14.9	583	0.075	3.27	12.3	0.95	0.29	166	< 2.0	0.931	161	53.7
	QA/QC RPD %				< 1	*	*	*	39	-	-	-	-	-	-	-	-	-	*	11	33	*	*	3	14	7	22	*	8	*	< 1	9	*	*	18	*	20	2	18
ST06-02	ST06-02-01-140915	Tailings	2014 09 15	0.0 - 0.1	8.5	< 0.10	0.33	2.73	14.5	1.61	17.4	23.3	3.98	0.35	0.18	25.4	19.3	8.46	0.38	11.6	184	0.64	0.147	10.4	17.4	**898**	5.09	16.1	602	0.078	4.60	8.09	1.18	0.40	157	< 2.0	0.944	**205**	55.7
ST06-03	ST06-03-140922	Tailings	2014 09 22	0.0 - 0.2	8.51	-	0.40	3.37	20.8	-	-	-	-	-	-	-	-	-	0.36	11.5	178	0.60	0.139	10.5	18.0	**874**	5.03	17.5	613	0.070	4.51	8.56	1.09	0.30	175	< 2.0	0.927	196	57.8
ST06-04	ST06-04-01-140922	Tailings	2014 09 22	0.0 - 0.2	8.59	-	0.46	3.82	19.4	-	-	-	-	-	-	-	-	-	0.42	12.0	191	0.68	0.142	11.1	18.8	**889**	5.68	18.9	683	0.075	5.97	9.53	1.18	0.35	175	< 2.0	1.04	191	61.8
ST07-02	ST07-02-140911	Tailings	2014 09 11	0.0 - 0.0	8.31	0.12	0.40	3.34	15.5	-	-	-	-	-	-	-	-	-	0.46	13.6	211	0.76	0.144	11.1	19.7	**938**	6.31	19.7	766	0.082	4.13	9.53	1.22	0.37	186	< 2.0	1.26	194	71.5
ST07-03	ST07-03-01-140911	Tailings	2014 09 11	0.0 - 0.1	8.35	-	0.35	2.91	16.4	-	-	-	-	-	-	-	-	-	0.41	11.9	180	0.64	0.182	9.89	16.8	**897**	5.04	16.8	604	0.080	5.04	8.08	1.13	0.35	156	< 2.0	1.07	**202**	60.2
	ST07-03-03-140911	Tailings	DUPLICATE	0.0 - 0.1	8.36	-	0.30	2.47	16.6	-	-	-	-	-	-	-	-	-	0.43	12.0	182	0.63	0.144	10.8	16.9	**921**	5.27	16.7	593	0.081	4.74	7.72	1.15	0.39	159	< 2.0	1.11	**203**	57.4
	QA/QC RPD %				< 1	-	*	*	1	-	-	-	-	-	-	-	-	-	*	< 1	1	*	*	9	< 1	3	5	*	2	*	6	5	2	*	2	*	4	< 1	5
	ST07-03-02-140911	Tailings	2014 09 11	0.2 - 0.5	8.42	0.17	0.41	3.43	20.1	17.1	14.1	10.9	2.88	1.05	1.11	27.1	15.7	10.2	0.40	11.9	194	0.70	0.135	10.7	18.2	**892**	5.51	17.9	650	0.074	4.44	8.72	1.13	0.33	173	< 2.0	1.09	195	61.3
ST08-02	ST08-02-01-140915	Tailings	2014 09 15	0.0 - 0.2	8.49	< 0.10	0.47	3.89	20.5	0.58	11.2	8.97	1.83	0.37	0.40	39.0	17.2	20.4	0.51	14.5	218	0.79	0.164	11.6	21.1	**934**	6.90	22.3	839	0.076	4.57	11.2	1.21	0.37	201	< 2.0	1.27	177	74.6
	ST08-02-02-140915	Tailings	2014 09 15	0.4 - 0.4	8.36	0.12	0.40	3.34	11.3	-	-	-	-	-	-	-	-	-	0.37	8.01	101	0.41	0.178	29.6	12.0	**207**	6.26	14.3	549	0.066	1.44	20.6	0.46	0.16	125	< 2.0	0.801	106	53.7
ST08-03	ST08-03-140915	Tailings	2014 09 15	0.0 - 0.1	8.77	-	0.33	2.76	24.3	-	-	-	-	-	-	-	-	-	0.37	11.5	117	0.51	0.152	12.0	13.9	**875**	4.72	12.4	555	0.102	4.53	7.66	1.02	0.44	90.9	< 2.0	0.850	**225**	56.3
ST08-04	ST08-04-140915	Tailings	2014 09 15	0.0 - 0.1	8.52	-	0.32	2.66	12.1	-	-	-	-	-	-	-	-	-	0.35	10.8	196	0.61	0.111	9.81	17.5	**882**	5.23	16.6	592	0.064	6.71	7.95	1.08	0.30	155	< 2.0	0.902	**201**	58.2
ST08-05	ST08-05-01-140915	Tailings	2014 09 15	0.1 - 0.2	8.28	-	0.17	1.41	10.4	-	-	-	-	-	-	-	-	-	0.28	8.46	93.2	0.36	0.123	15.8	10.5	**544**	4.00	10.4	448	0.052	3.10	10.6	0.69	0.22	98.8	< 2.0	0.559	122	43.2
	ST08-05-02-140915	Native Within Channel	2014 09 15	0.3 - 0.5	5.95	0.76	< 0.10	< 0.8	19.3	5.41	5.52	6.61	5.93	3.29	3.07	41.3	13.6	15.2	0.20	3.49	114	0.37	0.249	36.6	12.4	19.3	8.31	25.9	635	< 0.050	0.71	24.9	< 0.20	0.18	25.3	< 2.0	0.584	45	90
ST08-06	ST08-06-140915	Native Within Channel	2014 09 15	0.1 - 0.3	6.70	0.27	< 0.10	< 0.8	5.49	-	-	-	-	-	-	-	-	-	0.31	7.18	69.8	0.34	0.078	25.8	9.73	65.3	4.61	11.3	495	< 0.050	< 0.50	18.7	< 0.20	< 0.10	77.7	< 2.0	0.496	86.3	42
ST09-02	ST09-02-01-140915	Tailings	2014 09 15	0.0 - 0.2	8.58	-	0.34	2.87	23.6	-	-	-	-	-	-	-	-	-	0.27	9.46	107	0.48	0.169	9.99	12.3	**1,000**	4.34	12.0	489	0.095	4.42	6.67	1.02	0.39	93.3	< 2.0	0.667	170	51.4
	ST09-02-02-140915	Tailings	DUPLICATE	0.0 - 0.2	8.65	-	0.32	2.64	18.4	-	-	-	-	-	-	-	-	-	0.36	10.8	118	0.53	0.128	9.75	12.7	**1,070**	4.14	12.2	538	0.100	4.38	6.60	0.96	0.44	105	< 2.0	0.760	173	51
	QA/QC RPD %				< 1	-	*	*	25	-	-	-	-	-	-	-	-	-	*	13	10	*	*	2	3	7	5	*	10	*	< 1	1	*	*	12	*	13	2	< 1
ST09-03	ST09-03-140915	Tailings	2014 09 15	0.0 - 0.1	8.42	-	0.33	2.72	12.5	-	-	-	-	-	-	-	-	-	0.33	10.7	177	0.64	0.101	9.22	17.2	**885**	4.35	16.0	557	0.072	5.10	8.10	1.17	0.32	166	< 2.0	0.903	192	51.2
ST09-04	ST09-04-140915	Native Within Channel	2014 09 15	0.1 - 0.3	8.20	0.21	< 0.10	< 0.80	6.90	< 0.10	16.6	26.6	22.2	2.37	< 0.10	13.3	11.4	7.5	0.18	4.39	80.6	0.29	< 0.050	26.9	8.27	18.5	5.17	13.9	235	< 0.050	0.53	16.1	< 0.20	< 0.10	67.2	< 2.0	0.529	59.2	34.5
ST10-02	ST10-02-140914	Tailings	2014 09 14	0.0 - 0.1	8.42	< 0.10	0.31	2.58	13.6	0.11	17.8	15.2	2.64	0.12	< 0.10	31.1	21.0	11.9	0.39	12.7	191	0.66	0.135	10.5	18.8	**925**	5.74	18.1	671	0.072	4.72	8.68	1.21	0.36	166	< 2.0	1.04	**205**	61.6
ST10-03	ST10-03-140914	Tailings	2014 09 14	0.0 - 0.1	8.34	-	0.36	2.97	17.9	-	-	-	-	-	-	-	-	-	0.44	12.3	192	0.71	0.155	10.1	17.9	**863**	4.74	17.1	655	0.069	4.86	8.92	1.12	0.34	201	< 2.0	1.09	187	60.6
ST10-04	ST10-04-140914	Tailings	2014 09 14	0.0 - 0.2	8.54	-	0.35	2.89	17.2	-	-	-	-	-	-	-	-	-	0.38	12.2	186	0.68	0.132	10.3	17.3	**899**	5.13	17.0	642	0.083	5.39	8.04	1.04	0.34	161	< 2.0	1.02	198	61.5
ST11-02	ST11-02-01-140914	Tailings	2014 09 14	0.0 - 0.2	8.81	< 0.10	0.30	2.48	17.4	< 0.10	12.8	37.6	33.4	0.55	< 0.10	6.47	7.79	1.37	0.36	11.8	86.3	0.44	0.221	15.8	16.4	**1,350**	5.04	13.0	587	0.114	6.45	8.10	1.50	0.61	81.2	< 2.0	0.727	**289**	64.4
	ST11-02-02-140914	Tailings	2014 09 14	0.2 - 0.4	8.73	-	0.29	2.41	17.9	-	-	-	-	-	-	-	-	-	0.60	14.2	108	0.51	0.223	11.0	13.7	**1,360**	5.02	13.2	611	0.108	4.68	7.42	1.22	0.58	89.4	< 2.0	0.755	199	54.6
ST11-03	ST11-03-141029	Native Within Channel	2014 10 29	0.1 - 0.3	8.25	-	-	-	-	6.54	9.08	5.60	4.72	2.49	2.49	35.4	16.0	17.7	0.40	5.27	84.1	0.38	0.168	40.8	13.9	32.1	10.2	22.6	549	< 0.050	0.69	40.1	0.59	< 0.10	179	< 2.0	1.12	40.2	70.7
ST12-02	ST12-02-140914	Tailings	2014 09 14	0.0 - 0.2	8.99	-	0.31	2.58	23.2	-	-	-	-	-	-	-	-	-	0.28	10.9	107	0.48	0.206	11.7	14.1	**1,230**	4.86	13.0	562	0.113	4.36	7.38	1.23	0.51	92.9	< 2.0	0.753	**218**	61.4
ST12-03	ST12-03-140914	Tailings	2014 09 14	0.0 - 0.1	8.42	< 0.10	0.31	2.55	13.7	0.10	21.5	20.2	3.97	0.13	< 0.10	25.5	20.9	7.68	0.40	11.8	178	0.61	0.129	10.1	16.6	**903**	4.52	14.2	586	0.078	4.37	7.27	1.09	0.36	151	< 2.0	0.974	**203**	53.7
ST12-04	ST12-04-140914	Tailings	2014 09 14	0.0 - 0.1	8.51	-	0.31	2.56	4.20	-	-	-	-	-	-	-	-	-	0.36	11.7	193	0.65	0.119	10.1	18.1	**889**	5.24	17.6	622	0.067	4.50	8.55	1.10	0.31	162	< 2.0	0.915	**201**	59.8
ST12-05	ST12-05-140914	Native Within Channel	2014 09 14	0.3 - 0.4	7.27	0.30	< 0.10	< 0.80	13.2	12.3	8.23	9.04	8.24	6.45	8.66	19.4	10.0	17.7	0.39	8.03	95.8	0.40	0.084	36.4	12.6	30.4	7.15	15.2	696	0.057	0.51	25.9	0.32	< 0.10	66.6	< 2.0	0.732	71.4	53.8
ST13-02	ST13-02-140914	Tailings	2014 09 14	0.0 - 0.2	8.60	< 0.10	0.44	3.67	24.5	< 0.10	12.9	10.5	2.01	0.14	< 0.10	37.3	18.5	18.6	0.47	13.8	220	0.78	0.168	10.7	20.8	**918**	6.98	22.2	814	0.080	5.42	10.3	1.22	0.38	194	< 2.0	1.22	175	75.4

Associated ALS files: L1518225, L1519001, L1520490, L1522556, L1540219.
All terms defined within the body of SNC-Lavalin's report.
< Denotes concentration less than indicated detection limit or RPD less than indicated value.
- Denotes analysis not conducted.
n/a Denotes no applicable standard.
RPD Denotes relative percent difference.
* RPDs are not normally calculated where one or more concentrations are less than five times MDL.

BOLD Concentration greater than CSR Urban Park Land Use (PL) standard.

[a] The site-specific factors used for determining the matrix standards for this site include: intake of contaminated soil, groundwater used for drinking water, toxicity to soil invertebrates and plants, and groundwater flow to surface water used by freshwater aquatic life (whichever is most stringent).
[b] Standard varies with pH.

TABLE 1 (cont'd): Summary of Analytical Results for Physical Parameters, Particle Size and Total Metals in Soil

Sample Location	Sample ID	Sample Type	Sample Date (yyyy mm dd)	Depth Interval (m)	Miscellaneous Parameters: pH (pH)	Total Organic Carbon (%)	Total Inorganic Carbon (%)	Inorganic Carbon (as CACO3 Equiv) (%)	Moisture (%)	Particle Size: Gravel (%)	% Sand (0.125mm - 0.063mm) (%)	% Sand (0.25mm - 0.125mm) (%)	% Sand (0.50mm - 0.25mm) (%)	% Sand (1.00mm - 0.50mm) (%)	% Sand (2.00mm - 1.00mm) (%)	% Silt (0.0312mm - 0.004mm) (%)	% Silt (0.063mm - 0.0312mm) (%)	Clay (%)	Stong Acid Leachable - Total Metals: Antimony (µg/g)	Arsenic (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Cadmium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)	Copper (µg/g)	Lead (µg/g)	Lithium (µg/g)	Manganese (µg/g)	Mercury (µg/g)	Molybdenum (µg/g)	Nickel (µg/g)	Selenium (µg/g)	Silver (µg/g)	Strontium (µg/g)	Tin (µg/g)	Uranium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
BC Standards																																							
CSR Urban Park Land Use (PL)[a]					n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	20	15	400	4	1.5 - 35[b]	60	50	90-150[b]	100-400[b]	1,600	1,800	15	10	100	3	20	47,000	50	16	200	150-450[b]
Within Channel Locations (Cont'd)																																							
ST13-03	ST13-03-140914	Tailings	2014 09 14	0.0 - 0.1	8.30	-	0.32	2.65	6.59	-	-	-	-	-	-	-	-	-	0.30	10.8	170	0.61	0.134	9.38	16.1	**898**	4.84	15.7	571	0.086	4.36	7.33	1.04	0.32	145	< 2.0	0.824	184	56.3
ST13-04	ST13-04-01-140914	Tailings	2014 09 14	0.0 - 0.1	8.50	-	0.34	2.82	10.3	-	-	-	-	-	-	-	-	-	0.36	12.2	179	0.64	0.168	10.4	17.2	**940**	5.32	17.3	623	0.079	6.20	8.09	1.14	0.36	159	< 2.0	0.938	**204**	59.6
ST13-05	ST13-05-141029	Native Within Channel	2014 10 29	0.2 - 0.4	7.58	-	-	-	-	23.0	9.23	9.10	7.82	5.56	6.38	19.4	12.2	7.41	0.22	6.63	67.5	0.28	0.083	29.8	9.59	41.5	6.67	11.5	499	< 0.050	< 0.50	17.2	< 0.20	< 0.10	45.3	< 2.0	0.602	69.2	36.4
ST13-06	ST13-06-141029	Native Within Channel	2014 10 29	0.0 - 0.1	8.48	-	-	-	-	< 0.10	20.0	18.1	5.36	0.81	0.16	29.2	20.0	6.30	0.12	2.64	60.1	0.21	0.057	19.9	6.29	13.2	4.12	9.1	189	< 0.050	< 0.50	21.1	< 0.20	< 0.10	69.6	< 2.0	0.451	22.9	29.6
ST14-02	ST14-02-01-140914	Tailings	2014 09 14	0.0 - 0.2	8.80	< 0.10	0.24	1.97	9.72	< 0.10	10.0	38.5	36.0	< 0.10	< 0.10	6.44	7.16	1.83	0.26	8.74	136	0.46	0.153	8.49	12.3	**998**	3.96	10.2	431	0.078	4.51	6.44	0.99	0.35	134	< 2.0	0.580	162	45.5
	ST14-02-02-140914	Tailings	DUPLICATE	0.0 - 0.2	8.90	-	0.23	1.87	9.99	-	-	-	-	-	-	-	-	-	0.33	9.81	139	0.54	0.125	9.02	12.5	**1,010**	4.20	11.6	483	0.088	5.01	6.66	1.04	0.36	141	< 2.0	0.766	177	45.0
	QA/QC RPD %				1	*	*	*	3	*	*	*	*	*	*	*	*	*	*	12	2	*	*	6	2	1	6	*	11	*	11	3	*	*	5	*	28	9	1
ST14-03	ST14-03-140914	Tailings	2014 09 14	0.0 - 0.2	8.82	-	0.34	2.81	20.7	-	-	-	-	-	-	-	-	-	0.37	11.4	109	0.54	0.223	11.0	14.2	**996**	5.01	12.1	554	0.101	4.97	6.67	1.05	0.48	93.3	< 2.0	0.841	**230**	54.4
ST14-04	ST14-04-140914	Tailings	2014 09 14	0.0 - 0.2	8.42	-	0.28	2.31	18.8	-	-	-	-	-	-	-	-	-	0.41	13.1	195	0.72	0.146	12.4	19.6	**928**	5.69	18.6	727	0.081	5.42	10.4	1.11	0.42	180	< 2.0	1.10	190	66.8
ST15-02	ST15-02-01-140913	Tailings	2014 09 13	0.0 - 0.1	8.53	0.14	0.39	3.23	17.0	< 0.10	20.1	16.1	3.12	0.15	< 0.10	30.1	19.3	11.0	0.34	11.7	186	0.63	0.180	10.4	17.8	**873**	7.62	17.0	615	0.083	4.40	8.50	1.09	0.36	164	< 2.0	0.926	**203**	59.1
	ST15-02-02-140913	Native Within Channel	2014 09 13	0.2 - 0.3	7.20	-	< 0.10	< 0.80	18.0	0.64	9.27	8.72	7.22	5.01	5.37	24.4	12.5	26.9	0.54	10.5	204	0.69	0.083	**61.7**	16.0	63.7	8.67	20.3	694	0.083	0.60	38.7	< 0.20	< 0.10	87.7	< 2.0	0.730	100	74.4
ST15-03	ST15-03-140913	Tailings	2014 09 13	0.0 - 0.1	8.26	-	0.40	3.32	16.0	-	-	-	-	-	-	-	-	-	0.48	13.5	200	0.81	0.158	11.1	19.5	**876**	5.88	21.5	766	0.080	4.33	9.76	1.11	0.39	188	< 2.0	1.26	192	71.4
ST15-04	ST15-04-140913	Tailings	2014 09 13	0.0 - 0.1	8.90	-	0.33	2.74	15.3	-	-	-	-	-	-	-	-	-	0.37	11.8	179	0.55	0.133	10.5	16.5	**868**	4.27	12.4	608	0.075	4.42	7.34	1.09	0.30	138	< 2.0	0.937	200	55.4
ST16-02	ST16-02-140913	Tailings	2014 09 13	0.0 - 0.1	8.90	-	0.28	2.30	21.4	-	-	-	-	-	-	-	-	-	0.28	9.42	136	0.51	0.152	9.13	12.9	**910**	3.70	10.4	456	0.078	4.67	6.25	1.00	0.37	135	< 2.0	0.632	183	45.7
ST16-03	ST16-03-140913	Tailings	2014 09 13	0.0 - 0.0	8.40	-	0.32	2.67	20.2	-	-	-	-	-	-	-	-	-	0.29	10.8	118	0.49	0.139	10.2	13.9	**832**	4.60	12.2	496	0.093	4.98	6.46	0.96	0.41	88.0	< 2.0	0.653	**216**	50.6
ST16-04	ST16-04-01-140913	Native Within Channel	2014 09 13	0.3 - 0.4	6.93	-	0.10	0.86	25.6	-	-	-	-	-	-	-	-	-	0.35	4.37	153	0.24	0.222	25.4	6.83	38.3	10.8	8.0	805	0.216	0.68	15.6	< 0.20	0.31	60.3	< 2.0	0.433	50.2	93.8
	ST16-04-02-140913	Native Within Channel	2014 09 13	0.5 - 0.6	6.70	2.06	0.27	2.23	24.9	5.48	12.7	9.27	5.26	2.79	1.96	25.0	15.1	22.5	0.41	9.73	156	0.74	0.182	53.3	16.4	86.7	8.42	18.6	1,670	0.083	3.31	32.4	0.63	0.27	77.5	< 2.0	2.16	91.0	46.1
ST16-05	ST16-05-140913	Tailings	2014 09 13	0.4 - 0.6	8.54	-	0.48	4.00	18.7	-	-	-	-	-	-	-	-	-	0.37	12.2	153	0.58	0.280	9.90	15.8	**997**	5.21	14.4	673	0.117	7.34	6.77	1.34	0.53	148	< 2.0	0.947	199	77.4
ST16-06	ST16-06-140913	Tailings	2014 09 13	0.0 - 0.2	8.35	0.12	0.33	2.72	17.5	< 0.10	29.0	47.8	2.91	< 0.10	< 0.10	7.15	11.9	1.23	0.33	9.61	147	0.52	0.132	9.06	12.3	**977**	4.12	12.0	467	0.077	5.08	6.67	1.12	0.37	171	< 2.0	0.759	166	44.2
ST17-02	ST17-02-140912	Tailings	2014 09 12	0.1 - 0.2	8.42	0.29	0.46	3.84	49.0	< 0.10	33.9	34.9	1.63	0.10	< 0.10	11.2	16.6	1.59	0.37	10.3	155	0.56	0.149	11.3	14.4	**824**	4.45	12.4	533	0.083	5.36	8.43	0.99	0.37	177	< 2.0	0.877	**218**	46.8
ST17-03	ST17-03-140912	Tailings	2014 09 12	0.2 - 0.4	8.75	< 0.10	0.76	6.33	26.9	< 0.10	0.55	< 0.10	< 0.10	< 0.10	< 0.10	53.5	14.3	31.5	0.55	**16.5**	295	0.93	0.177	11.5	24.0	**1,560**	6.72	28.7	1,140	0.115	4.97	12.6	1.69	0.51	212	2.1	1.34	172	93.1
ST17-04	ST17-04-140912	Tailings	2014 09 12	0.0 - 0.2	8.88	-	0.32	2.63	16.6	-	-	-	-	-	-	-	-	-	0.37	11.2	179	0.65	0.150	10.3	16.5	**847**	4.44	13.3	585	0.081	4.58	7.29	1.08	0.32	155	< 2.0	0.979	**210**	54.4
ST17-05	ST17-05-140912	Tailings	2014 09 12	0.0 - 0.2	8.30	-	0.29	2.40	11.1	-	-	-	-	-	-	-	-	-	0.39	11.0	163	0.59	0.165	9.65	15.7	**833**	4.66	14.2	626	0.078	4.71	6.80	1.05	0.39	138	< 2.0	0.872	**206**	57.3
ST17-06	ST17-06-140912	Tailings	2014 09 12	0.0 - 0.1	8.46	-	0.30	2.51	17.4	-	-	-	-	-	-	-	-	-	0.32	11.3	120	0.53	0.203	9.38	13.2	**1,000**	5.17	12.0	590	0.101	4.84	6.60	1.07	0.46	109	< 2.0	0.915	198	57.4
ST17-07	ST17-07-140912	Tailings	2014 09 12	0.0 - 0.2	8.76	-	0.41	3.43	18.4	-	-	-	-	-	-	-	-	-	0.41	12.1	179	0.68	0.174	10.0	17.2	**876**	5.15	16.4	683	0.079	4.73	8.26	1.09	0.34	177	< 2.0	1.09	197	60.8
ST17-08	ST17-08-01-140912	Tailings	2014 09 12	0.0 - 0.1	8.66	-	0.38	3.20	9.65	-	-	-	-	-	-	-	-	-	0.36	11.0	106	0.53	0.148	10.9	14.2	**1,210**	5.02	12.3	566	0.090	4.80	6.75	1.40	0.46	108	< 2.0	0.759	**201**	51.1
	ST17-08-02-140912	Tailings	2014 09 12	0.2 - 0.3	8.61	-	0.27	2.26	16.2	-	-	-	-	-	-	-	-	-	0.27	9.56	96.3	0.51	0.173	10.5	14.5	**1,110**	4.05	11.6	476	0.081	6.00	6.84	1.18	0.44	104	< 2.0	0.625	**231**	49.9
ST18-02	ST18-02-01-140917	Tailings	2014 09 17	0.0 - 0.3	7.51	-	0.25	2.09	19.2	-	-	-	-	-	-	-	-	-	0.34	11.3	161	0.67	0.085	9.25	15.6	**938**	3.84	14.1	472	0.062	5.61	8.36	1.00	0.34	194	< 2.0	1.14	**242**	45.6
	ST18-02-02-140917	Tailings	DUPLICATE	0.0 - 0.3	8.80	-	0.22	1.81	17.5	-	-	-	-	-	-	-	-	-	0.30	11.9	148	0.66	0.119	9.68	16.2	**954**	4.39	13.9	460	0.061	5.78	9.24	1.17	0.39	167	< 2.0	1.11	**268**	49.4
	QA/QC RPD %				16	-	*	*	9	-	-	-	-	-	-	-	-	-	*	5	8	*	*	5	4	2	13	*	3	*	3	10	16	*	15	*	3	10	8
	ST18-02-03-140917	Tailings	2014 09 17	0.4 - 0.5	8.92	-	0.26	2.19	23.0	-	-	-	-	-	-	-	-	-	0.32	11.4	160	0.63	0.137	10.4	17.2	**881**	4.90	16.6	590	0.087	4.23	8.54	1.13	0.39	165	< 2.0	0.922	190	59.5
ST18-03	ST18-03-01-140913	Tailings	2014 09 13	0.1 - 0.2	8.88	< 0.10	0.34	2.82	19.2	< 0.10	23.8	19.5	3.65	0.12	< 0.10	25.3	21.5	6.12	0.39	11.1	169	0.58	0.142	10.5	16.6	**849**	7.20	15.2	545	0.083	5.13	7.40	1.13	0.33	145	< 2.0	0.911	**204**	214
	ST18-03-02-140913	Tailings	2014 09 13	0.5 - 0.7	8.50	-	0.45	3.78	21.7	-	-	-	-	-	-	-	-	-	0.28	11.1	119	0.56	0.161	8.58	13.9	**1,360**	4.41	16.8	712	0.170	3.38	6.49	0.86	0.62	86.1	< 2.0	0.948	**227**	79.8
ST18-04	ST18-04-140913	Tailings	2014 09 13	0.3 - 0.5	8.85	-	0.22	1.87	20.6	-	-	-	-	-	-	-	-	-	0.28	7.54	181	0.40	0.117	7.81	12.2	**823**	3.73	8.9	403	< 0.050	3.80	4.74	0.88	0.28	59.6	< 2.0	0.410	**225**	43.9
ST18-05	ST18-05-01-140917	Tailings	2014 09 17	0.0 - 0.2	8.66	-	0.26	2.16	23.5	-	-	-	-	-	-	-	-	-	0.39	11.9	176	0.67	0.130	10.3	17.4	**869**	5.33	16.9	623	0.085	4.11	8.44	1.14	0.37	183	< 2.0	1.03	191	57.5
	ST18-05-02-140917	Tailings	DUPLICATE	0.0 - 0.2	8.54	< 0.10	0.40	3.33	24.7	0.20	18.4	19.2	4.93	0.57	0.20	27.3	17.8	11.3	0.36	11.2	167	0.59	0.135	10.0	16.8	**896**	4.62	14.9	604	0.104	4.18	8.53	1.10	0.40	170	< 2.0	0.906	191	56.9
	QA/QC RPD %				1	*	*	*	5	*	*	*	*	*	*	*	*	*	*	6	5	*	*	3	4	3	14	*	3	*	2	1	4	*	7	*	13	0	1
	ST18-05-03-140917	Tailings	2014 09 17	0.2 - 0.4	8.71	-	0.19	1.62	25.2	-	-	-	-	-	-	-	-	-	0.49	11.2	118	0.53	0.188	10.0	13.5	**1,070**	4.81	12.0	502	0.096	4.56	6.51	1.22	0.46	134	< 2.0	0.835	198	50.3
Within Channel Locations - Replicate and Field Blank Samples																																							
ST01-07	ST01-07-140911	Replicate of ST01-06	2014 09 11	0.0 - 0.2	8.18	-	0.24	1.98	12.0	32.5	4.77	8.91	15.0	15.9	9.98	5.49	3.58	3.89	0.33	8.76	124	0.42	0.138	15.2	11.2	**540**	4.32	10.9	499	0.064	3.32	10.7	0.72	0.24	132	< 2.0	0.625	133	44.3
ST01-08	ST01-08-140916	Field Blank-Silica Sand	2014 09 16	0.0	7.81	-	< 0.10	< 0.80	< 0.25	< 0.10	32.9	17.1	0.85	< 0.10	< 0.10	20.7	22.1	6.27	< 0.1	0.395	1.20	< 0.20	< 0.050	< 0.50	0.16	1.27	1.43	< 5.0	3.0	< 0.050	< 0.50	< 0.50	< 0.20	< 0.10	3.75	< 2.0	0.087	< 0.20	5.5
ST01-09-04	ST01-09-04-140922	Replicate of ST01-09-01	2014 09 22	0.0 - 0.2	8.69	-	0.40	3.31	20.0	-	-	-	-	-	-	-	-	-	0.39	11.8	164	0.61	0.202	11.7	17.4	**906**	4.94	16.0	611	0.081	3.77	9.46	1.02	0.34	176	< 2.0	0.954	187	59.2
ST06-02-02	ST06-02-02-140915	Replicate of ST06-02-01	2014 09 15	0.0 - 0.1	8.40	< 0.10	0.33	2.75	11.0	-	-	-	-	-	-	-	-	-	0.36	11.8	177	0.65	0.135	10.6	16.9	**910**	5.00	15.2	605	0.076	5.31	7.83	1.13	0.39	153	< 2.0	0.950	**207**	56.2
ST06-04-02	ST06-04-02-140922	Replicate of ST06-04-01	2014 09 22	0.0 - 0.2	8.57	-	0.48	4.00	19.0	-	-	-	-	-	-	-	-	-	0.42	11.8	191	0.67	0.134	10.9	18.5	**871**	5.47	18.7	670	0.077	4.49	8.98	1.14	0.33	174	< 2.0	1.00	190	60.3
ST10-05	ST10-05-140914	Field Blank-Silica Sand	2014 09 14	0.0	7.59	-	< 0.10	< 0.80	< 0.25	-	-	-	-	-	-	-	-	-	< 0.1	1.29	2.36	< 0.20	< 0.050	< 0.50	0.30	2.07	3.21	< 5.0	5.1	< 0.050	< 0.50	0.60	< 0.20	< 0.10	12.9	< 2.0	0.128	0.40	7.9
ST13-04-02	ST13-04-02-140914	Replicate of ST13-04-01	2014 09 14	0.0 - 0.1	8.55	-	0.35	2.88	11.9	-	-	-	-	-	-	-	-	-	0.41	13.1	184	0.69	0.158	11.2	17.5	**931**	5.72	17.8	676	0.079	4.93	8.15	1.20	0.35	167	< 2.0	1.04	**212**	62.1
ST18-06	ST18-06-140916	Field Blank-Silica Sand	2014 09 16	0.0	7.73	-	< 0.10	< 0.80	< 0.25	-	-	-	-	-	-	-	-	-	< 0.1	0.537	2.07	< 0.20	< 0.050	< 0.50	0.28	2.84	2.90	< 5.0	5.4	< 0.050	< 0.50	0.63	< 0.20	< 0.10	6.68	< 2.0	0.137	0.37	8.0

Associated ALS files: L1518225, L1519001, L1520490, L1522556, L1540219.
All terms defined within the body of SNC-Lavalin's report.
< Denotes concentration less than indicated detection limit or RPD less than indicated value.
- Denotes analysis not conducted.
n/a Denotes no applicable standard.
RPD Denotes relative percent difference.
* RPDs are not normally calculated where one or more concentrations are less than five times MDL.

BOLD Concentration greater than CSR Urban Park Land Use (PL) standard.

[a] The site-specific factors used for determining the matrix standards for this site include: intake of contaminated soil, groundwater used for drinking water, toxicity to soil invertebrates and plants, and groundwater flow to surface water used by freshwater aquatic life (whichever is most stringent).
[b] Standard varies with pH.

TABLE 2: Summary of Soil Analytical Results for Nutrients and Salinity in Soil

					Nutrients									Soil Salinity														
Sample Location	Sample ID	Sample Type	Sample Date (yyyy mm dd)	Depth Interval (m)	Total Carbon (%) (%)	Nitrate Nitrogen (µg/g)	Available Nitrate (µg/g)	Total Nitrogen % (%)	Mineralizable Nitrogen (µg/g)	Available Phosphate (µg/g)	Available Potassium (µg/g)	Available Sulphate (µg/g)	Sulphate (µg/g)	% Saturation (%)	Conductivity (µS/cm)	Sodium Adsorption Ratio (None)	Theoretical Gypsum Req. (sodic) (t/ha)	Theoretical Gypsum Req. (brine) (t/ha)	Saturated Paste Sodium (µg/g)	Saturated Paste Chloride (µg/g)	Bicarbonate (µg/g)	Carbonate (µg/g)	Calcium (meq/100g) (meq/100g)	Magnesium (meq/100g) (meq/100g)	Potassium (meq/100g) (meq/100g)	Sodium (meq/100g) (meq/100g)	Cation Exchange Capacity (meq/100g)	Exchangeable Sodium Percentage[b] (%)
BC Standards																												
CSR Urban Park Land Use (PL)[a]					n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	200	90	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Background Locations																												
ST01-01	ST01-01-140906	Background	2014 09 06	0.0 - 0.2	0.5	< 0.30	< 1.0	0.021	20	293	48	< 3.0	< 1.0	27.9	59	< 0.80	< 0.10	< 0.10	< 3.0	1.0	3.0	< 2.0	3.99	0.79	< 0.50	< 0.50	8.32	3.00
ST03-01	ST03-01-140907	Background	2014 09 07	0.1 - 0.3	2.3	< 0.40	1.3	0.082	18	28.5	105	93.6	< 2.0	44.5	45	< 1.0	< 0.10	< 0.10	< 4.0	< 2.0	3.6	< 3.0	22.4	7.24	< 0.50	0.52	17.5	2.95
ST04-01	ST04-01-140905	Background	2014 09 05	0.1 - 0.3	0.9	< 0.40	< 1.0	0.034	13	60.5	35	4.1	< 2.0	37.7	57	< 1.0	< 0.10	< 0.10	< 4.0	< 2.0	3.7	< 2.0	8.47	1.08	< 0.50	< 0.50	7.32	3.42
ST04-03	ST04-03-140906	Background	2014 09 06	0.1 - 0.3	0.7	< 0.30	< 1.0	< 0.020	8	59.9	61	5.6	< 2.0	31.9	35	< 1.0	< 0.10	< 0.10	< 3.0	< 2.0	< 2.0	< 2.0	9.31	0.78	< 0.50	< 0.50	6.09	4.11
ST05-03	ST05-03-140922	Background	2014 09 22	0.1 - 0.2	-	-	-	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ST06-01	ST06-01-01-140905	Background	2014 09 05	0.0 - 0.1	1.1	< 0.50	< 1.0	0.051	17	39.2	83	4.0	5.2	52.7	120	< 0.70	< 0.10	< 0.10	< 5.0	4.3	6.2	< 3.0	3.22	< 0.50	< 0.50	< 0.50	10.1	2.48
	ST06-01-02-140905	Background	2014 09 05	0.1 - 0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ST06-01-03-140905	Background	DUPLICATE	0.1 - 0.3	0.8	< 0.40	< 1.0	0.034	10	30.2	60	4.2	< 2.0	43.2	45	< 1.0	< 0.10	< 0.10	< 4.0	< 2.0	< 3.0	< 3.0	3.61	0.82	< 0.50	< 0.50	10.7	2.34
	QA/QC RPD %				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ST07-01	ST07-01-140907	Background	2014 09 07	0.1 - 0.2	0.7	< 0.50	< 1.0	0.054	15	20.2	54	3.2	2.5	45.8	79	< 0.80	< 0.10	< 0.10	< 5.0	2.1	3.4	< 3.0	2.81	1.18	< 0.50	< 0.50	8.31	3.01
ST08-01	ST08-01-140905	Background	2014 09 05	0.1 - 0.3	0.6	< 0.30	< 1.0	0.036	20	23.5	68	< 3.0	< 2.0	30.1	52	< 1.0	< 0.10	< 0.10	< 3.0	< 2.0	< 2.0	< 2.0	1.34	0.53	< 0.50	< 0.50	7.50	3.33
ST09-01	ST09-01-01-140907	Background	2014 09 07	0.0 - 0.2	0.8	< 0.40	< 1.0	0.044	16	61.4	62	< 3.0	< 2.0	36.6	73	< 0.90	< 0.10	< 0.10	< 4.0	2.4	2.7	< 2.0	2.08	< 0.50	< 0.50	< 0.50	11.0	2.27
ST10-01	ST10-01-140905	Background	2014 09 05	0.1 - 0.3	0.4	< 0.30	< 1.0	0.022	18	36.7	46	< 3.0	< 2.0	35.0	50	< 1.0	< 0.10	< 0.10	< 3.0	< 2.0	2.7	< 2.0	2.34	0.75	< 0.50	< 0.50	6.38	3.92
ST11-01	ST11-01-140907	Background	2014 09 07	0.0 - 0.3	0.7	< 0.30	< 1.0	0.039	13	58.2	38	< 3.0	< 2.0	31.4	363	1.24	< 0.10	< 0.10	7.9	29.6	< 2.0	< 2.0	1.88	0.52	< 0.50	< 0.50	8.81	2.84
ST12-01	ST12-01-02-140904	Background	2014 09 04	0.0 - 0.2	3.3	1.41	2.2	0.282	28	< 2.0	210	11.5	3.4	56.7	123	< 0.50	< 0.10	< 0.10	< 6.0	< 3.0	13.2	< 3.0	37.8	6.59	0.71	< 0.50	47.8	0.52
ST13-01	ST13-01-140908	Background	2014 09 08	0.0 - 0.2	10.5	< 1.0	< 1.0	0.667	56	7.8	232	5.5	< 5.0	95.3	110	< 0.50	< 0.10	< 0.10	< 10	< 5.0	32.9	< 6.0	39.8	8.39	0.91	< 0.50	81.3	0.31
ST15-01	ST15-01-01-140908	Background	2014 09 08	0.0 - 0.1	3.4	< 0.60	< 1.0	0.175	80	11.4	99	< 3.0	3.3	64.2	88	< 0.80	< 0.10	< 0.10	< 6.0	3.9	6.3	< 4.0	4.38	1.75	< 0.50	< 0.50	26.2	0.95
	ST15-01-02-140908	Background	2014 09 08	0.2 - 0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ST15-01-03-140908	Background	DUPLICATE	0.2 - 0.3	0.6	< 0.30	< 1.0	0.037	23	6.6	46	< 3.0	< 2.0	31.3	51	< 1.0	< 0.10	< 0.10	< 3.0	< 2.0	< 2.0	< 2.0	2.24	0.78	< 0.50	< 0.50	8.59	2.91
	QA/QC RPD %				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ST16-01	ST16-01-01-140906	Background	2014 09 06	0.1 - 0.2	6.5	< 0.70	< 1.0	0.428	103	< 2.0	193	30	83.6	70.9	345	0.43	< 0.10	< 0.10	8.1	11.7	5.6	< 4.0	12.6	4.25	0.66	< 0.50	52.1	0.48
ST17-01	ST17-01-140912	Background	2014 09 12	0.1 - 0.2	1.1	< 0.60	< 1.0	0.065	18	< 2.0	32	< 3.0	< 3.0	61.0	43	< 2.0	< 0.10	< 0.10	< 6.0	< 3.0	< 4.0	< 4.0	1.25	< 0.50	< 0.50	< 0.50	13.5	1.85
ST18-01	ST18-01-140917	Background	2014 09 17	0.2 - 0.3	0.3	< 0.30	< 1.0	0.026	9	< 2.0	45	< 3.0	3.4	31.1	73	< 1.0	< 0.10	< 0.10	< 3.0	2.6	< 2.0	< 2.0	4.44	1.96	< 0.50	< 0.50	8.95	2.79
Within Channel Locations																												
ST01-02	ST01-02-01-140922	Tailings	2014 09 22	0.0 - 0.1	0.5	< 1.0	< 1.0	< 0.020	86	3.9	218	11.2	47.2	70.0	529	0.95	< 0.10	< 0.10	23.7	14.4	120	< 4.0	33.2	3.02	0.74	0.58	30.4	1.92
	ST01-02-03-140922	Tailings	DUPLICATE	0.0 - 0.1	4.7	< 4.0	< 1.0	0.210	88	4.2	248	12.5	50	71.8	561	1.05	< 0.10	< 0.10	27.7	17.4	124	< 4.0	30.4	2.92	0.81	0.84	30.3	2.78
	QA/QC RPD %				162	*	*	*	*	*	13	*	6	3	6	10	*	*	*	*	3	*	9	3	*	*	< 1	37
	ST01-02-02-140922	Native Within Channel	2014 09 22	0.1 - 0.2	2.7	0.47	< 1.0	0.154	48	9.4	70	25.3	41.5	40.6	328	< 0.40	< 0.10	< 0.10	< 4.0	4.5	11.0	< 2.0	18.1	1.93	< 0.50	< 0.50	24.6	1.02
ST01-05	ST01-05-01-140911	Tailings	2014 09 11	0.0 - 0.1	0.5	< 3.0	< 1.0	< 0.020	5	< 2.0	127	33.2	113	29.9	906	2.18	< 0.10	< 0.10	24.1	10.0	12.8	< 2.0	20.3	0.88	< 0.50	0.56	7.46	7.49
	ST01-05-03-140911	Native Within Channel	2014 09 11	0.2 - 0.3	4.6	0.74	1.7	0.261	95	< 2.0	86	13.3	29.6	62.5	323	< 0.30	< 0.10	< 0.10	< 6.0	10.8	61.6	< 4.0	20.2	2.50	< 0.50	< 0.5	28.3	0.88
ST01-09	ST01-09-01-140922	Tailings	2014 09 22	0.0 - 0.1	0.6	< 3.0	< 1.0	< 0.020	8	< 2.0	152	35.3	134	29.4	993	2.42	< 0.10	< 0.10	28.6	5.9	12.8	< 2.0	22.8	0.96	0.52	0.71	7.71	9.21
	ST01-09-03-140922	Tailings	DUPLICATE	0.0 - 0.1	0.5	< 3.0	< 1.0	< 0.020	5	< 2.0	142	40.6	162	29.7	1,160	2.61	< 0.10	< 0.10	33.4	7.4	20.4	< 2.0	22.6	0.89	0.50	0.65	6.90	9.37
	QA/QC RPD %				18	*	*	*	*	*	7	14	19	1	16	8	*	*	16	23	46	*	< 1	*	*	*	11	2
ST02-02	ST02-02-01-140910	Tailings	2014 09 10	0.0 - 0.1	0.7	< 0.40	< 1.0	0.028	10	3.8	72	20.4	71.7	37.1	613	0.97	< 0.10	< 0.10	12.9	9.1	20.8	< 2.0	10.1	0.76	< 0.50	< 0.50	5.79	4.32
	ST02-02-03-140910	Tailings	DUPLICATE	0.0 - 0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	QA/QC RPD %				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ST02-02-02-140910	Native Within Channel	2014 09 10	0.2 - 0.4	44.2	< 3.0	32.4	2.63	350	22.6	48	54.5	117	343	300	< 0.40	< 0.10	< 0.10	< 30	24	220	< 20	102	12.5	< 0.50	0.57	85.8	0.67
ST02-04	ST02-04-140910	Native Within Channel	2014 09 10	0.1 - 0.3	1.5	< 0.50	< 1.0	0.027	13	< 2.0	94	9.9	32.0	51.4	246	< 0.40	< 0.10	< 0.10	< 5.0	< 3.0	30.1	< 3.0	33.6	2.19	< 0.50	< 0.50	4.21	5.94
ST02-05	ST02-05-03-140910	Tailings	2014 09 10	0.4 - 0.6	0.4	< 3.0	< 1.0	< 0.020	6	< 2.0	83	41.7	164	26.9	1,150	0.98	< 0.10	< 0.10	13.8	4.0	7.2	< 2.0	15.3	0.96	< 0.50	< 0.50	4.65	5.38

Associated ALS files: L1518225, L1519001, L1520490, L1522556, L1540219.

All terms defined within the body of SNC-Lavalin's report.

< Denotes concentration less than indicated detection limit or RPD less than indicated value.

\- Denotes analysis not conducted.

n/a Denotes no applicable standard.

RPD Denotes relative percent difference.

* RPDs are not normally calculated where one or more concentrations are less than five times MDL.

BOLD Concentration greater than CSR Urban Park Land Use (PL) standard.

[a] The site-specific factors used for determining the matrix standards for this site include: intake of contaminated soil, groundwater used for drinking water, toxicity to soil invertebrates and plants, and groundwater flow to surface water used by freshwater aquatic life (whichever is most stringent).

[b] Values of less than method detection limit (0.5 meq/100g) were converted 0.25 meq/100g for estimating ESP.

TABLE 2 (Cont'd): Summary of Soil Analytical Results for Nutrients and Salinity in Soil

					Nutrients									Soil Salinity														
Sample Location	Sample ID	Sample Type	Sample Date (yyyy mm dd)	Depth Interval (m)	Total Carbon (%) (%)	Nitrate Nitrogen (µg/g)	Available Nitrate (µg/g)	Total Nitrogen % (%)	Mineralizable Nitrogen (µg/g)	Available Phosphate (µg/g)	Available Potassium (µg/g)	Available Sulphate (µg/g)	Sulphate (µg/g)	% Saturation (%)	Conductivity (µS/cm)	Sodium Adsorption Ratio (None)	Theoretical Gypsum Req. (sodic) (t/ha)	Theoretical Gypsum Req. (brine) (t/ha)	Saturated Paste Sodium (µg/g)	Saturated Paste Chloride (µg/g)	Bicarbonate (µg/g)	Carbonate (µg/g)	Calcium (meq/100g) (meq/100g)	Magnesium (meq/100g) (meq/100g)	Potassium (meq/100g) (meq/100g)	Sodium (meq/100g) (meq/100g)	Cation Exchange Capacity (meq/100g)	Exchangeable Sodium Percentage[b] (%)
BC Standards																												
CSR Urban Park Land Use (PL)[a]					n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	200	90	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Within Channel Locations (Cont'd)																												
ST02-07	ST02-07-140903	Native Within Channel	2014 09 03	0.3 - 0.8	0.5	0.86	1.3	0.037	8	< 2.0	32	22.5	9.9	48.3	122	< 0.60	< 0.10	< 0.10	< 5.0	< 2.0	12.9	< 3.0	23.1	8.37	< 0.50	0.65	22.4	2.89
ST02-08	ST02-08-140910	Native Within Channel	2014 09 10	0.1 - 0.3	0.1	< 0.30	< 1.0	< 0.020	5	2.8	40	3.6	5.7	27.8	71	< 0.90	< 0.10	< 0.10	< 3.0	< 1.0	< 2.0	< 2.0	4.67	1.10	< 0.50	< 0.50	4.63	5.40
ST03-02	ST03-02-140915	Tailings	2014 09 15	0.0 - 0.1	0.4	< 3.0	< 1.0	< 0.020	4	< 2.0	155	66.3	134	29.2	902	1.44	< 0.10	< 0.10	17.6	3.2	4.7	< 2.0	23.6	0.74	0.52	0.55	6.70	8.27
ST03-03	ST03-03-02-140909	Tailings	2014 09 09	0.1 - 0.3	0.5	< 0.40	< 1.0	< 0.020	3	< 2.0	36	23.8	83.9	39.8	534	0.97	< 0.10	< 0.10	12.0	< 2.0	15.4	< 2.0	8.12	< 0.50	< 0.50	< 0.50	2.67	9.36
	ST03-03-03-140909	Tailings	2014 09 09	0.3 - 0.6	0.8	< 0.30	< 1.0	< 0.020	17	< 2.0	156	27.5	44.6	30.1	456	2.30	< 0.10	< 0.10	15.1	5.1	12.5	< 2.0	24.7	1.54	0.53	< 0.50	7.12	3.51
ST03-05	ST03-05-01-140910	Tailings	2014 09 10	0.0 - 0.5	0.4	< 3.0	< 1.0	< 0.020	5	< 2.0	54	49.1	137	28.1	1,020	0.99	< 0.10	< 0.10	13.5	3.1	12.0	< 2.0	9.92	0.76	< 0.50	< 0.50	4.01	6.23
ST04-02	ST04-02-140915	Tailings	2014 09 15	0.0 - 0.1	0.4	< 0.30	< 1.0	< 0.020	3	2.0	72	8.1	20.3	32.6	232	1.64	< 0.10	< 0.10	8.4	< 2.0	13.5	< 2.0	11.0	< 0.50	< 0.50	< 0.50	2.90	8.62
ST05-02	ST05-02-01-140915	Tailings	2014 09 15	0.0 - 0.2	0.7	< 0.30	< 1.0	< 0.020	3	2.3	105	8.8	28.4	30.9	342	0.78	< 0.10	< 0.10	6.6	2.3	22.5	< 2.0	18.1	0.88	< 0.50	< 0.50	6.99	3.58
	ST05-02-02-140915	Tailings	DUPLICATE	0.0 - 0.2	0.6	< 0.30	< 1.0	< 0.020	3	< 2.0	80	10.9	33.1	32.2	362	0.90	< 0.10	< 0.10	8.3	2.4	23.0	< 2.0	12.8	0.78	< 0.50	< 0.50	9.82	2.55
	QA/QC RPD %				15	*	*	*	*	*	*	*	15	4	6	14	*	*	*	*	2	*	34	*	*	*	34	*
ST06-02	ST06-02-01-140915	Tailings	2014 09 15	0.0 - 0.1	0.4	< 6.0	< 1.0	< 0.020	4	< 2.0	162	104	343	31.6	1,940	2.46	< 0.10	< 0.10	51.4	13.3	9.5	< 2.0	23.3	0.75	0.54	0.71	6.09	11.6
ST07-02	ST07-02-140911	Tailings	2014 09 11	0.0 - 0.0	0.5	< 4.0	< 1.0	< 0.020	9	< 2.0	210	123	230	35.7	1,190	1.49	< 0.10	< 0.10	25.8	4.9	7.5	< 2.0	24.4	1.24	0.68	0.66	9.56	6.91
ST07-03	ST07-03-02-140911	Tailings	2014 09 11	0.2 - 0.5	0.5	< 3.0	< 1.0	< 0.020	8	< 2.0	187	85.8	266	33.8	1,460	1.59	< 0.10	< 0.10	30.5	6.4	8.0	< 2.0	25.3	1.04	0.61	0.62	8.06	7.67
ST08-02	ST08-02-01-140915	Tailings	2014 09 15	0.0 - 0.2	0.5	< 5.0	< 1.0	< 0.020	6	< 2.0	285	125	379	45.3	1,590	2.50	< 0.10	< 0.10	60.1	16.4	12.1	< 3.0	37.0	1.33	0.87	1.22	10.3	11.9
	ST08-02-02-140915	Tailings	2014 09 15	0.4 - 0.4	0.5	< 0.30	< 1.0	< 0.020	5	< 2.0	68	36.6	88.3	29.6	675	0.73	< 0.10	< 0.10	8.3	2.6	10.5	< 2.0	18.4	1.78	< 0.50	< 0.50	4.70	5.32
ST08-05	ST08-05-02-140915	Native Within Channel	2014 09 15	0.3 - 0.5	0.8	< 0.50	< 1.0	0.052	28	< 2.0	113	13.7	35.3	46.8	240	< 0.50	< 0.10	< 0.10	< 5.0	5.3	3.5	< 3.0	3.83	0.85	< 0.50	< 0.50	9.20	2.72
ST08-06	ST08-06-140915	Native Within Channel	2014 09 15	0.1 - 0.3	0.3	< 0.30	< 1.0	< 0.020	9	6.5	53	7.9	15.9	34.4	146	< 0.60	< 0.10	< 0.10	< 3.0	< 2.0	2.2	< 2.0	4.09	0.53	< 0.50	< 0.50	5.41	4.62
ST09-04	ST09-04-140915	Native Within Channel	2014 09 15	0.1 - 0.3	0.2	0.47	1.1	< 0.020	8	< 2.0	32	4.1	6.4	29.9	105	0.99	< 0.10	< 0.10	3.4	< 1.0	5.1	< 2.0	5.26	2.10	< 0.50	< 0.50	6.71	3.73
ST10-02	ST10-02-140914	Tailings	2014 09 14	0.0 - 0.1	0.4	< 7.0	< 1.0	< 0.020	6	< 2.0	214	174	509	35.8	2,320	2.80	< 0.10	< 0.10	73.3	16.2	8.7	< 2.0	25.5	0.83	0.65	0.95	7.55	12.6
ST11-02	ST11-02-01-140914	Tailings	2014 09 14	0.0 - 0.2	0.3	< 0.40	< 1.0	< 0.020	5	< 2.0	76	37.4	77.6	35.2	550	1.22	< 0.10	< 0.10	13.1	2.8	12.7	< 2.0	10.2	< 0.50	< 0.50	< 0.50	2.55	9.80
ST11-03	ST11-03-141029	Native Within Channel	2014 10 29	0.1 - 0.3	1.2	< 4.0	1.4	0.022	1.3	< 2.0	73	82.0	153	36.2	956	0.95	< 0.10	< 0.10	16.0	4.8	33.1	< 2.0	18.7	0.86	< 0.50	< 0.50	4.26	5.87
ST12-03	ST12-03-140914	Tailings	2014 09 14	0.0 - 0.1	0.3	< 6.0	< 1.0	< 0.020	5	< 2.0	167	111	316	32.4	1,750	2.42	< 0.10	< 0.10	47.0	11.3	9.5	< 2.0	22.8	0.74	0.54	0.92	5.98	15.3
ST12-05	ST12-05-140914	Native Within Channel	2014 09 14	0.3 - 0.4	0.3	0.38	< 1.0	0.025	15	< 2.0	86	5.2	17.9	34.1	170	< 0.50	< 0.10	< 0.10	< 3.0	< 2.0	2.5	< 2.0	9.37	1.88	< 0.50	< 0.50	11.2	2.23
ST13-02	ST13-02-140914	Tailings	2014 09 14	0.0 - 0.2	0.5	< 5.0	< 1.0	< 0.020	8	< 2.0	267	85.9	342	45.0	1,510	2.94	< 0.10	< 0.10	66.4	19.8	12.7	< 3.0	32.9	1.20	0.82	1.06	9.98	10.6
ST13-05	ST13-05-141029	Native Within Channel	2014 10 29	0.2 - 0.4	0.3	< 1.0	< 1.0	0.021	1.3	< 2.0	35	33.1	69.5	21.2	721	0.25	< 0.10	< 0.10	2.3	2.4	8.6	< 1.0	4.39	0.92	< 0.50	< 0.50	6.10	4.10
ST13-06	ST13-06-141029	Native Within Channel	2014 10 29	0.0 - 0.1	0.5	< 0.20	< 1.0	< 0.020	1.3	2.3	49	4.9	5.1	25.0	212	< 0.40	< 0.10	< 0.10	< 2.0	< 1.0	22.7	< 1.0	19.4	0.89	< 0.50	< 0.50	4.63	5.40
ST14-02	ST14-02-01-140914	Tailings	2014 09 14	0.0 - 0.2	0.3	< 0.40	< 1.0	< 0.020	5	< 2.0	79	12.8	8.5	44.7	132	0.87	< 0.10	< 0.10	4.8	3.0	15	< 3.0	10.9	< 0.50	< 0.50	< 0.50	4.14	6.04
ST15-02	ST15-02-01-140913	Tailings	2014 09 13	0.0 - 0.1	0.5	< 3.0	< 1.0	< 0.020	5	< 2.0	183	72.6	194	31.6	1,210	1.77	< 0.10	< 0.10	26.7	4.6	8.2	< 2.0	24.9	0.88	0.61	0.64	7.84	8.11
ST16-04	ST16-04-02-140913	Native Within Channel	2014 09 13	0.5 - 0.6	2.1	1.68	2.6	0.149	35	< 2.0	58	13.4	25.2	41.9	230	< 0.50	< 0.10	< 0.10	< 4.0	2.5	4.8	< 3.0	17.6	3.36	< 0.50	< 0.50	26.6	0.94
ST16-06	ST16-06-140913	Tailings	2014 09 13	0.0 - 0.2	0.4	< 4.0	< 1.0	< 0.020	8	< 2.0	68	43.4	147	38.6	816	1.59	< 0.10	< 0.10	23.6	4.9	11.9	< 2.0	10.1	< 0.50	< 0.50	< 0.50	4.39	5.69
ST17-02	ST17-02-140912	Tailings	2014 09 12	0.1 - 0.2	0.6	< 0.40	< 1.0	< 0.020	6	< 2.0	74	12.2	25.1	42.9	280	1.74	< 0.10	< 0.10	13.8	5.8	24.9	< 3.0	11.9	0.54	< 0.50	< 0.50	5.51	4.54
ST17-03	ST17-03-140912	Tailings	2014 09 12	0.2 - 0.4	0.9	< 5.0	< 1.0	< 0.020	6	< 2.0	418	76.0	200	51.4	918	1.72	< 0.10	< 0.10	16.3	16.3	17.1	< 3.0	33.6	1.69	1.23	1.01	9.81	10.3
ST18-03	ST18-03-01-140913	Tailings	2014 09 13	0.1 - 0.2	0.4	< 3.0	< 1.0	< 0.020	5	< 2.0	134	72.9	140	30.7	992	2.42	< 0.10	< 0.10	29.1	8.2	9.6	< 2.0	20.8	0.60	< 0.50	0.60	5.83	10.3
ST18-05	ST18-05-01-140917	Tailings	2014 09 17	0.0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ST18-05-02-140917	Tailings	DUPLICATE	0.0 - 0.2	0.5	< 2.0	< 1.0	< 0.020	4	< 2.0	183	51.5	103	32.6	718	1.65	< 0.10	< 0.10	19.3	4.8	11.6	< 2.0	25.6	1.03	0.58	0.80	7.97	10.0
	QA/QC RPD %				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Within Channel Locations - Replicate and Field Blank Samples																												
ST06-02-02	ST06-02-02-140915	Replicate of ST06-02-01	2014 09 15	0.0 - 0.1	0.4	< 7.0	1.5	< 0.020	5	< 2	175	190	432	34.5	2,120	2.32	< 0.10	< 0.10	54.4	13.2	9.7	< 2.0	24.3	0.89	0.58	0.88	6.23	14.2

Associated ALS files: L1518225, L1519001, L1520490, L1522556, L1540219.

All terms defined within the body of SNC-Lavalin's report.

< Denotes concentration less than indicated detection limit or RPD less than indicated value.

\- Denotes analysis not conducted.

n/a Denotes no applicable standard.

RPD Denotes relative percent difference.

* RPDs are not normally calculated where one or more concentrations are less than five times MDL.

BOLD Concentration greater than CSR Urban Park Land Use (PL) standard.

[a] The site-specific factors used for determining the matrix standards for this site include: intake of contaminated soil, groundwater used for drinking water, toxicity to soil invertebrates and plants, and groundwater flow to surface water used by freshwater aquatic life (whichever is most stringent).

[b] Values of less than method detection limit (0.5 meq/100g) were converted 0.25 meq/100g for estimating ESP.

TABLE 3: Summary of Analytical Results for Mine Process Reagents in Soil

Sample Location	Sample ID	Sample Type	Sample Date (yyyy mm dd)	Depth Interval (m)	Gross Parameters: EPH (C10-C19) (µg/g)	Gross Parameters: LEPH (C10-C19) (µg/g)	Gross Parameters: EPH (C19-C32) (µg/g)	Gross Parameters: HEPH (C19-C32) (µg/g)	Hydrocarbons: Heptane (C7) (µg/g)	Hydrocarbons: Octane (C8) (µg/g)	Volatile Organic Compounds: Acetone (µg/g)	Volatile Organic Compounds: Carbon disulphide (µg/g)	Volatile Organic Compounds: 2-Hexanone (µg/g)	Volatile Organic Compounds: Methyl ethyl ketone (µg/g)	Volatile Organic Compounds: Methyl isobutyl carbinol (µg/g)	Volatile Organic Compounds: Methyl isobutyl ketone (µg/g)	Volatile Organic Compounds: n-Pentane (µg/g)	Volatile Organic Compounds: 1,2,3-Trimethylbenzene (µg/g)
BC Standards																		
CSR Urban Park Land Use (PL)[a]					1,000	1,000	1,000	1,000	n/a	n/a	14,000	360	n/a	22,000	n/a	5,300	n/a	n/a
Within Channel Locations																		
ST01-03	ST01-03-140911	Tailings	2014 09 11	0.0 - 0.2	< 200	< 200	< 200	< 200	< 0.050	< 0.050	< 4	< 0.050	< 0.050	< 20	< 0.050	< 0.050	< 2.5	< 0.050
ST01-05	ST01-05-01-140911	Tailings	2014 09 11	0.0 - 0.1	< 200	< 200	< 200	< 200	< 0.050	< 0.050	< 4	< 0.050	< 0.050	< 20	< 0.050	< 0.050	< 2.5	< 0.050
ST01-09	ST01-09-01-140922	Tailings	2014 09 22	0.0 - 0.1	< 200	< 200	< 200	< 200	< 0.050	< 0.050	< 4	< 0.050	< 0.050	< 20	< 0.050	< 0.050	< 2.5	< 0.050
	ST01-09-03-140922	Tailings	DUPLICATE	0.0 - 0.1	< 200	< 200	< 200	< 200	< 0.050	< 0.050	< 4	< 0.050	< 0.050	< 20	< 0.050	< 0.050	< 2.5	< 0.050
	QA/QC RPD %				*	*	*	*	*	*	*	*	*	*	*	*	*	*
ST15-02	ST15-02-02-140913	Native Within Channel	2014 09 13	0.2 - 0.3	< 200	< 200	< 200	< 200	< 0.050	< 0.050	< 4	< 0.050	< 0.050	< 20	< 0.050	< 0.050	< 2.5	< 0.050
ST15-03	ST15-03-140913	Tailings	2014 09 13	0.0 - 0.1	< 200	< 200	< 200	< 200	< 0.050	< 0.050	< 4	< 0.050	< 0.050	< 20	< 0.050	< 0.050	< 2.5	< 0.050
ST16-03	ST16-03-140913	Tailings	2014 09 13	0.0 - 0.0	< 200	< 200	< 200	< 200	< 0.050	< 0.050	< 4	< 0.050	< 0.050	< 20	< 0.050	< 0.050	< 2.5	< 0.050
ST18-03	ST18-03-01-140913	Tailings	2014 09 13	0.1 - 0.2	< 200	< 200	< 200	< 200	< 0.050	< 0.050	< 4	< 0.050	< 0.050	< 20	< 0.050	< 0.050	< 2.5	< 0.050
	ST18-03-02-140913	Tailings	2014 09 13	0.5 - 0.7	< 200	< 200	< 200	< 200	< 0.050	< 0.050	< 4	< 0.050	< 0.050	< 20	< 0.050	< 0.050	< 2.5	< 0.050

Associated ALS files: L1518225, L1519001, L1520490, L1522556, L1540219.
All terms defined within the body of SNC-Lavalin's report.
< Denotes concentration less than indicated detection limit or RPD less than indicated value.
- Denotes analysis not conducted.
n/a Denotes no applicable standard.
RPD Denotes relative percent difference.
* RPDs are not normally calculated where one or more concentrations are less than five times MDL.

BOLD Concentration greater than CSR Urban Park Land Use (PL) standard.

[a] The site-specific factors used for determining the matrix standards for this site include: intake of contaminated soil, groundwater used for drinking water, toxicity to soil invertebrates and plants, and groundwater flow to surface water used by freshwater aquatic life (whichever is most stringent).

TABLE 3 (Cont'd): Summary of Analytical Results for Mine Process Reagents in Soil

Sample Location	Sample ID	Sample Type	Sample Date (yyyy mm dd)	Depth Interval (m)	Polycyclic Aromatic Hydrocarbons																			Glycols			Xanthate
					Naphthalene (µg/g)	2-Methylnaphthalene (µg/g)	Acenaphthylene (µg/g)	Acenaphthene (µg/g)	Fluorene (µg/g)	Phenanthrene (µg/g)	Anthracene (µg/g)	Fluoranthene (µg/g)	Pyrene (µg/g)	Benzo(a)anthracene (µg/g)	Chrysene (µg/g)	Benzo(b)fluoranthene (µg/g)	Benzo(k)fluoranthene (µg/g)	Benzo(a)pyrene (µg/g)	Indeno(1,2,3-cd)pyrene (µg/g)	Dibenz(a,h)anthracene (µg/g)	Benzo(g,h,i)perylene (µg/g)	PAH TEQ (µg/g)	B(a)P TPE (µg/g)	Propylene glycol (µg/g)	Ethylene glycol (µg/g)	Diethylene glycol (µg/g)	Xanthate as ethyl Xanthate (µg/g)
BC Standards																											
CSR Urban Park Land Use (PL)[a]					5	n/a	n/a	n/a	n/a	5	n/a	n/a	10	1	n/a	1	1	1	1	1	n/a	n/a	n/a	30,000	1,500	n/a	n/a
Within Channel Locations																											
ST01-03	ST01-03-140911	Tailings	2014 09 11	0.0 - 0.2	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	0.065	0.0605	< 10	< 10	< 10	< 5
ST01-05	ST01-05-01-140911	Tailings	2014 09 11	0.0 - 0.1	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	0.065	0.0605	< 10	< 10	< 10	< 5
ST01-09	ST01-09-01-140922	Tailings	2014 09 22	0.0 - 0.1	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	0.065	0.0605	< 10	< 10	< 10	< 5
	ST01-09-03-140922	Tailings	DUPLICATE	0.0 - 0.1	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	0.065	0.0605	< 10	< 10	< 10	< 5
		QA/QC RPD %			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
ST15-02	ST15-02-02-140913	Native Within Channel	2014 09 13	0.2 - 0.3	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	0.065	0.0605	< 10	< 10	< 10	< 5
ST15-03	ST15-03-140913	Tailings	2014 09 13	0.0 - 0.1	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	0.065	0.0605	< 10	< 10	< 10	< 5
ST16-03	ST16-03-140913	Tailings	2014 09 13	0.0 - 0.0	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	0.065	0.0605	< 10	< 10	< 10	< 5
ST18-03	ST18-03-01-140913	Tailings	2014 09 13	0.1 - 0.2	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	0.065	0.0605	< 10	< 10	< 10	< 5
	ST18-03-02-140913	Tailings	2014 09 13	0.5 - 0.7	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	0.065	0.0605	< 10	< 10	< 10	< 5

Associated ALS files: L1518225, L1519001, L1520490, L1522556, L1540219.

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n/a Denotes no applicable standard.

RPD Denotes relative percent difference.

* RPDs are not normally calculated where one or more concentrations are less than five times MDL.

BOLD Concentration greater than CSR Urban Park Land Use (PL) standard.

[a] The site-specific factors used for determining the matrix standards for this site include: intake of contaminated soil, groundwater used for drinking water, toxicity to soil invertebrates and plants, and groundwater flow to surface water used by freshwater aquatic life (whichever is most stringent).

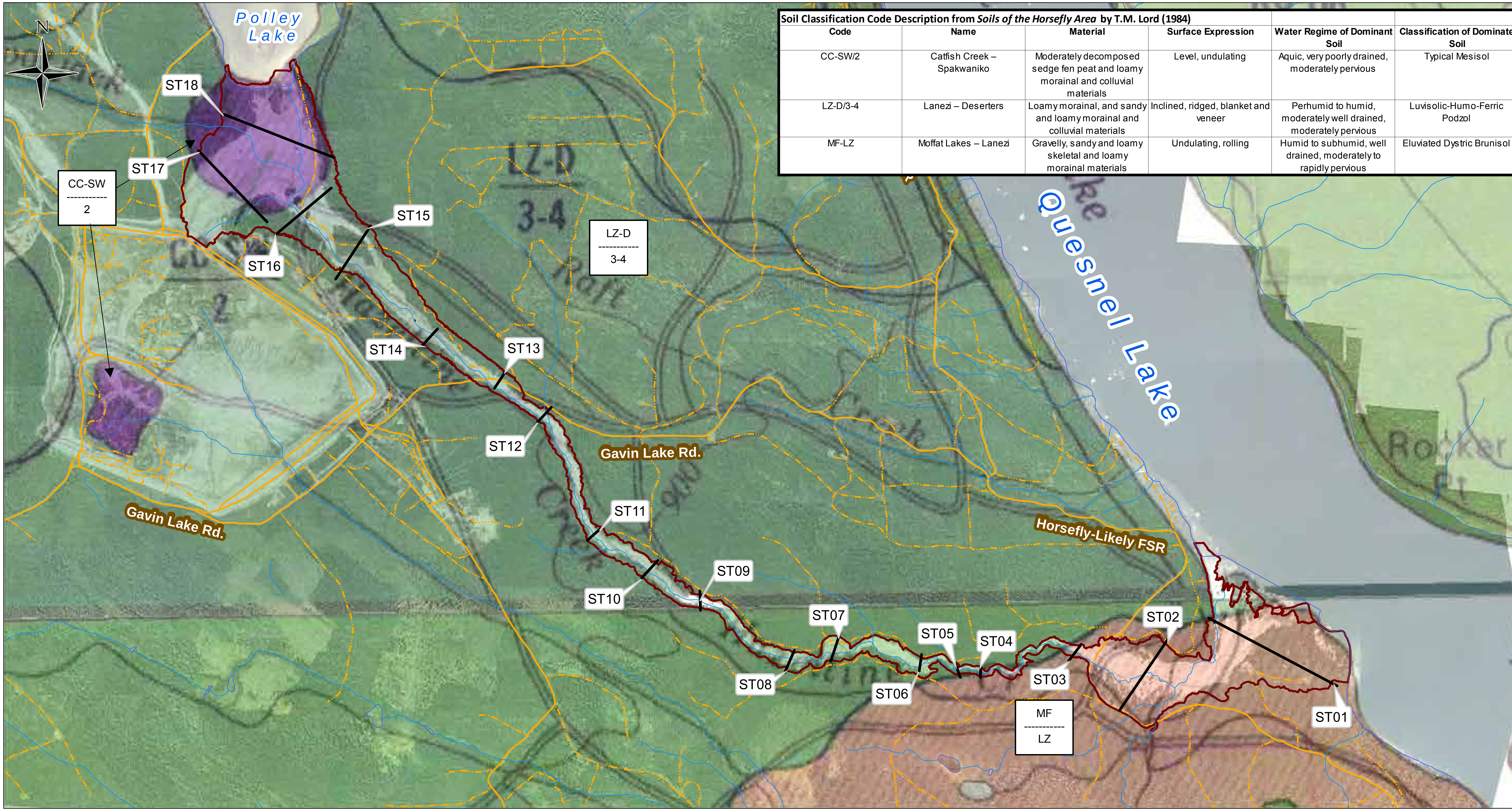
Table 4: Bulk Density Soil Log and Sample Results

Sample ID	Sample Date (yyyy mm dd)	Sample Type[a]	Description	Bulk Density (Mg/m^3)	Coordinates North (m)	Coordinates East (m)	Tailings Overburden Depth (m)	Sample Depth (m)
Hazeltine Creek								
ST01-01-BD-141001	2014 10 01	T	SILT (Tailings), sandy, fine grained, trace clay, grey, soft, low plasticity, wet	1.66	5817454	601636	-	0.0 - 0.15
ST01-02-BD-141001	2014 10 01	N (Till)	SILT (Till), sandy, fine to medium grained, trace gravel, brown, firm, no plasticity, damp	1.52	5817392	601726	0.05	0.05 - 0.20
ST02-01-BD-140930	2014 09 30	T	SAND (Tailings), some silt, grey, loose, damp	1.51	5817218	601122	-	0.0 - 0.15
ST02-02-BD-140930	2014 09 30	N (Lacustrine)	CLAY (Lacustrine), silty, trace fine grained sand, grey, soft, medium plasticity, moist	1.61	5817223	601092	0.00	0.0 - 0.15
ST03-01-BD-141001	2014 10 01	B	SILT (Till), sandy, fine grained, trace subrounded gravel, brown, soft, damp, low plasticity, roots/rootlets	1.04	5817280	600647	-	0.0 - 0.15
ST03-02-BD-141001	2014 10 01	N (Lacustrine)	CLAY (Lacustrine), silty, trace to some gravel, occasional cobbles, grey, stiff, medium plasticity, moist	2.00	5817303	600629	0.03	0.03 - 0.18
ST03-03-BD-141001	2014 10 01	T	SAND (Tailings), fine to medium grained, reddish brown with grey lenses, trace silt, loose, wet	1.38	5817308	600651	-	0.0 - 0.15
ST08-01-BD-141001	2014 10 01	B	SILT (Till), some fine to medium grained sand, trace clay, trace gravel, trace cobbles, light brown, firm, low plasticity, dry, roots/rootlets	1.26	5817321	598901	-	0 to 0.16
ST08-02-BD-141001	2014 10 01	T	SAND (Tailings), fine grained, some silt, grey, loose, wet to moist	1.67	5817276	598888	-	0 to 0.13
ST08-03-BD-141001	2014 10 01	N (Till)	SAND (Native), medium to coarse grained, some silt, some fine subrounded gravel, brown, loose, damp	1.86	5817280	598881	0.00	0.0 - 0.15
ST08-04-BD-141001	2014 10 01	N (Lacustrine)	SILT (Lacustrine), clayey, trace fine grained sand, grey, very stiff, damp	1.69	5817277	598786	0.00	0.0 - 0.12
ST11-01-BD-140930	2014 09 30	N (Till)	SILT (Till), sandy, fine to coarse grained, trace to some clay, some gravel, grey brown, firm, low plasticity, damp	1.82	5818118	597603	0.01	0.01 - 0.16
ST11-02-BD-140930	2014 09 30	T	SAND (Tailings), some silt, grey, loose, damp	1.59	5818109	597621	-	0.0 - 0.14
ST13-01-BD-140930	2014 09 30	N (Till)	SAND (Till), fine to medium grained, some silt, trace subrounded gravel, medium dense to dense, brown, damp, roots/rootlets	1.44	5819004	597036	0.03	0.03 - 0.18
ST13-02-BD-140930	2014 09 30	T	SAND (Tailings), fine to medium grained, trace silt, loose, moist	1.39	5818996	597021	-	0.0 - 0.15
ST14-01-BD-140930	2014 09 30	B	SILT (Till), some fine to medium grained sand, trace clay, frequent gravel, light brown, firm, no plasticity, dry, roots/rootlets	0.85	5819251	596545	-	0.0 - 0.14
ST15-01-BD-141002	2014 10 02	N (Till)	SAND (Till), fine to medium grained, silty, trace gravel, trace clay, reddish brown, dense, damp	1.90	5819982	595945	0.03	0.03 - 0.18
ST15-02-BD-141002	2014 10 02	T	SAND (Tailings), fine to medium grained, trace to some silt, grey, loose, damp to moist	1.52	5819985	595942	-	0.0 - 0.15
ST16-01-BD-141002	2014 10 02	T	SAND (Tailings), fine to medium grained, some silt, grey, loose, wet	1.60	5820124	595802	-	0.0 - 0.15
ST16-02-BD-141002	2014 10 02	B	SILT (Native), some fine grained sand, some gravel, dark brown to grey, firm, low plasticity, moist, roots/rootlets	0.90	5819959	595605	-	0.0 - 0.15
ST17-01-BD-141002	2014 10 02	T	SILT and CLAY (Tailings), some fine grained sand, grey, soft, medium plasticity, moist	1.54	5820221	595486	-	0 - 0.15
OBS02-01	2014 09 30	N	GRAVEL and COBBLES (Native), coarse, some sand, trace silt, grey, medium dense. No sample collected due to soil having estimated coarse fragment content > 50% (v/v).	-	5817222	601133	-	-
OBS03-01	2014 10 01	N	GRAVEL and COBBLES (Native) Coarse material across much of area upstream of new bridge location. No sample collected due to soil having estimated coarse fragment content > 50% (v/v).	-	5817297	600671	-	-
OBS08-01	2014 10 01	N	GRAVEL and COBBLES (Native), coarse, sandy, fine to medium grained, trace silt, grey brown, dense. No sample collected due to soil having estimated coarse fragment content > 50% (v/v).	-	5817272	598902	-	-
OBS13-01	2014 09 30	T	SAND (Tailings), fine to medium grained, trace to some silt, grey, loose, wet. No sample collected due to saturated and sloughing.	-	5818996	597015	-	-
OBS13-02	2014 09 30	D	SILT (Disturbed), some fine to medium grained sand, trace to some clay, light brown. Sample not collected given disturbed appearance and not being considered representative of transect conditions. Refer to Sample ST13-02-01-BD for description of till unit.	-	5819084	596930	-	-
OBS16-01	2014 10 02	N	SILT (Till), gravelly, frequent cobbles, brown, dense, damp. No sample collected due to soil having estimated coarse fragment content > 50% (v/v).	-	5820069	595840	-	-
OBS16-02	2014 10 02	F	BOULDERS and COBBLES (Fill / Suspect Dam Materials), coarse, angular, gravelly, variable colour. No sample collected due to soil having estimated coarse fragment content > 50% (v/v).	-	5820243	595782	-	-
OBS17-01	2014 10 02	T	SILT and CLAY (Tailings), some fine grained sand, grey, very soft, medium plasticity, moist to wet. No sample collected as soil appeared similar to that sampled at ST17-01-BD.	-	5820501	595346	-	-

[a] T = Tailings B = Background N = Native within channel D = Disturbed F = Fill

DRAWINGS

621717-4-1 – Surficial Soils Overview
621717-4-2 – Site Overview and Transect Plan
621717-4-3 – P1 to P11 – Sample Location Plan

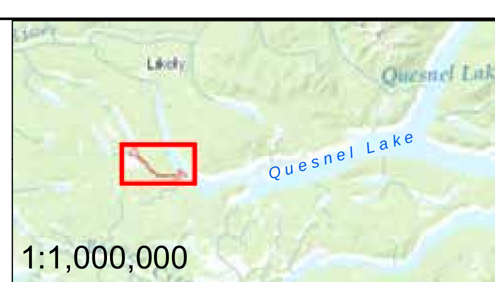


Soil Classification Code Description from *Soils of the Horsefly Area* by T.M. Lord (1984)

Code	Name	Material	Surface Expression	Water Regime of Dominant Soil	Classification of Dominate Soil
CC-SW/2	Catfish Creek – Spakwaniko	Moderately decomposed sedge fen peat and loamy morainal and colluvial materials	Level, undulating	Aquic, very poorly drained, moderately pervious	Typical Mesisol
LZ-D/3-4	Lanezi – Deserters	Loamy morainal, and sandy and loamy morainal and colluvial materials	Inclined, ridged, blanket and veneer	Perhumid to humid, moderately well drained, moderately pervious	Luvisolic-Humo-Ferric Podzol
MF-LZ	Moffat Lakes – Lanezi	Gravelly, sandy and loamy skeletal and loamy morainal materials	Undulating, rolling	Humid to subhumid, well drained, moderately to rapidly pervious	Eluviated Dystric Brunisol

LEGEND

- Soil Sampling Transects
- Streams
- Gravel Roads
- Rough Roads
- Affected Area



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NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 125 250 500 750 1,000 Meters

1. TRIM data provided by Mount Polley Mining Corporation
2. Orthophoto collected by McElhanney on August 5, 2014
3. Service Layer Credits: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

SNC • LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Mount Polley Mine, Likely, BC

Surficial Soils Overview

BY: AO	SCALE: 1:25,000	DATE: 2015/06/04	REF No: 621717-4-1	REV: 0
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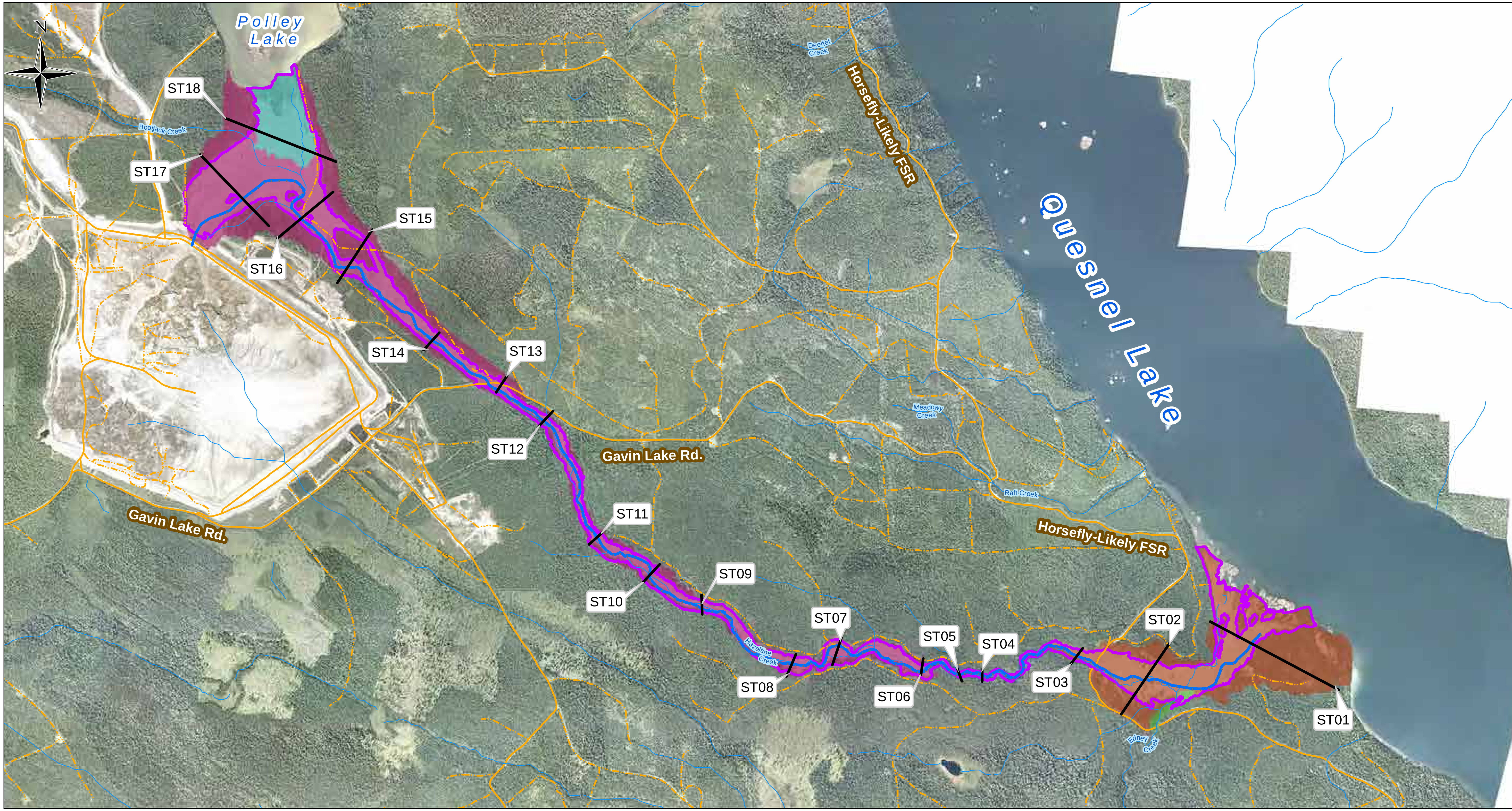
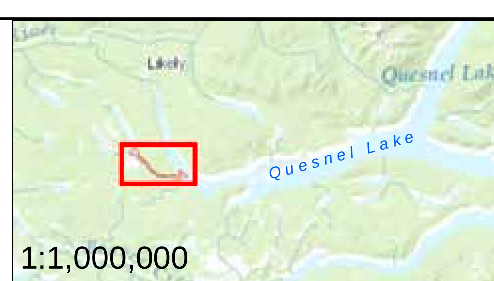


LEGEND

- Soil Sampling Transects
- New Hazeltine Creek Channel (Approximate)
- Streams
- Gravel Roads
- Rough Roads
- Scour Area

Affected Areas

- Canyon
- Edney Creek Mouth
- Lower Hazeltine Creek
- Polley Plug
- Upper Hazeltine Creek



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SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Mount Polley Mine, Likely, BC

Site Overview and Transect Plan

BY: AO	SCALE: 1:25,000	DATE: 2015/06/04	REF No: REV: 0
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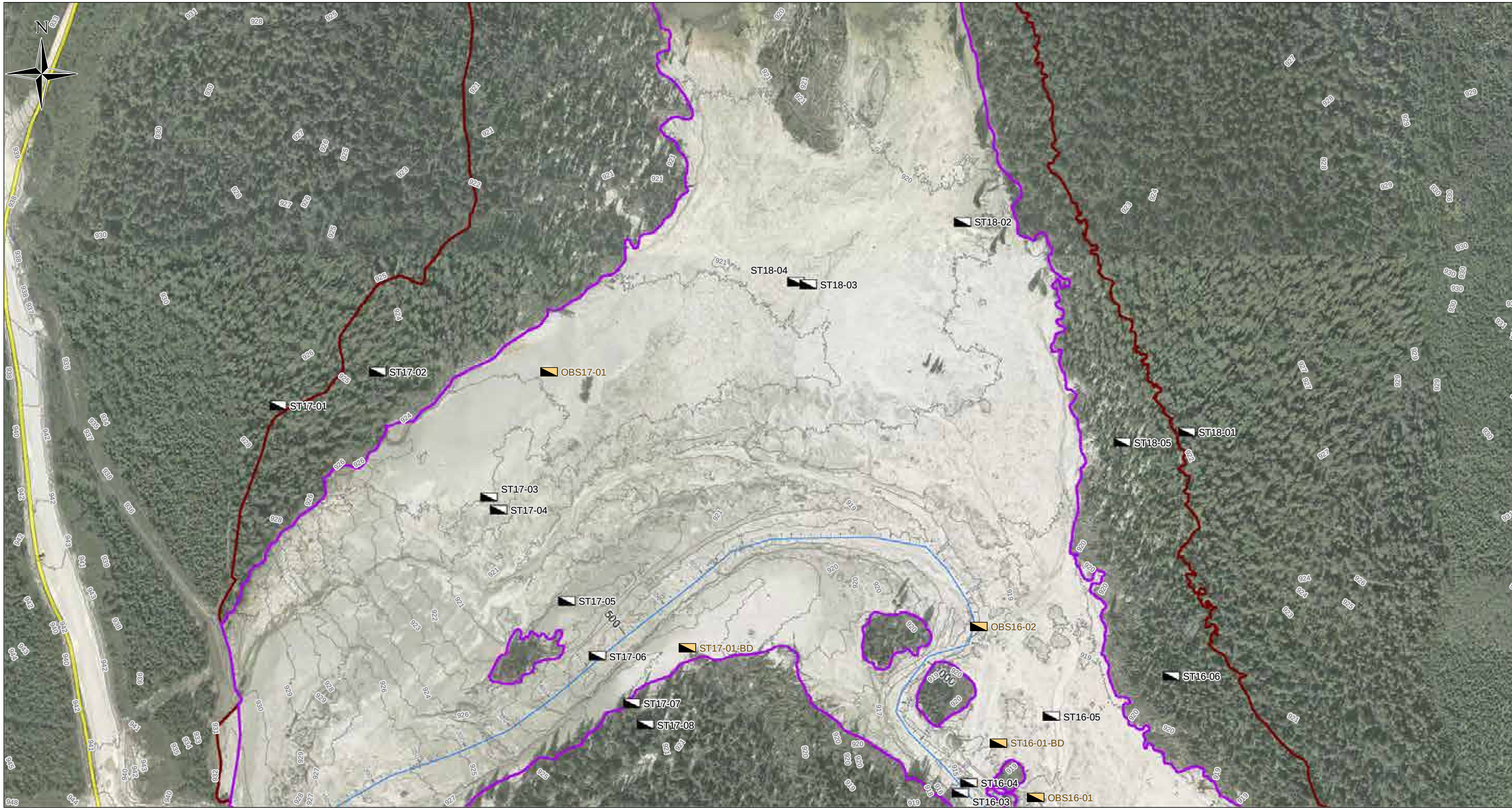
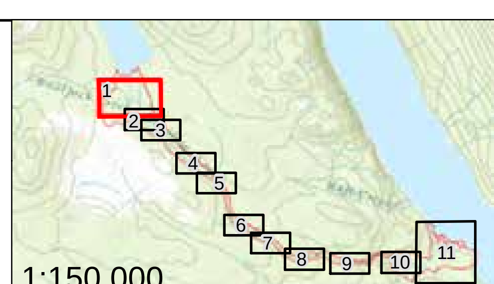


LEGEND

- Bulk Density Sample Locations
- Test Pit Locations
- Primary Access Road
- Scour Zone
- Affected Area
- Elevation Contours (1m)
- New Hazeltine Creek Channel (Approximate Distance from Tailings Storage Facility)



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REFERENCES

0 20 40 80 120 160 Meters

1. TRIM data provided by Mount Polley Mining Corporation
2. Orthophoto collected by McElhanney on August 5, 2014

SNC·LAVALIN

CLIENT NAME: Mount Polley Mining Corporation	PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Sample Location Plan
Page: 1

BY: AO	SCALE: 1:4,000	DATE: 2015/06/04	REF No: REV: 2
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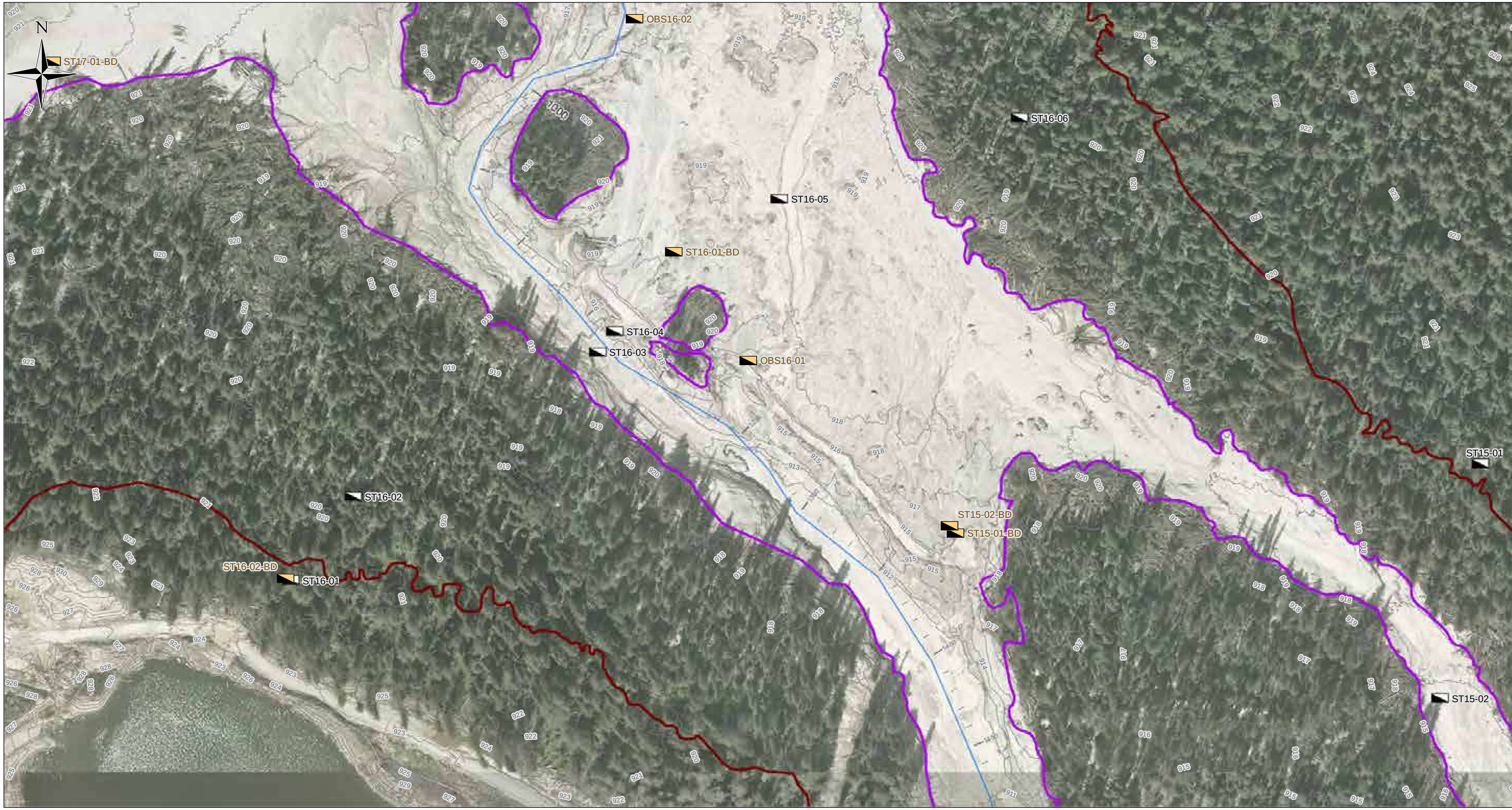
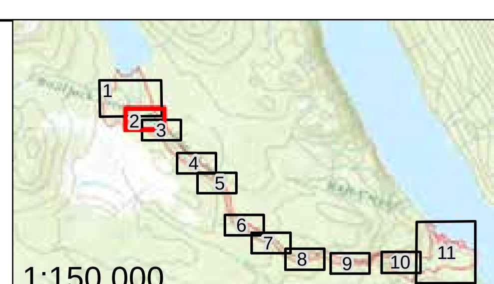


LEGEND

- Bulk Density Sample Locations
- Test Pit Locations
- Scour Zone
- Affected Area
- Elevation Contours (1m)
- New Hazeltine Creek Channel (Approximate Distance from Tailings Storage Facility)



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REFERENCES

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1. TRIM data provided by Mount Polley Mining Corporation
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SNC·LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Sample Location Plan
Page: 2

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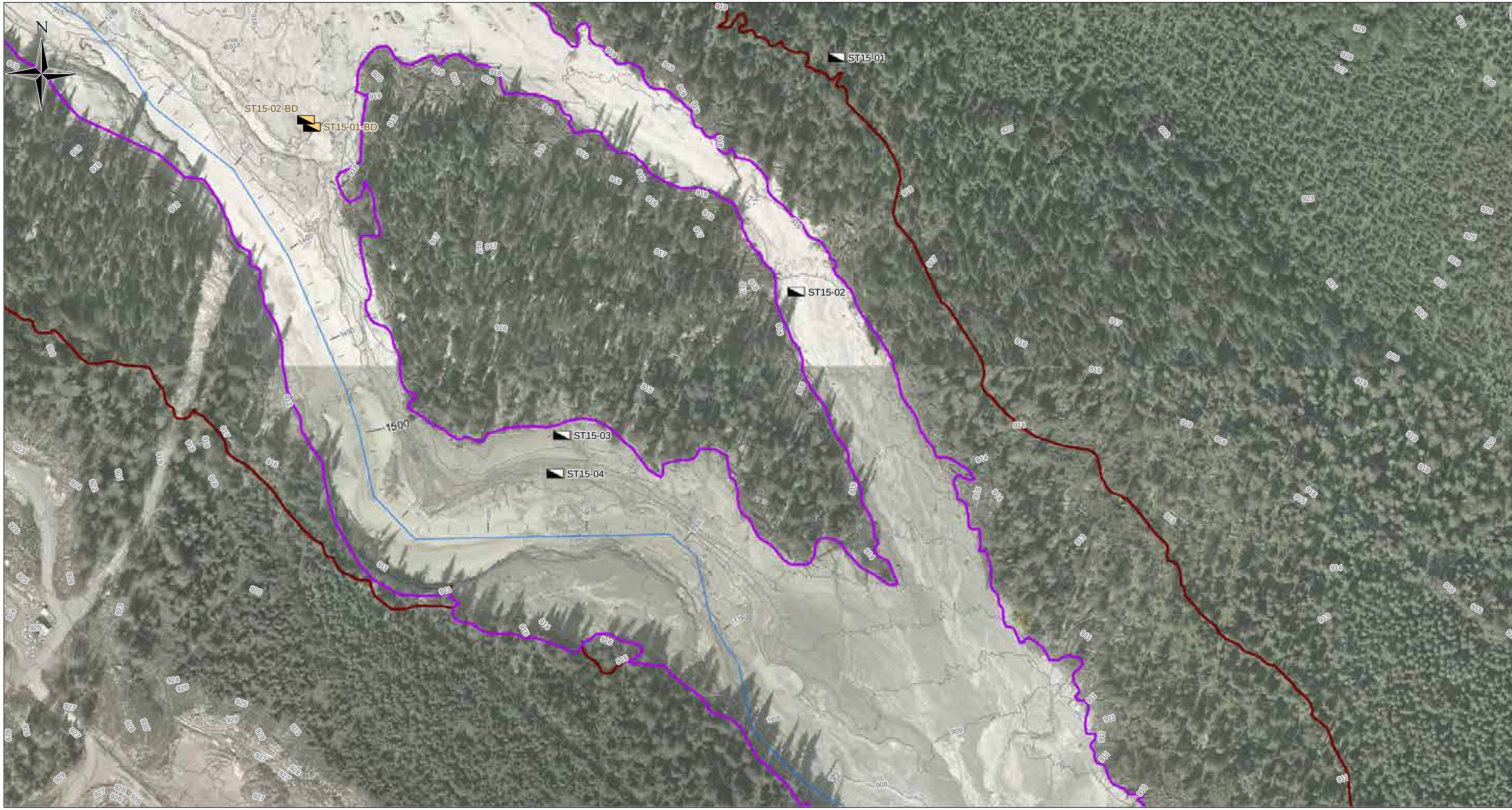
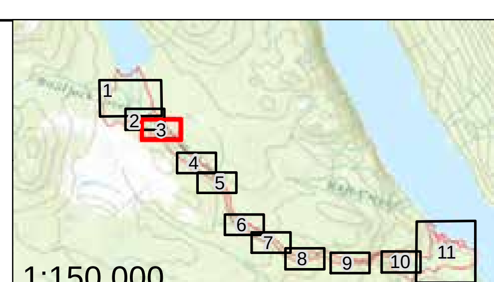


LEGEND

- Bulk Density Sample Locations
- Test Pit Locations
- Scour Zone
- Affected Area
- Elevation Contours (1m)
- New Hazeltine Creek Channel (Approximate Distance from Tailings Storage Facility)



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NOTES

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1. TRIM data provided by Mount Polley Mining Corporation
2. Orthophoto collected by McElhanney on August 5, 2014

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CLIENT NAME: Mount Polley Mining Corporation	PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Sample Location Plan
Page: 3

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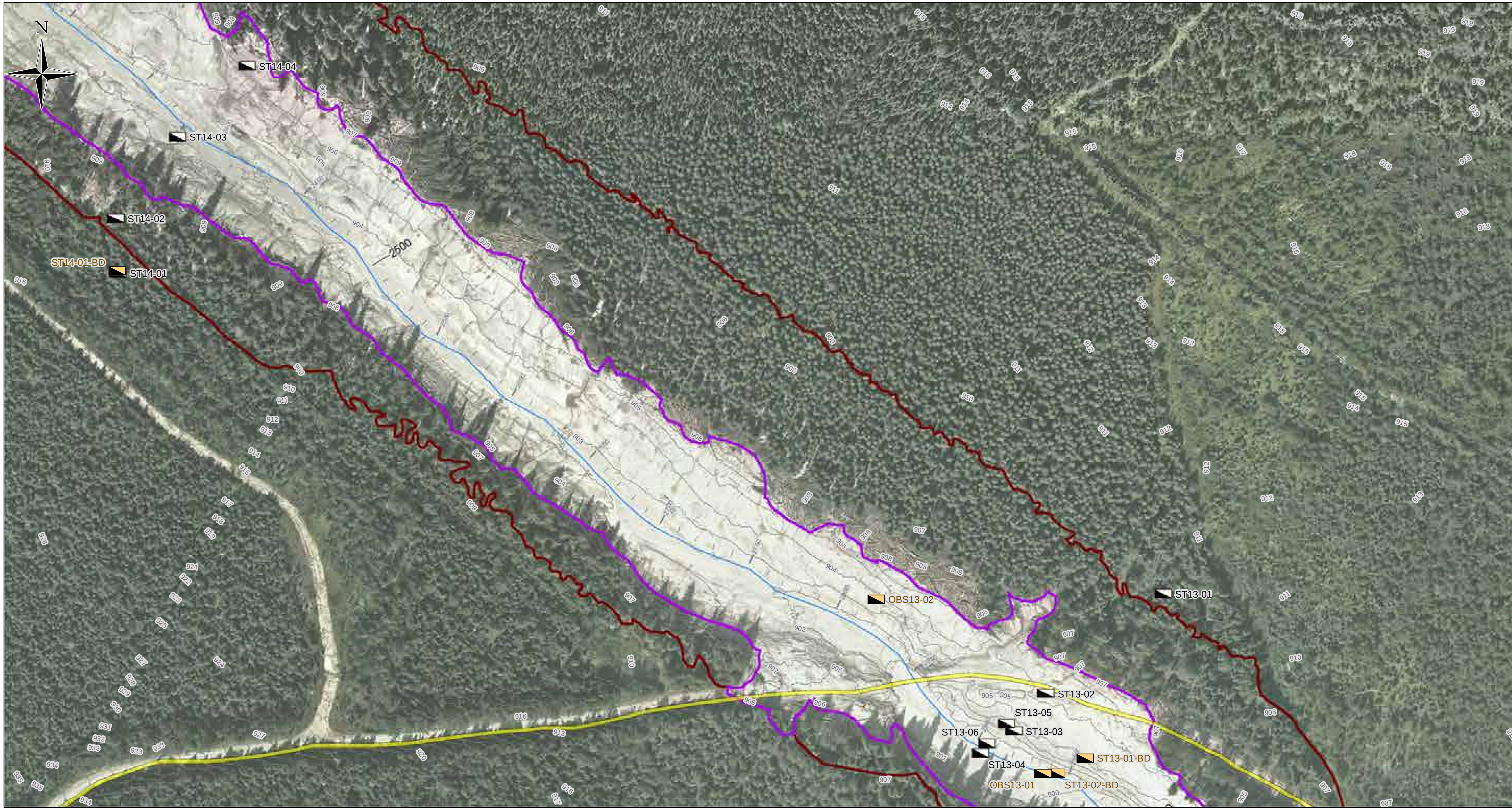
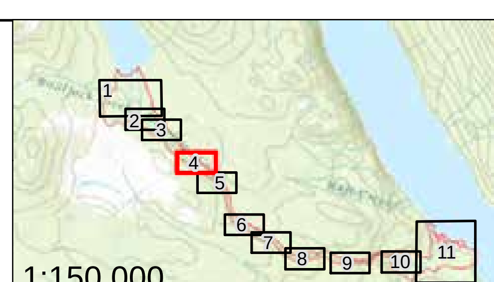


LEGEND

- Bulk Density Sample Locations
- Test Pit Locations
- Primary Access Road
- Scour Zone
- Affected Area
- Elevation Contours (1m)
- New Hazeltine Creek Channel (Approximate Distance from Tailings Storage Facility)



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2. Orthophoto collected by McElhanney on August 5, 2014

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CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Sample Location Plan
Page: 4

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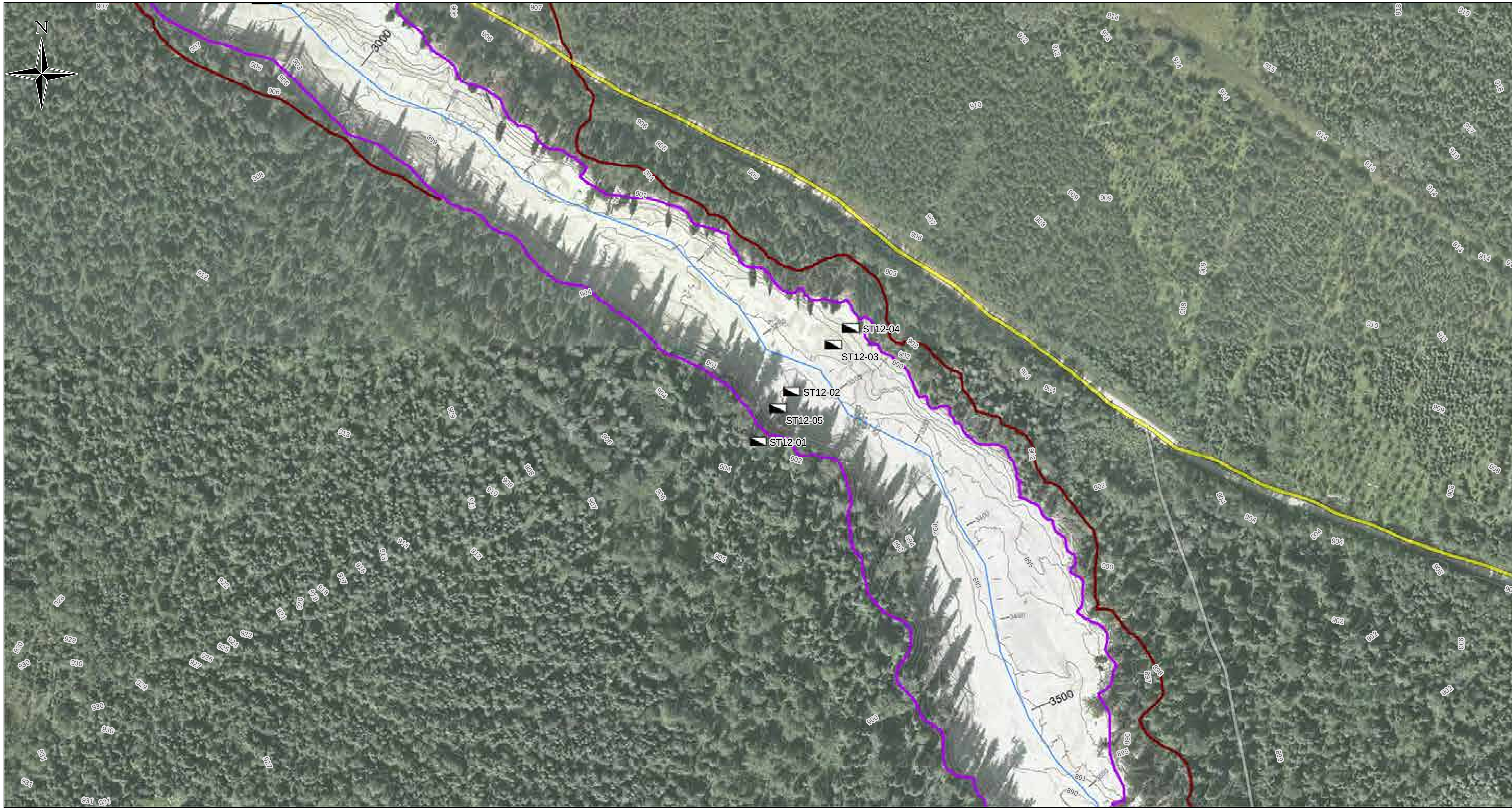
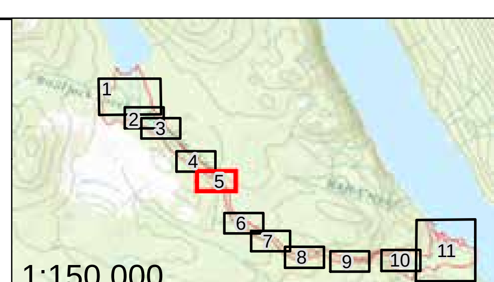


LEGEND

- Bulk Density Sample Locations
- Secondary Access Road/Trails
- Test Pit Locations
- Primary Access Road
- Scour Zone
- Affected Area
- Elevation Contours (1m)
- New Hazeltine Creek Channel (Approximate Distance from Tailings Storage Facility)



NOTES

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REFERENCES

0 10 20 40 60 80 Meters

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2. Orthophoto collected by McElhanney on August 5, 2014

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CLIENT NAME: Mount Polley Mining Corporation	PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Sample Location Plan
Page: 5

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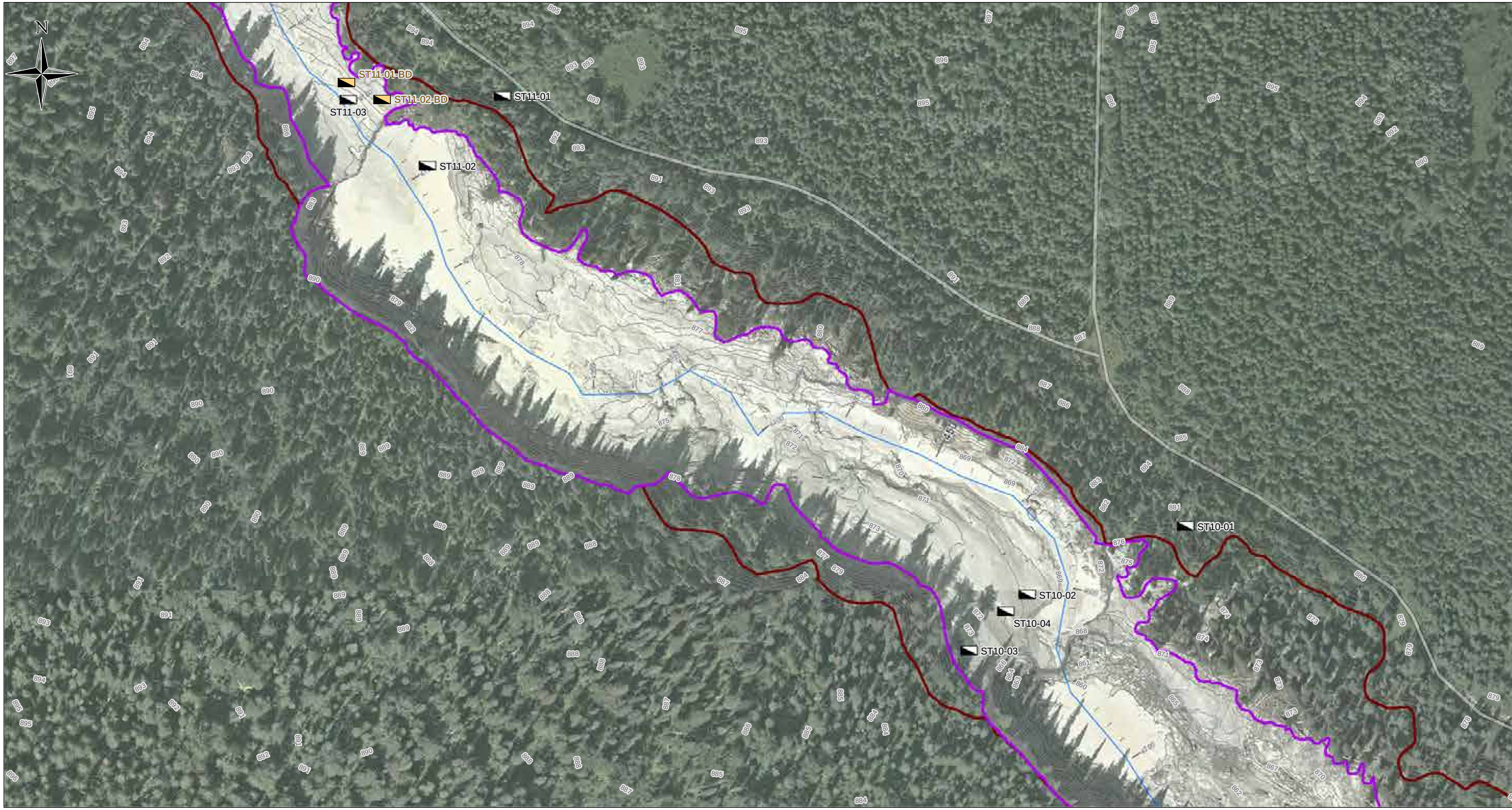
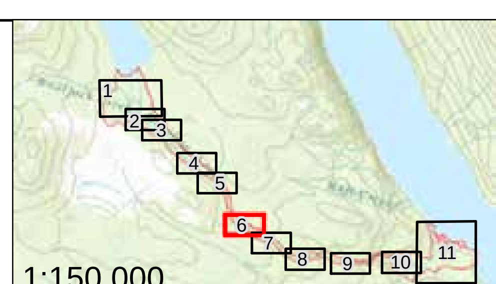


LEGEND

- Bulk Density Sample Locations
- Secondary Access Road/Trails
- Test Pit Locations
- Scour Zone
- Affected Area
- Elevation Contours (1m)
- New Hazeltine Creek Channel (Approximate Distance from Tailings Storage Facility)



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2. Orthophoto collected by McElhanney on August 5, 2014

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CLIENT NAME: Mount Polley Mining Corporation	PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Sample Location Plan
Page: 6

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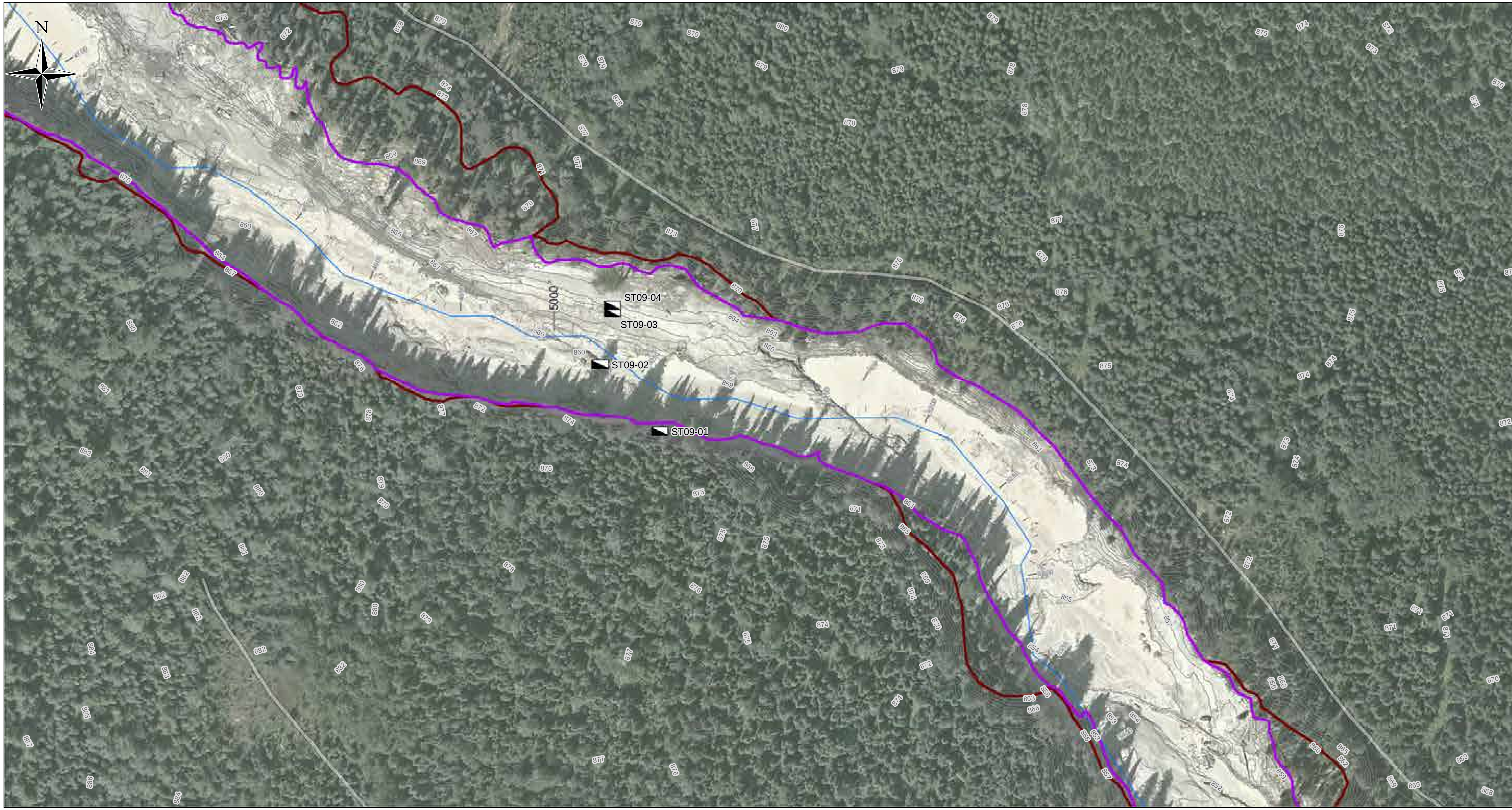
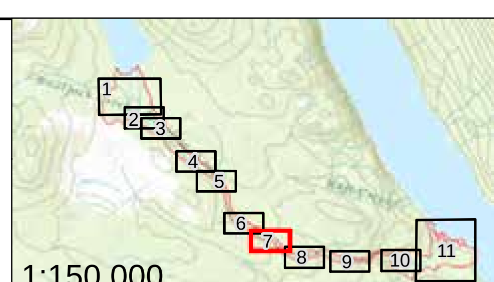


LEGEND

- Secondary Access Road/Trails
- Test Pit Locations
- Scour Zone
- Affected Area
- Elevation Contours (1m)
- New Hazeltine Creek Channel (Approximate Distance from Tailings Storage Facility)



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SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Sample Location Plan
Page: 7

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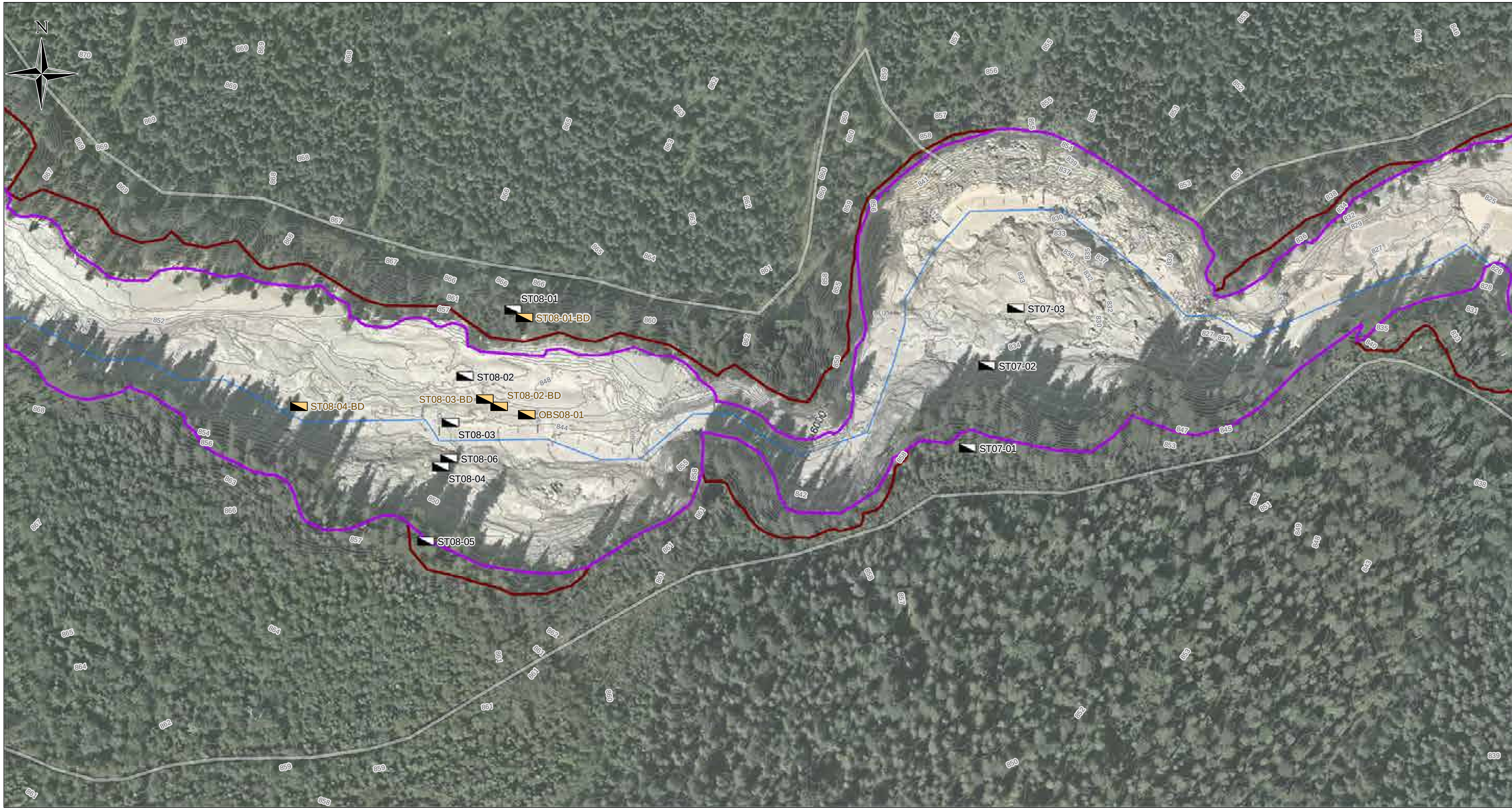
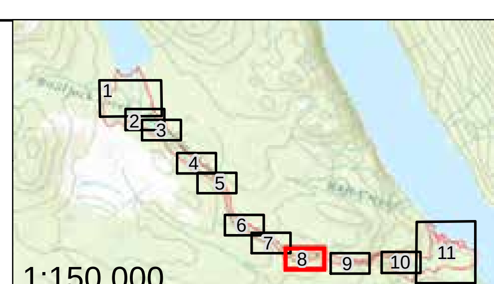


LEGEND

- Bulk Density Sample Locations
- Secondary Access Road/Trails
- Test Pit Locations
- Scour Zone
- Affected Area
- Elevation Contours (1m)
- New Hazeltine Creek Channel (Approximate Distance from Tailings Storage Facility)



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2. Orthophoto collected by McElhanney on August 5, 2014

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Sample Location Plan
Page: 8

BY: AO	SCALE: 1:2,000	DATE: 2015/06/04	REF No:	REV: 2
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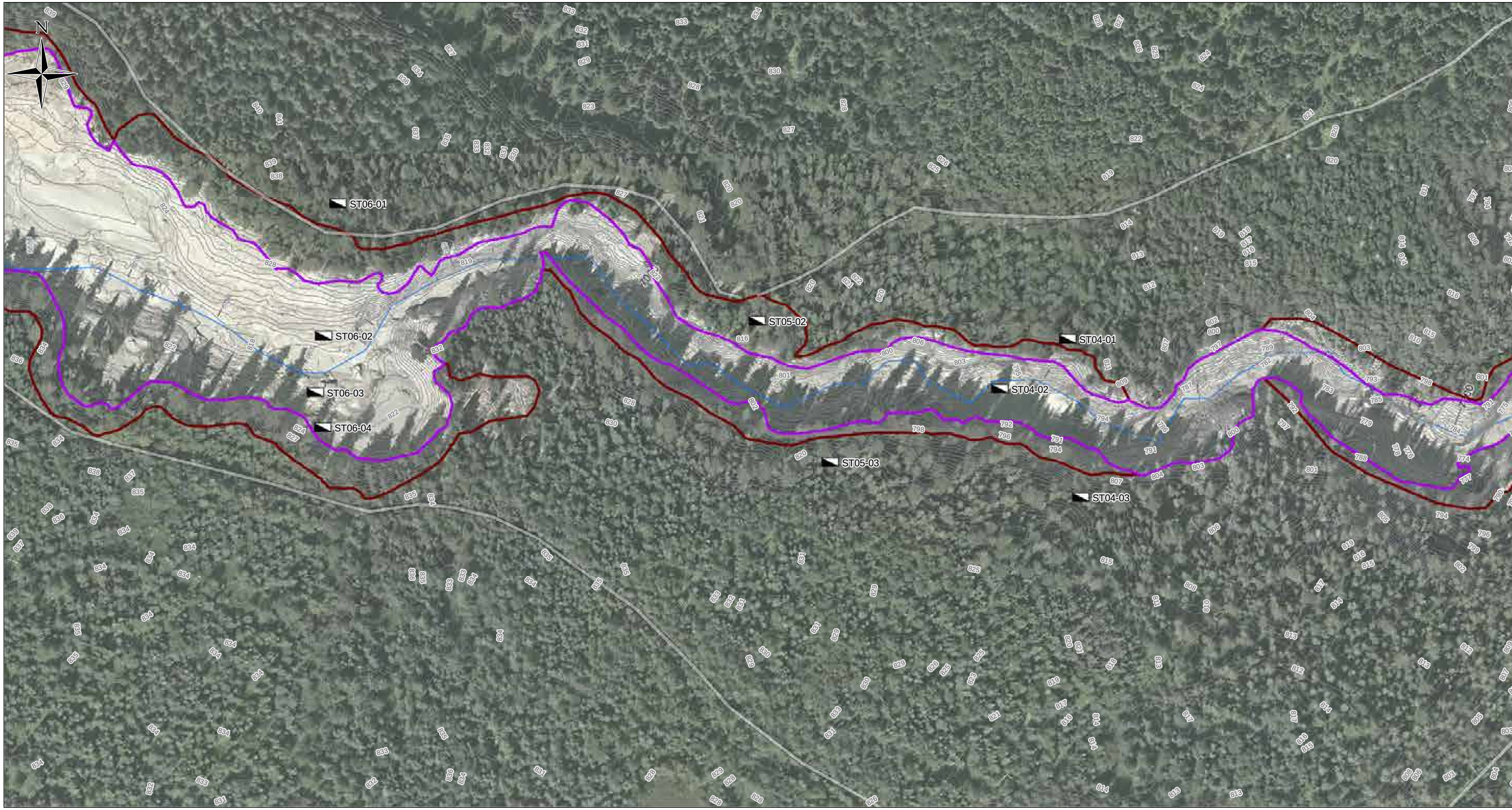
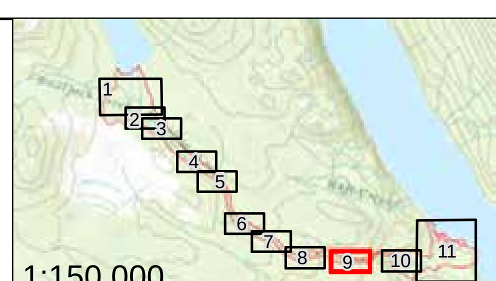


LEGEND

- Secondary Access Road/Trails
- Test Pit Locations
- Scour Zone
- Affected Area
- Elevation Contours (1m)
- New Hazeltine Creek Channel (Approximate Distance from Tailings Storage Facility)



NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 10 20 40 60 80 Meters

1. TRIM data provided by Mount Polley Mining Corporation
2. Orthophoto collected by McElhanney on August 5, 2014

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Sample Location Plan
Page: 9

BY: AO	SCALE: 1:2,000	DATE: 2015/06/04	REF No:	REV: 2
CHK'D: DS	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-4-3-P9	

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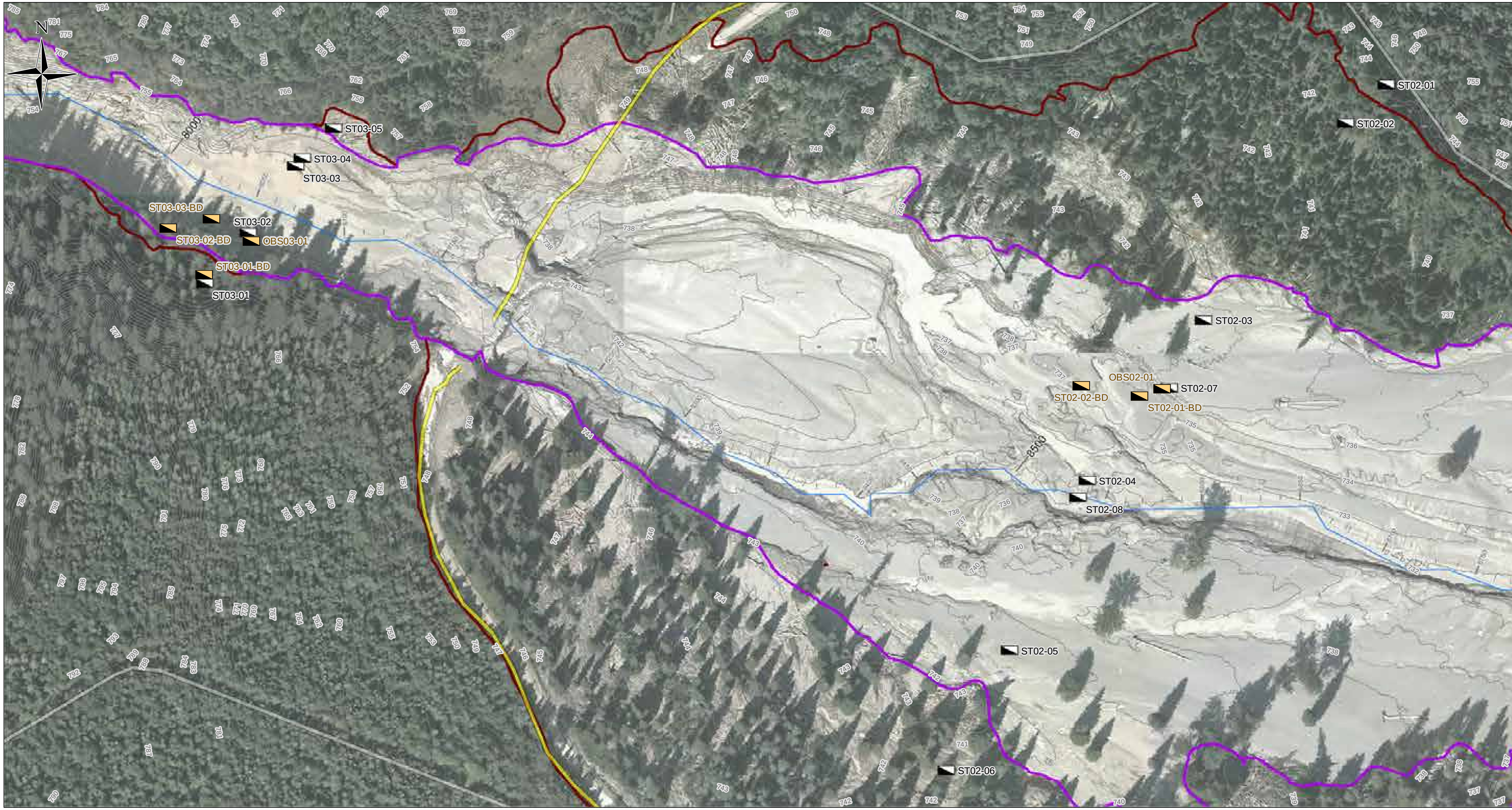
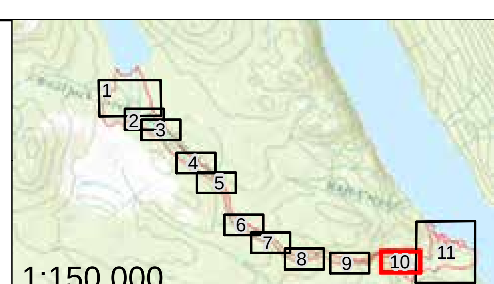


LEGEND

- Bulk Density Sample Locations
- Secondary Access Road/Trails
- Test Pit Locations
- Primary Access Road
- Scour Zone
- Affected Area
- Elevation Contours (1m)
- New Hazeltine Creek Channel (Approximate Distance from Tailings Storage Facility)



NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 10 20 40 60 80 Meters

1. TRIM data provided by Mount Polley Mining Corporation
2. Orthophoto collected by McElhanney on August 5, 2014

SNC · LAVALIN

CLIENT NAME: Mount Polley Mining Corporation	PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Sample Location Plan
Page: 10

BY: AO	SCALE: 1:2,000	DATE: 2015/06/04	REF No: REV: 2
CHK'D: DS	PROJ COORD SYS: NAD 1983 UTM Zone 10N		621717-4-3-P10

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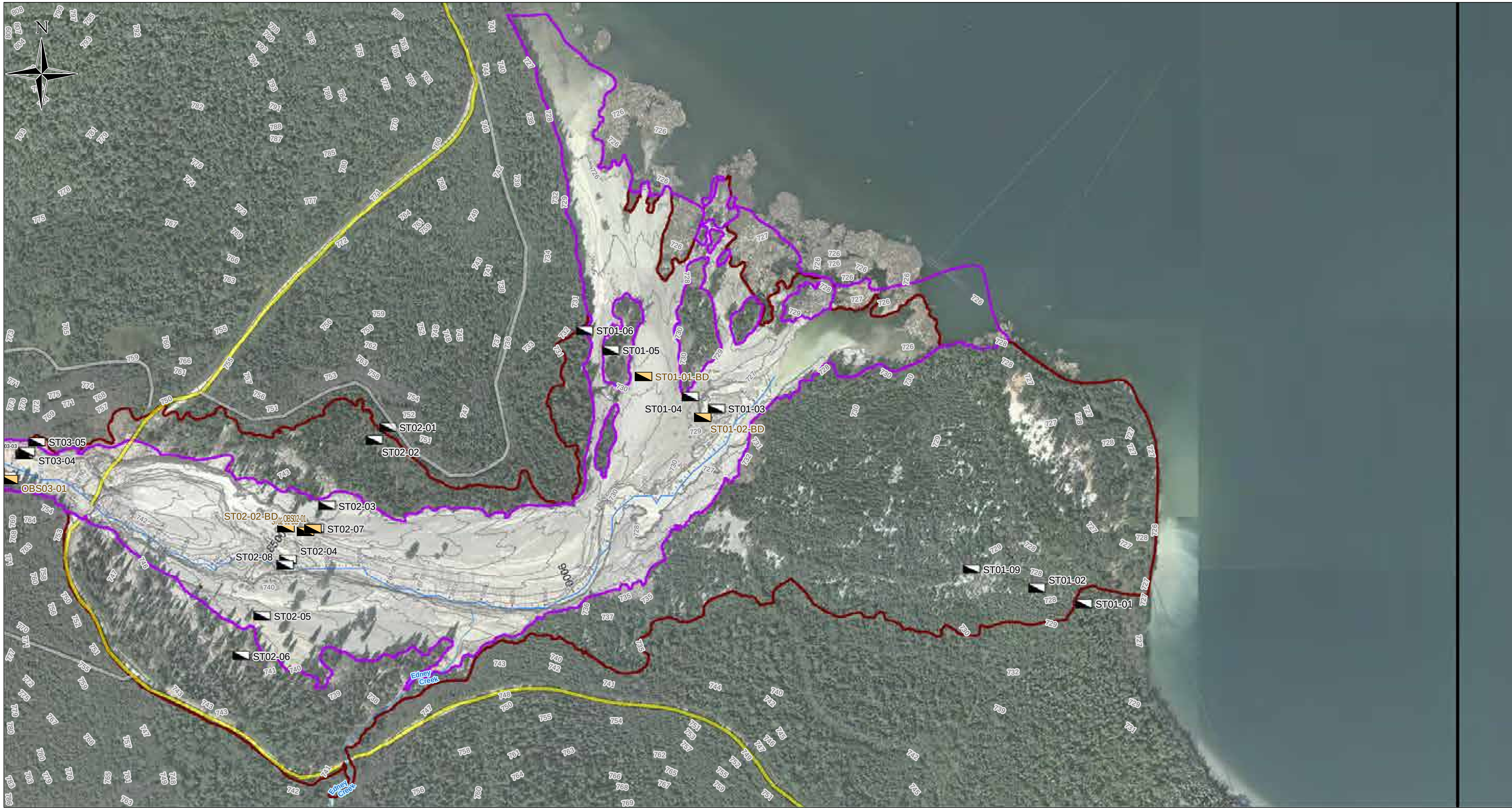
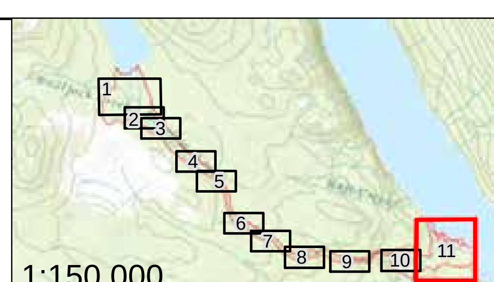


LEGEND

- Bulk Density Sample Locations
- Secondary Access Road/Trails
- Test Pit Locations
- Primary Access Road
- Scour Zone
- Affected Area
- Elevation Contours (1m)
- New Hazeltine Creek Channel (Approximate Distance from Tailings Storage Facility)



NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

REFERENCES

0 30 60 120 180 240 Meters

1. TRIM data provided by Mount Polley Mining Corporation
2. Orthophoto collected by McElhanney on August 5, 2014

SNC·LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Hazeltine Creek Study Area, Mount Polley Mine, BC

Sample Location Plan
Page: 11

BY: AO	SCALE: 1:6,000	DATE: 2015/06/04	REF No: 621717-4-3-P11 REV: 2
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MXD Path: \\Proj_srv\projects\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\4.0 Execution\4.5 GIS and Drawings\GIS\PEEIAR Figures\621717-4-3_P1_P14_SampleLocPlan.mxd

Project Path: P:\LOB\EIAM-BC\Current Projects\Mount Polley Mining Corporation\621717_Legally Privileged\

APPENDIX I

Site Photographs

Photograph 1: View facing east to TSF at ST18, showing loose, saturated tailings deposited around Polley Plug and Upper Hazeltine Creek (September 17, 2014).

Photograph 2: View facing upstream toward ST13, showing tailings deposition typical of Upper Hazeltine Creek (September 14, 2014).

Photograph 3: View facing east at ST02, showing tailings deposition typical of Lower Hazeltine Creek (September 7, 2014).

Photograph 4: View of ST11 showing unsafe access areas and unstable sidewalls (September 14, 2014).

Photograph 5: View looking upgradient of ST03 near terminus of canyon. Note the different depositional environments in foreground (September 7, 2014).

Photograph 6: View of ST16-02 Area, showing tailings depositional environment in adjacent forests of Upper Hazeltine Creek (September 13, 2014).

Photograph 7: View upstream of ST13, showing tailings depositional environments in Upper Hazeltine Creek (September 2, 2014).

Photograph 8: View facing east over ST04, showing limited tailings and limited access points in the Canyon. Note, walls at the base of the channel were mostly bedrock (September 5, 2014).

Photograph 9: View of area around ST01-09, showing tailings deposition over native soils in Lower Hazeltine Creek (September 22, 2014).

Photograph 10: View of ST18-02, showing tailings vertical variability near Polley Plug in Upper Hazeltine Creek (September 17, 2014).

Photograph 11: View of ST15-04, showing two tailings types. Grey tailings are shown above magnetite sands tailings (September 13, 2014).

Photograph 12: View of ST01-02, showing fine grey tailings over native A and B Horizon soils (September 14, 2014).

Photograph 13: View of ST02-07, showing a scoured sidewall soil profile in Lower Hazeltine Creek (September 3, 2014).

Photograph 14: View of ST08-02, showing the tailings deposited on top of the native soil (September 15, 2014).

Photograph 15: View of ST09 area of scour exposing native parent mineral soil along exposed channel sidewalls (September 7, 2014).

Photograph 16: View of ST01-05, showing typical sample equipment and soil profile (September 3, 2014).

Photograph 17: View of ST11-02, showing a tailings sample being collected from a deeper deposit of tailings found in Upper Hazeltine Creek (September 14, 2014).

Photograph 18: View of ST13, showing a bulk density sample being collected (September 30, 2014).

Photograph 19: View of background soil profile for ST01-06 (September 6, 2014).

Photograph 20: View of background soil profile for ST 02-02 (September 10, 2014).

Photograph 21: View of background soil profile for ST 03-01. Note the thick LHF layer (September 7, 2014).

Photograph 22: View of background soil profile for ST 04-01 (September 5, 2014).

Photograph 23: View of background soil profile for ST 05-03 (September 22, 2014).

Photograph 24: View of background soil profile for ST 06-01 (September 5, 2014).

Photograph 25: View of background soil profile for ST 07-01 (September 7, 2014).

Photograph 26: Soil profile for ST 08-01 (September 5, 2014).

Photograph 27: View of background soil profile for ST 09-01 (September 7, 2014).

Photograph 28: View of background soil profile for ST 10-01 (September 5, 2014).

Photograph 29: View of background soil profile for ST 11-01 (September 7, 2014).

Photograph 30: View of background soil profile for ST 12-01. Note the organic content of the profile (September 4, 2014).

Photograph 31: View of background soil profile for ST 13-01 (September 8, 2014).

Photograph 32: View of background soil profile for ST 14-01 (September 4, 2014).

Photograph 33: View of background soil profile for ST 15-01 (September 8, 2014).

Photograph 34: View of background soil profile for ST 16-01 (September 6,2 014).

Photograph 35: View of background soil profile for ST 17-01 (September 12, 2014).

Photograph 36: View of background soil profile for ST 18-01 (September 17,2014).

APPENDIX II

Laboratory Analytical Methods

[illegible]

ALS Test Code	Matrix	Test Description	Method Reference**	Method Reference
HG-200.2-CVAF-VA	Soil	Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAFS.	EPA 200.2/1631E (mod)	U.S. Environmental Protection Agency
MET-200.2-CCMS-VA	Soil	Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CRC ICPMS.	EPA 200.2/6020A (mod)	U.S. Environmental Protection Agency
EPH-TUMB-FID-VA	Soil	EPH in Solids by Tumbler and GCFID	BC MOE EPH GCFID	U.S. Environmental Protection Agency
VOC-M2-HSMS-VA	Soil	The soil methanol extract is added to water and reagents, then heated in a sealed vial to equilibrium. The headspace from the vial is transferred into a gas chromatograph. Target compound concentrations are measured using mass spectrometry detection.	EPA8260B, 5021, BC MELP	U.S. Environmental Protection Agency BC Ministry of Environment, Lands, and Parks
PH-1:2-VA	Soil	This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL	BC Ministry of Water, Land and Air Protection
ALK-PASTE-VA	Soil	A soil extract produced by the saturated paste extraction procedure is analyzed for alkalinity by methyl orange colourimetry.	Carter-CSSS / EPA 310.2 (modified)	Canadian Society of Soil Science
CL-PASTE-COLOR-VA	Soil	A soil extract produced by the saturated paste extraction procedure is analyzed for chloride by ferricyanide colourimetry.	Carter-CSSS / APHA 4500-Cl E (modified)	Canadian Society of Soil Science
EC-PASTE-VA	Soil	A soil extract produced by the saturated paste extraction procedure is analyzed by conductivity meter.	Carter-CSSS / APHA 2510B	Canadian Society of Soil Science

MET-PASTE-ICP-VA	Soil	A soil extract produced by the saturated paste extraction procedure is analyzed for Sodium, Calcium, and Magnesium by ICPOES as per "Soil Sampling and Methods of Analysis" by M. Carter.	Carter-CSSS / EPA 6010B (modified)	Canadian Society of Soil Science
NO3-PASTE-IC-VA	Soil	A soil extract produced by the saturated paste extraction procedure is analyzed for nitrate (as N) by Ion Chromatography with conductivity or UV detection.	Carter-CSSS / EPA 300.1 (modified)	Canadian Society of Soil Science
SAR-PASTE-CALC-VA	Soil	A soil extract produced by the saturated paste extraction procedure is analyzed for Sodium, Calcium, and Magnesium by ICPOES. Sodium Adsorption Ratio (SAR) is calculated as per "Soil Sampling and Methods of Analysis" by M. Carter.	Calculation	n/a
SAT-PCNT-VA	Soil	Saturation Percentage (SP) is the total volume of water present in a saturated paste (in mL) divided by the dry weight of the sample (in grams), expressed as a percentage, as described in "Soil Sampling and Methods of Analysis" by M. Carter.	Carter-CSSS	Canadian Society of Soil Science
SO4-PASTE-IC-VA	Soil	A soil extract produced by the saturated paste extraction procedure is analyzed for sulfate by Ion Chromatography with conductivity detection.	Carter-CSSS / EPA 300.1 (modified)	Canadian Society of Soil Science
TGR2-CALC-VA	Soil	Theoretical Gypsum Requirement is an estimate of the gypsum amendment required to remediate brine-contaminated or sodic soils, and is provided in units of tonnes per hectare (t/ha) for a treatment depth of 15cm. TGR(brine), intended for brine-contaminated soils, is calculated using Method A from "A Comparison of Methods for Gypsum Requirement of Brine-Contaminated Soils", by J. Ashworth (Cdn J. of Soil Science, 1999), available at www.alsglobal.com. TGR(sodic), intended for naturally sodic soils, uses the Oster and Frenkel method (Method B) from the same paper. Reported TGR values are capped	J. Ashworth et al (1999) Canadian Journal of Soil Science 79	

		at 50 t/ha, considered the maximum practical gypsum amendment. To convert TGR from t/ha to tons/acre, multiply by 0.446. To determine a TGR value for an alternate treatment depth, multiply by [desired treatment depth (cm) / 15 cm].		
LEPH/HEPH-CALC-VA		Light and Heavy Extractable Petroleum Hydrocarbons in Solids. These results are determined according to the British Columbia Ministry of Environment, Lands, and Parks Analytical Method for Contaminated Sites "Calculation of Light and Heavy Extractable Petroleum Hydrocarbons in Solids or Water". According to this method, LEPH and HEPH are calculated by subtracting selected Polycyclic Aromatic Hydrocarbon results from Extractable Petroleum Hydrocarbon results. To calculate LEPH, the individual results for Naphthalene and Phenanthrene are subtracted from EPH(C10-19). To calculate HEPH, the individual results for Benz(a)anthracene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenz(a,h)anthracene, Indeno(1,2,3-c,d)pyrene, and Pyrene are subtracted from EPH(C19-32). Analysis of Extractable Petroleum Hydrocarbons adheres to all prescribed elements of the BCMELP method "Extractable Petroleum Hydrocarbons in Solids by GC/FID" (Version 2.1, July 20, 1999).	BC MOE LABORATORY MANUAL (2005)	
PAH-TMB-H/A-MS-VA		This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Methods 3570 & 8270, published by the United States Environmental Protection Agency (EPA). The procedure uses a mechanical shaking technique to extract a subsample of the sediment/soil with a 1:1 mixture of hexane and acetone. The extract is then solvent exchanged	EPA 3570/8270	U.S. Environmental Protection Agency

		to toluene. The final extract is analysed by capillary column gas chromatography with mass spectrometric detection (GC/MS). Surrogate recoveries may not be reported in cases where interferences from the sample matrix prevent accurate quantitation. Because the two isomers cannot be readily chromatographically separated, benzo(j)fluoranthene is reported as part of the benzo(b)fluoranthene parameter.		
C-INORG-ORG-SK	Soil	Inorganic and Organic Carbon	SSSA (1996) P455-456	Soil Science Society of America Loeppert, Richard H. and Donald L. Suarez. 1996. Carbonate and gypsum. P. 455-456. In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd.ed.) American Society of Agronomy and Soil Science Society of America, Madison, WI. Book Series no. 5.
C-INORG-SK	Soil	Inorganic Carbon / Calcium Carbonate	SSSA (1996) P455-456	Soil Science Society of America Loeppert, Richard H. and Donald L. Suarez. 1996. Carbonate and gypsum. P. 455-456. In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd.ed.) American Society of Agronomy and Soil Science Society of America, Madison, WI. Book Series no. 5.
C-TOT-LECO-SK	Soil	Total Carbon by combustion method	SSSA (1996) P. 973-974	Soil Science Society of America Nelson, D.W. and Sommers, L.E. 1996. Total Carbon, organic carbon and organic matter. P. 973-974 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) American Society of Agronomy and Soil

				Science Society of America, Madison, WI. Book series no. 5
CAT-XTR-SK	Soil	Ammonium Acetate Extractable Cations	CSSS 19.4 - 1M NH4OAc Extraction @ pH 7	Canadian Society of Soil Science Keague, J.A. Soil Sampling and Methods of Analysis. Can. Soc. Soil Sci.(1978)p. 78-80.
CEC-SK	Soil	Cation Exchange Capacity (NH4OAC Extn)	CSSS(1978) 3.321/Comm Soil Sci 19(6)	Canadian Society of Soil Science McKeague, J.A. Soil Sampling and Methods of Analysis. Can. Soc. Soil Sci.(1978)p. 78-80. Gentry, C. 1988. Improved Method for Automated Determination of Ammonium in Soil Extracts. In: Comm Soil Sci Plant Anal. 19(6) p. 733.
ETL-ESP-SK	Soil	Exchangeable Sodium Percentage - Calc	Calculation	N/A
IC-CACO3-CALC-SK	Soil	Inorganic Carbon as CaCO3 Equivalent	Calculation	N/A
N-TOT-LECO-SK	Soil	Total Nitrogen by combustion method	SSSA (1996) P. 973-974	Soil Science Society of America Nelson, D.W. and Sommers, L.E. 1996. Total Carbon, organic carbon and organic matter. P. 973-974 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) American Society of Agronomy and Soil Science Society of America, Madison, WI. Book series no. 5
NO3-AVAIL-SK	Soil	Available Nitrate-N	Method = Alberta Ag (1988)	Recommended Methods of Soil Analysis for Canadian Prairie Agricultural Soils. Alberta Agriculture (1988) p. 19 and 28
PO4/K-AVAIL-SK	Soil	Plant Available Phosphorus and Potassium	Comm. Soil Sci. Plant Anal, 25 (5&6)	Communications in Soil Science and Plant Analysis. 25(5&6), 627-635 (1994). "Simultaneous Extraction of

				Available Phosphorus and Potassium With a New Soil Test : A Modification of Kelowna Extraction.
PSA-PIPET-DETAIL-SK	Soil	Particle size - Sieve and Pipette	SSIR-51 METHOD 3.2.1	Soil Survey Staff. 2009. Soil Survey Field and Laboratory Methods Manual. Soil Survey Investigations Report No. 51, Version 1.0. R. Burt (ed.). U.S. Department of Agriculture. Natural Resources Conservation Service. Method 3.2.1
S-TOT-LECO-SK	Soil	Total Sulphur by combustion method	ISO 15178:2000	ISO 15178:2000(E) Soil Quality - Determination of total sulphur by dry combustion. Prepared by Technical committee ISO/TC 190, Soil quality, subcommittee SC 3 Chemical methods and soil characteristics.
SO4-AVAIL-SK	Soil	Available Sulfate-S	REC METH SOIL ANAL - AB. AG(1988)	Recommended Methods of Soil Analysis for Canadian Prairie Agricultural Soils. Alberta Agriculture (1988) p. 19 and 28
ME-MS41-AX	Soil	A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are	Aqua Regia ICPMS	

APPENDIX III

Quality Assurance/Quality Control

APPENDIX III: QUALITY ASSURANCE/QUALITY CONTROL

For the SQIA, SNC-Lavalin and ALS implemented Quality Assurance and Quality Control (QA/QC) procedures as described and discussed below.

SNC-Lavalin QA/QC Methodology

SNC-Lavalin personnel followed internally established QA/QC protocols for field activities and verified QA/QC programs implemented by laboratories. This program included field, office and duplicate procedures. A list of components included in field, office and duplicate procedures are listed below:

- Senior supervision of field staff.
- Use of in house trained personnel.
- Implementation of SNC-Lavalin preferred operating procedures (POPs).
- Written field instructions.
- Documentation of all field activities:
  - Samples will be collected in a manner appropriate for the prevention of cross-contamination and other field sampling errors. Samples will be collected using an appropriate contaminant-free utensil and placed in contaminant-free containers specifically designed for such use and appropriate to the subsequent analyses.
- Chain-of-custody documentation for sample submission:
  - Use of an appropriate coding system for submitting samples to the analytical laboratory to ensure that information concerning location or expected concentration is unavailable to the analyst(s). A chain-of-custody form will be established to trace the movement and handling of samples from the field to their final destination.
- Use of a Canadian Association of Laboratory Accreditation (CALA) accredited laboratory.
- Adherence to laboratory sampling and analysis protocols (e.g., hold times, sample containers, preservatives, detection limits, approved methodology).
- Procedures to confirmation accurate transcription of laboratory data into tables.
- Review of laboratory QC performance (standards, spike recoveries etc.) to confirm results are within acceptable limits.
- At least one analytical (lab) duplicate for each batch of analyses.
- Results of the laboratory's internal checks will be included in the analytical report.
- Decontamination of sampling (trowels, mixing bowls) between sample locations.

- Use of an appropriate coding system for submitting samples to analytical laboratories to ensure that information concerning sample location or expected concentrations was unavailable; and
- Procedures to confirm the quality of field screening data by comparison of field data to laboratory analytical results;
- Development and implementation of a QA/QC flow chart to ensure all staff is aware of requirements and roles (see flow chart below).

Duplicate Samples

- Duplicate samples were collected in order to determine sampling precision. Blind field duplicates were submitted to the laboratory at an approximate frequency of 1 per 10 samples analyzed, as summarized in Table 1 below.

Table 1: Summary of Soil Quality Analysis including Duplicates

Parameter	Number of Samples Analyzed			
	Tailings	Within channel native	Background	Duplicates
Total Metals + pH	71	17	23	11
Nutrients	27	14	19	3*
Salinity	27	14	18	3*
Mine Processing Reagents	7	1	0	1
Grain (Particle) Size	19	13	0	3
Bulk Density	9	8	4	0

Note:

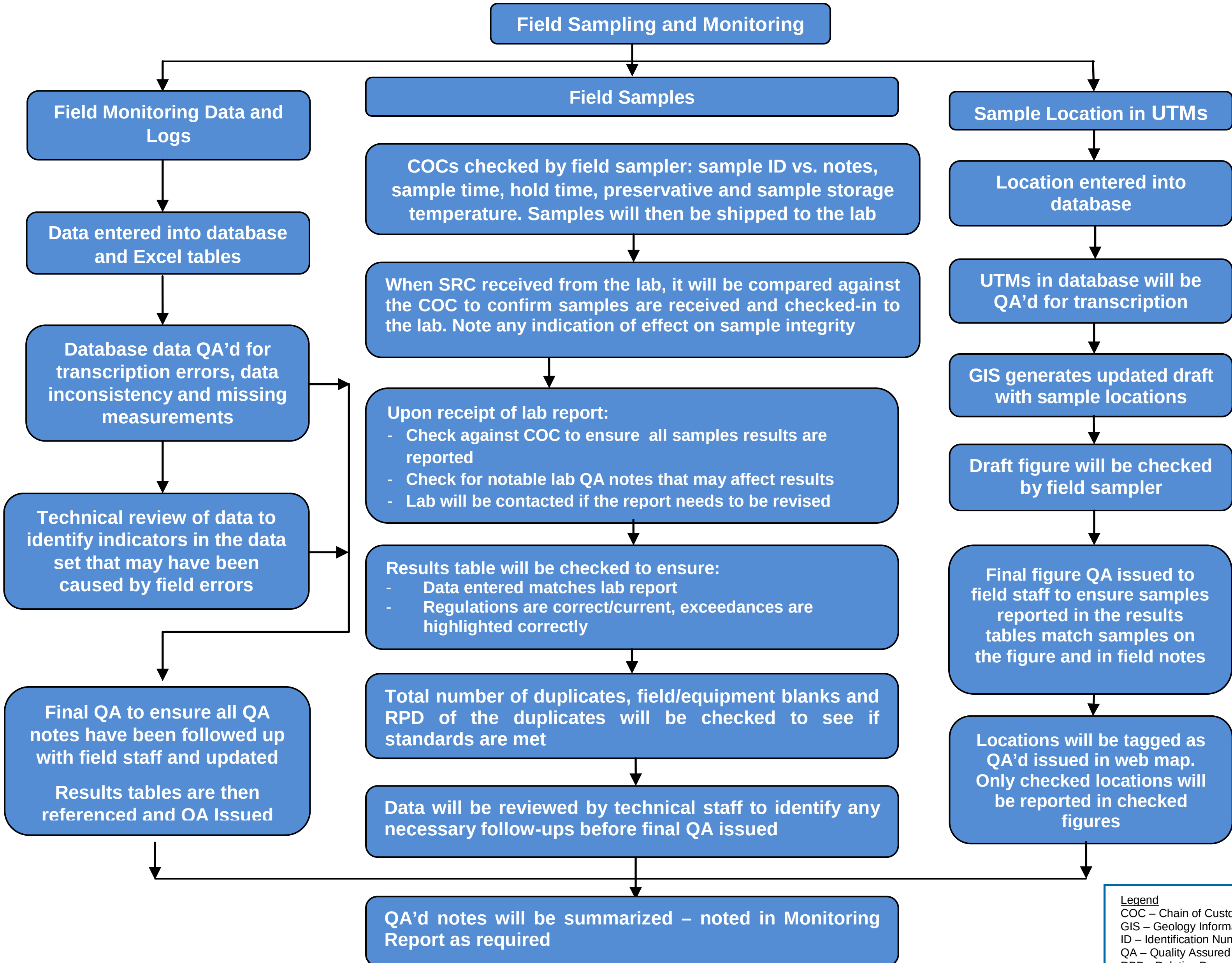
***** Seven duplicates were analyzed for parameters, however three samples had both the sample and the corresponding duplicate sample analyzed and four samples had the duplicate sample analyzed but not the corresponding sample analyzed.

- Analytical precision was evaluated by calculating the relative percent difference (RPD) between the results of each sample and its associated duplicate. The RPD is the absolute value of the difference between the two results divided by the average of the two results and is reported as a percentage, demonstrated as follows:

$$RPD = abs\ [(C_{sample} - C_{duplicate})/(C_{sample} + C_{duplicate})/2]*100$$

- Due to the sample heterogeneity, attributed primarily to site stratigraphy, SNC-Lavalin's select target range for RPDs was 60% for metals, Volatile Organic Carbon (VOC) and other organics including Light and Heavy Extractable Petroleum Hydrocarbons (LEPH/HEPH) and Glycol parameters in soil; and was 75% for Polycyclic Aromatic Hydrocarbons (PAH).

- RPD values greater than these values indicated that the variability was outside of SNC-Lavalin’s target range. When the analytical result of the original or duplicate sample was less than five times the laboratory detection limit, RPDs were not considered meaningful due to a relative increase in analytical variability at or near detection limits. Therefore, RPDs in such scenarios were not calculated.



Legend
COC – Chain of Custody
GIS – Geology Information System
ID – Identification Number
QA – Quality Assured
RPD - Relative Percent Difference
SRC – Sample Receive Confirmation
UTM - Universal Transverse Mercator

Additional QA/QC Notes

- Duplicate samples ST06-01-03 (duplicate of ST06-01-02), ST15-01-03 (duplicate of ST15-01-02), and ST18-05-02 (duplicate of ST18-05-01) along with their corresponding samples were analyzed for total metals, however only the duplicate samples were analyzed for nutrients and salinity parameters.
- Duplicate samples ST02-02-03 (duplicate of ST02-02-01) and ST14-02-02 (duplicate of ST14-02-01) along with their corresponding samples, were analyzed for total metals, but only the corresponding samples (not duplicates) were analyzed for particle size and/or nutrients and salinity.
- Sample ST18-05-02 only had total inorganic carbon (not total carbon) analyzed, and thus total organic carbon could not be calculated.

Laboratory QA/QC Procedures

In addition to QA/QC procedures implemented by SNC-Lavalin, the laboratory (ALS) also implements quality control. ALS's quality control included: Matrix Spikes, Spiked Blanks, Method Blanks, Duplicate Samples and Quality Control Standards. The definition of each of these is included below.

- **Matrix Spike:** a sample to which a known amount of the analyte of interest has been added. The blank spike sample is then carried through the sample analysis and preparation steps. Matrix spike samples are used to evaluate the accuracy of the method.
- **Spiked Blank:** a sample prepared by adding a known amount of analyte, usually from a secondary source, to a specified amount of sample (matrix). The blank spike sample is then carried through the sample analysis and preparation steps. Blank spike samples provide a measure of the analytical method's accuracy.
- **Method Blank:** a sample that is intended to contain none of the analytes of interest. A blank is used to detect contamination during sample handling preparation and/or analysis.
- **Duplicate Sample:** In addition to blind field duplicates collected by SNC-Lavalin, the laboratory also has a duplicate procedure which includes preparation and analysis of a replicate aliquot of a sample. Duplicates are analyzed to evaluate the variance in the measurement. The RPD for duplicate samples is reported.
- **Quality Control (QC) Standard:** a blank matrix to which a known amount of analyte has been added. This procedure is used to evaluate analyte recovery.

Laboratory QA/QC Results

The detailed results of the laboratory QA/QC are included in analytical reports contained in Appendix V.

Summary

The results of the QA/QC assessment were considered to be acceptable. Although two RPD results were in exceedance of SNC-Lavalin target value of 60% or 75%, the RPD exceedance did not affect the interpretation of results.

APPENDIX IV

Test Pit Logs

SNC-LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST01-01**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	728.510	Borehole Logged By:	VSD/DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 06
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817107.306	Easting: 602306.461	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SAND (A Horizon), fine to coarse grained, some silt, subangular, brown, loose, dry, roots.						
	SAND (BI Horizon), medium to coarse grained, some fine subrounded gravel, reddish brown, loose, damp, trace charcoal (charred wood), trace roots.		Sample Interval	**ST01-01**	36.2		
	SAND and GRAVEL (BII Horizon), fine to coarse grained sand, rounded to subrounded gravel, olive-brown, loose, damp, trace roots.						
	Bottom of hole at 0.5 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST01-01 = 5.98.
LFH: +0.04 - 0 m.

SNC·LAVALIN

Client	Test Pit No. : ST01-02
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	728.310	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 22
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817130.750	Easting: 602234.880	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SILT and CLAY (Suspect Tailings), grey, soft, moist, trace organics, leaves, grass.			**ST01-02-01** **ST01-02-03**	76.1		
	SILT (Native), trace coarse grained subrounded sand, trace fine gravel, black-orange-brown, medium dense, moist, trace organics, charcoal.			**ST01-02-02**	103.2		
	SILT and SAND (Native), fine to coarse grained subrounded sand, trace fine gravel, light brown, medium dense, moist, trace roots.						
	Bottom of hole at 0.5 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
ST01-02-03 is a blind field duplicate of ST01-02-01.
Contact Test pH: ST01-02-01 = 7.40 and ST01-02-02 = 7.25.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST01-03**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	727.940	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 11
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817404.550	Easting: 601747.117	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND (Tailings), fine to medium grained, some silt, orange and grey, loose, wet.			**ST01-03**	399		
	SILT and CLAY (Tailings), some coarse subrounded to rounded gravel, grey, very soft, wet. 15-25% coarse fragments.						
	Bottom of hole at 0.2 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST01-03 = 8.56.

Print Date: 2015.06.03 Date Approved: 2015.02.11

SNC·LAVALIN

Client	Test Pit No. : ST01-04
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	729.250	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 11
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817422.836	Easting: 601707.532	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SILT and SAND (Tailings), fine grained sand, trace grey, soft, damp, with trace orange sand pockets.		Sample Interval	**ST01-04**	402		
	GRAVEL (Tailings and Native), coarse subrounded to rounded, some fine grained sand, grey, medium dense, damp. 65-75% coarse fragments.						
	- below 0.4 m - becomes cobbly (refusal)						
	Bottom of hole at 0.4 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST01-04 = 8.42.

Print Date: 2015.06.03 Date Approved: 2015.03.23

SNC·LAVALIN

Client
Mount Polley Mining Corporation

Location
Hazeltine Creek Study Area, Likely, BC

Test Pit No. : ST01-05

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	728.260	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 11
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817493.807	Easting: 601586.262	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Sample Number	EC (µS/cm)
0	SILT and CLAY (Tailings), grey, very soft, wet.	ST01-05-01	316
	SAND (Tailings and Native), fine to coarse grained, grey and light brown, loose, damp.	ST01-05-02	100.4
	SILT and ORGANICS (Native), trace fine grained sand, dark brown, loose/soft, moist.	ST01-05-03	74.2
	Bottom of hole at 0.3 m.		
1			

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST01-05-01 = 8.32, ST01-05-02 = 8.48 and ST01-05-03 = 6.65.

SNC·LAVALIN

Client **Mount Polley Mining Corporation**	**Test Pit No. : ST01-06**
Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	727.960	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 11
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817523.571	Easting: 601546.503	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

Soil Vapour (ppm): ○ Reading within indicated scale; ● Reading outside indicated scale; scale 10^1, 10^2, 10^3, 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SAND and SILT (Tailings), fine grained, grey, soft/loose, damp.			**ST01-06**	293		
	SAND (Tailings), medium grained, grey, loose, damp.						
	SILT and CLAY (Native), dark brown-black, soft, trace organics.						
	Bottom of hole at 0.6 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST01-06 = 8.25.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST01-07**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	727.970	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 11
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817526.259	Easting: 601543.750	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery
0	SAND (Tailings), fine to medium grained, grey and light brown, loose, damp.			**ST01-07**	160	
	SILT and CLAY (Native), dark brown-black, loose, organics, roots.					
	Bottom of hole at 0.6 m.					
1						

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST01-07 = 8.56.
Replicate sample of ST01-07-01.

SNC·LAVALIN

Client: Mount Polley Mining Corporation	Test Pit No. : ST01-09
Location: Hazeltine Creek Study Area, Likely, BC	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	728.860	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 22
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817160.190	Easting: 602135.480	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1, 10^2, 10^3, 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SILT and CLAY (Tailings), some fine grained sand, grey, loose, wet.			**ST01-09-01** **ST01-09-03**	194		
	SAND (Tailings), fine grained, grey, loose, wet.			**ST01-09-02**	410		
	SILT and ORGANICS (Native), brown, loose, moist, roots.						
	Bottom of hole at 0.5 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
ST01-09-03 is a blind field duplicate of ST01-09-01.
Contact Test pH: ST01-09-01 = 9.00 and ST01-09-02 = 7.00.

SNC·LAVALIN

Client	Test Pit No. : ST01-09-04
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	728.880	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 22
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817159.381	Easting: 602134.892	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SILT and CLAY (Tailings), some fine grained sand, grey, loose, wet.			**ST01-09-04**	194		
	Bottom of hole at 0.4 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Replicate sample of ST01-09-01.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST02-01**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	743.150	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 03
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817376.147	Easting: 601246.867	Log Typed By:	SW

Drilling Legend
Sample Interval

Water/NAPL Levels
Water Level 1
Water Level 2
NAPL
NAPL

Reading within indicated scale
Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery
0	SAND (A Horizon), fine to medium grained, some silt to silty, trace fine gravel, dark brown, medium dense, damp, roots.					
	SAND (B Horizon), fine to medium grained, some silt, trace fine gravel, brown, medium dense, damp, roots.			**ST02-01**	13.2	
	Bottom of hole at 0.6 m.					
1						

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST02-01 = 7.15.
LFH: +0.07 - 0 m.

SNC·LAVALIN

Client	Test Pit No. : ST02-02
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	741.780	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 10
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817356.593	Easting: 601226.145	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Sample Number	EC (µS/cm)
0	SAND (Tailings), fine grained, some silt, grey, loose, wet, trace organics (grass).	**ST02-02-01** ST02-02-03	231
	SILT and ORGANICS (Native), dark brown-black, loose, wet, roots.	**ST02-02-02**	122.3
	Bottom of hole at 0.4 m.		
1			

NOTES
Bolded sample denotes sample analyzed.
ST02-02-03 is a blind field duplicate of ST02-02-01.
Contact Test pH: ST02-02-01 = 6.98 and ST02-02-02 = 6.67.

SNC-LAVALIN

Client	Test Pit No. : ST02-03
Mount Polley Mining Corporation	
Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	739.500	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 10
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817256.555	Easting: 601154.188	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND (Tailings), fine grained, grey, loose, damp.						
	SAND (Tailings and Native), medium to coarse grained, trace fine to coarse subrounded gravel, grey, loose, damp.			**ST02-03**	157.8		
	Bottom of hole at 0.3 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST02-03 = 8.49.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST02-04**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	735.370	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 10
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817175.176	Easting: 601095.164	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND (Tailings), fine grained, grey, loose, dry.						
	CLAY (Native), greenish grey with trace orange mottling, soft, moist.		Sample Interval	**ST02-04**	103.3		
	Bottom of hole at 0.3 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST02-04 = 8.63.

SNC-LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST02-05**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	740.510	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 10
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817088.830	Easting: 601055.707	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND (Tailings), fine grained, trace clay, grey, soft, moist with trace black and orange sand.			**ST02-05-01**	412		
	SAND (Tailings), medium grained, grey/brown with trace black-orange, loose, damp.			**ST02-05-02**	312		
	SAND and GRAVEL (Native), medium to coarse grained sand, fine to coarse rounded to subrounded gravel, grey, loose, damp, with trace orange-red-black medium to coarse grained sand.			**ST02-05-03**	190.2		
	Bottom of hole at 0.6 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST02-05-01 = 8.32, ST02-05-02 = 8.21 and ST02-05-03 = 8.43.

SNC·LAVALIN

Client	Test Pit No. : ST02-06
Mount Polley Mining Corporation	
Location	
Hazeltine Creek Study Area, Likely, BC	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	741.290	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 10
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817028.016	Easting: 601023.605	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1, 10^2, 10^3, 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery
0	SAND (Tailings), medium grained, grey-brown, loose, damp.			**ST02-06**	154.5	
	SILT and ORGANICS (Native), dark brown, loose, moist.					
1	Bottom of hole at 1.0 m.					

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST02-06 = 8.17

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST02-07**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	738.060	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 03
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817222.119	Easting: 601136.731	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery
0	SILT and SAND (Tailings), fine grained, grey, loose, dry.					
	SAND and GRAVEL (Native), fine to coarse grained sand, fine to coarse subrounded gravel, grey, firm, damp.					
	SAND and GRAVEL (Native), fine to coarse grained sand, fine to coarse gravel, reddish brown, medium dense, damp.			**ST02-07**	35.9	
	Bottom of hole at 0.8 m.					
1						

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST02-07 = 7.28.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN

Client	Test Pit No. : ST02-08
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	735.540	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 10
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817166.561	Easting: 601090.539	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1, 10^2, 10^3, 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SILT and SAND (Native), fine grained sand, yellowish brown with trace orange mottling, soft, moist.			**ST02-08**	185.5		
	Bottom of hole at 0.3 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST02-08 = 8.10.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN

Client: Mount Polley Mining Corporation	Test Pit No. : ST03-01
Location: Hazeltine Creek Study Area, Likely, BC	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	758.300	Borehole Logged By:	VSD/DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 07
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817275.319	Easting: 600647.328	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery
0	SAND (A Horizon), fine grained, silty, pale brown, loose, damp, roots.					
	SAND (B Horizon), fine grained, silt, some coarse rounded to subrounded gravel, some subrounded cobbles, brown grading to dark yellowish brown with depth, loose, moist, some roots.			**ST03-01**	18.2	
	Bottom of hole at 0.5 m.					
1						

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST03-01 = 5.32.
LFH: +0.12 - 0 m.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST03-02**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	748.250	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 15
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817300.938	Easting: 600669.337	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND and SILT (Tailings), fine grained sand, grey, medium dense, moist.			**ST03-02**	383		
	SILT and GRAVEL (Native), coarse, subrounded gravel, grey, loose, moist. 75-85%coarse fragments.						
	Bottom of hole at 0.1 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST03-02 = 8.31.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN

Client **Mount Polley Mining Corporation**	**Test Pit No. : ST03-03**
Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	748.380	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 09
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817334.750	Easting: 600693.390	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Sample Number	EC (µS/cm)
0	SAND (Taillings), fine to medium grained, brown and grey, loose, moist, interbedded lenses of SILT with fine grained sand.	ST03-03-01	177.7
	SAND (Tailings), fine grained, trace silt, light brown, loose, damp.	ST03-03-02	94.5
	SILT and GRAVEL (Native and Tailings), coarse rounded to subrounded gravel, trace to some fine grained sand, grey, loose, wet. 35-45% coarse fragments.	ST03-03-03	112.6
	Bottom of hole at 0.6 m.		
1			
2			

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST03-03-01 = 8.51, ST03-03-02 = 8.63 and ST03-03-03 = 8.88.

SNC·LAVALIN

Client	Test Pit No. : ST03-04
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	748.460	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 09
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817338.682	Easting: 600696.871	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND (Tailings), fine grained, fine to coarse gravelly, some silt, dense, damp. 70-80% coarse fragments.			**ST03-04**	65.4		
	Bottom of hole at 0.2 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST03-04 = 8.66.

Print Date: 2015.06.03 Date Approved: 2015.02.11

SNC·LAVALIN	Client: **Mount Polley Mining Corporation**	**Test Pit No. : ST03-05**
	Location: **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	749.830	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 10
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817353.974	Easting: 600712.729	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale; ● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND (Tailings), medium grained, grey to grey-brown, loose, damp, trace coarse woody debris, roots, organics.			**ST03-05-01**	380		
	SAND (Native), fine grained, some silt, trace coarse subrounded sand, trace clay, brown, loose, damp, some roots, trace charcoal.			**ST03-05-02**	119.3		
	Bottom of hole at 0.7 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST03-05-01 = 7.92 and ST03-05-02 = 6.24.

SNC·LAVALIN

Client	Test Pit No. : ST04-01
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	805.260	Borehole Logged By:	VSD
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 05
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817225.915	Easting: 600070.025	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SAND (A Horizon), fine grained, silty, trace coarse subangular sand, loose, damp, some roots.						
	SAND and SILT, fine grained sand, trace coarse subangular sand, trace fine subangular gravel, orange-brown, loose, damp, some roots.						
			Sample Interval	**ST04-01**	10.4		
	- below 0.24 m - becomes increased silt, pale olive-brown, roots with some subangular to subrounded cobbles 10-20 % coarse fragments						
	Bottom of hole at 0.4 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST04-01 = 6.00.
LFH: +0.04 - 0 m.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST04-02**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	795.970	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 15
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817200.553	Easting: 600035.593	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND (Tailings), medium grained, some silt, mottled grey-orange-brown, very soft/loose, wet to saturated.			**ST04-02**	107		
	Bottom of hole at 0.2 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST04-02 = 8.59.
Shovel Probe Depth: refusal at 1.15 m.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN

Client	Test Pit No. : ST04-03
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	810.860	Borehole Logged By:	VSD/DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 06
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817145.494	Easting: 600076.650	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SAND and GRAVEL (A Horizon), fine grained sand, some coarse grained subangular sand, fine subangular gravel, dark brown-purple, loose, damp, roots.						
	SAND, GRAVEL and COBBLES (B Horizon), medium to coarse grained subangular sand, coarse angular gravel, dark orange-brown, loose, damp.			**ST04-03**	10.9		
	- below 0.4 m - graded to dark yellowish brown						
	Bottom of hole at 0.5 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST04-03 = 5.98.
LFH:+0.07 - 0 m.

Print Date: 2015.06.03 Date Approved: 2015.03.23

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST05-02**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	811.150	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 15
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817235.024	Easting: 599912.392	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SILT (Tailings), some fine grained sand, grey, very soft, wet.						
	SAND (Tailings), fine grained, grey-orange-brown, very loose, wet to moist.			**ST05-02-01** **ST05-02-02**	113		
	SILT and ORGANICS (Native), dark brown-black, loose, moist.						
	Bottom of hole at 0.3 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
ST05-02-02 is a blind field duplicate of ST05-02-01.
Contact Test pH: ST05-02-01 = 7.85.

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST05-03**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	821.050	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 22
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817163.230	Easting: 599949.540	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SILT and GRAVEL (A Horizon), coarse subangular to angular gravel, pale grey, loose, damp, roots. 35-45 % coarse fragments.						
	SILT and SAND (B Horizon), fine grained, some subangular to angular gravel, pale grey-light brown, medium, damp, roots.			**ST05-03**	135		
	Bottom of hole at 0.3 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST05-03 = 4.93.
LFH: +0.10 - 0 m.

SNC·LAVALIN

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST06-01**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	832.970	Borehole Logged By:	VSD/DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 05
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817294.561	Easting: 599699.757	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

Soil Vapour (ppm): ○ Reading within indicated scale; ● Reading outside indicated scale. Scale: 10^1, 10^2, 10^3, 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SILT and SAND (A Horizon), coarse grained, trace clay, pale purplish grey, loose, damp, some roots.			**ST06-01-01**	14.7		
	SAND and GRAVEL, coarse grained sand, coarse angular gravel, some silt, orange-brown grading to pale grey with depth, compact, damp, some roots. 25-35 % coarse fragments (angular cobble).			**ST06-01-02** **ST06-01-03**	8.6		
	Bottom of hole at 0.5 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
ST06-01-03 is a blind field duplicate of ST06-01-02.
Contact Test pH: ST06-01-01 = 4.97 and ST06-01-02 = 5.93.
LFH: +0.04 - 0 m.

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST06-02**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	821.850	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 15
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817227.551	Easting: 599692.508	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SAND (Tailings), fine grained, grey, medium dense with mottling of CLAY and SILT, grey to pale green, damp. 5-15 % coarse fragments.			**ST06-02-01**	604		
	Bottom of hole at 0.3 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST06-02-01 = 8.19.

Print Date: 2015.06.03 Date Approved: 2015.03.19

SNC·LAVALIN

	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST06-02-02**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	821.790	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 15
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817226.600	Easting: 599692.199	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND and GRAVEL (Tailings), fine grained sand, coarse subrounded gravel, grey, medium dense, damp. 45-55 % coarse fragments.			ST06-02-02			
	Bottom of hole at 0.2 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Replicate sample of ST06-02-01.

SNC-LAVALIN

Client: Mount Polley Mining Corporation	Test Pit No. : ST06-03
Location: Hazeltine Creek Study Area, Likely, BC	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	819.940	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 22
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817198.700	Easting: 599688.200	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SILT and CLAY (Tailings and Native), some sand, grey, very soft, wet. 75-85% coarse fragments.			**ST06-03**	335		
	Bottom of hole at 0.5 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST06-03 = 8.48.

SNC·LAVALIN

Client	Test Pit No. : ST06-04
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	822.670	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 22
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817180.959	Easting: 599691.994	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale; ● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SILT (Tailings), some fine grained sand, grey, soft, wet.			**ST06-04-01**	270		
	SILT and GRAVEL (Tailings and Native), fine subrounded gravel, some sand, grey, soft, wet.						
	Bottom of hole at 0.3 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST06-04-01 = 9.08.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN

Client	Test Pit No. : ST06-04-02
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	822.670	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 22
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817180.959	Easting: 599692.994	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SILT (Tailings), some fine grained sand, grey, soft, wet.			**ST06-04-02**	243		
	SILT and ORGANICS (Native), brown-black, moist, roots, wood debris.						
	SILT and SAND (Native), fine grained, trace subrounded gravel, light brown, medium dense, moist.						
	Bottom of hole at 0.3 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Replicate sample of ST06-04-01.
Contact Test pH: ST06-04-02 = 8.85.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST07-01**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	851.030	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 07
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817255.134	Easting: 599125.766	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

Soil Vapour (ppm): ○ Reading within indicated scale; ● Reading outside indicated scale. Scale: 10^1, 10^2, 10^3, 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SAND and SILT (A Horizon), fine grained sand, light grey, loose, dry, roots.						
	SILT (B Horizon), some clay, trace coarse grained subounded sand, trace subrounded to angular gravel, very stiff, dry, some roots.		Sample Interval	**ST07-01**	26.3		
	Bottom of hole at 0.5 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST07-01 = 5.23.
LFH: +0.08 - 0 m.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN	Client: **Mount Polley Mining Corporation**	**Test Pit No. : ST07-02**
	Location: **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	834.070	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 11
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817297.063	Easting: 599135.545	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SAND (Tailings), fine to very fine grained, some silt, grey with trace orange at surface, loose, damp. - at 0.03 m - refusal at bedrock			**ST07-02**	297		
	Bottom of hole at 0.0 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST07-02 = 8.38.

SNC·LAVALIN

Client	Test Pit No. : ST07-03
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	832.360	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 11
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817326.107	Easting: 599150.328	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery
0	SAND (Tailings), fine grained, some silt, grey with trace orange near surface, loose, moist.			**ST07-03-01** ST07-03-03	627	
	SILT an GRAVEL (Tailings), subrounded to rounded, trace fine grained sand, grey with trace yellow-orange, loose, wet. 25-35% coarse fragments.			**ST07-03-02**	251	
	Bottom of hole at 0.5 m.					
1						

NOTES
Bolded sample denotes sample analyzed.
ST07-03-03 is a blind field duplicate of ST07-03-01.
Contact Test pH: ST07-03-01 = 8.04 and ST07-03-02 = 8.05.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN

Client	Test Pit No. : ST08-01
Client: **Mount Polley Mining Corporation**	**Test Pit No. : ST08-01**
Location: **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	861.020	Borehole Logged By:	VSD
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 05
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817325.286	Easting: 598895.121	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

Soil Vapour (ppm): ○ Reading within indicated scale; ● Reading outside indicated scale; scale 10^1, 10^2, 10^3, 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SILT (A Horizon), some fine grained sand, some clay, pale grey, loose, damp.						
	SILT and SAND (B Horizon), fine grained sand, trace coarse grained sand, trace fine subangular gravel, olive-brown, compact, damp, some roots.		Sample Interval	**ST08-01**	8.2		
	Bottom of hole at 0.5 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST08-01 = 5.44.
LFH: +0.03 - 0 m.

Print Date: 2015.06.03 Date Approved: 2015.03.19

SNC·LAVALIN

	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST08-02**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	849.190	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 15
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817291.420	Easting: 598870.794	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	CLAY and SILT (Tailings and pockets of Clay), grey, soft, wet.			**ST08-02-01**	300		
	SAND and GRAVEL (Native), fine to coarse grained sand, fine to coarse subrounded gravel, trace silt, dark brown-black, medium dense, moist. 25-35% coarse fragments.			**ST08-02-02**	199		
	Bottom of hole at 0.4 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST08-02-01 = 9.12 and ST08-02-02 = 9.12.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN

Client	Test Pit No. : ST08-03
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	848.200	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 15
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817268.019	Easting: 598863.406	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND (Tailings), fine to medium grained, trace silt, orange-black-brown, loose, wet.			**ST08-03**	191		
	SILT (Tailings), grey, very soft, wet to saturated.						
	Bottom of hole at 0.2 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST08-03 = 8.93.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST08-04**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	847.440	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 15
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817245.540	Easting: 598858.472	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND (Tailings), fine grained, grey, loose, damp.			**ST08-04**	478		
	SAND and GRAVEL (Native), fine to coarse grained subrounded sand, fine to coarse subrounded gravel, dark red-orange, loose, damp. 25-35% coarse fragments.						
	Bottom of hole at 0.2 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST08-04 = 8.58.

Print Date: 2015.06.03 Date Approved: 2015.03.19

SNC·LAVALIN

Client	Test Pit No. : ST08-05
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	852.290	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 15
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817207.801	Easting: 598850.824	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND (Tailings), fine grained, grey, loose, moist,						
	SAND (Tailings), medium grained, grey-orange-brown loose, damp.			**ST08-05-01**	17.5		
	SILT and ORGANICS (Native), dark brown, loose, roots.						
	SILT and GRAVEL (Native), coarse subrounded, pale grey-green, medium dense, damp, roots, trace organics.			**ST08-05-02**	92		
	Bottom of hole at 0.5 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST08-05-01 = 8.44 and ST08-05-02 = 6.34.

Print Date: 2015.06.03 Date Approved: 2015.03.19

SNC·LAVALIN

Client	Test Pit No. : ST08-06
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	847.320	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 15
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817249.841	Easting: 598862.608	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery
0	SILT (Tailings), trace coarse grained subrounded sand, light grey, medium dense, dry.					
	SAND (Native), some fine to coarse subrounded gravel, orange/pale green with black/brown, loose, damp. 5-15 % coarse fragments.			**ST08-06**	41	
	Bottom of hole at 0.6 m.					
1						

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST08-06 = 7.21.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST09-01**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	868.270	Borehole Logged By:	VSD
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 07
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817587.819	Easting: 598303.602	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1, 10^2, 10^3, 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SAND and SILT (A Horizon), fine grained sand, trace fine subrounded gravel, pale grey, loose, dry, roots.						
	SAND and SILT (BI Horizon), fine grained sand, trace coarse grained subrounded sand, yellowish brown, loose, damp, roots.			**ST09-01-01**	22.8		
	SILT (BII Horizon), some fine grained sand, trace coarse grained sand, trace subrounded gravel, pale olive-brown, dense, damp, roots.			**ST09-01-02**	20.2		
	Bottom of hole at 0.5 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST09-01-01 = 5.31 and ST09-01-02 = 6.28.
LFH: +0.08 - 0 m.

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST09-02**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	860.000	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 15
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817621.615	Easting: 598273.313	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND (Tailings), medium grained, trace fine grained sand, orange-black-brown, loose, wet to saturated.			**ST09-02-01** ST09-02-02	281		
	- at 0.2 m - encountered bedrock						
	Bottom of hole at 0.2 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
ST09-02-02 is a blind field duplicate of ST09-02-01.
Contact Test pH: ST09-02-01 = 8.33.

Print Date: 2015.06.03 Date Approved: 2015.03.19

SNC-LAVALIN

Client	Test Pit No. : ST09-03
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	862.600	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 15
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817647.980	Easting: 598279.641	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND (Tailings), fine grained, grey, medium dense, dry.			**ST09-03**	461		
	SAND and GRAVEL (Native), fine to coarse grained subrounded sand, fine to coarse subrounded gravel, dark brown-dark grey, compact.						
	Bottom of hole at 0.2 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST09-03 = 8.31.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN

Client	Test Pit No. : ST09-04
Mount Polley Mining Corporation	
Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	863.190	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 15
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817651.687	Easting: 598279.641	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SAND (Tailings), fine grained, grey, loose, dry.						
	SILT and CLAY (Native), dark brown-black, very stiff, damp, trace organics, trace roots.						
	SILT and SAND (Native), fine to medium grained, mottled orange-grey-light brown, stiff/dense, damp.		Sample Interval	**ST09-04**	49.7		
	SAND and GRAVEL (Native), coarse grained subrounded sand, coarse subrounded gravel, some medium grained sand, grey, pale green and orange mottled, medium dense, damp. 45-55% coarse fragments.						
	SILT and SAND (Native), fine grained, brown, medium dense, damp.						
1	Bottom of hole at 1.0 m.						

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST09-04 = 8.21.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN

Client	Test Pit No. : ST10-01
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	879.350	Borehole Logged By:	VSD/DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 05
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817892.602	Easting: 598028.840	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SILT and SAND (A Horizon), fine grained sand, grey-very pale purple, loose, damp, some roots.						
	SILT and SAND (B Horizon), fine grained sand, trace coarse grained sand, yellow-brown, medium dense, moist, some roots.		Sample Interval	**ST10-01**	7.5		
	SILT, some coarse grained sand, trace clay, grey-brown, very dense, moist.						
	Bottom of hole at 0.5 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST10-01 = 5.45.
LFH: +0.08 - 0 m.

Print Date: 2015.06.03 Date Approved: 2015.03.23

SNC·LAVALIN

Client **Mount Polley Mining Corporation**	**Test Pit No. : ST10-02**
Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	870.980	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 14
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817857.907	Easting: 597948.480	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SAND (Tailings), fine grained, some silt, grey, loose, moist.		Sample Interval	**ST10-02**	701		
	SAND, GRAVEL and SILT (Native), fine grained sand, coarse gravel, grey, very dense, damp. 75-85% coarse fragments.						
	Bottom of hole at 0.2 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST10-02 = 8.44.

Print Date: 2015.06.03 Date Approved: 2015.03.19

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST10-03**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	875.820	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 14
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817829.396	Easting: 597919.025	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SAND and SILT (Tailings), fine grained, grey, medium dense, damp, trace organics (suspect peat), in pockets.			**ST10-03**	491		
	SAND and GRAVEL (Native and Tailings), fine to coarse subrounded gravel, grey-green, loose, damp.						
	Bottom of hole at 0.2 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST10-03 = 8.15.

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST10-04**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	872.560	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 14
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5817849.253	Easting: 597937.763	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery
0	SILT, CLAY and SAND (Tailings), fine grained sand, grey, soft, wet interbedded with: SAND (Tailings), fine grained, grey, loose, damp.			**ST10-04**	355	
	SILT and GRAVEL (Native), fine to coarse subrounded gravel, grey, medium dense, moist. 55-65% coarse fragments.					
	Bottom of hole at 0.4 m.					
1						

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST10-04 = 9.07.

Print Date: 2015.06.03 Date Approved: 2015.03.19

SNC·LAVALIN

Client: Mount Polley Mining Corporation	Test Pit No. : ST11-01
Location: Hazeltine Creek Study Area, Likely, BC	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	891.860	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 07
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5818110.964	Easting: 597682.170	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SAND and SILT (A Horizon), fine grained sand, trace fine subrounded gravel, pale grey, loose, damp, roots.						
	SILT (B Horizon), some fine grained sand, trace coarse subrounded, pale olive brown, compact, damp, roots.						
	- below 0.12 m - becomes dense		Sample Interval	**ST11-01**	15.3		
	Bottom of hole at 0.5 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST11-01 = 5.10.
LFH: +0.06 - 0 m.

SNC-LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST11-02**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	877.080	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 14
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5818075.518	Easting: 597644.167	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery
0	SAND (Tailings), medium grained, orange-black-brown, very loose, wet.		Sample Interval	**ST11-02-01**	152	
			Sample Interval	**ST11-02-02**	190	
	SAND (Native and Tailings), fine to coarse grained, coarse subrounded gravel, grey-dark grey, loose, wet.					
	SAND (Tailings), medium grained, orange-black-brown, very loose.					
	Bottom of hole at 0.8 m.					
1						

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST11-02-01 = 8.88 and ST11-02-02 = 8.94.
Shovel Probe Depth: refusal at 1.3 m.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN

Client	Test Pit No. : ST11-03
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	n/a	Borehole Logged By:	TM
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5818109.000	Easting: 597604.000	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SILT (Tailings) fine to medium grained sandy, trace clay, light reddish grey-brown, soft, moist.						
	SAND and SILT (Native Till), trace fine to coarse gravel, light greenish grey, dense, damp.		Sample Interval	**ST11-03-01**			
	Bottom of hole at 0.3 m.						
1							

NOTES
Bolded sample denotes sample analyzed.

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST12-01**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	902.180	Borehole Logged By:	TM/VSD
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 04
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5818771.394	Easting: 597267.050	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	ORGANICS and SILT, black, loose, damp, roots.			**ST12-01-01**	55.7		
	SILTY CLAY (A Horizon), trace fine grained sand, dark grey-brown, stiff, medium plasticity, damp, trace roots.			**ST12-01-02**	72.9		
	SILT (B Horizon), clayey, some fine grained sand, light yellowish brown with orange mottling, firm to stiff, low plasticity, damp, trace roots.						
	Bottom of hole at 0.5 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
ST12-01-01 collected +0.18 m to 0 m.
Contact Test pH: ST12-01-01 = 6.27 and ST12-01-02 = 6.86.
LFH: +0.20 - 0 m.

Print Date: 2015.06.03 Date Approved: 2015.03.23

SNC·LAVALIN

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST12-02**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	898.220	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 14
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5818796.680	Easting: 597284.097	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND (Tailings), fine to medium grained, mottled black-orange-brown, loose, very wet.			**ST12-02**	90.3		
	CLAY, SAND and GRAVEL (Native), coarse grained subrounded sand, fine to coarse gravel, dark green, very stiff, wet.						
	Bottom of hole at 0.2 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST12-02 = 9.03.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN

Client	Test Pit No. : ST12-03
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	897.270	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 14
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5818820.642	Easting: 597305.462	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SAND (Tailings), fine grained, grey, loose, damp.			**ST12-03**	508		
	CLAY and SILT (Native), trace coarse subrounded to rounded sand, green-dark brown, stiff.						
	Bottom of hole at 0.2 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST12-03 = 8.54.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST12-04**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	898.480	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 14
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5818828.967	Easting: 597314.189	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SILT (Tailings), trace fine grained sand, light grey, medium dense, dry.			**ST12-04**	507		
	SAND and GRAVEL (Native), fine to coarse grained subrounded sand, fine to coarse subrounded to rounded gravel, dark grey-brown, compact, damp. 45-55% coarse fragments.						
	Bottom of hole at 0.2 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST12-04 = 8.68.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN

Client: Mount Polley Mining Corporation	Test Pit No. : ST12-05
Location: Hazeltine Creek Study Area, Likely, BC	PAGE 1 OF 1

Drilling Contractor: SNC-Lavalin Personnel	Date Monitored: n/a	Project Number:	621717
Drilling Method: Shovel	Ground Surface Elev. (m): 899.670	Borehole Logged By:	DRS
Borehole Dia. (m): n/a	Top of Casing Elev. (m): n/a	Date Drilled:	2014 09 14
Pipe/Slotted Pipe Dia. (m): none/none	Northing: 5818788.279 Easting: 597277.271	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND (Tailings), fine grained sand, some fine to coarse subrounded gravel.						
	SILT and CLAY (Native), trace fine to coarse grained subrounded sand, trace coarse subrounded gravel, brown with pale grey mottling, medium dense, damp.			**ST12-05**	59.3		
	Bottom of hole at 0.4 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST12-05 = 7.66.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST13-01**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	909.000	Borehole Logged By:	VSD
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 08
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5819087.033	Easting: 597075.399	Log Typed By:	SW

Drilling Legend
Sample Interval

Water/NAPL Levels
Water Level 1
Water Level 2
NAPL
NAPL

Reading within indicated scale
Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery
0	SILT and CLAY (A Horizon), some subangular gravel, dark greyish brown, medium dense, high plasticity, moist, some organics (suspect peat), roots.			**ST13-01**	29	
	SILT (B Horizon), some fine grained sand, gravelly, subangular fragments, frequent boulders, pale light olive-brown with orange mottling, dense, moist, trace roots.					
	Bottom of hole at 0.5 m.					
1						

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST13-01 = 6.33.
LFH: +0.08 - 0 m.

Print Date: 2015.06.03 Date Approved: 2015.03.23

SNC·LAVALIN

Client: Mount Polley Mining Corporation	Test Pit No. : ST13-02
Location: Hazeltine Creek Study Area, Likely, BC	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	905.260	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 14
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5819036.409	Easting: 597015.857	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SILT and CLAY (Tailings), trace fine grained sand, grey, very soft, wet.			**ST13-02**	395		
	Bottom of hole at 0.3 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST13-02 = 9.31.
Shovel probe Depth: refusal at 0.7 m.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN

Client **Mount Polley Mining Corporation**	**Test Pit No. : ST13-03**
Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	903.460	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 14
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5819017.274	Easting: 596999.606	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10¹ 10² 10³ 10⁴
0	SILT and SAND (Tailings), fine to medium grained, grey, firm, dry.			**ST13-03**	876		
	SAND and GRAVEL (Native), medium to coarse grained subrounded sand, coarse subrounded gravel, medium dense, dark brown-grey, damp.						
	SAND (Native), fine grained, trace coarse subrounded sand, light brown, very firm, damp.						
	Bottom of hole at 0.2 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST13-03 = 8.41.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC-LAVALIN

Client	Test Pit No. : ST13-04
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	902.220	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 14
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5819006.256	Easting: 596982.731	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery
0	SAND (Tailings), fine grained, some silt, grey, compact, damp.			**ST13-04-01**	326	
	CLAY and GRAVEL (Native), subangular and subrounded, dark green-grey, medium dense, damp.					
	Bottom of hole at 0.1 m.					
1						

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST13-04-01 = 8.76.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC-LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST13-04-02**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	902.370	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 14
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5819005.980	Easting: 596981.770	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SAND (Tailings), fine grained, some silt, grey, compact, damp.		Sample Interval	**ST13-04-02**			
	CLAY and GRAVEL (Native), fine subangular to subrounded gravel, dark green-grey, medium dense, damp.						
	Bottom of hole at 0.1 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Replicate sample of ST13-04-01.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST13-05**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	n/a	Borehole Logged By:	TM
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5819021.000	Easting: 596996.000	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SILT (Tailings), sandy, fine to medium grained, light reddish grey-brown, soft, moist.						
	SAND and GRAVEL (Native Till), silty, trace clay, brown, dense, damp.		Sample Interval	**ST13-05-01**			
	Bottom of hole at 0.4 m.						
1							

NOTES
Bolded sample denotes sample analyzed.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST13-06**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	900.729	Borehole Logged By:	TM
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5819011.000	Easting: 596986.000	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND (Native), some silt, trace fine gravel, light grey-green, very dense, to dense, damp.			**ST13-06-01**			
	Bottom of hole at 0.1 m.						
1							

NOTES
Bolded sample denotes sample analyzed.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN

Client	Test Pit No. : ST14-01
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	912.330	Borehole Logged By:	TM/VSD
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 04
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5819249.838	Easting: 596545.074	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SAND and SILT (A Horizon), trace subangular gravel, brown, loose, damp, roots.						
	SAND and SILT (B Horizon, Till), trace subangular gravel, greyish brown, dense, damp, trace roots.		Sample Interval	**ST14-01**	12.2		
	SILT and GRAVEL, fine to coarse subangular gravel, some coarse grained sand, grey, very dense, damp, trace roots. 10-20% coarse fragments.						
	Bottom of hole at 0.5 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST14-01 = 5.90.
LFH: +0.09 - 0 m.

SNC·LAVALIN	Client: **Mount Polley Mining Corporation**	**Test Pit No. : ST14-02**
	Location: **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	910.360	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 14
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5819277.606	Easting: 596543.899	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

Soil Vapour (ppm): ○ Reading within indicated scale; ● Reading outside indicated scale. Scale: 10^1, 10^2, 10^3, 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SAND (Tailings), fine to medium graned, trace silt, orange-black-brown mottled, loose, moist.		Sample interval	**ST14-02-01** **ST14-02-02**	114		
0.5	SILT and ORGANICS (Native), black, loose, moist.						
0.6	Bottom of hole at 0.6 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
ST14-02-02 is a blind field duplicate of ST14-02-01.
Contact Test pH: ST14-02-01 = 9.06.

Print Date: 2015.06.03 Date Approved: 2015.03.19

SNC·LAVALIN	Client: **Mount Polley Mining Corporation**	**Test Pit No. : ST14-03**
	Location: **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	906.210	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 14
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5819319.038	Easting: 596575.358	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND and SILT (Tailings), medium grained sand, black-brown-orange mottled, loose, moist.			**ST14-03**	316		
	CLAY (Tailings), fine grained sand, grey, loose, wet to saturated.						
	SAND and GRAVEL (Native), fine to coarse grained subrounded sand, coarse subrounded gravel, dark brown-dark grey, loose, wet, trace organics, roots.						
	Bottom of hole at 0.3 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST14-03 = 8.42.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST14-04**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	906.080	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 14
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5819354.908	Easting: 596610.520	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	CLAY and SAND (Tailings), fine to grained sand, grey, soft, moist with trace medium grained sand, orange-light brown.						
	CLAY, SAND and GRAVEL (Tailings and Native), fine grained sand, coarse subrounded gravel, grey, soft.			**ST14-04**	485		
	SAND and GRAVEL (Native), fine to coarse grained subrounded sand, coarse subrounded gravel, dark grey-brown, loose, moist.						
	Bottom of hole at 0.3 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST14-04 = 8.84.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST15-01**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	919.240	Borehole Logged By:	VSD
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 08
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5820016.647	Easting: 596210.937	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SILT and CLAY (A Horizon), some fine to coarse grained sand, trace gravel, dark brown, soft to medium hard, medium plasticity, moist, roots.			ST15-01-01	12.7		
	SILT (B Horizon), some clay, some coarse grained sand, some gravel, light olive brown with orange mottling, medium hard, low plasticity, moist, some roots.			ST15-01-02 ST15-01-03	9.1		
	Bottom of hole at 0.5 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
ST15-01-03 is a blind field duplicate of ST15-01-02.
Contact Test pH: ST15-01-01 = 4.95 and ST15-01-02 = 5.47.
LFH: +0.045 - 0 m.

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST15-02**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	915.350	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 13
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5819897.723	Easting: 596190.574	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND and CLAY (Tailings), fine grained sand, grey, soft, damp.			**ST15-02-01**	444		
	SILT (Native and Tailings), trace coarse grained sand, brown-light brown with grey mottling, medium dense, moist.			**ST15-02-02**	22.6		
	Bottom of hole at 0.3 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST15-02-01 = 8.75 and ST15-02-02 = 6.61.

SNC·LAVALIN

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST15-03**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	913.560	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 13
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5819824.912	Easting: 596071.578	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SILT and CLAY (Tailings), grey, medium damp.			**ST15-03**	640		
	SAND and GRAVEL (Native), fine to coarse grained subrounded sand, coarse subrounded gravel, dark grey, medium dense.						
	Bottom of hole at 0.3 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST15-03 = 8.45.

SNC • LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST15-04**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	912.560	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 13
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5819805.498	Easting: 596068.195	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	CLAY and SAND (Tailings), fine grained, grey, very soft, wet.			**ST15-04**	385		
	SAND (Native), fine to coarse grained, some fine subrounded gravel, grey-grey brown.						
	Bottom of hole at 0.3 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST15-04 = 8.57.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN

Client	Test Pit No. : ST16-01
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	921.330	Borehole Logged By:	VSD/DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 06
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5819957.489	Easting: 595607.377	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery
0	SILT (A Horizon), trace fine grained sand, dark grey, soft, medium plasticity, moist, some roots, some organics.			**ST16-01-01**	116.1	
	SILT and GRAVEL (B Horizon), fine to coarse subrounded and subangular gravel, pale grey-olive grey, very dense, moist, trace roots. 5-15% coarse fragments.			**ST16-01-02**	22.6	
	Bottom of hole at 0.5 m.					
1						

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST16-01-01 = 4.86 and ST16-01-02 = 5.87.
LFH:+0.12 - 0 m.

Print Date: 2015.06.03 Date Approved: 2015.03.23

SNC·LAVALIN

Client	Test Pit No. : ST16-02
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	919.880	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 13
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5819999.969	Easting: 595639.055	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SAND (Tailings), fine and medium grained, mottled grey-brown-orange, very loose, wet to saturated.			**ST16-02**	233		
	Bottom of hole at 0.1 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST16-02 = 8.66.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN

Client: Mount Polley Mining Corporation	Test Pit No. : ST16-03
Location: Hazeltine Creek Study Area, Likely, BC	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	915.460	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 13
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5820073.331	Easting: 595763.053	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1, 10^2, 10^3, 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SAND (Tailings), fine grained, black-dark orange, loose, wet.		Sample Interval	**ST16-03**	715		
	Below 0.05 m - orange-light brown.						
	SAND and GRAVEL (Native), fine to coarse grained sand, fine subrounded gravel, grey-green, very hard, moist.						
	Bottom of hole at 0.1 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST16-03 = 8.61.

Print Date: 2015.06.03 Date Approved: 2015.03.19

SNC·LAVALIN

Client	Test Pit No. : ST16-04
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	915.540	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 13
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5820083.913	Easting: 595771.763	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery
0	SAND (Tailings), fine grained, grey, loose, moist.					
	SILT and SAND (Tailings), fine grained, light brown with dark brown mottling, medium dense, moist.					
	SILT (Native), trace fine grained sand, brown-dark brown, loose, damp.		Sample Interval	**ST16-04-01**	285	
	SILT and CLAY (Native), trace fine subrounded gravel, brown-grey, medium dense, damp.		Sample Interval	**ST16-04-02**	89.4	
	Bottom of hole at 0.6 m.					
1						

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST16-04-01 = 7.08 and ST16-04-02 = 7.23.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN

Client	Test Pit No. : ST16-05
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	918.660	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 13
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5820151.172	Easting: 595855.364	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1, 10^2, 10^3, 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery
0	SAND (Tailings), fine grained, grey, very loose, wet.					
	SAND (Tailings), fine to medium grained, grey with orange-brown mottling within 0.05-0.1 m layers of medium grained sand, orange-black.		Sample Interval	**ST16-05**	273	
	Bottom of hole at 0.8 m.					
1						

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST16-05 = 9.21.

Print Date: 2015.06.03 Date Approved: 2015.03.19

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST16-06**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	919.430	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 13
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5820192.220	Easting: 595977.103	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND, medium grained, grey with some orange-brown, loose, wet.			**ST16-06**	348		
	SILT and ORGANICS (Native), dark brown, soft, wet, roots.						
	Bottom of hole at 0.5 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST16-06 = 8.07.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC-LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST17-01**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	927.000	Borehole Logged By:	AGD
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 12
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5820466.853	Easting: 595070.655	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1, 10^2, 10^3, 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SILT (A Horizon), trace fine grained sand, light grey, loose, damp, trace organics, roots.						
	SILT and SAND (BI Horizon), fine grained, trace coarse subrounded sand, pale brown, damp, trace roots.		Sample Interval	**ST17-01**	10.6		
	SILT, SAND and GRAVEL (BII Horizon), fine grained sand, fine subrounded to subangular gravel, pale brown-grey, medium stiff, damp, trace roots.						
	Bottom of hole at 0.5 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST17-01 = 5.60.
LFH: +0.06 - 0 m.

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST17-02**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	924.150	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 12
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5820501.207	Easting: 595171.521	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SAND (Tailings), fine grained, some silt, grey-light brown, soft, wet.			**ST17-02**	289		
	SILT and ORGANICS (Native), dark brown, loose, wet.						
	Bottom of hole at 0.3 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST17-02 = 7.69.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST17-03**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	921.680	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 12
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5820373.710	Easting: 595284.459	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	CLAY (Tailings), trace silt, grey with trace dark brown, very soft, moist, trace pockets of organics (suspect peat).						
			Sample interval	**ST17-03**	266		
	SAND and GRAVEL (Suspect Native), fine to coarse grained sand, fine subrounded to subangular gravel, subrounded to subangular cobbles, grey-light brown, medium dense, damp.						
	Bottom of hole at 0.8 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST17-03 = 9.16.

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST17-04**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	921.300	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 12
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5820360.931	Easting: 595294.281	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND and SILT (Tailings), fine grained, grey, very loose, moist to wet.			**ST17-04**	293		
	Bottom of hole at 0.4 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST17-04 = 9.13.
Shovel Probe Depth: refusal at 1.5 m.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC-LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST17-05**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	921.480	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 12
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5820268.510	Easting: 595363.733	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

Soil Vapour (ppm): ○ Reading within indicated scale; ● Reading outside indicated scale. Scale: 10^1, 10^2, 10^3, 10^4

Depth in Metres	Soil Description	Sample Number	EC (µS/cm)	% Recovery
0	SAND (Tailings), fine grained. some silt, grey, medium dense, damp.	**ST17-05**	519	
	SAND and GRAVEL (Native), fine to coarse grained sand, fine angular to subangular gravel, trace cobbles, medium dense, brown to orange-brown. 5-15% coarse fragments.			
	Bottom of hole at 0.3 m.			
1				

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST17-05 = 8.65.

Print Date: 2015.06.03 Date Approved: 2015.03.19

SNC·LAVALIN

Client **Mount Polley Mining Corporation**		**Test Pit No. : ST17-06**
Location **Hazeltine Creek Study Area, Likely, BC**		PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	920.310	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 12
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5820212.327	Easting: 595394.606	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval / Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SAND and SILT (Tailings), fine grained, grey, very loose, wet to saturated.			**ST17-06**	307		
	Bottom of hole at 0.1 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST17-06 = 8.58.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC-LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST17-07**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	921.470	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 12
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5820164.538	Easting: 595429.356	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval / Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SILT and CLAY (Tailings), trace fine grained sand, grey, very soft, wet. - below 0.35 m - increased gravel and cobble content.			**ST17-07**	252		
	Bottom of hole at 0.4 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST17-07 = 9.27.

Print Date: 2015.06.03 Date Approved: 2015.03.23

SNC·LAVALIN

Client	Test Pit No. : ST17-08
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	921.230	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 12
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5820142.757	Easting: 595443.325	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SAND (Tailings), medium grained, dark grey, loose, moist.			**ST17-08-01**	130		
	SAND (Tailings), medium grained, trace silt, orange-brown with dark grey-black mottling, loose, damp.			**ST17-08-02**	296		
	SILT and ORGANICS (Native), roots.						
	Bottom of hole at 0.7 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST17-08-01 = 8.10 and ST17-08-02 = 8.16.

Print Date: 2015.06.03 Date Approved: 2015.01.09

SNC·LAVALIN

Client: **Mount Polley Mining Corporation**	**Test Pit No. : ST18-01**
Location: **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	922.350	Borehole Logged By:	VSD
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 17
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5820440.100	Easting: 595992.810	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale; ● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery
0	CLAY and SILT (A Horizon), dark brown, medium stiff, medium plasticity, damp, abundant roots.					
	SILT (B Horizon), some subrounded to subangular gravel, light yellowish brown with orangish mottling, very dense, dry, trace roots.			**ST18-01**	9.2	
	Bottom of hole at 0.5 m.					
1						

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST18-01 = 6.25.
LFH: +0.20 - 0 m.

Print Date: 2015.06.03 Date Approved: 2015.03.23

SNC·LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST18-02**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	920.130	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 17
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5820653.410	Easting: 595765.340	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery
0	SAND and SILT (Tailings), fine to medium grained, grey and orange with black mottled layers, soft, loose, wet.		Sample Interval	**ST18-02-01** ST18-02-02	262	
	- below 0.2 m - becomes saturated					
	SAND (Tailings), medium to coarse grained subrounded, occasional pockets of medium grained sand, orange-brown-black, loose, wet.		Sample Interval	**ST18-02-03**	265	
	Bottom of hole at 0.6 m.					
1						

NOTES
Bolded sample denotes sample analyzed.
ST18-02-02 is a blind field duplicate of ST18-02-01.
Contact Test pH: ST18-02-01 = 9.09 and ST18-02-03 = 8.57.
Shovel Probe Depth: refusal at 0.8 m.

SNC·LAVALIN

Client	Test Pit No. : ST18-03
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	920.730	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 17
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5820589.698	Easting: 595608.743	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm)
0	SAND (Tailings), fine grained, trace silt, grey, loose, wet, occasional pockets of medium grained sand, brown-orange.			**ST18-03-01**	378		
	SAND (Tailings), medium grained, trace fine grained, orange-brown with trace grey mottling, loose, moist.			**ST18-03-02**	458		
	Bottom of hole at 0.8 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST18-03-01 = 9.09 and ST18-03-02 = 8.98.
Shovel Probed Depth: refusal at 1.55 m.

Print Date: 2015.06.03 Date Approved: 2015.03.23

SNC•LAVALIN	Client **Mount Polley Mining Corporation**	**Test Pit No. : ST18-04**
	Location **Hazeltine Creek Study Area, Likely, BC**	PAGE 1 OF 1

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	920.740	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 13
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5820592.608	Easting: 595596.141	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Soil Vapour (ppm): 10^1 10^2 10^3 10^4

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery
0	SAND (Tailings), fine grained, trace silt, grey, loose, wet.					
	SAND (Tailings), medium grained with some CLAY mottling (0.05-0.08 m wide), SAND, orange and brown, CLAY, grey, loose/soft, wet.		Sample Interval	**ST18-04**	281	
	Bottom of hole at 0.6 m.					
1						

NOTES
Bolded sample denotes sample analyzed.
Contact Test pH: ST18-04 = 9.44.
Shovel Probe Depth: refusal at 1.0 m.

Print Date: 2015.06.03 Date Approved: 2015.03.19

SNC·LAVALIN

Client	Test Pit No. : ST18-05
Mount Polley Mining Corporation	
Location	PAGE 1 OF 1
Hazeltine Creek Study Area, Likely, BC	

Drilling Contractor	SNC-Lavalin Personnel	Date Monitored	n/a	Project Number:	621717
Drilling Method	Shovel	Ground Surface Elev. (m)	920.320	Borehole Logged By:	DRS
Borehole Dia. (m)	n/a	Top of Casing Elev. (m)	n/a	Date Drilled:	2014 09 17
Pipe/Slotted Pipe Dia. (m)	none/none	Northing: 5820429.370	Easting: 595927.350	Log Typed By:	SW

Drilling Legend: Sample Interval

Water/NAPL Levels: Water Level 1; Water Level 2; NAPL; NAPL

○ Reading within indicated scale
● Reading outside indicated scale

Depth in Metres	Soil Description	Stratigraphy Plot	Sample Interval Core Run	Sample Number	EC (µS/cm)	% Recovery	Soil Vapour (ppm) 10^1 10^2 10^3 10^4
0	SILT (Tailings), some fine grained sand, grey, very soft.			ST18-05-01 ST18-05-02	290		
	SAND (Tailings), medium grained, orange-brown, loose, wet.			ST18-05-03	8.26		
	Bottom of hole at 0.5 m.						
1							

NOTES
Bolded sample denotes sample analyzed.
ST18-05-02 is a blind field duplicate of ST18-05-01.
Contact Test pH: ST18-05-01 = 8.93 and ST18-05-03 = 8.26.
Shovel Probe Depth: refusal at 0.9 m.

Print Date: 2015.06.03 Date Approved: 2015.01.09

APPENDIX V

Analytical Laboratory Reports

Provided on CD

APPENDIX VI

Statistical Summary

Table 1: Statistical Summary of pH and Metals Measured in Tailings, Native Within Channel and Background Samples

Parameter/ Contaminant	Tailings							Native Within Channel							Background						
	Count (n)	Minimum	Maximum	Mean	90th Percentile	95% UCLM	*Standard Deviation*	Count (n)	Minimum	Maximum	Mean	90th Percentile	95% UCLM	*Standard Deviation*	Count (n)	Minimum	Maximum	Mean	90th Percentile	95% UCLM	*Standard Deviation*
pH	71	7.51	9.09	8.499	8.88	8.556	*0.289*	17	5.95	8.48	7.299	8.334	7.619	*0.754*	23	4.69	7.13	5.62	6.536	5.858	*0.667*
Arsenic	71	7.54	16.5	11.23	13.1	11.55	*1.613*	17	0.434	14.7	6.984	10.04	8.426	*3.405*	23	3.06	14.2	6.978	11.28	8.096	*3.122*
Chromium	71	7.81	29.6	12.13	18.4	12.99	*4.225*	17	1	61.7	33.51	50.36	39.24	*13.54*	23	9.59	108	41.2	74.96	51.9	*23.52*
Copper	71	185	1560	868.7	1110	916.5	*241.3*	17	6.28	86.7	36.06	64.34	44.71	*20.41*	23	5.98	135	35.56	74.52	49.12	*34.89*
Manganese	71	403	1140	607.7	727	632.3	*121.5*	17	7.4	1670	556.4	803.2	710.8	*364.5*	23	170	7320	930	1188	1418	*1561*
Vanadium	71	106	289	187.1	218	193.6	*32.88*	17	2.04	100	59.7	88.48	70.6	25.75	23	40.2	133	70.01	103.2	78.42	*23.48*
Nickel															23	4.4	104	32.2	59.02	41.4	*23.05*
Selenium															23	0.2	4.29	0.923	0.59	0.805	*1.404*

Notes: UCLM = Upper Confidence Limit of the Mean
Last Updated: March 26, 2015

Figure 1: Histogram graphs show pH concentrations in tailings samples

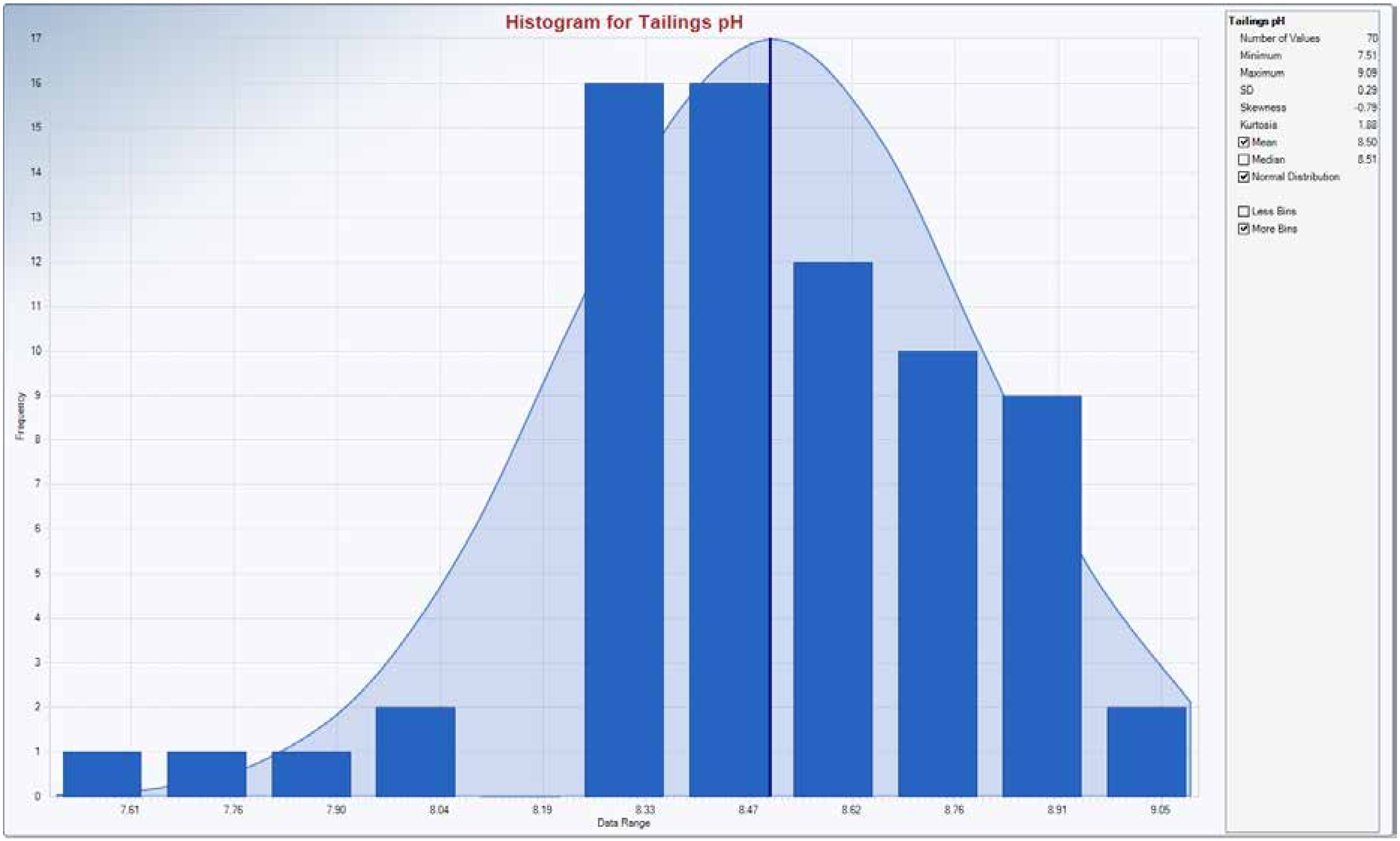


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Figure 2: Histogram graphs show total copper concentrations in tailings samples

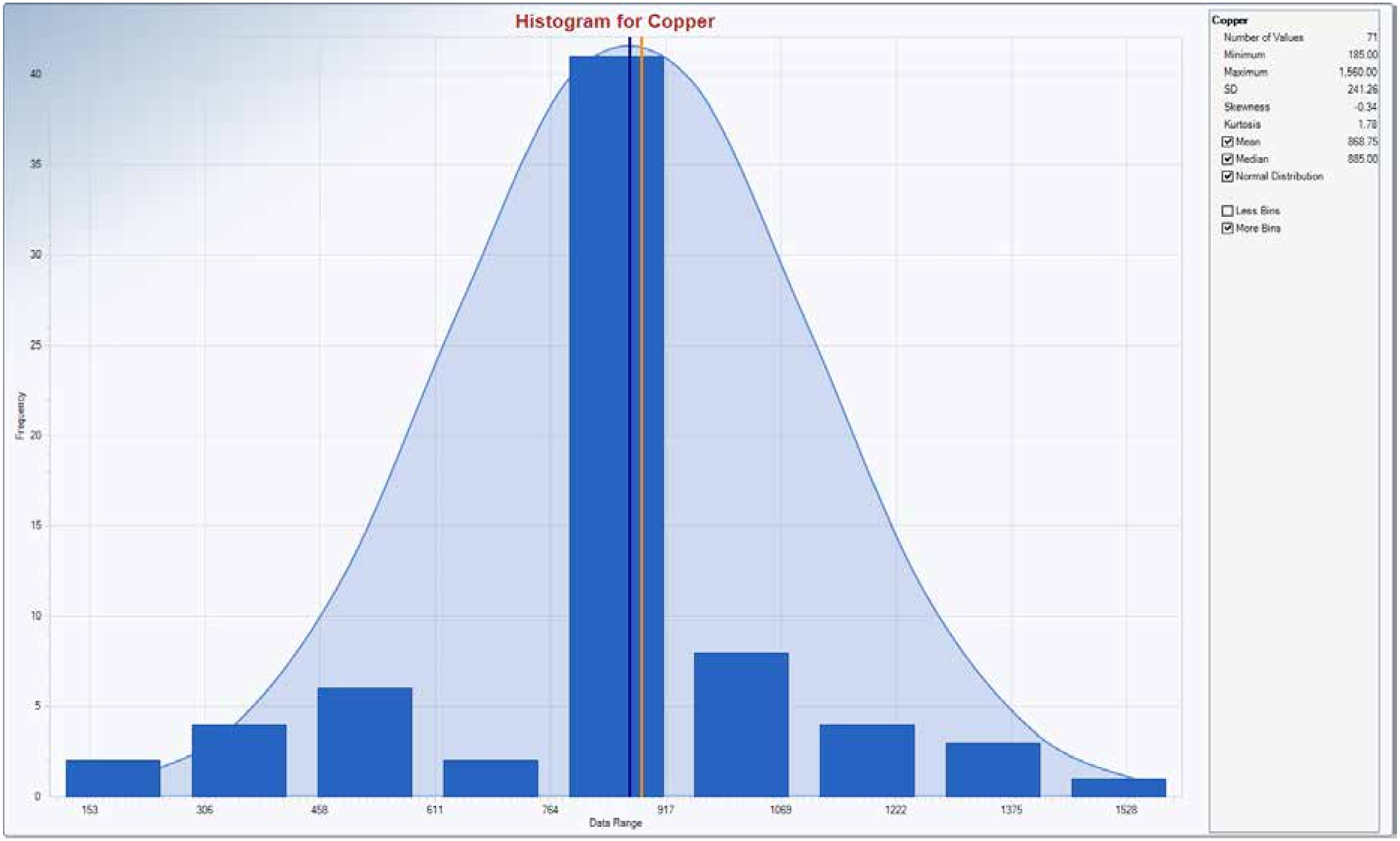

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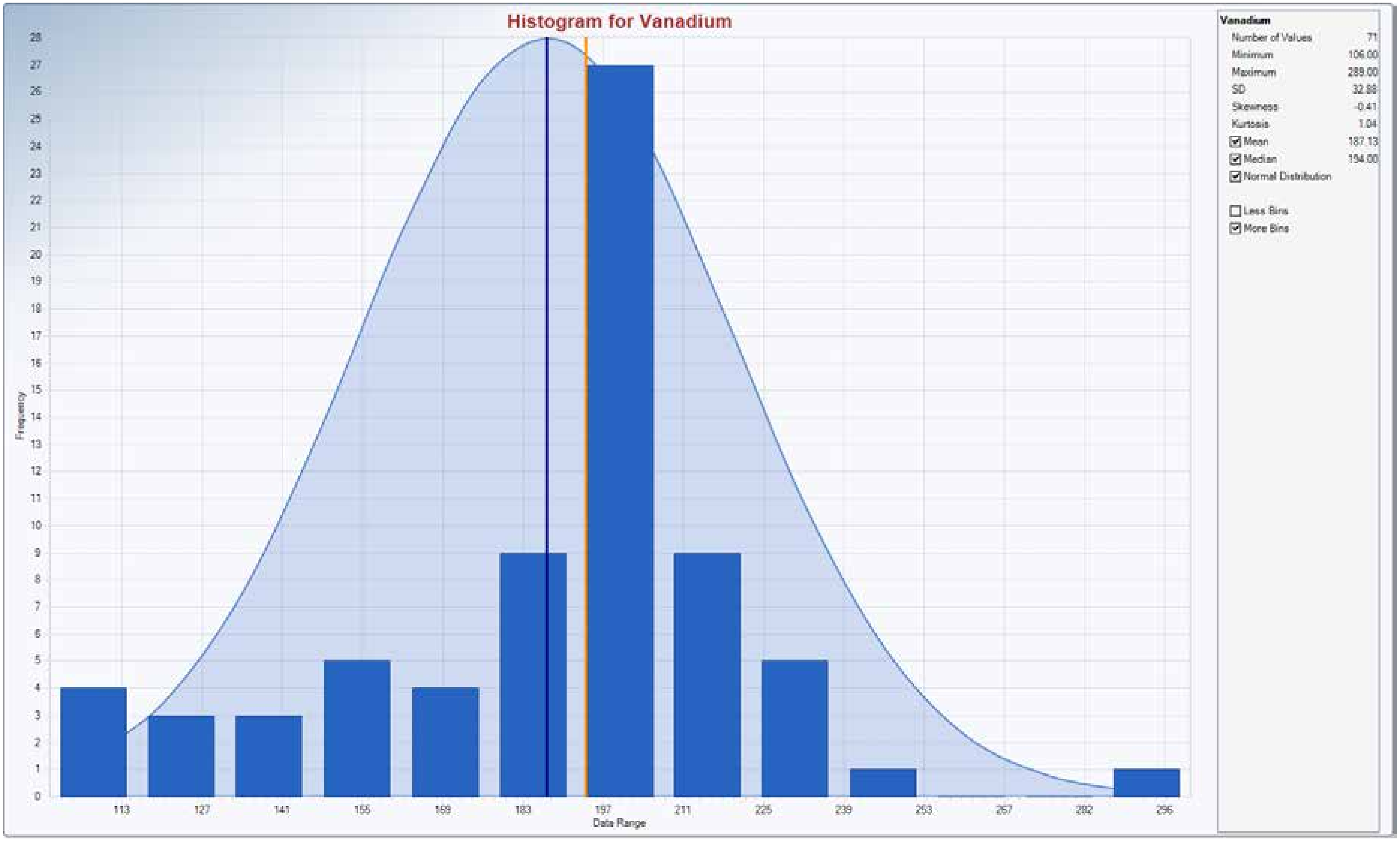
Figure 3: Histogram graphs show total vanadium concentrations in tailings samples

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APPENDIX E: MOUNT POLLEY MINE TAILINGS DAM FAILURE: SEDIMENT QUALITY IMPACT CHARACTERIZATION

Pierre Stecko, M.Sc., EP, R.P.Bio. and Cynthia Russel, B.Sc.

Minnow Environmental Inc.

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Mount Polley Tailings Dam Failure
Sediment Quality Impact Characterization

Report Prepared For:
Mount Polley Mining Corporation
Box 12, Likely, BC
V0L 1N0

Prepared By:
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101-1025 Hillside Ave.
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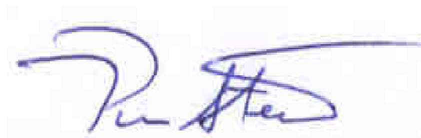
V8T 2A2

May 2015

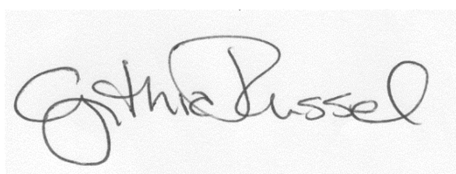
Mount Polley Tailings Dam Failure
Sediment Quality Impact Characterization

Report Prepared for:
Mount Polley Mining Corporation

Report Prepared by:
Minnow Environmental Inc.



Pierre Stecko, M.Sc., EP, RPBio
Project Manager



Cynthia Russel, B.Sc.
Project Principal / Reviewer

Katharina Batchelar, M.Sc.
Data Evaluation and Presentation

Cheryl Wiramanaden, Ph.D.
Sediment Stratigraphy Lead

Michael White, Ph.D.
Quesnel River Benthic Evaluation Lead

May 2015

PLAIN LANGUAGE SUMMARY

This report, prepared by Minnow Environmental Inc., provides an interim assessment of the impact of the August 4, 2014 Mount Polley tailings dam failure on receiving environment sediment quality. The failure resulted in the discharge of tailings and water into Polley Lake, Hazeltine Creek and Quesnel Lake.

The two key factors in the assessment of failure-related effects on sediment quality are: 1) changes to physical conditions of the sediment, and 2) changes in chemical composition of the sediment. Both of these can affect the capacity of sediment to support sediment dwelling organisms.

Several tools were used to assess the impact of the failure on sediment quality:

1. Measures and observations of sediment physical properties including sediment colour, texture, particle size composition, and organic carbon content;

2. Measurements of chemical content of sediment (including metals that were elevated in tailings);

3. Testing the toxicity of the sediment to indicator invertebrate species under laboratory conditions; and

4. Direct measurement of diversity and abundance of organisms in the benthic invertebrate community.

Analyses were conducted on sediment collected from Hazeltine Creek, Polley Lake, and Quesnel Lake. Sediment was not collected from the erosional Quesnel River, but this area was evaluated on the basis of the benthic invertebrate community and supporting water chemistry. Several locations were sampled in each of these water bodies, and multiple samples were collected at each location to characterize small-scale variations. Impact was characterized in comparison to sediment quality guidelines and reference (including pre-failure) sediment chemistry, the latter of which indicated naturally elevated concentrations of a number of metals prior to the dam failure. As expected, locations closest to the dam failure (or within the debris field downstream) were associated with the greatest disturbance in sediment physical condition, compared to those located further down Quesnel Lake. Many of these locations also exhibited elevated concentrations of sediment-associated metals, particularly copper.

Sediments in the failure-affected aquatic environments were associated with concentrations of copper that consistently exceeded provincial sediment quality guidelines

and that were several times higher than reference concentrations; these sediments also exhibited low total organic carbon content compared to reference sediments. Several studies conducted in collaboration with the geochemical assessment indicated low potential for bioavailability of metals to sediment-dwelling organisms under field conditions. Selective chemical extractions indicated that most metals were significantly liberated only in the strongest acid digest, meaning that they cannot be mobilized under natural conditions in the field. Copper was liberated in less aggressive extractions, but separate geochemical evaluation (SRK 2015) indicated limited copper mobility. These geochemical findings indicate that, although concentrations of several metals in sediment exceeded provincial guidelines, the copper and other associated metals may not be harmful.

Standard toxicity test organisms were evaluated under laboratory conditions to determine if sediment-dwelling organisms could survive and grow normally. In several samples, these organisms did not survive or grow as successfully as those exposed to reference sediment. The toxicity test results were difficult to interpret because the physical composition of tailings-influenced sediments differed from natural sediment. For example, organic carbon in the sediment, which is a food source for the test organisms, was very low in many samples (approximately 0.5% or lower at the most impacted locations). When poor growth or survival was observed, samples also contained much less organic carbon than recommended for normal performance of the tests. It is therefore possible that toxicity in some samples was due to food limitations, chemical influence, or both factors acting together. However, the study also provided indications of normal growth and survival in sediments that were collected distant from the areas of greatest tailings influence (i.e., Quesnel Lake locations distant from Hazeltine Creek).

Analysis of sediment-dwelling benthic invertebrate communities indicated fewer invertebrates and lower diversity in Hazeltine Creek, Polley Lake, and areas of Quesnel Lake that were influenced by the dam failure. This is expected because the dam failure and erosion of Hazeltine Creek would have resulted in scouring of the natural sediment, plus deposition of foreign materials on the sediment surface. The degree of physical and chemical impact was not constant across the study area. For example, invertebrate diversity and abundance in the samples from the shallow parts of Quesnel Lake more distant from Hazeltine Creek and in the Quesnel River showed normal diversity and abundance, indicating that benthic invertebrate communities in these locations were not impacted by the dam failure.

The results of this interim assessment indicate that there is strong evidence of an impact to sediments within Hazeltine Creek and within portions of Polley Lake and Quesnel Lake. The degree of physical, chemical and biological impact is consistent with the degree of tailings influence, which varies by location and type of habitat. Although both physical and chemical factors may be responsible for the observed biological effects, the data suggest that the physical impacts are the greater influence on the sediment-dwelling organisms for two reasons: 1) sediment geochemistry indicates that metals have low availability for uptake by sediment-dwelling invertebrates, and 2) the magnitude of responses to the benthic community are larger than would be expected from the sediment toxicity test results. Because the assessment was conducted within a few months of the tailings dam failure, benthic organisms would not have had sufficient time to re-establish following the disturbances related to the failure.

Hazeltine Creek is currently being restored and tailings have been removed from the creek bed. Benthic invertebrate succession is occurring naturally from the surrounding environment. Follow-up sampling and testing will be conducted in 2015 to further characterize sediment conditions and to monitor benthic invertebrate community abundance and diversity succession.

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1.0 INTRODUCTION

1.1 Site Description and Background

The Mount Polley Mining Corporation (MPMC) operates the Mount Polley copper-gold mine located approximately 9 kilometers southwest of the community of Likely, British Columbia and 56 kilometres north-east of the city of Williams Lake, British Columbia (Figure 1.1). Mining at Mount Polley was active from 1997 to 2001 and from 2005 to August 4th 2014, and has included the mining of six open pits (Figure 1.1) and one underground mine accessed through the Wight Pit. The Mount Polley Mine site also includes a crusher and mill (concentrator), waste rock disposal sites, a Tailings Storage Facility (TSF), seepage collection ponds, a surface water collection system, a settling pond, and access roads (Figure 1.1).

Early on the morning of August 4th 2014, the Mount Polley TSF dam failed and released an estimated 25.0 million cubic metres of water and tailings. The material flowed in a northeast direction to Polley Lake and in a southeast direction along Hazeltine Creek and into Quesnel Lake.

1.2 Objective

The objective of this sediment quality impact characterization is to characterize the impact of the tailings dam failure on receiving environment sediment quality (including spatial extent and magnitude). This includes the characterization of sediment geochemistry as it pertains to the potential mobility and bioavailability of sediment-associated metals and metalloids. It also includes application of an enhanced sediment quality triad (SQT) approach (concurrent sediment chemistry, sediment geochemistry, toxicity, and benthic invertebrate community monitoring) to evaluate potential effects of failure-impacted sediment to aquatic life. Sediment geochemistry was also evaluated separately in consideration of all available tailings and receiving environment geochemical data (SRK 2015), and associated findings are referenced in this report.

1.3 Report Overview

This report is presented in ten sections, the first of which is this introduction (Section 1.0). Section 2.0 provides an overview of the approach and study design for the sediment quality impact assessment. Section 3.0 provides a review of historical data used in the impact assessment. Section 4.0 provides the methods used in the collection of sediment quality data and in impact assessment. Sections 5.0 through 9.0 provide the results and assessment of data collected in Hazeltine Creek, Polley Lake, Quesnel Lake littoral,

N
W E
S

0 1 2
Kilometres

MAP INFORMATION
Map Projection NAD 83 UTM Zone 10U
Data Source: Department of Natural Resources Canada. All rights reserved.
Created By: R. Sutherland
Creation Date: May 2015
Project No.: 2542

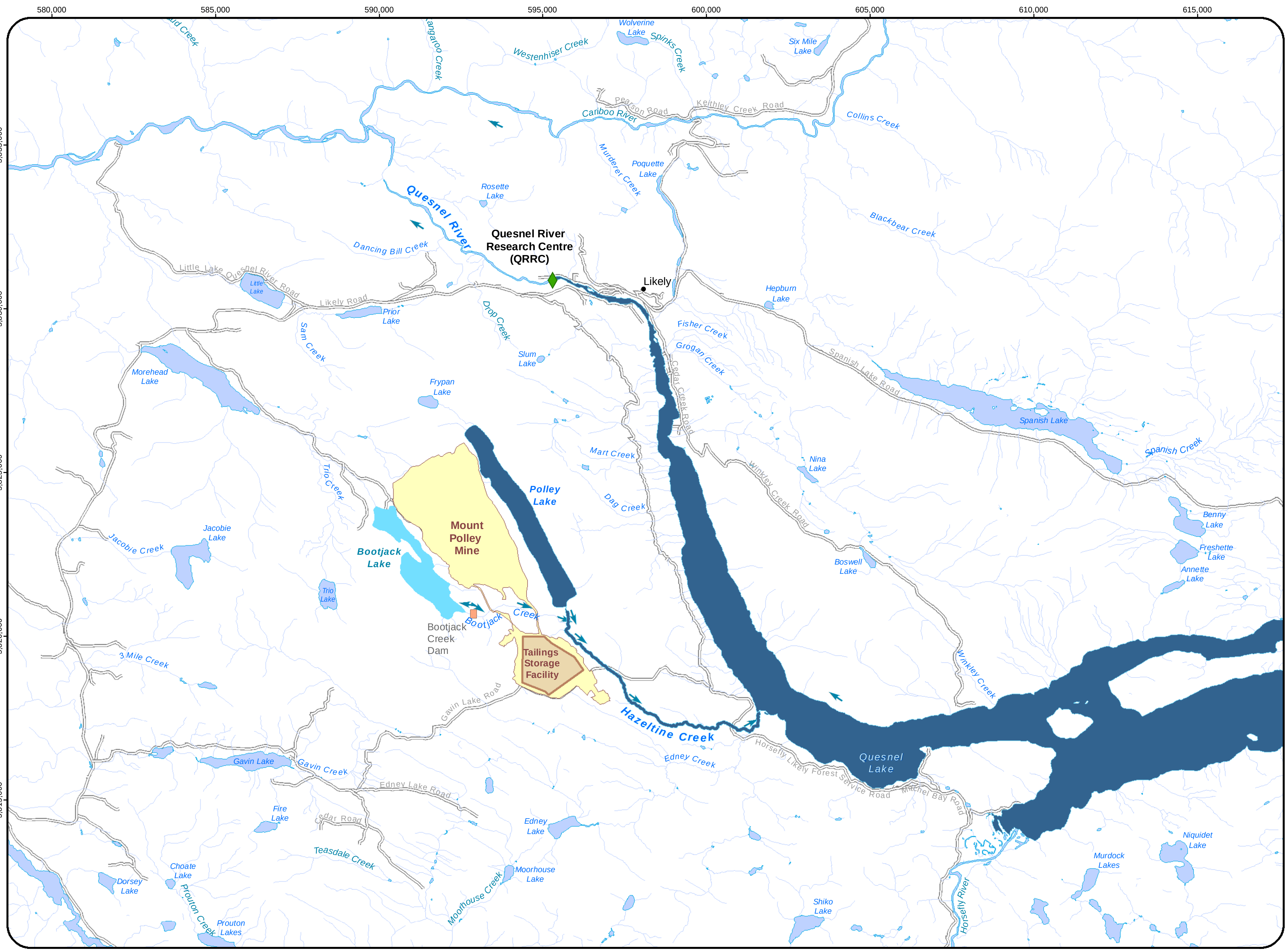
Features

- Bootjack Creek Dam
- Water Collection Ditch
- Mine Infrastructure
- Seepage Collection Pond
- Waterbody
- Watercourse
- Road
- Water Flow Direction

Figure 1.1: Overview of the Mount Polley Mine

Created by:
minnow environmental inc.

Quesnel Lake profundal and Quesnel River (Figure 1.2), respectively. Each of these sections begins with basic sediment quality (total concentrations) and is then augmented with the results of geochemical analyses undertaken to characterize the mobility of sediment-associated metals (including those undertaken by SRK [2015]). Results of sediment toxicity testing and benthic invertebrate community characterizations are then presented, both of which are considered in light of the chemical/geochemical characterizations. Each of sections 5.0 to 9.0 concludes with an integrated evaluation of the findings using a weight of evidence approach (WEA) to characterize sediment quality impact. Section 10.0 provides a summary of findings, including integrated conclusions of impact through the areas discussed independently in Sections 5.0 to 9.0. All references cited throughout the report are provided in Section 11.0.



Legend
- Bootjack Creek Dam
- Quesnel River Research Centre (QRRC)
- Towns
- Tailings Storage Facility
- Active Mine Operation
- Reference Waterbody
- Study Waterbody
- Waterbody
- Watercourse
- Road
- Water Flow Direction

0 1.5 3 4.5 6
Kilometres

MAP INFORMATION
Datum: NAD 83 Map Projection: UTM Zone 10U
Data Source: Department of Natural Resources Canada. All rights reserved.
Created By: R. Sutherland
Creation Date: March 2015
Project No.: 2542

Figure 1.2: Sediment Quality Impact Characterization Study Area

Created by:
minnow environmental inc.

2.0 APPROACH

2.1 Overall Approach

As stated in Section 1.2, the general objective of the Sediment Quality Impact Characterization (SQIC) was to characterize the impact of the tailings dam failure on receiving environment sediment quality. For the purposes of this assessment, Hazeltine Creek was considered a receiving environment although it currently does not represent an aquatic habitat. Restoration work is underway for Hazeltine Creek and it is planned to be a restored aquatic habitat in the future. The SQIC included the collection of physical, chemical and biological data from August to October 2014.

The study area, as defined in discussions among MPMC and environmental regulatory agencies, extends from the Mount Polley Mine Tailings Storage Facility (TSF) to the University of Northern British Columbia Quesnel River Research Centre (QRCC; Figure 1.2). This study area includes the following affected water bodies:

- Polley Lake;
- Hazeltine Creek;
- Quesnel Lake; and
- the Quesnel River.

A number of sampling areas were identified within each waterbody in an experimental design that included areas potentially affected by the tailings dam failure (including a spatial gradient where possible) and suitable reference areas, all with replication within areas (generally five stations per area; Table 2.1; as described in detail in Section 4.0).

Within Polley Lake, Hazeltine Creek, Quesnel Lake and Bootjack Lake (which served as a reference for Polley Lake), the SQIC included (Table 2.1):

1. Sediment sampling to characterize sediment physical and chemical characteristics (including total metals in both <2.0 mm and <63 µm sediments). This study component serves to characterize the physical and chemical impact of the dam failure on receiving environment sediments.
2. Geochemical characterization of the sediments using selective chemical extraction, shake flask tests, sediment porewater chemistry, acid-base accounting and particle size fractionation. This study component serves to characterize the potential mobility of sediment-associated metals.

Table 2.1: Overview of the MPMC SQIC Program Components, August to October 2014

	Waterbody				
	Polley Lake	Bootjack Lake (Reference)	Hazeltine Creek	Quesnel Lake	Quesnel River
"Exposed" Areas / Waterbody [1]:	4	0	3	4	4
Reference Areas / Waterbody [1]:	0	3	0	2	2
Program Components					
Sediment Quality (< 2.0 mm and < 63 µm)	●	●	●	●	-
Sediment Geochemical Characterization	●	●	●	●	-
Sediment Core Chemistry and Porewater	○			○	
Sediment Toxicity Testing	●	●	●	●	-
Benthic Invertebrate Community Characterization	●	●	-	●	●
Benthic Invertebrate Tissue Chemistry	-	-	-	-	●
Supporting Meter Measures	●	●	●	●	●

● data collected in August to October 2014

○ data collected at a subset of areas

[1] the majority of areas were characterized at five stations per area (see Section 4.0 for additional detail)

3. Sediment core collection for the characterization of vertical patterns of sediment chemistry and sediment porewater chemistry. This study component serves to characterize the potential for the mobilization of metals from sediment to overlying water.

4. Sediment toxicity testing using two test organisms – the freshwater/brackish water amphipod *Hyalella azteca* and the freshwater midge *Chironomus dilutus.* This study component serves to characterize the influence of failure-impacted sediments on the survival and growth of toxicity test organisms.

5. Benthic invertebrate community characterization using a number of community-level endpoints (density, taxon richness, diversity, evenness, community composition). This study component serves to characterize the influence of failure-impacted sediments on in-situ benthic invertebrate communities using sensitive endpoints that account for community-level interactions.

Within the Quesnel River, which is erosional and does not support sediment accumulation, the impact characterization included (Table 2.1):

1. Benthic invertebrate community characterization using a number of community-level endpoints (density, taxon richness, diversity, evenness, community composition). This study component serves to characterize the bioavailability of metals and the potential influence of the event on in-situ benthic invertebrate communities of the Quesnel River using sensitive endpoints that account for community-level interactions.

2. Benthic invertebrate tissue quality, including composite samples of the whole benthic invertebrate community and composite samples of one of the most common taxonomic groups (Perlidae, insects of the family Plecoptera [stoneflies], often referred to as common stoneflies). This study component serves to characterize the potential influence of the event on tissue chemistry of in-situ benthic invertebrates of the Quesnel River.

The data collected are used to provide a characterization of the physical and chemical impacts of the dam failure on sediment quality, as well as a characterization of the potential biological effects. To focus the analysis, the sediment quality evaluation included the identification of specific analytes whose concentrations in the study areas were most impacted by the dam failure. As described in detail in Section 4.0, these analytes are identified as either Parameters of Interest (POIs), which are analytes that were impacted by the failure to concentrations of concern with respect to potential effects to aquatic life (i.e., relative to effect-based guidelines and reference or pre-failure concentrations), and Indicator Parameters (IPs), which are analytes that were clearly associated with the failure (i.e., were substantially elevated relative to reference or pre-failure concentrations), but which remain lower than effect-based guidelines or for which no effect-based guidelines have been developed.

The interpretation of spatial differences in sediment chemistry, of the geochemical data, and of relationships between chemistry and biological responses were based on the POIs and the IPs in order to focus the SQIC on substances that represent the greatest risk to aquatic biota or are potentially most representative of the influence of the tailings dam failure. For these substances, environmental mobility was characterized and linked to measured biological observations to interpret bioavailability, effect and cause. Evaluation of the POIs in this manner is required because concentration-based screening tools (e.g., Sediment Quality Guidelines for the protection of aquatic life; BCMoE 2015a, 2015b) are suited to identifying concentrations below which effects are unlikely, but have a poor track record of predicting in-situ effects, particularly in instances where background concentrations are elevated and where the geochemical characteristics of the sediment differ from those under which the guidelines were developed (e.g., Prairie and McKee 1994; Campbell and Tessier 1996; ICMM 2007; Luoma and Rainbow 2008). Overall, the approach provides a solid basis for the initial characterization of the impact of the MPMC tailings dam failure on sediment quality.

2.2 Impact Characterization

Impact characterization includes physical impact (where and how have sediment physical characteristics been affected by the dam failure), chemical impact (where and how have sediment chemical and geochemical characteristics been affected by the dam failure), and biological impact (where and how have sediment-associated aquatic invertebrates been affected by the dam failure). Characterization of the physical and chemical impact on sediment includes the delineation of the affected area accomplished using a combination of electronic imaging and chemical characterization. Chemical impact is characterized by defining the differences in sediment chemistry relative to the pre-existing chemical condition and/or an appropriate reference chemical condition. Biological impact characterization is based on a weight-of-evidence approach (e.g., Burton et al 2002; Weed 2005; Suter and Cormier 2011; Alexander et al. 2015), whereby the chemical data, geochemical data, and biological data (toxicity testing and benthic invertebrate community structure) are integrated to identify biological impact relative to the pre-existing condition and/or an appropriate reference condition. This approach includes an enhanced

Sediment Quality Triad (SQT; Chapman 1990), with the additional consideration of chemical techniques for the estimation of metal mobility/bioavailability.

3.0 REVIEW OF HISTORICAL DATA

3.1 Environmental Context

To provide an effective basis for sediment quality impact characterization (i.e., comparison of data collected in 2014 to historical data), the pre-event receiving (Polley Lake, Hazeltine Creek, and Quesnel Lake) and reference (Bootjack Lake) environments were characterized based on existing physical, chemical, and biological data. Specifically, the assessment of data collected in 2014 relies substantially on comparison to pre-failure and reference conditions, and it is therefore important to understand sediment quality prior to the dam failure, including natural elevations in sediment metal concentrations relative to guidelines typically used in sediment quality assessment. These waterbodies have been previously characterized to various extents by the mine and a recent description of the receiving environments (Minnow 2014a) was used as a starting point, augmented with relevant data obtained through the Quesnel River Research Center. Available physical, chemical, and biological information for these waterbodies was compiled, and an inventory of the information reviewed is provided in Table 3.1.

3.2 Hazeltine Creek

The sediment quality of Hazeltine Creek has been assessed as part of several studies, both during baseline for the Mount Polley Mine in 1995 and 1996 (HKP 1996; HKP 1997), as well as during mine operation (Beak 2000; Minnow 2009; Minnow 2011; Karimlou 2011; van Lipzig 2011; Minnow 2013b; Minnow 2013c). Both the upper and lower regions of the creek have been evaluated in these studies (Figure 3.1), covering the area from the outlet of Polley Lake into Hazeltine Creek to the outlet of Hazeltine Creek into Quesnel Lake (Figure 3.1).

The assessment of sediment quality completed during baseline studies included sampling stations in upper Hazeltine Creek (W7) and in lower Hazeltine Creek (W11) (Tables 3.2-3.3, Appendix Tables A.1-A.2). The results of this sediment quality monitoring should be tempered by consideration that Hazeltine Creek is primarily an erosional creek and that the results of this monitoring include some unusually high concentrations of metals reported in 1996 (HKP 1997) that were not observed in 1995 (HKP 1996) and have not been observed since. These elevated concentrations may have been due to some unusual collection methods employed in 1995 and 1996 (e.g., using a coffee can), and the fact that baseline metal analyses were conducted only on the <63 µm fraction (silt and clay). Nonetheless, when compared to the BC Sediment Quality Guideline threshold effect levels (TEL; BCMoE 2015a, 2015b) mean 1995 baseline metals concentrations

Table 3.1: Inventory of Physical, Chemical and Biological Data Sources for Hazeltine Creek, Polley Lake, Bootjack Lake, and Quesnel Lake.

Study	Report Year	Scope of Study	Reference
The Paleolimnology of Eight Sockeye Salmon Nursery Lakes in British Columbia, Canada	1980	Documenting historic changes in trophic state of lakes (including Quesnel Lake) by examining diatoms in sediment cores	Stockner and Costella 1980
Environmental and Socioeconomic Impact Assessment for the Mount Polley Project	1990	Pre-development environmental and socio-economic impact assessment of the Mount Polley Mine project	Imperial Metals 1990
Mount Polley Project - Environmental Baseline and Monitoring Report 1995	1996	Environmental baseline study documenting pre-development conditions of aquatic and terrestrial ecosystems	HKP 1996
Mount Polley Project - Environmental Baseline and Monitoring Report 1996	1997	Continuation of 1996 environmental baseline study documenting baseline aquatic and terrestrial conditions	HKP 1997
Mount Polley Biological Monitoring Program - 1999	2000	Documenting baseline aquatic biological conditions in the vicinity of the Mount Polley Mine and supporting chemical measurements in water and sediment	Beak 2000
Hazeltine Creek Habitat Characterization	2007	Documenting the baseline physical habitat characteristics and fish habitat features	Minnow 2007a
Hazeltine Creek Habitat Characterization of the Reach below the New Proposed Effluent Discharge Location	2007	Continuation of work for Minnow 2007a but below the new proposed effluent discharge location	Minnow 2007b
Analysis of Baseline Water Quality Data of Hazeltine Creek at Station W7	2007	Baseline water quality at Station W7	Minnow 2007c
Analysis of Historical Data for the Identification of Optimal Timing for Potential Toxicity Testing in Hazeltine Creek	2007	Using the Biotic Ligand Model to predict seasonal patterns of copper bioavailability in Hazeltine Creek	Minnow 2007d
Mount Polley Mine - Aquatic Environmental Characterization of Hazeltine Creek - 2007	2009	Document the physical, chemical and biological conditions that could be affected by proposed discharge to Hazeltine Creek in a pre-discharge Environmental Effects Monitoring (EEM) study using EEM protocols	Minnow 2009
Mount Polley Mine Technical Assessment Report for a Proposed Discharge of Mine Effluent	2009	Technical assessment of the potential environmental impact of proposed discharge to Hazeltine Creek	Mount Polley 2009
Mount Polley Mine - Evaluation of the Water Quality of Polley and Bootjack Lakes	2010	Existing water quality of Polley Lake and evaluation of the influence of the mine on the water quality of the lake	Minnow 2010
Mount Polley Mine Selenium Monitoring 2009/2010	2011	Selenium monitoring in sediment, periphyton, benthic invertebrates and fish	Minnow 2011
Effects of mining on fine sediment quality; a comparison with regional metal background concentrations	2011	Assessment of mining influence on sediment quality of creeks within the Quesnel River catchment, including 3 sites within Hazeltine Creek	Karimlou 2011
Effects of mining on the geochemistry of fine sediments in streams; a study in the Quesnel River catchment	2011	Investigation of mining influence on the geochemistry of creek sediments in the Quesnel River catchment, including 3 sites within Hazeltine Creek	van Lipzig 2011
Phosphorus in Polley Lake	2013	Review of phosphorus in Polley Lake, investigate source of phosphorus and implications of increased phosphorus in lake	Minnow 2013a
Mount Polley Mine Selenium Monitoring 2012	2013	Selenium monitoring in sediment, periphyton, benthic invertebrates and fish	Minnow 2013b
Mount Polley Mine Selenium Monitoring 2013 Update Report	2013	Selenium monitoring in sediment, periphyton, benthic invertebrates and fish	Minnow 2013c
Aquatic Environmental Description Report Mount Polley Mine Discharge of Treated Water to Polley Lake	2014	Review of physical, chemical, and biological characteristics of Polley Lake and Hazeltine Creek, in support of proposed discharge to Polley Lake	Minnow 2014a
Technical Assessment Report Mount Polley Mine Discharge of Treated Water to Polley Lake	2014	Technical assessment of the potential environmental effects associated with proposed discharge of treated effluent to Polley Lake	Minnow 2014b

Legend

- Historical Sediment Sampling Stations
- Historical Benthic Invertebrate and Sediment Sampling Stations
- Water Collection Ditch
- Mine Infrastructure
- Seepage Collection Pond
- Waterbody
- Lake Bathymetry (10 m Intervals)
- Watercourse
- Road
- Water Flow Direction

Please note: Quesnel Lake bathymetry lines are an approximate representation only and may not precisely delineate accurate depths at larger scales.

0 280 560 840 1,120 1,400
Metres

MAP INFORMATION
Datum: NAD 83 Map Projection: UTM Zone 10U
Data Source: Department of Natural Resources Canada. All rights reserved.
Created By: R. Sutherland
Creation Date: March 2015
Project No.: 2542

Figure 3.1: Hazeltine Creek Sediment and Benthos Sampling Stations, 1995-2013

Created by:
minnow environmental inc.

Table 3.2: Sediment quality of upper Hazeltine Creek, 1995 - 2013[1].

Analyte	Units	BC SQGs [2]		1995 (W7)[3] HKP (1996)		1996 (W7)[3,4] HKP (1997)		1999 (W6)[5] Beak (2000)		2007 (W7) Minnow (2009)		2009 (W7) Minnow (2011)		2010 (W7) Minnow (2011)		2012 (W7 Pond) Minnow (2013b)		2013S (W7) Minnow (2013c)		2013S (W7 Pond) Minnow (2013c)		2013F (USW7 Pond) Minnow (2013c)		2013F (W7 Pond) Minnow (2013c)		Summary Statistics [6]		
		TEL	PEL	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	95th Percentile	Maximum
Physical Characteristics																												
Gravel (>2mm)	%	-	-	-	-	-	-	8.9	-	3.7	3.8	4.8	3.7	32	11	1.7	2.7	0.4	-	0.2	-	0.9	-	<0.10	-	9.4	33	49
Sand (2.0mm - 0.063mm)	%	-	-	-	-	-	-	49	-	40	5.7	58	12	55	11	21	11	20	-	23	-	24	-	13	-	40	65	76
Silt (0.063mm - 4µm)	%	-	-	-	-	-	-	31	-	43	2.5	30	9.4	10	13	67	12	71	-	68	-	64	-	75	-	43	76	76
Clay (<4µm)	%	-	-	-	-	-	-	10	-	14	1.5	7.0	3.9	2.4	3.3	10	1.8	8.1	-	8.9	-	11	-	13	-	8.1	14	15
TOC	%	-	-	-	-	-	-	3.2	-	10.4	2.4	7.9	0.6	1.9	3.1	11.3	1.7	-	-	-	-	7.6	0.7	11.2	1.1	8.6	12.8	13.1
Metals																												
Aluminum	mg/kg	-	-	-	-	-	-	11,700	1,500	15,100	1,200	-	-	10,200	2,190	13,500	1,420	15,300	1,200	15,500	990	16,500	1,310	17,600	890	14,900	18,000	19,000
Antimony	mg/kg	-	-	0.41	0.23	0.86	0.45	<0.2	0	-	-	-	-	0.26	0.07	0.24	0.02	0.30	0.02	0.30	0.02	0.28	0.01	0.30	0.01	0.29	0.37	0.81
Arsenic	mg/kg	5.9	17	11	8.6	7.0	5.1	2.9	0.4	5.9	1.3	5.2	0.4	4.9	1.1	3.6	0.2	4.6	0.6	4.3	0.3	3.2	0.2	4.0	0.2	5.0	8.2	25
Barium	mg/kg	-	-	-	-	-	-	101	15	125	27	104	18	69	23	96	10	118	10	120	6.9	113	11	132	6.6	111	136	156
Beryllium	mg/kg	-	-	-	-	-	-	0.33	0.06	-	-	-	-	0.26	0.07	0.34	0.03	0.38	0.04	0.41	0.02	0.40	0.03	0.44	0.02	0.38	0.46	0.46
Bismuth	mg/kg	-	-	-	-	-	-	<0.2	0	<20	0	-	-	<0.20	0	<0.20	0	<0.20	0	<0.20	0	<0.20	0	<0.20	0	1.5	16	20
Boron	mg/kg	-	-	-	-	-	-	4.5	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	5.4	5.5
Cadmium	mg/kg	0.6	3.5	<0.1	0	0.73	0.93	0.10	0	-	-	-	-	0.12	0.05	0.27	0.02	0.33	0.05	0.32	0.02	0.21	0.01	0.33	0.02	0.24	0.35	0.43
Calcium	mg/kg	-	-	-	-	-	-	-	-	9,700	860	-	-	6,340	1,560	11,100	930	12,100	1,300	12,000	927	14,800	11,000	12,300	534	11,500	13,400	34,500
Chromium	mg/kg	37.3	90	24	15	133	42	27	4.4	28	3.4	27	6.7	24	7.9	29	2.8	31	2.0	32	2.1	38	2.8	37	2.0	30	40	45
Cobalt	mg/kg	-	-	-	-	-	-	9.1	0.7	9.1	0.5	8.4	1.6	8.2	1.7	8.3	0.9	9.1	0.7	8.9	0.5	9.7	0.5	9.4	0.4	9.0	10	11
Copper	mg/kg	35.7	197	38	23	8,900	6,790	36	12	62	5.7	46	7.3	28	21	72	5.3	78	9.5	84	6.7	82	10	93	5.3	66	95	103
Iron	mg/kg	21,200	43,776	30,250	15,900	34,300	10,450	15,700	1,200	21,700	1,800	-	-	21,000	3,800	18,000	1,600	19,700	2,000	19,100	1,210	23,500	2,420	21,500	1,160	21,300	29,900	57,500
Lead	mg/kg	35	91	4	2	38	33	5.6	1.3	-	-	-	-	3.6	1.0	5.1	0.3	5.8	0.4	5.9	0.4	6.0	0.6	6.4	0.3	5.4	6.7	8.0
Lithium	mg/kg	-	-	-	-	-	-	-	-	13.3	1.3	-	-	9.3	1.8	11.4	1.1	12.6	1.2	13.4	0.8	13.2	1.0	14.0	0.9	12.6	14.8	15.3
Magnesium	mg/kg	-	-	-	-	-	-	-	-	5,900	470	-	-	5,750	828	4,900	690	5,160	302	5,240	357	6,280	456	5,930	287	5,550	6,430	6,930
Manganese	mg/kg	460	1,100	726	333	3,163	3,426	330	12	1,500	840	-	-	556	157	713	177	1,230	199	990	182	341	27	611	100	1,050	1,350	2,480
Mercury	mg/kg	0.17	0.49	0.053	0.027	0.076	0.018	<0.04	0	0.12	0.009	0.089	0.015	0.065	0.021	-	-	-	-	-	-	0.093	0.008	0.14	0.006	0.091	0.14	0.15
Molybdenum	mg/kg	-	-	-	-	-	-	0.40	0.17	-	-	-	-	0.71	0.47	0.99	0.11	1.2	0.23	1.2	0.14	1.0	0.09	1.1	0.17	1.0	1.5	1.6
Nickel	mg/kg	16	75	16	8.2	71	34	19	3.1	17	1.9	18	4.9	14	4.5	19	1.7	20	1.7	20	1.3	23	1.5	23	1.1	19	24	25
Phosphorus	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	768	132	1,020	56	1,200	140	1,160	104	1,220	128	1,280	105	1,130	1,380	1,470
Potassium	mg/kg	-	-	-	-	-	-	-	-	997	152	-	-	480	260	900	85	990	157	988	67	1,290	185	1,280	114	1,010	1,450	1,480
Selenium	mg/kg	2	-	<0.1	0	0.67	0.37	<1.0	0	<2.0	0	0.77	0.23	0.59	0.67	2.6	0.56	2.7	0.42	3.0	0.20	1.8	0.36	3.1	0.20	2.0	3.3	3.5
Silver	mg/kg	0.5	-	-	-	<0.1	0	<0.1	0	-	-	-	-	<0.10	0	0.11	0.01	0.14	0.02	0.15	0.03	0.11	0.01	0.15	0.01	0.13	0.16	0.22
Sodium	mg/kg	-	-	-	-	-	-	-	-	217	12	-	-	320	140	230	69	200	15	199	12	280	43	260	37	240	350	490
Strontium	mg/kg	-	-	-	-	-	-	93	13	77	9.6	-	-	56	22	97	4.4	109	8.1	112	7.0	101	6.6	109	4.8	98	118	125
Thallium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	0.053	0.006	0.070	0.006	0.075	0.009	0.076	0.006	0.075	0.010	0.091	0.005	0.075	0.094	0.098
Tin	mg/kg	-	-	-	-	-	-	0.67	0.06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.67	0.70	0.70
Titanium	mg/kg	-	-	-	-	-	-	390	5.8	570	27	-	-	757	43	478	73	546	59	529	56	707	153	570	62	572	776	962
Uranium	mg/kg	-	-	-	-	-	-	0.43	0.12	-	-	-	-	0.44	0.18	0.83	0.03	1.2	0.13	1.12	0.09	0.70	0.06	1.0	0.04	0.9	1.3	1.4
Vanadium	mg/kg	-	-	-	-	-	-	39	3.0	52.7	2.9	55.9	5.4	62.4	11	45.4	5.1	49.9	2.7	50.2	2.8	57.3	5.0	53.5	1.9	52.2	65.3	75.4
Zinc	mg/kg	123	315	48	19	2,444	2,724	44	8.2	54.0	3.5	49.6	4.3	44.6	12	54.4	4.8	62.7	5.1	62.1	4.2	56.3	2.4	63.9	2.8	55.7	67.6	82.0

[1] All values reported as < method detection limit (MDL) were used at the MDL value for calculation of summary statistics. If all reported values were < MDL, the mean is reported as < MDL.
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b) - TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] concentrations reported in 1995 and 1996 were for the silt and clay (<63 µm) fraction only.
[4] some unusually high sediment metal concentrations were reported for 1996 (HKP 1997) and are suspected errors.
[5] Particle fractions for these samples are as follow: gravel (>2mm), sand (2.0mm-0.050mm), silt (0.050mm-0.002mm), clay (<0.002mm).
[6] Summary statistics exclude data from 1996 (HKP 1997) due to suspected errors with this data.

(blue) indicates a mean concentration greater than the BCSQG TEL.
(orange) indicates a mean concentration greater than the BCSQG PEL.

Table 3.3: Sediment quality of lower Hazeltine Creek, 1995-2013 [1].

Analyte	Units	BC SQGs [2]		1995 (W11) [3] HKP (1996)		1996 (W11) [3,4] HKP (1997)		1999 (W11) [5] Beak (2000)		2007 (W11) Minnow (2009)		2010 (W11) Minnow (2011)		2012 (W11 mouth) Minnow (2013b)		Summary Statistics [6]		
		TEL	PEL	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	95th Percentile	Maximum
Physical Characteristics																		
Gravel	%	-	-	-	-	-	-	57	-	1.7	1.2	24	22	-	-	-	-	-
Sand (%)	%	-	-	-	-	-	-	34	-	63	12	64	17	-	-	-	-	-
Silt (%)	%	-	-	-	-	-	-	8.0	-	27	8.3	11	6.9	-	-	-	-	-
Clay (%)	%	-	-	-	-	-	-	2.0	-	8.7	2.1	1.3	0.9	-	-	-	-	-
Total Organic Carbon	%	-	-	-	-	-	-	-	-	2.9	1.0	0.6	0.4	7.7	1.9	3.8	9.0	9.8
Metals																		
Aluminum	mg/kg	-	-	-	-	-	-	10,200	680	12,400	400	8,750	537	-	-	10,100	12,550	12,800
Antimony	mg/kg	-	-	0.94	0.47	4.8	10	<0.2	0	-	-	0.31	0.03	-	-	0.56	1.3	1.9
Arsenic	mg/kg	5.9	17	9.9	1.4	9.2	5.0	7.3	1.2	10	1.4	10	1.7	-	-	10	12	12
Barium	mg/kg	-	-	-	-	-	-	97	2.3	102	6.4	67	10	-	-	84	104	109
Beryllium	mg/kg	-	-	-	-	-	-	0.30	0	-	-	0.27	0.02	-	-	0.28	0.30	0.30
Bismuth	mg/kg	-	-	-	-	-	-	<0.20	0	<20	0	<0.20	0	-	-	5.6	20	20
Boron	mg/kg	-	-	-	-	-	-	2.6	0.5	-	-	-	-	-	-	2.6	3.0	3.0
Cadmium	mg/kg	0.6	3.5	0.13	0.052	0.17	0.082	0.23	0.058	-	-	0.13	0.029	-	-	0.15	0.24	0.30
Calcium	mg/kg	-	-	-	-	-	-	-	-	6,790	369	5,250	391	-	-	5,830	7,030	7,120
Chromium	mg/kg	37	90	23	5.2	70	36	22	1.5	33	2.3	30	1.6	-	-	27	33	36
Cobalt	mg/kg	-	-	-	-	-	-	10	0	10	1.2	9.0	0.7	-	-	9.7	11	12
Copper	mg/kg	36	197	34	8.1	6,170	5,650	29	3.8	34	3.1	19	2.2	-	-	28	42	46
Iron	mg/kg	21,200	43,776	30,900	5,700	20,400	2,300	20,000	1,000	25,600	1,750	23,800	1,040	-	-	26,000	35,400	37,400
Lead	mg/kg	35	91	3.7	0.8	41	73	5.4	0.5	-	-	4.4	0.3	-	-	4.3	5.6	5.8
Lithium	mg/kg	-	-	-	-	-	-	-	-	13	0.31	8.6	0.43	-	-	10	13	13
Magnesium	mg/kg	-	-	-	-	-	-	-	-	6,110	71	5,430	375	-	-	5,690	6,160	6,190
Manganese	mg/kg	460	1,100	760	0	850	320	1,060	380	805	364	538	91	-	-	757	1,120	1,500
Mercury	mg/kg	0.17	0.49	0.088	0.063	0.030	0.016	<0.040	0	0.080	0.024	0.050	0.0009	-	-	0.067	0.14	0.19
Molybdenum	mg/kg	-	-	-	-	-	-	0.57	0.12	-	-	0.63	0.09	-	-	0.61	0.75	0.78
Nickel	mg/kg	16	75	17	4.8	30	12	21	1.0	22	1.1	20	2.2	-	-	19	24	26
Phosphorus	mg/kg	-	-	-	-	-	-	-	-	-	-	655	68	-	-	655	729	733
Potassium	mg/kg	-	-	-	-	-	-	-	-	860	70.9	492	43.8	-	-	630	910	940
Selenium	mg/kg	2	-	0.25	0.19	0.45	0.28	<1	0	-	-	0.27	0.05	1.1	0.29	0.60	1.3	1.5
Silver	mg/kg	0.5	-	-	-	<0.1	0	0.10	0	-	-	<0.1	0	-	-	0.1	0.1	0.1
Sodium	mg/kg	-	-	-	-	-	-	-	-	233	11.5	212	32.7	-	-	220	253	260
Strontium	mg/kg	-	-	-	-	-	-	57	8.3	62	8.0	48	6.9	-	-	54	67	68
Thallium	mg/kg	-	-	-	-	-	-	-	-	-	-	0.05	0.0004	-	-	0.1	0.05	0.05
Tin	mg/kg	-	-	-	-	-	-	1.1	0.1	-	-	-	-	-	-	1.1	1.1	1.1
Titanium	mg/kg	-	-	-	-	-	-	310	20	586	30	656	58	-	-	543	701	737
Uranium	mg/kg	-	-	-	-	-	-	0.7	0.1	-	-	0.4	0.09	-	-	0.5	0.7	0.8
Vanadium	mg/kg	-	-	-	-	-	-	39	4.0	66	4.8	70	4.8	-	-	61	75	78
Zinc	mg/kg	123	315	53	9.0	1,490	1,440	47	1.7	48	1.6	41	2.2	-	-	47	60	61

[1] All values reported as < method detection limit (MDL) were used at the MDL value for calculation of summary statistics. If all reported values were < MDL, the mean is reported as < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b) - TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] concentrations reported in 1995 and 1996 were for the silt and clay (<63 µm) fraction only.

[4] some unusually high sediment metal concentrations were reported for 1996 (HKP 1997) and are suspected errors.

[5] Particle fractions for these samples are as follow: gravel (>2mm), sand (2.0mm-0.050mm), silt (0.050mm-0.002mm), clay (<0.002mm).

[6] Summary statistics exclude data from 1996 (HKP 1997) due to suspected errors with this data.

(blue) indicates a mean concentration greater than the BCSQG TEL.

(orange) indicates a mean concentration greater than the BCSQG PEL.

exceeded the TELs for arsenic, copper, iron and manganese in upper Hazeltine Creek (W7; Table 3.2), and the TELs for arsenic, iron, manganese and nickel in lower Hazeltine Creek (W11; Table 3.3). As discussed in more detail in the methods section (Section 4.1.3), TELs represent concentrations below which adverse biological effects are expected to occur rarely (CCME 1999). They do not take into account the geochemical conditions of the sediment and do not effectively represent concentrations above which biological effects are expected, particularly in naturally mineralized areas such as those in the vicinity of the Mount Polley Mine. As applied herein, they provide benchmarks to identify metals with elevated pre-event concentrations and to focus the sediment quality assessment on parameters of interest.

Subsequent to baseline, the characterization of sediment quality in whole sediment from upper Hazeltine Creek (Beak 2000; Minnow 2009; Minnow 2011; Minnow 2013b; Minnow 2013c), has confirmed that concentrations of copper, iron and manganese were present at concentrations greater than TELs, or greater than the probable effect level (PEL; BCMoE 2015a) in the case of manganese (Table 3.2). PELs represent concentrations above which adverse biological effects are expected to occur frequently (CCME 1999). As noted above, they do not take into account the geochemical conditions of the sediment or conditions in naturally mineralized areas such as those in the vicinity of the Mount Polley Mine. Elevated concentrations of arsenic were not apparent subsequent to baseline, but mean concentrations of chromium, nickel and selenium have been observed at concentrations greater than TELs during one or more sampling events (Table 3.2). Of these analytes with mean concentrations elevated above TEL or PEL, concentrations of chromium, copper, nickel, and selenium were highest during the most recent sampling events (2013; with the exception of 1996 data). However, these higher concentrations in recent sampling years appeared to be associated with the higher content of fine particles and organic carbon captured in sampling (Table 3.2). Although not displayed in Table 3.2, sediment quality data for the <63 µm sediment fraction (silt and clay) from upper Hazeltine Creek (reported in a MSc. thesis; van Lipzig 2011) confirmed that mean chromium, copper, iron, manganese, nickel, and selenium concentrations were elevated above TEL within upper Hazeltine Creek, and also reported a mean arsenic concentration (6.83 mg/kg) greater than the TEL. This elevated arsenic concentration, which was not observed in the upper Hazeltine Creek sampling results for whole sediment between 1999 and 2013 (Table 3.2), may be due to the analysis of the fine sediment fraction (<63 µm) by van Lipzig (2011).

The characterization of sediment quality in whole sediment from lower Hazeltine Creek following the baseline studies (Beak 2000; Minnow 2009; Minnow 2011; Minnow 2013b) indicated that the same four analytes which were identified as elevated relative to TELs in 1995 (arsenic, iron, manganese, and nickel) remained elevated, and were generally present at concentrations similar to baseline (Table 3.3). The highest concentrations of selenium in lower Hazeltine Creek have been observed in the most recent sampling event in 2013 (with the exception of 1996 data), and appeared to be associated with higher organic carbon content (Table 3.3). Selenium has been identified as an analyte of interest for the Mount Polley Mine (Minnow 2014a), and as a result, the data set that exists for selenium is larger than those for other analytes in both upper and lower Hazeltine Creek (Tables 3.2 and 3.3). Sediment quality data for lower Hazeltine Creek was also reported by Karimlou (2011) and van Lipzig (2011) for the fine sediment fraction (<63 µm). Results from these two MSc. theses were not included in Table 3.3, but confirmed that mean concentrations of arsenic, iron, manganese, and nickel were elevated above TELs. In addition, mean concentrations of chromium, copper, selenium and zinc also exceeded TELs at lower Hazeltine Creek sampling areas (Karimlou 2011; van Lipzig 2011), and were higher than concentrations for these analytes characterized in whole sediment between 1999 and 2012 (Table 3.3). This is likely a result of the analysis of the fine sediment fraction by Karimlou (2011) and van Lipzig (2011). For both upper and lower Hazeltine Creek, summary statistics (mean, 95th percentile, maximum; Tables 3.2-3.3) were calculated from all raw sediment quality data (Appendix Tables A.1-A.2), with the exclusion of 1996 data (the results for which included clear outliers). Calculated 95th percentiles represent the historical reference values for each upper and lower Hazeltine Creek, and were used for interpretation of the 2014 Hazeltine Creek sediment quality data presented in this report to identify analytes meaningfully greater than historical reference.

The benthic invertebrate community of Hazeltine Creek was evaluated during baseline studies in 1995, 1996 (HKP 1996; HKP 1997) and during mine operations in 1999 and 2007 (Beak 2000; Minnow 2009). Benthic community indices (Table 3.4) were calculated based only on taxa that were included in the analysis of 2014 benthic invertebrate community data collected for this report (i.e., to ensure defensible comparisons, taxon exclusions outlined in Section 4.5.3 were applied to the historic data). In addition, taxon counts for larval, juvenile, or indeterminate organisms in historic data were considered redundant where an adult stage had been identified for the same taxon, and were excluded from taxon richness calculations. The benthic invertebrate community characteristics of upper and lower Hazeltine Creek were relatively stable from 1995 to 2007 (Table 3.4), with the exception of lower benthic invertebrate densities for both upper

Table 3.4: Benthic invertebrate community indices measured in erosional areas of upper and lower Hazeltine Creek, 1995 - 2007 [1].

Location	Date	Data Source	Mean Density (organisms/m^2)	Mean Taxon Richness	EPT (%)	Sampling Method
W7 (Upper Hazeltine Creek)	1995 - Sept 27	HKP (1996)	24,659	30	76	Surber
	1995 - Oct 9	HKP (1996)	29,048	32	74	Surber
	1995 - Oct 15	HKP (1996)	52,330	33	77	Surber
	1996 - Sept 25	HKP (1997)	16,965	37	53	Surber
	1996 - Oct 1	HKP (1997)	15,573	37	43	Surber
	1996 - Oct 8	HKP (1997)	7,721	31	56	Surber
	1999	Beak (2000)	38,420	41	56	Surber
	2007	Minnow (2009)	39,213	41	53	Surber
W11 (Lower Hazeltine Creek)	1995 - Sept 27	HKP (1996)	6,059	22	72	Surber
	1995 - Oct 9	HKP (1996)	23,829	25	45	Surber
	1995 - Oct 15	HKP (1996)	39,003	37	70	Surber
	1996 - Sept 25	HKP (1997)	5,744	30	10	Coffee Can
	1996 - Oct 6	HKP (1997)	3,667	6	19	Soup Can
	1996 - Oct 13	HKP (1997)	3,133	5	13	Soup Can
	1999	Beak (2000)	13,345	34	74	Surber
	2007	Minnow (2009)	32,596	42	53	Surber

[1] Taxa which were excluded from the benthic invertebrate endpoint calculations for the 2014 data (see section 4.5.3) were also excluded from the density and taxon richness calculations for the displayed historic data. Hydracarina were not identified beyond this taxonomic level in 1999 data for W7 and W11 (Beak 2000), or 1996-Oct 6 data for W11 (HKP 1997); Hydracarina (where present) were identified to lower taxonomic levels for all other displayed data sets. Ceratopogonidae (where present) were identified beyond the family level for all data sets except 1995-Oct 9 for W7 and W11 (HKP 1996).

and lower Hazeltine Creek (W7 and W11) in 1996 (HKP 1997). For lower Hazeltine Creek (W11), these lower densities may have been a result of the differing sampling methods in comparison to other years (Table 3.4). Taking all sampling years into account, Upper Hazeltine Creek had densities ranging between approximately 7,721 to 52,330 organisms/m^2, a taxon richness of 30 to 41, and a high proportion (43 to 76%) of metal intolerant taxa of the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT; mayflies, stoneflies, and caddisflies). The benthic invertebrate community of lower Hazeltine Creek, excluding data from 1996 (HKP 1997 due to unusual collection methodology and associated outlying results), had densities of approximately 6,059 to 39,003 organisms/m^2, taxon richness of 22 to 42, and a similarly high proportion metal intolerant EPT taxa (45 to 74%; Table 3.4). Community condition observed in 2007 (Minnow 2009) was similar to baseline, and the continued dominance of metal intolerant EPT taxa in Hazeltine Creek was considered indicative of good ecosystem health. The benthic community data collection in 2007 (Minnow 2009) in upper and lower Hazeltine Creel was conducted using an approach consistent with the Environmental Effects Monitoring (EEM) program under the Metal Mining Effluent Regulations (MMER) of the federal *Fisheries Act* (Environment Canada 2012a; Government of Canada 2015). These 2007 data for Hazeltine Creek and the associated reference areas (in Cedar and Whiffle Creeks) can therefore be used in the future for a before-after-control-impact approach to assess benthic invertebrate community recovery within Hazeltine Creek over time.

3.3 Polley Lake

The sediment quality of Polley Lake has been assessed both prior to the development of the mine, as part of baseline studies conducted for Mount Polley Mine in 1989, 1995, and 1996 (Imperial Metals 1990, HKP 1996, HKP 1997), as well as following the initiation of mine operations (Beak 2000; Minnow 2011, 2013b). Metal concentrations reported in 1989 (Imperial Metals 1990) and October 1996 (HKP 1997) were based on the <0.149 mm and <63 µm sediment fractions, respectively.

Sampling has been conducted within the two deepest areas of Polley Lake (Stations P1, P2, and L; 30 to 36 m depth), as well as at several mid-depth areas throughout the lake (approximately 0.5 to 20 m depth; Figure 3.2). The characterization of sediment quality during baseline (Imperial Metals 1990, HKP 1996, HKP 1997) reported concentrations of chromium, copper, manganese, mercury, and nickel for all sampling events above the TELs (Table 3.5; Appendix Table A.3), and concentrations of arsenic, cadmium, iron, and selenium elevated above TELs during one or more sampling events. Baseline concentrations of copper also exceeded the PEL in all instances (with concentrations up

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MAP INFORMATION
Datum: NAD 1983 Map Projection: Zone 10U
Data Source: Department of Natural Resources Canada. All rights reserved.
Created By: R. Sutherland
Creation Date: March 2015
Project No.: 2542

Legend

- Deep, Historical Benthic Invertebrate and Sediment Sampling Stations
- Mid-depth, Historical Sediment Sampling Stations
- Mid-depth, Historical Benthic Invertebrate and Sediment Sampling Stations
- Bootjack Creek Dam
- Water Collection Ditch
- Mine Infrastructure
- Waterbody
- Bootjack Lake Bathymetry (5 m Intervals)
- Polley Lake Bathymetry (10 m Intervals)
- Watercourse
- Road
- Water Flow Direction

For sites P1 and P2, only the most recent locations are shown. The sampling coordinates varied in past years for these sites.

Figure 3.2: Polley Lake Sediment and Benthos Sampling Stations, 1989-2012

Created by:
minnow environmental inc.

Table 3.5: Sediment quality of Polley Lake, 1989 - 2012 [1].

Analyte	Units	BC SQG [2]		1989 Imperial Metals (1990) [a]		May-95 HKP (1996)				May-96 HKP (1997)				Oct-96[4] HKP (1997)			
		TEL	PEL	L [3]	B	P1 [b] (mean)	Standard deviation	P2 [c] (mean)	Standard deviation	P1 (mean)	Standard deviation	P2 (mean)	Standard deviation	P1 [d] (mean)	Standard deviation	P2 [d] (mean)	Standard deviation
Station depth (m)				**~30**	**~6**	**30.7**		**30.4 - 30.7**		**31**		**30.5**		**29.3**		**29.0**	
Physical Characteristics																	
% Gravel (>2mm)	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Sand (2.0mm - 0.063mm)	%	-	-	32	88	21	-	30	-	-	-	-	-	27	3.6	29	3.5
% Silt (0.063mm - 4µm)	%	-	-	32	8.2	50	-	47	-	-	-	-	-	59	2.2	59	4.0
% Clay (<4µm)	%	-	-	36	3.8	29	-	23	-	-	-	-	-	14	3.0	13	0.5
Total Organic Carbon	%	-	-	-	-	18.4	0.21	18.9	0.21	20.7	0.2	20.7	0.1	-	-	-	-
Metals																	
Aluminum	mg/kg	-	-	13,100	6,700	-	-	-	-	-	-	-	-	-	-	-	-
Antimony	mg/kg	-	-	-	-	0.81	0.08	0.90	0.17	0.79	0.07	0.84	0.03	0.68	0.53	1.10	0.48
Arsenic	mg/kg	5.9	17	15.5	2.25	5.55	0.42	5.84	0.45	5.30	0.47	4.70	1.14	4.65	0.20	5.73	0.70
Barium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Beryllium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bismuth	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boron	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	mg/kg	0.6	3.5	-	-	0.63	0.06	0.57	0.06	0.30	0.35	0.27	0.29	0.33	0.15	0.23	0.06
Calcium	mg/kg	-	-	15,900	9,000	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	mg/kg	37.3	90	61	26	59	0	62	2.1	68	1.0	65	1.0	52	5.1	56	10
Cobalt	mg/kg	-	-	18	13	-	-	-	-	-	-	-	-	-	-	-	-
Copper	mg/kg	35.7	197	282	50	346	9.0	385	11	370	8.7	347	5.7	262	33	289	35
Iron	mg/kg	21,200	43,776	60,600	17,700	30,700	2,730	28,700	1,560	29,600	557	28,900	300	18,400	1,190	19,700	2,350
Lead	mg/kg	35	91	9.5	<5.0	18	1.0	14	3.1	16	0.6	14	3.1	8	2.3	10	2.1
Lithium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium	mg/kg	-	-	12,900	6,300	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	mg/kg	460	1,100	2,140	469	1,580	89	1,680	251	1,640	32	1,550	10	645	87	1,010	236
Mercury	mg/kg	0.17	0.49	0.21	0.04	0.26	0.02	0.25	0.03	0.23	0.01	0.21	0.01	0.23	0.058	0.18	0.018
Molybdenum	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	mg/kg	16	75	42	14	39	1.2	41	1.5	42	1.5	38	2.0	32	3.1	35	5.8
Phosphorus	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phosphorus, Total	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	mg/kg	2	-	-	-	1.7	0.15	1.9	0.10	2.6	0.20	2.4	0.10	1.7	0.10	2.0	0.26
Silver	mg/kg	0.5	-	-	-	-	-	-	-	<0.1	0	<0.1	0	0.4	0.1	0.4	0.06
Sodium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfur, Total	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Titanium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	mg/kg	-	-	109	57.3	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	mg/kg	123	315	99	46	94	2.0	99	5.1	98	1.5	93	1.2	77	5.5	82	12

[1] All values reported as < method detection limit (MDL) were used at the MDL value for calculation of summary statistics. If all reported values were < MDL, the mean is reported as < MDL.
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b) - TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Station L assessed in 1989 is equivalent to station P2 assessed in following sampling years. Concentrations reported in 1989 were for the <0.149mm fraction only. Station depths for 1989 were approximated from a bathymetric map.
[4] Concentrations reported in October 1996 were for the silt and clay (<63µm) fraction only.
[5] Summary statistics for mid-depth areas include data from stations B (1989), PL-1 to PL-5 (May 2009), A to C (October 2009), and POL-1 to POL-5 (2012).
[a] Particle size fractions for these samples are as follows: sand (0.053mm-2.0mm), silt (0.002mm-0.053mm), clay (<0.002mm).
[b] Particle size results for this station are based on one composite sample and the size fractions are as follows: sand (2.0mm-0.0705mm), silt (0.0705mm-0.0041mm), clay (<0.0041mm).
[c] Particle size results for this station are based on one composite sample,and the size fractions are as follows: sand (2.0mm-0.0675mm), silt (0.0675mm-0.0041mm), clay (<0.0041mm)
[d] Particle size fractions for these samples are as follows: sand (2.0mm-0.063mm), silt (0.063mm-0.0040mm or 0.0039mm), clay (<0.0040mm or 0.0039mm)
[e] Reported sand fraction also included silt and clay fractions (< 0.002mm-2mm).

(blue) indicates a mean concentration greater than the BCSQG TEL.
(orange) indicates a mean concentration greater than the BCSQG PEL.

Table 3.5: Sediment quality of Polley Lake, 1989 - 2012 [1].

Analyte	Units	BC SQG [2]		1999 Beak (2000)				May-09 Minnow (2011)		Oct-09 Minnow (2011)				2012 Minnow (2013b)				Summary Statistics (Deep Areas P1 and P2)			Summary Statistics (Mid-depth) [5]		
		TEL	PEL	P1 (mean)	Standard deviation	P2 (mean)	Standard deviation	PL-1 to PL-5 (mean)	Standard deviation	P1	P2	A, B, C (mean)	Standard deviation	P1	P2	POL-1 to POL-5 (mean)	Standard deviation	Mean	95th Percentile	Maximum	Mean	95th Percentile	Maximum
Station depth (m)				**18**		**18**		**11 - 12**		**36.3**	**25.3**	**0.40 - 0.71**		**33.5**	**32.6**	**19.3 - 20.2**							
Physical Characteristics																							
% Gravel (>2mm)	%	-	-	-	-	-	-	1.0	0	<1.0	<1.0	1	0	<0.1	<0.1	-	-	-	-	-	-	-	-
% Sand (2.0mm - 0.063mm)	%	-	-	100[e]	-	100[e]	-	38	16	1.0	1.0	76	18	0.9	0.7	-	-	-	-	-	-	-	-
% Silt (0.063mm - 4µm)	%	-	-	-	-	-	-	53	13	56	53	18	15	88	87	-	-	-	-	-	-	-	-
% Clay (<4µm)	%	-	-	-	-	-	-	9.2	3.2	43	46	6	3	11	12	-	-	-	-	-	-	-	-
Total Organic Carbon	%	-	-	14.0	-	18.0	-	6.8	2.7	15.5	16.9	0.5	0.4	12.7	14.6	14.9	3.1	18.2	20.8	20.9	8.4	16.6	17.1
Metals																							
Aluminum	mg/kg	-	-	15,700	577	14,700	1,530	-	-	-	-	-	-	21,900	18,700	-	-	16,078	20,620	21,900	6,700	6,700	6,700
Antimony	mg/kg	-	-	<0.20	0.00	<0.20	0.00	<10	0.00	<10	<10	<10	0.00	0.46	0.43	-	-	0.67	1.22	1.65	<10	<10	<10
Arsenic	mg/kg	5.9	17	8.13	0.96	5.30	0.26	6.28	2.49	5.50	6.40	8.10	5.37	8.86	7.18	-	-	6.17	8.94	15.50	6.44	12.9	14.3
Barium	mg/kg	-	-	170	20	133	5.8	114	19.4	145	167	87.8	50.5	212	239	-	-	167	227	239	104	141	141
Beryllium	mg/kg	-	-	0.57	0.06	0.47	0.06	0.54	0.05	<0.5	0.58	0.51	0.01	0.66	0.55	-	-	0.54	0.63	0.66	0.53	0.60	0.63
Bismuth	mg/kg	-	-	0.2	0.06	0.3	0.1	-	-	-	-	-	-	<0.2	<0.2	-	-	0.2	0.4	0.4	-	-	-
Boron	mg/kg	-	-	16	1.2	16	0.58	-	-	-	-	-	-	-	-	-	-	16	17	17	-	-	-
Cadmium	mg/kg	0.6	3.5	0.40	0.00	0.40	0.10	<0.5	0.00	0.67	0.63	0.58	0.14	0.57	0.42	-	-	0.42	0.69	0.70	0.53	0.66	0.74
Calcium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	15,800	13,200	-	-	14,967	15,890	15,900	9,000	9,000	9,000
Chromium	mg/kg	37.3	90	39	1.7	43	9.2	35	5.9	37	50	32	16	47	41	-	-	54	68	69	33	46	49
Cobalt	mg/kg	-	-	11	0	10	0.8	10	1.5	9.8	12	11	2.7	14	12	-	-	12	16	18	11	13	13
Copper	mg/kg	35.7	197	170	12	193	21	226	110	239	313	211	315	369	253	-	-	295	380	397	201	510	574
Iron	mg/kg	21,200	43,776	31,000	3,606	23,700	1,530	-	-	-	-	-	-	35,100	41,000	-	-	28,474	39,230	60,600	17,700	17,700	17,700
Lead	mg/kg	35	91	12	1.0	15	1.7	<30	0	<30	<30	<30	0	14	12	-	-	13	18	19	<30	<30	<30
Lithium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	18.0	13.3	-	-	15.7	17.8	18.0	-	-	-
Magnesium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	9,380	7,560	-	-	9,947	12,548	12,900	6,300	6,300	6,300
Manganese	mg/kg	460	1,100	3,170	208	2,200	346	-	-	-	-	-	-	1,630	3,850	-	-	1,779	3,310	3,850	469	469	469
Mercury	mg/kg	0.17	0.49	0.20	0.01	0.24	0.01	0.14	0.04	0.22	0.29	0.10	0.08	-	-	-	-	0.23	0.29	0.30	0.12	0.18	0.20
Molybdenum	mg/kg	-	-	1.3	0.12	1.5	0.40	<4.0	0	4.6	5.7	4.4	0.75	6.3	5.6	-	-	3.1	6.1	6.3	4.2	4.8	5.3
Nickel	mg/kg	16	75	27	1.2	31	5.6	22	4.1	26	34	13.8	2.8	34	30	-	-	35	43	44	18	25	25
Phosphorus	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	1,790	3,490	-	-	2,640	3,405	3,490	-	-	-
Phosphorus, Total	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	2,680	9,390	-	-	6,035	9,055	9,390	-	-	-
Potassium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	1,600	1,420	-	-	1,510	1,591	1,600	-	-	-
Selenium	mg/kg	2	-	1.8	0.17	1.7	0.06	1.2	0.43	2.5	3.7	0.51	0.01	6.3	6.9	5.0	1.5	2.4	5.4	6.9	2.5	6.0	6.5
Silver	mg/kg	0.5	-	0.3	0.06	0.3	0	<2.0	0	<2.0	<2.0	<2.0	0	0.4	0.3	-	-	0.3	0.4	0.5	<2.0	<2.0	<2.0
Sodium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	570	360	-	-	465	560	570	-	-	-
Strontium	mg/kg	-	-	110	10.0	106	7.5	-	-	-	-	-	-	127	117	-	-	111	125	127	-	-	-
Sulfur, Total	mg/kg	-	-	-	-	-	-	2,290	692	6,530	8,470	2,200	2,830	10,600	13,400	-	-	9,750	12,980	13,400	2,260	4,651	5,470
Thallium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	0.11	0.096	-	-	0.10	0.11	0.11	-	-	-
Tin	mg/kg	-	-	0.5	0.06	0.8	0.06	<5.0	0	<5.0	<5.0	<5.0	0	<2.0	<2.0	-	-	0.7	0.8	0.8	<5.0	<5.0	<5.0
Titanium	mg/kg	-	-	400	10.0	350	45.8	-	-	-	-	-	-	855	660	-	-	471	787	855	-	-	-
Uranium	mg/kg	-	-	1.4	0.06	1.4	0.1	-	-	-	-	-	-	1.2	1.1	-	-	1.3	1.5	1.5	-	-	-
Vanadium	mg/kg	-	-	57	1.7	48	6.0	83	25	88	93	114	38	112	90	-	-	73	111	112	90	137	143
Zinc	mg/kg	123	315	62	0	65	5.3	61	10	59	74	51	30	91	71	-	-	83	99	105	56	83	86

[1] All values reported as < method detection limit (MDL) were used at the MDL value for calculation of summary statistics. If all reported values were < MDL, the mean is reported as < MDL.
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b) - TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Station L assessed in 1989 is equivalent to station P2 assessed in following sampling years. Concentrations reported in 1989 were for the <0.149mm fraction only. Station depths for 1989 were approximated from a bathymetric map.
[4] Concentrations reported in October 1996 were for the silt and clay (<63µm) fraction only.
[5] Summary statistics for mid-depth areas include data from stations B (1989), PL-1 to PL-5 (May 2009), A to C (October 2009), and POL-1 to POL-5 (2012).
[a] Particle size fractions for these samples are as follows: sand (0.053mm-2.0mm), silt (0.002mm-0.053mm), clay (<0.002mm).
[b] Particle size results for this station are based on one composite sample and the size fractions are as follows: sand (2.0mm-0.0705mm), silt (0.0705mm-0.0041mm), clay (<0.0041mm).
[c] Particle size results for this station are based on one composite sample,and the size fractions are as follows: sand (2.0mm-0.0675mm), silt (0.0675mm-0.0041mm), clay (<0.0041mm)
[d] Particle size fractions for these samples are as follows: sand (2.0mm-0.063mm), silt (0.063mm-0.0040mm or 0.0039mm), clay (<0.0040mm or 0.0039mm)
[e] Reported sand fraction also included silt and clay fractions (< 0.002mm-2mm).

(blue) indicates a mean concentration greater than the BCSQG TEL.
(orange) indicates a mean concentration greater than the BCSQG PEL.

to 385 mg/kg), and iron and manganese exceeded the PEL during one or more sampling event. Only one sample was collected during baseline studies from mid-depth areas in Polley Lake (Station B; Imperial Metals 1990), with reported concentrations of copper and manganese exceeding the TEL (Table 3.5). It should be noted that metal concentrations reported for 1989 (Imperial Metals 1990) and October 1996 (HKP 1997) were based on the <0.149 mm and <63 µm sediment fractions, respectively.

Following the initiation of mine operations, evaluation of whole sediment quality from the basin stations within Polley Lake has confirmed that arsenic, cadmium, chromium, iron, manganese, mercury, nickel, and selenium remained at concentrations higher than TEL (Table 3.5; Appendix Table A.3). Concentrations of copper, which are locally elevated and were above PEL during baseline, remained above PEL (with concentrations up to 369 mg/kg observed in 2012). Manganese concentrations increased approximately two-fold relative to concentrations observed prior to and including 1999 (at station P2 only) with the highest concentration reported for the most recent sampling event in 2012 (Minnow 2013b). Similarly, the highest observed concentrations for selenium and molybdenum were reported for the most recent sampling event (2012), with concentrations approximately 3 to 4 times higher than those reported during or prior to 1999. Silver concentrations were above TEL subsequent to baseline, but these were due to a method detection limit above the TEL (Table 3.5). Such increases must be interpreted with caution because baseline sediment collections were conducted using an Ekman grab or ponar (Imperial Metals 1990; HKP 1996; HKP 1997) whereas subsequent collections were by gravity corer which generally collects fine surficial sediment more effectively. Within mid-depth sampling areas, studies subsequent to baseline (Minnow 2011; Minnow 2013b) have confirmed that copper concentrations remained elevated above TEL, however were also found to be higher than the PEL (Table 3.5). Mean concentrations of arsenic, nickel, selenium, and silver also exceeded TEL subsequent to baseline studies (Table 3.5), whereas concentrations of these analytes were below TELs during baseline. Silver concentrations, however, were all below the detection limit.

Concentrations of selenium at mid-depth stations were highest during the most recent sampling year (Minnow 2013b), but were also associated with higher total organic carbon content in the sediment than in other sampling years (Table 3.5). Similar to the basin sediment results, these observed differences in sediment quality at mid-depth stations over time must be interpreted with caution because higher metal concentrations observed in 2009 and 2012 were associated with a higher content of fine sediment particles captured (< 63µm), and the baseline sediment quality data was based on one sample.

Summary statistics (mean, 95th percentile, maximum; Table 3.5) were calculated for both the basin and mid-depth sampling areas within Polley Lake from all raw sediment quality data for each area (Appendix Table A.3). Calculated 95th percentiles represent the historical reference values for each of the basin and mid-depth sampling areas of Polley Lake, and were used for interpretation of the respective 2014 Polley Lake sediment quality data (for basin or mid-depth areas) presented in this report. For mid-depth sampling areas, 95th percentile historical reference values could only be calculated for the reduced set of analytes reported, and as such there is a reduced list of historical reference values for use in interpretation of 2014 data.

The benthic invertebrate community of Polley Lake was assessed during baseline studies (1989-1996) as well as in 1999. All samples were collected within each of the two deep basins (P1 and P2 or L) with the exception of the benthic invertebrate samples collected at the mid-depth station B in 1989 (Figure 3.2). Similar to the approach used for the Hazeltine Creek benthic community data, benthic community indices (Table 3.6) are based only on taxa that were included in the analysis of 2014 benthic invertebrate community data in the present report (i.e., to ensure defensible comparisons, taxon exclusions outlined in Section 4.5.3 were applied), and taxa considered redundant (counts of larval, juvenile, or indeterminate organisms where an adult stage had been identified for the same taxon), were excluded from taxon richness calculations. Within the basins of Polley Lake, the density of the benthic invertebrate community ranged from 77 to 1,048 organisms/m^2, and taxon richness ranged from 1 to 12 (Table 3.6). The temporal differences in benthic invertebrate density and taxon richness within each station are quite large, with the highest values observed in 1999 at both P1 and P2. For instance, mean invertebrate densities in 1999 observed at P1 and P2 were 4 and 13 times higher, respectively, than those measured in October 1995, and taxon richness was 6 and 8 times higher, respectively (Table 3.6). Although there may be some differences in taxon richness values among sampling years due to the level of identification achieved by differing taxonomists (Table 3.6) the reasons for the large differences in density among years are unclear given that detailed sample collection and laboratory processing protocols are not available. The large differences in benthic invertebrate density among years should be considered in the interpretation of results collected in 2014. Benthic invertebrate community species composition in Polley Lake has been dominated by Chironomidae (midges) and Oligochaetae (worms).

Table 3.6: Benthic invertebrate community indices in Polley Lake, 1989 - 1999 [1].

Date	Data Source	Location	Depth (m)	Mean density (organisms/m²)	Mean taxon richness	Sampling Method
1989 - Aug	Imperial Metals (1990) [2]	B	8	1,685	11	Standard ponar; 355 µm seive used in laboratory
		L [3]	20	77	4	Standard ponar; 355 µm seive used in laboratory
1995 - May	HKP (1996)	P1	30.7	417	3	Ekman; 200 µm seive used in laboratory
		P2	30.4 - 30.7	139	2	Ekman; 200 µm seive used in laboratory
1995 - Oct	HKP (1996)	P1	26.5	104	2	Ekman; 200 µm seive used in laboratory
		P2	26.5	78	1	Ekman; 200 µm seive used in laboratory
1996 - May	HKP (1997)	P1	31	87	1	Ekman; unspecified seive size
		P2	30.5	235	2	Ekman; unspecified seive size
1999 - Aug	Beak (2000)	P1	18	448	12	Petite ponar; 200 µm seive size
		P2	18	1,048	8	Petite ponar; 200 µm seive size

[1] Taxa which were excluded from the benthic invertebrate endpoint calculations for the 2014 data in the present report (see section 4.5.3) were also excluded from the density and taxon richness calculations for the displayed historic data. Taxa identified as Hydracarina were not identified beyond this taxonomic level in data from October 1995 (HKP 1996) and 1999 (Beak 2000); Hydracarina (where present) were identified to lower taxonomic levels for all other data sets. Ceratogonidae (where present) were identified beyond the family level for all displayed data sets.

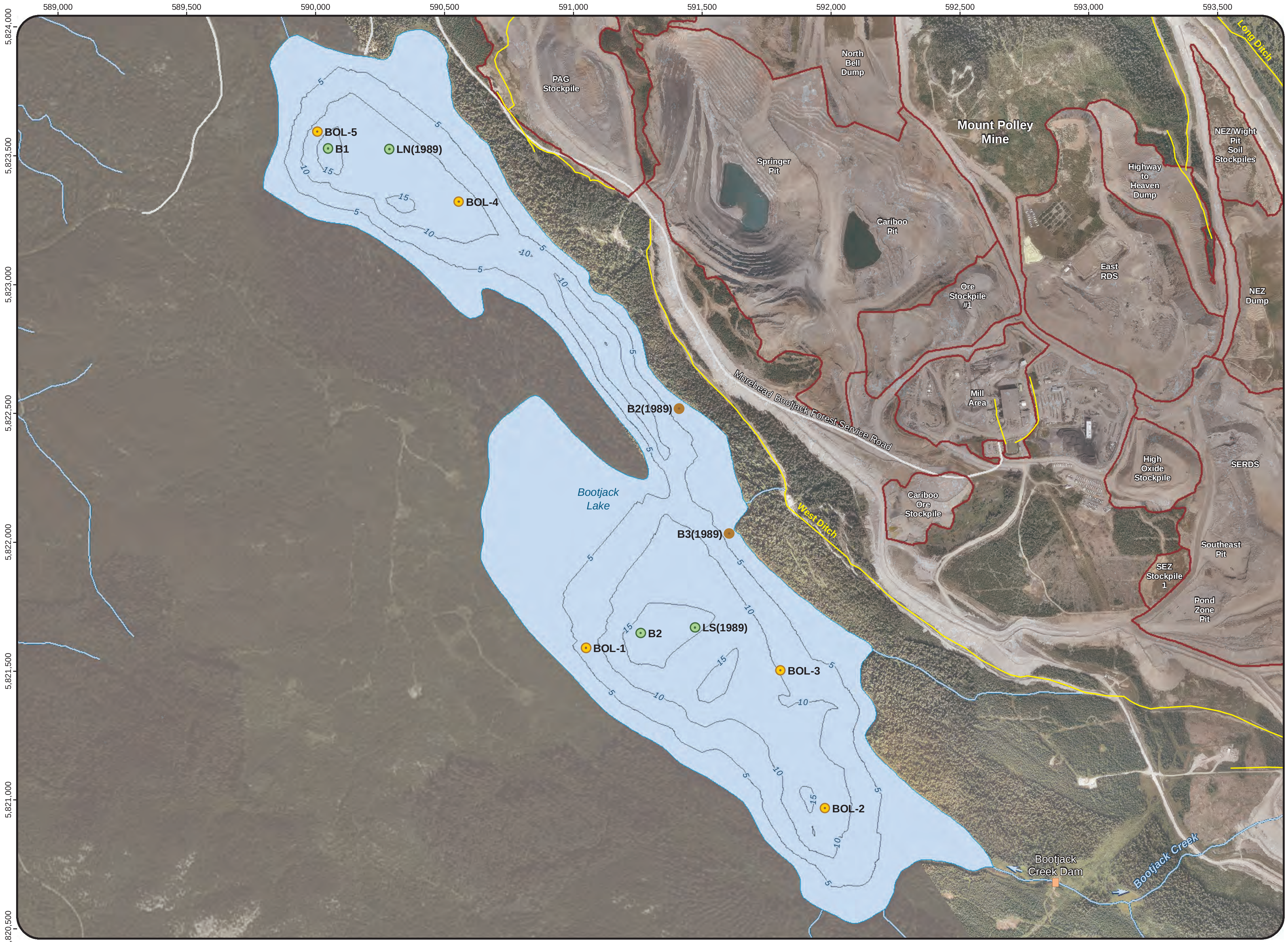
[2] Density and taxon richness values shown for 1989 data are based on single samples and are not mean values.

[3] Station L assessed in 1989 is equivalent to station P2 assessed in following sampling years.

3.4 Bootjack Lake

Sediment quality in Bootjack Lake has been characterized both prior to mine development during baseline (Imperial Metals 1990, HKP 1996, HKP 1997), as well as following baseline (Beak 2000; Minnow 2011, 2013b). Sampling has been conducted within the two deepest areas (basins) of Bootjack Lake (B1, B2, LN, and LS; 10 to 17 m depth), and within several mid-depth stations throughout the lake (3 to approximately 12 m depth; Figure 3.3), although sampling efforts have generally been focused within the deep basin areas. Sediment quality of the basin areas sampled during baseline studies (Imperial Metals 1990, HKP 1996, HKP 1997) have shown concentrations of manganese, mercury, and nickel above the TEL guidelines, and concentrations of copper above the PEL in both basins for all baseline sampling events (Table 3.7; Appendix Table A.4). In addition, concentrations of arsenic, chromium, iron, and selenium have exceeded the TEL during one or more sampling events (Table 3.7). The sediment quality of mid-depth sites was evaluated at two stations during the 1989 baseline study (Imperial Metals 1990), and reported concentrations of arsenic, chromium, iron, manganese, and nickel exceeded TELs at one or both stations, and copper concentrations exceeded the PEL at both stations (Table 3.7). Metal concentrations reported for 1989 (Imperial Metals 1990) and October 1996 (HKP 1997) were based on the <0.149 mm and <63 µm sediment fractions, respectively.

The assessment of sediment quality in the deep basins of Bootjack Lake following mine development demonstrated that concentrations of arsenic, chromium, iron, manganese, mercury, nickel and selenium have remained elevated above the TEL, and concentrations of copper also remained higher than the PEL (Table 3.7). Sediment cadmium concentrations exceeded the TEL in 2009 (the highest reported cadmium concentrations), whereas cadmium concentrations during baseline were below TEL. This was also true for silver, however all silver results exceeding the guideline were less than the method detection limit (Table 3.7). Generally, sediment metal concentrations were similar both before and following the initiation of mine operations, with the exception of cadmium (discussed above), manganese, titanium, and vanadium (Table 3.7). Manganese concentrations were highest in the most recent sampling event (2012), and were approximately double those concentrations reported prior to and including 1996 (Imperial Metals 1990; HKP 1996; HKP 1997). Concentrations of both titanium and vanadium reported in 2009 and 2012 were approximately double those reported during 1999 sampling (concentrations of these metals were not reported prior to 1999).



Legend

- Deep, Historical Benthic Invertebrate and Sediment Sampling Stations
- Mid-depth, Historical Sediment Sampling Stations
- Mid-depth, Historical Benthic Invertebrate and Sediment Sampling Stations
- Bootjack Creek Dam
- Water Collection Ditch
- Mine Infrastructure
- Waterbody
- Bootjack Lake Bathymetry (5 m Intervals)
- Watercourse
- Roads
- Water Flow Direction

Note: For sites B1 and B2, only the most recent locations are shown. The sampling coordinates varied in past years for these sites.

N W E S

0 150 300 450 600 750
Metres

MAP INFORMATION
Datum: NAD 83 Map Projection: UTM Zone 10U
Data Source: Department of Natural Resources Canada. All rights reserved.
Created By: R. Sutherland
Creation Date: March 2015
Project No.: 2542

Figure 3.3: Bootjack Lake Sediment and Benthos Sampling Stations, 1989-2012

Created by:
minnow environmental inc.

Table 3.7: Sediment Quality of Bootjack Lake, 1989 - 2012 [1].

Analyte	Units	BC SQG [2]		1989 [3]				May-95				May-96				Oct-96[4]				1999			
				Imperial Metals (1990) [a]				HKP (1996)				HKP (1997)				HKP (1997)				Beak (2000)			
		TEL	PEL	LN (North Basin)	LS (South Basin)	B2	B3	B1 [b] (mean)	Standard deviation	B2 [b] (mean)	Standard deviation	B1 (mean)	Standard deviation	B2 (mean)	Standard deviation	B1 [c] (mean)	Standard deviation	B2 [c] (mean)	Standard deviation	B1 (mean)	Standard deviation	B2 (mean)	Standard deviation
Station depth (m)				~9	~13	~3	~5	17.1		15.7		13.5		13.5		10.1		14.3		10		11	
Physical Characteristics																							
% Gravel (>2mm)	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-
% Sand (2.0mm - 0.063mm)	%	-	-	27	29	7.8	76	21	-	14	-	-	-	-	-	21	0.2	12	2.1	100[d]	-	100[d]	-
% Silt (0.063mm - 4µm)	%	-	-	31	28	61	13	54	-	58	-	-	-	-	-	63	6.2	70	3.2	-	-	-	-
% Clay (<4µm)	%	-	-	43	43	31	11	26	-	29	-	-	-	-	-	15	6.0	18	3.4	-	-	-	-
Total Organic Carbon	%	-	-	-	-	-	-	18.0	0.1	18.5	0.1	20.4	0.2	21.5	0.2	-	-	-	-	11	-	20	-
Metals																							
Aluminum	mg/kg	-	-	12,800	13,000	13,300	11,000	-	-	-	-	-	-	-	-	-	-	-	-	10,600	693	15,700	577
Antimony	mg/kg	-	-	<0.05	<0.05	<0.05	<0.05	1.3	0.04	1.5	0.43	1.1	0.09	1.4	0.11	1.4	0.45	1.5	0.06	<0.2	0	0.2	0
Arsenic	mg/kg	5.9	17	6.0	7.0	8.0	7.0	4.8	0.4	6.4	0.2	5.2	0.5	7.6	0.5	5.9	1.4	6.2	0.5	4.9	0.5	5.7	0
Barium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	153	5.8	257	5.8
Beryllium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.4	0.1	0.7	0
Bismuth	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	0.1	0.3	0.1
Boron	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	1.0	17	0.6
Cadmium	mg/kg	0.6	3.5	<0.25	<0.25	<0.25	<0.25	0.40	0	0.57	0.06	<0.1	0	<0.1	0	0.30	0	0.30	0.10	0.30	0	0.43	0.06
Calcium	mg/kg	-	-	12,900	11,700	18,500	20,200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	mg/kg	37	90	51	50	42	23	42	1.0	43	3.1	45	0	55	0.6	40	10	34	2.9	28	4.0	35	3.1
Cobalt	mg/kg	-	-	16	17	18	13	-	-	-	-	-	-	-	-	-	-	-	-	8.8	0.10	9.5	0.25
Copper	mg/kg	36	197	645	625	361	345	453	17.1	476	17.8	458	1.0	606	6.1	435	67	402	56	183	15.3	307	5.8
Iron	mg/kg	21,200	43,776	22,500	27,300	38,200	26,100	27,500	361	27,800	1,370	24,900	458	29,300	200	18,700	2,110	18,500	1,500	21,000	0	28,000	0
Lead	mg/kg	35	91	10	12	13	7.5	12	1.0	16	0.6	13	1.7	15	1.5	9.0	1.0	11	0.6	9.6	0.4	14	2.1
Lithium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium	mg/kg	-	-	8,800	8,600	11,200	7,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	mg/kg	460	1,100	540	763	858	694	827	18.9	916	19.4	730	17.8	925	5.7	550	22.0	685	33.6	653	20.8	1,700	100
Mercury	mg/kg	0.17	0.49	0.29	0.30	0.17	0.061	0.23	0	0.29	0.006	0.22	0.008	0.28	0.001	0.27	0.031	0.26	0.021	0.16	0.010	0.33	0.015
Molybdenum	mg/kg	-	-	7.3	9.4	<5.0	<5.0	-	-	-	-	-	-	-	-	-	-	-	-	1.2	0.10	2.0	0.10
Nickel	mg/kg	16	75	37	38	25	16	30	0.6	32	2.0	29	1.2	36	0.6	26	5.1	25	2.1	20	2.1	26	1.5
Phosphorus	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phosphorus, Total	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	mg/kg	2		-	-	-	-	2.0	0.1	1.8	0.2	2.3	0.1	3.1	0.1	1.7	0.2	1.6	0.3	<1.0	0	1.6	0.3
Silver	mg/kg	0.5		<0.25	<0.25	0.5	0.5	-	-	-	-	<0.1	0	<0.1	0	0.4	0.1	0.5	0.1	0.2	0.1	0.4	0
Sodium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	89	5.5	143	5.8
Sulfur, Total	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.7	0.1	0.6	0.1
Titanium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	387	5.8	317	23
Uranium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4	0.2	2.8	0.1
Vanadium	mg/kg	-	-	69	72	126	96	-	-	-	-	-	-	-	-	-	-	-	-	40	1.5	44	1.7
Zinc	mg/kg	123	315	102	110	105	109	92	3.5	99	4.7	89	1.2	104	0.6	91	4.6	77	5.8	58	1.5	71	2.5

[1] All values reported as < method detection limit (MDL) were used at the MDL value for calculation of summary statistics. If all reported values were < MDL, the mean is reported as < MDL.
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b) - TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Stations LN and LS assessed in 1989 are approximately equivalent to stations B1 and B2 assessed in following sampling years. Concentrations reported in 1989 were for the <0.149mm fraction only. Station depths for 1989 were approximated from a bathymetric map.
[4] Concentrations reported in October 1996 were for the silt and clay (<63µm) fraction only.
[5] Summary statistics for mid-depth areas include data from stations B2 and B3 (1989), A (2009), and BOL-1 to BOL-5 (2012).
[a] Particle size fractions for these samples are as follows: sand (2.0mm-0.053mm), silt (0.053mm-0.002mm), clay (<0.002mm).
[b] Particle size results for this station are based on one composite sample and the size fractions are as follows: sand (2.0mm-0.065mm), (0.065mm-0.0041mm), clay (<0.0041mm).
[c] Particle size fractions for these samples are as follows: sand (2.0mm-0.063mm), silt (0.063mm-0.0039 or 0.0038mm), clay (<0.0039 or < 0.0038mm).
[d] Reported sand fraction also included silt and clay fractions (< 0.002mm-2mm).

(blue) indicates a mean concentration greater than the BCSQG TEL.
(orange) indicates a mean concentration greater than the BCSQG PEL.

Table 3.7: Sediment Quality of Bootjack Lake, 1989 - 2012 [1].

Analyte	Units	BC SQG [2]		2009 Minnow (2011)			2012 Minnow (2013b)				Summary Statistics Deep Stations: (B1, B2, LN, LS)			Summary Statistics (Mid-depth Stations) [5]		
		TEL	PEL	B1	B2	A	B1	B2	BOL-1 to BOL-5 (mean)	Standard deviation	Mean	95th Percentile	Maximum	Mean	95th Percentile	Maximum
Station depth (m)				**11.7**	**12.6**	**1.3**	**19**	**17.5**	**11.8 - 12.2**							
Physical Characteristics																
% Gravel (>2mm)	%	-	-	<1.0	<1.0	5.0	<0.10	<0.10	-	-	-	-	-	-	-	-
% Sand (2.0mm - 0.063mm)	%	-	-	1.0	1.0	72	1.5	0.7	-	-	-	-	-	-	-	-
% Silt (0.063mm - 4µm)	%	-	-	60	57	19	89	91	-	-	-	-	-	-	-	-
% Clay (<4µm)	%	-	-	38	42	4.0	10	8.5	-	-	-	-	-	-	-	-
Total Organic Carbon	%	-	-	17.8	18.6	2.3	17.5	16.1	16.0	2.5	18.7	21.5	21.7	13.7	18.0	18.3
Metals																
Aluminum	mg/kg	-	-	-	-	-	17,700	19,500	-	-	14,200	18,700	19,500	12,200	13,200	13,300
Antimony	mg/kg	-	-	<10	<10	<10	0.93	1.1	-	-	1.0	1.7	2.0	3.4	<10	<10
Arsenic	mg/kg	5.9	17	6.9	6.1	6.6	6.5	7.5	-	-	6.0	7.6	8.0	7.2	7.9	8.0
Barium	mg/kg	-	-	236	274	66.8	223	306	-	-	227	292	306		66.8	
Beryllium	mg/kg	-	-	0.7	0.8	<0.5	0.6	0.8	-	-	0.6	0.8	0.8		<0.5	
Bismuth	mg/kg	-	-	-	-	-	<0.2	<0.2	-	-	0.3	0.3	0.3	-	-	-
Boron	mg/kg	-	-	-	-	-	-	-	-	-	14	17	17	-	-	-
Cadmium	mg/kg	0.6	3.5	0.90	0.81	<0.50	0.42	0.48	-	-	0.35	0.72	0.90	0.33	<0.50	<0.50
Calcium	mg/kg	-	-	-	-	-	11,900	8,050	-	-	11,100	12,800	12,900	19,400	20,100	20,200
Chromium	mg/kg	37	90	41	41	14	39	38	-	-	41	55	55	26	40	42
Cobalt	mg/kg	-	-	12	11	8.4	12	12	-	-	11	16	17	13	17	18
Copper	mg/kg	36	197	460	440	193	425	388	-	-	431	618	645	300	359	361
Iron	mg/kg	21,200	43,776	-	-	-	26,900	28,000	-	-	24,700	29,200	29,500	32,200	37,600	38,200
Lead	mg/kg	35	91	<30	<30	<30	8.0	12	-	-	12	16	16	10	13	13
Lithium	mg/kg	-	-	-	-	-	11.5	12.2	-	-	11.9	12.2	12.2	-	-	-
Magnesium	mg/kg	-	-	-	-	-	6,020	5,400	-	-	7,210	8,770	8,800	9,350	11,000	11,200
Manganese	mg/kg	460	1,100	-	-	-	1,730	1,280	-	-	903	1,720	1,800	776	850	858
Mercury	mg/kg	0.17	0.49	0.36	0.39	<0.050	-	-	-	-	0.27	0.36	0.39	0.09	0.16	0.17
Molybdenum	mg/kg	-	-	5.0	<4.0	<4.0	4.1	3.8	-	-	3.6	8.3	9.4	4.7	<5.0	<5.0
Nickel	mg/kg	16	75	28	29	7.8	29	29	-	-	29	37	38	16	24	25
Phosphorus	mg/kg	-	-	-	-	-	1,530	2,640	-	-	2,090	2,590	2,640	-	-	-
Phosphorus, Total	mg/kg	-	-	-	-	-	1,280	2,410	-	-	1,850	2,350	2,410	-	-	-
Potassium	mg/kg	-	-	-	-	-	1,360	1,420	-	-	1,390	1,420	1,420	-	-	-
Selenium	mg/kg	2		2.2	2.0	<0.50	2.7	2.3	2.4	0.4	1.9	3.1	3.1	2.1	2.8	2.9
Silver	mg/kg	0.5		<2	<2	<2	0.4	0.4	-	-	0.3	0.5	0.5	0.5	0.5	0.5
Sodium	mg/kg	-	-	-	-	-	200	210	-	-	205	210	210	-	-	-
Strontium	mg/kg	-	-	-	-	-	128	99	-	-	115	147	150	-	-	-
Sulfur, Total	mg/kg	-	-	5,830	4,320	530	7,300	5,900	-	-	5,840	7,090	7,300		530	
Thallium	mg/kg	-	-	-	-	-	0.12	0.14	-	-	0.13	0.14	0.14	-	-	-
Tin	mg/kg	-	-	<5.0	<5.0	<5.0	<2.0	<2.0	-	-	0.6	0.8	0.8		5	
Titanium	mg/kg	-	-	-	-	-	712	517	-	-	417	644	712	-	-	-
Uranium	mg/kg	-	-	-	-	-	2.5	2.4	-	-	2.2	2.9	2.9	-	-	-
Vanadium	mg/kg	-	-	75	72	61	68	76	-	-	57	75	76	94	123	126
Zinc	mg/kg	123	315	74	73	71	79	78	-	-	85	105	110	95	109	109

[1] All values reported as < method detection limit (MDL) were used at the MDL value for calculation of summary statistics. If all reported values were < MDL, the mean is reported as < MDL.
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b) - TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Stations LN and LS assessed in 1989 are approximately equivalent to stations B1 and B2 assessed in following sampling years. Concentrations reported in 1989 were for the <0.149mm fraction only. Station depths for 1989 were approximated from a bathymetric map.
[4] Concentrations reported in October 1996 were for the silt and clay (<63µm) fraction only.
[5] Summary statistics for mid-depth areas include data from stations B2 and B3 (1989), A (2009), and BOL-1 to BOL-5 (2012).
[a] Particle size fractions for these samples are as follows: sand (2.0mm-0.053mm), silt (0.053mm-0.002mm), clay (<0.002mm).
[b] Particle size results for this station are based on one composite sample and the size fractions are as follows: sand (2.0mm-0.065mm), (0.065mm-0.0041mm), clay (<0.0041mm).
[c] Particle size fractions for these samples are as follows: sand (2.0mm-0.063mm), silt (0.063mm-0.0039 or 0.0038mm), clay (<0.0039 or < 0.0038mm).
[d] Reported sand fraction also included silt and clay fractions (< 0.002mm-2mm).

(blue) indicates a mean concentration greater than the BCSQG TEL.
(orange) indicates a mean concentration greater than the BCSQG PEL.

The limited sediment quality data available from mid-depth stations in Bootjack Lake subsequent to baseline confirmed the presence of arsenic and copper concentrations greater than TEL but not PEL (Table 3.7). Reported silver concentrations also exceeded the TEL, however were based solely on results less than the method detection limit. In general, the concentrations of analytes reported in 2009 for mid-depth sampling areas were lower than those reported during the 1989 baseline study. For instance, concentrations of chromium, and nickel which exceeded TEL during baseline were lower than TEL in 2009 (iron and manganese were not reported in 2009), and copper exceeded the PEL during the 1989 baseline study but exceeded only the TEL during the 2009 study. Results from the 2009 (Minnow 2011) study, however, are based on a single sample, and different sediment particle size fractions were used within these studies (bulk sediment in 2009 vs. <0.149 mm sediment fraction in 1989); therefore caution should be taken in interpreting these differences in analyte concentrations among studies. Selenium and total organic carbon were the only analytes measured during 2012 sampling (Minnow 2013b), and the mean selenium concentration reported in the most recent sampling year (2012) was higher than that reported in 2009, but was also associated with a higher organic carbon content in the sediment and within the range of selenium concentrations reported for the basins of Bootjack Lake (Table 3.7). Summary statistics (mean, 95th percentile, maximum; Table 3.7) were calculated for both the basin and mid-depth sampling areas within Bootjack Lake from all the raw sediment quality data (Appendix Table A.4). Calculated 95th percentiles represent the historical reference values for each of the basin and mid-depth sampling areas of Bootjack Lake, and were used for interpretation of the respective 2014 Bootjack Lake sediment quality data (for basin or mid-depth areas) presented in this report.

Similar to Polley Lake, the benthic invertebrate community of Bootjack Lake was assessed during baseline studies (1989-1996) as well as in 1999. The majority of sampling has been conducted within each of the two deepest areas of the lake (basins B1 and B2), with the exception of two mid-depth stations which were sampled in 1989 (stations B2 and B3; Figure 3.3). The benthic invertebrate community indices (Table 3.8) were calculated using the same methods described in Section 3.2 (i.e. taxon exclusions outlined in Section 4.5.3 were applied, and taxa considered redundant were excluded from taxon richness calculations). The density of the benthic invertebrate community varied widely among sampling years within the basin stations of Bootjack Lake, from 35 – 5,975 organisms/m^2, and taxon richness ranged from 1 to 23 (Table 3.8). The lowest observed density and taxon richness values occurred during the 1995 and 1996 baseline study years (HKP 1996; HKP 1997), while the values for these indices observed in 1999

Table 3.8: Benthic invertebrate community indices in Bootjack Lake, 1989 - 1999 [1].

Date	Data Source	Location	Depth (m)	Mean density (organisms/m^2)	Mean taxon richness	Sampling Method
1989 - Aug	Imperial Metals (1990) [2]	LN (North Basin)	12	5,975	16	standard ponar; 355 µm seive used in laboratory
		LS (South Basin)	11	364	8	standard ponar; 355 µm seive used in laboratory
		B2	9	172	5	standard ponar; 355 µm seive used in laboratory
		B3	3	1,570	8	standard ponar; 355 µm seive used in laboratory
1995 - May	HKP (1996)	B1	17.1	35	1	Ekman; 200 µm seive used in laboratory
		B2	15.7	217	2	Ekman; 200 µm seive used in laboratory
1995 - Oct	HKP (1996)	B1	14.6	246	2	Ekman; 200 µm seive used in laboratory
		B2	14.0	98	1	Ekman; 200 µm seive used in laboratory
1996 - May	HKP (1997)	B1	13.5	104	2	Ekman; unspecified seive size
		B2	13.5	226	3	Ekman; unspecified seive size
1999 - Aug	Beak (2000)	B1	10	3,524	15	Petite ponar; 200 µm seive size
		B2	11	3,076	23	Petite ponar; 200 µm seive size

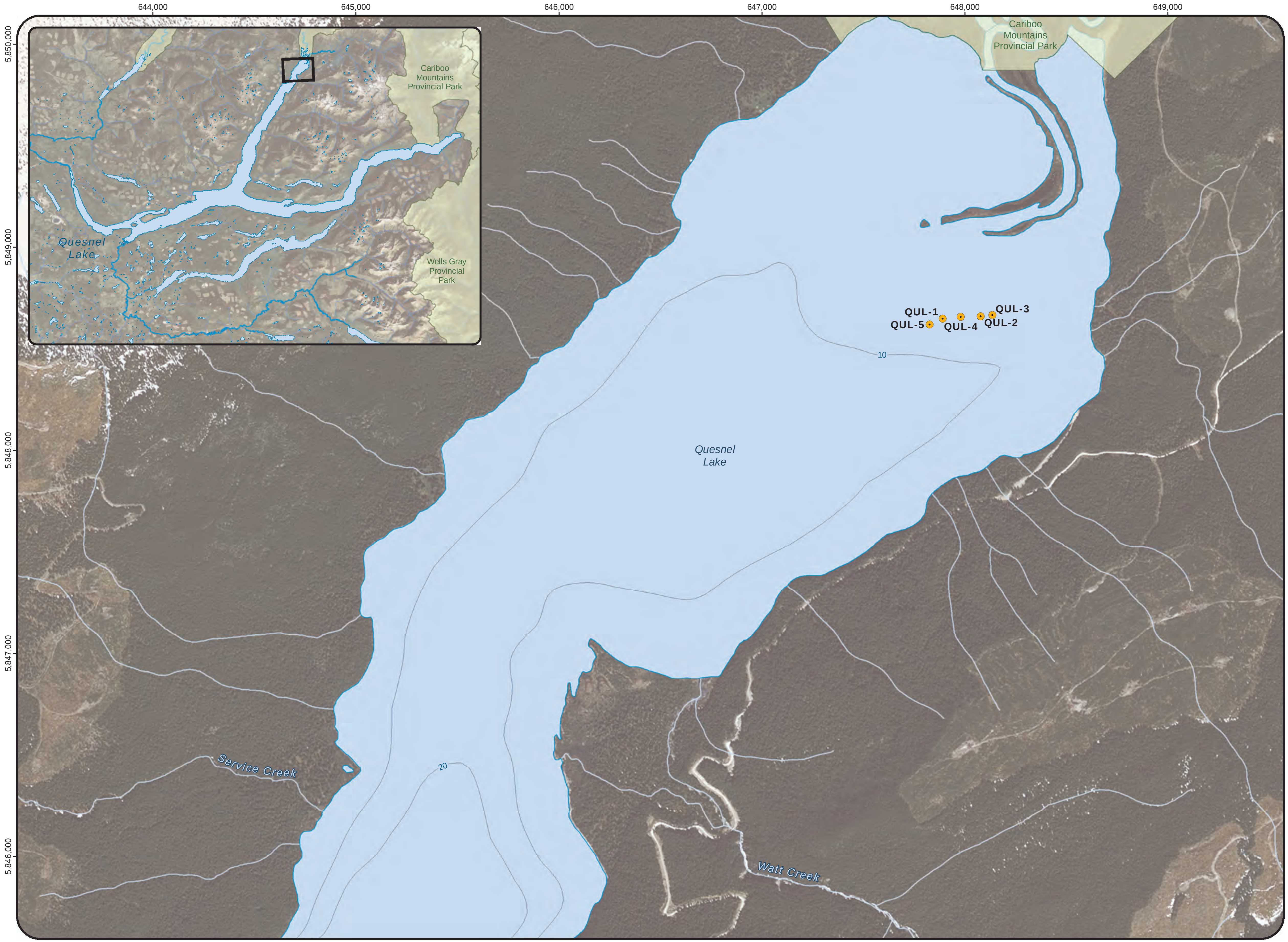
[1] Taxa which were excluded from the benthic invertebrate endpoint calculations for 2014 data in the present report (see section 4.5.3) were also excluded from the density and taxon richness calculations for the displayed historic data. Hydracarina (where present) were identified beyond this taxonomic level for all displayed data sets except 1999-Aug (Beak 2000). Ceratopogonidae (where present) were identified beyond the family level in all displayed data sets.

[2] Density and taxon richness values shown for 1989 data (Imperial Metals 1990) are based on single samples and are not mean values.

(Beak 2000) were similar to those observed during the 1989 baseline study (Imperial Metals 1990). As with the Polley Lake benthic invertebrate community data (Section 3.3), there may be some differences in taxon richness values among sampling years due to the level of identification achieved by differing taxonomists (Table 3.8), however the reasons for the large differences in density among years are unclear because detailed sample collection and laboratory processing protocols are not available for all sampling years. Within mid-depth sampling stations (B2 and B3; 1989), density ranted from 172-1,570 organisms/m^2, and taxon richness ranged from 5-8 (Table 3.8). The large differences in benthic invertebrate density among years should be considered in the interpretation of results collected in 2014. Benthic invertebrate community taxon composition in Bootjack Lake among years has been dominated by Chironomidae and Chaoboridae (midges) and Oligochaetae (worms).

3.5 Quesnel Lake

The existing historical sediment quality data for Quesnel Lake is very limited, and to the best of our knowledge, there is no historical benthic invertebrate community data available. Efforts were made to obtain historical sediment quality or benthic invertebrate community data through contact with the BC Ministry of Environment and through publication lists provided by the Quesnel River Research Centre. Unfortunately, these search efforts did not result in acquiring historical data for either sediment quality or benthic invertebrate community, and a gap in historical data exists for Quesnel Lake. Sediment was collected in 2012 (Minnow 2013b) from a littoral sampling location in the North Arm of Quesnel Lake (Figure 3.4) and was analysed for total organic carbon content and selenium concentration. The mean selenium concentration measured in 2012 at the Quesnel Lake North Arm (0.37 mg/kg) was well below the TEL guideline (Table 3.9). The calculated 95th percentiles (Table 3.9) represent the historical reference values for these analytes, and were used for interpretation of the 2014 sediment quality data from littoral sampling areas of Quesnel Lake presented in this report.



Legend

- 2012 Sampling Station
- Protected Areas
- Waterbody
- Quesnel Lake Bathymetry (10 m Intervals)
- Watercourse
- Road

N W E S

0 200 400 600 800

Metres

MAP INFORMATION
Datum: NAD 83 Map Projection: UTM Zone 10U
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Figure 3.4: Quesnel Lake Sediment Sampling Stations, 2012

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Table 3.9: Selenium concentrations and % total organic carbon in littoral sediment samples from the North Arm of Quesnel Lake, 2012

Sample ID	Units	BC SQG [1]		QUL-1	QUL-2	QUL-3	QUL-4	QUL-5	Mean	95th Percentile	Standard deviation
	Date Sampled	TEL	PEL	14-May-12	14-May-12	14-May-12	14-May-12	14-May-12			
Organic / Inorganic Carbon											
Total Organic Carbon	%	-	-	2.87	2.15	2.46	2.64	2.19	2.46	2.82	0.30
Metals											
Selenium	mg/kg	2	-	0.39	0.32	0.41	0.40	0.32	0.37	0.41	0.04

[1] British Columbia Working Sediment Quality Guidelines (BCMOE 2006) - TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

(shaded box) indicates a mean concentration greater than the BCSQG TEL.

4.0 SEDIMENT QUALITY IMPACT CHARACTERIZATION METHODS

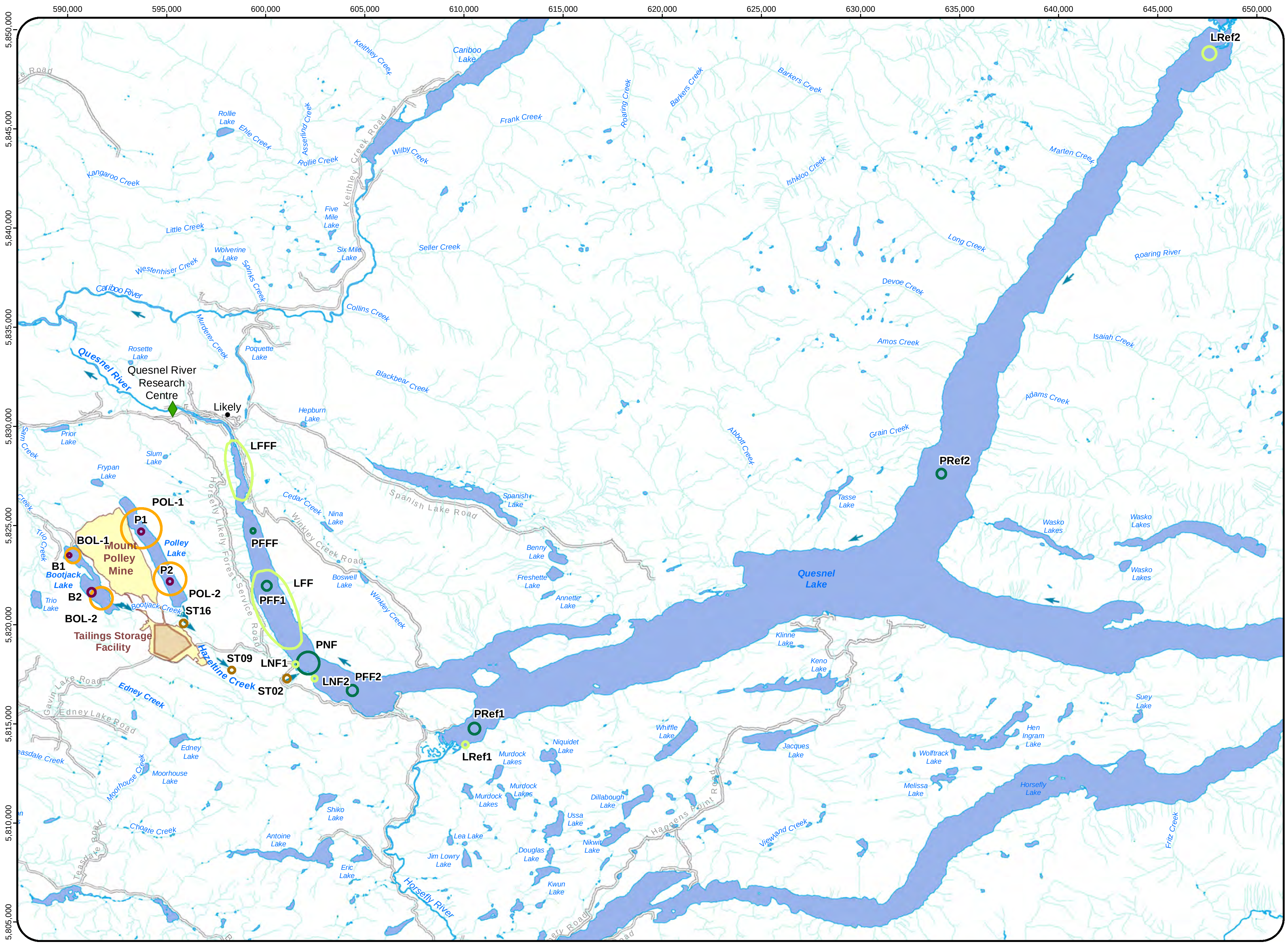
The sediment quality impact characterization (SQIC) included physical, chemical and biological data collections to address the key questions outlined in Section 2.0. The SQIC included the following general components (Table 2.1):

- Sediment chemical characterization;
- Sediment geochemical characterization, including selective chemical extraction, shake flask testing, porewater chemistry, acid-base accounting, and particle size fractionation;
- Sediment core chemistry and porewater chemistry;
- Sediment toxicity testing;
- Benthic invertebrate community characterization; and
- Benthic invertebrate tissue chemistry.

Detailed descriptions of sampling, analytical and interpretive methodology associated with each of these general components are provided in the sections that follow. These sections outline: 1) the objective of the monitoring component; 2) an overview of the Study Design; 3) a detailed description of methodology and measurements; 4) a description of laboratory analyses; and 5) a description of how data were interpreted. Whenever possible, data collection methodology was consistent with recognized guidance for field sampling and analysis (e.g., the British Columbia Field Sampling Manual [BCWLAP 2003]; Technical Guidance for Environmental Effects Monitoring [Environment Canada 2012a]; Canadian Aquatic Biomonitoring Network Protocols [Environment Canada 2012b]).

Field data collection in support of the SQIC was undertaken between August 7th and October 26th 2014. Data were collected from potentially impacted areas located downstream of the Mount Polley Mine (based on the apparent debris field) as well as at unimpacted reference areas. Study areas (Figure 4.1) included:

- Hazeltine Creek (Figure 4.2);
- Polley Lake (Figure 4.3);
- Quesnel Lake (both littoral and profundal areas; Figures 4.4 and 4.5);



Legend

- Bootjack and Polley Lakes Mid-depth Stations
- Bootjack and Polley Lakes Deep Stations
- Hazeltine Creek Stations
- Quesnel Lake Littoral Stations
- Quesnel Lake Profundal Stations
- Quesnel River Research Centre (QRRC)
- Towns
- Tailings Storage Facility
- Active Mine Operation
- Waterbody
- Watercourse
- Road
- Water Flow Direction

0 2 4 6 8
Kilometres

MAP INFORMATION
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Figure 4.1: Sediment Quality Impact Characterization Sampling Areas

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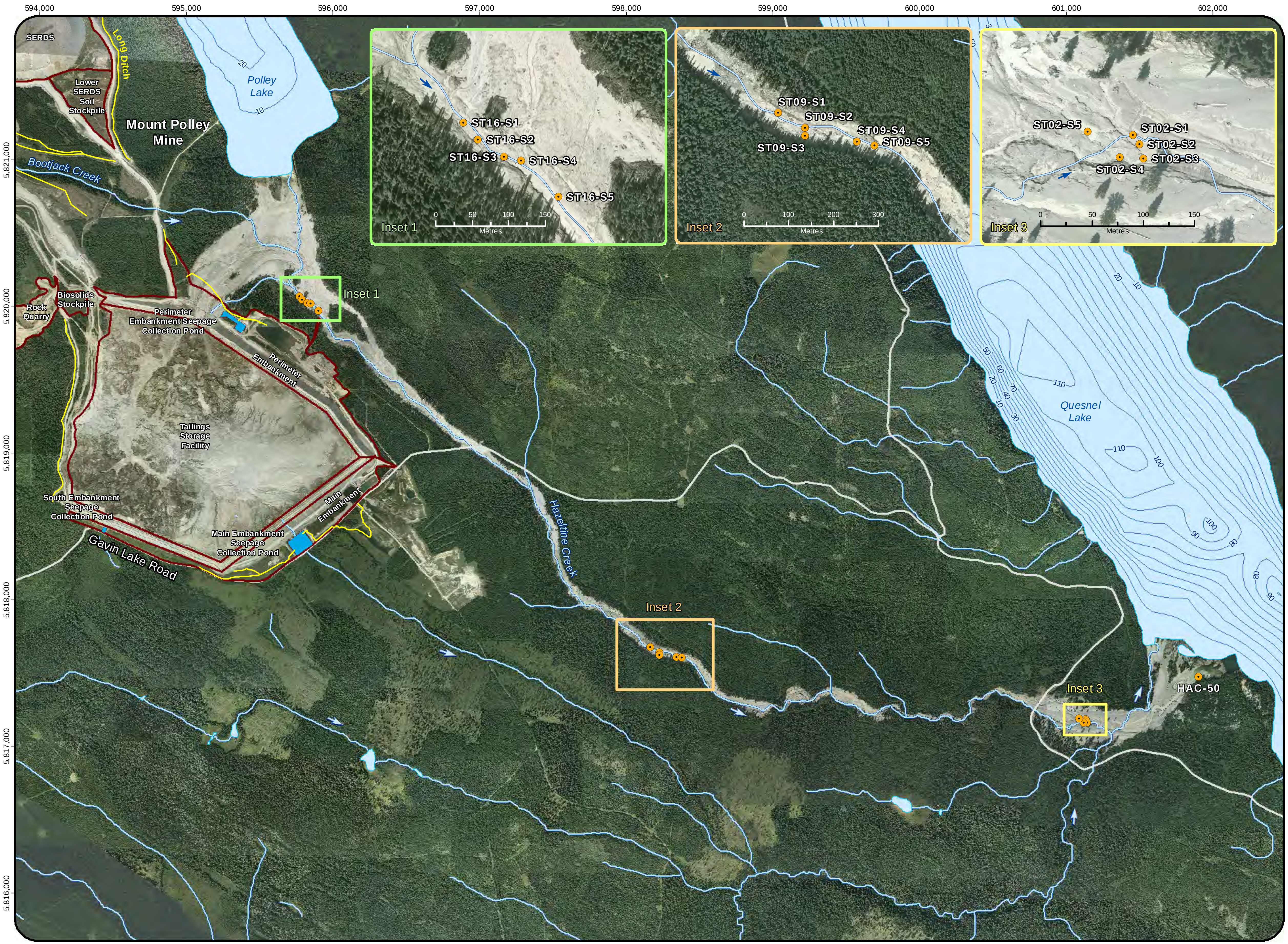

Legend

- Hazeltine Creek Sampling Areas / Stations 2014
- Water Collection Ditch
- Mine Infrastructure
- Seepage Collection Pond
- Waterbody
- Lake Bathymetry (10 m Intervals)
- Watercourse
- Road
- Water Flow Direction

N W E S

0 250 500 750 1,000 1,250

Metres

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Figure 4.2: Hazeltine Creek Sampling Areas / Stations, 2014

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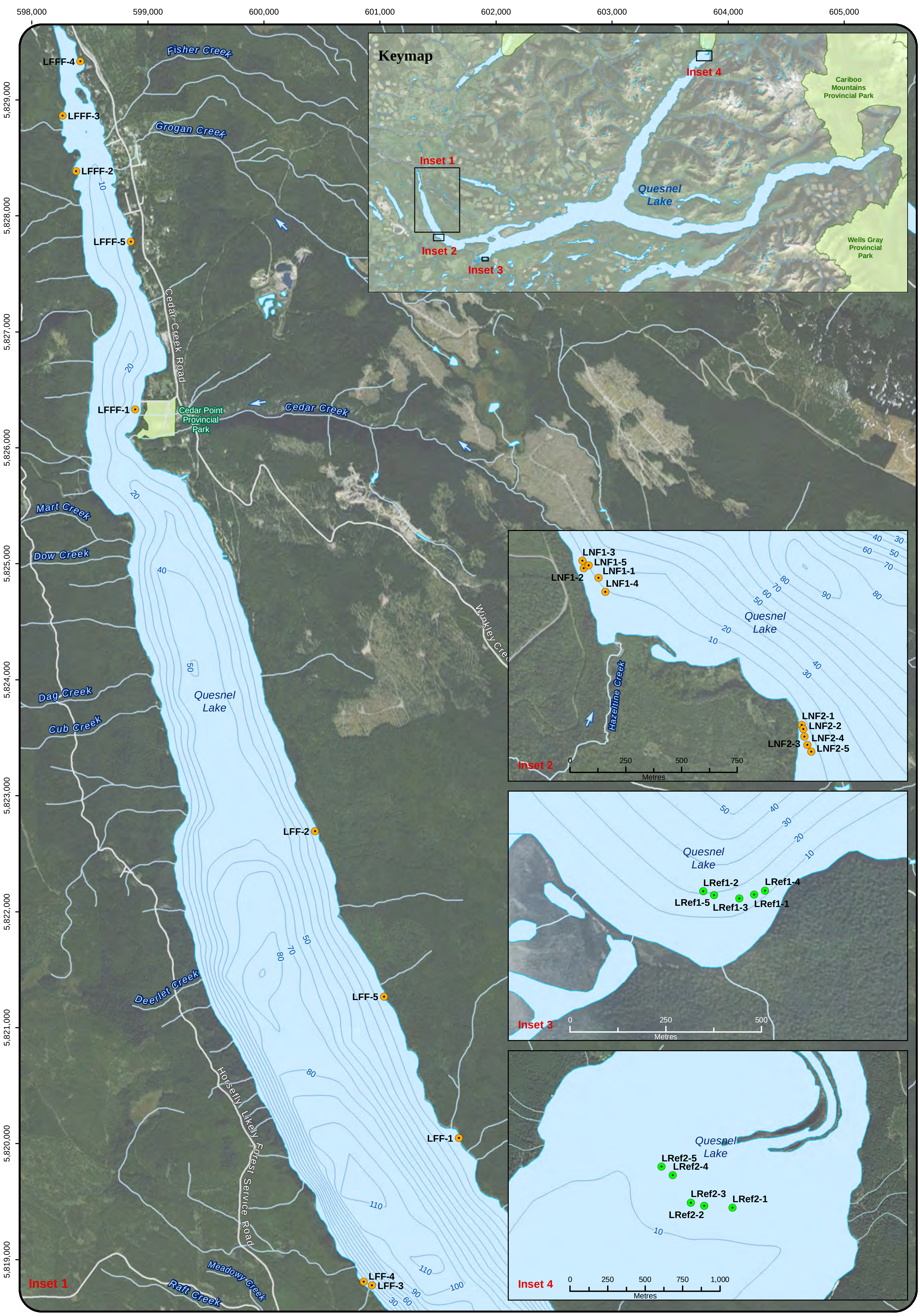
Figure 4.3: Polley and Bootjack Lakes Sampling Areas / Stations, 2014



N
W E
S

0 500 1,000 1,500

Metres

MAP INFORMATION
Datum: NAD 1983 Map Projection: Zone 10U
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Legend

- Littoral Sampling Areas / Stations - Exposed
- Littoral Sampling Areas /Stations - Reference
- Protected Areas
- Waterbody
- Watercourse
- Quesnel Lake Bathymetry (10 m Intervals)
- Roads
- Water Flow Direction

Please note: Quesnel Lake bathymetry lines are an approximate representation only and may not precisely delineate accurate depths at larger scales.

Figure 4.4: Quesnel Lake Littoral Sampling Areas / Stations 2014

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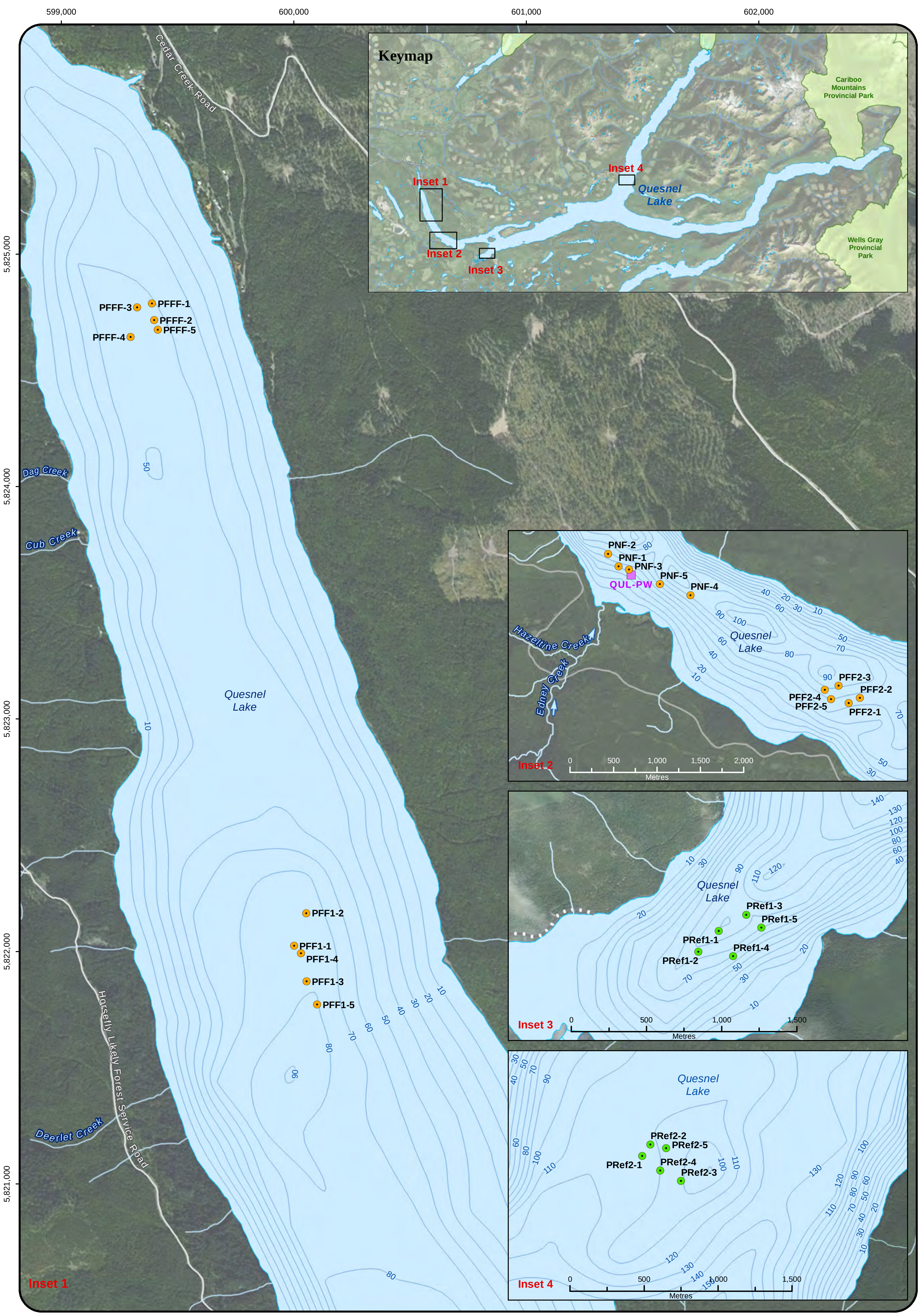

N
W E
S

0 200 400 600 800
Metres

MAP INFORMATION
Datum: NAD 1983 Map Projection: Zone 10U
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Project No.: 2542

Legend

- Quesnel Profundal- Exposed
- Quesnel Profundal - Reference
- Sediment Coring Sampling Areas
- Protected Areas
- Waterbody
- Watercourse
- Quesnel Lake Bathymetry (10 m Intervals)
- Roads
- Water Flow Direction

Please note: Quesnel Lake bathymetry lines are an approximate representation only and may not precisely delineate accurate depths at larger scales.

Figure 4.5: Quesnel Lake Profundal Sampling Areas / Stations 2014

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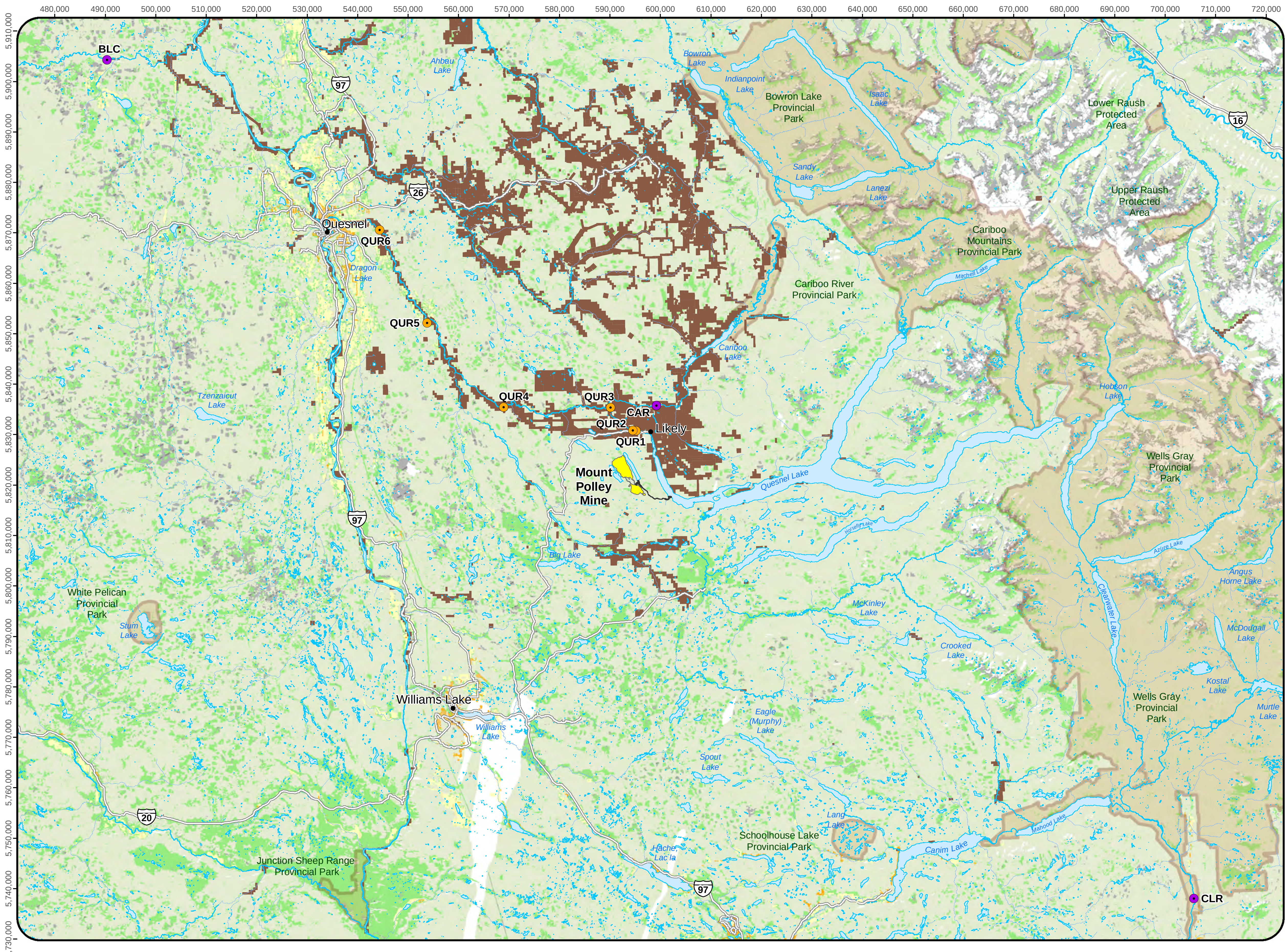
- Quesnel River (to QRCC; Figure 4.6);
- Lake reference areas (Bootjack Lake [Figure 4.3], Quesnel Lake upstream [Figures 4.4 and 4.5]); and
- River reference areas (Cariboo River and Clearwater River; Figure 4.6)

Within each of the study areas depicted in Figures 4.2 to 4.5, sediment samples were collected at a total of five replicate stations to facilitate statistical comparisons among areas in accordance with the study design depicted in Table 4.1. Although study components are discussed independently in the sections that follow, it must be noted that, at any given location, samples for the different program components were collected concurrently in order to optimize efficiency and data comparability (e.g., samples for basic chemistry, geochemical characterization, sediment toxicity and benthic invertebrate community characterization were typically collected on either the same day or on subsequent days for all sampling locations. The precise location of each sampling station is provided in Appendix Table B.1.

4.1 Sediment Physical and Chemical Characterization

The objective of the sediment physical and chemical characterization was to characterize the physical and chemical condition of sediments in potentially impacted areas relative to reference areas and pre-event conditions (where data are available). This includes the identification of parameters of interest (POIs) and indicator parameters (IPs) and the examination of their distributions through potentially impacted areas to determine the spatial extent of impact. POIs are defined as analytes that are elevated relative to effects-based guidelines and reference or background concentrations (Figure 4.7). IPs are defined as analytes that are not elevated relative to effects-based guidelines, but are elevated relative to reference and/or background by an average of two or more times at any exposed area (Figure 4.7).

Sediment physical and chemical characterization included the collection of sediment samples at a total of 102 stations within Hazeltine Creek, Polley Lake, Bootjack Lake and Quesnel Lake (Table 4.1; Figures 4.2 to 4.5). Within Hazeltine Creek, three areas (upper, middle and lower) were sampled (Table 4.2; Figure 4.2). In Polley Lake, two deep areas (the north and south basin, respectively) and two shallower areas were sampled, with two deep areas and one shallow area sampled within Bootjack Lake as reference (Table 4.2; Figure 4.3). Sampling in Quesnel Lake was also conducted at two depth strata - littoral (1.0 to 2.0 meter depth) and profundal (approximately 80 to 100 meters depth). Both the littoral and profundal sampling of Quesnel Lake included two reference areas as well as



Features

- City
- Exposed Sampling Locations
- Reference Sampling Locations
- Historic Placer Mining Titles
- Hazeltine Creek
- Active Mine Operation
- Protected Areas
- Snow/Ice
- Rock/Rubble; Exposed
- Developed
- Cropland & Pasture
- Low Vegetation
- Forest
- Waterbody
- Watercourse
- Road

0 5 10 15 20 25 30 35 40
Kilometres

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Datum: NAD 83 Map Projection: UTM Zone 10U
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Figure 4.6: Reference Rivers (n=3) and Quesnel River (n=6) Sampling Areas, Mount Polley Mine, 2014

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Table 4.1: MPMC SQIC Study Design Overview, August to October 2014

Waterbody	Exposed Areas	Reference	Reference Areas	Stations per Area	Stations	Historical Data	Analysis Method
Hazeltine Creek	3	None	0	5	15	Hazeltine Creek	Before-After
Polley Lake Deep	2	Bootjack Lake	2	3	12	Polley Lake Bootjack Lake	Before-After Control-Impact
Polley Lake Mid-Depth	2	Bootjack Lake	1	5	15	Polley Lake Bootjack Lake	Control-Impact
Quesnel Lake Littoral	4	Quesnel Lake Littoral	2	5	30	None	Multiple Control-Impact Gradient
Quesnel Lake Profundal	4	Quesnel Lake Profundal	2	5	30	None	Multiple Control-Impact Gradient
TOTAL	15	-	7	3 - 5	102	-	-

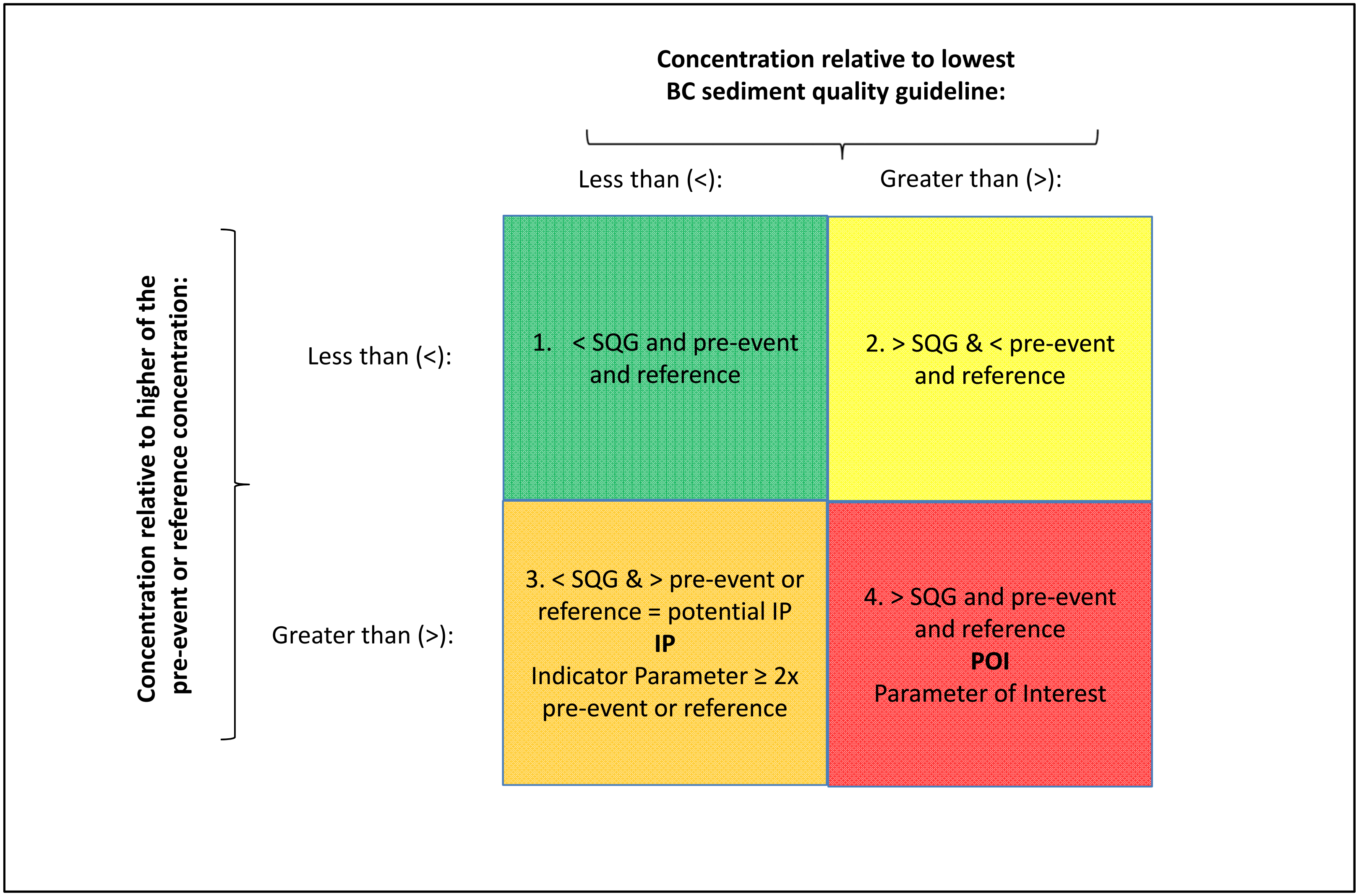


Figure 4.7: Two-way screening of sediment quality data

Table 4.2: Overview of sediment and benthic invertebrate collection methods, Mount Polley Mine, August to October 2014.

Waterbody	Area	Area Type	Station	Sediment Chemistry		Particle Size and Total Organic Carbon		Sediment Geochemistry [a]		Sediment Toxicity Testing			Benthic Invertebrate Community	
				Sampling Equipment	# of cores/ grabs per composite	Sampling equipment	# of grabs per composite	Sampling equipment	# of cores/ grabs per composite	Sampling equipment	# of toxicity replicates collected	# of grabs per toxicity replicate	Sampling equipment	# of grabs per benthos sample
Hazeltine Creek	ST-16	Upstream	ST-16-01	Stainless shovel	5	Stainless shovel	5	Stainless shovel	5	Stainless shovel	1	5	-	-
			ST-16-02	Stainless shovel	5	Stainless shovel	5	Stainless shovel	5	Stainless shovel	1	5	-	-
			ST-16-03	Stainless shovel	5	Stainless shovel	5	Stainless shovel	5	Stainless shovel	1	5	-	-
			ST-16-04	Stainless shovel	5	Stainless shovel	5	Stainless shovel	5	Stainless shovel	1	5	-	-
			ST-16-05	Stainless shovel	5	Stainless shovel	5	Stainless shovel	5	Stainless shovel	1	5	-	-
	ST-09	Middle	ST-09-01	Stainless shovel	5	Stainless shovel	5	Stainless shovel	5	Stainless shovel	1	5	-	-
			ST-09-02	Stainless shovel	5	Stainless shovel	5	Stainless shovel	5	Stainless shovel	1	5	-	-
			ST-09-03	Stainless shovel	5	Stainless shovel	5	Stainless shovel	5	Stainless shovel	1	5	-	-
			ST-09-04	Stainless shovel	5	Stainless shovel	5	Stainless shovel	5	Stainless shovel	1	5	-	-
			ST-09-05	Stainless shovel	5	Stainless shovel	5	Stainless shovel	5	Stainless shovel	1	5	-	-
	ST-02	Downstream	ST-02-01	Stainless shovel	5	Stainless shovel	5	Stainless shovel	5	Stainless shovel	1	5	-	-
			ST-02-02	Stainless shovel	5	Stainless shovel	5	Stainless shovel	5	Stainless shovel	1	5	-	-
			ST-02-03	Stainless shovel	5	Stainless shovel	5	Stainless shovel	5	Stainless shovel	1	5	-	-
			ST-02-04	Stainless shovel	5	Stainless shovel	5	Stainless shovel	5	Stainless shovel	1	5	-	-
			ST-02-05	Stainless shovel	5	Stainless shovel	5	Stainless shovel	5	Stainless shovel	1	5	-	-
Polley Lake	POL-1	Mid-Depth North Side	POL-1-01	Tech Ops corer	3	Petite ponar	5	Tech Ops corer	3	Petite ponar	1	5	Petite ponar	5
			POL-1-02	KB corer	12	Petite ponar	5	KB corer	12	Petite ponar	1	5	Petite ponar	5
			POL-1-03	Tech Ops corer	5 [b]	Petite ponar	5	Tech Ops corer	5 [b]	Petite ponar	1	5	Petite ponar	5
			POL-1-04	Tech Ops corer	3	Petite ponar	5	Tech Ops corer	3	Petite ponar	1	5	Petite ponar	5
			POL-1-05	Tech Ops corer	3	Petite ponar	5	Tech Ops corer	3	Petite ponar	1	5	Petite ponar	5
	POL-2	Mid-Depth South Side	POL-2-01	Tech Ops corer	3	Petite ponar	5	Tech Ops corer	3	Petite ponar	1	5	Petite ponar	5
			POL-2-02	Tech Ops corer	3	Petite ponar	5	Tech Ops corer	3	Petite ponar	1	5	Petite ponar	5
			POL-2-03	Petite ponar	3 [c]	Petite ponar	5	Petite ponar	3 [c]	Petite ponar	1	5	Petite ponar	5
			POL-2-04	Tech Ops corer	5 [b]	Petite ponar	5	Tech Ops corer	5 [b]	Petite ponar	1	5	Petite ponar	5
			POL-2-05	Tech Ops corer	3	Petite ponar	5	Tech Ops corer	3	Petite ponar	1	5	Petite ponar	5
	POL-P1	North Deep [d]	POL-P1-01	KB corer	10	Petite ponar	5	KB corer	10	Petite ponar	1	5	Petite ponar	5
			POL-P1-02	KB corer	9	Petite ponar	5	KB corer	9	Petite ponar	1	5	Petite ponar	5
			POL-P1-03	KB corer	11	Petite ponar	5	KB corer	11	Petite ponar	1	5	Petite ponar	5
	POL-P2	South Deep [d]	POL-P2-01	Tech Ops corer	3	Petite ponar	5	Tech Ops corer	3	Petite ponar	1	5	Petite ponar	5
			POL-P2-02	Tech Ops corer	3	Petite ponar	5	Tech Ops corer	3	Petite ponar	1	5	Petite ponar	5
			POL-P2-03	Tech Ops corer	3	Petite ponar	5	Tech Ops corer	3	Petite ponar	1	5	Petite ponar	5
Bootjack Lake (Reference)	BOL-1	Mid-Depth	BOL-1-01	Tech Ops corer	3	Petite ponar	5	Tech Ops corer	3	Petite ponar	1	5	Petite ponar	5
			BOL-1-02	Tech Ops corer	3	Petite ponar	5	Tech Ops corer	3	Petite ponar	1	5	Petite ponar	5
			BOL-1-03	Tech Ops corer	6 [b]	Petite ponar	6 [b]	Tech Ops corer	6 [b]	Petite ponar	1	6 [b]	Petite ponar	5
			BOL-1-04	Tech Ops corer	3	Petite ponar	5	Tech Ops corer	3	Petite ponar	1	5	Petite ponar	5
			BOL-1-05	Tech Ops corer	3	Petite ponar	5	Tech Ops corer	3	Petite ponar	1	5	Petite ponar	5
	BOL-B1	North Deep [d]	BOL-B1-01	Tech Ops corer	3	Petite ponar	5	Tech Ops corer	3	Petite ponar	1	5	Petite ponar	5
			BOL-B1-02	Tech Ops corer	3	Petite ponar	5	Tech Ops corer	3	Petite ponar	1	5	Petite ponar	5
			BOL-B1-03	Tech Ops corer	3	Petite ponar	5	Tech Ops corer	3	Petite ponar	1	5	Petite ponar	5
	BOL-B2	South Deep [d]	BOL-B2-01	Tech Ops corer	3	Petite ponar	5	Tech Ops corer	3	Petite ponar	1	5	Petite ponar	5
			BOL-B2-02	Tech Ops corer	3	Petite ponar	5	Tech Ops corer	3	Petite ponar	1	5	Petite ponar	5
			BOL-B2-03	Tech Ops corer	3	Petite ponar	5	Tech Ops corer	3	Petite ponar	1	5	Petite ponar	5

Table 4.2: Overview of sediment and benthic invertebrate collection methods, Mount Polley Mine, August to October 2014.

Waterbody	Area	Area Type	Station	Sediment Chemistry		Particle Size and Total Organic Carbon		Sediment Geochemistry [a]		Sediment Toxicity Testing			Benthic Invertebrate Community	
				Sampling Equipment	# of cores/ grabs per composite	Sampling equipment	# of grabs per composite	Sampling equipment	# of cores/ grabs per composite	Sampling equipment	# of toxicity replicates collected	# of grabs per toxicity replicate	Sampling equipment	# of grabs per benthos sample
Quesnel Lake Littoral	QUL-45 (LNF1)	Near-Field 1	QUL-45-01	Petite ponar	15	Petite ponar	15	Petite ponar	15	Petite ponar	5	3	Petite ponar	5
			QUL-45-02	Petite ponar	15	Petite ponar	15	Petite ponar	15	Petite ponar	5	3	Petite ponar	5
			QUL-45-03	Petite ponar	15	Petite ponar	15	Petite ponar	15	Petite ponar	5	3	Petite ponar	5
			QUL-45-04	Petite ponar	15	Petite ponar	15	Petite ponar	15	Petite ponar	5	3	Petite ponar	5
			QUL-45-05	Petite ponar	15	Petite ponar	15	Petite ponar	15	Petite ponar	5	3	Petite ponar	5
	QUL-49 (LNF2)	Near-Field 2	QUL-49-01	Petite ponar	15	Petite ponar	15	Petite ponar	15	Petite ponar	5	3	Petite ponar	5
			QUL-49-02	Petite ponar	15	Petite ponar	15	Petite ponar	15	Petite ponar	5	3	Petite ponar	5
			QUL-49-03	Petite ponar	15	Petite ponar	15	Petite ponar	15	Petite ponar	5	3	Petite ponar	5
			QUL-49-04	Petite ponar	15	Petite ponar	15	Petite ponar	15	Petite ponar	5	3	Petite ponar	5
			QUL-49-05	Petite ponar	15	Petite ponar	15	Petite ponar	15	Petite ponar	5	3	Petite ponar	5
	QUL-47 (LFF)	Far-Field	QUL-47-01	Petite ponar	4	Petite ponar	4	Petite ponar	24	Petite ponar	1	4	Petite ponar	5
			QUL-47-02	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
			QUL-47-03	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
			QUL-47-04	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
			QUL-47-05	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
	QUL-48 (LFFF)	Far-Far-Field	QUL-48-01	Petite ponar	10 [e]	Petite ponar	10 [e]	Petite ponar	30	Petite ponar	1	10 [e]	Petite ponar	5
			QUL-48-02	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
			QUL-48-03	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
			QUL-48-04	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
			QUL-48-05	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
	QUL-51 (LRef1)	Reference	QUL-51-01	Petite ponar	15	Petite ponar	15	Petite ponar	15	Petite ponar	5	3	Petite ponar	5
			QUL-51-02	Petite ponar	15	Petite ponar	15	Petite ponar	15	Petite ponar	5	3	Petite ponar	5
			QUL-51-03	Petite ponar	15	Petite ponar	15	Petite ponar	15	Petite ponar	5	3	Petite ponar	5
			QUL-51-04	Petite ponar	16 [e]	Petite ponar	16 [e]	Petite ponar	16 [e]	Petite ponar	5	3	Petite ponar	5
			QUL-51-05	Petite ponar	16 [e]	Petite ponar	16 [e]	Petite ponar	16 [e]	Petite ponar	5	3	Petite ponar	5
	QUL-52 (LRef2)	Reference	QUL-52-01	Petite ponar	5	Petite ponar	5	Petite ponar	25	Petite ponar	1	5	Petite ponar	5
			QUL-52-02	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
			QUL-52-03	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
			QUL-52-04	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
			QUL-52-05	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5

Table 4.2: Overview of sediment and benthic invertebrate collection methods, Mount Polley Mine, August to October 2014.

Waterbody	Area	Area Type	Station	Sediment Chemistry		Particle Size and Total Organic Carbon		Sediment Geochemistry [a]		Sediment Toxicity Testing			Benthic Invertebrate Community	
				Sampling Equipment	# of cores/ grabs per composite	Sampling equipment	# of grabs per composite	Sampling equipment	# of cores/ grabs per composite	Sampling equipment	# of toxicity replicates collected	# of grabs per toxicity replicate	Sampling equipment	# of grabs per benthos sample
Quesnel Lake Profundal	QULP-1 (PNF)	Near-Field	QULP-1-01	Van Veen	3	Van Veen	3	Van Veen	3	Van Veen	5	1	Petite ponar	5
			QULP-1-02	Petite ponar	5	Petite ponar	5	Petite ponar	5	Petite ponar	5	1	Petite ponar	5
			QULP-1-03	Petite ponar	5	Petite ponar	5	Petite ponar	5	Petite ponar	5	1	Petite ponar	5
			QULP-1-04	Petite ponar	5	Petite ponar	5	Petite ponar	5	Petite ponar	5	1	Petite ponar	5
			QULP-1-05	Petite ponar	5	Petite ponar	5	Petite ponar	5	Petite ponar	5	1	Petite ponar	5
	QULP-2 (PFF1)	Far-Field 1	QULP-2-01	Petite ponar	5	Petite ponar	5	Petite ponar	5	Petite ponar	5	1	Petite ponar	5
			QULP-2-02	Petite ponar	5	Petite ponar	5	Petite ponar	5	Petite ponar	5	1	Petite ponar	5
			QULP-2-03	Petite ponar	5	Petite ponar	5	Petite ponar	5	Petite ponar	5	1	Petite ponar	5
			QULP-2-04	Petite ponar	5	Petite ponar	5	Petite ponar	5	Petite ponar	5	1	Petite ponar	5
			QULP-2-05	Petite ponar	5	Petite ponar	5	Petite ponar	5	Petite ponar	5	1	Petite ponar	5
	QULP-4 (PFF2)	Far-Field 2	QULP-4-01	Petite ponar	5	Petite ponar	5	Petite ponar	25	Petite ponar	1	5	Petite ponar	5
			QULP-4-02	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
			QULP-4-03	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
			QULP-4-04	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
			QULP-4-05	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
	QULP-3 (PFFF)	Far-Far-Field	QULP-3-01	Petite ponar	5	Petite ponar	5	Petite ponar	25	Petite ponar	1	5	Petite ponar	5
			QULP-3-02	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
			QULP-3-03	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
			QULP-3-04	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
			QULP-3-05	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
	QULP-5 (PRef1)	Reference	QULP-5-01	Petite ponar	5	Petite ponar	5	Petite ponar	5	Petite ponar	5	1	Petite ponar	5
			QULP-5-02	Petite ponar	5	Petite ponar	5	Petite ponar	5	Petite ponar	5	1	Petite ponar	5
			QULP-5-03	Petite ponar	5	Petite ponar	5	Petite ponar	5	Petite ponar	5	1	Petite ponar	5
			QULP-5-04	Petite ponar	5	Petite ponar	5	Petite ponar	5	Petite ponar	5	1	Petite ponar	5
			QULP-5-05	Petite ponar	5	Petite ponar	5	Petite ponar	5	Petite ponar	5	1	Petite ponar	5
	QULP-6 (PRef2)	Reference	QULP-6-01	Petite ponar	5	Petite ponar	5	Petite ponar	25	Petite ponar	1	5	Petite ponar	5
			QULP-6-02	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
			QULP-6-03	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
			QULP-6-04	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5
			QULP-6-05	Petite ponar	5	Petite ponar	5			Petite ponar	1	5	Petite ponar	5

[a] For Bootjack and Polley Lakes, samples collected by petite ponar for particle size and total organic carbon analysis were used for sediment geochemistry analyses where the sediment volume collected using the indicated sampling method was insufficient for the analyses.

[b] Additional grabs collected for field duplicate samples.

[c] Coring unsuccessful due to sediment consistency; petite ponar was used to collect sediment chemistry sample.

[d] Two additional toxicity samples collected at within this area, each comprised of a 5 ponar composite

[e] Additional grabs collected to provide sufficient sample volume for required analyses.

areas designated as near-field, far-field and far-far-field (Table 4.2; Figures 4.4 and 4.5). The identification codes used for sampling stations during field sampling differed from those that are used in the present report, and a key to the corresponding sampling codes is presented in Table 4.3.

4.1.1 Sample Collection

Sediment samples were collection from running waters of Hazeltine Creek, as a well as lake environments of Polley Lake, Quesnel Lake and Bootjack Lake. In Hazeltine Creek, sediment samples were collected using a stainless steel shovel. Sampling using a grab device (a petite ponar sampler) was attempted, but did not yield good samples due to limited penetration depth as a result of high sediment density. All Hazeltine Creek sediment samples were collected from wetted sampling stations that supported the accumulation of finer materials (i.e., small pools or backwaters). Five replicate stations were sampled to represent each sampling area (Table 4.2; Figure 4.2). At each sampling station, a composite sediment sample was prepared from five scoops of sediment collected with the shovel. Surficial sediment was carefully collected to ensure the capture of a uniform depth (top 3 cm) and to limit disturbance that could result in loss of fines. Each scoop was placed in a plastic tote. After five scoops were collected, the material within the tote was homogenized using a stainless steel spoon and transferred into four 250 mL glass sampling jars labeled with the project number, sample location and collection date. All sampling equipment was rinsed between stations using site water. Duplicate (split) sediment samples were collected at a target frequency of 10% for quality assurance / quality control (QA/QC) purposes. Supporting information collected at each sampling site included GPS (Geographic Positioning System) coordinates, sampling depth, field meter measurements of temperature, specific conductance, dissolved oxygen and pH (using a YSI EXO™ handheld portable field meter equipped with YSI EXO2™ Sonde), site photographs (including photographs of sediment samples), notes of the presence or absence of aquatic vegetation, and other physical observations (sediment texture, colour, density, etc.). Immediately after collection, samples were placed into a cooler with ice packs, where they were maintained cool prior to transport to the field laboratory where they were placed in a refrigerator and held until shipment to the analytical laboratory.

In Polley and Bootjack Lakes, sediments for the analysis of metal concentrations were collected using either a Kajak-Brinkhurst (KB) corer or a Tech Ops corer in accordance with technical guidance for gravity coring outlined in the British Columbia Field Sampling Manual (BCWLAP 2003) and the federal Technical Guidance Manual for Environmental

Table 4.3: Overview of Quesnel Lake area and station sampling codes used in the present report corresponding to sampling codes used in field collections.

Waterbody Area	Area and station IDs used in report		Area and station IDs used for field collections	
	Area	Station ID	Area	Station ID
Quesnel Lake Littoral	LRef1	LRef1-1	QUL - 51	QUL-51-01
		LRef1-2		QUL-51-02
		LRef1-3		QUL-51-03
		LRef1-4		QUL-51-04
		LRef1-5		QUL-51-05
	LRef2	LRef2-1	QUL - 52	QUL-52-01
		LRef2-2		QUL-52-02
		LRef2-3		QUL-52-03
		LRef2-4		QUL-52-04
		LRef2-5		QUL-52-05
	LNF1	LNF1-1	QUL - 45	QUL-45-01
		LNF1-2		QUL-45-02
		LNF1-3		QUL-45-03
		LNF1-4		QUL-45-04
		LNF1-5		QUL-45-05
	LNF2	LNF2-1	QUL - 49	QUL-49-01
		LNF2-2		QUL-49-02
		LNF2-3		QUL-49-03
		LNF2-4		QUL-49-04
		LNF2-5		QUL-49-05
	LFF	LFF-1	QUL - 47	QUL-47-01
		LFF-2		QUL-47-02
		LFF-3		QUL-47-03
		LFF-4		QUL-47-04
		LFF-5		QUL-47-05
	LFFF	LFFF-1	QUL - 48	QUL-48-01
		LFFF-2		QUL-48-02
		LFFF-3		QUL-48-03
		LFFF-4		QUL-48-04
		LFFF-5		QUL-48-05
Quesnel Lake Profundal	PRef1	PRef1-1	QULP-5	QULP-5-01
		PRef1-2		QULP-5-02
		PRef1-3		QULP-5-03
		PRef1-4		QULP-5-04
		PRef1-5		QULP-5-05
	PRef2	PRef2-1	QULP-6	QULP-6-01
		PRef2-2		QULP-6-02
		PRef2-3		QULP-6-03
		PRef2-4		QULP-6-04
		PRef2-5		QULP-6-05
	PNF	PNF-1	QULP - 1	QULP-1-01
		PNF-2		QULP-1-02
		PNF-3		QULP-1-03
		PNF-4		QULP-1-04
		PNF-5		QULP-1-05
	PFF1	PFF1-1	QULP-2	QULP-2-01
		PFF1-2		QULP-2-02
		PFF1-3		QULP-2-03
		PFF1-4		QULP-2-04
		PFF1-5		QULP-2-05
	PFFF	PFFF-1	QULP-3	QULP-3-01
		PFFF-2		QULP-3-02
		PFFF-3		QULP-3-03
		PFFF-4		QULP-3-04
		PFFF-5		QULP-3-05
	PFF2	PFF2-1	QULP-4	QULP-4-01
		PFF2-2		QULP-4-02
		PFF2-3		QULP-4-03
		PFF2-4		QULP-4-04
		PFF2-5		QULP-4-05

Effects Monitoring (EEM; Environment Canada 2012a), with the exception of one sampling station (see Table 4.2). Sediment samples for physical analysis (particle size distribution) and chemical analysis of total organic carbon (TOC) were collected using a petite ponar grab sampler. Briefly, the KB corer is a gravity corer that collects samples in 2” (5.08 cm) diameter core tubes. Core collection relies on a combination of surface tension within the core and suction supplied by a plunger that seals the top of the core tube after being deployed by a messenger. The Tech Ops corer is a gravity corer that collects samples in 4” (10.16 cm) diameter core tubes. Core collection relies on a combination of surface tension within the core and suction supplied by an automatic seal (plunger assembly) that shuts in response to sampler retrieval (upward pull). As with sampling areas in Hazeltine Creek, five replicate stations were sampled to represent each mid-depth sampling area (Table 4.2; Figure 4.3). However, at the basins, three replicate stations were sampled to represent each basin due to due to the small sampling area. Success rates for each of the core devices tended to vary with sampling location in accordance with sediment characteristics and both devices were used in the program (Table 4.2).

During coring, care was taken to control the rate at which the coring device was lowered, to maintain the corer in a vertical position during descent and to allow the corer to penetrate the sediment with minimal sediment disturbance. The corer was then carefully retrieved to surface and an extruder head was inserted into the bottom of the core tube to prevent any sediment slippage. Core samples were rejected if there was evidence of slippage, that the core did not penetrate the substrate vertically, or that the sediment-water interface was disturbed within the core. The core tube was then removed from the corer and the extruder head was then used to push the sediment upwards towards the top of the core tube in a controlled fashion with care taken to minimize suspension of fines. In the event of suspension, momentum was stopped, allowing the solids to re-settle. Once the sediment was extruded to near the top of the tube, an extrusion collar marked in 1-cm intervals was carefully aligned on the top of the tube and the sediment extruded upwards into the collar. A core slicer was then carefully inserted between the tube and the collar at the 3-cm interval, to collect the top 3-cm of sediment, which was then transferred into three 250 mL glass sampling jar labeled with the project number, sample location and collection date. The procedure was then repeated twice more if using the Tech Ops corer or approximately nine times more if using the KB corer to provide a composite sample of sufficient volume for the required analyses. All sampling equipment was rinsed between stations using site water. As indicated above, duplicate (split) sediment samples were collected at a target frequency of 10% for quality assurance/quality control (QA/QC) purposes and supporting information was collected at each sampling site. Immediately after collection, samples were placed into a cooler with ice packs, where they were maintained cool prior to transport to the field laboratory where they were placed in a refrigerator and held until shipment to the analytical laboratory.

In Quesnel Lake, sediment samples (both littoral and profundal) were collected using a stainless steel petite ponar grab sampler (15.24 cm x 15.24 cm; 0.023 m^2 sampling area) in accordance with technical guidance outlined in the British Columbia Field Sampling Manual (BCWLAP 2003) and the federal Technical Guidance Manual for Environmental Effects Monitoring (EEM; Environment Canada 2012a), with the exception of one sampling station (see Table 4.2). Two coring devices were tested in Quesnel Lake, but could not consistently retrieve sediment due to sediment texture (either hard sediment resulting in insufficient penetration depth, or soupy sediment resulting in loss of material from the core). Profundal grab samples (mean depth approximately 100 meters) were collected with the assistance of a commercial line hauler (Ace Line Hauler Brutus Plus 40). As with sampling areas in Hazeltine Creek and Polley Lake (mid-depth), five replicate stations were sampled to represent each sampling area (Table 4.2; Figures 4.4 and 4.5). At each station, composite samples of the top three centimetres of surficial sediment of five to fifteen acceptable petite-Ponar grabs (i.e., full to each edge of the sampler) were collected. Each petite ponar grab was collected into a plastic sampling tote and observed for completeness and any unusual characteristics. If the sample was deemed acceptable, surficial material to a depth of 3 cm was transferred to a second tote using a stainless steel spoon. Remaining sediment was discarded. The procedure was then repeated for all subsequent grabs. At that point, the material within the tote was homogenized using a stainless steel spoon and transferred into four 250 mL glass sampling jars labeled with the project number, sample location and collection date. All sampling equipment was rinsed between stations using site water. As indicated above, duplicate (split) sediment samples were collected at a target frequency of 10% for quality assurance / quality control (QA/QC) purposes and supporting information was collected at each sampling site. Immediately after collection, samples were placed into a cooler with ice packs, where they were maintained cool prior to transport to the field laboratory where they were placed in a refrigerator and held until shipment to the analytical laboratory.

Sediment samples were shipped to the analytical laboratory (ALS Environmental, Burnaby BC) at minimum frequency of weekly. Prior to shipment, samples were placed in a cooler with frozen ice packs and a chain-of custody form was prepared and packed with the samples. Coolers were shipped overnight for next day delivery to the analytical laboratory.

4.1.2 Laboratory Analysis

Upon receipt, ALS Environmental opened the cooler(s), measured temperature to verify the maintenance of cold samples, removed each sample from the cooler(s), logged the sample, and assigned each sample a unique sample identification code. A sample receipt confirmation was then sent to MPMC for verification.

Laboratory analysis included moisture content, pH, particle size distribution, total organic carbon content, total nitrogen concentration, and metal concentrations (Table 4.4). Total organic carbon content and metals were determined in bulk sediment (<2 mm diameter) in accordance with Canadian Council of Ministers of the Environment (CCME) protocol and also in the silt/clay fraction (<63 µm diameter) in accordance with recent recommendations by the British Columbia Ministry of Environment (BCMoE 2012). The former is more suitable for comparisons to sediments quality guidelines, which were based on chemical concentrations in bulk sediment (e.g., CCME 1999), while the latter have the advantage reducing variability that can arise due to the inclusion of larger particles. In programs targeting fine sediments, particularly in lakes, differences would be expected to be small. In receiving environments, all else being equal, one would expect enrichment in finer fractions (Horowitz and Elrick 1987; Horowitz 1991). However, this is based on an assumption of a dominant influence of surface sorption processes in defining metal concentrations and may not apply in the case of one major anthropogenic input. Upon completion of the analyses, data reports were provided by ALS Environmental to MPMC electronically in Adobe Acrobat Portable Document Format (PDF) and as MSExcel files.

4.1.3 Data Analysis

Upon receipt of the analytical data, data files were managed by MPMC. Prior to use in data analysis and interpretation, a Data Quality Assessment (DQA) was completed by Minnow and included an examination of data completeness, method detection limits achieved, laboratory precision, laboratory accuracy, and field precision. The DQA process is described in more detail in Appendix C and resulted in some requests for re-analysis.

Following the completion of DQA, all sediment quality data were compiled for analysis in MSExcel. Sediment quality data were summarized, by area, by calculating mean, median, standard deviation, standard error, minimum and maximum. Data were then

Table 4.4: Analytes and method detection limits for sediment quality, MPMC SQIC, 2014

		Basic Sediment Chemistry				
		Moisture and pH	Particle Size	Total Nitrogen	Metals and Mercury and Total Organic Carbon (<2 mm)	Metals and Mercury and Total Organic Carbon (<63 µm)
ALS Laboratory Method Code:		MOISTURE-VA and PH-1:2-VA	PSA-PIPET+GRAVEL-SK	N-TOT-LECO-SK	MET-200.0-CCMS-VA and HG-TOT-LOW-CVAFS-VA (Metals) C-TOT-ORG-LECO-SK (TOC)	MET-63UM-CCMS-VA and HG-63UM-CVAF-VA (Metals) C-TOT-ORG-LECO-63UM-SK (TOC)
Method :		ASTM D2974-00 Method A (Moisture) BC WLAP method: pH (pH)	SSIR-51 Method 3.2.1	SSSA 1996	EPA 200.2 / 6020A (Metals) EPA 200.2 / 1613E (Mercury) SSSA 1996 (TOC)	EPA 200.2 / 6020A (Metals) EPA 200.2 / 245.7 (Mercury) SSSA 1996 (TOC)
Analyte	**Units**					
Moisture	%	0.25				
pH	pH units	0.1				
% Gravel (>2mm)	%		0.1			
% Sand (2.0mm - 0.063mm)	%		0.1			
% Silt (0.063mm - 4um)	%		0.1			
% Clay (<4um)	%		0.1			
Total Organic Carbon (TOC)	%				0.1	0.1
Total Nitrogen	mg/kg			0.02		
Aluminum (Al)	mg/kg				50	50
Antimony (Sb)	mg/kg				0.1	0.1
Arsenic (As)	mg/kg				0.05	0.05
Barium (Ba)	mg/kg				0.5	0.5
Beryllium (Be)	mg/kg				0.1	0.1
Bismuth (Bi)	mg/kg				0.1	0.1
Boron (B)	mg/kg				10	10
Cadmium (Cd)	mg/kg				0.05	0.05
Calcium (Ca)	mg/kg				50	50
Chromium (Cr)	mg/kg				0.5	0.5
Cobalt (Co)	mg/kg				0.1	0.1
Copper (Cu)	mg/kg				0.5	0.5
Iron (Fe)	mg/kg				50	50
Lead (Pb)	mg/kg				0.1	0.1
Lithium (Li)	mg/kg				5	5
Magnesium (Mg)	mg/kg				10	10
Manganese (Mn)	mg/kg				0.2	0.2
Mercury (Hg)	mg/kg				0.005	0.005
Molybdenum (Mo)	mg/kg				0.1	0.1
Nickel (Ni)	mg/kg				0.5	0.5
Phosphorus (P)	mg/kg				50	50
Potassium (K)	mg/kg				100	100
Selenium (Se)	mg/kg				0.1	0.1
Silver (Ag)	mg/kg				0.05	0.05
Sodium (Na)	mg/kg				100	100
Strontium (Sr)	mg/kg				0.1	0.1
Thallium (Tl)	mg/kg				0.05	0.05
Tin (Sn)	mg/kg				0.2	0.2
Titanium (Ti)	mg/kg				1	1
Uranium (U)	mg/kg				0.05	0.05
Vanadium (V)	mg/kg				0.2	0.2
Zinc (Zn)	mg/kg				1	1

evaluated in comparison to British Columbia Working Sediment Quality Guidelines for the protection of aquatic life (SQGs; BCMoE 2015a, 2015b), Contaminated Sites Regulation (CSR) standards (Government of British Columbia 1996), and reference concentrations.

SQGs are numerical criteria that are protective of sediment-dwelling organisms based on long-term exposure. Most British Columbia SQGs have been adopted from the CCME (CCME 1999) or from Ontario (OMOE 1993) and have two levels - an Interim Sediment Quality Guideline (ISQG) or Threshold Effect Level (TEL, occasionally also referred to as a Lowest Effect Level or LEL) and a Probable Effect Level (PEL, occasionally also referred to as a Severe Effect Level or SEL). The TEL represents the concentration below which adverse biological effects are expected to occur rarely, whereas the PEL represents the concentration above which adverse biological effects are expected to occur frequently (CCME 1999). Data from which many of the SQGs were developed were strongly weighted by data for Great Lakes basin sediments (e.g., Jaagumagi 1988; Jaagumagi et al 1989), which tend to have substantially lower natural content of many metals relative to sediments in mineralized areas (e.g., Prairie and McKee 1994). Therefore natural background and/or reference concentrations of sediment metals, particularly at mineralized areas of the Canadian Shield, can often exceed SQGs. It is also notable that the BCSQG are not based on cause-effect studies, but rather on correlative levels of substances found in the sediment where biological effects have been measured (i.e., co-occurrence data; BCMoE 2015a, 2015b). Therefore, caution should be exercised in the application of these guidelines.

CSR standards for sediment (Government of British Columbia 1996) are sediment quality standards that were developed to assist in determining whether sediments are contaminated, and if sediment clean up proceeds, whether they meet remediation criteria (BCMoE 2005). CSR standards have been defined for a limited number of analytes in two levels of sediment - sensitive and typical (Government of British Columbia 1996). Sensitive sediment is defined as sediment at a site with sensitive aquatic habitat and for which sensitive management objectives apply and typically apply to sediments in the ecologically active zone (top one meter) of an aquatic receiving environment (BCMoE 2013). Typical sediment is defined as any sediment that is not sensitive sediment, and generally apply to sediments below the ecologically active zone (top one meter) of an aquatic receiving environment (BCMoE 2013). Thus, CSR standards for sensitive sediment apply to Hazeltine Creek and Quesnel Lake littoral sediments, and CSR standards for typical sediment apply to Polley Lake and Quesnel Lake profundal sediments. Lastly, reference values also fall into two categories - pre-event data and data collected at reference sites in 2014. Pre-event and reference data were compiled and used to calculate reference screening values. For each pre-event or reference dataset, 95th percentile values were calculated and compared. The highest pre-event or reference 95th percentile value was then used to screen the data from the exposed areas to identify analytes present in impacted areas at concentrations greater than pre-event and/or reference.

Collectively, guidelines and references values were used in a two-way screening to classify analytes into four categories as depicted in Figure 4.7:

1. Those whose concentrations are lower than guideline and reference;
2. Those whose concentrations are greater than guideline but not reference;
3. Those whose concentrations are lower than guideline (or for which no guideline exists) but greater than reference; and
4. Those whose concentrations are greater than both guideline and reference.

This screening process was used to define Parameters of Interest (POIs) and Indicator Parameters (IPs). POIs are defined as analytes in Category 4 (those with concentrations are greater than both guideline and reference) and IPs are defined as analytes that fall into Category 3 (those with concentrations lower than guideline [or for which no guideline exists] but greater than reference). All POIs were examined in detail in comparison to all guidelines (both BCSQG and CSR standards) and in comparison to all reference values (both pre-event and unexposed reference). IPs were examined for the magnitude of elevations in relation to reference, and all IPs elevated by a factor of two or more were examined in the same manner as the POIs. IPs that were elevated by a factor of less than two, and analytes that fall into categories 1 and 2 were not examined further.

Sediment quality data were also summarized using Principal Components Analysis (PCA). PCA is a multivariate statistical ordination technique that can be used to reduce a large number of environmental variables and to assist in the identification of patterns in datasets. In this case, PCA was used to reduce the sediment metals data (32 analytes; Table 4.4) and to assist in the identification of which metals best explain variability with the datasets (spatial variability). The former serves to reduce the number of variables considered in examining relationships and the latter serves to augment the identification of POIs and IPs. PCA was performed using the program PC-ORD© version 6 (McCune and Mefford 2011). Prior to running PCA, analytes for which 100% of the available data were below laboratory method detection limits (MDL), or analytes for which an incomplete dataset existed were excluded from the data matrix. All data points were then transformed using a logarithmic transformation (log [concentration x+1]) as concentration data are generally log-normally distributed. To ensure that each interpreted axis explained more variation in the dataset than by chance alone ($p<0.05$), a Monte Carlo randomization test was performed using 9999 randomized runs of the original dataset (McCune and Grace 2002). Principal component axes were then generated from the correlation matrix of the remaining sediment data and the results for the axes identified as significant were plotted to identify analytes that best explained similarities and differences in sediment chemistry among stations.

POIs and IPs were then subject to more detailed data analysis that included:

1. Plots in relation to all guidelines and reference values;
2. Examination of relationships to physical variables; and
3. Examination of geochemical data (see Sections 4.2 and 4.3).

Plots of all POIs and selected IPs were prepared in MSExcel. Plots provide average concentration with 95 percent confidence limit by area (i.e., bar charts with error bars). Available guidelines (BCSQG and CSR standards), reference concentrations, and background concentrations were added to the plots as lines to facilitate comparison of concentrations to these benchmarks.

Relationships between the POIs, IPs and PCA axes to physical variables (particle size) and other chemical variables (total organic carbon content) were evaluated using correlation analysis. Spearman correlation (often referred to a Spearman Rank-Order correlation) was competed using SPSS version 12.0 statistical software (SPSS 2003). Following the derivation of correlation coefficients, a Bonferroni-type correction (i.e., p-value [0.05] divided by the total number of correlations examined for independent variables) was applied to minimize the risk of declaring false positive correlations since at least 5% of derived correlations would be expected to occur by chance alone at an uncorrected p-value of 0.05. Any significant correlations found at the Bonferroni-adjusted p-value or at a p-value of 0.01 were further investigated using scatter plots to determine if a continuous distribution of data was realized (possible causal relationships) or if these relationships were “leveraged” by outlying points (or groups of points).

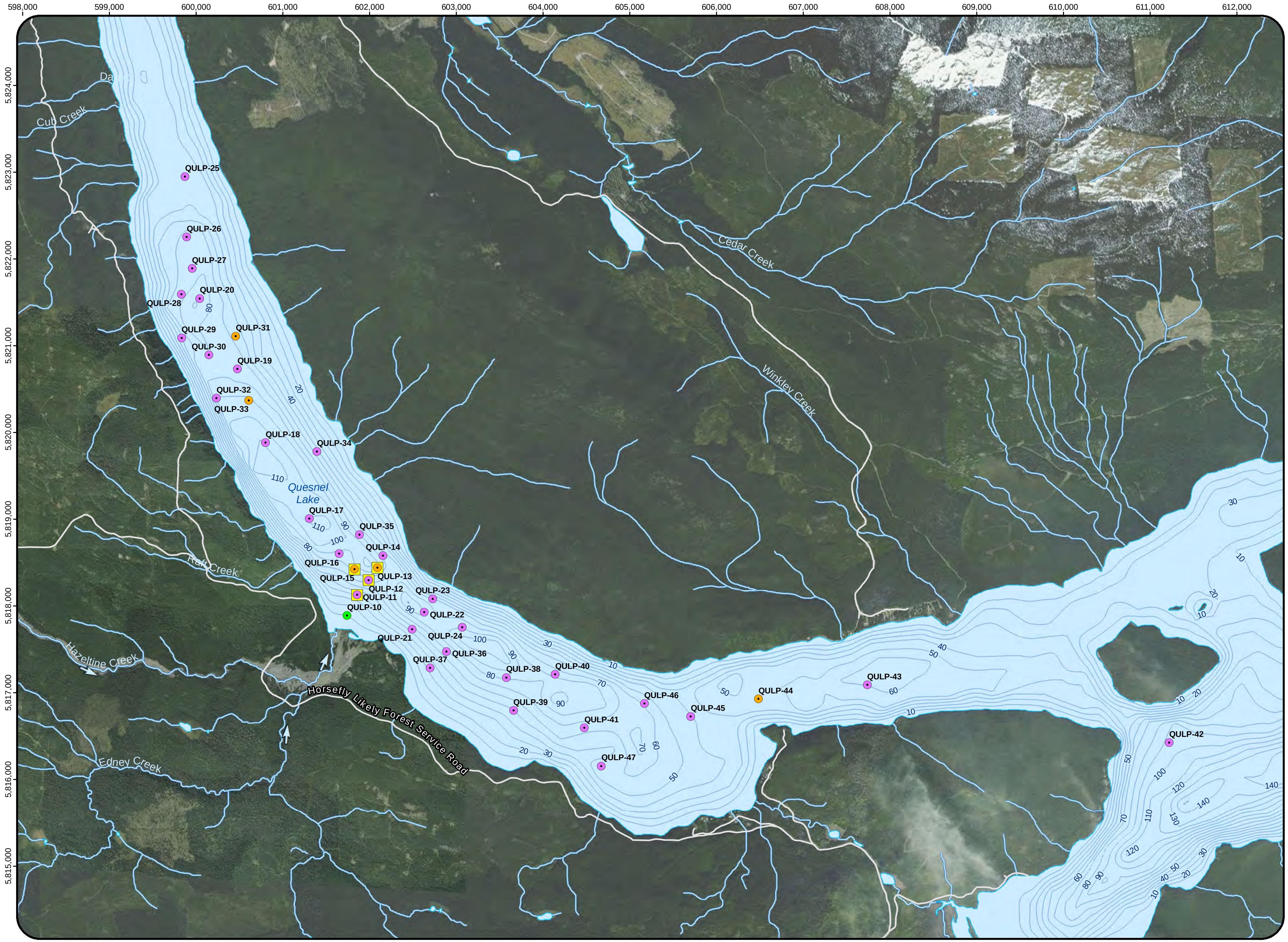
4.2 Spatial Extent

Characterizing the spatial extent of the influence of the dam failure on sediment quality is important to the effective characterization of impact. The objective of the spatial extent evaluation is to define the spatial extent of the physical disturbance associated with the event (physical erosion and deposition) as well as the spatial extent and magnitude of chemical disturbance. Characterization of the spatial extent of physical disturbance was based on observations made during the fieldwork (e.g., physical erosion in Hazeltine Creek, deposition within Hazeltine Creek, Polley Lake and Quesnel Lake), bottom / sub-bottom imaging conducted by Tetra Tech (discussed in detail in Tetra Tech 2015), and sediment chemical characteristics evident in chemical characterization. The evaluation of spatial extent, particularly in Quesnel Lake is based on the collection of a large number of sediment samples, providing a reasonable resolution within the constraints of sampling in three months (August through October 2014).

4.2.1 Data Collection

Characterization of the spatial extent of the influence of the dam failure on sediment quality was based on a combination of sediment quality and bottom/sub-bottom imaging. In addition to the sediment quality data previously described (Section 4.1.1), a total of 37 sediment samples were collected from Quesnel Lake between September 5th and 9th, 2014 to provide additional resolution of the spatial extent of the influence of the dam failure on sediment quality of Quesnel Lake (Figure 4.8). The samples were collected by Minnow and Tetra Tech using grab procedures similar to those previously described. Deviation from grab procedures described in Section 4.1.1 included the use of a Van Veen grab sampler (35.87 cm x 27.94 cm; 0.1 m^2) and no compositing of multiple grabs. Use of this larger sampler was possible because sampling was from the Tetra Tech oceanographic boat, which was available for a limited time period and was equipped with a large oceanographic winch. As with all other sediments collected as part of the SQIC, sediment from the top 3 cm of the grab sample was spooned from a tote into four 250 mL glass jars labeled with the project number, sample location and collection date. All sampling equipment was rinsed between stations using site water. Immediately after collection, samples were placed into a cooler with ice packs, where they were maintained cool prior to transport to the field laboratory where they were placed in a refrigerator and held until shipment to the analytical laboratory. A total of 33 of the 37 samples (including one composite sample) were submitted for analysis (Figure 4.8). Some samples that were well bracketed by others were held pending the receipt of analytical results and were ultimately not submitted as results for adjacent samples showed limited difference.

Bathymetric mapping and bottom/sub-bottom imaging was conducted by Tetra Tech between August 30th and September 6th 2014 and is described in detail under separate cover (Tetra Tech 2015). Briefly, Tetra Tech deployed an oceanographic boat from



Legend

Sediment Sampling Station

- Sample observed; not collected
- Sample collected, not analysed
- Sample collected, analysed
- Sample collected for QULP-A composite
- Waterbody
- Lake Bathymetry (10 m Intervals)
- Watercourse
- Road
- Water Flow Direction

Please note: Quesnel Lake bathymetry lines are an approximate representation only and may not precisely delineate accurate depths at larger scales.

N W E S

0 500 1,000 1,500 2,000
Metres

MAP INFORMATION
Datum: NAD 83 Map Projection: UTM Zone 10U
Data Source: Department of Natural Resources Canada. All rights reserved.
Created By: R. Sutherland
Creation Date: March 2015
Project No.: 2542

Figure 4.8: Quesnel Lake Sediment Spatial Impact Delineation Sampling Stations, 2014

Created by:

minnow environmental inc.

Bothell, Washington (USA) to complete bathymetric mapping, imaging, and to assist with the collection of sediment samples for spatial delineation. Geophysical techniques focused on delineating the depositional footprint of the tailings dam failure within Quesnel Lake. Bottom mapping was undertaken using multi-beam bathymetry, acoustic sub-bottom profiling, and sidescan sonar throughout the west basin of Quesnel Lake. Equipment utilized for bottom mapping included a combination of an EdgeTech 2000-DSS 100/600kHz sidescan sonar, a 2-16kHz sub-bottom profiler and a RESON 7125 400kHz multibeam sonar. Mapping attempted to delineate bottom type and the thickness of deposited material based on reflectance and travel time.

4.2.2 Laboratory Analysis

Laboratory analyses for the delineation of spatial extent included a subset of the analyses conducted for physical and chemical characterization as described in Section 4.1.2. Specifically, analyses included particle size distribution, pH, moisture content, total organic carbon, total nitrogen, and metal concentrations in both the < 63 µm fraction and < 2 mm fraction.

4.2.3 Data Analysis

Delineation of spatial extent focused on the POIs and IPs identified as described above (Section 4.1.3). Concentrations of the POIs and IPs were superimposed on the bottom mapping competed by Tetra Tech using ArcGIS software (Esri ArcGIS 10.2.1 with Spatial Analyst). For the POIs and IPs, spatial extent was further characterized based on magnitudes of elevation. Specifically, ratios of the POIs and IPs at exposed stations relative to reference and/or pre-event data were calculated to reflect the magnitude of elevation. These ratios were tabulated to support the graphic depictions of spatial extent of sediment quality impact. Lastly, summaries of the biological findings (toxicity test results and benthic invertebrate community results) were also tabulated to further support the delineation of the spatial extent of sediment quality impact.

4.3 Sediment Geochemical Characterization

There are numerous factors that affect the mobility and bioavailability of sediment-associated metals. While metal concentrations that are below sediment quality guidelines provide a reliable indicator of an absence of biological effect, metal concentrations greater than sediment quality guidelines suggest the possibility of effect, but generally do not provide a reliable indication of effects. Therefore, a number of additional methods to evaluate potential effects were included in the SQIC. One of these additional methods is sediment geochemical characterization.

The objective of the sediment geochemical characterization is to provide information on the leachability/extractability of sediment-associated metals, which serves to provide insight into their potential mobility and bioavailability. Sediment geochemical characterization was undertaken in all depositional sampling areas (Table 2.1), and included a number of techniques:

- Selective chemical extractions;
- Shake flask tests;
- Porewater sampling and analysis;
- Acid-Base accounting;
- Particle Size Fractionation; and
- Sediment Stratigraphy Studies.

The manner in which each of these sediment geochemical characterizations contributes to understanding of the potential mobility and bioavailability is briefly described in the sub-sections that follow.

Selective Chemical Extractions

Most evaluations of sediment quality use strong acid digests to release sediment-associated metals for chemical analysis, generally referred to as "total metal". However, digestion by strong acid does not mimic any process that is likely to occur in a natural environment, nor does it reflect the fraction to which sediment-associated aquatic organisms could realistically be exposed. On the other hand, selective chemical extractions typically apply weaker reagents in an effort to mimic the fraction (or fractions) of sediment-associated metal that could be released under natural conditions. A number of selective chemical extraction schemes have been developed to better understand how and where metals are associated with sediments (mechanistic and "phase" approaches, respectively; Horowitz 1991). Although no scheme is likely to perfectly mimic mobilization under natural conditions (e.g., Kheboian and Bauer 1987; Tack and Verloo 1995), these selective extractions are useful in providing an indication of the fraction of "total" metal that could be mobilized under different circumstances and, importantly from the perspective of exposure characterization, the fraction of "total" that could not realistically be mobilized (e.g., Tessier and Campbell 1987).

Although many selective chemical extraction schemes have been proposed, the sequential extraction scheme of Tessier et al (1979) was selected for application to the

SQIC. Briefly, the “Tessier Procedure” involves five sequential extraction steps of increasing strength as outlined in Table 4.5. Results of the procedure will assist in determining the potential for elements to become bioavailable under changing chemical conditions (which may be chemically or biologically induced). The exchangeable, carbonate, reducible, and oxidizable fractions of the modified Tessier extraction method (Table 4.5) represent the fractions of sediment-associated metals that could be released under: 1) changes in ionic strength; 2) changes in pH; 3) reducing conditions such as those that could occur with diagenesis; and 4) oxidizing conditions (Tessier et al. 1979). The final digest in the procedure is a strong acid digest (concentrated nitric and hydrochloric acids) that mobilizes metals resistant to the first four digestion steps. The final digest in this procedure is the same digest used to mobilize total metals in the conventional chemical characterization described in Section 4.1.

Shake Flask Tests

As with selective extractions, a number of shake flask tests have been developed to mimic metal mobilization from sediment. These include tests designed to mimic mobilization with exposure to natural water (e.g., the Meteoric Water Mobility Procedure, the Synthetic Precipitation Leaching Procedure), exposure to acidified water (e.g., the British Columbia Special Waste Extraction Procedure), and to mimic toxicity characteristics (e.g., the Toxicity Characteristic Leaching Procedure). A simple shake flask test using deionized water was selected to provide an intuitive estimate of the relative mobility of sediment associated metals - a 3:1 deionized water to solid ratio, shaken for 24 hours (Price 1997). After 24 hours, solids are allowed to settle and supernatant was subject to chemical analysis as described below.

Porewater Sampling and Analysis

Sediments for porewater determinations were collected in Hazeltine Creek, in Polley Lake and in Quesnel Lake. As with the shake flask elutriates, porewater chemistry provides an indication of the relative mobility of sediment-associated analytes. Samples for porewater determinations in Hazeltine Creek were collected using the same techniques described above, whereas porewater collection from sediment core samples taken in Polley and Quesnel Lake was undertaken for the additional purpose of characterizing vertical patterns in redox and the implications for metal flux within sediment and from sediment to porewater and overlying water. The latter is described below under the sub-section entitled “Sediment Stratigraphy”.

Table 4.5: Sequential extraction method for sediment (modified Tessier procedure after Tessier et al. 1979), MPMC SQIC, 2014.

Step	Fraction	Reagent	Procedure	Fraction mobilized and mobilizing conditions
I	Exchangeable and Adsorbed	Magnesium chloride (1 M $MgCl_2 \cdot 6H_2O$)	1. Add 16mL of 1 M $MgCl_2 \cdot 6H_2O$ 2. Place on a shaker table of 1 hour 3. Centrifuge on high for 30 minutes 4. Pipette the supernatant into a centrifuge tube for analysis 5. Add 16 mL Deionized water into the tube with the sediment and hand shake one minute 6. Pipette supernatant 7. Discard supernatant	Fraction of trace metals that are likely to be mobilized by changes in water ionic composition
II	Carbonate Metal	Sodium acetate (1 M NaOAc)	1. Add 16 mL of 1 M NaOAc, adjust pH to 5 using Acetic Acid (HOAc) if necessary 2. Shake for 2.5 hours 3. Repeat steps 4-7 as in Step II	Fraction of trace metals that are susceptible to changes in pH
III	Easily Reducible and Iron Oxides	Hydroxylamine hydrochloride in acetic acid (0.1 M NH_2OH-HCl (25% V/V in HOAc))	1. Add 40 mL of 0.04 M 0.1 M NH_2OH-HCl solution 2. Hand shake for 1 minute 3. Place in the oven at 96 ± 3 ºC for 6 hours, hand shaking every hour 4. After 6 hours, remove from the oven and hand shake 5. Repeat steps 4-7 in step II	Fraction of trace metals that are mobilized under anoxic conditions
IV	Organic Bound Metal	Nitric acid then ammonium acetate (0.02 M HNO_3 then 3.2 M NH_4OAc)	1. Add 6 ml of 0.02 M HNO_3 2. Add 10 mL of 30% H_2O_2 and adjust to pH 2 with HNO_3 3. Hand shake for 1 minute. 4. Place in the oven at 85 ± 2 ºC for 2 hours 5. Shake at the end of one hour and two hours 6. Add 6 mL of H_2O_2(pH 2 with HNO_3)and hand shake 7. Heat to 85 ± 2 ºC for 3 hour. Shake every hour 8. Cool Sample 9. Add 10 mL of 3.2 M NH_4OAc in 20% V/V HNO_3 10. Add 8 mL H_2O (Dilute to 40mL) 11. Shake with a wrist shaker for 30 minutes 12. Repeat step 4-7 as in step II	Fraction of trace metals that are mobilized due to the degradation of organic matter under oxidizing conditions
V	Residual Metal	Aqua regia (CSR (EPA 200.2))	1. Add 10 mL DI water, 5 mL HNO_3 and 5 mL HCl 2. Cold digest for 60 minutes 3. Digest for 2 hours ± 15 minutes at sub-boiling reflux temperature 4. Cool 5. Bulk to 50 mls with DI water, cap and shake	Fraction of trace metals that are contained in minerals and are not expected to be mobilized over a reasonable time span under normal environmental conditions

Acid-Base Accounting

Acid-Base accounting is a procedure used to predict the drainage chemistry of tailings and waste rock. It is ultimately used to predict the potential of tailings to produce acid, as summarized in Net Neutralization Potential (NNP) or the Neutralization Potential Ratio (NPR; Price 1997).

Particle Size Fractionation

Particle size fractionation, the determination of chemistry and geochemistry of different particle size fractions, provides a characterization of potential geochemical differences in different particle size classes. This information can be used, in turn, to provide perspective on the geochemical characteristics of material that may have dispersed to lesser or greater distances within the receiving environment (i.e., coarse versus fine material, respectively). It is anticipated that smaller particle size fractions would be transported further downstream than coarser size fractions; therefore these data would assist in understanding metal transport associated with the tailings plume depositing particles.

Sediment Stratigraphy

Sediment stratigraphy studies were undertaken to determine vertical patterns in metal chemistry and the current post-depositional flux (if any) of sediment-associated elements from sediment / sediment pore-water into overlying lake water at two study areas - Polley Lake and Quesnel Lake (Figures 4.3 and 4.5). This included a determination of whether / where a redox boundary exists in the sediment horizon. The redox boundary (i.e., the depth where sediment or water becomes reducing) may be critical if it occurs at a shallow depth in sediments (i.e., where benthic invertebrates occur). If biologically active sediment becomes reducing, iron and manganese and associated metal(loids), may be released and become available to resident biota. Conversely, in oxidizing environments, organic matter may be bacterially degraded resulting in the release of metals associated with organics (e.g., copper). Vertical patterns of pore-water metal concentration, sediment metal concentration, sediment porosity data (obtained from a separate core), and overlying water metal concentrations can be used to characterize concentration gradients across the sediment-water interface and potential for metal loading from the sediment to the overlying water.

4.3.1 Sample Collection

Sediment samples for geochemical characterization were collected as previously described (Section 4.1.1), with the exception that all samples for sediment stratigraphy studies were collected by gravity coring using a Tech Ops corer as described in Section 4.1.1. The sample collected for particle size fractionation (from lower Hazeltine Creek; Figure 4.2), was collected in the same manner as other Hazeltine Creek samples, with the only difference being the collection of a greater volume (40 L) to accommodate laboratory fractionation by particle size.

All samples for geochemical characterization were treated in the same manner as described previously (Section 4.1.1) prior to their shipment to the analytical laboratory (ALS Environmental, Burnaby BC) at a minimum frequency of weekly. Prior to shipment, samples were placed in a cooler with frozen ice packs and a chain-of custody form was prepared and packed with the samples. Coolers were shipped overnight using Greyhound Express.

Sediment cores collected for sediment stratigraphy included cores collected from Polley Lake and from Quesnel Lake. Cores were collected from the near-field profundal area (108 m depth) of Quesnel Lake on September 1st, 2014 and from the Polley Lake Basins (P1 and P2; 29 m depth) on September 3rd and 4th, 2014. Core length varied with sediment density from 19 cm to 72 cm in length. All cores were capped and transported to the mine site for inspection and sectioning (which typically occurred the next day). On the day of core sectioning, the core was measured and photographs and notes were taken, identifying any observable horizons. The core was then mounted on the extruding apparatus (constructed in-house), and, using a pressure of no greater than 40 psi, water was used to slowly push an extruder bung up the core and thereby push the sediment up the core tube in 1 cm increments. Each sediment section was collected using a lexan collar (marked at 1 cm intervals) and a box slicer (stainless steel). If collecting sections for sediment chemistry, the section was placed into a re-sealable bag using a scraper. The scraper, collar and box slicer were cleaned between sections using site water. Each section was then placed in a cooler with ice packs until the samples could be frozen later the same day.

If the core was being sectioned for pore-water extraction and analysis, the following modifications were made to the method. The core sectioning table, core tube and all sectioning equipment were placed in a temporary glove bag, and prior to uncapping the sediment core, the glove bag was filled with nitrogen gas. A steady flow of nitrogen was maintained during the whole procedure, such that the glove bag always had a positive pressure applied to it. This prevented air (and oxygen) from entering the core sectioning environment, and maintained an inert atmosphere. Each sediment section was placed into an acid-washed plastic centrifuge tube (85 mL; polycarbonate), and capped securely. Once six sediment sections had been collected, the capped centrifuge tubes were removed from the inert atmosphere and placed in a centrifuge (Eppendorf Centrifuge 5804 R) that was refrigerated to 4°C. The samples were then centrifuged for 30 minutes at 10,000 g to separate the pore-water from the sediment, according to the US EPA method for pore-water extraction (USEPA 2001).

After centrifugation was complete, the capped centrifuge tubes were brought back into the inert atmosphere. Pore-water was extracted using nitrogen gas-purged plastic transfer pipettes, and preserved (when necessary). For metals analysis, samples were preserved using nitric acid; for sulphide analysis, samples were preserved using zinc acetate followed by sodium hydroxide addition; and samples for anions analysis required no preservative. All preservatives and sample vials for pore-water analysis were provided by the analytical laboratory, ALS Environmental (Burnaby BC). The pore-water samples were then capped, with a nitrogen gas headspace, removed from the inert atmosphere and placed in a cooler containing ice packs until they could be refrigerated the same day. Pore-water samples were shipped to the analytical laboratory on the same day or the next day, such that all analyte holding times were met (i.e., 8 days for sulphide analysis).

4.3.2 Laboratory Analysis

Selective Chemical Extractions

Selective chemical extractions were completed by ALS Environmental according to the modified Tessier sequential extraction procedure outlined in Table 4.5. Metals were determined by collision cell ICP-MS (inductively coupled plasma-mass spectrometry), with method detection limits as specified in Table 4.6.

Shake Flask Tests

Shake flask tests were completed by ALS Environmental according to the method described by Price (1997); a 3:1 deionized water to solid ratio was shaken for 24 hours. After 24 hours, solids were allowed to settle and supernatant was subject to chemical analysis for metals by ICP-OES (inductively coupled plasma-optical emission spectrophotometry) and mercury by CVAFS (cold vapour atomic fluorescence spectrophotometry; Table 4.6).

Table 4.6: Analytes and method detection limits for sediment extracts and porewater, MPMC SQIC, 2014.

	Modified Tessier Sequential Extraction	Shake Flask Test Metals and Mercury	Sediment Porewater
ALS Laboratory Method Code:	**MET-TESS-EA-CCMS-VA; MET-TESS-CM-CCMS-VA; MET-TESS-FEO-CCMS-VA; MET-TESS-OB-CCMS-VA; MET-TESS-RES-CCMS-VA**	**MET-SHKFLSK-ICP-VA and HG-SHKFLSK-CVAFS-VA**	**MET-T-CCMS-VA**
Method :	**Tessier 1979 (modified) / EPA 6020A**	**Price 1997**	**APHA 3030 B&E / EPA SW-846 6020A**
Analyte	mg/kg	mg/L	mg/L
Aluminum (Al)	50	0.2	0.003
Antimony (Sb)	0.1	0.05	0.0001
Arsenic (As)	0.05	0.05	0.0001
Barium (Ba)	20	0.01	0.00005
Beryllium (Be)	0.2	0.005	0.0001
Bismuth (Bi)	0.2	0.1	0.0005
Boron (B)	-	-	0.01
Cadmium (Cd)	0.05	0.01	0.00001
Calcium (Ca)	50	0.05	0.10
Chromium (Cr)	5	0.01	0.0005
Cobalt (Co)	0.1	0.01	0.0001
Copper (Cu)	0.5	0.01	0.0005
Iron (Fe)	50	0.03	0.06
Lead (Pb)	0.5	0.05	0.00005
Lithium (Li)	5	-	0.001
Magnesium (Mg)	-	0.1	0.20
Manganese (Mn)	5	0.005	0.0001
Mercury (Hg)	-	0.00005	0.0001
Molybdenum (Mo)	0.5	0.03	0.0005
Nickel (Ni)	2	0.05	0.001
Potassium (K)	-	0.3	0.10
Selenium (Se)	0.2	0.05	0.0005
Silicon (Si)	-	0.05	0.1
Silver (Ag)	0.1	0.01	0.00001
Sodium (Na)	-	2	0.05
Strontium (Sr)	5	0.005	0.0002
Thallium (Tl)	0.05	0.2	0.00001
Tin (Sn)	2	0.03	0.0001
Titanium (Ti)	5	0.01	0.02
Uranium (U)	0.05	0.5	0.00001
Vanadium (V)	0.2	0.03	0.001
Zinc (Zn)	1	0.02	0.003

Porewater Sampling and Analysis

Hazeltine Creek sediment samples for porewater were processed using a different methodology that the core samples from Polley and Quesnel Lake described above (Section 4.3.1) due to much more coarse and dense substrate (core samples could not be collected). These sample were processed by ALS Environmental (Burnaby, BC), where they were centrifuged (using a Thermo Scientific Sorvall™ ST 40) at 3600 rpm for 15 minutes to separate water and solid. The supernatant was removed by pipette and subject to chemical analysis for hardness, total metals and dissolved metals using methods summarized in Table 4.6.

Acid-Base Accounting

Acid-Base accounting (ABA) was completed by ALS Minerals (North Vancouver, BC) in accordance with ABA Package 5 with the Sobek method (USEPA 1978; Table 4.7).

Particle Size Fractionation

The large (40 L) sediment sample for particle size fractionation was collected near the mouth of Hazeltine Creek (Station HAC50; Figure 4.2), dried and sieved at the analytical laboratory (ALS Environmental) to yield four particle size fractions: 1) sand (125 µm to 2 mm diameter); 2) very fine sand (63 µm to 125 µm diameter); 3) medium-coarse silt (25 µm to 63 µm diameter); and 4) clay and fine silt (< 25 µm diameter). Each of these fractions was subject to analysis for total metals and metals following the selective extraction procedure. Analytical procedures were as outlined in Tables 4.4 and 4.6.

Sediment Stratigraphy

Chemical analysis of sediment samples (1 centimeter slices) and extracted porewater samples collected as part of the sediment stratigraphy studies was completed by ALS Environmental according to the methods outlined in Table 4.4.

4.3.3 Data Analysis

Analysis of sediment geochemical data was generally similar to that applied to the general sediment physical and chemical characterization as described in Section 4.1.3. However, analysis of the geochemical data was focused on the POIs identified in analysis of the total metals data as they represent the analytes of greatest interest.

Table 4.7: Acid Base Accounting procedure (ABA5, Sobek Method), MPMC SQIC, 2014.

Parameter	Units	Method Description
Maximum Potential Acidity (MPA)	tCaCO3/1Kt	Sobek; % total sulphur * 31.25
Fizz Rating	Unity	addition of 1 or 2 drops of HCL to 0.5 g sample
Net Neutralization Potential (NNP)	tCaCO3/1Kt	MPA - NP
Paste pH	pH units	10 g sample saturated with de-ionized water; pH meter
Neutralization Potential (NP)	tCaCO3/1Kt	Sobek; 2.0 g sample treated with HCl until reaction is complete; titrated with NaOH to pH 7.0
Neutralization Potential Ratio (NPR)	Unity	NP / MPA
Total Sulphur (S) - Leco	%	0.1 g heated to 1350 °C under oxygen; Leco analysis of sulphur dioxide
Sulphate Sulphur (S) - HCl Leachable	%	Hydrochloric Acid (HCl) Leachable
Sulphate Sulphur (S) - Carbonate Leach	%	Sodium Carbonate (Na_2CO_3) Leach
Sulphide Sulphur (S) - Calculated Leco	%	Difference Calculation
Carbon Dioxide (CO_2)	%	0.02 g sample treated with Perchloric Acid ($HClO_4$) to evolve CO_2, measured by CO_2 coulometer
Inorganic Carbon (C)	%	Calculated from CO_2

Selective Chemical Extractions

Analysis of the selective chemical extraction data included the preparation of plots to characterize the apparent partitioning of POIs in sediment. For each POI, the dominant phase was identified and discussed relative to known environmental processes that could potentially mobilize the more easily extracted phases. POIs for which the majority of sediment-associated concentration was in potentially mobile forms were distinguished from those for which the majority of sediment-associated concentration was in a residual form. Concentrations of POIs in each phase and cumulative concentrations in the easily extracted phases (e.g., sum of Phase 1 through 3) were also screened using the same tools used to screen total metal concentrations (guidelines and reference as described in Section 4.1.3) in order to identify if concentrations in easily extracted phases alone might be present at concentrations of potential concern. Lastly, as described in Section 4.2.3, a spatial analysis was also completed to characterize any differences in partitioning and/or extractable concentrations relative to reference and with distance from the mine.

Shake Flask Tests and Porewater

Analysis of the shake flask and porewater data included a screening against British Columbia Water Quality Guidelines (BCWQG) for the protection of aquatic life (BCMoE 2015a, 2015b). It is not expected that that shake flask tests nor sediment porewater should meet BCWQG (which apply to surface waters); rather these were used to distinguish POIs with the potential to be released from sediments in potentially meaningful concentrations from those without that potential. As described in Section 4.2.3, a spatial analysis of shake flask test results and porewater chemistry was also completed to characterize any differences relative to reference and with distance from the mine.

Acid-Base Accounting

Acid-base accounting data were evaluated primarily on the basis of the Neutralization Potential Ratio (NPR). The NPR allows the classification of materials into four categories of potential Acid Rock Drainage (ARD): 1) likely (NPR <1); possibly (NPR 1-2); low (NPR 2-4) and none (NPR >4; Price 1997). A spatial analysis of NPR results was also completed to characterize any differences relative to reference and with distance from the mine.

Particle Size Fractionation

Particle size fractionation data were examined to characterize differences in POI concentrations in four different particle size classes (sand, very fine sand, medium-coarse silt, and clay/fine silt). In addition, concentrations of POIs in each fraction were screened against BCSQGs to evaluate whether the POIs (originally identified on the basis of BCSQG exceedences; Section 4.1.3) were elevated in each size category. Implications for dispersion within the receiving environment were considered.

Sediment Stratigraphy

Sediment porewater POI concentrations determined in sediment stratigraphy studies were evaluated as previously indicated for sediment total metals (Section 4.1.3) and porewater (above). However, the focus of these studies is the characterization vertical patterns of sediment metal concentrations and potential diffusive flux.

If sediment and pore-water metal concentrations suggest meaningful gradients, pore-water diffusive flux is based on the concentration gradient between the pore-water metal concentration in the top sediment section (0 to 1 cm), and the metal concentration in the overlying water. It considers diffusion and the random path-length that an ion diffuses through, given the particles that obstruct it. Other factors, such as attenuation of metals in sediment, are not considered in the calculation of diffusive flux.

Pore-water diffusive flux calculations were made according to Ullman and Allen (1982), using literature-based ideal solution diffusion co-efficients (Li and Gregory 1974) which were corrected for geometric tortuosity and the solution conditions of pore water to determine the bulk sediment diffusion coefficient, Dsi.

The equation for diffusive flux was as follows:

$$Ji = \Phi \times Dsi$$ Ullman and Allen (1982)

Where Ji is the flux of solute, i ($mg/cm^2/yr$); Φ is sediment porosity; and Dsi is the bulk sediment diffusion co-efficient of solute i.

Ideal solution diffusion co-efficients (Doi) for temperature conditions of 4°C were used in calculations, literature value diffusion co-efficients (Li and Gregory 1974) were corrected to 4°C using the Stokes-Einstein relationship. The literature value diffusion co-efficient for arsenic assumed the oxidized As(V) form, H_2AsO_4-, this is likely the appropriate oxidation state for Quesnel Lake, and the de-protonated form ($HAsO_4^{2-}$) is likely most appropriate for the pH of sediment in Quesnel Lake (pH 8.4) and Polley Lake (pH 7.45 and 7.90 in P1, and P2 respectively). The extra charge on the arsenic oxyanion would likely result in a slowing of diffusion, such that the calculated fluxes would be a conservative estimate. In a reducing environment, arsenite would predominate, ($H_3AsO_3^0$), which would have zero charge, and again, using the diffusion co-efficient for the di-protonate arsenate moiety would result in a conservative estimate for diffusive flux.

The bulk sediment diffusion co-efficient was calculated using geometric tortuosity, which is related to porosity (Boudreau 1996). Porosity for Quesnel Lake was determined using archived sediment sections (Φ=0.875), as sediment compaction had not occurred, the use of deeper sediment sections for this purpose was considered reasonable. The lower porosity for Quesnel Lake is fairly typical for very fine tailings material. Polley Lake porosity was taken to be 0.956, the highest porosity observed in sediment from both stations, this corresponded to a sediment density of 2.74 g/mL. This sediment density is slightly higher than that typically used for sandy sediment (2.5 g/mL; Cornett et al. 1989), which may be due to particle size differences.

4.4 Sediment Toxicity

The objective of the sediment toxicity testing program is to determine whether sediment affected by the tailings dam failure has the potential to cause adverse effects to aquatic life (e.g., Besser et al. 2015), and if so, to what spatial extent. It also forms one component of the sediment quality triad approach (concurrent sediment chemistry, toxicity and benthic invertebrate monitoring; Chapman 1990) to evaluating sediment degradation and associated biological implications. In considering sediment toxicity tests within a weight-of-evidence-approach (WEA), it must be considered that sediment toxicity tests employ laboratory cultured organisms that may not reflect the particular sensitivity/tolerance level of site organisms (Cairns and Mount 1990; Luoma and Rainbow 2008; Janssens et al. 2009), and that difference in survival and growth measured in sediment toxicity tests can be a result of physical factors (e.g., sediment texture and organic content) as well as contaminants (e.g., Ankley et al. 1994).

Sediment toxicity testing was conducted at all study areas (Table 2.1) concurrent with the sediment sampling for chemical and geochemical characterization (Sections 4.1 and 4.3), and was generally designed to allow statistical comparison among areas as depicted in Table 4.1. However, additional comparisons, defined a-priori, were made between near-field and far-field stations in Quesnel Lake and corresponding reference stations to characterize spatial variability at a smaller scale (Table 4.8). Two sediment toxicity tests were applied: 1) the 10-day survival and growth of *Chironomus tentans* (dilutus; a freshwater midge; Environment Canada 1997); and 2) the 14-day test of survival and growth of *Hyalella azteca* (an amphipod; Environment Canada 2013).

Table 4.8: Summary of statistical comparisons of sediment toxicity test results.

A) Area Comparisons

Waterbody	Final Area Code	Original Area Code	Area Description	Laboratory Control	Reference Area	Reference Area(s)
Hazeltine Creek	ST-16	ST-16	Upstream	✓	×	-
	ST-09	ST-09	Midstream	✓	×	-
	ST-02	ST-02	Downstream	✓	×	-
Polley Lake	POL-1	POL-1	Mid-Depth, North Side	✓	✓	BOL-1
	POL-2	POL-2	Mid-Depth, South Side	✓	✓	BOL-1
	POL-P1	POL-P1	North Deep	✓	✓	BOL-B1, BOL-B2
	POL-P2	POL-P2	South Deep	✓	✓	BOL-B1, BOL-B2
Quesnel Lake Littoral	LNF-1	QUL-45	Near Field 1	✓	✓	LRef1, LRef 2
	LNF-2	QUL-49	Near Field 2	✓	✓	LRef1, LRef 2
	LFF	QUL-47	Far Field	✓	✓	LRef1, LRef 2
	LFFF	QUL-48	Far-Far Field	✓	✓	LRef1, LRef 2
Quesnel Lake Profundal	PNF	QULP-1	Near Field 1	✓	✓	PRef1, PRef 2
	PFF-1	QULP-2	Near Field 2	✓	✓	PRef1, PRef 2
	PFF-2	QULP-4	Far Field	✓	✓	PRef1, PRef 2
	PFFF	QULP-3	Far-Far Field	✓	✓	PRef1, PRef 2

B) Station Comparisons

Waterbody	Final Area Code	Area Description	Station	Laboratory Control	Reference Area	Reference Stations
Quesnel Lake Littoral	LNF-1	Near Field 1	LNF-1-01	✓	✓	LRef1-01, LRef1-02, LRef1-03, LRef1-04, LRef1-05
			LNF-1-02	✓	✓	
			LNF-1-03	✓	✓	
			LNF-1-04	✓	✓	
			LNF-1-05	✓	✓	
	LNF-2	Near Field 2	LNF-2-01	✓	✓	LRef1-01, LRef1-02, LRef1-03, LRef1-04, LRef1-05
			LNF-2-02	✓	✓	
			LNF-2-03	✓	✓	
			LNF-2-04	✓	✓	
			LNF-2-05	✓	✓	
Quesnel Lake Profundal	PNF	Near Field 1	PNF-01	✓	✓	PRef1-01, PRef1-02, PRef1-03, PRef1-04, PRef1-05
			PNF-02	✓	✓	
			PNF-03	✓	✓	
			PNF-04	✓	✓	
			PNF-05	✓	✓	
	PFF-1	Near Field 2	PFF-1-01	✓	✓	PRef1-01, PRef1-02, PRef1-03, PRef1-04, PRef1-05
			PFF-1-02	✓	✓	
			PFF-1-03	✓	✓	
			PFF-1-04	✓	✓	
			PFF-1-05	✓	✓	

4.4.1 Sample Collection

Samples for toxicity testing were collected using a petite ponar grab sampler as described in Section 4.1.1. Each sample was generally a composite three to five grabs with the exception that within the profundal areas of Quesnel Lake, where 5 toxicity replicates were collected at each station, each toxicity replicate was composed of one grab (Table 4.2). Composited sediment was placed into 500 mL glass sampling jars labeled with the project number, sample location and collection date. In accordance with technical guidance (Environment Canada 2013), field replicates were used in the toxicity testing. For area comparisons, one replicate was collected from each station as outlined in Table 4.2. For the additional comparisons between near-field stations, far-field stations and reference stations in Quesnel Lake (Table 4.8), five-separate 500 mL field replicates were collected from of each five stations per area (i.e., 25 samples per area) using the same collection techniques and compositing approach. All sampling equipment was rinsed between stations or replicates using site water.

Following collection, sediment samples for toxicity testing were maintained cool (on ice or in a refrigerator) and then shipped to the toxicity test laboratory as soon as possible after collection. To the extent possible, sediments were held so that the testing could be run in appropriate batches that included sediments from the respective exposed and reference areas within a study creek or lake (i.e., Hazeltine Creek, Polley Lake, Quesnel Lake littoral and Quesnel Lake profundal). However, given the duration of the sampling program, some deviation from the ideal batch composition was required to ensure that sediments were held for no more than two weeks prior to testing.

4.4.2 Laboratory Analysis

Sediment toxicity tests were completed in accordance with technical guidance (Environment Canada 1997; 2013) by Nautilus Environmental (Burnaby, BC), which is certified by the Canadian Association for Laboratory Accreditation (CALA).

4.4.3 Data Analysis

Statistical analyses were conducted by Nautilus Environmental using CETIS (Comprehensive Environmental Toxicity Information System) software (Tidepool Scientific Software). All test results were statistically compared to concurrent laboratory controls. However, because tests for some areas were run in different batches, some normalization was required to make valid comparisons among batches. Specifically, in order to compare results between test batches, the test data were normalized to the underlying performance of the laboratory controls by dividing the data by the control response. This process resulted in removing the between-test differences in control performance. In the case of survival, the control response was normalized to the control acceptance criteria (i.e., 80% for H. azteca and 70% for C. tentans), and the samples were calculated as a percentage of normalized control performance. The samples were normalized to the control acceptance criteria, rather than to 100%, since there were cases where the performance of the samples exceeded the laboratory control performance, which would have produced normalized rates of survival exceeding 100%. For both species, weight data were normalized to the control value of controls run during the test with the reference site for that area. To normalize weight between tests, a weight correction factor was determined by dividing the average laboratory control growth for that specific test date by the average control growth for test corresponding to the reference site test. This correction factor was then applied to all replicates for that test date in order to correct for the differences in growth rates of the controls between tests.

The data normalization resulted in a dataset that could then be compared across test dates, since it removed the variance associated with differing growth and survival rates of the controls from the different test initiation dates. The normalized data were used to perform defined statistical comparisons among areas and stations (Table 4.8) using tests suited to the normality and variance (equal or unequal) of the particular dataset, and included the Fisher Exact Test, two-sample t-test, ANOVA and Fisher Exact / Bonferroni-Hommel test as selected using rules built in to the CETIS software. Statistical significance level was defined as $p = 0.05$. Sediment toxicity was identified as environmentally meaningful in cases where survival and/or growth were significantly reduced relative to laboratory control sediment (sand) and relative to field-collected reference sediment. In cases where toxicity was identified (statistically significant differences in survival and/or growth relative to laboratory and reference sediments), results were also evaluated relative to the spatial distribution of sampling areas.

Potential relationships between sediment toxicity and physical and chemical conditions of the study areas were explored using correlation analysis (e.g., Suter et al. 2015). In order to reduce the number of comparisons made, toxicity test results were compared to physical variables and to a reduced set of chemical variables (e.g., meter measures, sediment chemistry PCA axes, POIs and selected IPs as identified in the sediment quality data evaluation). Following derivation of correlation coefficients, a Bonferroni-type correction (i.e., a p-value of 0.05 divided by the total number of correlations examined for independent variables only) was applied to minimize the risk of declaring false positive correlations since at least 5% of derived correlations would be expected to occur by chance alone at an uncorrected p-value of 0.05. Any significant correlations found at the Bonferroni-adjusted p-value or at a p-value of 0.01 were further investigated using scatter plots to determine if a continuous distribution of data was realized (possible causal relationships) or if these relationships were “leveraged” by outlying points (or groups of points). Significant correlations, coupled with careful examination of scatterplots, were used to identify the factors that most contribute to variability in sediment toxicity. The causative merits of these factors were then considered in light of known physical and chemical mechanisms of toxicity.

Sediment toxicity test data were also integrated with the concurrently collected sediment chemistry and benthic invertebrate community data to apply a weight-of-evidence approach (WEA) to interpretation of potential effects of the tailings dam failure on sediment chemistry and aquatic life (i.e., the sediment quality triad; see Section 4.7).

4.5 Benthic Invertebrate Community

The objective of the benthic invertebrate community program was to characterize the influence of the tailings dam failure on benthic invertebrate communities. Benthic invertebrate community sampling also serves as an integral component of the sediment quality triad to assist in the evaluation of effects associated with the failure-derived material (i.e., concurrent sediment chemistry, toxicity and benthic invertebrate community monitoring; Chapman 1990). A secondary objective of the sampling was to provide post-event baseline data against which to track benthic invertebrate community recovery over time.

Benthic invertebrate community monitoring was conducted at all study areas (Table 2.1), with the exception of Hazeltine Creek. No benthic invertebrate community sampling was conducted in Hazeltine Creek in 2014 due to the absence of appropriate erosional habitat post-event (i.e., substrates were entirely fine materials derived from the tailings pond and scoured creek bed). Benthic invertebrate community samples were collected concurrent with, and at the same location as, sediment samples (Figure 4.1 to 4.5), and the sampling strategy was generally designed to allow statistical comparison among areas as depicted in Table 4.1. Within each area, five stations were sampled to provide adequate statistical power to definitively detect differences between the respective influenced and reference study areas (Environment Canada 2012a). Additional benthic samples were collected in the Quesnel River (six sites) for evaluation of potential failure-related effects using a Reference Condition Approach (RCA; Bailey et al. 2004). RCA reference sites included the Cariboo River, the Clearwater River, and the Blackwater River (Figure 4.6).

4.5.1 Sample Collection

Benthic invertebrate community samples were collected from lake environments (Polley Lake, Bootjack Lake and Quesnel Lake) and from running waters of the Quesnel River and associated reference areas. In lakes, samples were collected using grab techniques consistent with established provincial and federal protocols (i.e., BCWLAP 2003; Environment Canada 2012a). Benthic invertebrate samples were collected using a petite ponar grab sampler (often referred to as a petite ponar dredge sampler) with dimensions of 15.24 cm x 15.24 cm (6" x 6"). Five stations were sampled in each area to provide adequate statistical power to detect differences of ± two standard deviations at an α and β of 0.10. One sample was collected at each station and was a composite of five sub-samples (grabs; 0.116 m^2 of bottom area in total), to ensure that each sample was representative of the station. Upon retrieval, all samples were closely examined to verify that only high quality, comparable samples were retained (based on factors such as particle size, organic matter, presence or absence of plants or algae). Each grab was placed into a tub to evaluate whether the grab was complete (i.e., that the grab captured the surface material and was full to each edge) and to evaluate the depth to which the grab penetrated. Incomplete or unusual samples were discarded. Accepted grab samples were rinsed from the ponar into the tub to ensure the complete removal of all material. Sampling was repeated until five acceptable grabs were collected. Details about each acceptable grab were recorded on field sheets.

Composite samples collected from littoral areas of Quesnel Lake were then placed into a 500 µm mesh sieve bag and sieved free of all material less than 500 µm in diameter. Composite samples from Polley Lake, Bootjack Lake and the profundal areas of Quesnel Lake were placed into a 250 µm mesh sieve bag and sieved free of all material less than 250 µm in diameter. This difference in sieve sizes used in deep versus shallow lake areas reflects the lower productivity, smaller organism size and smaller average particle size of profundal environments (e.g., Ward 1992).

After sieving, the retained material (sample) from the five composited grabs was carefully transferred to labelled 1 or 2-L wide mouth plastic jars using a stainless steel spoon and a wash bottle while working over a plastic tub to avoid any potential loss of organisms. Any organisms that adhered to the sieve bag were removed and added to the sample. All samples were labelled internally (using wooden sticks) and externally with the station number, area identifier, project number, date and field personnel in order to ensure correct identification at the laboratory. Samples were preserved with buffered formalin solution to achieve a nominal concentration of 10%. Supporting information collected at each sampling site included GPS (Geographic Positioning System) coordinates, sampling depth, field meter measurements of temperature, specific conductance, dissolved oxygen and pH (using a YSI EXO™ handheld portable field meter equipped with YSI EXO2™ Sonde), site photographs (including photographs of sediment samples), notes of the presence or absence of aquatic vegetation, and other physical observations (sediment texture, colour, density, etc.).

Larger rivers, such as the Quesnel, are particularly challenging for biological assessment (e.g., Flotemersch et al. 2006). The depth, velocity, morphology, and substrate of the Quesnel River limits benthic invertebrate sampling to the littoral margins. To improve detection of potential impacts, habitat variability was reduced by standardizing the sampled habitat to the most consistent, biologically relevant, feasibly sampled habitat available throughout the Quesnel River. This was determined to be habitat of cobble littoral margins with water velocities of approximately 0.20 m/s, sampled at a depth of approximately 50 cm. Benthic invertebrate samples from the Quesnel River and associated reference areas were collected using a kick-and-sweep technique that was modified from the protocol developed under the Canadian Aquatic Biomonitoring Network (CABIN; Environment Canada 2012b).

The protocol involves a 3-minute travelling kick-and-sweep using a kick net with a triangular aperture measuring 36 cm per side and mesh having 400 µm openings. This type of sampling is best suited to substrate that is dominated by large cobble and boulder. During sampling, the field technician typically moves across the stream channel (from bank to bank, dependant on stream depth and width) in a ‘zig-zag’ pattern moving upstream for a timed kick of three minutes. With the net being held immediately downstream of the technician’s feet, the detritus and invertebrates are disturbed from the substrate and passively collected in the kick-net by the stream current. After three minutes of sampling time, the sampler stops and returns to the stream bank with the sample. The kick-net is rinsed with water to move all debris and invertebrates into the collection cup at the bottom of the net. The collection cup is then removed so the contents can be poured into a labelled plastic jar and preserved in a 10% buffered formalin solution. A single sample is taken at each area. This protocol was modified in two ways: 1) kick sampling occurred parallel to the shoreline at 50 cm of water depth, and 2) triplicate samples were taken and kick time was reduced from 3 minutes to 1 minute. The modification to sampling transect orientation was required due to the nature of the Quesnel River. The reduction of sample time was conducted to provide replication while maintaining the same level of overall search effort.

Immediately after completion of the three 1-minute kick-and-sweeps, material collected within the D-net was carefully transferred into a labeled one-litre, wide-mouth plastic jar. All samples were labelled internally (using wooden sticks) and externally with the station number, area identifier, project number, date and field personnel in order to ensure correct identification at the laboratory. Samples were preserved with buffered formalin solution to achieve a nominal concentration of 10%. Supporting information collected at each sampling site included GPS (Geographic Positioning System) coordinates, sampling depth, water velocity (using a Marsh-McBirney Flowmate Model 2000 portable velocity meter), stream width (using a Bushnell Yardace Pro Sport 450 range finder), stream depth, substrate characteristics, the type and relative coverage of any aquatic vegetation, water samples (with one field duplicate), field meter measurements of temperature, specific conductance, dissolved oxygen and pH (using a YSI 650 MDS field meter equipped with a YSI 600 XLM sonde that was calibrated daily), site photographs, notes of the presence or absence of aquatic vegetation, and other physical observations.

Supporting water quality samples were collected at all areas concurrent with benthic invertebrate community sampling. Samples were collected directly into pre-cleaned sample bottles provided by the laboratory and preserved (as required) immediately. Samples being analyzed for dissolved organic carbon (DOC) were collected into a clean container, filtered through a 0.45-μm membrane affixed to a sterile syringe, and transferred to an appropriate sample bottle. Water samples were collected by wading into a mid-channel area, moving from downstream to upstream, so as not to collect water downstream of disturbed substrates. All samples were collected at 25 cm depth where total water depth was 50 cm. Water samples were stored in coolers with ice packs. The samples were re-packed with ice for shipment to the analytical laboratory (ALS Environmental in Burnaby, BC) approximately each day or every other day.

All preserved benthic invertebrate samples were placed in coolers or totes and stored at the Mount Polley Mine prior to shipment to Cordillera Consulting (Summerland, British Columbia) for taxonomic analysis. Senior taxonomists at Cordillera Consulting are certified under the Taxonomic Certification Program of the Society of Freshwater Sciences (SFS) for benthic invertebrate taxonomy.

Supporting water samples were shipped in coolers on ice to ALS Environmental in Burnaby, BC, for analysis of dissolved organic carbon (DOC), total metals, dissolved metals, anions (nitrate, nitrite, sulphate, chloride, and fluoride), ammonia, total Kjeldahl nitrogen (TKN), total phosphorus, dissolved phosphorus, orthophosphate, alkalinity, hardness, turbidity, total suspended solids, total dissolved solids, pH, and conductivity.

4.5.2 Laboratory Analysis

Benthic invertebrate community samples were sent to Cordillera Consulting (lead taxonomist Sue Salter), in Summerland BC, for sorting and taxonomic identification using standard methods that incorporate QA/QC measures (e.g., Environment Canada 2002; 2012a; 2014). Taxonomists at Cordillera have achieved certification for Group 1 (general Arthropods West), 2 (Ephemeroptera, Plecoptera and Trichoptera East and West), and 3 (Chironomids West) benthic organisms in the Taxonomic Certification Program (http://nabstcp.atlanticwebfitters.ca/) of the Society for Freshwater Science (formerly the North American Benthological Society). Organisms were identified to the lowest practical level (LPL) (typically genus or species) using up-to-date taxonomic keys. Following identification, representative specimens of each taxon were placed in separate vials to create a reference collection for the project.

Briefly, upon arrival, each benthic sample was logged into proprietary software, followed by a check of proper preservation and the addition of Rose Bengal dye. Sample processing was initiated with sample washing, including elutriation to remove sand and gravel, with the remaining organic material examined to estimate the total number of invertebrates and preserved in 70% ethanol. If the estimated number of invertebrates was greater than 600 individuals and the sample was fine and non-clumping, a subsample was taken using a Marchant Box (Marchant 1989) as described by Environment Canada (2014). Of the 87 benthic samples collected from lake environments, only 11 required sub-sampling.

Samples (or sub-samples) were then sorted using a gridded Petri dish under low power stereo microscope into family/order while maintaining counts (but totals exclude Nemata, Platyhelminthes, Ostracoda, Copepoda, Cladocera, Collembola and any terrestrial drop-ins). When specimens were broken, only heads were counted towards the total, and larval and pupa exuviae were not counted. If the 300th organism was found part way through counting a cell, the entire cell was completed. All sorted organisms were stored in 80% ethanol by family/order in separate labeled vials and debris was preserved and labeled separately. Identifications of all insects to the genus/species level and non-insects to the genus/species level where possible (but to minimum family level) were conducted by experienced, certified taxonomists using standard keys and comparison to an externally-verified reference collection, and effort lists compiled by PNAMP (Pacific Northwest Aquatic Monitoring Partnership). Following identification and counting, representative specimens of each taxon were preserved in 75% ethanol (with 3% glycerol) in a museum quality vial with a polyseal lid to create a voucher collection. The interior labels were used to identify the taxa, the client, date collected, site code and the project.

Laboratory quality assurance/quality control (QA/QC) included an assessment of sub-sampling error and sorting efficiency on at least 10% of the samples (Environment Canada 2002, 2012a). All data were then entered into proprietary software, which was also used to calculate benthic invertebrate community metrics and generate the taxonomic report.

4.5.3 Data Analysis

Benthic invertebrate community data associated with lake environments (Polley Lake, Bootjack Lake and Quesnel Lake) were evaluated using the control-impact study designs summarized in Table 4.1 and benthic invertebrate community data of the Quesnel River were evaluated using a Reference Condition Approach (RCA; Bailey et al. 2004). Benthic invertebrate communities were evaluated using metrics of mean invertebrate density (organisms per m^2; grab samples) or mean abundance (kick-and-sweep samples), mean taxonomic richness, Simpson's Evenness Index (calculated as in Smith and Wilson 1996; Environment Canada 2012) and the Bray-Curtis Index of Dissimilarity (calculated as in Bray and Curtis 1957). These biological endpoints (density, taxon richness, diversity, evenness and community composition) were calculated following the exclusion of Collembola, Ostracods, Cladocera, Copepoda, Malastrocoda because these are pelagic organisms, and Nemata and Turbellaria because these organisms are so small that they are not reliably retained during sieving and can therefore substantially contribute to spatial and/or temporal variability, thereby reducing power to detect general differences in benthic invertebrate community condition. The primary indices were calculated at the lowest practical level of taxonomy. Simpson's Index of Diversity (calculated as in Smith and Wilson 1996; Environment Canada 2012a) was also used to describe benthic invertebrate communities. The relative proportions of the most abundant taxa were also computed (calculated as the abundance of each respective dominant/indicator taxon relative to the total number of organisms in the sample). Dominant/indicator taxon groups were defined as those groups representing more than 5% of total organism abundance or any groups considered to be important indicators of environmental stress. All required and selected endpoints were summarized by reporting mean, median, minimum, maximum, standard deviation, 90% confidence intervals of the mean, and sample size for each sampling site.

Correspondence analysis (CA) was then used to further examine benthic invertebrate community structure. CA is a multivariate technique, which is used to create synthetic species prevalence axes extracted in a sequential manner. Each score (number) on a CA axis is the sum of a weighted vector of species proportion. Species with correlated proportions vary together and will have similar weights and scores on a CA axis. When depicted in two-dimensional plots, taxa that tend to co-occur plot together, while those that rarely co-occur plot farther apart. Similarly, stations sharing many taxa plot closest to one another, while those with little in common plot farthest apart. The greatest variation among either taxa or stations is explained by the first axis, with other axes accounting for progressively less variation. This type of multivariate analysis describes not only which stations have distinct benthic communities but also how these benthic communities differ among stations (i.e., which particular taxa differ). Prior to CA, the data were screened for rare taxa, as these can distort results. Taxa occurring at 5% or fewer of the stations were removed. After screening and data reduction, a proportional data matrix was used to conduct a CA using the program PC-ORD© version 6 (McCune and Mefford 2011). Scores for both taxa and stations were calculated to evaluate the associations of organisms and stations. To ensure that each interpreted axis explained more variation in the dataset than by chance alone ($p<0.05$), a Monte Carlo randomization test was performed using 999 randomized runs of the original dataset (McCune and Grace 2002).

Benthic invertebrate community metrics for all lakes (i.e., all control-impact or multiple control-impact designs) were then plotted, by area, to explore spatial patterns in the benthic community data (the approach to statistical evaluation of the Quesnel River data using the RCA approach is described separately below). Multivariate analysis of variance (MANOVA), followed by analysis of variance (ANOVA) and, as applicable, *post-hoc* Bonferroni comparisons, were used to test for differences in benthic metrics among areas. Data were transformed as necessary to satisfy assumptions of normality and homogeneity of variance. In instances where variances could not be homogenized by transformation, post-hoc tests not requiring this assumption (Tamhane's) were used instead of Bonferroni comparisons. Statistical tests and plots were generated using SPSS version 22 software (IBM Corp. 2013). An effect on the benthic invertebrate community was defined as a statistically significant difference between an event-exposed area and the comparable reference area at an alpha level of 0.10 (Environment Canada 2012a). Interpretation of benthic community metrics was enhanced by inspection of raw data and taxonomic proportions to detect patterns of ecologically relevant differences between reference and exposure areas. Ecological and habitat requirements of benthic invertebrates, as outlined in standard references (Clarke 1981; Edmunds et al. 1976; Weiderholm 1983; Wiggins 1996; Merritt et al. 2008), were used in data interpretation. Lastly, to verify the conclusions derived from the statistically appropriate ANOVA and post-hoc testing, additional pairwise t-testing was conducted and results compared to the ANOVA/post-hoc results. This step essentially asks the question of whether conclusions would differ if the study design were based on simple control-impact comparisons.

In instances when a significant difference between effluent-exposed and reference area means was detected using ANOVA, the magnitude of the difference was calculated for that metric. The Technical Guidance Document (Environment Canada 2012a) states that the benthic invertebrate community survey should minimally have sufficient power to detect a difference (effect size) of ± two standard deviations (SDs). Therefore, the magnitude of the difference was calculated to reflect the number of reference mean SDs as follows:

(exposure mean – reference mean) / SD of the reference mean

If a significant difference between areas was not detected for a benthic metric, then the minimum effect size that could be detected was calculated using the mean square error generated from the ANOVA as an estimate of variability, with alpha and beta equal to 0.10. The minimum detectable effect size was based on the minimum number of reference area standard deviations, according to the following equation:

$\delta = [(t_\alpha+t_\beta)(\sqrt{MSE})(\sqrt{2/n})]/SD_{ref}$, where

δ = minimum detectable effect size,

MSE = mean square error

n = sample size per area (in this case = 5), and

SD_{ref} = standard deviation of the reference mean.

For Polley Lake basins (POL-P1 and POL-P2), historical benthic invertebrate community data were available (HKP 1996, 1997; Beak 2000), and 1999 data (Beak 2000) were of sufficient quality to allow quantitative temporal comparison. The data (Beak 2000) were used to recalculate the metrics described above following the same exclusion rules as above to ensure valid temporal comparison. Metrics for the Polley Lake basins (2014) were then compared to the data from 1999 (Beak 2000) using the same general approach outlined above.

The RCA experimental design (applied to Quesnel River benthic invertebrate community data) evaluates exposed sites against a reference condition, which is composed of multiple reference sites. Therefore, a traditional ANOVA evaluation cannot be used in an RCA design. When testing for statistical differences between exposed sites and multiple reference areas, two non-central tests were employed; a one-sample, non-central, equivalence test; and a one-sample, non-central, interval test (Kilgour et al. 1998).

Determination that a test site is different from the reference condition (i.e. outside the range of reference values) was based on a critical effect size of 1.96 reference standard deviations and tested using two null hypotheses: H_{01} – the absolute value of the reference mean subtract the test site value is ≥ 1.96 reference standard deviations (equivalence test), and H_{02} – the absolute value of the reference mean subtract the test site value is ≤ 1.96 reference standard deviations (interval test). This testing results in three possible outcomes: a non-central p-value (ncP) < 0.1 (interval test) that indicates a community endpoint is outside of the reference condition; a ncP > 0.9 (equivalence test) that indicates a community endpoint is within the reference condition; and a ncP-value between 0.1 and 0.9 that is inconclusive with respect to potential difference from the reference condition (Kilgour et al. 1998). Any exposed stations found to be statistically outside the range of reference conditions (ncP < 0.1) were further evaluated through inspection of the raw data and taxonomic proportions. The ecological and habitat requirements of the dominant taxa were assessed using standard references (Clarke 1981, Edmunds et al. 1976, Weiderholm 1983, Wiggins 1996, Merritt et al. 2008) in order to consider the statistical results of benthic invertebrate community survey in the context of ecological and habitat requirements.

Potential relationships between benthic invertebrate community metrics and physical and chemical conditions of the study areas were explored using correlation analysis as part of causal assessment (Suter et al. 2015). In order to reduce the number of potential correlations considered, benthic invertebrate community metrics were compared to physical variables and to a reduced set of chemical variables (e.g., meter measures, sediment chemistry PCA axes, POIs and selected IPs in lakes; meter measures and water chemistry PCA axes in the Quesnel River). Following derivation of correlation coefficients, a Bonferroni-type correction (i.e., p-value [0.05] divided by the total number of correlations examined for independent variables only) was applied to minimize the risk of declaring false positive correlations since at least 5% of derived correlations would be expected to occur by chance alone at an uncorrected p-value of 0.05. Any significant correlations found at the Bonferroni-adjusted p-value or at a p-value of 0.01 were further investigated using scatter plots to determine if a continuous distribution of data was realized (possible causal relationships) or if these relationships were leveraged by outlying points (or groups of points). The effects of leverage were carefully considered because any difference in benthic community attributes of the effluent-exposed areas relative to reference might be correlated with failure-related differences in water or sediment quality regardless of cause. Significant correlations, coupled with careful examination of scatterplots, were used to identify the factors that most contribute to variability in benthic invertebrate community endpoints. These factors were then considered in light of known physical and chemical influences on benthic invertebrate communities (e.g., stimulation by nutrient enrichment, toxicity by exposure to high metal concentrations).

Benthic invertebrate community data were also integrated with the concurrently collected sediment chemistry and sediment toxicity test data to apply a weight-of-evidence approach (WEA) to interpretation of potential effects of the tailings dam failure on sediment chemistry and aquatic life (i.e., the sediment quality triad; see Section 4.7).

4.6 Benthic Invertebrate Tissue

The objective of benthic tissue collections was to characterize the influence of the tailings dam failure on tissue quality of benthic invertebrates of the Quesnel River. A secondary objective of the sampling is to provide post-event baseline data against which to track potential changes in benthic invertebrate tissue quality over time.

Benthic invertebrate samples for tissue analysis were collected from the Quesnel River and associated reference sites (Table 2.1). Reference sites included the Cariboo River, the Clearwater River, and the Blackwater River (Figure 4.6). Benthic invertebrate tissue samples were collected concurrent with, and at the same location as, benthic invertebrate community samples.

4.6.1 Sample Collection

At each site, two benthic invertebrate tissue samples were collected, one a composite of the entire benthic community and the second a composite of the Plecopteran (stonefly) family Perlidae (often referred to as golden stones). Perlidae were chosen because they are easily identifiable in the field, were estimated to be present and in large numbers at most areas, and having a single taxon provides some standardization across areas that address concerns often raised when amalgamating whole community tissue samples.

Samples of the entire benthic community were collected by kick-and-sweep as described above (Section 4.5.1), with the exception that collection was not timed as the objective was simply to collect sufficient tissue for chemical analysis. Samples of Perlidae were obtained by removing cobble from the streambed and inspecting their undersides for organisms. In both cases, sampling was continued until the required 200 mg of sample was attained (required for the effective analytical determination of analytes of interest. To ensure that invertebrate picking was not biased toward large mobile organisms the whole sample was sorted. If the total tissue collected did not exceed the minimum 200 mg necessary for laboratory measurements additional kick samples were collected. Specific effort was made to target similar habitats for collection of both community and tissue samples within each area. Once the tissue sample was collected, organisms were picked free of debris in the field, placed into a labelled 30-mL (1-oz) Whirl-Pak® bag and stored in a cooler with ice packs until transferred to a freezer later the same day. Frozen samples were shipped by courier in coolers with ice packs to SRC (Saskatchewan Research Council) Analytical Laboratories.

4.6.2 Laboratory Analysis

Upon receipt, SRC opened the cooler(s), measured temperature to verify the maintenance of cold samples, removed each sample from the cooler(s), logged the sample, and assigned each sample a unique sample identification code. Laboratory analysis included freeze-drying and determination of total metals using ICP (inductively coupled plasma). Results were reported on a dry-weight basis, along with moisture content to allow future conversion of results to a wet-weight basis, if required.

4.6.3 Data Analysis

Metal concentrations in composite samples of the whole benthic invertebrate community and in composite samples of Perlidae only (golden stoneflies) were assessed by ANOVA with post-hoc contrasts as described in Section 4.5.3. In addition, metal composition gradients determined through PCA were examined to describe spatial differences/patterns.

4.7 Data Integration

Beyond the interpretation of individual components of the sediment quality impact characterization, it is critical that relationships among the components are characterized and considered, and data are applied in a weight-of-evidence approach (WEA). The objective of data integration is to use all available data to define chemical and biological impact.

In data integration, relationships among components of the monitoring plan were specifically explored to determine which analytes consistently emerge as evidence of impact and to characterize relationships among endpoints to determine biological effects and their probable cause. The key tool for this examination, as outlined in the sediment toxicity section (Section 4.4.3) and in the benthic invertebrate community section (Section 4.5.3), is correlation analysis. Throughout this report, a weight of evidence is built by adding layers of information (e.g., sediment quality is considered in light of water quality; benthic invertebrate community condition is considered in light of water quality, sediment quality, toxicity test results and physical conditions) to identify relationships and concordance.

Relationships among program components were also explored by compiling the results of the different monitoring components in a table and examining concordance of effects. This WEA evaluation is a collective evaluation of all pertinent information so that the full spectrum of information is adequately considered (USEPA 2004). The concordance table was used to identify locations that were clearly impacted, those that were clearly un-impacted (or mildly impacted), and those for which the evidence is equivocal in order to communicate magnitude and extent of impact.

5.0 HAZELTINE CREEK

Sediment quality impact characterization in Hazeltine Creek included sediment chemistry, sediment geochemical characterization and sediment toxicity testing (Table 4.1; Figure 4.2). Benthic invertebrate community samples were not collected in Hazeltine Creek due to the absence of appropriate erosional habitat post-event (i.e., substrates were entirely fine materials derived from the tailings pond and scoured creek bed). As the geomorphology of Hazeltine Creek stabilizes and typical erosional habitat (cobble and gravel) becomes available (i.e., exposed by hydrological/geomorphological processes), benthic invertebrate community recovery will be monitored.

Data Quality Assessment (DQA; Appendix C with supporting data in Appendix J) indicated that sediment quality data and toxicity test results were of good quality and can therefore be used in the sediment quality impact characterization.

5.1 Sediment Physical and Chemical Characterization

Substrates of Hazeltine Creek were observed to be composed primarily of two types of sediment: orange and black sand and grey fines. The same categories were previously reported (SRK 2014), with the former (orange and black sand) being dominated by plagioclase feldspar and magnetite and the latter (grey fines) being dominated by potassium feldspar and plagioclase, with minor biotite mica and quartz (SRK 2014, 2015). Substrates at the three sampling areas in Hazeltine Creek were predominantly sand and silt (Table 5.1; Appendix Table E.1). Substrate at the uppermost area (ST16) was somewhat more coarse (approximately 70% sand and 30% silt) than substrates at the mid- (ST09) and lower (ST02) areas (approximately 20-30% sand and 60-70% silt; Table 5.1). Total organic carbon (TOC) content of all sediment samples was low (<0.2%).

Arsenic, copper, iron and nickel were the only analytes with concentrations in Hazeltine Creek sediment greater than working sediment quality guidelines for the protection of aquatic life (probable effect levels [PELs] in the case of copper and iron and threshold effect levels [TELs] in the case of arsenic and nickel) and pre-event concentrations (Tables 5.1 and 5.2; Figure 5.1). Both arsenic and nickel were elevated above reference only in the <63 µm sediment (compared to historical results based on bulk sediment) at one of three areas only (Table 5.2). Concentrations of eight additional analytes were present in Hazeltine Creek sediment at concentrations more twice pre-event concentrations (calcium, cobalt, molybdenum, phosphorus, silver, sodium, titanium and vanadium; Tables 5.3 and 5.4; Figure 5.2). In accordance with the framework set out in Section 4.0, arsenic, copper, iron and nickel are designated as Parameters of Interest

Table 5.1: Summary of sediment quality data for Hazeltine Creek, Mount Polley Mine, 2014. Metals data are based on the <2mm fraction of sediment[1].

Analyte	Units	BC SQG [2]		Historic Hazeltine Creek 95th Percentile [3]		Upper Creek (ST16)		Mid Creek (ST09)		Lower Creek (ST02)	
Sample ID		TEL	PEL	Lower Creek	Upper Creek	Mean	t*SE	Mean	t*SE	Mean	t*SE
Physical Tests											
Moisture	%	-	-	-	-	25.4	4.72	28.7	2.00	28.8	5.25
pH (1:2 soil:water)	pH	-	-	-	-	8.87	0.213	8.55	0.064	8.51	0.213
Particle Size											
% Gravel (>2mm)	%	-	-	-	33	<0.10	0	0.17	0.18	0.13	0.078
% Sand (2.0mm - 0.063mm)	%	-	-	-	65	69.6	7.61	23.3	13.4	30.4	18.9
% Silt (0.063mm - 4µm)	%	-	-	-	76	30.0	7.53	68.3	10.1	60.6	15.6
% Clay (<4µm)	%	-	-	-	14	0.47	0.092	8.29	3.26	8.91	4.54
Texture	-	-	-	-	-	-	-	-	-	-	-
Leachable Anions & Nutrients											
pH	pH	-	-	-	-	8.56	0.058	8.30	0.152	8.37	0.488
Anions and Nutrients											
Total Nitrogen by LECO	%	-	-	-	-	<0.020	0	<0.020	0	<0.020	0
Organic / Inorganic Carbon											
Total Organic Carbon	%	-	-	9.0	12.8	<0.10	0	0.17	0.026	0.14	0.046
Metals											
Aluminum	mg/kg	-	-	12,550	18,000	11,960	689	13,960	1,986	15,060	3,118
Antimony	mg/kg	-	-	1.3	0.37	0.45	0.28	0.35	0.036	0.44	0.041
Arsenic	mg/kg	5.9	17	12.1	8.2	11.4	0.56	7.77	0.56	10.7	1.53
Barium	mg/kg	-	-	104	136	110	10.2	104	12.3	148	44.8
Beryllium	mg/kg	-	-	0.30	0.46	0.62	0.22	0.42	0.064	0.55	0.14
Bismuth	mg/kg	-	-	20	16	0.29	0	<0.20	0	<0.20	0
Boron	mg/kg	-	-	3.0	5.4	10	0	<10	0	10	0
Cadmium	mg/kg	0.6	3.5	0.24	0.35	0.156	0.0262	0.178	0.0176	0.190	0.0207
Calcium	mg/kg	-	-	7,030	13,400	24,440	1,586	27,840	2,026	27,060	2,627
Chromium	mg/kg	37.3	90	33.1	40.1	10.3	1.33	27.1	5.10	21.0	8.08
Cobalt	mg/kg	-	-	11.0	10.4	13.6	1.06	12.7	1.68	15.2	2.04
Copper	mg/kg	35.7	197	42.0	94.6	**991**	176	**286**	76.9	**588**	306
Iron	mg/kg	21,200	43,776	35,400	29,900	**55,240**	8,508	**39,660**	7,493	**51,140**	9,025
Lead	mg/kg	35	91	5.6	6.7	5.18	1.07	6.87	1.17	6.29	0.779
Lithium	mg/kg	-	-	12.9	14.8	12.9	0.711	19.2	5.00	17.3	3.45
Magnesium	mg/kg	-	-	6,160	6,430	7,402	581	8,204	1,202	9,204	1,921
Manganese	mg/kg	460	1,100	1,120	1,350	551	29.5	506	45.5	620	103
Mercury	mg/kg	0.17	0.49	0.140	0.145	0.102	0.00524	0.0580	0.0162	0.0792	0.0215
Molybdenum	mg/kg	-	-	0.75	1.5	5.08	0.872	1.72	0.40	3.30	1.88
Nickel	mg/kg	16	75	24	24	6.56	0.314	23.4	5.25	16.2	7.27
Phosphorus	mg/kg	-	-	729	1,380	1,320	149	1,049	95.6	1,314	180
Potassium	mg/kg	-	-	910	1,450	880	45.6	1,388	224	1,506	391
Selenium	mg/kg	2	-	1.3	3.3	1.09	0.059	0.49	0.067	0.89	0.32
Silver	mg/kg	0.5	-	0.10	0.16	0.48	0.089	0.18	0.032	0.30	0.091
Sodium	mg/kg	-	-	253	350	724	39.8	448	52.2	774	362
Strontium	mg/kg	-	-	67	118	98.6	6.67	154	14.6	148	28.6
Thallium	mg/kg	-	-	0.051	0.094	0.098	0.13	0.070	0.019	0.062	0.015
Tin	mg/kg	-	-	1.1	0.70	<2.0	0	<2.0	0	<2.0	0
Titanium	mg/kg	-	-	701	776	1,061	74.8	1,029	52.4	1,376	350
Uranium	mg/kg	-	-	0.7	1.3	0.884	0.0797	0.86	0.12	1.01	0.126
Vanadium	mg/kg	-	-	75	65.3	216	31.8	111	28.2	182	46.0
Zinc	mg/kg	123	315	60.2	67.6	53.5	3.13	56.6	9.22	60.1	6.67

(blue) Value is > TEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

[1] Reported TOC, TN, pH and moisture data are based on bulk sediment. Data < method detection limit (MDL) were used at the MDL for calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a; BCMOE 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

Table 5.2: Summary of sediment quality data for Hazeltine Creek, Mount Polley Mine, 2014. Data are based on the <63µm fraction of sediment[1].

Analyte	Units	BC SQG[2]		Historic Hazeltine Creek 95th Percentile[3]		Upper Creek (ST16)		Mid Creek (ST09)		Lower Creek (ST02)	
Sample ID		TEL	PEL	Lower Creek	Upper Creek	Mean	t*SE	Mean	t*SE	Mean	t*SE
Physical Tests											
pH (1:2 soil:water)	pH					8.65	0.150	8.53	0.080	8.55	0.182
Organic / Inorganic Carbon											
Total Organic Carbon	%	-	-	9.0	12.8	<0.10	0	0.15	0.047	0.12	0.032
Metals											
Aluminum	mg/kg	-	-	12,550	18,000	10,620	356	14,820	2,097	16,720	3,498
Antimony	mg/kg	-	-	1.3	0.37	0.31	0.033	0.35	0.047	0.40	0.073
Arsenic	mg/kg	5.9	17	12	8.2	**14.7**	0.65	7.60	0.53	11.7	2.95
Barium	mg/kg	-	-	104	136	109	9.43	100	13.9	166	72.9
Beryllium	mg/kg	-	-	0.30	0.46	0.48	0.029	0.35	0.032	0.49	0.17
Bismuth	mg/kg	-	-	20	16	<0.10	0	0.12	0.014	0.11	0.014
Boron	mg/kg	-	-	3.0	5.4	<10	0	<10	0	10	0.56
Cadmium	mg/kg	0.6	3.5	0.24	0.35	0.160	0.0106	0.186	0.0112	0.191	0.0416
Calcium	mg/kg	-	-	7,030	13,400	27,560	872	28,920	1,129	27,880	3,438
Chromium	mg/kg	37.3	90	33.1	40.1	22.8	2.31	32.0	2.99	28.4	10.2
Cobalt	mg/kg	-	-	11	10	24.0	1.90	13.6	1.10	18.4	3.90
Copper	mg/kg	35.7	197	42.0	94.6	**687**	42.6	**172**	39.4	**449**	318
Iron	mg/kg	21,200	43,776	35,400	29,900	**138,800**	13,121	**43,980**	3,474	**65,980**	19,810
Lead	mg/kg	35	91	5.6	6.7	6.33	0.323	7.65	0.556	7.53	0.648
Lithium	mg/kg	-	-	12.9	14.8	11.8	0.885	17.4	3.42	16.3	3.69
Magnesium	mg/kg	-	-	6,160	6,430	6,572	229	8,742	988	10,428	2,603
Manganese	mg/kg	460	1,100	1,120	1,350	626	19.8	519	38.9	676	137
Mercury	mg/kg	0.17	0.49	0.140	0.145	0.0770	0.00245	0.0394	0.00363	0.0653	0.0175
Molybdenum	mg/kg	-	-	0.75	1.5	4.66	0.442	1.22	0.21	2.44	1.35
Nickel	mg/kg	16	75	24	24	11.1	0.893	**28.0**	3.48	22.5	9.43
Phosphorus	mg/kg	-	-	729	1,380	2,442	166	1,142	81.1	1,530	317
Potassium	mg/kg	-	-	910	1,450	794	41.7	1,342	213	1,534	457
Selenium	mg/kg	2	-	1.3	3.3	1.38	0.151	0.44	0.060	0.89	0.31
Silver	mg/kg	0.5	-	0.10	0.16	0.446	0.0632	0.148	0.0241	0.244	0.119
Sodium	mg/kg	-	-	253	350	552	29.6	352	55.8	718	479
Strontium	mg/kg	-	-	67	118	85.7	3.4	158	8.45	145	17.1
Thallium	mg/kg	-	-	0.05	0.094	<0.050	0	0.078	0.015	0.060	0.017
Tin	mg/kg	-	-	1.1	0.70	1.13	0.0915	0.64	0.16	1.09	0.60
Titanium	mg/kg	-	-	701	776	1,058	42.5	975	88.3	1,309	403
Uranium	mg/kg	-	-	0.7	1.3	1.04	0.061	0.873	0.033	1.05	0.202
Vanadium	mg/kg	-	-	75	65.3	542	65.8	120	18.0	229	96.2
Zinc	mg/kg	123	315	60.2	67.6	70.1	3.00	59.7	6.70	68.2	5.33

(blue) Value is > TEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a; BCMOE 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

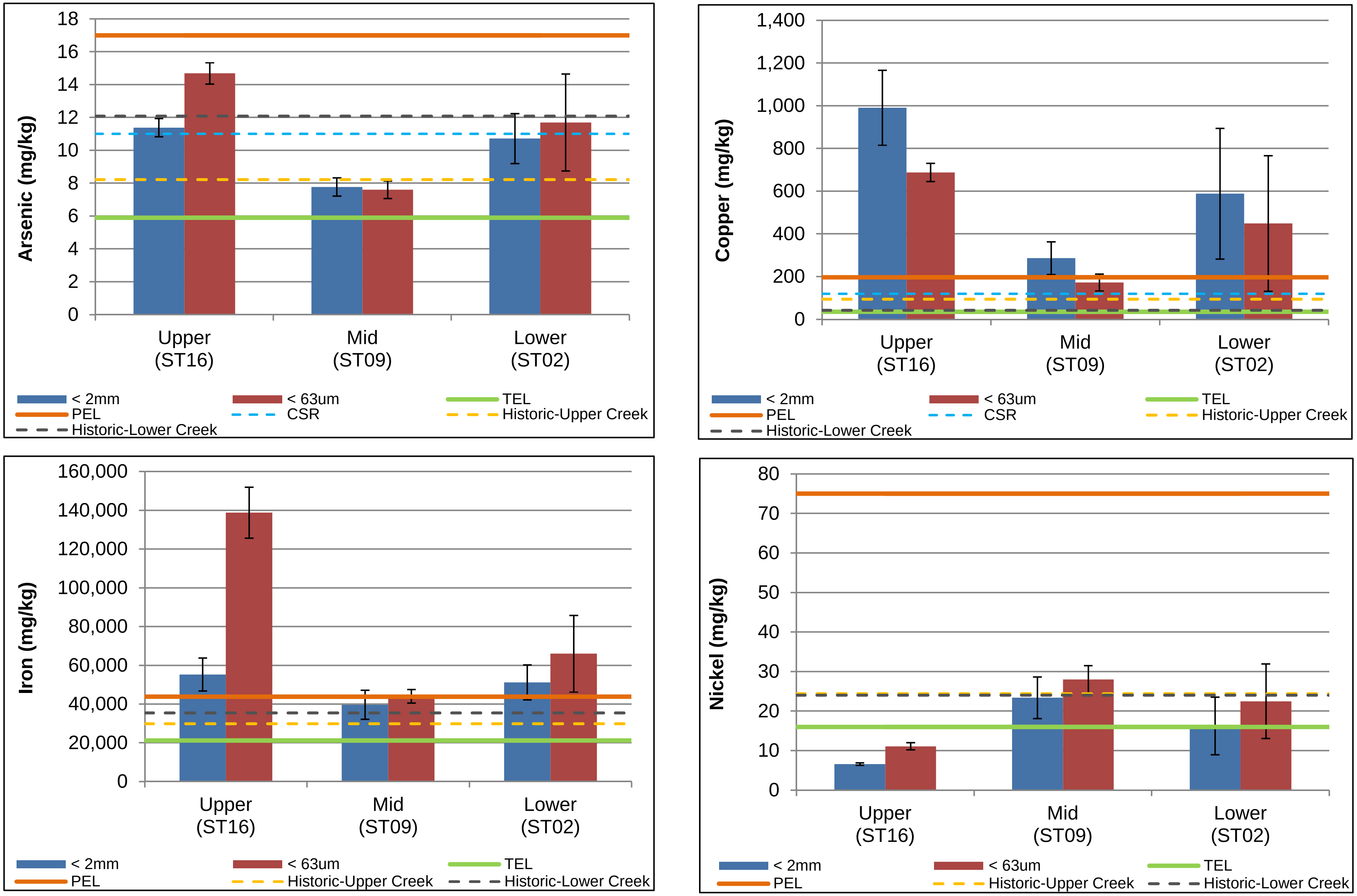


Figure 5.1: Mean metal concentrations (± t*SE) for parameters of interest in Hazeltine Creek sampling areas, Mount Polley Mine, 2014.

TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level; CSR = Contaminated Sites Regulation - Sensitive; Historic = Historic 95th percentile for either upper or lower Hazeltine Creek areas. Historic data are based predominantly on bulk sediment.

Table 5.3: Ratio of exposed mean to historic mean metal concentrations[1,2] in the < 2mm fraction of sediment from Hazeltine Creek, Mount Polley Mine, 2014. Ratios with a value > 2 are highlighted .

Analyte	Upper Creek (ST16)	Mid Creek (ST09)	Lower Creek (ST02)
Organic / Inorganic Carbon			
Total Organic Carbon	0.012	0.020	0.016
Metals			
Aluminum	0.8	0.9	1.0
Antimony	0.8	0.6	0.8
Arsenic	1.2	0.8	1.1
Barium	1.0	0.9	1.3
Beryllium	1.7	1.1	1.5
Bismuth	0.1	0.0	0.0
Boron	2.2 [3]	2.2 [3]	2.2 [3]
Cadmium	0.6	0.7	0.8
Calcium	2.1	2.4	2.4
Chromium	0.3	0.9	0.7
Cobalt	1.4	1.3	1.6
Copper	15	4.3	8.9
Iron	2.1	1.5	2.0
Lead	1.0	1.3	1.2
Lithium	1.0	1.5	1.4
Magnesium	1.3	1.4	1.6
Manganese	0.5	0.5	0.6
Mercury	1.1	0.6	0.9
Molybdenum	4.9	1.7	3.2
Nickel	0.3	1.2	0.8
Phosphorus	1.2	0.9	1.2
Potassium	0.9	1.4	1.5
Selenium	0.5	0.2	0.4
Silver	3.8	1.4	2.3
Sodium	3.0	1.9	3.2
Strontium	1.0	1.6	1.5
Thallium	1.3	0.9	0.8
Tin	1.9	1.9	1.9
Titanium	1.9	1.8	2.4
Uranium	1.0	1.0	1.1
Vanadium	3.6	1.8	3.0
Zinc	1.0	1.0	1.1

[1] The highest mean concentration for each analyte from among the Upper and Lower Hazeltine Creek historical data was used as the historic mean for calculation of the ratio.

[2] Mean values < method detection limit (MDL) were used at the MDL for calculation of exposed to reference ratios.

[3] Ratios > 2 for boron resulted from a detection limit in 2014 (10 mg/L) that was 2x higher than reported detectable historic data. Ratios > 2 for boron were not highlighted as a result.

Table 5.4: Ratio of exposed mean to historic mean metal concentrations[1,2] in the < 63µm fraction of sediment from Hazeltine Creek, Mount Polley Mine, 2014. Ratios with a value > 2 are highlighted.

Analyte	Upper Creek (ST16)	Mid Creek (ST09)	Lower Creek (ST02)
Organic / Inorganic Carbon			
Total Organic Carbon	0.012	0.018	0.013
Metals			
Aluminum	0.7	1.0	1.1
Antimony	0.6	0.6	0.7
Arsenic	1.5	0.8	1.2
Barium	1.0	0.9	1.5
Beryllium	1.3	0.9	1.3
Bismuth	0.0	0.0	0.0
Boron	2.2 [3]	2.2 [3]	2.3 [3]
Cadmium	0.7	0.8	0.8
Calcium	2.4	2.5	2.4
Chromium	0.8	1.1	0.9
Cobalt	2.5	1.4	1.9
Copper	10	2.6	6.8
Iron	5.3	1.7	2.5
Lead	1.2	1.4	1.4
Lithium	0.9	1.4	1.3
Magnesium	1.2	1.5	1.8
Manganese	0.6	0.5	0.6
Mercury	0.8	0.4	0.7
Molybdenum	4.5	1.2	2.4
Nickel	0.6	1.4	1.2
Phosphorus	2.2	1.0	1.4
Potassium	0.8	1.3	1.5
Selenium	0.7	0.2	0.4
Silver	3.5	1.1	1.9
Sodium	2.3	1.5	3.0
Strontium	0.9	1.6	1.5
Thallium	0.7	1.0	0.8
Tin	1.1	0.6	1.0
Titanium	1.8	1.7	2.3
Uranium	1.2	1.0	1.2
Vanadium	9.0	2.0	3.8
Zinc	1.3	1.1	1.2

[1] The highest mean concentration for each analyte from among the Upper and Lower Hazeltine Creek historical data was used as the historic mean for calculation of the ratio.

[2] Mean values < method detection limit (MDL) were used at the MDL for calculation of exposed to reference ratios.

[3] Ratios > 2 for boron resulted from a detection limit in 2014 (10 mg/L) that was 2x higher than reported detectable historic data. Ratios > 2 for boron were not highlighted as a result.

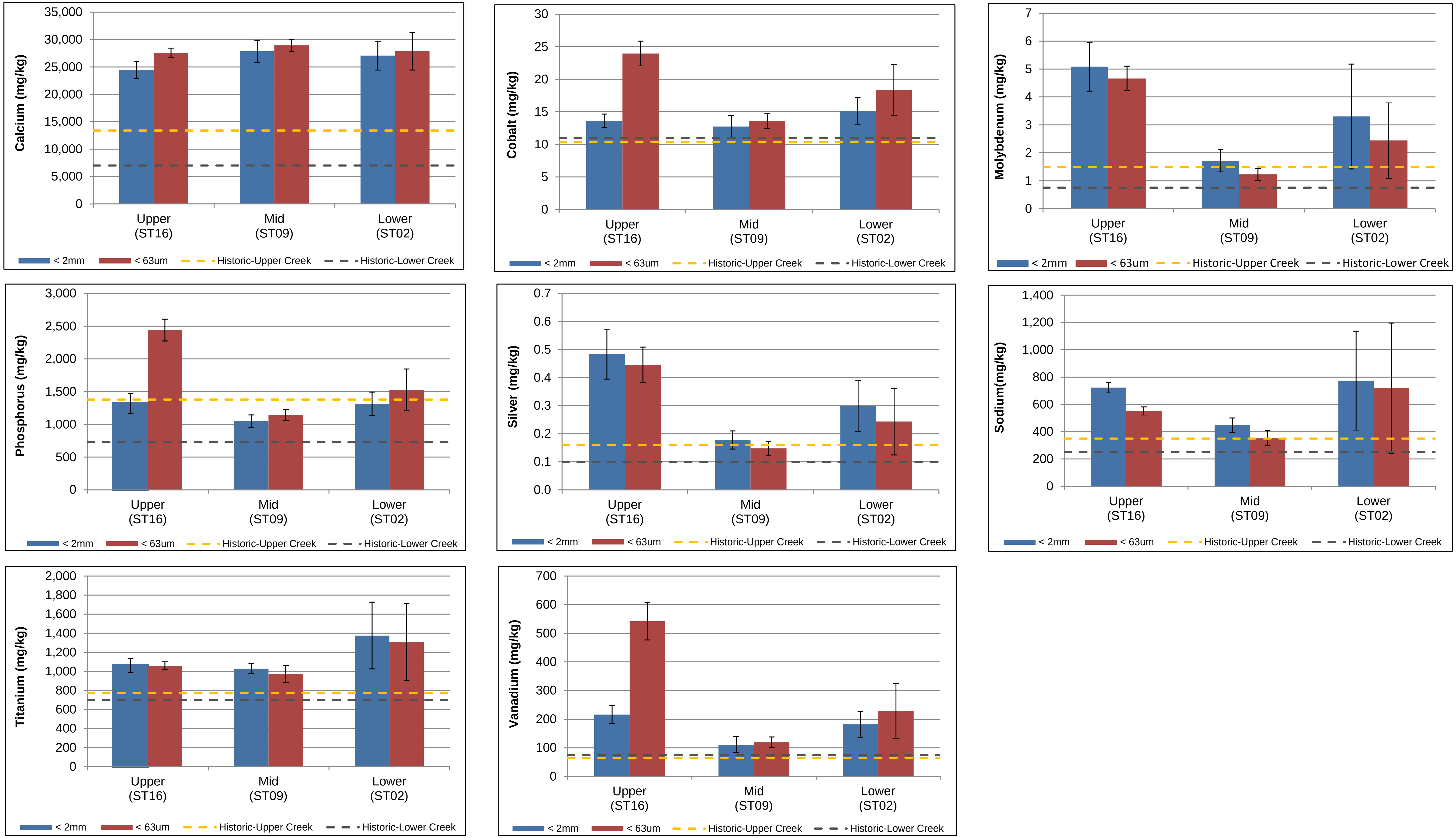


Figure 5.2: Mean metal concentrations (± t*SE) for indicator parameters in sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014.

Historic = Historic 95th percentile for either upper or lower Hazeltine Creek areas. Historic data are based predominantly on bulk sediment.

(POIs) and calcium, cobalt, molybdenum, phosphorus, silver, sodium, titanium and vanadium are designated as Indicator Parameters (IPs).

Principal Components Analysis (PCA) was effective in distinguishing the sediments of area ST16 (upstream) from area ST09 (mid) and some ST02 (downstream) stations primarily on the basis of higher percent sand/lower percent fines, lower TOC content, and higher concentrations of a number of metals (arsenic, beryllium, copper, iron, mercury, molybdenum, phosphorus, selenium, silver and sodium; Figure 5.3). With the exception of calcium, cobalt, nickel, titanium and vanadium, this list includes all POIs and IPs identified above and serves to confirm their designations.

Of the four POIs and eight IPs, copper was the most substantially elevated, with mean concentrations up to approximately five times the PEL and fifteen times pre-event concentrations (Tables 5.1 to 5.4; Figures 5.1 and 5.2). Copper concentration was greatest at area ST16 (upstream) and, unlike the other POIs, was enriched in <2 mm fraction relative to <63 µm fraction (Figure 5.1). Iron was also elevated relative to the PEL, but to a much lower mean magnitude (up to approximately 1.3 times in the <2.0 mm fraction and 3.2 times in the <63 µm fraction) and up to approximately 2.1-times background and 5.3-times background in the <2.0 mm and <63 µm fraction, respectively (Tables 5.1 to 5.4; Figure 5.1). Iron was notably elevated in the fines at area ST16 (upstream; 5.3-times; Table 5.4), where concentration in the <63 µm fraction was more than double that in the <2.0 mm fraction (Figure 5.1). As indicated above, mean concentrations of arsenic and nickel only exceeded reference in the <63 µm sediment (compared to historical results based on bulk sediment) at one of three areas only (arsenic at ST16 [upstream] and nickel and ST09 [mid-stream]).

Of the IPs, concentrations of calcium, cobalt, phosphorus, and vanadium were generally higher in the <63 µm sediment than in the <2.0 mm sediment, whereas the opposite was true of molybdenum, silver, sodium and titanium (Figure 5.2).

Concentrations of copper, molybdenum, silver and vanadium were all negatively correlated with percent fines (percent silt and clay), whereas concentrations of nickel and calcium were positively correlated with percent fines (Table 5.5; Appendix Figure E.1). Similarly, concentrations of arsenic, copper, iron, molybdenum, phosphorus, silver, sodium and vanadium were negatively correlated with sediment total organic carbon (TOC) content and concentrations of nickel were positively correlated with TOC, despite the fact that TOC content was low and spanned a very narrow range from <0.10 to 0.20 % (Table 5.5; Appendix Tables E.1-E.2; Appendix Figure E.2). Overall, these relationships indicate that concentrations of most POIs and IPs (with the exceptions of calcium and

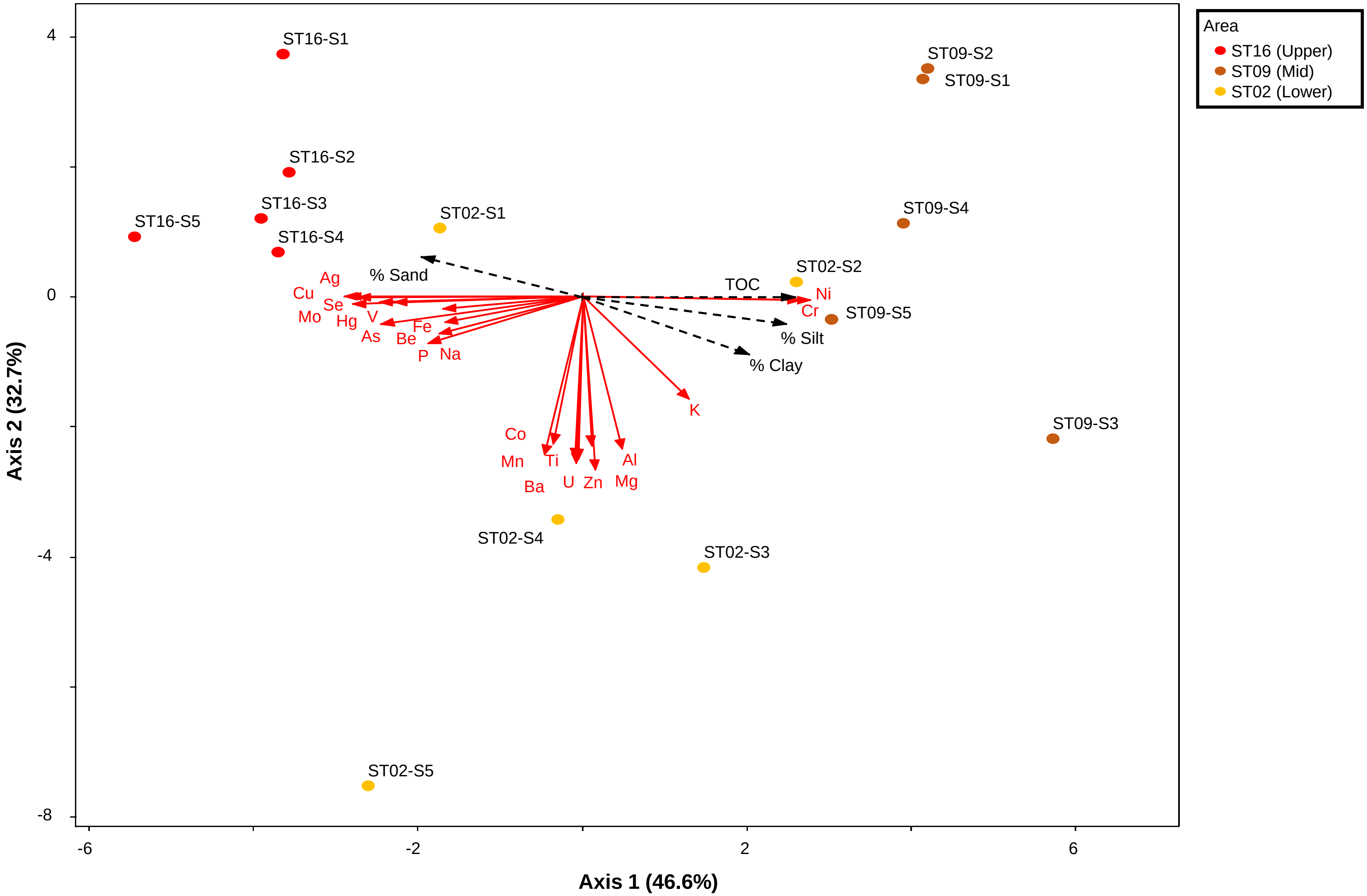


Figure 5.3: Biplot of principal component analysis (PCA) of metal concentrations in sediment (<2 mm fraction) from Hazeltine Creek sampling stations, Mount Polley Mine, 2014. Vector length is proportional to the magnitude of direct correlation of metals (solid red vector lines) and indirect correlation of sediment physical characteristics (black dashed vector lines) with PCA values of each axis (Appendix Tables E.3-E.4). Only metals with significant (p-value <0.010) Spearman's correlation and r-values > 0.7 with either axis are displayed, all sediment physical characteristics are displayed [a].

[a] Boron and tin were excluded from calculations due to a lack of variability in the data (all values for each analyte were the same).

Table 5.5: Spearman's Rank Correlation results for correlation of concentrations of parameters of interest and indicator parameters (in < 2mm sediment fraction) relative to % fines (silt and clay) and total organic carbon in sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014 [1].

Metal		Correlation Parameter	Silt and Clay (%)	Total Organic Carbon (%)
Parameters of Interest	Arsenic	Correlation Coefficient	-0.567	-0.714
		Sig. (2-tailed)	0.0275	0.0028
	Copper	Correlation Coefficient	-0.836	-0.846
		Sig. (2-tailed)	0.0001	0.0001
	Iron	Correlation Coefficient	-0.425	-0.715
		Sig. (2-tailed)	0.1143	0.0027
	Nickel	Correlation Coefficient	0.918	0.774
		Sig. (2-tailed)	<0.0000	0.0007
Indicator Parameters	Calcium	Correlation Coefficient	0.825	0.523
		Sig. (2-tailed)	0.0002	0.0457
	Cobalt	Correlation Coefficient	0.114	-0.320
		Sig. (2-tailed)	0.6848	0.2450
	Molybdenum	Correlation Coefficient	-0.746	-0.834
		Sig. (2-tailed)	0.0014	0.0001
	Phosphorus	Correlation Coefficient	-0.436	-0.653
		Sig. (2-tailed)	0.1045	0.0084
	Silver	Correlation Coefficient	-0.844	-0.856
		Sig. (2-tailed)	0.0001	<0.0000
	Sodium	Correlation Coefficient	-0.564	-0.658
		Sig. (2-tailed)	0.0284	0.0076
	Titanium	Correlation Coefficient	0.201	-0.089
		Sig. (2-tailed)	0.4732	0.7518
	Vanadium	Correlation Coefficient	-0.693	-0.800
		Sig. (2-tailed)	0.0042	0.0003

(orange) Significant correlation; p-value < 0.002 (Bonferroni corrected p-value for 24 comparisons).
(grey) Correlation scatterplot inspected; p <0.01.

[1] Values < method detection limit (MDL) were used at the MDL for calculations.
Note: n=15 for all correlations.

nickel) are associated with sandy, low TOC sediment, which is consistent with event-derived materials (i.e., tailings and scoured Hazeltine channel). The negative relationships with particle size and TOC for most POIs and IPs indicates that the dominant process influencing sediment concentrations of these analytes are primary the chemistry of the source material rather than secondary sorptive processes in the receiving environment.

5.2 Sediment Geochemical Characterization

There are numerous factors that affect the bioavailability of sediment-associated metals. While metal concentrations that are below sediment quality guidelines generally provide a reliable indicator of an absence of effect, sediment quality results that exceed those benchmarks provide a less reliable indication that effects are probable. Geochemical characterization can assist in identifying the potential mobility and bioavailability of metals associated with mine-influenced sediments.

Selective extractions indicated that concentrations of most POIs and IPs were primarily in the residual phase; that is, they could only be extracted by the strongest acid digest (a combination of concentrated nitric and hydrochloric acid; Table 5.6; Figure 5.4; Appendix Table E.7; Appendix Figures E.4-E.5). Residual metals are unlikely to be mobilized under any conditions that could realistically occur in Hazeltine Creek, nor in interactions with aquatic organisms (i.e., contact with the gill or ingestion) and are therefore considered not biologically available (e.g., Tessier et al. 1979; Campbell and Tessier 1996). Exceptions included calcium, which was predominantly in the carbonate phase (as expected), and copper, which was predominantly in the “organic” phase” (Figure 5.4). However, as there was very little organic matter in the Hazeltine Creek sediments, it is unlikely that this pool of copper was actually organic bound, and there is literature-based evidence that the “organic” fraction can include oxalates which can be formed by the peroxidation of clays (e.g., Farmer and Mitchell 1963) and can be partially broken down in peroxide digests (Gleyzes 2002). In addition, Tessier et al. (1979) observed some alteration of smectite, chlorite and mica minerals (silicates, often alumino-silicates) in the organic digestion (which uses nitric acid, hydrogen peroxide and ammonium acetate; Table 4.5).

Concentrations of copper in selective extraction fractions 1 to 3 (exchangeable + carbonate bound + reducible) alone approached pre-event concentrations (Figure 5.4). However, separate integrated consideration of mineralogy, sequential extraction results and mineral solubility indicates that these forms would not be mobile under environmentally realistic conditions (SRK 2015). This interpretation is being tested by on-going laboratory weathering tests of the Hazeltine Creek sediments (i.e., humidity cell

Table 5.6: Summary of selectively extracted (Tessier extraction) metals data for sediment from Hazeltine Creek, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1]. Only analytes with detectable concentrations are displayed.

Analyte	Units	BC SQG [2]		Historic Hazeltine Creek 95th Percentile [3] (total metal concentration)		Upper Hazeltine Creek (ST16)		Mid Hazeltine Creek (ST09)		Lower Hazeltine Creek (ST02)	
Sample ID		TEL	PEL	Lower Creek	Upper Creek	Mean	t*SE	Mean	t*SE	Mean	t*SE
Exchangeable & Adsorbed Metals											
Arsenic	mg/kg	5.9	17	12.1	8.2	<0.050	0	0.051	0.0039	0.052	0.0032
Calcium	mg/kg	-	-	7,030	13,400	707	46.4	1,166	181	1,157	231
Copper	mg/kg	35.7	197	42.0	94.6	4.93	0.222	1.02	0.27	3.13	2.18
Manganese	mg/kg	460	1,100	1,120	1,350	<8.0	0.68	22.1	4.51	17.8	11.7
Potassium	mg/kg	-	-	910	1,450	<100	0	<100	0.0	112	33.3
Sodium	mg/kg	-	-	253	350	<100	0	<100	0.00	102	5.55
Strontium	mg/kg	-	-	67.1	118	6.14	0.570	8.44	1.68	11.7	5.56
Carbonate Metals											
Aluminum	mg/kg	-	-	12,550	18,000	<50	0	<50	0	54	11
Arsenic	mg/kg	5.9	17	12.1	8.2	<0.050	0	0.055	0.013	0.067	0.017
Barium	mg/kg	-	-	104	136	15.7	2.27	17.0	3.59	25.3	11.0
Calcium	mg/kg	-	-	7,030	13,400	7,590	226	13,494	6,194	11,196	2,666
Cobalt	mg/kg	-	-	11.0	10.4	<0.10	0	0.16	0.076	0.18	0.074
Copper	mg/kg	35.7	197	42.0	94.6	17.3	1.52	10.0	7.65	42.2	31.5
Iron	mg/kg	21,200	43,776	35,400	29,900	<50	0	87.4	42.4	90.8	29.5
Lead	mg/kg	35	91	5.6	6.7	<0.50	0	0.82	0.38	0.82	0.27
Manganese	mg/kg	460	1,100	1,120	1,350	53.8	1.19	81.7	37.0	83.8	28.8
Strontium	mg/kg	-	-	67	118	12.3	0.757	65.8	30.4	42.2	11.4
Uranium	mg/kg	-	-	0.73	1.26	<0.050	0	0.054	0.011	0.053	0.0077
Zinc	mg/kg	123	315	60.2	67.6	<1.0	0	<1.0	0	1.0	0.11
Easily Reducible Metals and Iron Oxides											
Aluminum	mg/kg	-	-	12,550	18,000	697	60.9	792	176	1,078	383
Arsenic	mg/kg	5.9	17	12.1	8.2	0.927	0.0821	0.590	0.0801	1.11	0.520
Barium	mg/kg	-	-	104	136	10.5	1.69	11.9	2.27	15.0	3.96
Cadmium	mg/kg	0.6	3.5	0.24	0.35	0.052	0.0043	0.072	0.0048	0.062	0.018
Calcium	mg/kg	-	-	7,030	13,400	2,306	322	4,786	4,487	2,878	3,422
Chromium	mg/kg	37.3	90	33.1	40.1	1.29	0.199	2.47	0.315	2.24	0.553
Cobalt	mg/kg	-	-	11.0	10.4	0.66	0.029	2.98	0.598	1.99	0.775
Copper	mg/kg	35.7	197	42.0	94.6	92.5	10.4	33.1	6.35	81.4	48.9
Iron	mg/kg	21,200	43,776	35,400	29,900	2,260	155	3,222	436	2,896	467
Lead	mg/kg	35	91	5.6	6.7	2.06	0.218	3.11	0.836	2.28	0.654
Manganese	mg/kg	460	1,100	1,120	1,350	50.6	3.10	98.6	27.9	84.4	37.1
Nickel	mg/kg	16	75	24	24	0.65	0.039	7.50	1.51	4.15	2.66
Phosphorus	mg/kg	-	-	729	1,380	105	10	75	29	124	46
Strontium	mg/kg	-	-	67	118	13.0	1.17	23.7	18.6	20.4	7.36
Titanium	mg/kg	-	-	701	776	1.1	0.11	1.5	0.11	1.3	0.20
Uranium	mg/kg	-	-	0.73	1.26	0.072	0.0091	0.080	0.015	0.090	0.014
Vanadium	mg/kg	-	-	75	65.3	7.16	0.558	5.12	0.731	6.96	1.95
Zinc	mg/kg	123	315	60.2	67.6	4.2	0.16	7.9	1.2	7.3	1.3
Organic Bound Metals											
Aluminum	mg/kg	-	-	12,550	18,000	418	18.6	673	123	769	195
Arsenic	mg/kg	5.9	17	12.1	8.2	1.06	0.080	0.682	0.246	1.24	0.517
Barium	mg/kg	-	-	104	136	6.75	0.960	6.96	0.986	10.3	3.54
Calcium	mg/kg	-	-	7,030	13,400	822	124	968	301	997	205
Chromium	mg/kg	37.3	90	33.1	40.1	<0.50	0	0.53	0.094	<0.50	0
Cobalt	mg/kg	-	-	11.0	10.4	1.06	0.091	1.0	0.11	1.27	0.175
Copper	mg/kg	35.7	197	42.0	94.6	**614**	35.4	**183**	57.8	**362**	193
Iron	mg/kg	21,200	43,776	35,400	29,900	539	36.8	375	54.0	609	204
Lead	mg/kg	35	91	5.6	6.7	0.96	0.17	0.83	0.078	0.92	0.19
Manganese	mg/kg	460	1,100	1,120	1,350	6.6	0.30	9.7	1.40	11.8	2.4
Molybdenum	mg/kg	-	-	0.75	1.5	1.58	0.25	<0.50	0.00	0.74	0.39
Nickel	mg/kg	16	75	24	24	<0.50	0	0.91	0.27	0.80	0.30
Selenium	mg/kg	2	-	1.3	3.3	0.56	0.024	0.30	0.060	0.53	0.19
Strontium	mg/kg	-	-	67	118	8.02	0.827	7.48	2.11	9.00	1.99
Titanium	mg/kg	-	-	701	776	1.2	0.16	1.7	0.14	1.8	0.30
Uranium	mg/kg	-	-	0.73	1.26	0.074	0.0034	0.075	0.013	0.089	0.013
Vanadium	mg/kg	-	-	74.5	65.3	0.61	0.039	0.89	0.16	0.992	0.19
Zinc	mg/kg	123	315	60.2	67.6	4.7	0.24	4.2	0.26	4.7	0.58
Residual Metals											
Aluminum	mg/kg	-	-	12,550	18,000	10,192	894	12,360	2,054	12,820	2,252
Antimony	mg/kg	-	-	1.3	0.37	0.21	0.043	0.25	0.043	0.28	0.054
Arsenic	mg/kg	5.9	17	12.1	8.2	9.21	0.666	6.21	0.904	7.90	0.654
Barium	mg/kg	-	-	104	136	79.6	6.89	57.9	11.5	78.7	20.5
Beryllium	mg/kg	-	-	0.30	0.46	0.37	0.020	0.25	0.026	0.34	0.085
Cadmium	mg/kg	0.6	3.5	0.24	0.35	0.061	0.015	<0.050	0	<0.050	0
Calcium	mg/kg	-	-	7,030	13,400	11,440	1,112	5,320	1,333	8,674	2,341
Chromium	mg/kg	37.3	90	33.1	40.1	9.62	0.80	24.3	5.44	17.8	8.09
Cobalt	mg/kg	-	-	11.0	10.4	12.2	0.695	8.41	1.20	11.5	2.09
Copper	mg/kg	35.7	197	42.0	94.6	**223**	64.6	53.4	13.9	**104**	51.1
Iron	mg/kg	21,200	43,776	35,400	29,900	**52,800**	5,202	34,300	4,898	**44,640**	5,785
Lead	mg/kg	35	91	5.6	6.7	1.95	0.144	2.32	0.282	2.32	0.338
Lithium	mg/kg	-	-	12.9	14.8	11.2	0.493	15.8	3.60	14.3	2.62
Manganese	mg/kg	460	1,100	1,120	1,350	418	25.4	274	35.4	381	90.1
Molybdenum	mg/kg	-	-	0.75	1.5	3.09	0.653	1.40	0.237	2.25	0.739
Nickel	mg/kg	16	75	24	24	5.56	0.36	15.2	3.80	11.3	4.62
Selenium	mg/kg	2	-	1.3	3.3	0.50	0.064	<0.20	0	0.27	0.11
Silver	mg/kg	0.5	-	0.10	0.16	0.33	0.028	0.13	0.023	0.22	0.084
Strontium	mg/kg	-	-	67	118	49.1	4.95	34.8	6.77	51.6	18.1
Thallium	mg/kg	-	-	0.051	0.094	<0.050	0	0.063	0.012	0.051	0.0039
Titanium	mg/kg	-	-	701	776	1,025	137	923	155	1,197	400
Uranium	mg/kg	-	-	0.73	1.26	0.632	0.0774	0.546	0.0841	0.615	0.0926
Vanadium	mg/kg	-	-	74.5	65.3	213	20.9	99.3	19.1	165	34.2
Zinc	mg/kg	123	315	60.2	67.6	47.4	2.14	43.9	7.82	46.2	4.48

(blue) Value is > TEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a; BCMOE 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

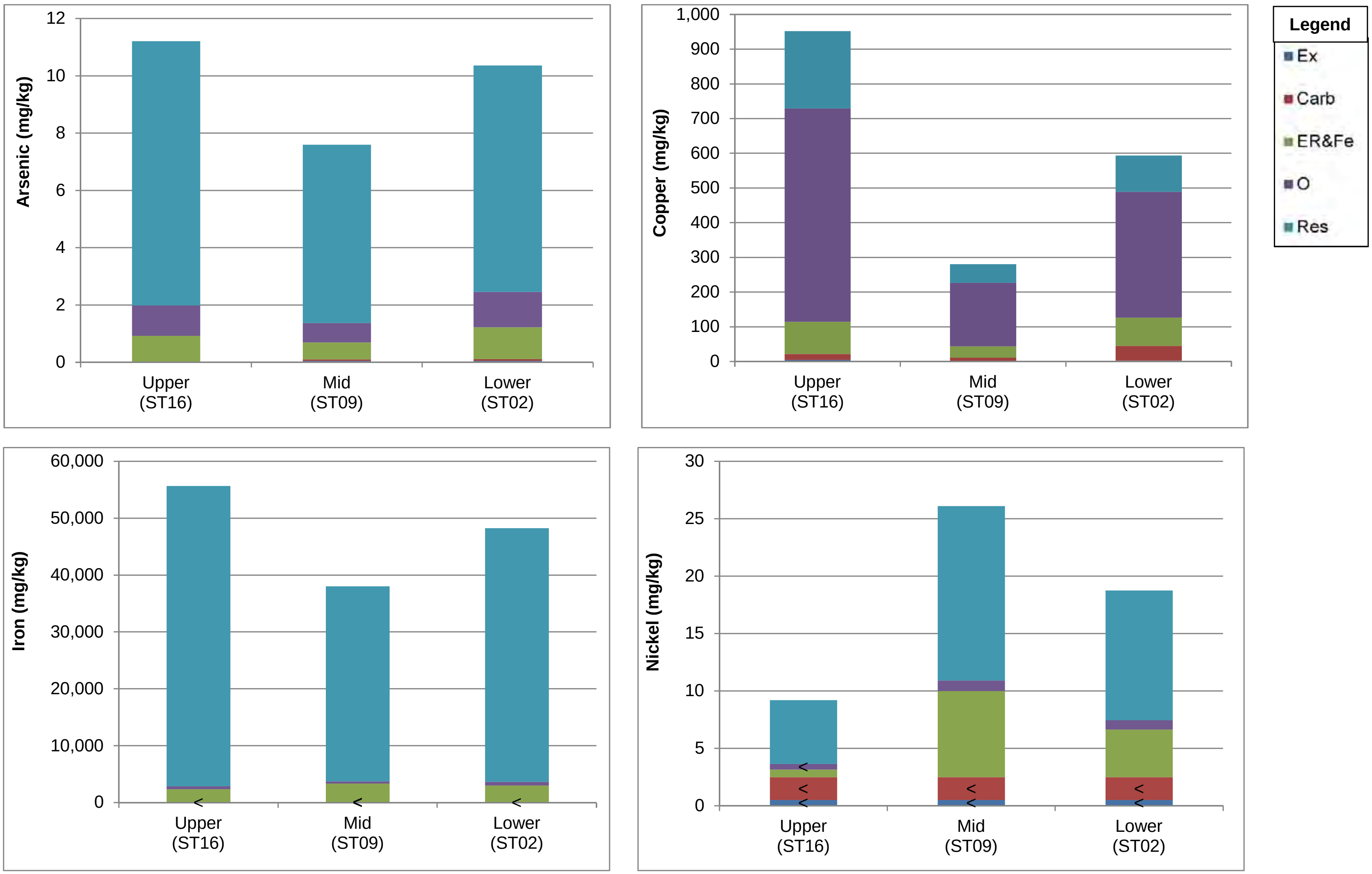


Figure 5.4: Mean concentrations of selectively extracted parameters of interest in sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Selective extractions included Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe), Organic Bound Metals (O), and Residual Metals (Res).

Mean values < MDL are indicated with a < symbol. Means are reported as < MDL if all data used in their calculation were < MDL.

kinetic testing). Therefore, sediment copper also appears to be present in Hazeltine Creek sediments in forms that are not mobile and this immobility suggests limited concern for aquatic biota.

Shake flask tests and porewater chemistry indicated low mobility of metals associated with Hazeltine Creek sediments, with copper being the only metal mobilized in shake flask tests and present in sediment porewater at concentrations greater than British Columbia Water Quality Guidelines (BCWQG; Tables 5.7 and 5.8; Appendix Tables E.8 and E.9). BCWQG do not apply to sediment porewater, but are used herein as an indication of low mobility. The mean concentration of porewater selenium at one area only (ST16, upper Hazeltine Creek) was slightly greater than the BCWQG (0.0025 mg/L vs. guideline of 0.002 mg/L; Table 5.8).

Acid-Base accounting results indicated no potential for acid generation in the Hazeltine Creek sediments (Appendix Tables E.11-E.12). Mean neutralization potential ratio (NPR; the ratio of neutralization potential to maximum potential acidity) ranged from 4.9 at area ST16 (upstream) to 19 at area ST09 (mid-stream). NPR greater than 4 indicates no potential for Acid Rock Drainage (ARD; Price 1997). High NPR in Hazeltine Creek sediment is consistent with high NPR observed in tailings (SRK 2014, 2015). Lower NPR downstream suggests that the NPR of mine tailings may be greater than that of the scoured Hazeltine Creek bed material.

Examination of metal concentrations in four different particle size categories in a large sample collected from lower Hazeltine Creek (at HAC50; Figure 4.2) indicated that concentrations of POIs and IPs were generally similar among size fractions (Table 5.9; Figures 5.5 and 5.6). A pattern of slightly increasing concentrations with decreasing particle size was evident for most analytes; however copper was an exception, with higher concentrations in the sand fraction (Figure 5.5). These subtle patterns have some implications to the dispersion of metals in Quesnel Lake as fine particles are expected to have travelled further downstream. Examination of selective extraction results (Appendix Table E.13 and Appendix Figures E.6-E.7) and shake flask results (Appendix Table E.14) for this sample indicated similar partitioning as observed at areas ST16, ST09 and ST02, and also indicated that copper was the only metal mobilized in shake flask testing to a concentration greater than a BCWQG. Shake flask results indicated greater copper mobility associated with fine sediments than coarse sediments, which is consistent with higher concentrations of easily reducible and “organic” copper in fine sediments (Appendix Figures E.6-E.7)

Table 5.7: Summary of leachable (Shakeflask) metals data for sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Data are based on bulk sediment [1]. Only analytes with detectable concentrations are displayed.

Analyte	Units	BCWQG [2]			HWR [3]	Upper Creek (ST16)		Mid Creek (ST09)		Lower Creek (ST02)	
Sample ID		Type	Chronic	Acute		Mean	t*SE	Mean	t*SE	Mean	t*SE
Leachable Metals											
Barium	mg/L	W	1.0	-	100	0.028	0.0069	0.024	0.0080	0.040	0.023
Calcium	mg/L	-	-	-	-	16.5	3.11	20.7	4.44	24.1	15.7
Copper	mg/L	A	0.0055	0.015	100	0.042	0.016	<0.010	0	0.015	0.012
Iron	mg/L	A	-	1.0	-	0.097	0.064	<0.030	0	<0.030	0
Magnesium	mg/L	-	-	-	-	2.34	0.674	3.24	0.706	3.50	2.26
Manganese	mg/L	A	1.21	2.05	-	0.0463	0.00717	0.0302	0.00903	0.201	0.395
Molybdenum	mg/L	A	1	2	-	<0.030	0	<0.030	0	0.042	0.027
Potassium	mg/L	-	-	-	-	2.9	0.80	<2.0	0	3.6	2.3
Silicon	mg/L	-	-	-	-	4.40	0.200	4.17	0.316	5.26	1.57
Sodium	mg/L	-	-	-	-	9.2	4.7	4.7	1.5	12	13
Strontium	mg/L	-	-	-	-	0.217	0.0488	0.1926	0.0432	0.287	0.173

(Orange shading) Value is > one or all guidelines (values < MDL excluded from comparison).

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Water Quality Guidelines (BCMOE 2015a; BCMOE 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.

[3] Hazardous Waste Regulation (Government of British Columbia 1988)

Table 5.8: Porewater metals data for sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014 [1]. Only analytes with detectable concentrations are displayed.

Analyte	Units	BCWQG [2]			Upper Creek (ST16) [3]		Mid Creek (ST09)		Lower Creek (ST02)	
Sample ID		Type	Chronic	Acute	Mean	t*SE	Mean	t*SE	Mean	t*SE
Date Sampled										
Physical Tests										
Hardness (as CaCO3)	mg/L	-	-	-	463	-	202	65.0	318	185
Total Metals										
Aluminum	mg/L	-	-	-	0.0376	-	0.0401	0.0381	0.1516	0.233
Antimony	mg/L	W	0.01	-	0.00206	-	0.00083	0.00022	0.00082	0.00059
Arsenic	mg/L	A	-	0.005	0.00245	-	0.00112	0.000162	0.00329	0.00372
Barium	mg/L	W	1	-	0.0439	-	0.0576	0.0236	0.0694	0.0292
Boron	mg/L	A	-	1.2	0.110	-	0.038	0.010	0.081	0.078
Cadmium [4]	mg/L	A	0.00045	0.0017	<0.000020	-	0.000014	0.0000068	0.000040	0.000033
Calcium	mg/L	-	-	-	145	-	65.2	21.4	105	63.8
Chromium [5]	mg/L	W	0.00	-	<0.00050	-	<0.00050	0	0.00051	0.000033
Cobalt	mg/L	A	0.004	0.11	0.00157	-	<0.00020	0.000056	0.00130	0.0022
Copper	mg/L	A	0.011	0.028	0.0485	-	0.0095	0.0014	0.0221	0.0282
Iron	mg/L	A	-	1	<0.060	-	0.075	0.042	0.181	0.171
Lead	mg/L	A	0.015	0.30	<0.00010	-	0.000072	0.000061	0.00013	0.000094
Lithium	mg/L	-	-	-	0.00830	-	0.00159	0.000383	0.00545	0.00733
Magnesium	mg/L	-	-	-	25.1	-	11.1	3.76	16.3	7.53
Manganese	mg/L	A	1.8	3.6	0.438	-	0.00706	0.00614	0.656	1.52
Molybdenum	mg/L	A	1	2	0.1330	-	0.0247	0.0160	0.0667	0.137
Nickel [6]	mg/L	W	-	0.15	0.00190	-	0.00187	0.000427	0.00321	0.00213
Potassium	mg/L	-	-	-	7.57	-	1.80	0.528	5.19	6.36
Selenium	mg/L	A	0.002	-	0.0025	-	0.0015	0.0008	0.0012	0.0011
Silicon	mg/L	-	-	-	5.70	-	3.67	0.49	5.53	3.37
Silver	mg/L	A	0.0015	0.0030	<0.000020	-	0.000012	0.0000054	0.000022	0.000014
Sodium	mg/L	-	-	-	69.0	-	13.4	8.14	42.4	69.1
Strontium	mg/L	-	-	-	1.75	-	0.552	0.208	1.16	1.02
Tin	mg/L	-	-	-	<0.00020	-	<0.00020	0.000056	0.00020	0.00015
Titanium	mg/L	-	-	-	<0.020	-	<0.020	0	0.024	0.012
Uranium	mg/L	W	0.01	-	0.00408	-	0.00457	0.000535	0.00502	0.00189
Vanadium	mg/L	-	-	-	<0.0020	-	0.0018	0.00046	0.0024	0.0016
Dissolved Metals										
Aluminum	mg/L	A	0.05	0.10	0.0079	0.0038	0.0035	0.0014	0.0052	0.0062
Antimony	mg/L	-	-	-	0.00222	0.000404	0.00078	0.00017	0.00079	0.00057
Arsenic	mg/L	-	-	-	0.00268	0.000604	0.00104	0.00013	0.00303	0.00347
Barium	mg/L	-	-	-	0.0460	0.0271	0.0559	0.0227	0.0650	0.0306
Boron	mg/L	-	-	-	0.084	0.053	0.036	0.0092	0.078	0.077
Cadmium	mg/L	A	0.00045	0.0017	0.000033	0.000034	0.000015	0.0000063	0.000034	0.000030
Calcium	mg/L	-	-	-	105	51.4	63.1	20.3	101	63.1
Cobalt	mg/L	-	-	-	0.00091	0.00070	<0.00020	0.000056	0.0011	0.0021
Copper	mg/L	-	-	-	0.0446	0.083	0.00823	0.00168	0.0141	0.0129
Lead	mg/L	-	-	-	0.00020	0.00043	<0.00010	0.000028	<0.00020	0.000076
Lithium	mg/L	-	-	-	0.00675	0.00283	0.00154	0.000315	0.0053	0.0073
Magnesium	mg/L	-	-	-	19.3	11.7	10.7	3.46	15.7	7.35
Manganese	mg/L	-	-	-	0.231	0.305	0.000760	0.000740	0.62	1.5
Molybdenum	mg/L	-	-	-	0.0981	0.0591	0.0234	0.0149	0.0651	0.135
Nickel	mg/L	-	-	-	0.0016	0.0011	0.00175	0.000375	0.0030	0.0021
Potassium	mg/L	-	-	-	6.06	2.99	1.75	0.512	5.04	6.18
Selenium	mg/L	-	-	-	0.00225	0.00047	0.00139	0.000762	0.0011	0.0011
Silicon	mg/L	-	-	-	5.45	0.557	3.49	0.412	5.05	3.36
Sodium	mg/L	-	-	-	47.8	39.9	13.0	7.47	41.3	68.4
Strontium	mg/L	-	-	-	1.31	0.622	0.523	0.190	1.12	1.01
Titanium	mg/L	-	-	-	<0.020	0	<0.020	0	0.020	0
Uranium	mg/L	-	-	-	0.00280	0.00182	0.00438	0.000502	0.00483	0.00181
Vanadium	mg/L	-	-	-	0.0026	0.0026	0.0016	0.00044	0.0021	0.0015
Zinc	mg/L	-	-	-	0.0046	0.0017	0.0032	0.00061	0.0037	0.00078

(orange) Value is > one or all guidelines (values < MDL excluded from comparison).

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < highest MDL if all the data used in their calculation were < MDL.

[2] British Columbia Water Quality Guidelines (BCMOE 2015a; BCMOE 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.

[3] Insufficient porewater volume to analyse total or dissolved metals in sample ST16-04 or to analyse total metal concentrations in samples ST16-S2, ST16-S3 or ST16-S5. Total metal concentrations are based only on the result from one sample (ST16-S1) as a result.

[4] Displayed guideline value is for dissolved cadium.

[5] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.

[6] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)

Table 5.9: Raw sediment quality data for Hazeltine Creek size-fractioned sediment sample HAC50, Mount Polley Mine, 2014.

Analyte	Units	BC SQG [1]		Historic Hazeltine Creek 95th Percentile [2]		HAC50			
Size Fraction		TEL	PEL	Lower Creek	Upper Creek	<25µm	63µm - 25µm	125µm - 63µm	2mm - 125µm
Date Sampled						23-Aug-14	23-Aug-14	23-Aug-14	23-Aug-14
Physical Tests									
pH (1:2 soil:water)	pH	-	-	-	-	8.71	8.60	8.59	8.23
Leachable Anions & Nutrients									
pH	pH	-	-	-	-	8.65	8.68	8.67	8.46
Organic / Inorganic Carbon									
Total Organic Carbon	%	-	-	9.0	12.8	0.14	<0.10	0.10	0.18
Metals									
Aluminum	mg/kg	-	-	12,550	18,000	23,900	22,500	22,300	21,000
Antimony	mg/kg	-	-	1.3	0.37	0.52	0.50	0.44	0.40
Arsenic	mg/kg	5.9	17	12.1	8.2	**14.9**	**14.7**	**13.9**	**13.3**
Barium	mg/kg	-	-	104	136	282	280	236	215
Beryllium	mg/kg	-	-	0.30	0.46	0.90	0.78	0.74	0.71
Bismuth	mg/kg	-	-	20	16	<0.20	<0.20	<0.20	<0.20
Cadmium	mg/kg	0.6	3.5	0.24	0.35	0.172	0.152	0.163	0.163
Calcium	mg/kg	-	-	7,030	13,400	36,400	32,900	30,100	28,600
Chromium	mg/kg	37.3	90	33.1	40.1	14.8	12.2	11.4	10.5
Cobalt	mg/kg	-	-	11.0	10.4	23.7	22.7	21.3	20.3
Copper	mg/kg	35.7	197	42.0	94.6	**872**	**884**	**870**	**950**
Iron	mg/kg	21,200	43,776	35,400	29,900	**55,800**	**52,800**	**50,400**	**46,400**
Lead	mg/kg	35	91	5.6	6.7	8.33	7.50	6.99	6.66
Lithium	mg/kg	-	-	12.9	14.8	23.4	22.1	20.6	19.3
Magnesium	mg/kg	-	-	6,160	6,430	15,600	14,900	14,400	13,400
Manganese	mg/kg	460	1,100	1,120	1,350	940	947	891	828
Mercury	mg/kg	0.17	0.49	0.140	0.145	0.0699	0.0788	0.0806	0.0789
Molybdenum	mg/kg	-	-	0.75	1.5	4.51	4.30	4.29	4.11
Nickel	mg/kg	16	75	24	24	12.7	11.3	10.4	9.91
Phosphorus	mg/kg	-	-	729	1,380	1,560	1,620	1,470	1,390
Potassium	mg/kg	-	-	910	1,450	2,290	2,300	2,190	1,950
Selenium	mg/kg	2	-	1.3	3.3	1.22	1.19	1.16	1.24
Silver	mg/kg	0.5	-	0.10	0.16	0.41	0.39	0.40	0.36
Sodium	mg/kg	-	-	253	350	1,540	1,540	1,470	1,370
Strontium	mg/kg	-	-	67	118	220	191	189	181
Thallium	mg/kg	-	-	0.051	0.094	<0.050	<0.050	<0.050	<0.050
Tin	mg/kg	-	-	1.1	0.70	2.4	2.0	<2.0	<2.0
Titanium	mg/kg	-	-	701	776	1,950	1,880	1,780	1,730
Uranium	mg/kg	-	-	0.73	1.26	1.41	1.32	1.20	1.17
Vanadium	mg/kg	-	-	75	65.3	203	195	186	172
Zinc	mg/kg	123	315	60.2	67.6	**128**	79.6	75.8	74.1

(blue)	Value is > TEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.
(orange)	Value is > PEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

[1] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a; BCMOE 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[2] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

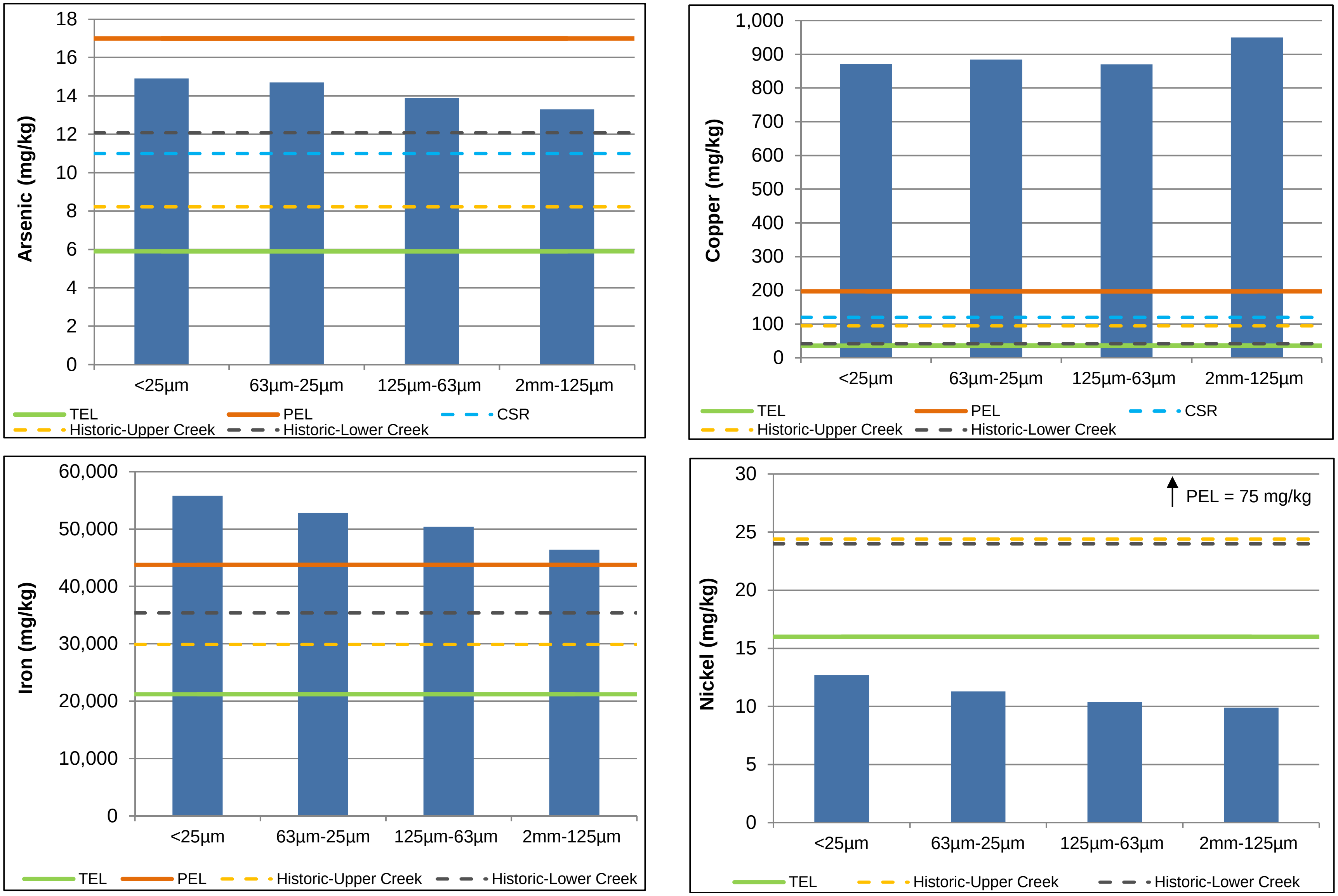


Figure 5.5: Metal concentrations for parameters of interest in Hazeltine Creek size-fractioned sediment sample HAC50, Mount Polley Mine, 2014. Fractions include sand (2mm-125 µm), very fine sand (125-63 µm), medium coarse silt (63-25 µm), and fine silt and clay (<25µm).

TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level; CSR = Contaminated Sites Regulation - Sensitive; Historic = Historic 95th percentile for either upper or lower Hazeltine Creek areas. Historic data are based predominantly on bulk sediment.

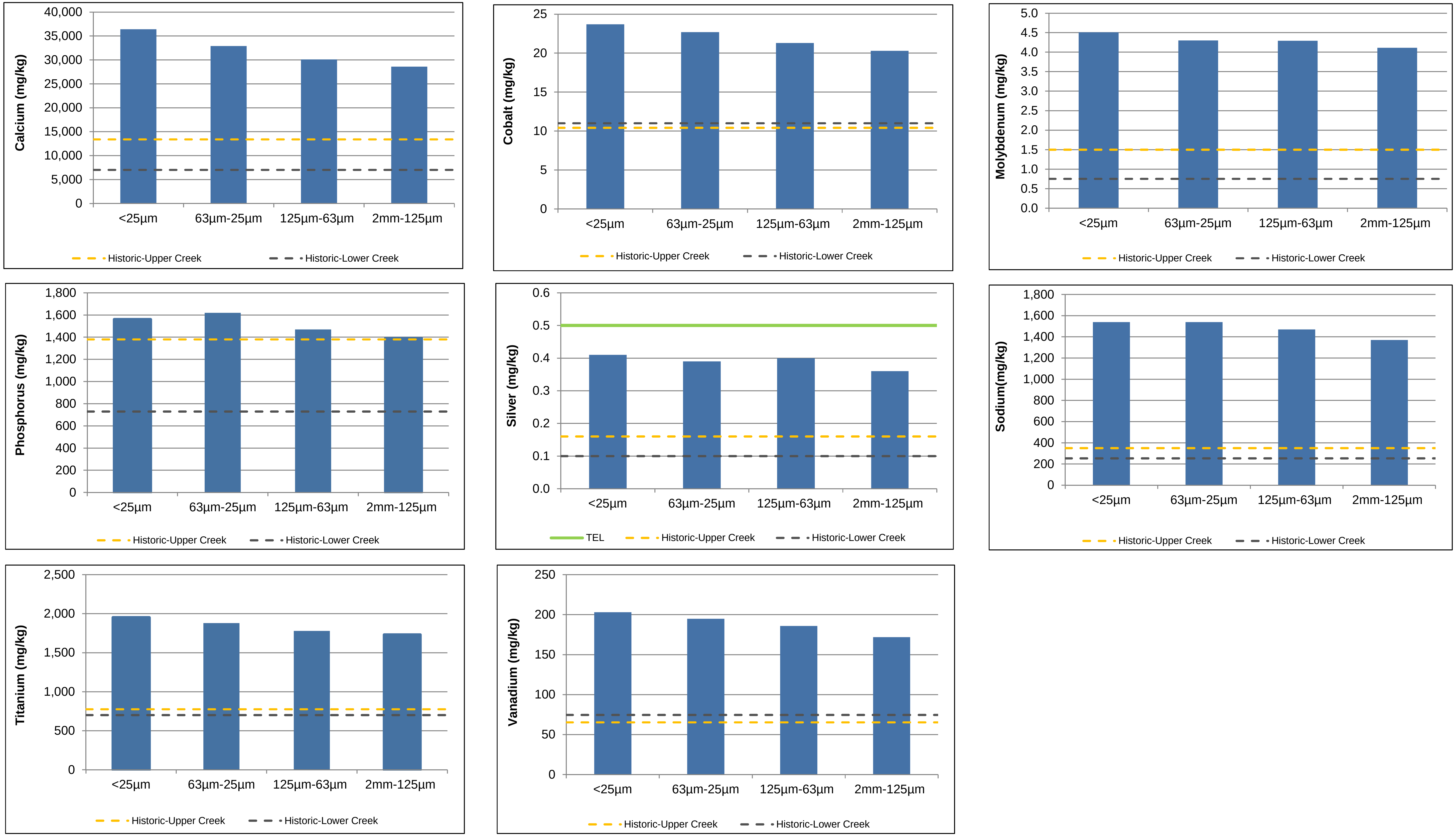


Figure 5.6: Metal concentrations for indicator parameters in Hazeltine Creek size-fractioned sediment sample HAC50, Mount Polley Mine, 2014. Fractions include sand (2mm-125 µm), very fine sand (125-63 µm), medium coarse silt (63-25 µm), and fine silt and clay (<25µm).

TEL = Threshold (or Lowest) Effect Level; Historic = Historic 95th percentile for either upper or lower Hazeltine Creek areas. Historic data are based predominantly on bulk sediment.

5.3 Sediment Toxicity

Sediment toxicity testing indicated significantly reduced survival and growth of the freshwater/brackish water amphipod *Hyalella azteca* at two of four areas within Hazeltine Creek - ST16 (upper) and HAC50 (lower; Figure 5.7; Appendix Table F.1). Survival and growth of *H. azteca* were particularly low at upper Hazeltine Creek (23% and 8% of laboratory control, respectively; Appendix Table F.2), in apparent association with coarser sediment characterized by highest copper concentration (Section 5.1). Conversely, both survival and growth of *H. azteca* at areas ST09 (middle Hazeltine Creek) and ST02 (lower Hazeltine Creek) did not differ from laboratory controls (Figure 5.7; Appendix Table F.1). Survival of the freshwater midge *Chironomus dilutus* was significantly reduced relative to concurrent laboratory controls throughout Hazeltine Creek (40 to 80% of control survival; Figure 5.7; Appendix Tables F.1-F.2). Growth of *C. dilutus* was not adversely affected in samples collected at ST16 (upper Hazeltine Creek), ST09 (middle Hazeltine Creek) or ST02 (lower Hazeltine Creek), but was significantly reduced in sediment collected from station HAC50 (also lower Hazeltine Creek; growth 63% of control; Figure 5.7; Appendix Tables F.1-F.2).

Correlation analysis was conducted between the sediment toxicity test endpoints and percent fines, TOC content, concentrations of POIs, IPs, PCA axes and selective copper extracts. There were no significant relationships between *C. dilutus* survival or growth and any sediment physical or chemical parameters at the Bonferroni-adjusted p-level (Table 5.10). A few negative associations between *C. dilutus* survival and growth and POIs and IPs were evident at $p<0.01$ (Table 5.10). Survival of *H. azteca* was positively correlated with percent fines and calcium at the Bonferroni-adjusted p-level (Table 5.10; Appendix Figure I.1). A number of negative associations between *H. azteca* survival or growth and POIs and IPs (including exchangeable and organic copper) were evident at $p<0.01$ (Table 5.10; Appendix Figure I.2). Although correlation does not necessarily indicate causation, the positive relationships with percent TOC and PCA axis 1 (lower concentrations of POIs and IPs) and the negative relationships with arsenic, copper, iron, molybdenum, silver, vanadium, exchangeable copper and organic copper represent plausible mechanisms of biological effect.

5.4 Benthic Invertebrate Community

No benthic invertebrate community sampling was conducted in Hazeltine Creek in 2014 due to the absence of appropriate erosional habitat post-event (i.e., substrates were entirely fine materials derived from the tailings pond and scoured creek bed). Benthic invertebrate sampling will be undertaken in the future (starting in 2015) to track recovery

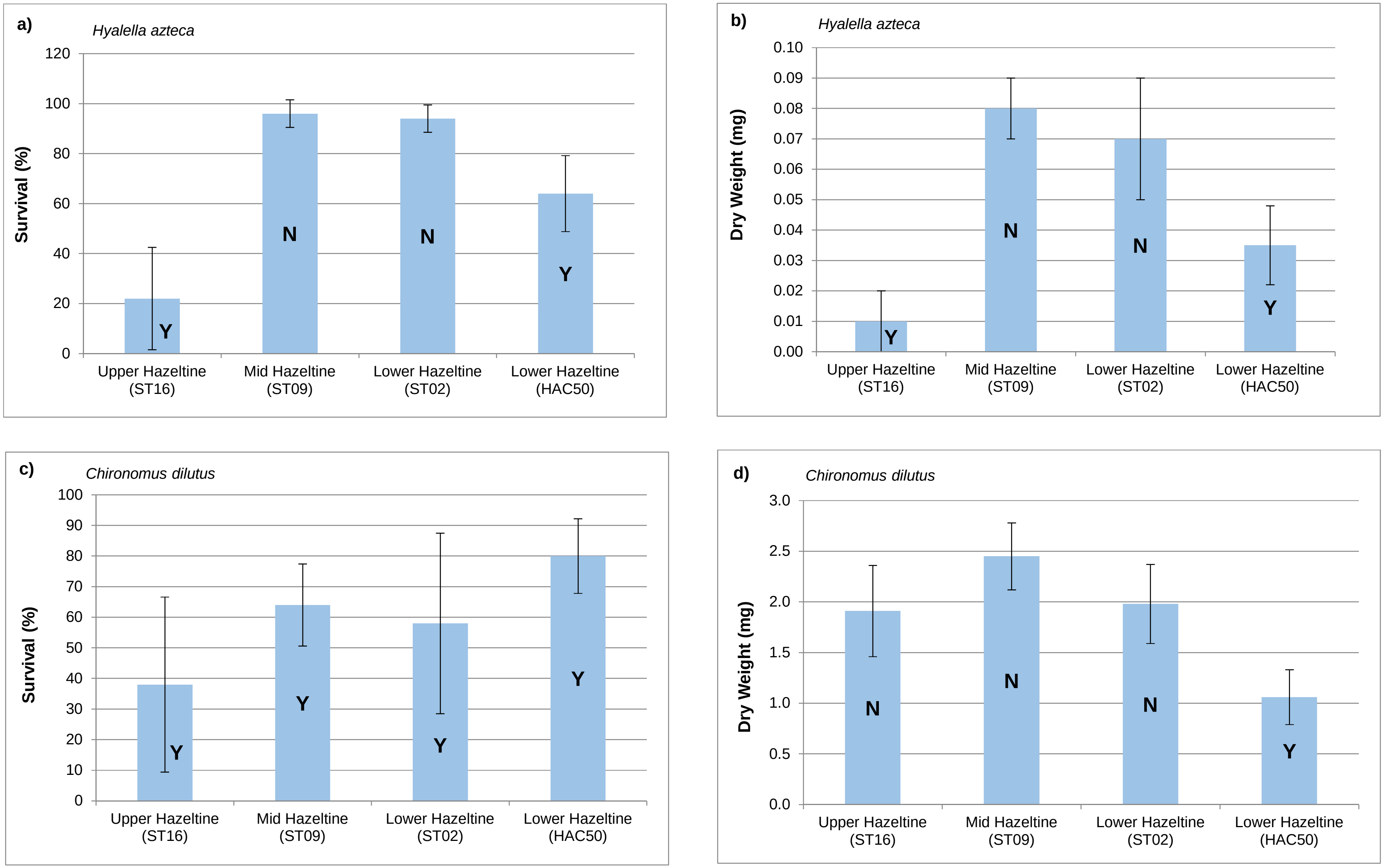


Figure 5.7: Toxicity tests of Hazeltine Creek sediment, Mount Polley Mine, 2014. Results for *Hyalella azteca* a) Survival (%), b) Dry Weight (mg) and *Chironomus dilutus* c) Survival (%), d) Dry Weight (mg). Error bars represent standard deviation. Letters represent significant differences (Y) or no differences (N) between samples and the control ($p < 0.05$). Control results are not shown.

Table 5.10: Spearman's Rank Correlation results for correlation of toxicity test results versus sediment physical characteristics, parameters of interest, indicator parameters, PCA axes and copper extracts (all in < 2mm sediment fraction) Hazeltine Creek sampling areas, Mount Polley Mine, 2014 [1].

Physical/Chemical Parameter		Correlation Parameter	*Hyalella azteca*		*Chironomus dilutus*	
			Survival	Growth	Survival	Growth
Physical	Fines	Correlation Coefficient	0.798	0.727	0.275	0.638
		Sig. (2-tailed)	0.0004	0.0021	0.3219	0.0105
	TOC	Correlation Coefficient	0.452	0.743	0.513	0.553
		Sig. (2-tailed)	0.0904	0.0015	0.0505	0.0326
Parameters of Interest	Arsenic	Correlation Coefficient	-0.454	-0.645	-0.647	-0.618
		Sig. (2-tailed)	0.0893	0.0094	0.0091	0.0141
	Copper	Correlation Coefficient	-0.629	-0.689	-0.580	-0.695
		Sig. (2-tailed)	0.0119	0.0045	0.0234	0.0040
	Iron	Correlation Coefficient	-0.425	-0.718	-0.546	-0.584
		Sig. (2-tailed)	0.1141	0.0026	0.0354	0.0221
	Nickel	Correlation Coefficient	0.752	0.675	0.352	0.627
		Sig. (2-tailed)	0.0012	0.0058	0.1978	0.0123
Indicator Parameters	Calcium	Correlation Coefficient	0.852	0.590	0.153	0.423
		Sig. (2-tailed)	<0.0001	0.0205	0.5860	0.1163
	Cobalt	Correlation Coefficient	0.137	-0.189	-0.532	-0.284
		Sig. (2-tailed)	0.6274	0.5008	0.0414	0.3042
	Molybdenum	Correlation Coefficient	-0.524	-0.651	-0.470	-0.692
		Sig. (2-tailed)	0.0452	0.0086	0.0773	0.0043
	Phosphorus	Correlation Coefficient	-0.358	-0.606	-0.466	-0.681
		Sig. (2-tailed)	0.1897	0.0166	0.0799	0.0052
	Silver	Correlation Coefficient	-0.701	-0.742	-0.507	-0.674
		Sig. (2-tailed)	0.0036	0.0015	0.0536	0.0058
	Sodium	Correlation Coefficient	-0.420	-0.427	-0.587	-0.456
		Sig. (2-tailed)	0.1195	0.1120	0.0214	0.0878
	Titanium	Correlation Coefficient	0.162	-0.029	-0.435	-0.063
		Sig. (2-tailed)	0.5638	0.9184	0.1050	0.8241
	Vanadium	Correlation Coefficient	-0.672	-0.770	-0.578	-0.634
		Sig. (2-tailed)	0.0061	0.0008	0.0240	0.0111
PCA Axes	PCA Axis 1	Correlation Coefficient	0.732	0.756	0.473	0.652
		Sig. (2-tailed)	0.0019	0.0011	0.0747	0.0084
	PCA Axis 2	Correlation Coefficient	-0.462	-0.209	0.332	-0.138
		Sig. (2-tailed)	0.0827	0.4543	0.2260	0.6248
Copper Extracts	Exchangeable	Correlation Coefficient	-0.501	-0.673	-0.636	-0.570
		Sig. (2-tailed)	0.0569	0.0060	0.0108	0.0265
	Carbonate	Correlation Coefficient	-0.111	-0.307	-0.403	-0.472
		Sig. (2-tailed)	0.6927	0.2664	0.1365	0.0758
	Easily Reducible	Correlation Coefficient	-0.416	-0.446	-0.595	-0.528
		Sig. (2-tailed)	0.1227	0.0958	0.0193	0.0432
	Organic	Correlation Coefficient	-0.639	-0.691	-0.459	-0.674
		Sig. (2-tailed)	0.0104	0.0044	0.0853	0.0059

Significant correlation; p-value < 0.0006 (Bonferroni corrected p-value for 80 comparisons).
Correlation scatterplot inspected; p <0.01.

[1] Values < method detection limit (MDL) were used at the MDL for calculations. Absolute survival and growth values were used for correations since all samples were run in the same laboratory batch using the same controls.

Note: n=15 for all correlations.

and characterize benthic invertebrate community condition relative to pre-event conditions (e.g., Minnow 2009).

5.5 Data Integration and Summary

Sediment collected from Hazeltine Creek following the dam failure is characterized by low TOC compared to pre-failure levels and concentrations of copper and iron greater than SQG PELs and pre-event concentrations. Concentrations of arsenic and nickel were greater than SQG TELs at a subset of sample locations and only in <63 µm sediment (not <2.0 mm sediment). Copper was more substantially elevated than any other analyte, with mean concentrations up to five times the PEL and 15 times background. Sediment geochemical evaluations indicated that, for most POIs and IPs, concentrations were mostly in the residual phase, a fraction that is not considered mobile or biologically available. However, copper was a notable exception, with the majority occurring in the "organic" phase (although this appears to be mineral), and with concentrations in the exchangeable, carbonate and easily reducible phases approaching pre-event concentrations. Separate integrated consideration of mineralogy, sequential extraction results and mineral solubility indicates that these forms would not be mobile under environmentally realistic conditions (SRK 2015).

Sediment toxicity testing indicated some adverse effects to both test species (*H. azteca* and *C. dilutus*), but also indicated no effect at some combinations of endpoint and location (e.g., no reduction in *H. azteca* survival and growth at the mid-stream area and no reduction in *C. dilutus* growth at three of four areas). Survival and growth of *C. dilutus* were weakly associated with concentrations of several POIs and IPs. Survival of *H. azteca* was positively correlated with percent fines and calcium, and growth of *H. azteca* was weakly associated percent fines and percent TOC in the positive direction, and with POIs and IPs (including exchangeable and organic copper) win the negative direction. These relationships suggest negative biological effects due to low TOC and elevated concentrations of failure-related metals including copper in selective extracts.

Overall, an impact of the dam failure was evident in sediment quality throughout Hazeltine Creek. Copper represents the analyte of greatest concern, both with respect to its absolute concentration relative to guidelines and its geochemical partitioning. Sediment toxicity testing confirmed effects on test organisms that were weakly associated with low TOC and elevated concentrations of POIs and IPs, including exchangeable and organic copper, but also indicated some instances of no toxicity.

6.0 POLLEY LAKE

Sediment quality impact characterization in Polley Lake included sediment chemistry, sediment geochemical characterization, sediment stratigraphy, toxicity testing, and benthic invertebrate community characterization (Table 4.1; Figure 4.3). Samples were collected from two areas at mid-depth (north and south sides of Polley Lake at approximately 20 m depth) and in two deep basins (also on the north and south sides of Polley Lake, at approximately 29 m depth). The deep basins were included because they have been sampled on several previous occasions, providing pre-event data for interpretation of impact. Bootjack Lake served as a reference for Polley Lake (Figure 4.3). Data Quality Assessment (DQA; Appendix C with supporting data in Appendix J) indicated that sediment quality data, toxicity test results and benthic invertebrate community data were of good quality and can therefore be used in the sediment quality impact characterization.

6.1 Sediment Physical and Chemical Characterization

Surficial sediment (top 5 cm) of Polley Lake was observed to be heterogeneous, typically composed of dark brown fines (consistent with pre-event and reference sediment) with varying quantities of grey fines either on top of the sediment or mixed into the sediment. In general, the sediment collected from the south side of Polley Lake was quite variable, with some samples being composed entirely of brown fines and others composed entirely of grey fines. This was especially true within the basin area POL-P2 and the two mid-depth areas closest to the southern end of the lake (POL-2-02 and POL-2-03), where the proportion of grey fines was roughly equal to or greater than the proportion of native brown fines collected. Sediment from the north side of Polley Lake showed a layering of grey fines over native brown to dark brown fines. Although the proportion of these layers varied among sampling stations, the native brown fines generally comprised the greater proportion of the sample, and in some instances the proportion of grey fines was fairly small.

Surficial sediments at the mid-depth areas and the basins of Polley Lake and Bootjack Lake (reference) were predominantly silt, with smaller fractions of sand and clay (Table 6.1; Appendix Tables E.15-E.16 and E.19-E.20). Mean total organic carbon (TOC) content of Polley Lake mid-depth sediment (approximately 0.8% at the south side and 3% at the north side; Table 6.1) was lower than that of mid-depth sediment from Bootjack Lake (approximately 18%; Table 6.1) and Polley Lake pre-event levels (mean 8.4%; Table 3.5). Mean TOC content was slightly lower in the Polley Lake basins (11.2% and 9.8%;

Table 6.1: Summary of sediment quality data for mid-depth and deep stations in Polley Lake and associated reference areas in Bootjack Lake, Mount Polley Mine, 2014. Metals data are based on the < 2mm fraction of sediment[1].

Sample ID	Units	BC SQGs [2]		Mid-depth								Deep Lake									
				Reference Value [3]		Reference (Bootjack Lake)		Exposed (Polley Lake)				Reference Value [3]		Reference (Bootjack Lake)				Exposed (Polley Lake)			
						BOL-1		POL-1 (North)		POL-2 (South)				B1 (North)		B2 (South)		P1 (North)		P2 (South)	
		TEL	PEL	Historical Polley Mid-depth 95th Percentile [4]	Bootjack 2014 Mid-depth 95th Percentile (<2mm)	Mean	t*SE	Mean	t*SE	Mean	t*SE	Historical Polley Deep 95th Percentile [4]	Bootjack 2014 Deep 95th Percentile (< 2 mm)	Mean	t*SE	Mean	t*SE	Mean	t*SE	Mean	t*SE
Physical Tests [5]																					
Moisture	%	-	-	-	94.1	93.3	0.85	65.5	8.96	62.0	19.0	-	93.8	93.5	0.29	93.4	1.25	87.8	6.07	73.9	50.4
pH (1:2 soil:water)	pH	-	-	-	6.3	6.43	0.13	-	-	8.24	0.694	-	6.01	6.46	0.42	6.09	0.27	7.70	0.44	8.11	0.98
Particle Size [6]																					
% Gravel (>2mm)	%	-	-	-	<0.10	<0.10	0	<0.10	0	<0.10	0	-	<0.10	<0.10	0	<0.10	0	<0.10	0	<0.10	0
% Sand (2.0mm - 0.063mm)	%	-	-	-	7.8	2.58	4.76	2.14	1.95	15.8	8.27	-	21	11.2	34.5	0.49	0.23	0.36	0.17	0.74	0.82
% Silt (0.063mm - 4µm)	%	-	-	-	88.1	84.5	3.34	91.5	1.51	78.6	6.86	-	84	76.7	28.3	83.5	2.50	79.7	8.13	79.1	3.39
% Clay (<4µm)	%	-	-	-	15.6	12.9	3.82	6.36	1.33	5.64	2.95	-	17	12.1	6.5	16.0	2.25	19.9	8.05	20.1	4.19
Texture	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leachable Anions & Nutrients [5]																					
pH	pH	-	-	-	6.0	6.06	0.096	7.09	0.116	7.62	0.59	-	5.81	5.96	0.25	5.88	0.20	7.00	1.08	7.05	0.34
Anions and Nutrients [5]																					
Total Nitrogen by LECO	%	-	-	-	1.9	1.69	0.28	0.204	0.241	0.225	0.317	-	1.68	1.61	0.20	1.54	0.138	0.63	-	0.58	1.61
Organic / Inorganic Carbon [6]																					
Total Organic Carbon	%	-	-	16.6	18.9	17.7	1.44	3.14	3.25	0.82	0.83	20.8	17	14.4	9.61	16.9	1.31	11.2	2.35	9.83	5.25
Metals [5]																					
Aluminum	mg/kg	-	-	6,700	21,160	19,780	2,058	22,140	2,468	20,900	4,254	20,620	19,900	18,800	1,242	19,533	1,578	26,600	2,865	26,667	7,028
Antimony	mg/kg	-	-	<10	1.02	0.95	0.085	0.49	0.026	0.52	0.12	1.2	1.0	0.87	0.066	0.98	0.19	0.72	0.11	0.63	0.26
Arsenic	mg/kg	5.9	17	12.9	6.65	6.19	0.42	11.6	0.65	11.9	1.09	8.9	7.1	5.85	0.71	6.79	0.96	**11.3**	2.74	**12.7**	3.99
Barium	mg/kg	-	-	141	233	218	21.7	239	18.9	222	30.2	227	280	193	21.7	262	64.4	224	93.2	255	79.6
Beryllium	mg/kg	-	-	0.60	0.77	0.68	0.12	0.74	0.038	0.72	0.072	0.63	0.77	0.65	0.087	0.75	0.063	0.79	0.24	0.92	0.28
Bismuth	mg/kg	-	-	-	<0.20	<0.20	0	<0.20	0	<0.20	0	0.4	<0.20	<0.20	0	<0.20	0	<0.20	0	<0.20	0
Boron	mg/kg	-	-	-	19	17	1.5	11	0.68	12	4.2	17	17	17	1.4	15	6.6	18	7.590	17	15
Cadmium	mg/kg	0.6	3.5	0.656	0.531	0.451	0.119	0.150	0.030	0.173	0.137	0.69	0.48	0.431	0.062	0.466	0.070	0.363	0.157	0.29	0.34
Calcium	mg/kg	-	-	9,000	10,660	10,048	683	26,920	1,848	27,280	4,705	15,890	10,750	10,667	287	7,910	424	20,733	9,166	30,167	15,877
Chromium	mg/kg	37.3	90	45.7	41.9	39.3	3.93	17.2	5.45	18.6	13.5	68	39	38.1	3.04	35.7	6.96	37.7	17.5	28.3	44.5
Cobalt	mg/kg	-	-	13.0	12.4	11.7	1.29	16.6	1.85	16.7	2.6	16	12	12.0	0.25	11.9	0.66	19.9	3.94	22.0	7.0
Copper	mg/kg	36	197	510	450	393	57.2	**562**	48.8	**573**	48.7	380	442	426	62.7	376	9.41	**630**	267	**699**	312
Iron	mg/kg	21,200	43,776	17,700	25,820	24,360	2,489	**26,580**	1,243	**37,300**	7,417	39,230	31,750	24,933	2,361	29,333	8,753	31,167	4,508	34,600	4,836
Lead	mg/kg	35	91	<30	12.0	10.4	3.36	6.76	0.799	5.92	1.26	18	12	7.72	0.99	11.4	1.00	8.45	1.80	7.26	3.63
Lithium	mg/kg	-	-	-	14.8	13.3	2.00	20.2	2.73	17.4	3.56	17.8	13.5	13.2	0.76	12.4	2.61	20.5	10.2	24.5	7.72
Magnesium	mg/kg	-	-	6,300	6,340	5,630	689	11,880	1,938	10,726	1,909	12,548	5,930	5,823	362	5,270	522	13,167	3,525	14,967	6,374
Manganese	mg/kg	460	1,100	469	968	864	94.7	825	63.5	731	88.2	3,310	1,678	1,016	287	1,450	889	923	144	909	434
Mercury	mg/kg	0.17	0.49	0.182	0.392	0.329	0.084	-	-	-	-	0.29	0.34	0.268	0.064	0.333	0.024	0.142	0.064	-	-
Molybdenum	mg/kg	-	-	4.85	4.63	3.41	1.11	3.39	0.306	4.49	2.62	6.1	3.5	3.35	0.45	3.41	0.43	7.42	2.79	6.55	5.86
Nickel	mg/kg	16	75	25.1	30.5	28.0	4.11	14.2	3.37	14.7	10.6	42.6	28.0	27.4	0.76	27.6	1.31	30.0	13.5	23.9	31.3
Phosphorus	mg/kg	-	-	-	1,426	1,316	166	1,372	118	1,430	339	3,405	2,755	1,247	75.9	2,360	1,637	1,053	201	1,357	678
Potassium	mg/kg	-	-	-	1,626	1,516	228	2,496	219	2,042	398	1,591	1,555	1,393	62.5	1,427	438	2,407	696	2,280	415
Selenium	mg/kg	2	-	5.99	2.94	2.68	0.34	1.46	0.33	1.62	1.19	5.37	3.05	2.94	0.35	2.71	0.63	3.52	1.61	2.51	3.67
Silver	mg/kg	0.5	-	<2.0	0.44	0.40	0.057	0.26	0.032	0.30	0.06	0.41	0.41	0.40	0.038	0.40	0.014	0.37	0.052	0.39	0.18
Sodium	mg/kg	-	-	-	228	216	18.8	1,328	197	1,184	277	560	220	217	14.3	207	37.9	1,137	648	1,133	439
Strontium	mg/kg	-	-	-	121	115	7.15	241	22.3	219	34.0	125	122	121	4.30	97.6	4.45	190	98.7	214	71.9
Thallium	mg/kg	-	-	-	0.161	0.137	0.027	0.050	0.0011	0.057	0.018	0.11	0.15	0.131	0.039	0.129	0.013	0.083	0.037	0.070	0.060
Tin	mg/kg	-	-	<5.0	<2.0	<2.0	0	2.0	0	2.0	0.11	0.8	<2.0	<2.0	0	<2.0	0	<2.0	0	2.23	0.517
Titanium	mg/kg	-	-	-	698	600	98.6	1,670	216	1,624	289	787	669	663	20.2	456	200	1,393	438	1,810	925
Uranium	mg/kg	-	-	-	2.84	2.43	0.448	1.21	0.0629	1.38	0.297	1.5	2.5	2.40	0.445	2.32	0.038	1.66	0.535	1.77	0.917
Vanadium	mg/kg	-	-	137	73.6	69.2	4.89	99.4	3.74	141	33.5	111	76.0	68.1	2.88	73.4	11.1	112	19.72	128	30.2
Zinc	mg/kg	123	315	82.9	81.6	76.8	7.66	63.6	7.66	62.5	20.8	99	80.7	79.6	3.48	77.8	3.99	90.8	8.54	89.8	41.6

Value is > TEL. Values shown in bold text also exceeded highest detectable Reference Value (historical Polley Lake or 2014 Bootjack Lake 95th Percentile value) for either mid-depth or deep areas.

Value is > PEL. Values shown in bold text also exceeded highest detectable Reference Value (historical Polley Lake or 2014 Bootjack Lake 95th Percentile value) for either mid-depth or deep areas.

[1] Reported TOC, TN, pH and moisture data are based on bulk sediment. Data < method detection limit (MDL) were used at the MDL for calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] The 5th percentile is reported for pH.

[4] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

[5] Samples were collected using a sediment corer.

[6] Samples were collected using a petite ponar.

Table 6.1) relative to the Bootjack Lake basins (14.4% and 16.9%; Table 6.1) and Polley Lake pre-event levels (mean 18.2%; Table 3.5).

Copper and iron were the only analytes with concentrations in Polley Lake mid-depth sediment greater than guidelines (the TEL in the case of iron and the PEL in the case of copper) and reference concentrations (Tables 6.1 and 6.2; Figure 6.1). In the Polley Lake deep areas (POL-P1 and POL-P2), arsenic and copper were the only analytes with concentrations greater than guidelines (the TEL in the case of arsenic and the PEL in the case of copper) and reference concentrations in all basins, with zinc elevated at one area (POL-P1, the north basin) in <63 µm sediment only (Tables 6.1 and 6.2; Figure 6.1). Concentrations of five additional analytes were present in Polley Lake mid-depth and/or deep sediment (<2 mm) at concentrations more than two times greater than reference concentrations (calcium, molybdenum, sodium, strontium and titanium; Table 6.3). This list of IPs differs from that identified for Hazeltine Creek (due to the different applicable reference data), with the absence of silver and vanadium and the inclusion of strontium and titanium. One additional IP, tin, was identified on the basis of concentrations more than two times greater than reference concentration in <63 µm sediment of the Polley Lake basins (both P1 and P2; Table 6.3). Thus, in accordance with the framework set out in Section 4.0, arsenic, copper, iron, and zinc are designated as POIs and calcium, molybdenum, sodium, strontium, tin and titanium are designated as IPs.

Principal Components Analysis (PCA) of the mid-depth sediment data was effective in distinguishing sediments of Polley Lake from those of Bootjack Lake (reference) primarily on the basis of axis 1 scores, indicating coarser sediment (more sand and less clay), lower TOC content, and higher concentrations of a number of metals (arsenic, cobalt, copper, sodium, strontium, titanium and vanadium; Figure 6.2). PCA of deep basin sediment data was also effective in distinguishing sediments of Polley Lake from those of Bootjack Lake (reference) primarily on the basis of axis 1 scores, indicating more clay in Polley Lake sediments and more TOC in Bootjack Lake sediments and higher concentrations of a number of metals (arsenic, calcium, cobalt, copper, lithium, magnesium, potassium, sodium, strontium, titanium and vanadium) in Polley Lake sediments (Figure 6.3). PCA axis 2 served primarily to distinguish stations P1-01 and P1-02 on the basis of higher zinc concentrations (Figure 6.3). Overall, PCA assisted in confirming the importance of the POIs and IPs in describing spatial variability in sediment quality.

Of the five POIs and six IPs, sodium was the most substantially elevated in Polley Lake, with concentrations in the <2 mm sediment up to approximately six times reference and

Table 6.2: Summary of sediment quality data for mid-depth and deep stations in Polley Lake and associated reference areas in Bootjack Lake, Mount Polley Mine, 2014. Data are based on the < 63 µm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		Mid-depth								Deep Lake									
				Reference Value [3]		Reference (Bootjack Lake)		Exposed (Polley Lake)				Reference Value [3]		Reference (Bootjack Lake)				Exposed (Polley Lake)			
						BOL-1 (Bootjack Lake)		POL-1 (North Polley Lake)		POL-2 (South Polley Lake)				B1 (North)		B2 (South)		P1 (North)		P2 (South)	
		TEL	PEL	Historical Polley Mid-depth 95th Percentile [4]	Bootjack 2014 Mid-depth 95th Percentile (<63 µm)	Mean	t*SE	Mean	t*SE	Mean	t*SE	Historical Polley Deep 95th Percentile [4]	Bootjack 2014 Deep 95th Percentile (<63 µm)	Mean	t*SE	Mean	t*SE	Mean	t*SE	Mean	t*SE
Physical Tests [5]																					
pH (1:2 soil:water)	pH	-	-	-	6.19	6.24	0.071	-	-	7.99	0.29	-	5.98	6.21	0.25	6.01	0.14	7.81	-	7.93	1.41
Organic / Inorganic Carbon [6]																					
Total Organic Carbon	%	-	-	16.6	18.2	17.0	1.68	1.88	2.39	0.48	0.39	20.8	16.5	13.7	4.05	15.7	2.61	9.15	5.67	7.67	7.17
Metals [5]																					
Aluminum	mg/kg	-	-	6,700	19,600	18,000	2,188	21,520	2,018	20,920	3,424	20,620	18,525	17,333	2,770	17,700	1,972	26,967	1,597	24,100	6,726
Antimony	mg/kg	-	-	<10	1.05	0.91	0.13	0.46	0.021	0.50	0.067	1.2	0.86	0.81	0.075	0.80	0.15	0.87	0.36	0.55	0.29
Arsenic	mg/kg	5.9	17	12.9	6.65	5.98	0.69	12.0	0.509	12.7	0.956	8.9	6.4	5.95	0.99	6.09	0.45	**12.4**	1.37	**12.6**	3.94
Barium	mg/kg	-	-	141	259	227	34.0	245	18.4	232	24.4	227	248	199	36.2	243	17.4	288	59.1	254	90.3
Beryllium	mg/kg	-	-	0.60	0.78	0.68	0.12	0.74	0.063	0.75	0.096	0.63	0.70	0.60	0.18	0.69	0.02	0.91	0.20	0.86	0.18
Bismuth	mg/kg	-	-	-	0.17	0.14	0.027	<0.10	0	0.10	0.011	0.4	0.15	<0.10	0	0.13	0.052	0.15	0.076	0.12	0.052
Boron	mg/kg	-	-	-	17	15	1.9	11	0.56	11	1.5	17	17	16	2.5	13	1.4	16	5.0	14	13
Cadmium	mg/kg	0.6	3.5	0.656	0.497	0.427	0.105	0.115	0.0179	0.145	0.097	0.69	0.40	0.350	0.070	0.394	0.032	0.275	0.208	0.234	0.277
Calcium	mg/kg	-	-	9,000	10,740	9,534	1,462	29,000	1,100	29,240	4,228	15,890	10,925	10,443	1,789	7,420	1,006	24,667	10,187	29,467	16,573
Chromium	mg/kg	37.3	90	45.7	47.8	42.1	7.18	11.7	1.41	15.0	9.11	68	98	39.8	6.47	61.9	119	35.6	26.2	45.4	126
Cobalt	mg/kg	-	-	13.0	12.1	11.0	1.30	15.4	1.67	17.1	2.86	16.4	11.7	10.5	0.80	11.0	2.12	20.5	3.76	21.3	8.40
Copper	mg/kg	36	197	510	424	360	62.7	**539**	28.7	**556**	73.3	380	380	370	15.5	340	95.5	**722**	212	**689**	393
Iron	mg/kg	21,200	43,776	17,700	25,220	23,400	2,030	**25,280**	2,020	**42,240**	12,720	39,230	28,300	23,833	5,213	26,600	5,170	29,600	3,286	32,700	9,467
Lead	mg/kg	35	91	<30	11.8	10.1	3.13	5.75	0.525	5.72	1.29	18	10	6.56	0.89	10.1	1.03	9.69	0.94	6.85	3.35
Lithium	mg/kg	-	-	-	14.5	12.6	2.12	18.9	3.48	17.3	4.31	17.8	12.1	11.3	3.05	11.1	0.25	24.3	6.24	24.0	10.0
Magnesium	mg/kg	-	-	6,300	6,146	5,370	744	10,942	1,712	10,446	2,424	12,548	5,538	5,370	603	4,823	892	13,967	3,204	14,333	8,375
Manganese	mg/kg	460	1,100	469	912	820	86.9	702	32.7	718	84.0	3,310	1,498	953	301	1,303	632	847	216	855	359
Mercury	mg/kg	0.17	0.49	0.182	0.362	0.304	0.069	0.0720	0.0054	0.0796	0.0288	0.29	0.28	0.191	0.021	0.255	0.079	0.117	0.0353	0.104	0.0819
Molybdenum	mg/kg	-	-	4.85	5.21	3.99	1.19	3.24	0.176	4.03	1.83	6.1	4.3	3.22	0.578	3.62	2.24	6.86	2.87	5.63	4.93
Nickel	mg/kg	16	75	25.1	34.0	29.8	5.33	10.6	1.38	12.2	7.59	43	75	27.8	4.47	47.6	90.1	29.1	18.1	34.2	81.4
Phosphorus	mg/kg	-	-	-	1,452	1,328	149	1,440	175	1,522	486	3,405	2,605	1,290	301	2,240	1,205	1,018	235	1,317	846
Potassium	mg/kg	-	-	-	1,514	1,354	212	2,060	229	2,000	351	1,591	1,368	1,287	263	1,253	28.7	2,453	277	2,110	693
Selenium	mg/kg	2	-	5.99	2.76	2.49	0.36	1.07	0.12	1.38	0.80	5.37	2.60	2.48	0.40	2.37	0.43	3.30	1.78	2.14	3.06
Silver	mg/kg	0.5	-	<2.0	0.419	0.364	0.070	0.239	0.0147	0.279	0.0385	0.41	0.38	0.33	0.022	0.36	0.080	0.35	0.064	0.34	0.087
Sodium	mg/kg	-	-	-	228	222	5.55	1,184	154	1,200	192	560	245	233	37.9	190	24.8	1,267	319	1,143	621
Strontium	mg/kg	-	-	-	116	106	12.7	259	24.3	230	21.3	125	134	125	31.5	88.9	20.1	249	77.3	214	79.0
Thallium	mg/kg	-	-	-	0.143	0.127	0.0171	<0.050	0	0.053	0.0083	0.11	0.13	0.108	0.011	0.115	0.038	0.082	0.057	0.065	0.066
Tin	mg/kg	-	-	<5.0	6.9	5.64	1.53	1.75	0.168	1.91	0.203	0.8	1.4	0.49	0.14	1.0	1.4	3.05	3.59	2.01	0.453
Titanium	mg/kg	-	-	-	655	554	97.4	1,696	116	1,736	247	787	784	751	130	407	69.5	1,660	301	1,653	1,032
Uranium	mg/kg	-	-	-	2.59	2.21	0.42	1.13	0.018	1.28	0.091	1.5	2.06	2.02	0.14	1.93	0.19	1.41	0.23	1.49	0.91
Vanadium	mg/kg	-	-	137	69.0	65.4	3.57	98.1	8.22	160	54.3	111	66.9	64.4	7.56	63.7	0.87	105	8.96	120	51.7
Zinc	mg/kg	123	315	82.9	80.1	71.9	9.90	55.6	6.32	59.4	18.4	99	98	68.3	5.64	80.8	58.7	**151**	171	91.0	63.5

(blue) Value is > TEL. Values shown in bold text also exceeded highest detectable Reference Value (historical Polley Lake and 2014 Bootjack Lake 95th Percentile values) for either mid-depth or deep areas.

(orange) Value is > PEL. Values shown in bold text also exceeded highest detectable Reference Value (historical Polley Lake and 2014 Bootjack Lake 95th Percentile values) for either mid-depth or deep areas.

[1] Data < method detection limit (MDL) were used at the MDL for calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] The 5th percentile is reported for pH.

[4] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

[5] Samples were collected using a sediment corer.

[6] Samples were collected using a petite ponar.

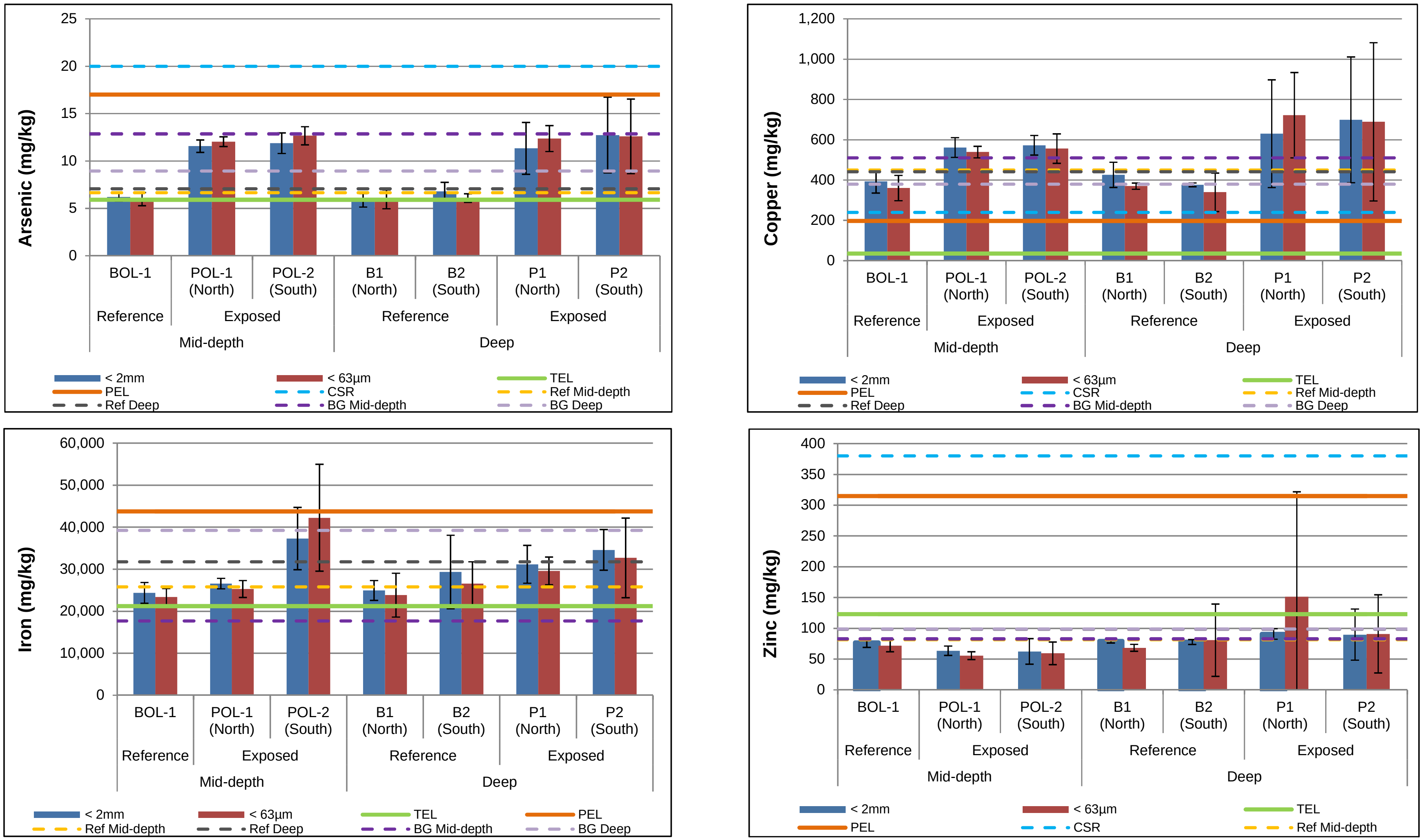


Figure 6.1: Mean metal concentrations (± t*SE) for parameters of interest in sediment from mid-depth and deep sampling areas of Polley Lake and associated reference lake (Bootjack Lake), Mount Polley Mine, 2014.

TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level; CSR = Contaminated Sites Regulation - Typical; BG = Historic 95th percentile for either mid-depth or deep areas. Ref Mid-depth and Ref Deep values were selected as the highest detectable Bootjack Lake 95th percentile value from the < 2mm and < 63 µm fractions within each sampling area (Mid-depth or Deep). Historic sediment metal concentrations are based predominantly on bulk sediment samples.

Table 6.3: Ratio of exposed mean to reference mean metal concentrations[1,2] in sediment from mid-depth and deep lake sampling areas of Polley Lake, Mount Polley Mine, 2014. Ratios with a value > 2 are highlighted.

Analyte	Mid-depth				Deep Lake			
	<2 mm fraction		<63 µm fraction		<2 mm fraction		<63 µm fraction	
	POL-1 (North)	POL-2 (South)	POL-1 (North)	POL-2 (South)	P1 (North)	P2 (South)	P1 (North)	P2 (South)
Organic / Inorganic Carbon								
Total Organic Carbon	0.2	0.05	0.1	0.03	0.6	0.5	0.5	0.4
Metals								
Aluminum	1.1	1.1	1.2	1.2	1.4	1.4	1.5	1.4
Antimony	0.05	0.05	0.05	0.05	0.7	0.6	1.1	0.7
Arsenic	1.8	1.8	1.9	2.0	1.7	1.9	2.0	2.0
Barium	1.1	1.0	1.1	1.0	0.9	1.0	1.2	1.0
Beryllium	1.1	1.1	1.1	1.1	1.0	1.2	1.3	1.2
Bismuth	1.0	1.0	0.7	0.7	0.8	0.8	0.6	0.5
Boron	0.7	0.7	0.7	0.8	1.1	1.0	1.0	0.9
Cadmium	0.3	0.3	0.2	0.3	0.8	0.6	0.7	0.6
Calcium	2.7	2.7	3.0	3.1	1.4	2.0	1.6	2.0
Chromium	0.4	0.5	0.3	0.4	0.7	0.5	0.6	0.7
Cobalt	1.4	1.4	1.4	1.6	1.7	1.8	1.7	1.8
Copper	1.4	1.5	1.5	1.5	1.5	1.6	2.0	1.9
Iron	1.1	1.5	1.1	1.8	1.1	1.2	1.0	1.1
Lead	0.2	0.2	0.2	0.2	0.6	0.6	0.7	0.5
Lithium	1.5	1.3	1.5	1.4	1.3	1.6	1.6	1.5
Magnesium	1.9	1.7	1.7	1.7	1.3	1.5	1.4	1.4
Manganese	1.0	0.8	0.9	0.9	0.5	0.5	0.5	0.5
Mercury	-	-	0.2	0.3	0.4	-	0.5	0.4
Molybdenum	0.8	1.1	0.8	1.0	2.2	1.9	1.9	1.6
Nickel	0.5	0.5	0.4	0.4	0.9	0.7	0.6	0.7
Phosphorus	1.0	1.1	1.1	1.1	0.4	0.5	0.4	0.5
Potassium	1.6	1.3	1.5	1.5	1.6	1.5	1.6	1.4
Selenium	0.5	0.6	0.4	0.5	1.2	0.9	1.3	0.9
Silver	0.1	0.1	0.1	0.1	0.9	1.0	1.0	1.0
Sodium	6.1	5.5	5.3	5.4	2.4	2.4	2.7	2.5
Strontium	2.1	1.9	2.4	2.2	1.6	1.8	2.0	1.7
Thallium	0.4	0.4	0.4	0.4	0.6	0.5	0.7	0.6
Tin	0.4	0.4	0.3	0.3	1.0	1.1	3.0	2.0
Titanium	2.8	2.7	3.1	3.1	2.1	2.7	2.2	2.2
Uranium	0.5	0.6	0.5	0.6	0.7	0.7	0.7	0.7
Vanadium	1.1	1.6	1.1	1.8	1.5	1.7	1.4	1.6
Zinc	0.8	0.8	0.8	0.8	1.1	1.1	1.8	1.1

[1] The highest mean concentration for each analyte from among Polley Lake historical data (1989 - 2012) and 2014 Bootjack Lake data for the associated sampling depth (mid-depth or deep) and sediment fraction (<63 µm or <2 mm) was used as the reference mean for calculation of the ratio.

[2] Mean values < method detection limit (MDL) were used at the MDL for calculation of exposed/reference ratios.

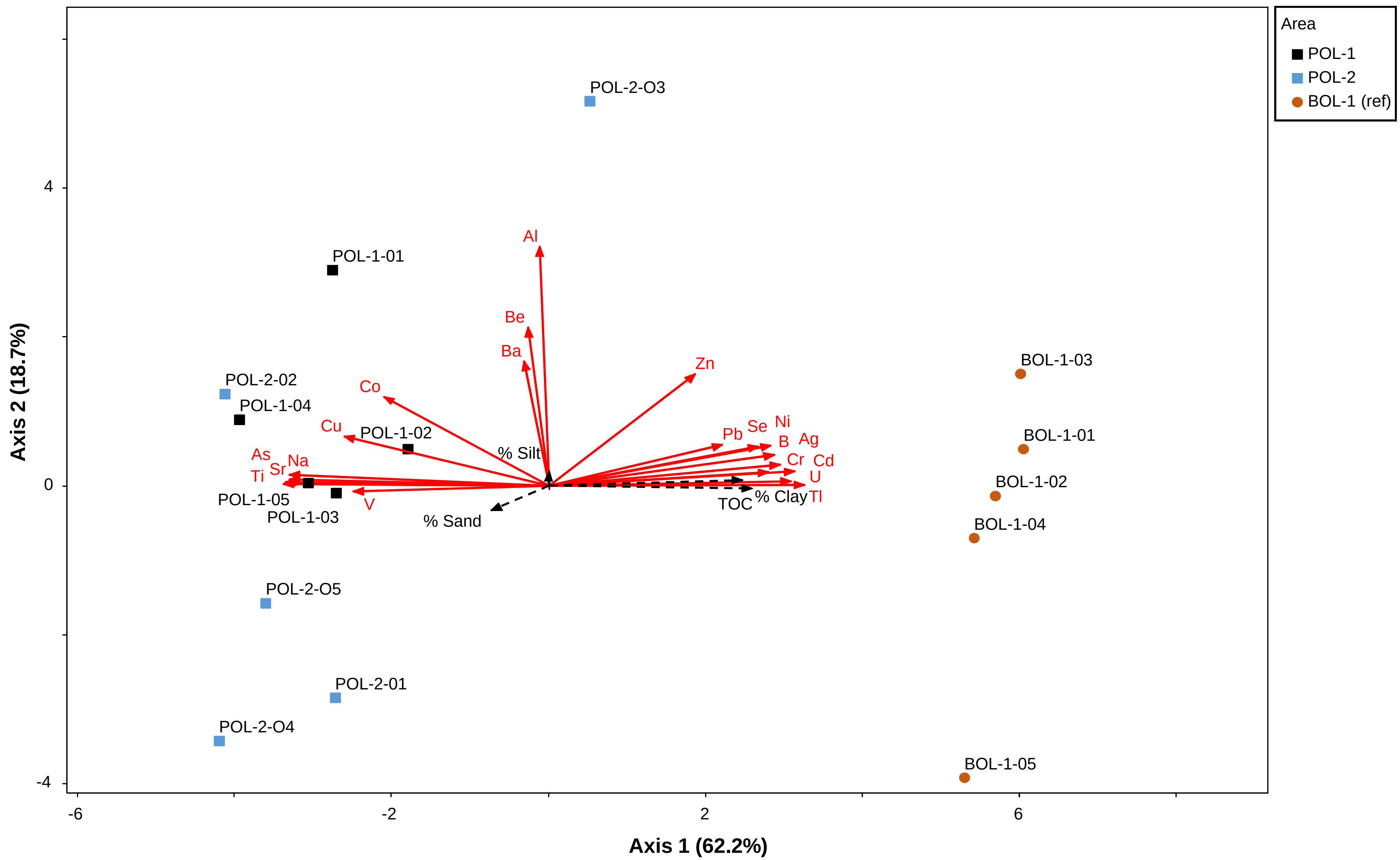


Figure 6.2: Biplot of principal component analysis (PCA) of metal concentrations in sediment (< 2mm fraction) from Polley and Bootjack Lake mid-depth sampling stations, Mount Polley Mine, 2014. Vector length is proportional to the magnitude of direct correlation of metals (solid red vector lines) and indirect correlation of sediment physical characteristics (black dashed vector lines) with PCA values of each axis (Appendix Tables E.23-E.24). Only metals with significant (p-value <0.010) Spearman's correlation and r-values > 0.7 with either axis are displayed, all sediment physical characteristics are displayed [a].

[a] Bismuth, and mercury were excluded from calculations due to a lack of variability in the data (all values for each analyte were the same), or an incomplete data set

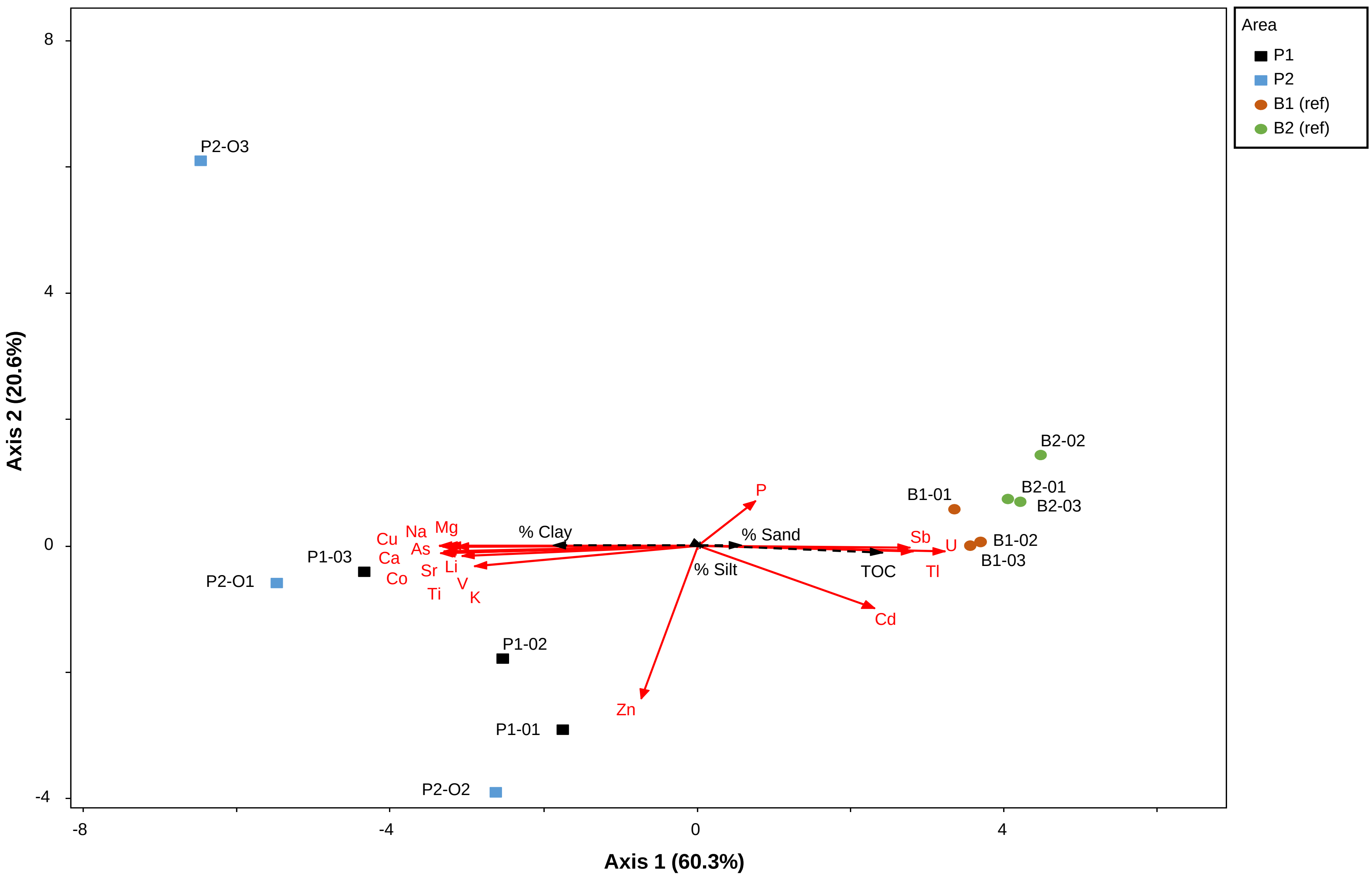


Figure 6.3: Biplot of principal component analysis (PCA) of metal concentrations in sediment (< 2mm fraction) from Polley and Bootjack Lake deep sampling stations, Mount Polley Mine, 2014. Vector length is proportional to the magnitude of direct correlation of metals (solid red vector lines) and indirect correlation of sediment physical characteristics (black dashed vector lines) with PCA values of each axis (Appendix Tables E.25-E.26). Only metals with significant (p-value <0.010) Spearman's correlation and r-values > 0.7 with either axis are displayed, all sediment physical characteristics are displayed [a].

[a] Boron, bismuth, and mercury were excluded from calculations due to a lack of variability in the data (all values for each analyte were the same), or an incomplete data set.

concentrations in the <63 µm sediment up to approximately five times reference (Table 6.3; Figure 6.4). Arsenic in all Polley Lake sediment was elevated to concentrations greater than reference and also to concentrations greater than the SQG TELs (but below SQG PELs). However, concentrations of arsenic at the mid-depth areas, but not in the basins, were lower than their pre-event concentrations (Figure 6.1). Copper concentrations were also elevated in all Polley Lake sediments to concentrations greater than reference and also to concentrations slightly greater than the SQG PELs. As with arsenic, concentrations of copper at mid-depth areas were similar to pre-event concentrations, whereas copper concentrations in the deep basins in 2014 were higher than at any other area, and also higher than pre-event concentrations (Figure 6.1). Concentrations of iron were notably elevated at one mid-depth area (POL-2; south side) to concentrations greater than reference, pre-event and approaching the SQG PEL (Figure 6.1). This elevation in iron concentration relative to other locations, particularly relative to the north side of Polley Lake (POL-1), was not observed for other POIs and IPs (Figures 6.1 and 6.4). Generally, there were few differences in POI and IP concentrations in sediment of the south and north sides of Polley Lake (Figures 6.1 and 6.4), suggesting a spatially consistent influence of the failure on sediment quality of Polley Lake.

Zinc was the only analyte with concentration correlated with percent fines (percent silt and clay), with a positive relationship largely driven by lower percent fines and zinc concentration at the Polley Lake mid-depth area 2 (south side; Table 6.4; Appendix Figure E.12). Concentrations of most POIs and IPs (arsenic, copper, iron, calcium, sodium, strontium and titanium) were negatively correlated with total organic carbon content, with lowest concentrations occurring with highest TOC in reference Bootjack Lake (Table 6.4; Appendix Figures E.13-E.14). One the one hand, this is consistent with a dam failure-influence defined by the input of inorganic sediments with elevated POI and IP concentrations to Polley Lake. On the other hand, concentrations of zinc were positively correlated with TOC, with highest concentrations of zinc occurring at the Polley Lake deep basins (Appendix Figure E.12).

6.2 Sediment Geochemical Characterization

As previously indicated, there are numerous factors that affect the bioavailability of sediment-associated metals. While metal concentrations that are below the sediment quality guidelines generally provide a reliable indicator of an absence of effect, sediment quality results that exceed those benchmarks provide a less reliable indication that effects are probable. Geochemical characterization can assist in characterizing the potential mobility and bioavailability of metals associated with mine-influenced sediments.

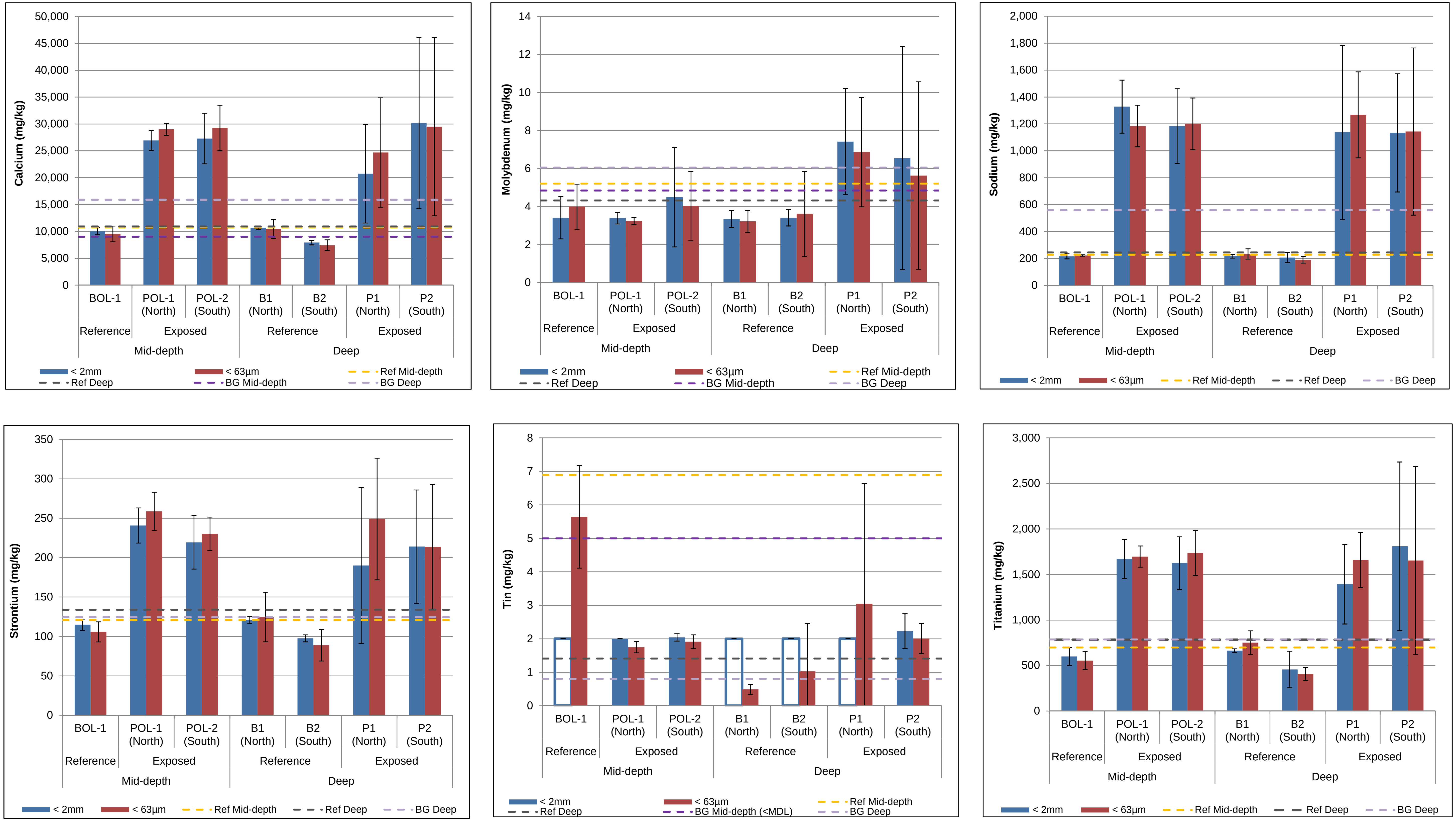


Figure 6.4: Mean metal concentrations (± t*SE) for indicator parameters in sediment from mid-depth and deep sampling areas of Polley Lake and associated reference lake (Bootjack Lake), Mount Polley, 2014. Hollow bars indicate all values used to calculate the mean were < the method detection limit (MDL).

BG = Historic 95th percentile for either mid-depth or deep areas, and are based predominantly on bulk sediment samples.
Ref Mid-depth and Ref Deep values were selected as the highest detectable Bootjack Lake 95th percentile value from the < 2mm and < 63 µm fractions within each sampling area (Mid-depth or Deep).

Table 6.4: Spearman's Rank Correlation results for concentrations of parameters of interest and indicator parameters (in < 2mm sediment fraction) relative to % fines (silt and clay) and total organic carbon in sediment from Polley and Bootjack Lake mid-depth and deep lake sampling areas, Mount Polley Mine, 2014 [1].

	Metal	Correlation Parameter	Silt and Clay (%)	Total Organic Carbon (%)
Parameters of Interest	Arsenic	Correlation Coefficient	0.040	-0.709
		Sig. (2-tailed)	0.8427	<0.0000
	Copper	Correlation Coefficient	0.085	-0.625
		Sig. (2-tailed)	0.6752	0.0005
	Iron	Correlation Coefficient	0.007	-0.513
		Sig. (2-tailed)	0.9722	0.0062
	Zinc	Correlation Coefficient	0.536	0.493
		Sig. (2-tailed)	0.0039	0.0089
Indicator Parameters	Calcium	Correlation Coefficient	-0.233	-0.757
		Sig. (2-tailed)	0.2411	<0.0000
	Molybdenum	Correlation Coefficient	0.247	-0.318
		Sig. (2-tailed)	0.2149	0.1057
	Sodium	Correlation Coefficient	-0.088	-0.713
		Sig. (2-tailed)	0.6618	<0.0000
	Strontium	Correlation Coefficient	-0.212	-0.789
		Sig. (2-tailed)	0.2886	<0.0000
	Tin	Correlation Coefficient	0.059	-0.194
		Sig. (2-tailed)	0.7698	0.3312
	Titanium	Correlation Coefficient	-0.205	-0.750
		Sig. (2-tailed)	0.3056	<0.0000

Significant corelation; p-value < 0.003 (Bonferroni corrected p-value for 20 comparisons).

Correlation scatterplot inspected; p < 0.01

[1] Values < method detection limit (MDL) were used at the MDL for calculations.

Note: n = 27 for all correlations.

As observed with Hazeltine Creek sediments, selective extractions indicated that concentrations of most POIs and IPs were primarily in the residual phase; that is, they could only be extracted by the strongest acid digest (a combination of concentrated nitric and hydrochloric acid; Table 6.5; Figure 6.5; Appendix Tables E.35-E.38; Appendix Figures E.15-E.16). As previously discussed, residual metals are unlikely to be mobilized under any conditions that could realistically occur in the environment, nor in interactions with aquatic organisms (i.e., contact with the gill or ingestion) and are therefore considered not biologically available (e.g., Tessier et al. 1979; Campbell and Tessier 1996). Exceptions included copper and molybdenum, which had greatest concentrations of in the "organic" phase (Figure 6.5; Table 6.5; Appendix Tables E.35-E.38). As previously discussed (Section 5.2), it is likely that the "organic" phase represents mineral copper. Concentrations of copper in selective extraction fractions 1 to 3 (exchangeable + carbonate bound + reducible) were greater than reference (Figure 6.5). However, separate integrated consideration of mineralogy, sequential extraction results and mineral solubility indicates that these forms would not be mobile under environmentally realistic conditions (SRK 2015). Therefore, sediment copper also appears to be present in Polley Lake sediments in forms that are not mobile and this immobility suggests limited concern for aquatic biota.

Shake flask tests indicated low mobility of metals associated with Polley Lake sediments, with copper and manganese being the only metals mobilized in shake flask tests (at mid-depth areas only) to concentrations greater than British Columbia Water Quality Guidelines (BCWQG) and reference (Table 6.6; Appendix Tables E.39-E.42). The identification of copper and manganese as more mobile than other metals is consistent with the results of the selective extractions above. In the case of copper, the highest mean concentration mobilized in the shake flask tests (0.032 mg/L at the south side of Polley Lake; Area POL-P2) was the same as reference (BOL-B2; Table 6.6). As previously stated, BCWQG do not apply to sediment leachates, but are used herein as an indication of low mobility.

Acid-Base accounting results indicated lower potential for acid generation in sediments collected from Polley Lake than in reference sediments collected from Bootjack Lake (Appendix Tables E.12 and E.43-E.44). Mean neutralization potential ratio (NPR; the ratio of neutralization potential to maximum potential acidity) was highest at the mid-depth area at the south side of Polley Lake (NPR 9.9 at POL-2, where NPR greater than 4 indicates no potential for Acid Rock Drainage; Price 1997). Decreasing NPR with distance from the point of impact on Polley Lake (south side) indicates that acid potential associated with

Table 6.5: Summary of selectively extracted (Tessier extraction) metals data for Polley Lake mid-depth and deep sampling areas and associated Bootjack Lake reference areas, Mount Polley Mine, 2014. Data are based on <2 mm fraction of sediment [1,2]. Only metals with detectable concentrations are displayed.

Analyte	Units	BC SQGs [3]		Mid-depth							Deep Lake								
				Bootjack Reference Mid-depth 95th Percentile	Reference (Bootjack Lake)		Exposed (Polley Lake)				Bootjack Reference Deep (B1 and B2) 95th Percentile	Reference (Bootjack Lake)				Exposed (Polley Lake)			
					BOL-1		POL-1 (North)		POL-2 (South)			BOL-B1 (North)		BOL-B2 (South)		POL-P1 (North)		POL-P2 (South)	
		TEL	PEL		Mean	t*SE	Mean	t*SE	Mean	t*SE		Mean	t*SE	Mean	t*SE	Mean	t*SE	Mean	t*SE
Exchangeable & Adsorbed Metals																			
Arsenic	mg/kg	5.9	17	0.065	0.059	0.0069	0.051	0.0022	0.051	0.0018	0.086	<0.050	0	0.076	0.035	0.061	0.026	0.063	0.030
Barium	mg/kg	-	-	125	108	20.3	<21	3.5	<29	7.4	138	87.6	2.96	136	8.72	24	11	<34	17
Cadmium	mg/kg	0.6	3.5	0.173	0.143	0.0327	<0.050	0	0.053	0.0083	0.197	0.158	0.00799	0.189	0.0263	0.085	0.049	0.060	0.022
Calcium	mg/kg	-	-	7,648	6,732	908	2,408	568	2,980	2,934	6,818	6,607	856	5,347	794	6,323	2,880	4,890	7,200
Cobalt	mg/kg	-	-	0.35	0.30	0.081	<0.10	0	<0.10	0	0.65	0.34	0.050	0.60	0.15	<0.10	0	<0.10	0
Copper	mg/kg	35.7	197	0.78	0.68	0.13	1.47	0.518	0.78	0.21	3.78	1.44	0.517	3.65	0.453	1.09	1.2	1.09	1.48
Iron	mg/kg	21,200	43,776	<50	<50	0	<50	0	<50	0	190	<50	0	155	114	<50	0	<50	0
Lead	mg/kg	35	91	<0.50	<0.50	0	<0.50	0	<0.50	0	0.55	<0.50	0	0.52	0.10	<0.50	0	<0.50	0
Manganese	mg/kg	460	1,100	493	359	133	91.6	22.9	72.2	37.6	1,008	405	258	887	438	114	128	99.6	181
Molybdenum	mg/kg	-	-	<0.50	<0.50	0	<2.0	0	<4.0	1	<0.50	<0.50	0	<0.50	0	2.64	1.6	<4.0	2.5
Nickel	mg/kg	16	75	<0.50	<0.50	0	<0.50	0	<0.50	0	0.89	<0.50	0	0.88	0.038	<0.50	0	<0.50	0
Potassium	mg/kg	-	-	190	176	38.9	108	13.6	116	28.6	183	133	37.9	167	51.7	137	28.7	153	37.9
Sodium	mg/kg	-	-	<100	<100	0	<100	0	132	88.8	<100	<100	0	<100	0	220	65.7	177	169
Strontium	mg/kg	-	-	72.5	63.7	9.6	22.6	3.86	26.2	22.9	63.2	61.9	4.79	54.9	9.34	46.7	8.58	42.4	44.9
Uranium	mg/kg	-	-	<0.050	<0.050	0	<0.050	0	0.053	0.0078	<0.050	<0.050	0	<0.050	0	0.050	0.0014	0.061	0.049
Vanadium	mg/kg	-	-	<0.20	<0.20	0	<0.20	0	<0.20	0	<0.20	<0.20	0	<0.20	0	0.26	0.14	0.24	0.15
Zinc	mg/kg	123	315	2.1	1.6	0.52	<1.0	0	<1.0	0	3.3	1.5	0	3.1	0.75	<1.0	0	<1.0	0
Carbonate Metals																			
Aluminum	mg/kg	-	-	<50	<50	0	<50	0	63	23	<50	<50	0	<50	0	62	52	73	68
Arsenic	mg/kg	5.9	17	0.150	0.114	0.0377	<0.050	0	0.125	0.0850	0.171	0.089	0.0076	0.147	0.0773	0.175	0.46	0.195	0.208
Barium	mg/kg	-	-	36.9	32.7	5.09	56.8	12.7	55.7	14.8	42.3	28.6	0.861	42.0	1.43	50.9	42.7	62.3	41.7
Cadmium	mg/kg	0.6	3.5	0.082	0.070	0.017	<0.050	0	0.065	0.042	0.075	0.069	0.019	0.059	0.015	0.080	0.13	0.092	0.0918
Calcium	mg/kg	-	-	898	819	132	7,816	438	8,578	3,202	806	775	132	676	62.4	4,867	4,306	10,083	12,591
Chromium	mg/kg	37.3	90	<5.0	<5.0	0	<5.0	0	<5.0	0	<5.0	<5.0	0	<5.0	0	7.8	11.9	<5.0	0
Cobalt	mg/kg	-	-	0.26	0.24	0.034	<0.10	0	0.20	0.15	0.29	0.26	0.038	0.273	0.0379	0.27	0.62	0.35	0.25
Copper	mg/kg	35.7	197	2.32	2.04	0.252	1.24	0.730	14.1	17.9	4.06	3.76	1.01	3.01	1.30	11.3	45.5	22.0	45.7
Iron	mg/kg	21,200	43,776	315	162	147	<50	0	155	143	569	123	99.2	484	297	99.3	212	151	221
Lead	mg/kg	35	91	0.71	0.60	0.11	<0.50	0	0.72	0.32	0.74	<0.50	0	0.66	0.28	1.00	2.17	0.82	0.46
Manganese	mg/kg	460	1,100	141	130	16.0	74.8	9.43	101	45.1	185	160	44.8	157	108	103	99.0	123	71.1
Molybdenum	mg/kg	-	-	<0.50	<0.50	0	<0.50	0	<0.50	0	<0.50	<0.50	0	<0.50	0	0.56	0.27	<0.50	0
Nickel	mg/kg	16	75	<2.0	<2.0	0	<2.0	0	<2.0	0	<2.0	<2.0	0	<2.0	0	2.8	3.4	<2.0	0
Phosphorus	mg/kg	-	-	<50	<50	0	<50	0	<50	0	53	<50	0	51	5.7	<50	0	<50	0
Strontium	mg/kg	-	-	9.8	9.0	1.3	85.2	24.4	73.4	19.1	8.9	8.7	0.80	8.5	0.66	58.4	64.1	63.9	54.1
Uranium	mg/kg	-	-	0.562	0.507	0.0643	0.075	0.021	0.115	0.133	0.569	0.484	0.0298	0.553	0.0611	0.226	0.375	0.204	0.339
Vanadium	mg/kg	-	-	0.97	0.54	0.39	0.21	0.027	0.63	0.67	1.16	0.43	0.15	1.02	0.510	1.43	4.0	1.11	1.63
Zinc	mg/kg	123	315	3.9	3.4	0.62	<1.0	0	1.7	1.7	3.7	3.5	0.72	3.4	0.52	2.4	6.2	2.6	3.4
Easily Reducible Metals and Iron Oxides																			
Aluminum	mg/kg	-	-	1,114	990	183	2,130	394	1,880	411	1,018	760	21.7	901	388	1,547	1,243	1,703	1,301
Arsenic	mg/kg	5.9	17	1.01	0.918	0.0893	1.28	0.23	1.47	0.323	1.48	0.881	0.225	1.40	0.273	1.79	0.565	1.71	0.75
Barium	mg/kg	-	-	48.3	42.7	8.29	27.6	3.95	27.5	7.49	65.0	37.3	2.98	61.3	14.3	40.7	11.5	30.0	22.5
Beryllium	mg/kg	-	-	0.34	0.30	0.058	0.22	0.016	0.22	0.048	0.35	0.28	0.063	0.33	0.087	0.29	0.080	0.27	0.15
Cadmium	mg/kg	0.6	3.5	0.199	0.168	0.0465	0.054	0.0070	0.063	0.037	0.157	0.145	0.0396	0.141	0.0263	0.168	0.216	0.098	0.13
Calcium	mg/kg	-	-	727	660	90.5	3,148	1,051	2,128	749	664	641	83.6	528	14.6	2,237	2,057	2,033	733
Chromium	mg/kg	37.3	90	2.37	2.16	0.273	2.66	0.185	2.29	0.766	2.57	2.00	0.0994	2.53	0.103	3.22	1.35	2.38	1.61
Cobalt	mg/kg	-	-	1.43	1.23	0.195	1.55	0.159	1.36	0.399	1.34	1.31	0.0896	1.21	0.0657	2.11	0.461	1.73	0.966
Copper	mg/kg	35.7	197	7.50	5.94	1.47	14.1	2.44	17.7	10.1	7.13	7.05	0.283	5.73	0.0941	8.09	5.6	35.1	117
Iron	mg/kg	21,200	43,776	5,480	4,874	691	2,900	239	2,714	1,132	9,138	5,373	1,179	8,350	2,782	4,090	1,056	3,397	2,347
Lead	mg/kg	35	91	2.91	2.32	0.863	2.33	0.231	1.79	0.51	3.12	1.83	0.23	2.84	0.916	2.99	1.10	1.88	1.21
Manganese	mg/kg	460	1,100	193	152	43.4	131	13.2	89	36	222	176	95.2	182	165	174	101	94.5	79.7
Nickel	mg/kg	16	75	3.59	3.23	0.442	2.05	0.342	1.95	1.32	3.42	3.32	0.337	3.18	0.137	4.39	1.20	2.97	4.17
Phosphorus	mg/kg	-	-	100	81	22	97	13	103	39	311	106	38.0	263	200	78	35	101	128
Strontium	mg/kg	-	-	8.44	7.86	0.766	40.8	1.74	37.6	10.7	8.02	7.89	0.411	7.23	0.474	27.3	15.4	32.3	32.6
Titanium	mg/kg	-	-	<1.0	<1.0	0	1.1	0.16	1.1	0.068	<1.0	<1.0	0	<1.0	0	1.0	0.14	1.1	0.14
Uranium	mg/kg	-	-	0.523	0.460	0.107	0.150	0.0121	0.153	0.0846	0.578	0.528	0.0584	0.572	0.0186	0.307	0.231	0.214	0.238
Vanadium	mg/kg	-	-	13.3	11.2	2.13	8.42	0.891	10.1	8.23	18.4	10.8	0.379	18.3	0.517	20.9	5.97	15.3	16.5
Zinc	mg/kg	123	315	17.2	15.4	2.36	8.7	0.79	8.0	4.3	16.8	16.3	2.11	15.8	0.517	16.8	7.35	11.5	11.0
Organic Bound Metals																			
Aluminum	mg/kg	-	-	5,098	4,384	839	1,272	207	1,730	1,712	4,613	4,307	324	4,497	432	3,983	1,723	3,100	5,007
Arsenic	mg/kg	5.9	17	2.44	2.21	0.252	0.428	0.0876	0.569	0.596	2.12	1.87	0.162	1.91	0.635	1.40	1.3	1.05	2.18
Barium	mg/kg	-	-	18.7	15.3	3.53	17.5	3.53	14.2	6.30	15.7	10.4	0.872	15.1	2.23	9.1	4.3	11.1	12.5
Cadmium	mg/kg	0.6	3.5	0.099	0.077	0.025	<0.050	0	<0.050	0	0.061	0.054	0.011	0.056	0.0100	0.054	0.019	<0.050	0
Calcium	mg/kg	-	-	768	651	162	909	151	945	334	839	773	227	320	138	1,493	202	1,275	1,492
Chromium	mg/kg	37.3	90	18.2	16.3	2.19	1.57	1.04	3.26	5.92	17.8	17.3	1.94	14.5	2.66	11.9	10.9	7.85	21.9
Cobalt	mg/kg	-	-	5.80	5.20	0.735	1.66	0.256	2.27	1.60	5.57	5.42	0.598	5.12	0.727	4.40	2.4	3.69	4.83
Copper	mg/kg	35.7	197	386	326	61.2	**499**	22.3	**492**	45.4	361	347	46.1	298	48.4	**522**	302	**557**	358
Iron	mg/kg	21,200	43,776	5,424	4,296	1,074	432	93.2	1,293	2,453	4,905	4,790	375	3,927	432	4,860	6,094	3,222	8,670
Lead	mg/kg	35	91	1.85	1.44	0.619	0.91	0.075	0.72	0.22	1.10	0.60	0.057	0.94	0.51	1.21	0.309	0.88	0.84
Manganese	mg/kg	460	1,100	62.4	54.2	9.57	15.5	3.52	19.9	21.6	63.1	60.5	8.34	51.8	19.1	54.1	38.1	39.2	64.8
Molybdenum	mg/kg	-	-	4.25	3.52	0.672	1.36	0.71	1.63	1.28	3.80	3.55	0.311	3.36	1.22	2.82	1.25	2.19	2.65
Nickel	mg/kg	16	75	13.6	12.1	1.75	1.20	0.46	2.33	3.70	13.2	12.9	1.43	10.5	1.56	7.88	6.96	5.37	14.4
Selenium	mg/kg	2	-	3.08	2.75	0.372	1.16	0.28	1.41	1.08	3.16	3.07	0.311	2.69	0.0497	**3.35**	1.57	2.29	3.59
Strontium	mg/kg	-	-	6.79	6.27	0.769	15.2	5.08	13.1	2.17	7.18	6.88	0.973	5.07	0.662	14.2	1.55	13.0	8.83
Titanium	mg/kg	-	-	232	178	118	11.0	24.8	2.6	2.5	48	13.6	13.2	32.9	49.4	5.2	3.5	4.2	10
Uranium	mg/kg	-	-	1.33	1.04	0.271	0.135	0.0278	0.213	0.223	1.10	1.07	0.151	0.777	0.246	0.565	0.573	0.449	0.992
Vanadium	mg/kg	-	-	29.6	25.8	3.89	2.26	1.91	5.31	11.2	26.6	24.0	3.07	25.2	5.02	21.9	29.1	14.3	42.8
Zinc	mg/kg	123	315	23.1	20.0	2.87	4.6	0.50	6.9	6.5	22.7	22.4	0.941	18.3	3.10	15.3	12.5	12.4	22.0
Residual Metals																			
Aluminum	mg/kg	-	-	15,280	14,680	1,066	20,500	1,731	18,600	2,318	15,900	14,767	517	15,367	1,745	21,333	5,512	22,733	9,895
Antimony	mg/kg	-	-	0.74	0.69	0.061	0.41	0.066	0.40	0.077	0.88	0.67	0.075	0.85	0.080	0.58	0.052	0.50	0.25
Arsenic	mg/kg	5.9	17	4.17	3.80	0.349	**9.93**	0.600	**10.0**	1.07	4.67	4.18	0.162	4.48	0.672	**8.33**	2.56	**10.4**	5.54
Barium	mg/kg	-	-	68.9	60.0	11.1	165	17.7	130	19.0	79.5	63.1	2.37	75	16.1	136	67.6	133	64.7
Beryllium	mg/kg	-	-	0.20	0.2	0	0.54	0.059	0.51	0.093	<0.20	<0.20	0	<0.20	0	0.41	0.21	0.55	0.34
Calcium	mg/kg	-	-	3,738	2,450	1,214	13,320	1,948	12,716	4,291	2,725	2,710	49.7	1,723	180	7,127	3,371	10,920	11,727
Chromium	mg/kg	37.3	90	22.6	21.7	1.64	11.8	2.20	12.6	6.00	22.1	20.7	1.03	21.6	1.74	21.3	5.23	17.3	21.6
Cobalt	mg/kg	-	-	5.15	4.79	0.396	13.6	1.66	13.4	0.49	5.0	4.82	0.176	4.91	0.275	12.9	5.96	16.4	10.7
Copper	mg/kg	35.7	197	79.6	73.8	6.45	**105**	17.0	**96**	17.2	83.3	81.7	6.25	75.4	7.21	**114**	60.5	**125**	91.2
Iron	mg/kg	21,200	43,776	15,360	14,860	773	**23,580**	2,163	**33,700**	10,857	15,825	14,100	657	15,267	1,865	21,200	3,727	**27,567**	14,874
Lead	mg/kg	35	91	6.70	5.90	1.51	3.48	0.405	3.05	0.855	6.67	4.64	0.584	6.34	1.08	5.07	1.62	3.61	2.65
Lithium	mg/kg	-	-	10.8	10.1	1.0	17.8	2.60	16.1	2.39	9.3	9.0	0.66	8.9	0.38	18.2	6.29	22.2	12.5
Manganese	mg/kg	460	1,100	195	168	29.0	**514**	63.7	**462**	7.78	182	180	7.45	151	5.17	422	193	**550**	378
Molybdenum	mg/kg	-	-	0.84	0.58	0.23	1.44	0.75	1.94	0.27	0.73	0.68	0.14	0.67	0.15	1.79	0.507	2.19	0.837
Nickel	mg/kg	16	75	14	13	2.0	10.1	1.71	10.0	4.2	14	11.4	0.379	13.5	0.994	16.0	0.287	14.5	12.1
Silver	mg/kg	0.5	-	0.45	0.38	0.11	0.25	0.018	0.29	0.057	0.38	0.36	0.043	0.37	0.038	0.37	0.043	0.36	0.16
Strontium	mg/kg	-	-	57.7	37.5	19.5	86.3	20.0	78.5	18.7	42.9	42.0	3.52	24.5	0.717	53.8	22.1	71.5	43.1
Thallium	mg/kg	-	-	0.071	0.065	0.0072	<0.050	0	<0.050	0	0.062	0.057	0.0043	0.061	0.0052	0.060	0.0076	0.055	0.020
Tin	mg/kg	-	-	<2.0	<2.0	0	2.0	0.056	<2.0	0	<2.0	<2.0	0	<2.0	0	4.8	12	2.1	0.43
Titanium	mg/kg	-	-	785	698	119	1,916	246	1,668	45.1	880	875	17.4	663	88.1	1,637	482	2,010	968
Uranium	mg/kg	-	-	0.480	0.415	0.0589	0.893	0.0606	0.775	0.168	0.404	0.370	0.0431	0.371	0.118	0.596	0.255	0.754	0.436
Vanadium	mg/kg	-	-	38.1	33.7	4.19	92.3	10.2	129	49.6	36.6	36.2	1.51	32.0	0.941	66.3	26.7	101	87.0
Zinc	mg/kg	123	315	37.0	35.1	2.98	50.7	6.57	47.2	6.34	37.3	35.4	0.717	36.7	1.97	54.0	15.7	59.7	30.3

(blue) Value is > TEL. Values shown in bold text also exceed associated Bootjack Lake Mid-depth or Deep Reference 95th Percentile values.
(orange) Value is > PEL. Values shown in bold text also exceed associated Bootjack Lake Mid-depth or Deep Reference 95th Percentile values.

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
[2] Samples were collected using a sediment corer or petite ponar.
[3] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[4] Contaminated Sites Regulation (Government of British Columbia 1996)

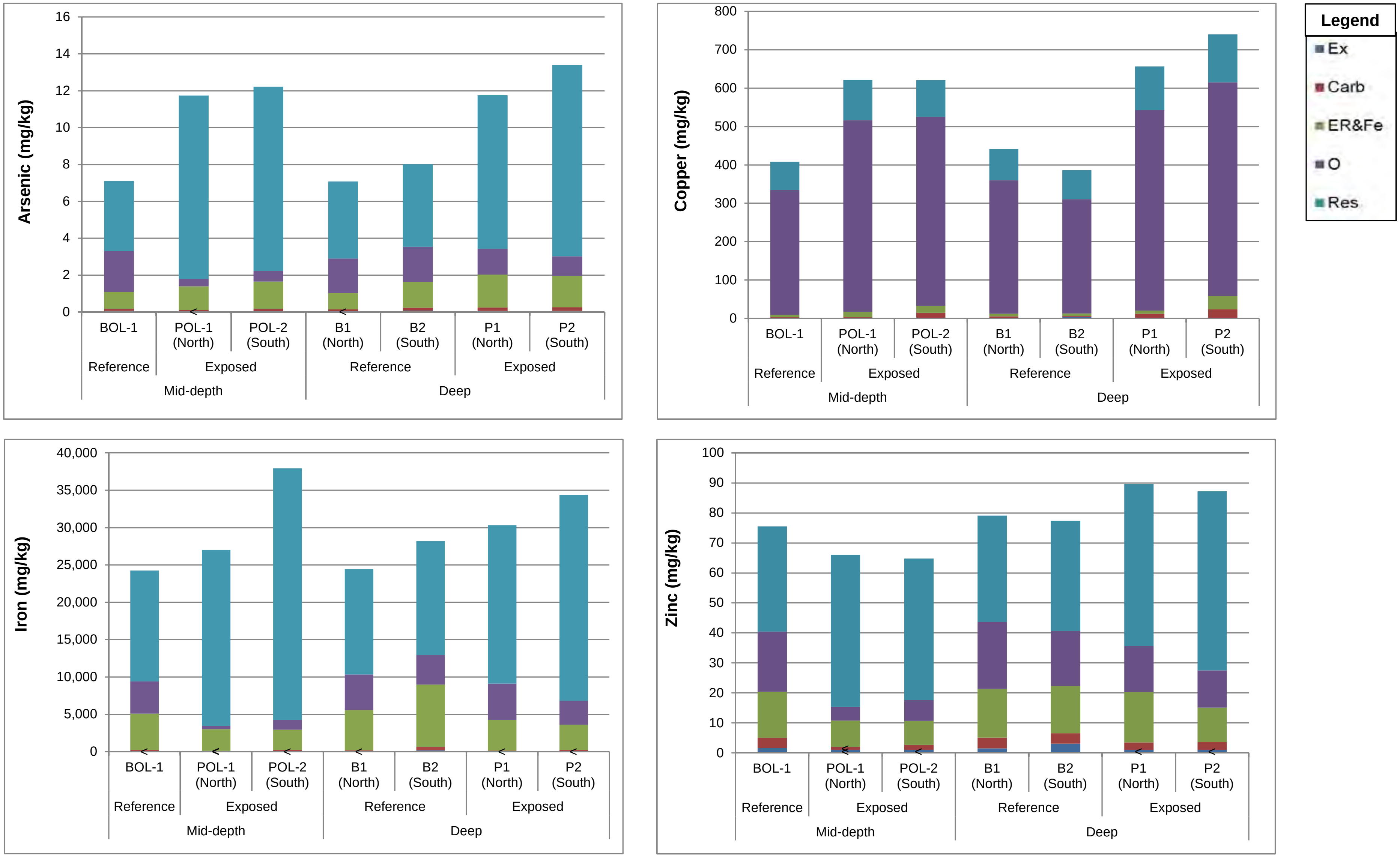


Figure 6.5: Mean concentrations of selectively extracted parameters of interest in sediment from mid-depth and deep sampling areas of Polley Lake, Mount Polley, 2014. Selective extractions included Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe), Organic Bound Metals (O), and Residual Metals (Res).

Mean values < MDL are indicated with a < symbol. Means are reported as < MDL if all data used in their calculation were < MDL.

Table 6.6: Summary of leachable (Shakeflask) metals data for sediment from Polley Lake mid-depth and deep sampling areas and associated Bootjack Lake reference areas, Mount Polley Mine, 2014. Data are based on bulk sediment [1,2]. Only metals with detectable concentrations are displayed.

Sample ID	Units	BCWQG [3]			HWR [4]	Mid-depth							Deep Lake								
						Bootjack Reference Mid-depth 95th Percentile	Reference (Bootjack Lake)		Exposed (Polley Lake)				Bootjack Reference Deep (B1 and B2) 95th Percentile	Reference (Bootjack Lake)				Exposed (Polley Lake)			
							BOL-1		POL-1 (North)		POL-2 (South)			BOL-B1 (North)		BOL-B2 (South)		POL-P1 (North)		POL-P2 (South)	
		Type	Chronic	Acute			Mean	t*SE	Mean	t*SE	Mean	t*SE		Mean	t*SE	Mean	t*SE	Mean	t*SE	Mean	t*SE
Aluminum	mg/L	-	-	-	-	2.36	1.49	0.839	<0.20	0	0.27	0.18	2.78	0.63	0.29	2.02	3.2	<0.20	0	0.67	0.50
Barium	mg/L	W	1.0	-	100	0.154	0.127	0.026	0.075	0.023	0.050	0.014	0.163	0.132	0.016	0.12	0.17	0.078	0.048	0.098	0.051
Calcium	mg/L	-	-	-	-	27.7	24.6	4.23	114	51.6	55	30.6	36.1	33.4	8.61	17.1	3.73	146	12.5	108	5.17
Copper	mg/L	A	0.0055	0.015	100	0.019	0.015	0.0048	0.011	0.0022	**0.021**	0.027	0.049	<0.010	0	0.032	0.058	0.011	0.0025	0.032	0.026
Iron	mg/L	A	-	1.0	-	0.571	0.374	0.194	0.096	0.10	0.126	0.25	1.07	0.130	0.0398	0.73	1.4	0.031	0.0043	0.133	0.102
Magnesium	mg/L	-	-	-	-	3.99	3.59	0.55	13.3	4.48	6.77	3.68	5.83	5.02	2.70	2.53	0.647	18.7	10.9	14.9	1.27
Manganese	mg/L	A	1.21	2.05	-	0.625	0.251	0.34	**2.88**	1.93	0.763	1.79	2.08	0.292	0.387	1.37	2.9	0.490	1.89	1.06	3.60
Molybdenum	mg/L	A	1	2	-	<0.030	<0.030	0.000	0.056	0.023	0.059	0.039	0.056	<0.030	0	0.041	0.049	0.080	0.11	0.180	0.0399
Phosphorus	mg/L	A	-	0.0050-0.015	-	0.31	0.30	0.0056	<0.30	0	<0.30	0	0.46	<0.30	0	0.40	0.22	<0.30	0	0.36	0.14
Potassium	mg/L	-	-	-	-	<2.0	<2.0	0	5.6	0.78	4.1	1.2	3.4	2.2	0.38	2.6	2.3	4.4	3.4	6.0	3.5
Silicon	mg/L	-	-	-	-	42.7	31.1	12.0	10.6	2.24	8.35	2.66	52.2	20.8	2.66	37.1	64.1	11.5	3.79	17.7	4.96
Sodium	mg/L	-	-	-	-	3.8	3.6	0.22	13.8	1.60	11.0	4.0	10.8	3.5	0.57	6.6	14	21.5	1.94	26.8	11.3
Strontium	mg/L	-	-	-	-	0.276	0.254	0.0328	0.897	0.362	0.462	0.215	0.352	0.324	0.090	0.189	0.066	1.01	0.086	0.853	0.192
Titanium	mg/L	-	-	-	-	0.028	0.020	0.0081	0.014	0.0038	0.010	0.00068	0.030	<0.010	0	0.023	0.028	0.017	0.0038	0.019	0.0066
Vanadium	mg/L	-	-	-	-	<0.030	<0.030	0	<0.030	0	<0.030	0	<0.030	<0.030	0	<0.030	0	<0.030	0	0.031	0.0043

[shaded] Value is > one or all guidelines. Values shown in bold text also exceed associated Bootjack Lake Mid-depth or Deep Reference 95th Percentile values.

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] Samples were collected using a sediment corer or petite ponar.

[3] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.

[4] Hazardous Waste Regulation (Government of British Columbia 1988)

the impacted sediments was lower than reference and far-field sediments (i.e., the mine-influenced materials had higher neutralization potential than native sediment).

6.3 Sediment Stratigraphy

Sediment cores for characterization of vertical stratigraphy (examination of physical and chemical changes with depth below surface) were collected from two locations in Polley Lake - the basins P1 and P2 (Figure 4.3). Two cores were collected from each location; one for sediment chemistry profiling and one for pore-water chemistry profiling.

6.3.1 Sediment Core Observations

North Basin (P1)

A comparison of the two sediment cores from the North Basin, collected at the same time and location, documented the spatially heterogeneous nature of the observable deposition of mine-derived material in Polley Lake; cores collected side-by-side differed in appearance (Appendix Figure E.17). The core collected for sediment chemistry analysis showed little observable intrusion of grey-coloured material whereas the core collected for pore-water chemical analysis showed intrusion of grey-coloured material throughout the generally brown sediment. Although smearing of sediment and tailings material would confound any conclusions derived from external core observations, it was evident that the two cores differed. Therefore, pore-water and sediment chemistry profiles cannot be considered synchronous. The heterogeneous deposition of tailings in Polley Lake was also noted in the general sediment quality characterization (Section 6.1). In the top 1 cm of the sediment chemistry core, a very fine layer of grey material was deposited over black sediment and the amount of grey material present in each section decreased with depth. By 3 cm in depth, the core was over 95% black in colour, and the black sediment dominated to the bottom of the 23 cm long core. Observations made during the sectioning of the core collected for pore-water chemical analysis indicated that some grey material was noted in the top 0 to 7 cm, but in general the sediment was brown, getting gradually darker down-core. The sediment material became clay-like in consistency at around 16 cm depth.

South Basin (P2)

A comparison of the two sediment cores from the south basin (Appendix Figure E.18), further confirmed the heterogeneous nature of the sediment and observable deposition of mine-derived material in Polley Lake. As a result, the cores collected for sediment chemistry and pore water could not be considered synchronous. The core collected for sediment chemistry analysis showed intrusion of grey-coloured material in the majority of the length of the core. In contrast, the core collected for pore-water chemical analysis showed little intrusion of grey-coloured material throughout the generally brown sediment. Sectioning of the cores showed that the majority of grey material was located in the 6 to 10 cm sections. The top 1 cm of the core had a thin layer of fine grey material deposited over brown sediment; but by 2 cm depth the sediment was mostly brown in colour. Grey sediment started to become observable by 5 cm with approximately 50% tailings in the 6 to 10 cm sections. The amount of grey material present in each section decreased to nil by 13 cm. Observations indicated that the material was not mixed with natural sediment and indicated the depth at which tailings intruded into natural sediment (i.e., to 13 cm; Appendix Figure E.19). This apparent intrusion of grey material into native sediment (as opposed to settling on top of native sediment) may help to explain why sediment in Polley Lake was so different among cores collected from the same location at the same time.

Observations made during the sectioning of the core collected for pore-water chemical analysis indicated that some grey material was present in the top 3 cm. The remainder of the core was brown in colour and grey material was not observed. Additionally, sediment was likely reducing as a sulphurous odour was detected when the glove bag (used to keep the sediment core samples in an inert atmosphere) was periodically opened.

6.3.2 Sediment Chemistry Profiles

North Basin (P1)

The chemistry of the top 12 cm of sediment (in 1 cm sections) collected at P1 was screened against BC SQGs and against sediment quality data collected from the same station prior to the tailings dam failure. Concentrations of copper and manganese were both greater than PEL throughout the whole core (Figure 6.6). However, concentrations of manganese did not exceed the pre-dam failure sediment concentration collected from the same station in 2012 (1,630 mg/kg; Table 3.5). For copper, only the top 0 to 2 cm of sediment exceeded the pre-dam failure concentration of 369 mg/kg (Table 3.5). Other elements (arsenic, iron, and nickel) were above the TEL, but below the PEL. The top 2 cm of sediment iron and arsenic concentrations in 2012 prior to the dam failure were 35,100 mg/kg, and 8.86 mg/kg respectively (Table 3.5), and current (2014) sediment core concentrations of iron, arsenic and nickel concentrations were similar.

In general, the sediment chemistry profiles of the core agreed with the observations from sectioning the core. Only copper showed elevated concentrations in the top sections (compared to lower sections) of the core, and was also elevated above the 2012 copper

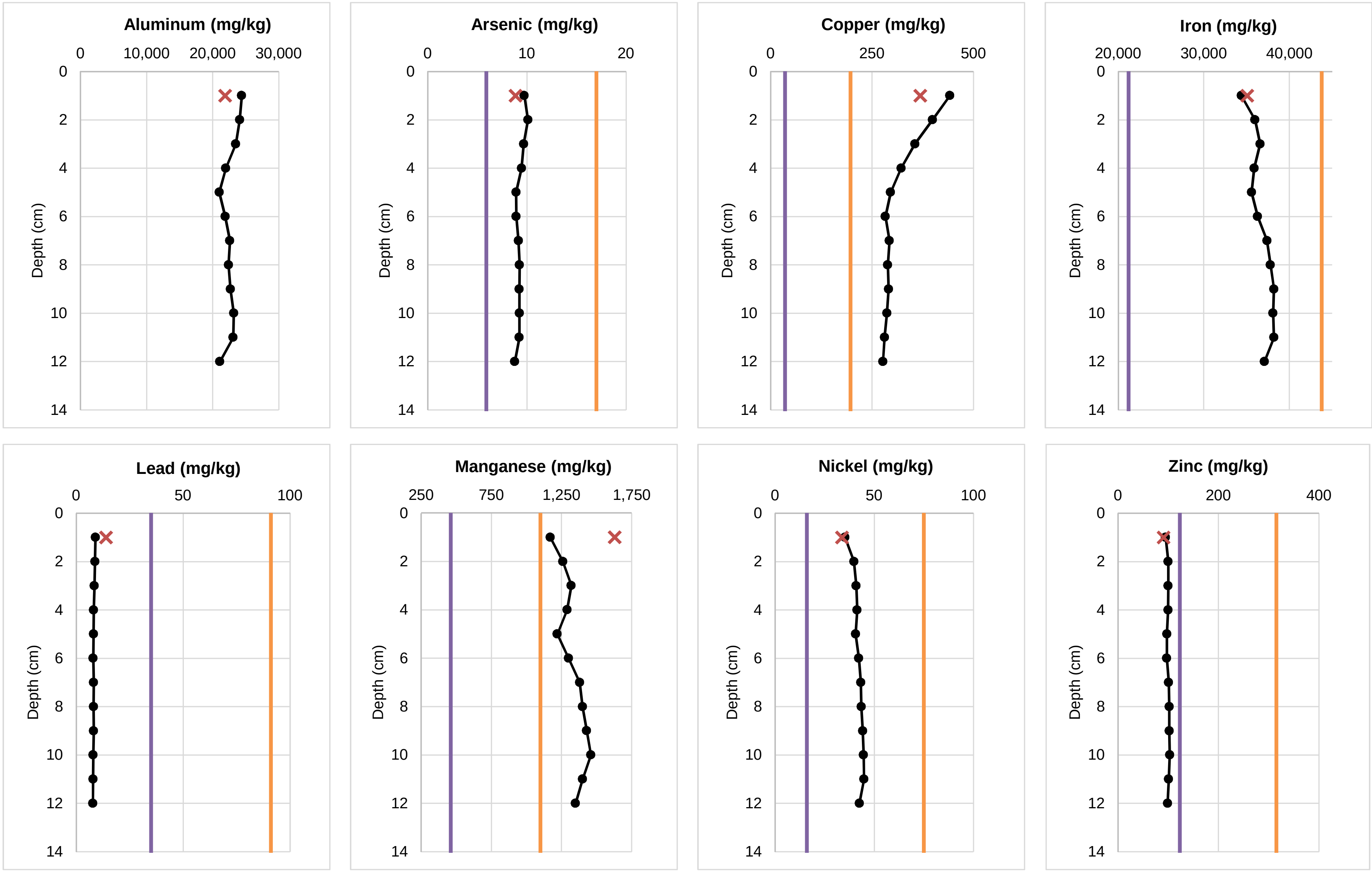


Figure 6.6: Sediment chemistry profiles of aluminum, arsenic, copper, iron, lead, manganese, nickel and zinc from the northern station (POL-P1-PW) of Polley Lake in September 2014 (black dots) and May 2012 (red X; Minnow 2014). Threshold Effect Level (TEL) is displayed in purple, while the Probable Effect Level (PEL) is in orange.

concentration in the 0 to 2 cm sections. The depth profile of copper may reflect a general accumulation of copper, associated with the ore body and/or mining activity over time, rather than an influence of the tailings dam failure.

Sediments were likely under reducing conditions given the low dissolved oxygen concentrations observed in the water column at depths greater than 7 m (Golder 2015). Any decrease in concentrations of arsenic, iron, manganese and nickel in the top section relative to the lower sections could be due to post-depositional reductive dissolution of iron and manganese, and elements associated with them (i.e., arsenic and nickel). This may be a dominant process compared to any elevated sediment concentrations associated with the thin layer of grey tailings material that was observed to have deposited over the sediment. Elevated sediment concentrations relative to the sediment quality guidelines (arsenic, copper, iron, manganese and nickel) in this specific core may be due to naturally elevated concentrations and/or some past influence of local geology or mine activity and subsequent sequestration in sediment. In general, this sediment chemistry profile is not reflective of any strong influence of recently deposited material.

South Basin (P2)

Copper concentration throughout the core collected at the Polley Lake south basin (P2) was greater than the PEL and was also greater than the 2012 concentration of 253 mg/kg collected from the same location (Figure 6.7; Table 3.5). Arsenic, iron, nickel, and manganese concentrations were all elevated above the TEL; however all were also at or below the 2012 sediment concentration collected from the same location (Table 3.5), although arsenic at a depth of 6 to 10 cm was elevated to a concentration greater than in 2012 (see below). The elevation of copper throughout the core to concentrations greater than in 2012, indicates an influence of the dam failure at this location.

Sediment core observations identified the greatest influence on sediment quality in sediment sections at a depth of 6 to 10 cm below surface. This was generally corroborated by the sediment concentration profiles of aluminum, arsenic, copper and iron (Figure 6.7), two of which are POIs (copper and iron; Section 6.1). Although manganese concentrations in 2014 were generally lower than in 2012, the manganese concentration profile also reflected a failure-related influence at 6 to 10 cm.

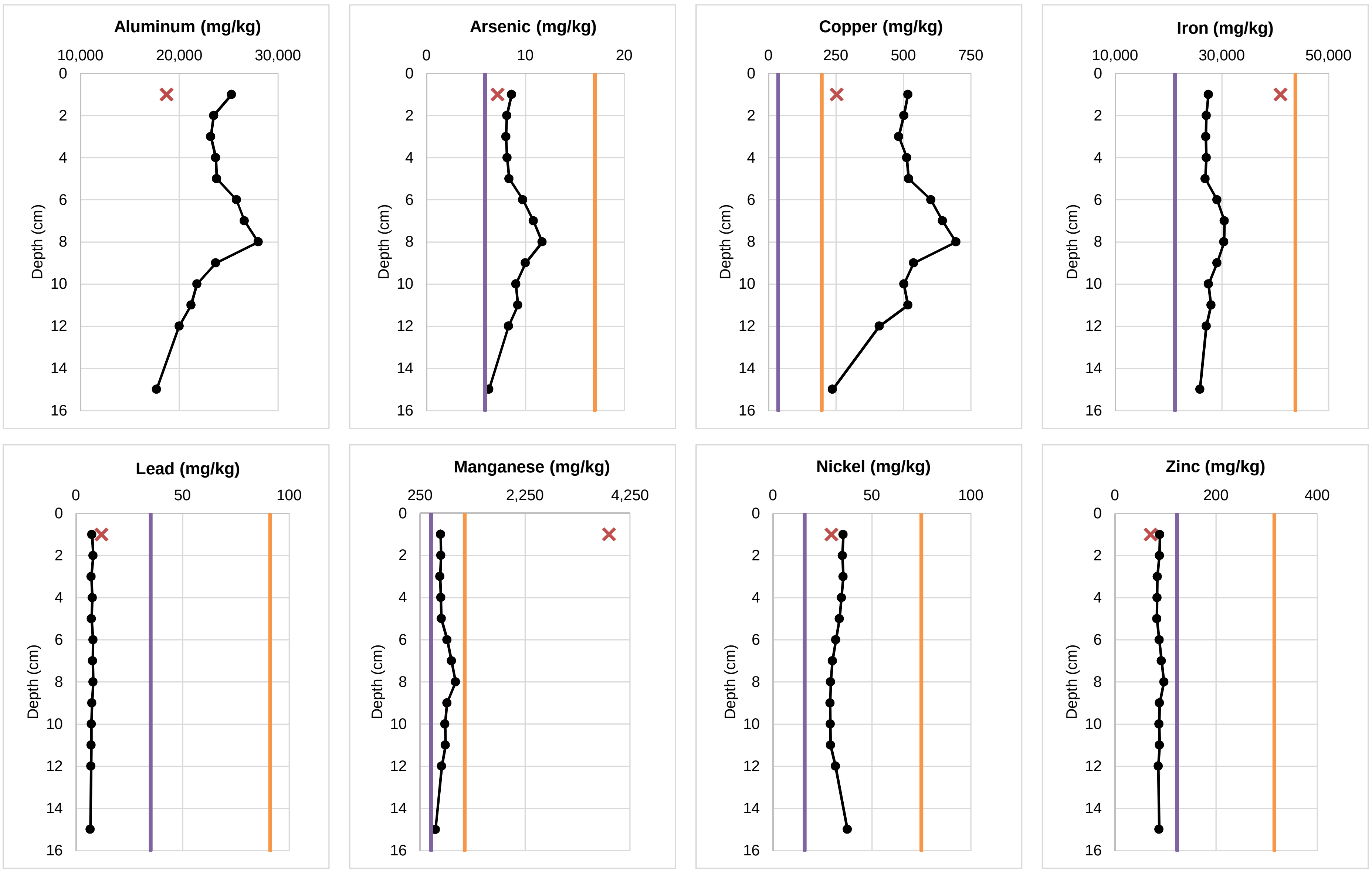


Figure 6.7: Sediment chemistry profiles of aluminum, arsenic, copper, iron, lead, manganese, nickel and zinc from the southern station (POL-P2-PW) of Polley Lake in September 2014 (black dots) and May 2012 (red X; Minnow 2014). Threshold Effect Level (TEL) is displayed in purple, while the Probable Effect Level (PEL) is in orange.

6.3.3 Sediment Pore-Water Profiles

North Basin (P1)

Observations made while sectioning the core from P1 for pore-water profiling indicated the presence of grey material mostly in the top 7 cm. Pore-water concentrations of arsenic, copper, lead and sulphate were elevated in the top 11 cm (Figure 6.8). Pore-water iron concentrations showed depletion around 2 to 10 cm, which was likely associated with changing redox conditions as the tailings material and natural sediments interacted. There is some evidence to indicate that the overlying water and natural sediments were under reducing conditions (Golder 2015) while the tailings materials were oxidized. This would result in increased soluble concentrations of iron at the interface of natural sediment and mine-derived material, and in close proximity to the sediment-water interface where reducing conditions occurred. Manganese (which undergoes reduction at a similar cell potential to iron) showed no such depletion in concentration, which may reflect the moderate concentration of manganese in the tailings.

The low concentrations of nitrite and sulphide in the top 11 cm suggest that conditions were oxidizing. The subsequent increase in both nitrite and nitrate concentration at 12 cm suggest that the naturally deposited sediment may be a greater source of nitrate compared to the tailings. The presence of increased nitrite at 12 cm suggests sub-oxic conditions. The depletion of nitrate deeper into the sediment core suggests that sediments become more reducing with depth. Limited extractable pore-water from sediment resulted in low sample volumes for sulphide analysis and subsequent poor detection limits for sulphide, compared to Polley Lake station P2 sediment pore-water samples.

It is likely that because Polley Lake is dimictic (mixes completely twice per year), although tailings were oxidized at the time of sampling, over time the deposited materials may become reducing as, during summer and winter, both the water column above, and the sediments below the deposited tailings will be reducing. Therefore, the reductive dissolution of iron-containing materials is possible and may result in the remobilization of other metals associated with it – the most likely candidate for this would be arsenic. However, the iron-containing tailings (i.e., magnetite sands; SRK 2015) may not have been deposited in Polley Lake to a large spatial extent (SRK 2015), and iron concentrations do not appear to have been elevated compared to those observed in 2012 (Table 3.5). Furthermore, separate evaluation of potential post-depositional mobility indicated very low risk of metal mobilization under reducing conditions (SRK 2015).

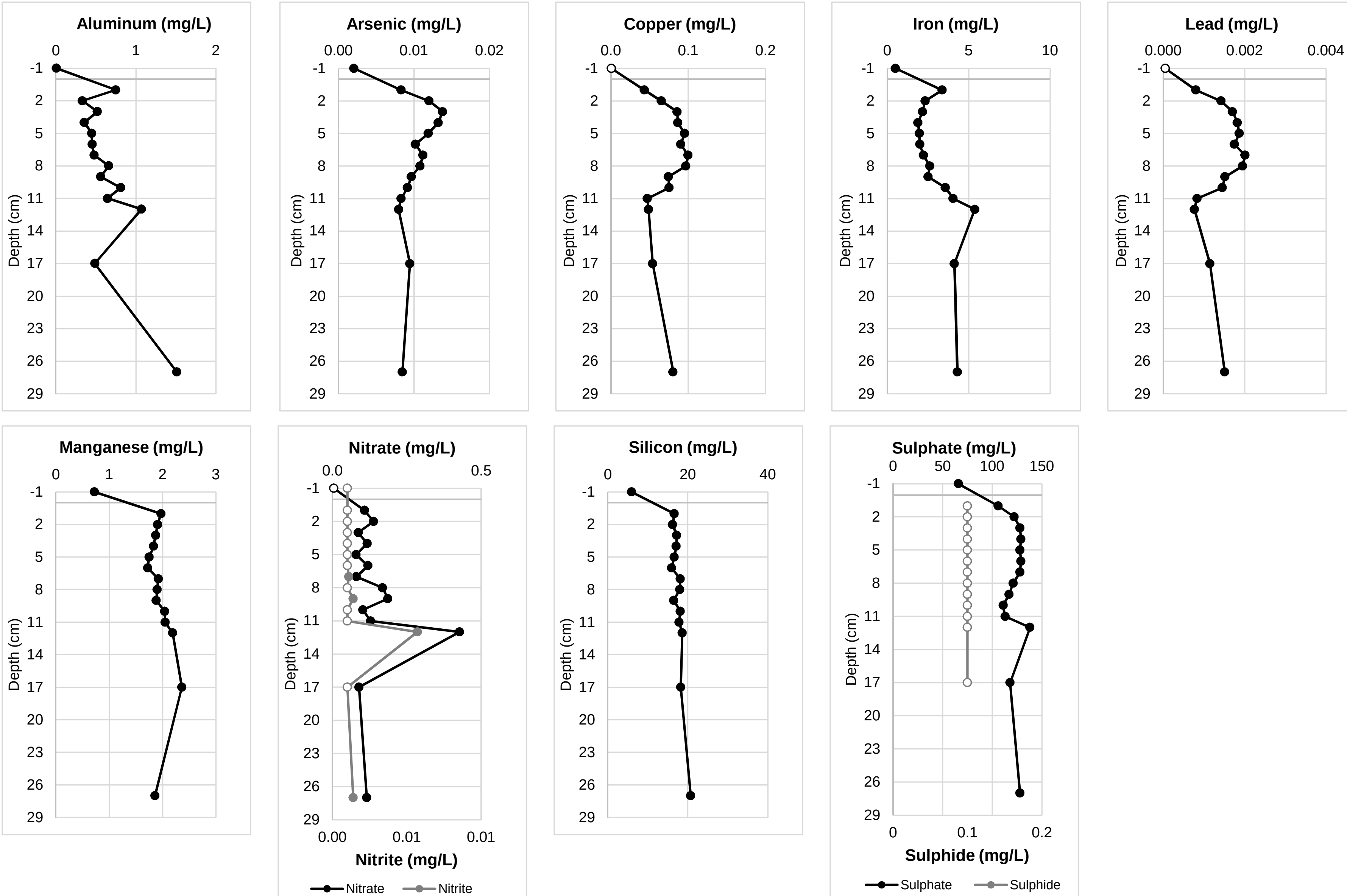


Figure 6.8: Pore water profiles of aluminum, arsenic, copper, iron, lead, manganese, nitrate, nitrite, silicon, sulphate, and sulphide from the northern station (POL-P1-PW) of Polley Lake, September 2014. Open data markers (o) indicate that the concentration was below the Method Detection Limit (MDL) [1].

[1] Analyte concentrations shown at a depth of -1 cm indicate concentrations in overlying water samples collected at POL-P1-PW.

South Basin (P2)

Core observations indicated that grey materials were present in the top 0 to 3 cm only. In general, pore-water profiles of the mine-associated elements (arsenic, copper, iron) showed no predominant pattern associated with the observed location of the mine-derived material (0 to 3 cm; Figure 6.9). The 0 to 1 cm sediment section pore-water concentrations were somewhat elevated in iron, arsenic, and copper, but in general, pore-water metal concentrations gradually increased with depth. Sulphide concentrations also increased with depth indicating that metals generally became more soluble as sediment conditions became more reducing. Sulphate and nitrate were not depleted, therefore sediment conditions were probably sub-oxic, not sulphidic. Thus, sediment conditions were likely sufficiently reducing for the reductive dissolution of oxidized iron (and the co-dissolution of metals associated with iron oxyhydroxides), but not sulphidic (i.e., no significant precipitation of iron sulphides would occur). This area would therefore have the same potential to reduce iron oxides and associated metals remobilizing them as described for Polley Lake station P1.

It is possible that the majority of iron associated with the source materials may be associated with the larger sand particles (i.e., magnetite sands; SRK 2015), rather than the grey fines. These larger particles may not have been deposited into Polley Lake to a large spatial extent compared to the grey tailings (SRK 2015). Therefore, the potential for the post-depositional reduction of iron and associated release of co-precipitated metals may be low in Polley Lake (as this is a sorptive process that occurs when the secondary mineral, amorphous iron oxyhydroxides precipitate from solution), and the form of iron in magnetite sands is not amorphous, but actually made up of primary minerals (i.e., predominantly magnetite). This is consistent with separate evaluation of potential post-depositional mobility, which indicated very low risk of metal mobilization under reducing conditions (SRK 2015).

6.4 Sediment Toxicity

Sediment toxicity testing indicated no instances of significantly reduced survival or growth of the freshwater/brackish water amphipod *Hyalella azteca* in Polley Lake sediments relative to concurrent laboratory controls and both references (Figure 6.10; Appendix Table F.1; Appendix Figures F.1-F.2). Absolute survival (i.e., non-normalized) ranged from 90% at POL-1 to 98% at POL-2 and at POL-P1; Appendix Tables F.3-F.4). Relative growth in Polley Lake sediments was greater than 100% in all but one area - POL-P1 (Polley Lake North basin), where it was 57% of reference (Appendix Tables F.3-F.4). At the Polley Lake basins (POL-P1 and POL-P2), there were no instances of significantly

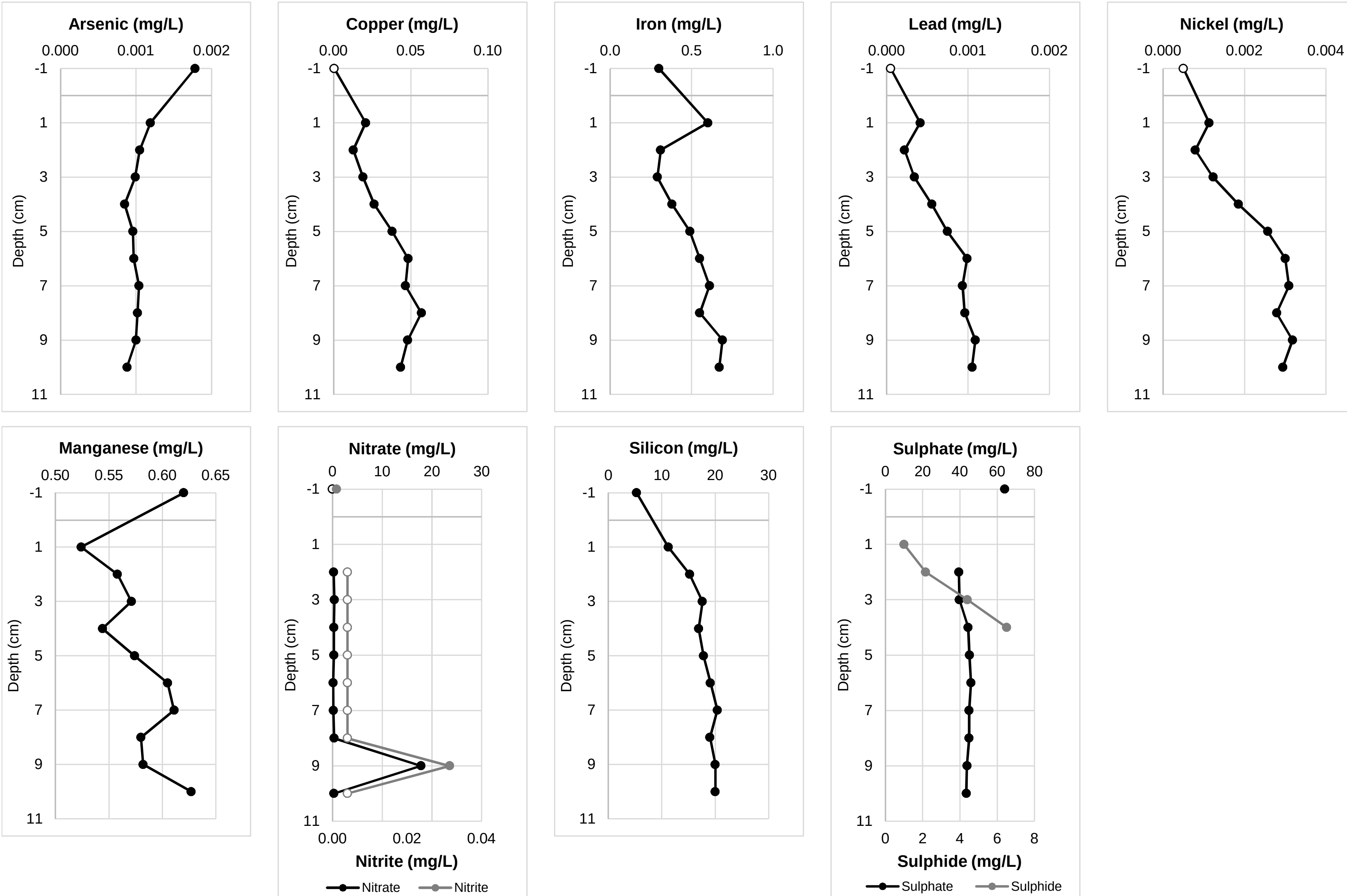


Figure 6.9: Pore water profiles of arsenic, copper, iron, lead, nickel, manganese, nitrate, nitrite, silicone, sulphate, and sulphide from southern station (POL-P2-PW) of Polley Lake, September 2014. Open data markers (o) indicate that the concentration was below the Method Detection Limit (MDL).

[1] Analyte concentrations shown at a depth of -1 cm indicate concentrations in overlying water samples collected at POL-P2-PW.

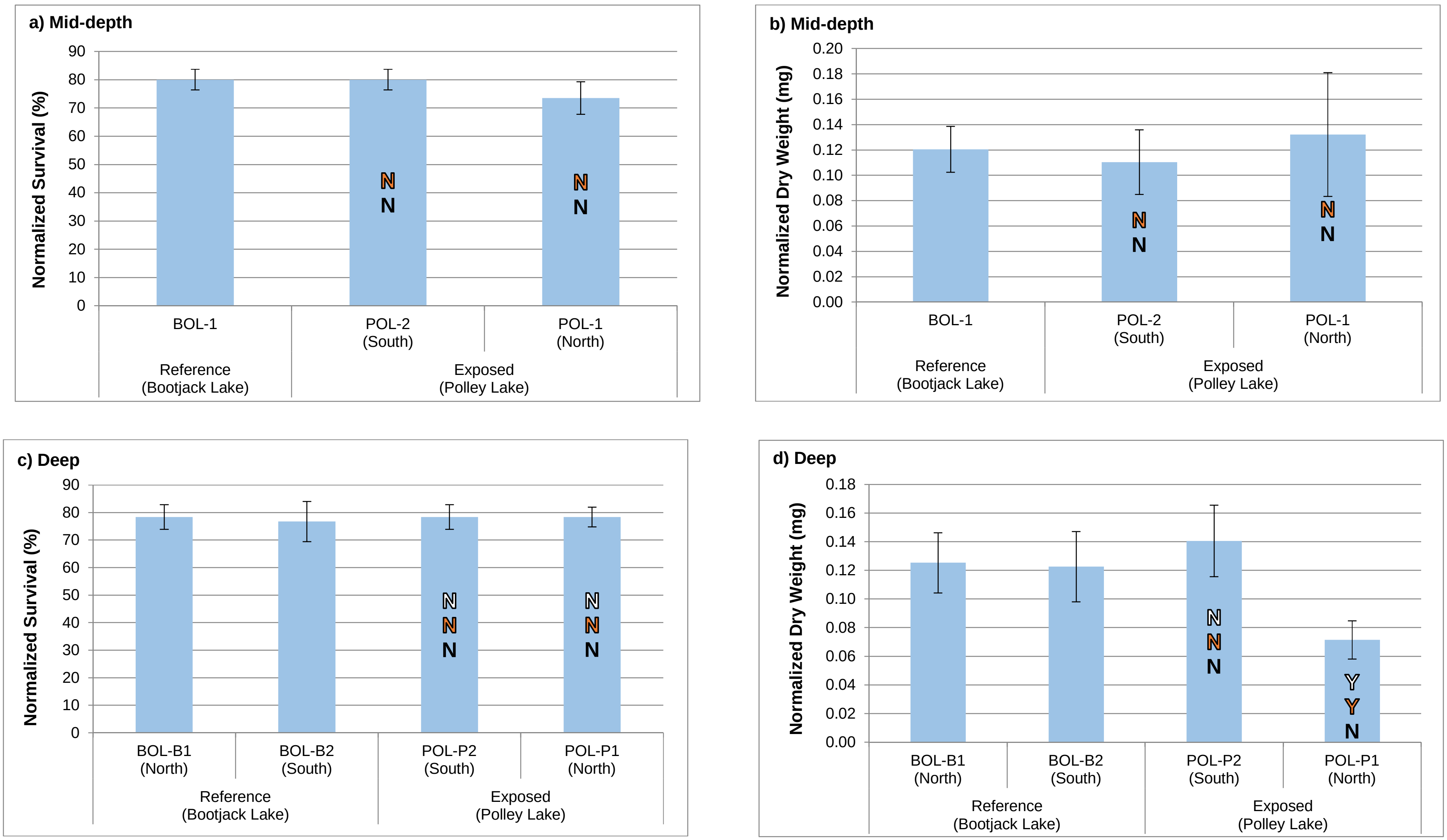


Figure 6.10: Toxicity tests of Polley and Bootjack Lake mid-depth and deep sediment on *Hyalella azteca* , Mount Polley Mine, 2014. Results for mid-depth a) Normalized Survival (%), b) Normalized Dry Weight (%), and deep c) Normalized Survival (%), d) Normalized Dry Weight (%). Error bars represent standard deviation. Letters represent significant differences (Y) or no differences (N) between samples and the Control (Black), Reference 1 (Orange) and Reference 2 (White) ($p < 0.05$). Control results are not displayed.

reduced survival or growth of the freshwater midge *Chironomus dilutus* relative to concurrent laboratory controls and both references (Figure 6.11; Appendix Table F.1). However, at area POL-2 (mid-depth at the south side of Polley Lake), survival, but not growth, was significantly reduced relative to concurrent laboratory controls and reference (Figure 6.11; Appendix Table F.1; Appendix Figures F.3-F.4). Absolute survival (i.e., non-normalized) of *C. dilutus* at area POL-2 was 64% (Appendix Tables F.5-F.6). No significant reductions in either survival or growth were observed at area POL-1 (mid-depth at the north side of Polley Lake; Figure 6.11; Appendix Table F.1). Overall, the toxicity data indicate very few effects in Polley Lake, the one exception being a modest reduction in survival of *C. dilutus* at area POL-2.

6.5 Benthic Invertebrate Community

Benthic invertebrate community samples of mid-depth areas of Polley Lake were compared to a reference area in Bootjack Lake (Table 4.1; Figure 4.2) in a Control-Impact (CI) design. In addition, samples from the Polley Lake deep areas (Basins P1 and P2) were compared to the Bootjack Lake reference using a before-after-control-impact (BACI) design based on data collected in 2014 and those collected at the same locations in 1999 (Beak 2000). Although the BACI design is considered to be an “optimal” study design (e.g., Green 1979), some caution must be applied in its interpretation due to the different benthic laboratories that provided the taxonomic analyses for the two studies (i.e., before and after). In addition, care must be taken in a BACI analysis to resist the temptation to interpret “area” effects when significant interactions “area*time” have been identified in the two-way ANOVA. Samples were collected by petite ponar grab sampler at five stations per area at the mid-depth areas and three stations per area at the basins.

6.5.1 Primary Metrics

Mean benthic organism density (individuals/m^2) and taxon richness were significantly lower at both Polley Lake mid-depth areas (POL-1 [north] and POL-2 [south]) relative to the Bootjack Lake reference (Figure 6.12; Appendix Table G.2). However, low density and low taxon richness were also observed in baseline studies conducted in 1995 and 1996 (Tables 3.6 and 3.8). Simpson’s diversity did not differ significantly among areas, but variability was high (Figure 6.12). Lastly, Simpson’s Evenness was significantly greater at both Polley Lake mid-depth areas than at the Bootjack Lake reference (Figure 6.12), presumably reflecting the presence of fewer taxa (communities represented by fewer taxa generally have greater evenness). Overall, the primary metrics indicate a potential impact to the mid-depth benthic invertebrate community of Polley Lake as evident in significantly lower density and taxon richness than reference. A low number of

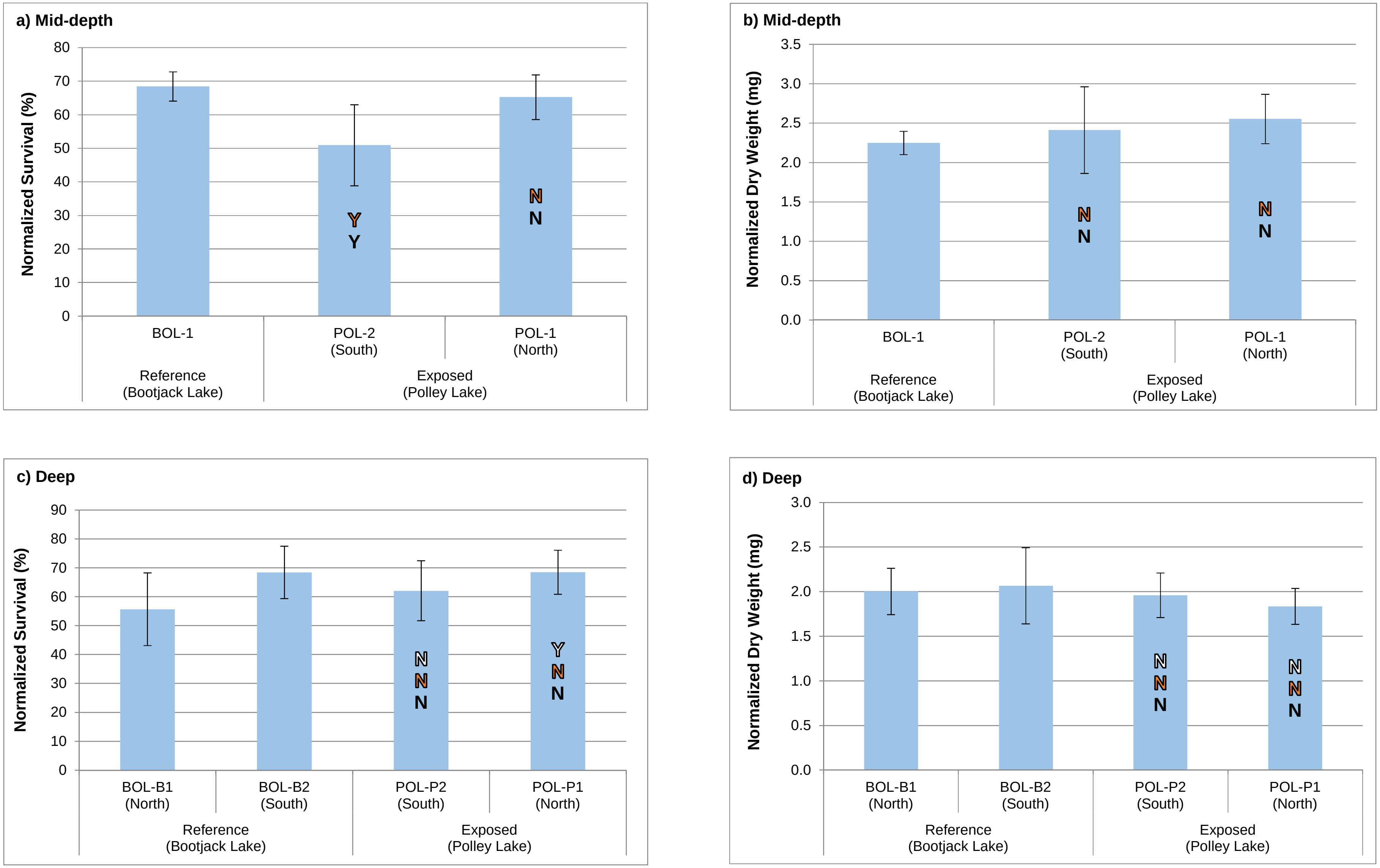


Figure 6.11: Toxicity tests of Polley and Bootjack Lake mid-depth and deep sediment on *Chironomus dilutus*, Mount Polley Mine, 2014. Results for mid-depth a) Normalized Survival (%), b) Normalized Weight (%), and deep c) Normalized Survival (%), d) Normalized Dry Weight (%). Error bars represent standard deviation. Letters represent significant differences (Y) or no differences (N) between samples and the Control (Black), Reference 1 (Orange) and Reference 2 (White) ($p < 0.05$). Control results are not displayed.

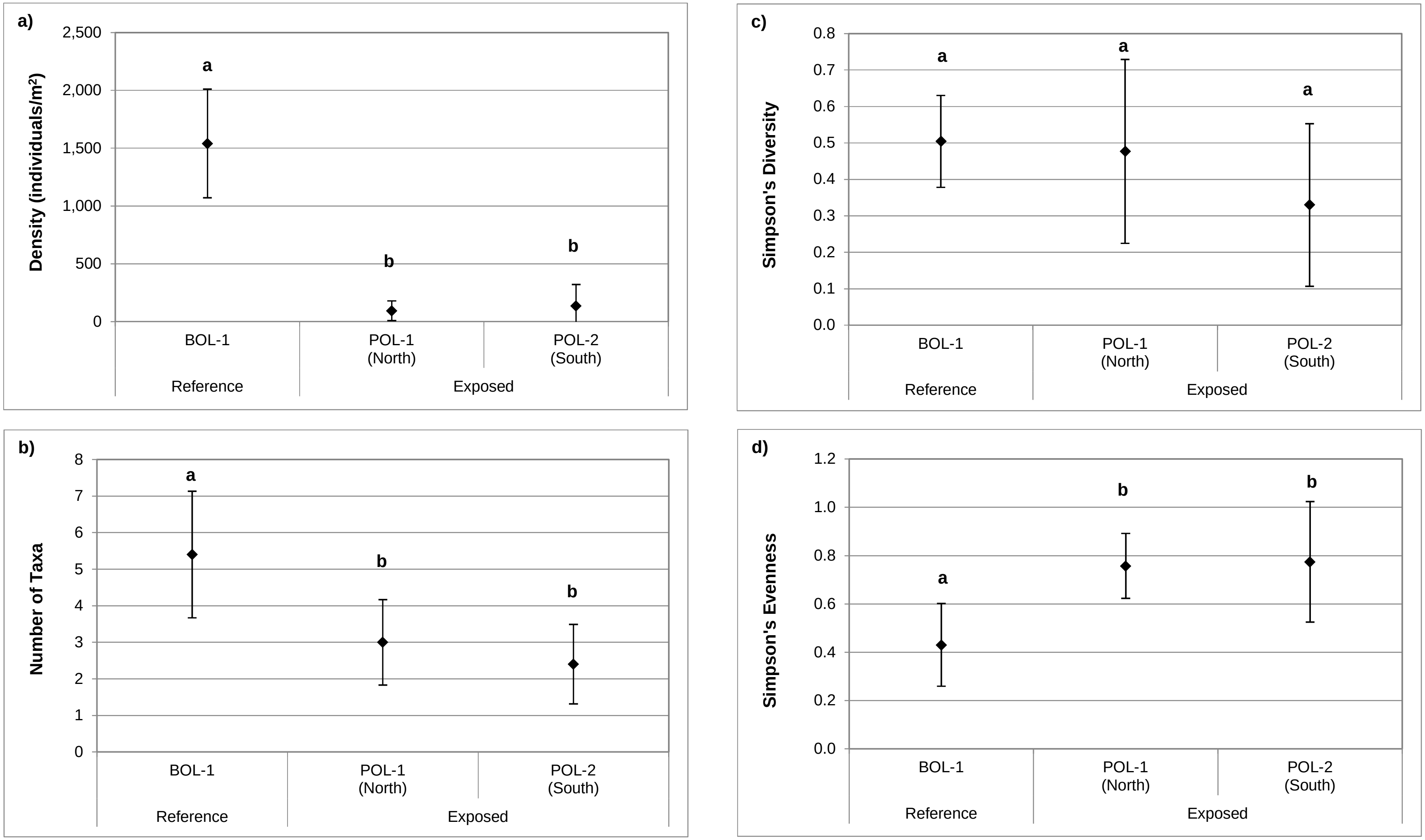


Figure 6.12: Comparison of a) benthic invertebrate density, b) number of taxa, c) Simpson's Diversity and d) Simpson's Eveness, Mount Polley Mine, 2014. Bootjack and Polley Lake mid-depth area comparisons. Data represents area means and 90% confidence intervals. Different letters above data points indicate areas that were significantly different ($p < 0.1$).

taxa relative to reference can be indicative of a degraded benthic invertebrate community (Pielou 1974; Begon et. al. 1996).

Benthic sampling at deep area P2, the Polley Lake south basin, yielded no benthic invertebrates, indicating a direct impact of the dam failure. At area P1, located at the north side of Polley Lake (opposite the area of tailings input to Polley Lake), BACI indicated that Simpsons Evenness increased from 1999 more than it did at reference (which was similar in 1999 and 2014; Figure 6.13; Appendix Table G.8). Of the endpoints for which BACI differences (area*time) were not identified between P1 and reference (note that it is not defensible to evaluate endpoints in area comparisons when a significant area*time interaction has been identified), density and taxon richness were significantly lower at P1 than at the Bootjack reference (11.5 per m^2 vs. 2,140 per m^2, and 1.33 vs. 3.33; Figure 6.14; Appendix Tables G.9 and G.10), suggesting an impacted benthic invertebrate community. However, as noted above, low density and taxon richness were also observed in baseline studies conducted in 1995 and 1996 (Table 3.6).

6.5.2 Community Composition

Dominant invertebrate taxon groups at the Polley and Bootjack Lake mid-depth areas and basins included oligochaete worms, non-biting midges (Chironomidae), mites (Acari), and EPT taxa (Ephemeroptera, Plecoptera, Trichoptera – mayflies, stoneflies and caddisflies; Figure 6.15; Appendix Tables G.3-G.4).

The Bray-Curtis index of dissimilarity (BC index) indicated that the community composition of both Polley Lake mid-depth areas differed from that of the Bootjack Lake reference area (Figure 6.16; Appendix Table G.2). Community differences detected by the BC index are non-directional and not necessarily related to chemical exposure. That is, communities may be significantly dissimilar due to chemical effects or to natural factors (e.g., subtle habitat differences). No statistically significant differences in the proportions of key benthic invertebrate taxa were observed among exposed and reference areas (Figure 6.16). A difference in community composition was observed on CA axis 2 (which explained 22.6% of community variance; Appendix Table G.2), based on which POL-1 (the north side of Polley Lake) differed from reference (Bootjack Lake) and POL-2 (the south side of Polley Lake; Figure 6.16). Area POL-1 had high positive scores on CA axis 2, indicating high relative abundance of the non-biting midge (chironomid) *Procladius* and simultaneous low relative abundance of diurnally-planktonic *Chaoborus* larvae, whereas both BOL-1 and POL-2 had low CA axis 2 scores, indicating higher relative abundance of *Chaoborus* and variable abundance of *Procladius* (Figure 6.16; Appendix Table G.5; Appendix Figure G.1).

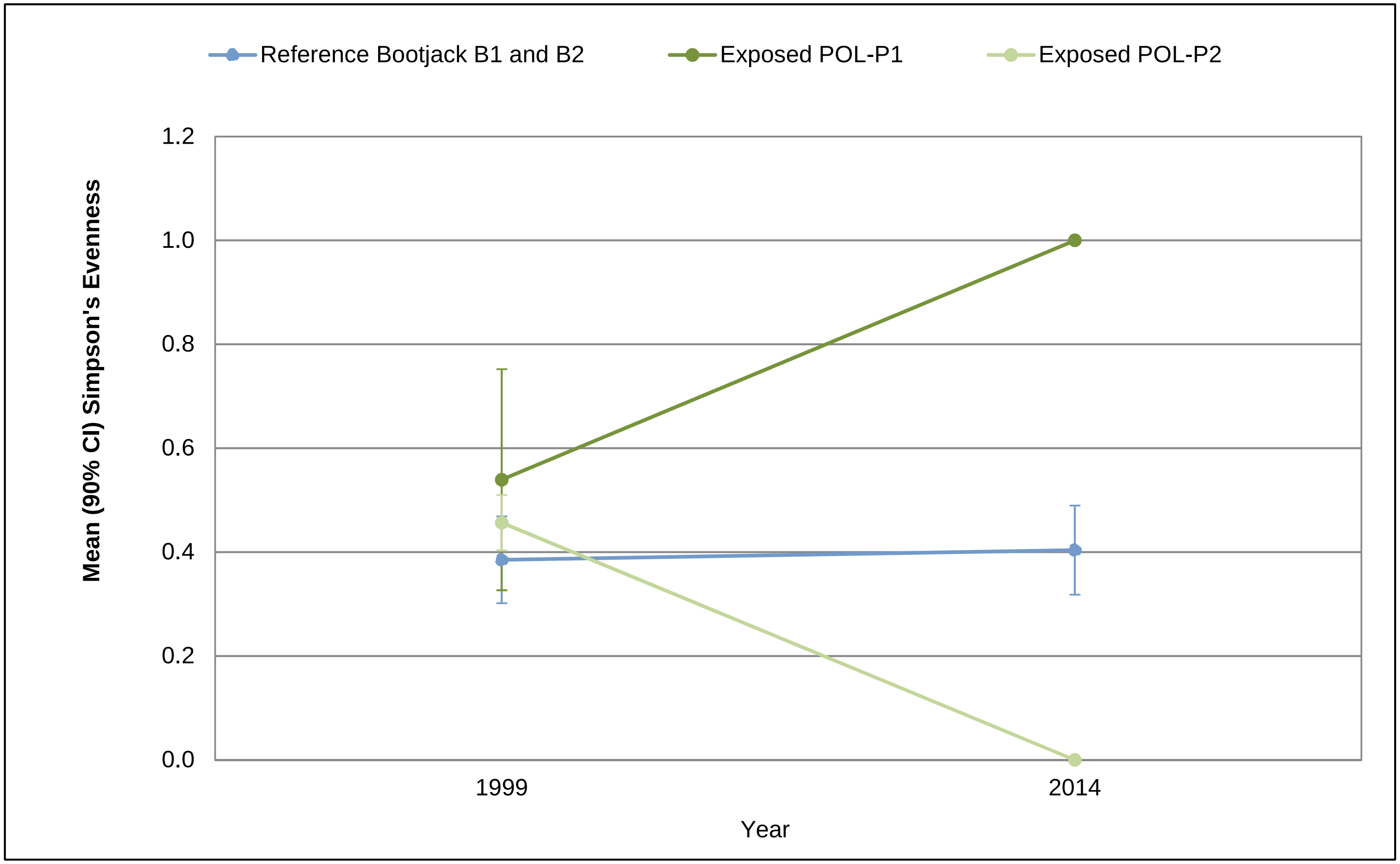


Figure 6.13: Before-After; Control-Impact (BACI) Analysis of effects on Simpson's Evenness, Polley Lake deep lake areas, Mount Polley Mine, 2014. Dashed lines indicate slopes that were not significantly different from reference.

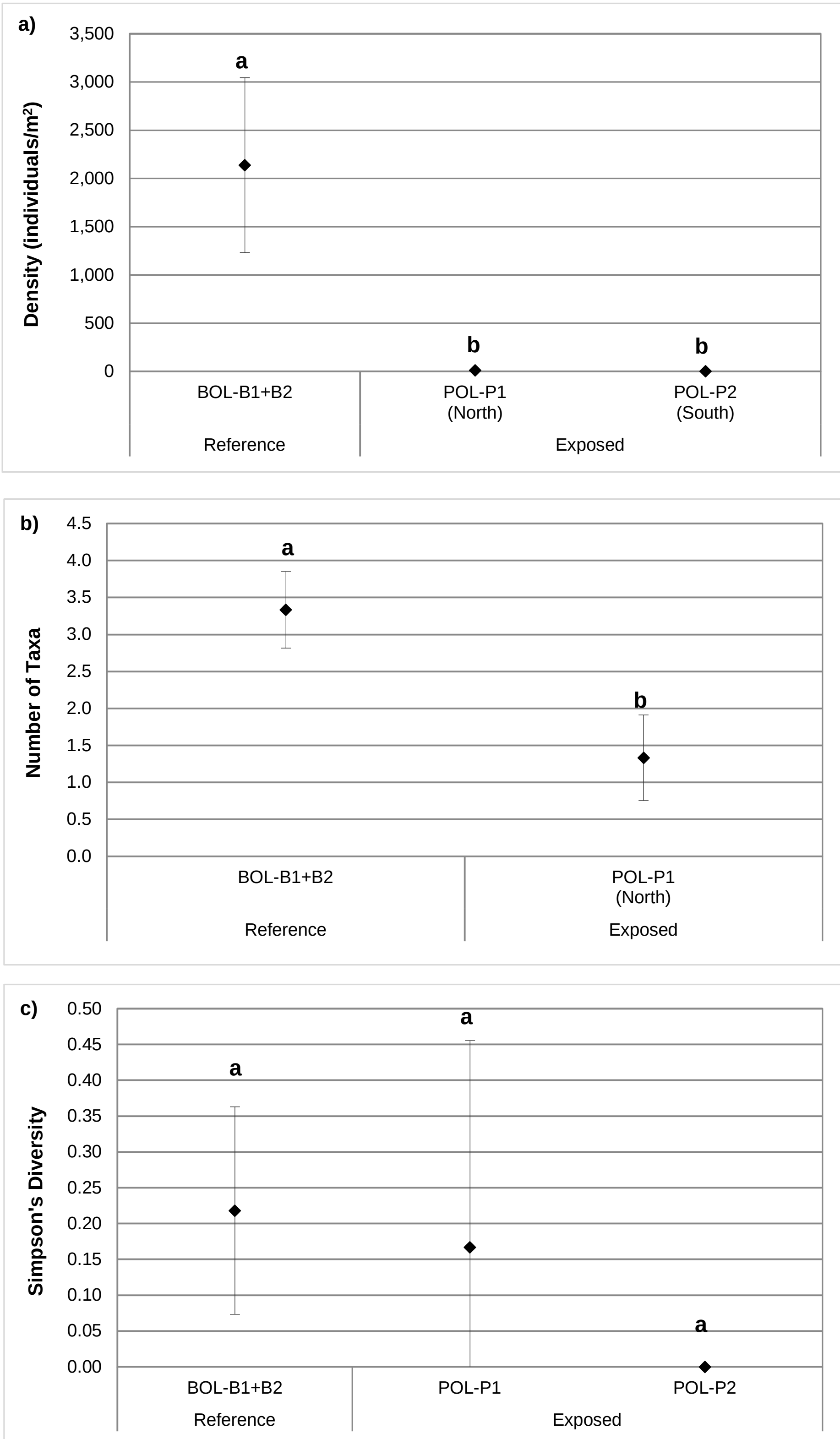
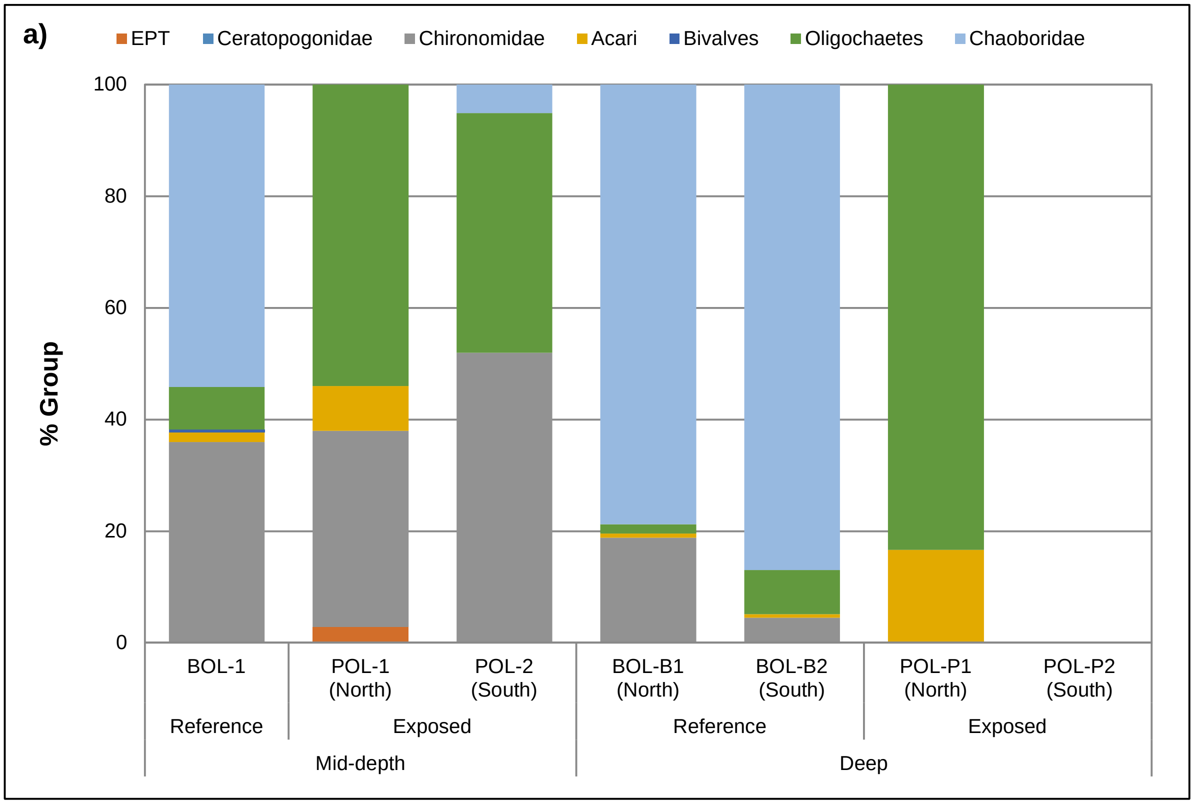


Figure 6.14: Comparison of a) benthic invertebrate density, b) number of taxa and c) Simpson's Diversity, among Polley and Bootjack Lake deep lake areas, Mount Polley Mine, 2014. Data represent area means and 90% confidence intervals. Different letters above data points indicate areas that were significantly different ($p < 0.1$).



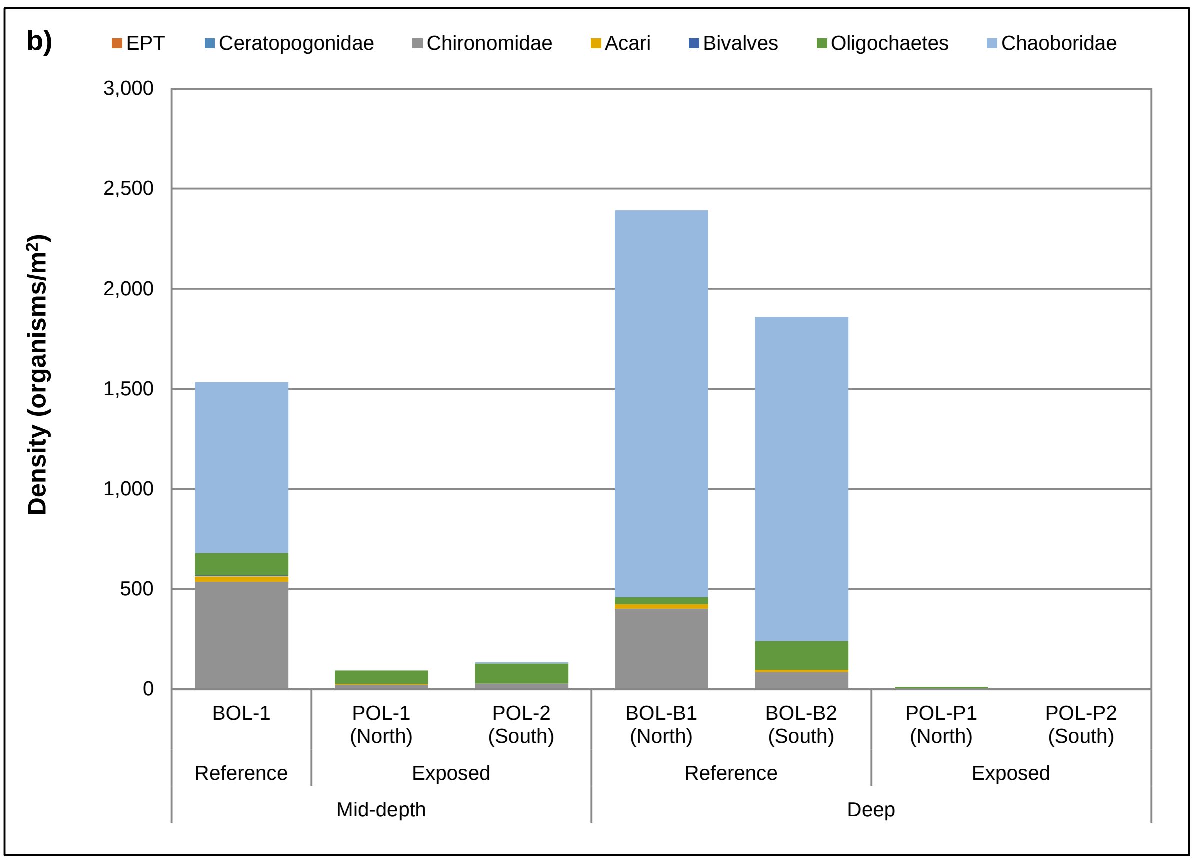


Figure 6.15: Relative mean proportions (a) and mean density (b) of major benthic invertebrate groups, Polley and Bootjack Lake mid-depth and deep sampling areas, Mount Polley Mine, 2014.

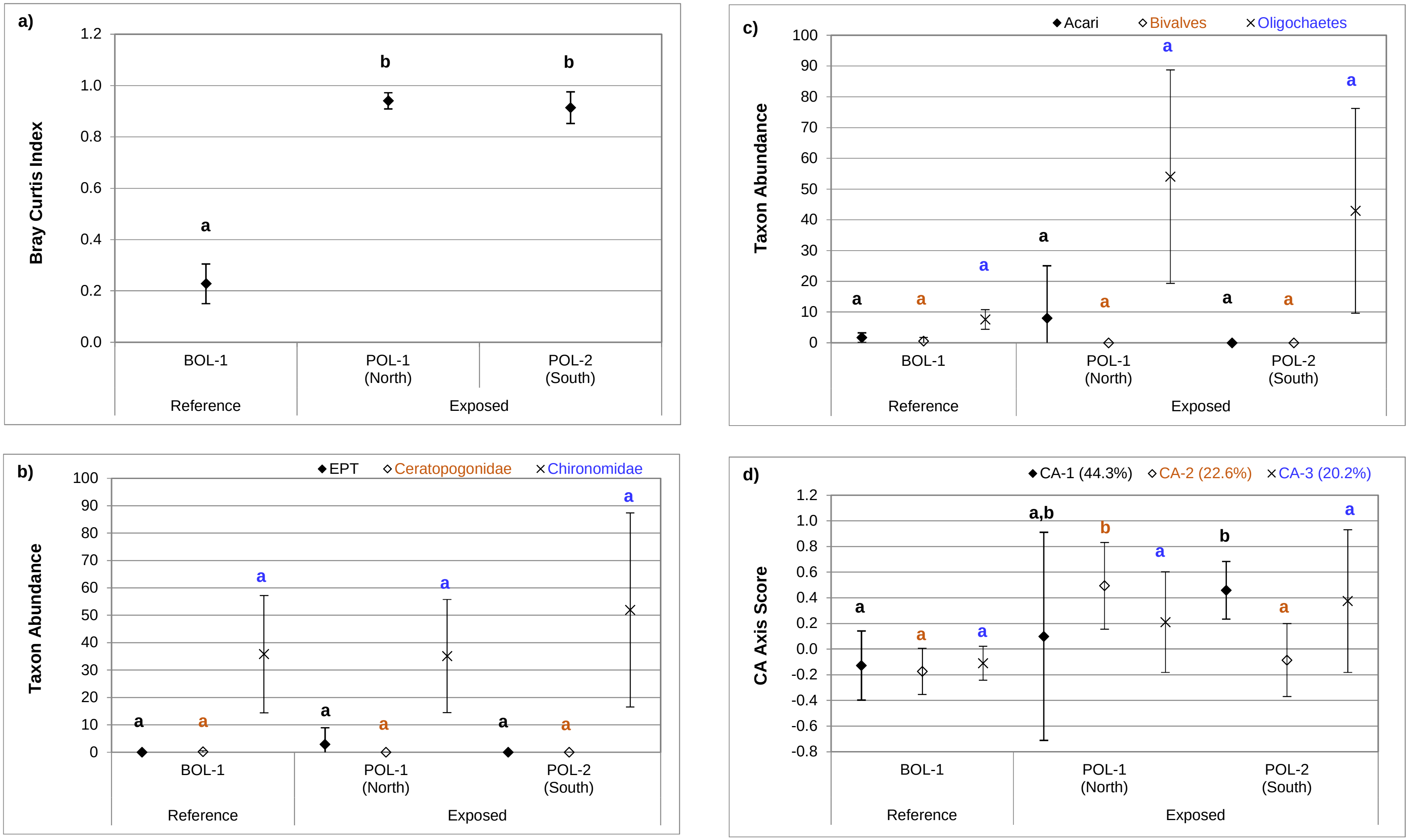


Figure 6.16: Comparison of a) Bray Curtis Index, b) percent Acari, Bivalves and Oligochaetes, c) percent EPT, Ceratopogonidae and Chironomidae and d) CA Axis Score, Mount Polley Mine, 2014. Bootjack and Polley Lake mid-depth area comparisons. Data represents area means and 90% confidence intervals. Different letters above data points indicate areas that were significantly different ($p < 0.1$).

BACI evaluation indicated some differences in how Polley Lake and Bootjack Lake (reference) benthic community composition changed from 1999 to 2014 (Figure 6.17; Appendix Table G.8). Most meaningful was the greater increase in Bray-Curtis distance relative to the 1999 Polley Lake median at P1 than the Bootjack Lake reference (Figure 6.17), indicating an effect on benthic community composition. As previously indicated, community differences detected by the BC index are non-directional and not necessarily related to chemical exposure; however, examination of community composition indicated a greater increase in the relative proportion of oligochaetes at area P1 compared to reference (Figure 6.17). Oligochaetes are pollution tolerant organisms (e.g., Barbour et al. 1999) and community dominance by oligochaetes is typically considered indicative of environmental degradation. Statistically significant interactions were also observed on all three Correspondence Analysis (CA) axes, with CA Axis 1 (30.7% of community variance) essentially detecting the change in the relative abundance of oligochaetes discussed above. CA axis 2 (18.3% of community variance) mainly captured a temporal change in community composition at the reference area, whereas CA Axis 3 scores (14.9% of community variance) increased at P1 while decreasing at reference (Figure 6.17), indicating a notable change in the P1 benthic community from good representation by the chironomids *Protanypus* and *Einfeldia* and the naidid worm *Vejdovskyella* in 1999 to the absence of these taxa in 2014 (Appendix Table G.13; Appendix Figure G.2). Conversely, Bootjack Lake (reference) stations were more likely to be dominated by other chironomids (*Synorthocladius*, *Tanytarsus*, *Cricotopus*, *Sergentia*), and immature tubificids with hair chaetae (Appendix Table G.13; Appendix Figure G.2).

6.6 Correlation Analysis

Correlation analysis was conducted between the biological endpoints (sediment toxicity test and benthic invertebrate community endpoints) and dissolved oxygen, specific conductance, percent fines, sediment TOC content, sediment concentrations of POIs, IPs, PCA axes and selective copper extracts for the mid-depth areas (Table 6.7) and the deep areas (Table 6.8). The only relationship between any of the toxicity test endpoints and the sediment physical/chemical measures was a weak negative correlation between the relative growth of *H. azteca* and carbonate copper (Tables 6.7 and 6.8; Appendix Figure I.4). Given that no significant reduction in *H. azteca* growth was observed relative to concurrent laboratory controls and both references (Section 6.4), this correlation may not be indicative of cause. Overall, the limited number of correlations is perhaps not surprising as the chemical impact on Polley Lake sediment was generally modest and

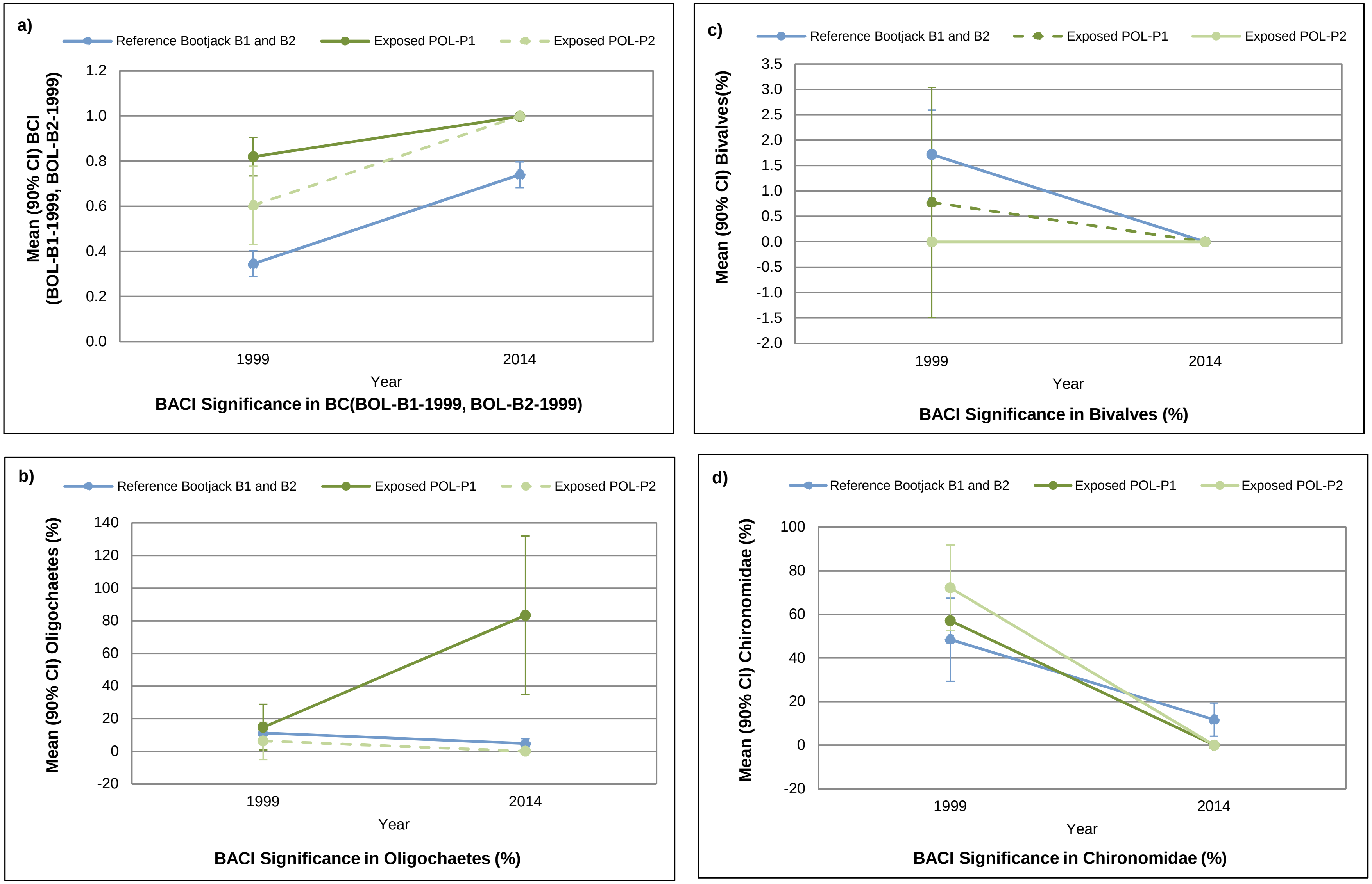
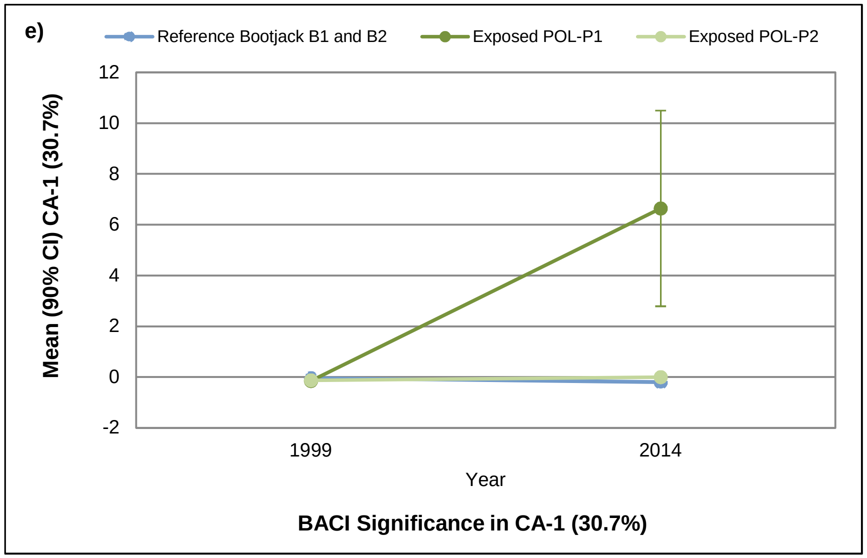
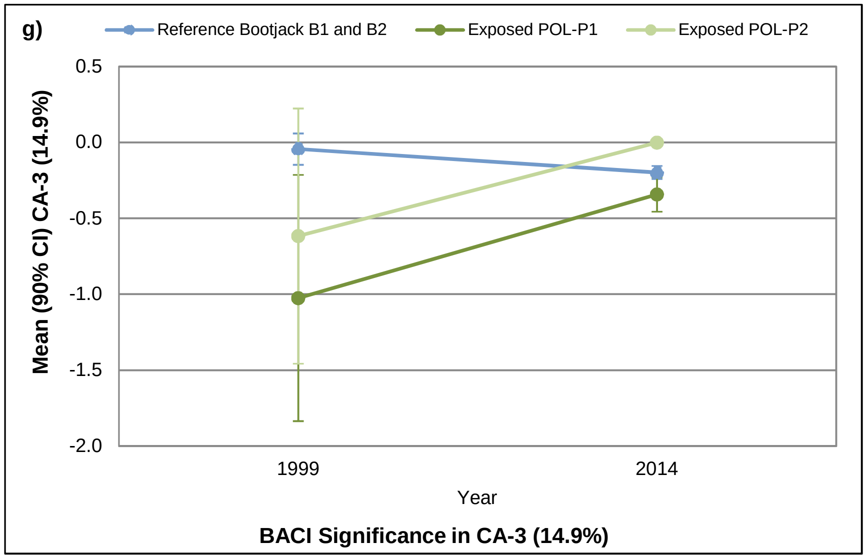


Figure 6.17: Before-After; Control-Impact (BACI) Analysis of Effects on a) Bray Curtis Index (BCI), b) percent Oligochaetes, c) percent Bivalves and d) percent Chironomidae, Polley Lake deep areas, Mount Polley Mine, 2014. Dashed lines indicate slopes that were not significantly different from reference.





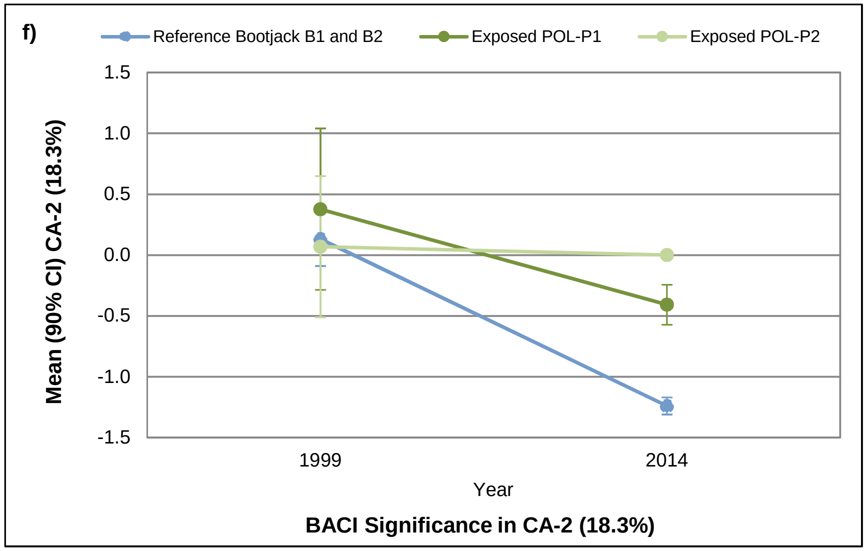


Figure 6.17: Before-After; Control-Impact (BACI) Analysis of Effects on e) CA-1 (30.7%), f) CA-2 (18.3%) and g) CA-3 (14.9%), Polley Lake deep areas, Mount Polley Mine, 2014. Dashed lines indicate slopes that were not significantly different from reference.

Table 6.7: Spearman's Rank Correlation results for correlation of toxicity test results and benthic invertebrate community metrics versus water in-situ measures, sediment physical characteristics, parameters of interest, indicator parameters, PCA axes scores, copper extracts (all in < 2mm sediment fraction) in Polley and Bootjack mid-depth sampling areas, Mount Polley Mine, 2014 [1].

Physical/Chemical Parameter		Correlation Parameter	Toxicity Endpoints				Benthic Invertebrate Community Metrics													
			Hyalella azteca		*Chironomus dilutus*															
			Normalized Survival	Normalized Growth	Normalized Survival	Normalized Growth	Density (Ind./m^2)	Number of Taxa	Simpson's D	Simpson's E	Bray Curtis Index	EPT (%)	Ceratopogonidae (%)	Chironomidae (%)	Acari (%)	Bivalves (%)	Oligochaetes (%)	CA Axis 1 (44.3%)	CA Axis 2 (22.6%)	CA Axis 3 (20.2%)
Water In-Situ Measures	Dissolved Oxygen (mg/L; bottom)	Correlation Coefficient	NA	NA	NA	NA	0.878	0.745	0.189	-0.801	-0.781	-0.186	0.433	-0.282	0.461	0.433	-0.111	-0.527	-0.202	-0.727
		Sig. (2-tailed)	NA	NA	NA	NA	0.0000	0.0014	0.4989	0.0003	0.0006	0.5079	0.1069	0.3083	0.0834	0.1069	0.6942	0.0434	0.4704	0.0021
	Specific Conductivity (µS/cm; bottom)	Correlation Coefficient	NA	NA	NA	NA	-0.848	-0.625	-0.140	0.662	0.782	0.433	-0.402	0.186	-0.521	-0.402	0.243	0.691	0.261	0.667
		Sig. (2-tailed)	NA	NA	NA	NA	0.0001	0.0128	0.6199	0.0072	0.0006	0.1066	0.1370	0.5072	0.0462	0.1370	0.3823	0.0044	0.3471	0.0066
Sediment Physical	Fines	Correlation Coefficient	0.004	0.146	0.619	-0.179	0.502	0.307	0.025	-0.436	-0.298	0.000	-0.186	-0.282	0.151	-0.186	-0.041	-0.309	0.041	-0.538
		Sig. (2-tailed)	0.9884	0.6025	0.0138	0.5243	0.0567	0.2663	0.9295	0.1041	0.2799	1.000	0.5079	0.3083	0.5912	0.5079	0.8843	0.2621	0.8843	0.0386
	TOC	Correlation Coefficient	0.169	0.313	0.541	-0.155	0.714	0.628	0.297	-0.551	-0.609	-0.248	0.186	-0.179	0.581	0.186	-0.361	-0.614	-0.270	-0.560
		Sig. (2-tailed)	0.5465	0.2563	0.0374	0.5800	0.0028	0.0121	0.2825	0.0333	0.0159	0.3735	0.5075	0.5239	0.0231	0.5075	0.1857	0.0150	0.3302	0.0300
Parameters of Interest	Arsenic	Correlation Coefficient	-0.423	-0.221	-0.297	0.120	-0.457	-0.550	-0.276	0.291	0.459	0.062	-0.249	-0.129	-0.626	-0.249	0.716	0.418	0.709	0.149
		Sig. (2-tailed)	0.1166	0.4294	0.2826	0.6696	0.0866	0.0336	0.3185	0.2930	0.0855	0.8259	0.3717	0.6464	0.0126	0.3717	0.0027	0.1207	0.0031	0.5961
	Copper	Correlation Coefficient	-0.066	-0.086	-0.424	0.111	-0.613	-0.688	-0.397	0.493	0.722	0.000	-0.433	0.254	-0.587	-0.433	0.331	0.177	0.506	0.420
		Sig. (2-tailed)	0.8153	0.7613	0.1157	0.6945	0.0151	0.0046	0.1431	0.0617	0.0024	1.000	0.1069	0.3618	0.0215	0.1069	0.2287	0.5281	0.0544	0.1191
	Iron	Correlation Coefficient	0.157	-0.029	-0.538	0.261	-0.652	-0.670	-0.279	0.604	0.429	-0.247	-0.433	0.061	-0.525	-0.433	0.354	0.375	0.136	0.433
		Sig. (2-tailed)	0.5770	0.9195	0.0384	0.3480	0.0084	0.0063	0.3143	0.0171	0.1106	0.3739	0.1069	0.8298	0.0444	0.1069	0.1956	0.1680	0.6293	0.1073
	Zinc	Correlation Coefficient	0.388	0.121	0.350	-0.368	0.294	0.120	-0.214	-0.236	-0.209	-0.247	0.062	0.232	0.247	0.062	-0.586	-0.372	-0.529	-0.182
		Sig. (2-tailed)	0.1534	0.6664	0.2008	0.1773	0.2877	0.6689	0.4427	0.3973	0.4545	0.3739	0.8266	0.4051	0.3755	0.8266	0.0216	0.1724	0.0426	0.5155
Indicator Parameters	Calcium	Correlation Coefficient	-0.351	-0.232	-0.297	0.214	-0.448	-0.606	-0.252	0.384	0.425	-0.062	-0.309	-0.100	-0.529	-0.309	0.645	0.336	0.672	0.225
		Sig. (2-tailed)	0.2002	0.4051	0.2817	0.4431	0.0940	0.0166	0.3649	0.1573	0.1139	0.8266	0.2620	0.7229	0.0424	0.2620	0.0094	0.2208	0.0061	0.4197
	Molybdenum	Correlation Coefficient	-0.033	-0.404	-0.386	-0.089	-0.534	-0.560	-0.200	0.500	0.443	0.247	-0.186	0.500	-0.559	-0.186	-0.068	0.558	-0.164	0.490
		Sig. (2-tailed)	0.9071	0.1358	0.1554	0.7517	0.0403	0.0298	0.4744	0.0574	0.0980	0.3739	0.5079	0.0577	0.0302	0.5079	0.8099	0.0308	0.5581	0.0639
	Sodium	Correlation Coefficient	-0.364	-0.047	-0.187	0.118	-0.536	-0.524	-0.215	0.352	0.658	0.310	-0.435	0.039	-0.427	-0.435	0.447	0.346	0.712	0.350
		Sig. (2-tailed)	0.1820	0.8690	0.5045	0.6746	0.0395	0.0450	0.4410	0.1988	0.0076	0.2602	0.1055	0.8891	0.1126	0.1055	0.0951	0.2062	0.0029	0.2013
	Strontium	Correlation Coefficient	-0.520	-0.248	-0.199	0.182	-0.529	-0.504	-0.098	0.388	0.615	0.371	-0.310	0.070	-0.496	-0.310	0.521	0.406	0.732	0.286
		Sig. (2-tailed)	0.0469	0.3719	0.4776	0.5155	0.0425	0.0553	0.7272	0.1528	0.0146	0.1728	0.2615	0.8050	0.0601	0.2615	0.0466	0.1331	0.0019	0.3010
	Tin	Correlation Coefficient	0.214	0.309	-0.033	-0.433	-0.248	-0.285	-0.248	0.000	0.093	-0.071	-0.071	0.371	-0.184	-0.071	0.000	0.248	0.000	0.310
		Sig. (2-tailed)	0.4431	0.2620	0.9082	0.1069	0.3722	0.3040	0.3735	1.0000	0.7420	0.8003	0.8003	0.1732	0.5112	0.8003	1.0000	0.3735	1.0000	0.2615
	Titanium	Correlation Coefficient	-0.235	-0.009	-0.285	0.130	-0.502	-0.560	-0.170	0.392	0.530	-0.031	-0.248	0.057	-0.511	-0.248	0.603	0.234	0.699	0.288
		Sig. (2-tailed)	0.3986	0.9748	0.3024	0.6430	0.0564	0.0300	0.5448	0.1487	0.0424	0.9128	0.3735	0.8396	0.0517	0.3735	0.0174	0.4005	0.0037	0.2979
PCA Axes	PCA Axis 1 (62.2%)	Correlation Coefficient	0.293	0.132	0.329	-0.121	0.484	0.560	0.157	-0.415	-0.452	0.000	0.186	0.011	0.429	0.186	-0.581	-0.338	-0.663	-0.349
		Sig. (2-tailed)	0.2896	0.6387	0.2306	0.6664	0.0676	0.0298	0.5756	0.1243	0.0906	1.000	0.5079	0.9698	0.1101	0.5079	0.0232	0.2182	0.0070	0.2030
	PCA Axis 2 (18.7%)	Correlation Coefficient	0.194	0.104	0.100	-0.314	-0.287	-0.475	-0.449	0.198	0.449	-0.062	-0.433	0.343	-0.332	-0.433	-0.198	-0.004	-0.021	0.136
		Sig. (2-tailed)	0.4888	0.7134	0.7235	0.2539	0.3001	0.0739	0.0935	0.4784	0.0935	0.8266	0.1069	0.2109	0.2271	0.1069	0.4784	0.9899	0.9395	0.6293
Copper Extracts	Exchangeable	Correlation Coefficient	-0.478	0.064	-0.143	0.257	-0.595	-0.226	0.197	0.422	0.681	0.433	-0.124	0.136	-0.293	-0.124	0.227	0.218	0.475	0.189
		Sig. (2-tailed)	0.0713	0.8199	0.6110	0.3549	0.0193	0.4173	0.4825	0.1173	0.0052	0.1069	0.6605	0.6296	0.2885	0.6605	0.4159	0.4350	0.0733	0.4989
	Carbonate	Correlation Coefficient	-0.037	-0.696	-0.115	-0.200	0.405	0.035	-0.322	-0.254	-0.338	-0.124	0.247	-0.175	-0.030	0.247	0.038	-0.055	-0.088	-0.256
		Sig. (2-tailed)	0.8955	0.0039	0.6837	0.4748	0.1342	0.9023	0.2423	0.3614	0.2182	0.6605	0.3739	0.5327	0.9161	0.3739	0.8944	0.8445	0.7563	0.3579
	Easily Reducible	Correlation Coefficient	-0.309	-0.054	-0.265	0.104	-0.523	-0.569	-0.182	0.357	0.363	-0.062	-0.124	-0.075	-0.568	-0.124	0.717	0.508	0.583	0.268
		Sig. (2-tailed)	0.2620	0.8496	0.3391	0.7134	0.0453	0.0267	0.5155	0.1908	0.1838	0.8266	0.6605	0.7905	0.0273	0.6605	0.0026	0.0534	0.0226	0.3340
	Organic	Correlation Coefficient	-0.105	-0.102	-0.329	0.007	-0.766	-0.795	-0.339	0.665	0.818	0.124	-0.433	0.366	-0.531	-0.433	0.162	0.349	0.381	0.564
		Sig. (2-tailed)	0.7089	0.7179	0.2315	0.9798	0.0009	0.0004	0.2164	0.0069	0.0002	0.6602	0.1066	0.1792	0.0417	0.1066	0.5643	0.2025	0.1611	0.0287

Significant correlation; p-value < 0.0001 (Bonferroni corrected p-value for 408 comparisons among Table 6.7 and Appendix Table I.1).

Correlation scatterplot inspected; p <0.01.

[1] Values < method detection limit (MDL) were used at the MDL for calculations. Normalized survival and growth are relative to corresponding laboratory controls.

NA = Correlation was not performed between these two parameters.

Note: n=15 for all correlations.

Table 6.8: Spearman's Rank Correlation results for correlation of toxicity test results and benthic invertebrate community metrics versus water in-situ measures, sediment physical characteristics, parameters of interest, indicator parameters, PCA axes scores, copper extracts (all in < 2mm sediment fraction) in Polley and Bootjack Lake deep sampling areas, Mount Polley Mine, 2014[1].

Physical/Chemical Parameter		Correlation Parameter	Toxicity Endpoints				Benthic Invertebrate Community Metrics										
			Hyalella azteca		*Chironomus dilutus*												
			Normalized Survival	Normalized Growth	Normalized Survival	Normalized Growth	Density (Ind./m^2)	Number of Taxa	Simpson's D	Simpson's E	Bray Curtis Index (BOL-B1 and BOL-B2)	Chironomidae (%)	Acari (%)	Oligochaetes (%)	CA Axis 1 (30.7%)	CA Axis 2 (18.3%)	CA Axis 3 (14.9%)
Water In-situ Measures	Dissolved Oxygen (mg/L; bottom)	Correlation Coefficient	NA	NA	NA	NA	0.689	0.648	0.574	-0.186	-0.706	0.930	0.126	-0.390	-0.931	-0.706	0.464
		Sig. (2-tailed)	NA	NA	NA	NA	0.0133	0.0227	0.0509	0.5626	0.0103	<0.0000	0.6967	0.2105	<0.0000	0.0102	0.1283
	Specific Conductivity (µS/cm; bottom)	Correlation Coefficient	NA	NA	NA	NA	-0.921	-0.885	-0.764	-0.365	0.779	-0.923	-0.377	-0.189	0.706	0.874	-0.013
		Sig. (2-tailed)	NA	NA	NA	NA	<0.0000	0.0001	0.0038	0.2439	0.0028	<0.0000	0.2270	0.5574	0.0104	0.0002	0.9691
Sediment Physical	Fines	Correlation Coefficient	0.074	-0.373	-0.306	-0.137	-0.313	-0.259	-0.267	0.368	0.256	-0.652	0.208	0.643	0.671	0.302	-0.568
		Sig. (2-tailed)	0.8202	0.2321	0.3342	0.6704	0.3225	0.4161	0.4024	0.2394	0.4227	0.0216	0.5163	0.0241	0.0168	0.3401	0.0538
	TOC	Correlation Coefficient	-0.051	-0.091	-0.102	-0.245	0.702	0.723	0.123	0.000	-0.638	0.411	0.468	0.293	-0.286	-0.540	0.067
		Sig. (2-tailed)	0.8746	0.7787	0.7517	0.4433	0.0109	0.0078	0.7027	1.000	0.0256	0.1849	0.1251	0.3557	0.3680	0.0701	0.8360
Parameters of Interest	Arsenic	Correlation Coefficient	0.168	0.077	-0.219	-0.077	-0.871	-0.878	-0.573	-0.270	0.682	-0.892	-0.250	-0.145	0.674	0.836	-0.131
		Sig. (2-tailed)	0.6016	0.8122	0.4947	0.8122	0.0002	0.0002	0.0516	0.3969	0.0146	<0.0001	0.4341	0.6538	0.0163	0.0007	0.6860
	Copper	Correlation Coefficient	0.172	-0.028	0.314	0.014	-0.698	-0.810	-0.334	-0.021	0.783	-0.713	-0.320	-0.233	0.691	0.783	-0.198
		Sig. (2-tailed)	0.5936	0.9312	0.3203	0.9656	0.0115	0.0014	0.2894	0.9477	0.0026	0.0093	0.3110	0.4665	0.0128	0.0026	0.5383
	Iron	Correlation Coefficient	0.423	0.256	-0.184	-0.221	-0.860	-0.748	-0.697	-0.458	0.661	-0.808	-0.344	-0.193	0.528	0.793	0.147
		Sig. (2-tailed)	0.1710	0.4225	0.5676	0.4907	0.0003	0.0051	0.0117	0.1340	0.0193	0.0015	0.2740	0.5487	0.0775	0.0021	0.6493
	Zinc	Correlation Coefficient	0.018	-0.315	0.529	0.084	-0.399	-0.497	-0.334	0.121	0.544	-0.489	-0.281	0.018	0.568	0.462	-0.208
		Sig. (2-tailed)	0.9551	0.3191	0.0769	0.7954	0.1993	0.1005	0.2894	0.7089	0.0676	0.1067	0.3768	0.9566	0.0541	0.1304	0.5163
Indicator Parameters	Calcium	Correlation Coefficient	0.446	0.144	0.350	-0.210	-0.774	-0.793	-0.407	-0.188	0.868	-0.722	-0.328	-0.322	0.678	0.894	-0.092
		Sig. (2-tailed)	0.1457	0.6561	0.2650	0.5121	0.0031	0.0021	0.1894	0.5578	0.0003	0.0081	0.2978	0.3081	0.0153	<0.0001	0.7764
	Molybdenum	Correlation Coefficient	0.047	-0.105	0.018	0.336	-0.780	-0.871	-0.638	0.078	0.732	-0.825	-0.515	0.039	0.730	0.624	-0.222
		Sig. (2-tailed)	0.8835	0.7456	0.9566	0.2861	0.0028	0.0002	0.0256	0.8095	0.0068	0.0010	0.0869	0.9047	0.0070	0.0300	0.4876
	Sodium	Correlation Coefficient	0.475	-0.039	0.189	-0.222	-0.772	-0.701	-0.329	-0.047	0.834	-0.779	-0.157	-0.057	0.744	0.886	-0.253
		Sig. (2-tailed)	0.1183	0.9047	0.5572	0.4876	0.0032	0.0111	0.2961	0.8859	0.0007	0.0028	0.6253	0.8605	0.0056	0.0001	0.4282
	Strontium	Correlation Coefficient	0.395	0.004	0.276	-0.098	-0.714	-0.768	-0.334	-0.053	0.824	-0.714	-0.258	-0.205	0.724	0.848	-0.237
		Sig. (2-tailed)	0.2035	0.9914	0.3859	0.7617	0.0091	0.0035	0.2885	0.8694	0.0010	0.0091	0.4186	0.5228	0.0077	0.0005	0.4588
	Tin	Correlation Coefficient	0.107	0.414	-0.062	-0.312	-0.586	-0.598	-0.468	-0.589	0.468	-0.413	-0.360	-0.586	0.195	0.586	0.325
		Sig. (2-tailed)	0.7413	0.1810	0.8473	0.3239	0.0454	0.0402	0.1247	0.0440	0.1247	0.1819	0.2508	0.0454	0.5431	0.0454	0.3020
	Titanium	Correlation Coefficient	0.395	0.112	0.286	-0.126	-0.822	-0.813	-0.392	-0.163	0.885	-0.705	-0.382	-0.307	0.638	0.878	-0.088
		Sig. (2-tailed)	0.2044	0.7292	0.3680	0.6967	0.0010	0.0013	0.2081	0.6124	0.0001	0.0104	0.2203	0.3319	0.0255	0.0002	0.7852
PCA Axes	PCA Axis 1 (60.3%)	Correlation Coefficient	-0.343	-0.140	-0.265	0.049	0.829	0.835	0.399	0.149	-0.870	0.713	0.437	0.314	-0.610	-0.843	0.032
		Sig. (2-tailed)	0.2745	0.6646	0.4060	0.8799	0.0009	0.0007	0.1991	0.6441	0.0002	0.0093	0.1558	0.3203	0.0351	0.0006	0.9220
	PCA Axis 2 (20.6%)	Correlation Coefficient	-0.121	0.350	-0.543	-0.203	0.384	0.461	0.305	-0.277	-0.580	0.459	0.328	-0.138	-0.589	-0.406	0.286
		Sig. (2-tailed)	0.7090	0.2652	0.0680	0.5273	0.2172	0.1318	0.3358	0.3841	0.0480	0.1333	0.2987	0.6698	0.0439	0.1908	0.3680
Copper Extracts	Exchangeable	Correlation Coefficient	-0.128	0.000	-0.642	-0.168	0.473	0.583	0.290	-0.128	-0.660	0.448	0.476	0.176	-0.487	-0.466	0.056
		Sig. (2-tailed)	0.6921	1.000	0.0244	0.6021	0.1207	0.0467	0.3605	0.6925	0.0196	0.1443	0.1180	0.5835	0.1085	0.1271	0.8617
	Carbonate	Correlation Coefficient	0.142	0.441	-0.063	0.294	-0.444	-0.493	-0.435	-0.440	0.450	-0.168	-0.616	-0.621	0.028	0.346	0.437
		Sig. (2-tailed)	0.6587	0.1517	0.8446	0.3541	0.1477	0.1034	0.1575	0.1526	0.1426	0.6018	0.0329	0.0312	0.9306	0.2711	0.1550
	Easily Reducible	Correlation Coefficient	0.205	0.210	0.247	0.231	-0.695	-0.738	-0.515	-0.156	0.798	-0.411	-0.780	-0.434	0.356	0.554	0.166
		Sig. (2-tailed)	0.5236	0.5128	0.4391	0.4705	0.0121	0.0062	0.0868	0.6282	0.0019	0.1849	0.0028	0.1588	0.2557	0.0617	0.6066
	Organic	Correlation Coefficient	0.128	-0.077	0.335	0.105	-0.688	-0.792	-0.326	0.057	0.790	-0.705	-0.335	-0.173	0.702	0.744	-0.236
		Sig. (2-tailed)	0.6921	0.8122	0.2870	0.7456	0.0134	0.0022	0.3006	0.8610	0.0022	0.0104	0.2867	0.5911	0.0109	0.0055	0.4596

Significant correlation; p-value < 0.0001 (Bonferroni corrected p-value for 336 comparisons among Table 6.8 and Appendix Table I.2).

Correlation scatterplot inspected; p <0.01.

[1] Values < method detection limit (MDL) were used at the MDL for calculations. Normalized survival and growth are relative to corresponding laboratory controls.

NA = Correlation was not performed between these two parameters.

Note: n=12 for all correlations.

responses in toxicity tests were limited to a slight reduction in survival of *C. dilutus* at area POL-2 (the south side of Polley Lake).

Benthic invertebrate density was positively related to dissolved oxygen and negatively related to specific conductance at the mid-depth areas at the Bonferroni-adjusted p-level (Table 6.7). The former is consistent with low dissolved oxygen at the time of sample collection. No relationships between benthic invertebrate community metrics and sediment chemistry were observed at the mid-depth areas at the Bonferroni-adjusted p-level (Table 6.7). Nine significant correlations were observed in the deep basins at the Bonferroni-adjusted p-level. Percent Chironomidae and CA-axis-1 (mainly representing the oligochaete worm *Lumbriculus*) were correlated with dissolved oxygen (positively and negatively, respectively), suggesting that the low dissolved oxygen observed in Polley Lake favours *Lumbriculus* over Chironomidae. Density, number of taxa and percent Chironomidae were all negatively correlated with specific conductance (Table 6.7), which represents a generic measure of the influence of the dam failure on water quality (i.e., represents higher combined ion concentration). Lastly, a positive correlation between Bray-Curtis dissimilarity and titanium, a negative correlation between percent chironomidae (non-biting midges) and arsenic, and positive correlation between CA axis 2 (which represents lower relative abundance of Chaoborus and higher relative abundance of the naidid *Vejdovskyella* and the chironomid *Einfeldia*) and concentrations of calcium and sodium were observed (Table 6.8; Appendix Figure I.5). At the $p<0.01$ level of significance, a number of additional relationships were apparent (Tables 6.7 and 6.8; Appendix Figure I.6). Although correlation does not necessarily indicate cause, taken together, the relationships observed in the two datasets indicate benthic invertebrate density and/or taxon richness were positively correlated with dissolved oxygen, sediment TOC and negatively correlated with specific a number of POIs and IPs – copper, iron and organic copper at the mid-depth areas and arsenic, copper, iron, most IPs, and copper in the easily reducible and organic phases in the basins. In the basins, both density and number of taxa were also positively correlated with sediment PCA axis 1, which represents concentrations of the POIs and IPs in the negative direction (Figure 6.3). Similarly, Bray-Curtis index of dissimilarity was positively correlated with a number of POIs, IPs and selective extracts of copper (Tables 6.7 and 6.8).

6.7 Data Integration, Summary and Spatial Extent

Sediment collected from Polley Lake following the dam failure was characterized by concentrations of copper greater than SQG PELs and pre-event concentrations and concentrations of arsenic, iron, and zinc greater than TELs and pre-event concentrations.

Copper concentrations at mid-depth areas were similar to pre-event concentrations, but concentrations in the deeper basins were higher than PELs and pre-event concentrations. Sediment geochemical evaluations indicated that, for most POIs and IPs, concentrations were mostly in the residual phase, a fraction that is not considered mobile or biologically available. However, copper was a notable exception, with the majority occurring in the "organic" phase (which appears to be mineral), and with concentrations in the exchangeable, carbonate and easily reducible phases greater than reference. Separate integrated consideration of mineralogy, sequential extraction results and mineral solubility indicates that these forms would not be mobile under environmentally realistic conditions (SRK 2015).

Sediment stratigraphy evaluation indicated that copper was elevated at the south basin at a depth of 6 to 10 cm below surface, indicating heterogeneous intrusion rather than surface influence (settling). Pore-water evaluation indicated some locally elevated metal concentrations at interfaces of mine-derived materials and native sediment. Failure-affected sediments were generally oxidizing, with sediment becoming more reducing with depth (sub-oxic but not sulphidic). Sediments were likely sufficiently reducing to drive reductive dissolution of iron oxides, but because mine-derived material is mostly mineral, this may not result in significant metal mobilization. This is consistent with separate evaluation of potential post-depositional mobility, which indicated very low risk of metal mobilization under reducing conditions (SRK 2015).

Sediment toxicity testing indicated no adverse effect to *H. azteca*, reduced survival of *C. dilutus* at one location (64%), and no effect on growth of *C. dilutus*. The benthic invertebrate community of Polley Lake had lower density and taxon richness than the reference lake (Bootjack Lake). Polley Lake density and taxon richness were within the range documented in some baseline studies, but below those documented in 1999 (the only pre-event sampling with full taxonomic data available). There were no benthic organisms at the south basin of Polley Lake, indicating an unequivocal impact. Benthic invertebrate community composition at the Polley Lake north basin differed dramatically from 1999, with greater proportional representation of oligochaetes and lower proportional representation of Chironomidae, whereas a similar difference was not observed at reference. As oligochaetes are pollution tolerant organisms, this suggests an impact to benthic invertebrate community composition.

Correlation analysis indicated few significant relationships between the toxicity tests endpoints and sediment physical/chemical conditions, which is consistent with limited biological response. Correlation analysis indicated significant relationships between several benthic invertebrate endpoints and TOC content and concentrations of POIs and IPs – in general, there were indications that benthic invertebrate density and taxon richness decreased and Bray-Curtis index of dissimilarity increased with lower TOC content and higher POI and IP concentrations, which suggests a failure-related effect on these metrics. A number of supporting benthic invertebrate community metrics (e.g., percent oligochaete worms and CA axes) showed similar relationships with POIs and IPs.

Overall, an impact of the dam failure was evident in sediment quality of Polley Lake. Copper represents the analyte of greatest concern, both with respect to its absolute concentration relative to guidelines and its geochemical partitioning. Sediment stratigraphic assessment indicated heterogeneous intrusion of mine-derived material and some evidence of metal mobility at interface locations due to reductive dissolution of oxidized mine-derived material. Separate evaluation of potential post-depositional mobility indicated very low risk of metal mobilization under reducing conditions (SRK 2015). Sediment toxicity testing indicated that response was restricted to a reduction in survival of *C. dilutus* at the Polley Lake south deep basin (Area P2), which was also the area of highest copper in potentially mobile phases (fractions 1 to 3). The benthic invertebrate community of Polley Lake had reduced density, taxon richness and some compositional differences relative to Bootjack Lake reference samples and significant relationships to TOC and the POIs and IPs suggests a failure-related effect on these metrics. Given the limited toxicity, it is likely that observed effects on the benthic invertebrate community are more physical (i.e., smothering and low TOC) than chemical. The influence of the dam failure was detectable throughout Polley Lake, but, as might be expected, was more substantial at the south side of the lake.

7.0 QUESNEL LAKE - LITTORAL

Sediment quality impact characterization in the littoral zone of Quesnel Lake included sediment chemistry, sediment geochemical characterization, sediment toxicity testing, and benthic invertebrate community characterization (Table 4.1; Figure 4.4). Data Quality Assessment (DQA; Appendix C with supporting data in Appendix J) indicated that sediment quality data, toxicity test results and benthic invertebrate community data were of good quality and can therefore be used in the sediment quality impact characterization.

7.1 Sediment Physical and Chemical Characterization

Surficial sediment (top 5 cm) within the near-field littoral areas of Quesnel Lake was composed of a mixture of light grey or tan coloured fines, very fine sand (orange and black in colour), and varying amounts of organic matter and woody debris. At the near-field area closest to the mouth of Hazeltine Creek (LNF1), sediment was generally composed entirely of light grey and tan coloured fines with moderate amounts of woody debris, while sediment at the second near-field area (LNF2) was composed of a layer of light grey or tan coloured fines over either hard packed fine sand or a considerable layer of fine organic matter mixed with grey fines. Sediment samples from the second near-field area (LNF2) had a sulphurous odour associated with the layer of fine organic matter that suggested anoxic conditions. Samples from all other littoral sampling areas in Quesnel Lake (reference, far-field, and far-far-field) were generally composed of medium or dark brown fines mixed with varying amounts of sand, organic or woody debris, and aquatic macrophytes (mainly Canadian waterweed; *Elodea canadensis*).

Sediment at the four exposed areas and two reference areas in the littoral zone of Quesnel Lake was predominantly silt and sand (Table 7.1; Appendix Table E.45). Sediment at LNF2 (the near-field area located to the south of the Hazeltine Creek mouth, where scour material flowed through the woods; Figure 4.4) had a higher proportion of silt and clay than all other areas (Table 7.1). Total organic carbon ranged from a low of 0.22% at LNF1 (the mouth of Hazeltine Creek) to 7.36% at LFFF (the far-far-field area located north of Cedar Point near the Town of Likely and the Quesnel Lake outlet; Tables 7.1 and 7.2; Figure 4.4). A spatial pattern of increasing TOC was evident proceeding from area LNF1 to LFFF (Tables 7.1 and 7.2), associated with the input of failure-derived materials low in TOC content. Sediments collected at LNF2 had greater TOC content (2.69%) than those collected at LNF1, possibly due to the presence of the organic debris observed in the field.

Table 7.1: Summary of sediment quality data for Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Metals data are based on the < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		Reference 95th Percentile [3]		Reference				Exposed							
						LRef1 (QUL-51)		LRef2 (QUL-52)		LNF1 (QUL-45)		LNF2 (QUL-49)		LFF (QUL-47)		LFFF (QUL-48)	
		TEL	PEL	LRef1	LRef2 [4]	Mean	t*SE	Mean [4]	t*SE [4]	Mean	t*SE	Mean	t*SE	Mean	t*SE	Mean	t*SE
Physical Tests																	
Moisture	%	-	-	43.7	53.4	40.7	3.39	48.9	12.1	32.6	5.99	46.4	7.05	48.0	11.4	73.6	9.47
pH (1:2 soil:water)	pH	-	-	6.37	-	6.56	0.20	-	-	8.48	0.26	8.48	0.83	6.84	0.28	6.38	0.29
Particle Size																	
% Gravel (>2mm)	%	-	-	1.8	0.1	1.0	0.80	0.11	0.043	1.1	2.9	0.11	0.039	1.47	1.70	5.2	5.74
% Sand (2.0mm - 0.063mm)	%	-	-	66	59.0	60	7.9	38	55	49	2.7	8.4	4.9	66	10	35	18.0
% Silt (0.063mm - 4um)	%	-	-	42	76.4	35	8.0	59	52	42	2.5	85	4.2	30	10	54	16.7
% Clay (<4um)	%	-	-	4.9	6.3	4.2	0.73	3.9	6.3	8.1	2.3	6.8	2.2	2.9	1.5	5.4	5.25
Texture	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leachable Anions & Nutrients																	
pH	pH	-	-	6.06	-	6.08	0.021	-	-	8.53	0.30	7.03	0.37	-	-	-	-
Anions and Nutrients																	
Total Nitrogen by LECO (TN)	%	-	-	0.071	0.138	0.066	0.0062	0.113	0.070	<0.020	0	0.100	0.084	0.102	0.088	0.482	0.362
Organic / Inorganic Carbon																	
Total Organic Carbon (TOC)	%	-	-	0.83	2.53	0.75	0.10	1.97	1.47	0.22	0.083	2.69	2.27	2.33	3.12	7.36	4.22
Metals																	
Aluminum	mg/kg	-	-	10,340	22,520	9,788	587	20,233	7,102	15,020	979	15,400	800	12,738	2,928	18,420	4,058
Antimony	mg/kg	-	-	0.22	<0.10	0.19	0.02	<0.10	0	0.38	0.052	0.38	0.022	0.23	0.13	0.83	0.55
Arsenic	mg/kg	5.9	17	3.91	2.29	3.48	0.409	2.09	0.502	**10.9**	0.97	**10.3**	0.70	3.37	1.51	**9.06**	6.62
Barium	mg/kg	-	-	94.6	71.5	77.8	16.0	54.8	49.0	149	12.9	175	6.88	58.4	29.7	111	112
Beryllium	mg/kg	-	-	0.26	0.62	0.24	0.019	0.51	0.29	0.59	0.074	0.54	0.024	0.32	0.042	0.44	0.14
Bismuth	mg/kg	-	-	<0.20	0.38	<0.20	0	0.29	0.24	<0.20	0	<0.20	0	<0.20	0	<0.20	0
Boron	mg/kg	-	-	<10	<10	<10	0	<10	0	<10	0	<10	0	<10	0	<10	0
Cadmium	mg/kg	0.6	3.5	0.220	0.091	0.207	0.0134	0.079	0.051	0.148	0.0420	0.175	0.0464	0.149	0.106	0.483	0.298
Calcium	mg/kg	-	-	5,960	11,035	5,464	459	8,133	8,581	22,720	1,353	23,340	1,202	9,830	2,023	9,576	1,501
Chromium	mg/kg	37.3	90	35.9	48.4	35.4	0.624	43.3	16.2	15.0	4.40	17.0	0.82	33.0	11.6	47.0	15.9
Cobalt	mg/kg	-	-	9.4	21.7	8.51	0.850	18.3	8.90	15.7	1.58	14.5	0.67	10.0	1.81	14.2	4.78
Copper	mg/kg	35.7	197	20.4	39.1	19.3	1.48	29.8	27.4	**728**	76.3	**462**	40.4	25.3	3.70	**70.5**	50.1
Iron	mg/kg	21,200	43,776	18,700	44,220	17,940	768	39,567	11,856	**44,920**	2,264	**46,100**	7,206	22,360	4,887	28,740	6,162
Lead	mg/kg	35	91	3.2	12.4	3.11	0.136	10.5	6.32	4.91	0.30	5.42	0.428	4.51	1.13	8.54	2.03
Lithium	mg/kg	-	-	8.7	44.2	8.4	0.48	38.0	19.5	14.9	1.24	14.4	1.14	11.1	0.74	16.8	2.29
Magnesium	mg/kg	-	-	5,658	11,200	5,258	401	9,963	3,808	9,180	710	8,786	708	6,376	1,542	9,392	4,122
Manganese	mg/kg	460	1,100	299	507	252	51.2	398	304	**600**	63.2	**616**	50.1	298	43.7	358	90.5
Mercury	mg/kg	0.17	0.49	0.0258	-	0.0246	0.00143	-	-	0.0848	0.0044	0.0652	0.029	0.0510	0.0242	0.0829	0.0337
Molybdenum	mg/kg	-	-	0.52	<0.50	0.51	0.017	<0.50	0	3.61	0.410	3.03	0.211	<0.50	0	0.96	0.38
Nickel	mg/kg	16	75	24.0	58.0	21.7	2.23	49.1	24.6	10.2	0.91	13.6	1.41	23.5	1.89	42.3	6.94
Phosphorus	mg/kg	-	-	876	725	821	56.6	646	206	1,212	64.1	1,194	132	598	232	765	84.2
Potassium	mg/kg	-	-	736	3,598	702	46.8	2,730	2,537	1,380	122	1,452	90.1	756	300	1,096	414
Selenium	mg/kg	2	-	0.42	0.29	0.36	0.057	0.25	0.12	0.95	0.10	0.79	0.080	0.48	0.62	1.4	1.31
Thallium	mg/kg	-	-	0.098	0.278	0.084	0.015	0.21	0.19	<0.050	0	<0.050	0	0.051	0.0022	0.11	0.0369
Tin	mg/kg	-	-	<2.0	<2.0	<2.0	0	<2.0	0	<2.0	0	<2.0	0	<2.0	0	<2.0	0
Titanium	mg/kg	-	-	936	994	860	70.8	876	303	1,222	112	1,314	148	1,047	283	852	591
Silver	mg/kg	0.5	-	<0.10	<0.10	<0.10	0	<0.10	0	0.33	0.029	0.24	0.014	0.10	0	0.30	0.36
Sodium	mg/kg	-	-	268	358	238	35.6	343	37.9	944	46.9	806	41.7	290	217	202	38.7
Strontium	mg/kg	-	-	39.9	91.6	38.3	1.71	79.9	39.6	155	15.2	159	10.3	70.9	38.8	66.1	16.1
Uranium	mg/kg	-	-	0.673	1.63	0.621	0.0474	1.38	0.974	0.876	0.0747	1.08	0.134	0.767	0.365	1.21	0.36
Vanadium	mg/kg	-	-	49.2	37.0	46.0	3.44	32.6	12.3	168	7.53	166	32.8	71.7	25.9	70.8	24.1
Zinc	mg/kg	123	315	47.6	81.3	44.7	3.07	73.8	22.2	53.8	7.05	54.0	2.43	39.5	4.61	87.9	46.2

(blue) Value is > TEL. Values shown in bold text also exceed Reference 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed Reference 95th Percentile values.

[1] Reported TOC, TN, pH, and moisture data are based on bulk sediment. Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Reference 95th percentile was calculated using displayed metals data for the < 2mm sediment fraction, and using displayed TOC, pH, TN, particle size and moisture data. The 5th percentile is reported for pH.

[4] Summary statistics (95th percentile, mean, t*SE, and maximum) for reference area LRef2 are based only on data from replicates QUL-52-01 to QUL-52-03 due to high sand content in replicates QUL-52-04 and QUL-52-05 (> 90%).

Table 7.2: Summary of sediment quality data for Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Data are based on the < 63µm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		Reference 95th Percentile [3]		Reference				Exposed							
						LRef1 (QUL-51)		LRef2 (QUL-52)		LNF1 (QUL-45)		LNF2 (QUL-49)		LFF (QUL-47)		LFFF (QUL-48)	
		TEL	PEL	LRef1	LRef2	Mean	t*SE	Mean	t*SE	Mean	t*SE	Mean	t*SE	Mean	t*SE	Mean	t*SE
Physical Tests																	
pH (1:2 soil:water)	pH	-	-	6.32	6.40	6.54	0.264	7.06	0.874	8.57	0.37	8.00	0.43	6.55	0.38	6.06	0.58
Organic / Inorganic Carbon																	
Total Organic Carbon	%	-	-	1.35	1.92	1.12	0.231	1.63	0.410	0.21	0.088	0.52	0.27	1.78	1.50	5.83	2.38
Metals																	
Aluminum	mg/kg	-	-	14,760	25,540	13,260	1,717	21,140	4,120	17,920	1,101	15,180	1,221	12,440	1,822	17,360	1,547
Antimony	mg/kg	-	-	0.36	<0.10	0.30	0.064	<0.10	0	0.43	0.029	0.37	0.063	0.23	0.059	0.72	0.53
Arsenic	mg/kg	5.9	17	4.92	2.54	4.08	0.96	2.27	0.253	**13.0**	0.61	**10.6**	1.46	3.09	1.21	**9.52**	6.93
Barium	mg/kg	-	-	133	77	124	9.63	51.7	23.8	195	15.8	168	12.3	55.4	10.3	78.5	20.7
Beryllium	mg/kg	-	-	0.39	0.69	0.35	0.044	0.53	0.15	0.68	0.059	0.54	0.068	0.30	0.026	0.40	0.066
Bismuth	mg/kg	-	-	0.14	0.47	0.11	0.022	0.30	0.15	<0.10	0	<0.10	0	0.10	0.0056	0.12	0.027
Boron	mg/kg	-	-	<10	<10	<10	0	<10	0	<10	0	<10	0	<10	0	<10	0
Cadmium	mg/kg	0.6	3.5	0.351	0.114	0.313	0.0423	0.0916	0.022	0.133	0.0167	0.138	0.0123	0.173	0.108	0.389	0.121
Calcium	mg/kg	-	-	7,736	14,400	7,136	662	8,698	5,211	28,300	2,112	23,860	3,432	8,712	1,368	9,886	1,226
Chromium	mg/kg	37.3	90	54.2	58.1	49.5	5.10	46.5	10.8	15.5	1.96	16.8	1.80	43.8	11.4	**60.2**	9.08
Cobalt	mg/kg	-	-	11.9	24.2	10.3	1.75	17.5	6.10	20.3	1.06	14.9	1.54	9.32	1.80	13.9	3.11
Copper	mg/kg	35.7	197	34.8	49.4	30.3	4.58	33.1	14.8	**652**	65.3	**462**	39.3	30.1	4.16	**55.8**	22.2
Iron	mg/kg	21,200	43,776	26,180	48,160	23,680	2,715	39,860	7,451	**62,740**	9,079	**50,640**	12,670	23,240	5,315	29,360	4,252
Lead	mg/kg	35	91	6.01	14.6	5.27	0.761	11.9	2.56	5.76	0.252	5.27	0.371	5.31	1.29	9.16	2.37
Lithium	mg/kg	-	-	13.2	45.8	11.5	1.77	38.2	7.31	18.2	1.51	14.7	1.48	11.8	2.48	16.1	1.31
Magnesium	mg/kg	-	-	6,950	12,320	6,360	621	10,306	1,876	11,320	862	8,434	808	6,356	1,600	9,984	1,627
Manganese	mg/kg	460	1,100	365	529	309	66.1	366	147	**695**	47.7	**574**	53.1	274	60.3	331	55.9
Mercury	mg/kg	0.17	0.49	0.0457	0.0171	0.0377	0.0076	0.0150	0.0023	0.0773	0.0046	0.0736	0.00808	0.0463	0.0188	0.0725	0.0265
Molybdenum	mg/kg	-	-	0.86	0.44	0.78	0.10	0.38	0.070	3.75	0.250	2.84	0.220	0.73	0.60	1.10	0.51
Nickel	mg/kg	16	75	33.1	69.1	29.3	4.22	52.1	15.6	12.2	0.566	12.7	0.651	26.1	5.57	46.3	7.77
Phosphorus	mg/kg	-	-	1,230	1,114	1,136	110	1,006	143	1,660	176	1,388	264	863	311	734	54.9
Potassium	mg/kg	-	-	1,312	4,328	1,120	211	2,590	1,594	1,786	109	1,438	177	762	165	1,156	209
Selenium	mg/kg	2	-	0.70	0.32	0.58	0.13	0.27	0.044	1.02	0.040	0.75	0.072	0.53	0.48	**2.10**	1.97
Silver	mg/kg	0.5	-	0.166	0.124	0.144	0.0241	0.082	0.040	0.325	0.0300	0.237	0.0249	0.083	0.051	0.194	0.112
Sodium	mg/kg	-	-	406	424	386	20.8	362	71.0	1,160	57.6	784	51.6	274	122	248	43.4
Strontium	mg/kg	-	-	70.4	114	63.3	8.17	81.2	30.4	193	14.3	151	12.7	60.3	14.0	71.2	18.9
Thallium	mg/kg	-	-	0.148	0.310	0.123	0.025	0.180	0.118	<0.050	0	<0.050	0	0.056	0.012	0.095	0.035
Tin	mg/kg	-	-	0.40	0.56	0.35	0.058	0.42	0.13	1.63	0.123	1.20	0.339	0.33	0.11	1.18	1.19
Titanium	mg/kg	-	-	1,084	1,071	990	107	721	320	1,690	94.1	1,304	351	956	302	1,067	202
Uranium	mg/kg	-	-	1.15	1.95	0.988	0.177	1.64	0.305	1.21	0.131	0.958	0.140	0.933	0.254	1.19	0.330
Vanadium	mg/kg	-	-	61.5	39.9	56.9	5.07	30.6	8.65	235	31.9	182	55.4	67.9	29.0	72.6	15.8
Zinc	mg/kg	123	315	68.2	87.6	60.8	8.00	74.5	12.0	63.1	5.40	54.3	2.05	45.1	4.27	73.8	10.0

(blue) Value is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Summary statistics are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Reference 95th percentile was calculated using displayed data for the <63µm sediment fraction. The 5th percentile is reported for pH.

Arsenic, copper, iron and manganese were the only analytes with concentrations in Quesnel Lake near-field littoral sediment exposed areas greater than guidelines (PELs in the case of copper and iron, and TELs in the case of arsenic and manganese) and reference concentrations (Tables 7.1 and 7.2; Figure 7.1). However, it is notable that concentrations of arsenic and manganese were similar to or lower than those previously encountered in Hazeltine Creek (Tables 3.2 and 3.3; Tables 5.1 and 5.2). Concentrations of ten additional analytes were present in Quesnel Lake littoral sediment at concentrations more than two times greater than reference concentrations (barium, calcium, mercury, molybdenum, selenium, silver, sodium, strontium, tin and vanadium; Tables 7.3 and 7.4). This list includes the IPs identified for Hazeltine Creek (Section 5.1), with the addition of barium, mercury, selenium, strontium, tin and vanadium. Concentrations of both mercury and selenium were similar to or lower than those previously encountered in Hazeltine Creek (Tables 3.2 and 3.3; Tables 5.1 and 5.2). In accordance with the framework set out in Section 4.0, arsenic, copper, iron and manganese are designated as POIs and barium, calcium, mercury, molybdenum, selenium, silver, sodium, strontium, tin and vanadium are designated as IPs. All POIs identified in the evaluations of Hazeltine Creek and Polley Lake (i.e., arsenic, copper, iron, manganese and nickel; Sections 5 to 6) are considered as part of this characterization of Quesnel Lake littoral sediment.

Principal Components Analysis (PCA) was effective in distinguishing sediments of the near-field exposed areas (LNF1 and LNF2) from other areas primarily on the basis of negative axis 1 scores, indicating finer sediment and higher concentrations of a number of metals (arsenic, barium, beryllium, calcium, cobalt, copper, iron, magnesium, manganese, molybdenum, phosphorus, potassium, silver, sodium, and vanadium; Figure 7.2). With the exception of mercury, selenium, tin and vanadium, this list includes all POIs and IPs identified above and serves to confirm their importance.

Of the four POIs and ten IPs, copper was the most substantially elevated, with concentrations up to approximately 3.7 times the PEL and 24 times reference (Tables 7.1 to 7.4; Figures 7.1 and 7.3). Copper concentration was greatest at areas LNF1 and LNF2 (near-field areas, and was slightly enriched in the <2 mm fraction relative to the <63 µm fraction; Figure 7.1). Concentrations of the other POIs were generally enriched in the <63 µm fraction relative to the <2 mm fraction (Figure 7.1). Concentrations of arsenic, copper, iron and manganese decreased with distance from LNF1 to LFF, but were generally greater at LFFF than at LFF (Figure 7.1), presumably due to the much higher concentration of TOC at LFFF rather than any failure-related influence (similar elevations of chromium, nickel and selenium were also observed at LFFF, presumably for the same

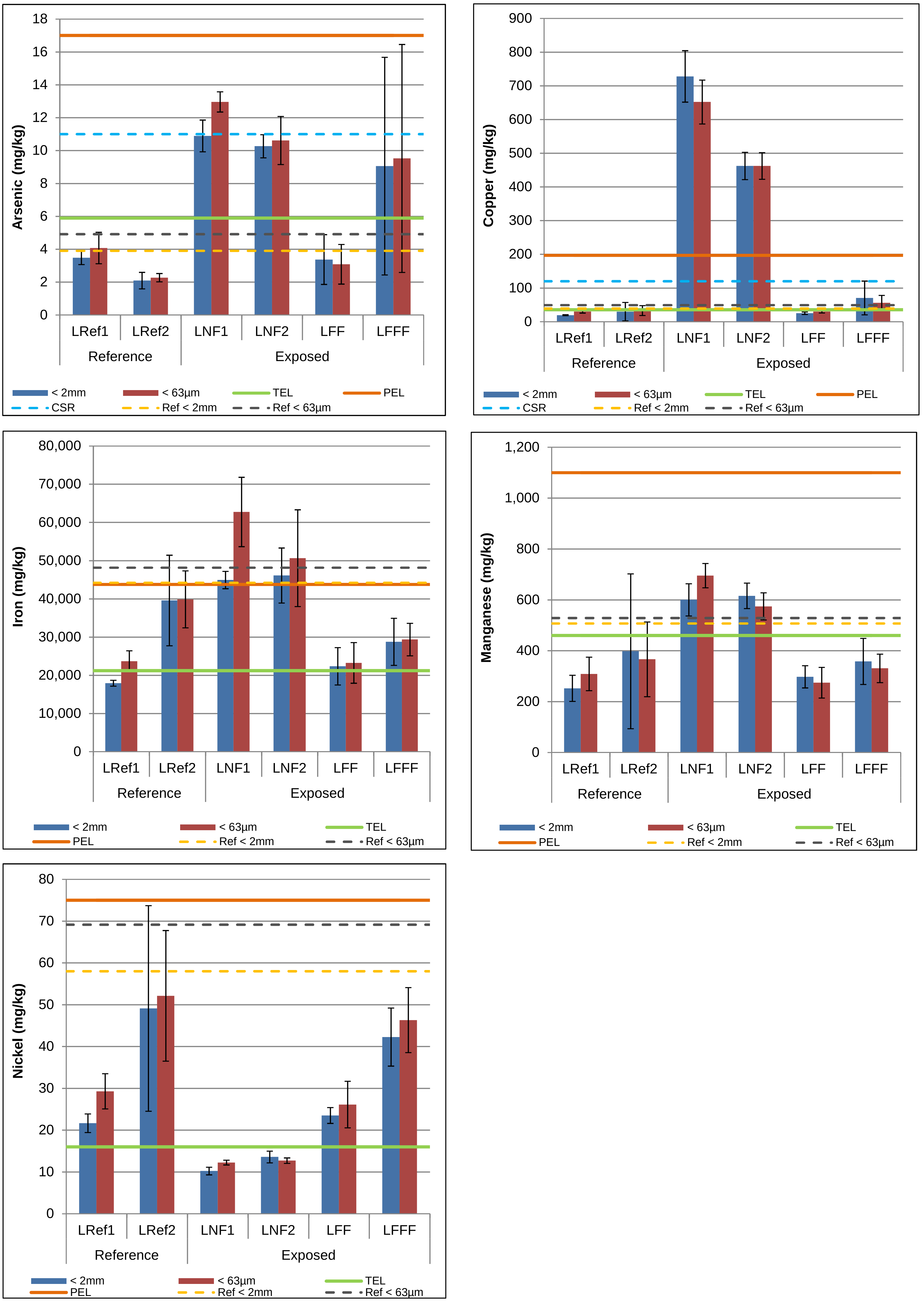


Figure 7.1: Mean metal concentrations (± t*SE) in sediment from Quesnel Lake littoral sampling areas for parameters of interest identified in Quesnel Lake littoral and other sampling areas (Polley Lake), Mount Polley Mine, 2014.

TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level; CSR = Contaminated Sites Regulation - Sensitive; BG = Historic 95th percentile. Ref < 2mm and Ref < 63 µm values were selected as the highest 95th percentile value for an anlalyte in either the LRef1 or LRef2 reference areas for the < 2mm and < 63 µm sediment fractions.

Table 7.3: Ratio of exposed mean to reference mean metal concentrations[1,2] in the < 2mm fraction of sediment from littoral sampling areas of Quesnel Lake, Mount Polley Mine, 2014. Ratios with a value > 2 are highlighted.

Analyte	Exposed sampling area			
	LNF1 (QUL-45)	LNF2 (QUL-49)	LFF (QUL-47)	LFFF (QUL-48)
Organic / Inorganic Carbon				
Total Organic Carbon (TOC)	0.1	1.4	1.2	3.7
Metals				
Aluminum	0.7	0.8	0.6	0.9
Antimony	2.0	2.0	1.2	4.3
Arsenic	3.1	3.0	1.0	2.6
Barium	1.9	2.3	0.8	1.4
Beryllium	1.2	1.1	0.6	0.9
Bismuth	0.7	0.7	0.7	0.7
Boron	1.0	1.0	1.0	1.0
Cadmium	0.7	0.8	0.7	2.3
Calcium	2.8	2.9	1.2	1.2
Chromium	0.3	0.4	0.8	1.1
Cobalt	0.9	0.8	0.5	0.8
Copper	24.4	15.5	0.8	2.4
Iron	1.1	1.2	0.6	0.7
Lead	0.5	0.5	0.4	0.8
Lithium	0.4	0.4	0.3	0.4
Magnesium	0.9	0.9	0.6	0.9
Manganese	1.5	1.5	0.7	0.9
Mercury	3.4	2.7	2.1	3.4
Molybdenum	7.1	6.0	1.0	1.9
Nickel	0.2	0.3	0.5	0.9
Phosphorus	1.5	1.5	0.7	0.9
Potassium	0.5	0.5	0.3	0.4
Selenium	2.7	2.2	1.3	3.8
Silver	3.3	2.4	1.0	3.0
Sodium	2.7	2.3	0.8	0.6
Strontium	1.9	2.0	0.9	0.8
Thallium	0.2	0.2	0.2	0.5
Tin	1.0	1.0	1.0	1.0
Titanium	1.4	1.5	1.2	1.0
Uranium	0.6	0.8	0.6	0.9
Vanadium	3.6	3.6	1.6	1.5
Zinc	0.7	0.7	0.5	1.2

[1] The highest mean concentration for each analyte from among the littoral reference areas (LRef1 and LRef2) was used as the reference mean for calculation of the ratio.

[2] Mean values < method detection limit (MDL) were used at the MDL for calculation of exposed/reference ratios.

Table 7.4: Ratio of exposed mean to reference mean metal concentrations[1,2] in the < 63µm fraction of sediment from littoral sampling areas of Quesnel Lake, Mount Polley Mine, 2014. Ratios with a value > 2 are highlighted.

Analyte	Exposed sampling area			
	LNF1 (QUL-45)	LNF2 (QUL-49)	LFF (QUL-47)	LFFF (QUL-48)
Organic / Inorganic				
Total Organic Carbon	0.1	0.3	1.1	3.6
Metals				
Aluminum	0.8	0.7	0.6	0.8
Antimony	1.4	1.3	0.8	2.4
Arsenic	3.2	2.6	0.8	2.3
Barium	1.6	1.4	0.4	0.6
Beryllium	1.3	1.0	0.6	0.8
Bismuth	0.3	0.3	0.3	0.4
Boron	1.0	1.0	1.0	1.0
Cadmium	0.4	0.4	0.6	1.2
Calcium	3.3	2.7	1.0	1.1
Chromium	0.3	0.3	0.9	1.2
Cobalt	1.2	0.9	0.5	0.8
Copper	19.7	13.9	0.9	1.7
Iron	1.6	1.3	0.6	0.7
Lead	0.5	0.4	0.4	0.8
Lithium	0.5	0.4	0.3	0.4
Magnesium	1.1	0.8	0.6	1.0
Manganese	1.9	1.6	0.7	0.9
Mercury	2.1	2.0	1.2	1.9
Molybdenum	4.8	3.6	0.9	1.4
Nickel	0.2	0.2	0.5	0.9
Phosphorus	1.5	1.2	0.8	0.6
Potassium	0.7	0.6	0.3	0.4
Selenium	1.7	1.3	0.9	3.6
Silver	2.2	1.6	0.6	1.3
Sodium	3.0	2.0	0.7	0.6
Strontium	2.4	1.9	0.7	0.9
Thallium	0.3	0.3	0.3	0.5
Tin	3.9	2.9	0.8	2.8
Titanium	1.7	1.3	1.0	1.1
Uranium	0.7	0.6	0.6	0.7
Vanadium	4.1	3.2	1.2	1.3
Zinc	0.8	0.7	0.6	1.0

[1] The highest mean concentration for each analyte from among the littoral reference areas (LRef1 and LRef2) was used as the reference mean for calculation of the ratio.

[2] Mean values < method detection limit (MDL) were used at the MDL for calculation of exposed/reference ratios.

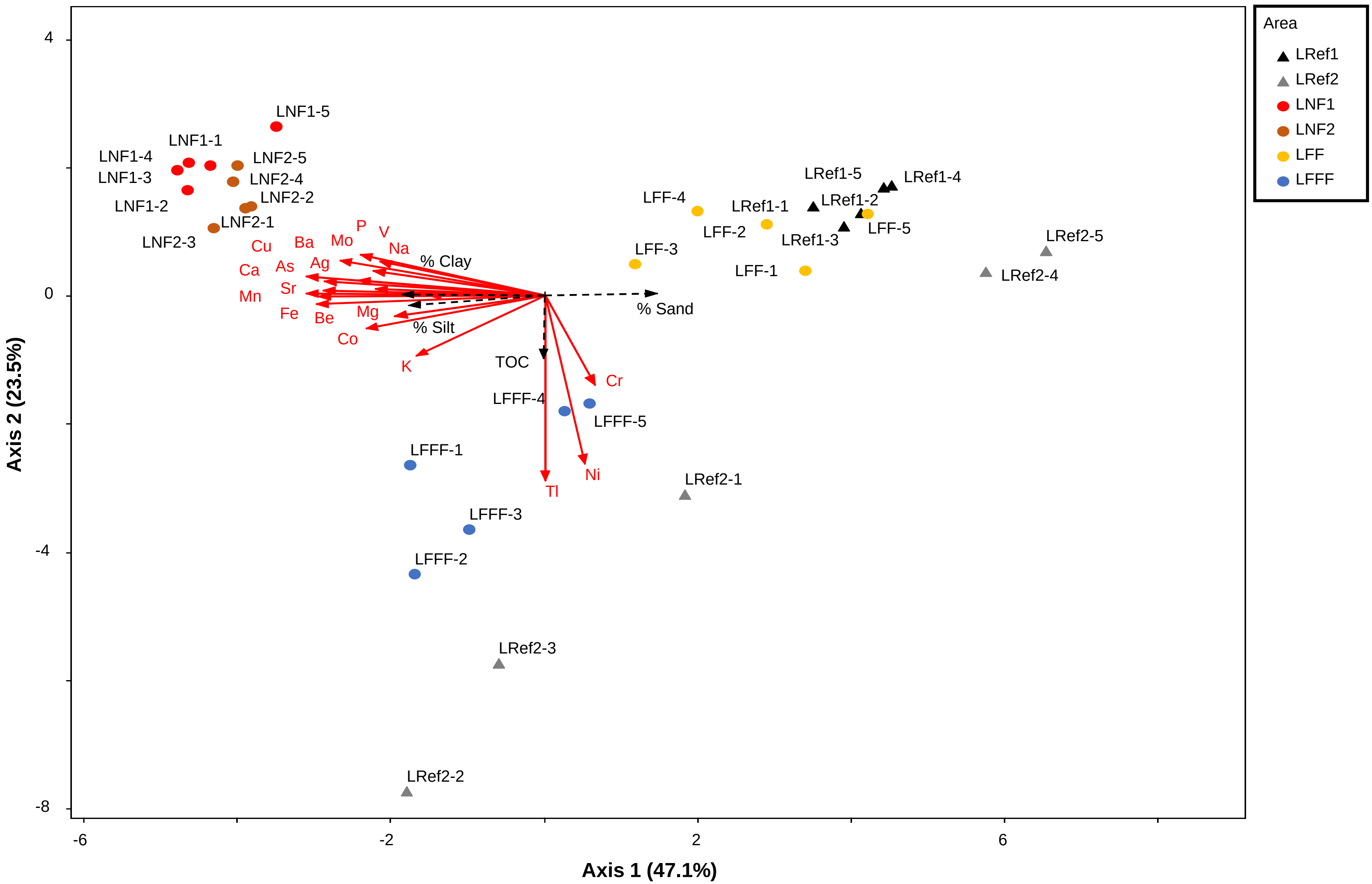


Figure 7.2: Biplot of principal component analysis (PCA) of metal concentrations in sediment (<2 mm fraction) from Quesnel Lake littoral sampling stations, Mount Polley Mine, 2014. Vector length is proportional to the magnitude of direct correlation of metals (solid red vector lines) and indirect correlation of sediment physical characteristics (black dashed vector lines) with PCA values of each axis (Appendix Tables E.47-E.48). Only metals with significant (p-value <0.010) Spearman's correlation and r-values > 0.7 with either axis are displayed, all sediment physical characteristics are displayed [a].

[a] Boron, mercury, and tin were excluded from calculations due to a lack of variability in the data (all values for each analyte were the same), or an incomplete data set.

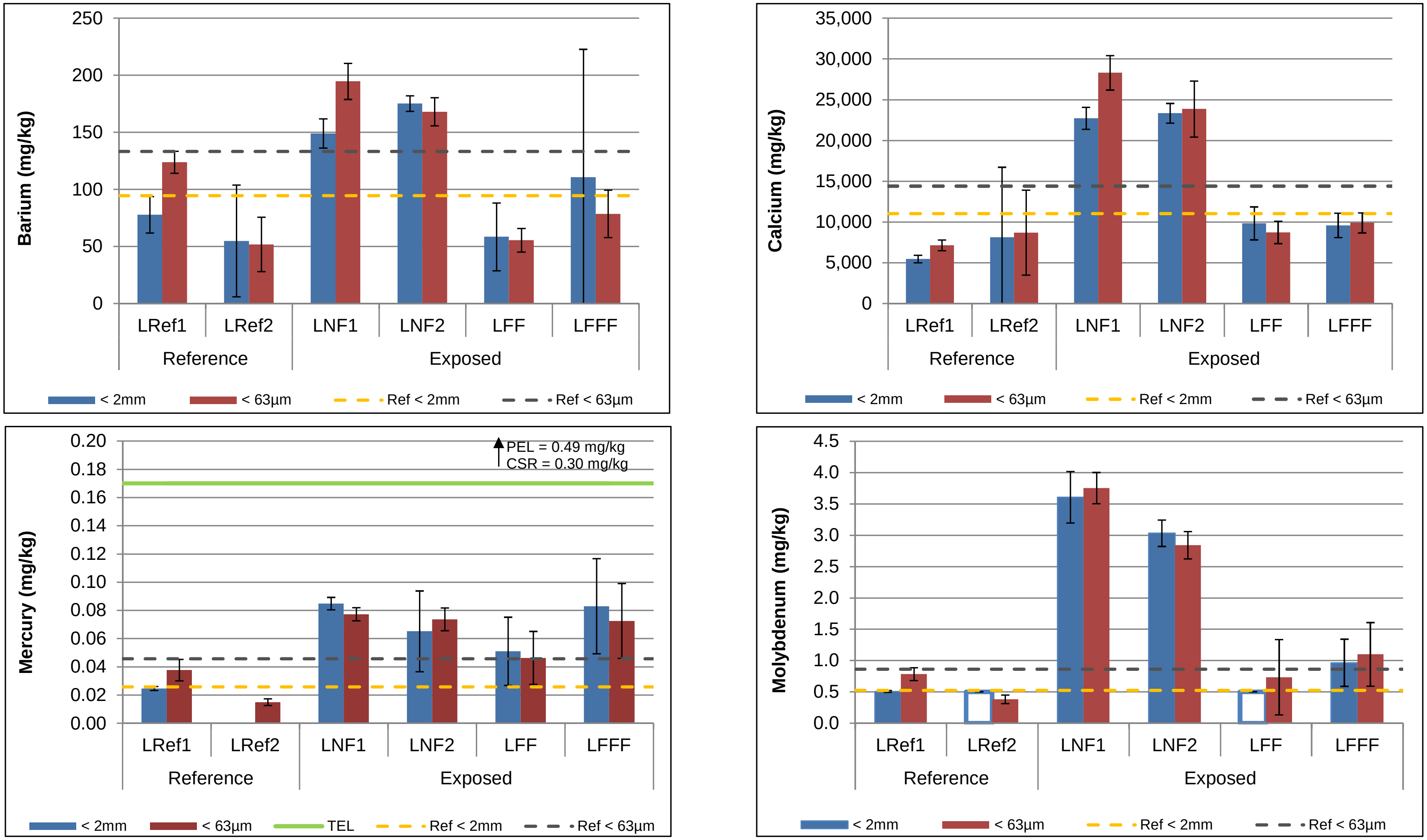


Figure 7.3: Mean metal concentrations (± t*SE) for indicator parameters in sediment from littoral sampling areas in Quesnel Lake, Mount Polley Mine, 2014. Hollow bars indicate all values used to calculate the mean were < the method detection limit.

TEL = Threshold (or Lowest) Effect Level; BG = Historic 95th percentile; CSR = Contaminated Sites Regulation - Sensitive. Ref < 2mm and Ref < 63 µm values were selected as the highest 95th percentile value for an anlalyte in either the LRef1 or LRef2 reference areas for the < 2mm and < 63 µm sediment fractions.

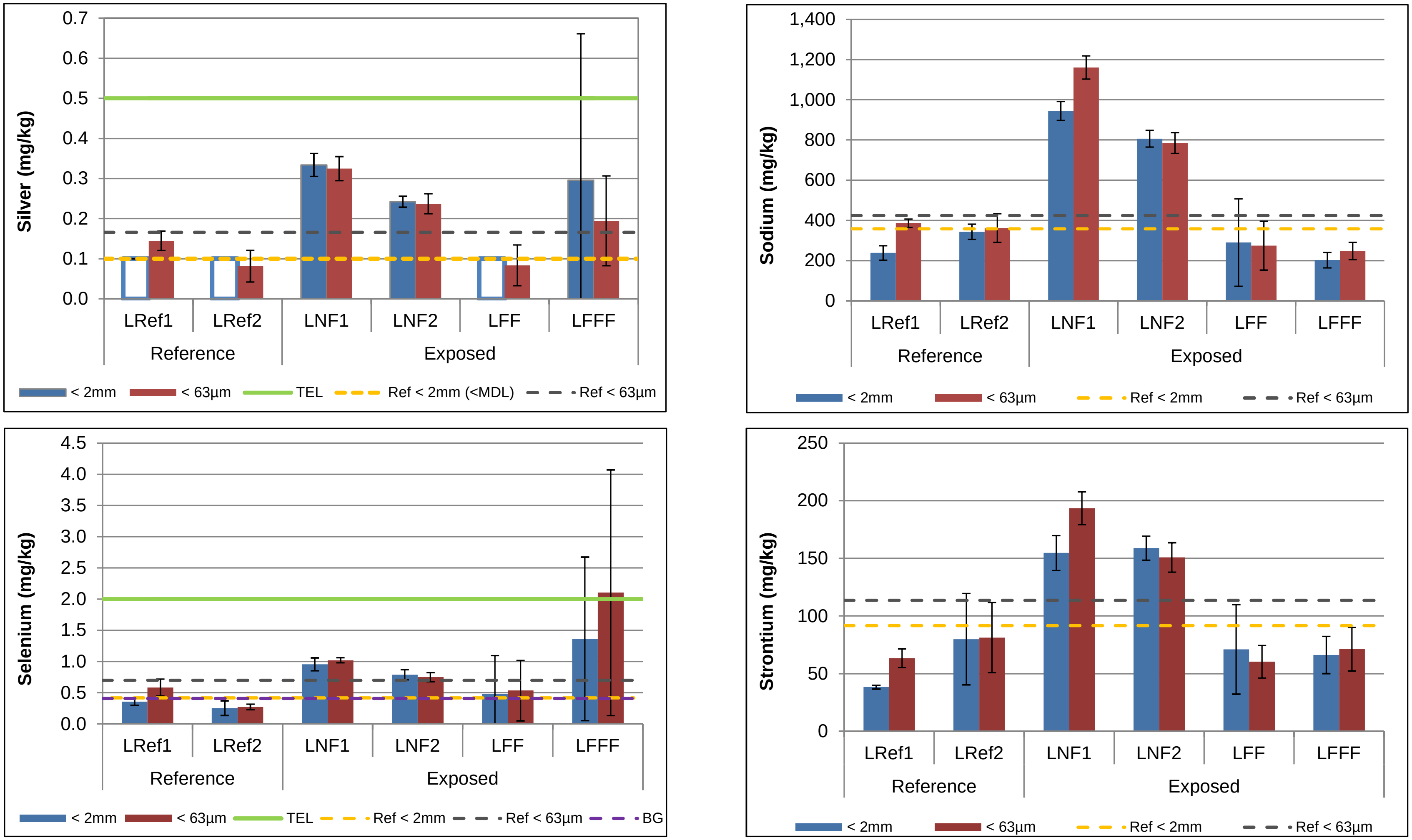
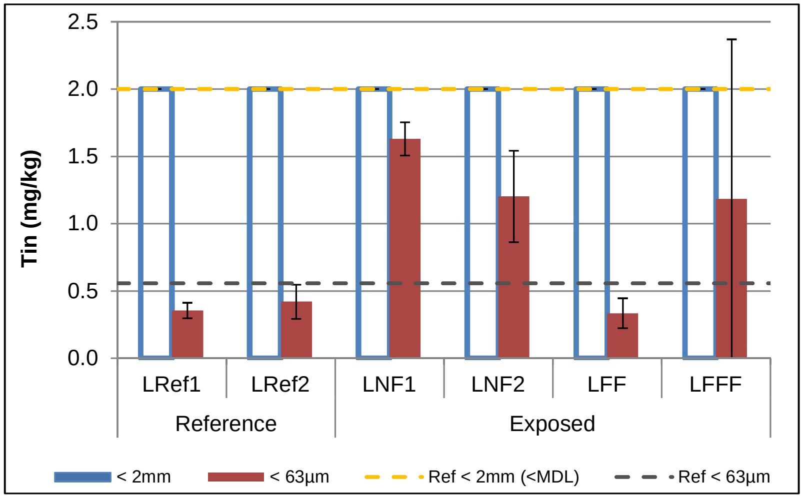


Figure 7.3: Mean metal concentrations (± t*SE) for indicator parameters in sediment from littoral sampling areas in Quesnel Lake, Mount Polley Mine, 2014. Hollow bars indicate all values used to calculate the mean were < the method detection limit.

TEL = Threshold (or Lowest) Effect Level; BG = Historic 95th percentile; CSR = Contaminated Sites Regulation - Sensitive. Ref < 2mm and Ref < 63 µm values were selected as the highest 95th percentile value for an anlalyte in either the LRef1 or LRef2 reference areas for the < 2mm and < 63 µm sediment fractions.



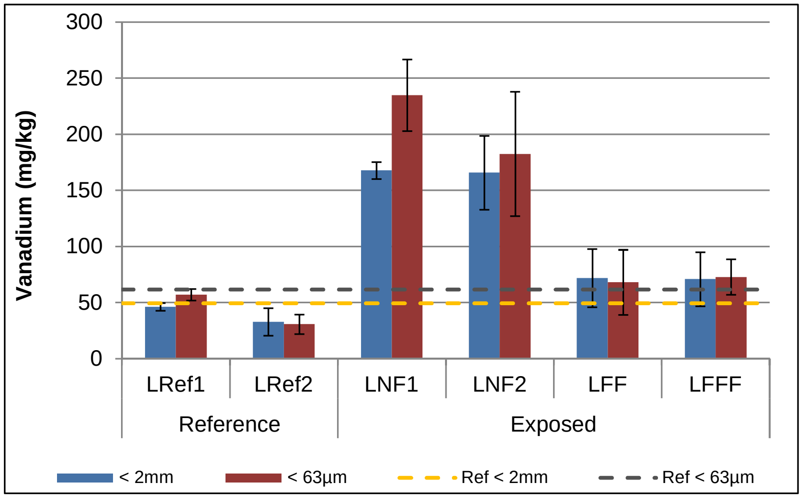


Figure 7.3: Mean metal concentrations (± t*SE) for indicator parameters in sediment from littoral sampling areas in Quesnel Lake, Mount Polley Mine, 2014. Hollow bars indicate all values used to calculate the mean were < the method detection limit.

TEL = Threshold (or Lowest) Effect Level; BG = Historic 95th percentile; CSR = Contaminated Sites Regulation - Sensitive. Ref < 2mm and Ref < 63 µm values were selected as the highest 95th percentile value for an anlalyte in either the LRef1 or LRef2 reference areas for the < 2mm and < 63 µm sediment fractions.

reason). Concentrations of POIs were below SQG-TELs and/or reference at area LFF (Figure 7.1). Similarly, concentrations of all IPs decreased with distance from LNF1 to LFF, but were generally greater at LFFF than at LFF (Figure 7.3). Concentrations of IPs were generally similar to reference at area LFF (Figure 7.3).

Concentrations of all POIs and most IPs were positively correlated with percent fines (percent silt and clay), and there were no negative correlations with percent fines (Table 7.5; Appendix Figures E.25-E.26). Only two statistically significant relationships were observed with sediment total organic carbon (TOC) content – a positive relationship with nickel and a negative relationship with sodium (Table 7.5; Appendix Figure E.25). Thus, the dominant physical relationship was a positive relationship between concentrations of POIs and IPs and fines.

7.2 Sediment Geochemical Characterization

As previously indicated, there are numerous factors that affect the bioavailability of metals in sediments. While metal concentrations that are below the sediment quality guidelines generally provide a reliable indicator of an absence of effect, sediment quality results that exceed those benchmarks provide a less reliable indication that effects are probable. Geochemical characterization can assist in characterizing the potential mobility and bioavailability of metals associated with mine-influenced sediments.

Selective extractions indicated that concentrations of most POIs and IPs were primarily in the residual phase; that is, they could only be extracted by the strongest acid digest (a combination of concentrated nitric and hydrochloric acid; Table 7.6; Appendix Table E.51; Figure 7.4; Appendix Figures E.27-E.28). As previously discussed, residual metals are unlikely to be mobilized under any conditions that could realistically occur in the environment, nor in interactions with aquatic organisms (i.e., contact with the gill or ingestion) and are therefore considered not biologically available (e.g., Tessier et al. 1979; Campbell and Tessier 1996). Exceptions included copper and molybdenum, which had greatest concentrations of in the “organic” phase (Figure 7.4; Appendix Figures E.27-E.28). As previously discussed (Section 5.2), it is likely that the “organic” phase represents mineral copper. This copper partitioning differed substantially from that observed in reference sediment and far-field sediment, where copper approximately 60% of sediment-associated copper was in residual form (Figure 7.4).

Concentrations of copper in Fractions 1 to 3 (exchangeable + carbonate bound + reducible) at near-field areas exceeded reference (Figure 7.4). However, separate integrated consideration of mineralogy, sequential extraction results and mineral solubility

Table 7.5: Spearman's Rank Correlation results for correlation of concentrations of parameters of interest and indicator parameters (in < 2mm sediment fraction) relative to % fines (silt and clay) and total organic carbon in sediment from Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014 [1].

	Metal	Correlation Parameter	Silt and Clay (%)	Total Organic Carbon (%)
Parameters of Interest	Arsenic	Correlation Coefficient	0.600	-0.095
		Sig. (2-tailed)	0.0005	0.6170
	Copper	Correlation Coefficient	0.748	-0.058
		Sig. (2-tailed)	<0.0000	0.7623
	Iron	Correlation Coefficient	0.719	-0.115
		Sig. (2-tailed)	<0.0000	0.5449
	Manganese	Correlation Coefficient	0.745	-0.025
		Sig. (2-tailed)	<0.0000	0.8951
	Nickel	Correlation Coefficient	-0.125	0.666
		Sig. (2-tailed)	0.5103	0.0001
Indicator Parameters	Barium	Correlation Coefficient	0.782	-0.014
		Sig. (2-tailed)	<0.0000	0.9395
	Calcium	Correlation Coefficient	0.655	0.002
		Sig. (2-tailed)	0.0001	0.9930
	Mercury	Correlation Coefficient	0.610	0.356
		Sig. (2-tailed)	0.0055	0.1345
	Molybdenum	Correlation Coefficient	0.656	-0.141
		Sig. (2-tailed)	0.0001	0.4568
	Selenium	Correlation Coefficient	0.474	0.209
		Sig. (2-tailed)	0.0082	0.2683
	Silver	Correlation Coefficient	0.645	-0.061
		Sig. (2-tailed)	0.0001	0.7487
	Sodium	Correlation Coefficient	0.452	-0.558
		Sig. (2-tailed)	0.0122	0.0014
	Strontium	Correlation Coefficient	0.733	-0.039
		Sig. (2-tailed)	<0.0000	0.8363
	Tin	Correlation Coefficient	NA	NA
		Sig. (2-tailed)	NA	NA
	Vanadium	Correlation Coefficient	0.522	-0.176
		Sig. (2-tailed)	0.0031	0.3528

[orange] Significant correlation; p-value < 0.002 (Bonferroni corrected p-value for 30 comparisons).

[grey] Correlation scatterplot inspected; p <0.01.

[1] Values < method detection limit (MDL) were used at the MDL for calculations

NA = Not Applicable; statistics were unable to be calculated due to lack of variability in data (all values were the same).

Note: n=30 for all correlations except mercury (n = 19).

Table 7.6: Summary of data for selectively extracted (Tessier extraction) metals in sediment from Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment, and only analytes with detectable concentrations are displayed [1].

Sample ID	Units	BC SQGs [2]		Reference Value [3]		LRef1 (QUL-51)		LRef2 (QUL-52) Composite	LNF1 (QUL-45)		LNF2 (QUL-49)		LFF (QUL-47) Composite	LFFF (QUL-48) Composite
		TEL	PEL	LRef1	LRef2	Mean	t*SE		Mean	t*SE	Mean	t*SE		
Exchangeable & Adsorbed Metals														
Arsenic	mg/kg	5.9	17	<0.050	<0.050	<0.050	0	<0.050	<0.050	0	0.052	0.0050	<0.050	0.061
Barium	mg/kg	-	-	28.3	<14	22.8	5.12	<14	18.2	5.48	<25	3.4	<15	<15
Cadmium	mg/kg	0.6	3.5	0.069	<0.050	0.059	0.010	<0.050	<0.050	0	0.056	0.011	<0.050	0.11
Calcium	mg/kg	-	-	1,037	1,350	912	116	1,350	1,288	176	2,548	1,360	2,010	3,700
Cobalt	mg/kg	-	-	0.35	<0.10	0.30	0.049	<0.10	<0.10	0	0.12	0.032	0.21	0.47
Copper	mg/kg	35.7	197	0.52	<0.50	0.50	0.011	<0.50	2.21	0.430	0.95	0.32	<0.50	<0.50
Manganese	mg/kg	460	1,100	35.0	23.9	29.2	8.93	23.9	9.08	1.35	85.6	61.4	22.5	31.3
Molybdenum	mg/kg	-	-	<0.50	<1.0	<0.50	0	<1.0	0.60	0.014	0.68	0.063	<0.50	<0.50
Nickel	mg/kg	16	75	0.93	<0.50	0.82	0.11	<0.50	<0.50	0	<0.50	0	0.51	0.98
Potassium	mg/kg	-	-	<100	<100	<100	0	<100	106	6.80	<100	0	<100	<100
Strontium	mg/kg	-	-	7.39	8.24	6.26	1.07	8.24	13.5	1.81	20.2	9.56	11.7	21.9
Zinc	mg/kg	123	315	1.1	<1.0	1.0	0.056	<1.0	<1.0	0	<1.0	0	<1.0	<1.0
Carbonate Metals														
Aluminum	mg/kg	-	-	<50	<50	<50	0	<50	60	8.1	<50	0	<50	<50
Arsenic	mg/kg	5.9	17	0.084	<0.050	0.068	0.017	<0.050	0.060	0.010	0.155	0.0519	<0.050	0.12
Barium	mg/kg	-	-	10.6	8.60	8.8	1.8	8.60	28.6	3.77	30.6	3.94	4.80	7.70
Cadmium	mg/kg	0.6	3.5	<0.050	<0.050	<0.050	0	<0.050	<0.050	0	0.052	0.0040	<0.050	<0.050
Calcium	mg/kg	-	-	86	1,300	79	7.5	1,300	8,582	480	7,954	1,352	178	454
Cobalt	mg/kg	-	-	0.44	0.25	0.37	0.086	0.25	0.26	0.048	0.47	0.14	0.23	0.37
Copper	mg/kg	35.7	197	1.25	<0.50	1.09	0.155	<0.50	**37.7**	7.41	12.6	8.72	<0.50	<0.50
Iron	mg/kg	21,200	43,776	233	<50	186	58.8	<50	82	14	97	57	<50	<50
Lead	mg/kg	35	91	<0.50	<0.50	<0.50	0	<0.50	0.56	0.070	0.71	0.11	<0.50	<0.50
Manganese	mg/kg	460	1,100	26.2	38.1	15.5	12.6	38.1	76.5	4.13	95.2	15.4	11.5	10.8
Strontium	mg/kg	-	-	<5.0	6.80	<5.0	0	6.80	38.1	7.69	33.2	4.18	<5.0	<5.0
Uranium	mg/kg	-	-	0.11	0.12	0.103	0.015	0.12	0.053	0.0046	0.16	0.085	0.12	0.26
Vanadium	mg/kg	-	-	<0.20	<0.20	<0.20	0	<0.20	<0.20	0	0.32	0.052	<0.20	<0.20
Zinc	mg/kg	123	315	1.2	<1.0	1.1	0.11	<1.0	1.0	0.11	1.6	0.67	<1.0	1.5
Easily Reducible Metals and Iron Oxides														
Aluminum	mg/kg	-	-	828	1,010	794	33.1	1,010	1,366	326	1,258	82.1	826	1,170
Arsenic	mg/kg	5.9	17	0.789	0.167	0.73	0.085	0.167	1.50	0.123	1.54	0.133	0.448	2.03
Barium	mg/kg	-	-	13.5	8.33	11.6	2.32	8.33	16.1	2.56	21.5	2.65	5.98	13.1
Cadmium	mg/kg	0.6	3.5	0.093	<0.050	0.089	0.0056	<0.050	0.053	0.0071	0.062	0.016	<0.050	0.18
Calcium	mg/kg	-	-	496	710	452	43.7	710	1,472	186	1,790	335	627	719
Chromium	mg/kg	37.3	90	2.88	1.70	2.76	0.133	1.70	1.67	0.229	1.56	0.255	2.29	2.86
Cobalt	mg/kg	-	-	2.69	4.46	2.42	0.411	4.46	1.39	0.326	1.53	0.400	2.36	3.37
Copper	mg/kg	35.7	197	3.25	3.90	2.95	0.321	3.90	**77.9**	11.0	**54.8**	19.4	1.99	1.96
Iron	mg/kg	21,200	43,776	3,992	5,230	3,692	323	5,230	2,522	622	2,790	585	3,090	5,340
Lead	mg/kg	35	91	1.22	4.75	1.14	0.072	4.75	1.47	0.219	1.58	0.222	1.64	3.43
Manganese	mg/kg	460	1,100	46.2	74.4	39.6	7.98	74.4	69.7	14.5	63.8	14.5	35.7	41.3
Nickel	mg/kg	16	75	5.84	9.65	5.26	0.603	9.65	1.71	0.508	2.48	0.70	4.88	7.91
Phosphorus	mg/kg	-	-	104	<50	87.4	18.5	<50	180	29.1	135	37.2	54.0	<50
Strontium	mg/kg	-	-	5.44	6.22	4.89	0.568	6.22	25.6	2.56	33.6	2.42	4.15	5.38
Titanium	mg/kg	-	-	1.0	2.0	1.0	0	2.0	1.1	0.14	<1.0	0	<1.0	<1.0
Uranium	mg/kg	-	-	0.109	0.282	0.098	0.011	0.282	0.0954	0.0175	0.144	0.052	0.120	0.343
Vanadium	mg/kg	-	-	5.27	1.94	5.06	0.255	1.94	7.05	1.75	5.99	0.465	4.75	6.96
Zinc	mg/kg	123	315	12.0	10.0	11.1	0.85	10.0	5.80	1.52	7.20	2.12	8.00	18.2
Organic Bound Metals														
Aluminum	mg/kg	-	-	743	783	679	78.4	783	745	130	1,191	511	1,110	3,110
Arsenic	mg/kg	5.9	17	0.246	0.085	0.213	0.0373	0.085	0.446	0.200	1.22	0.401	0.195	1.56
Barium	mg/kg	-	-	6.23	1.40	5.17	1.19	1.40	9.16	1.30	13.6	4.57	2.52	7.38
Cadmium	mg/kg	0.6	3.5	<0.050	<0.050	<0.050	0	<0.050	0.050	0.0011	<0.050	0	<0.050	<0.050
Calcium	mg/kg	-	-	522	367	473	62.7	367	670	86.9	1,232	220	665	916
Chromium	mg/kg	37.3	90	2.70	1.80	2.54	0.160	1.80	<0.50	0	1.98	1.45	3.30	11.6
Cobalt	mg/kg	-	-	1.52	0.96	1.15	0.438	0.96	1.29	0.145	1.45	0.162	1.26	4.10
Copper	mg/kg	35.7	197	3.73	4.00	3.44	0.441	4.00	**529**	41.5	**341**	33.9	6.57	29.0
Iron	mg/kg	21,200	43,776	301	310	262	44.2	310	353	10.4	656	326	531	4,000
Lead	mg/kg	35	91	<0.50	<0.50	<0.50	0	<0.50	0.62	0.065	0.83	0.28	<0.50	2.2
Manganese	mg/kg	460	1,100	8.2	6.5	7.8	0.50	6.50	10.2	1.96	13.5	4.81	10.0	33.5
Molybdenum	mg/kg	-	-	<0.50	<0.50	<0.50	0	<0.50	0.95	0.20	1.49	0.49	<0.50	0.67
Nickel	mg/kg	16	75	2.10	2.40	1.83	0.326	2.40	0.50	0.0056	1.19	0.678	2.35	9.54
Selenium	mg/kg	2	-	0.28	<0.20	0.26	0.022	<0.20	0.69	0.081	0.70	0.11	0.27	1.75
Strontium	mg/kg	-	-	2.71	2.82	2.43	0.361	2.82	9.16	0.457	12.4	3.32	3.15	4.97
Titanium	mg/kg	-	-	57.3	28.8	46.3	16.0	28.8	1.54	0.55	7.0	5.6	11.9	21.9
Uranium	mg/kg	-	-	0.062	0.066	0.056	0.0057	0.066	0.073	0.0074	0.169	0.057	0.070	0.25
Vanadium	mg/kg	-	-	2.97	2.29	2.73	0.283	2.29	0.67	0.13	3.36	2.72	2.69	10.4
Zinc	mg/kg	123	315	4.2	3.1	3.8	0.40	3.1	4.1	0.99	4.8	1.2	2.9	14
Residual Metals														
Aluminum	mg/kg	-	-	9,092	14,200	8,396	772	14,200	12,840	992	13,020	1,419	9,930	13,000
Antimony	mg/kg	-	-	0.20	<0.10	0.18	0.014	<0.10	0.29	0.053	0.29	0.034	0.13	0.42
Arsenic	mg/kg	5.9	17	2.85	1.44	2.36	0.461	1.44	**8.66**	0.720	**7.33**	0.752	2.48	4.91
Barium	mg/kg	-	-	41.0	25.1	37.7	4.57	25.1	84.3	5.59	96.0	7.03	31.1	32.3
Beryllium	mg/kg	-	-	<0.20	0.25	<0.20	0	0.25	0.41	0.037	0.38	0.037	<0.20	<0.20
Calcium	mg/kg	-	-	4,092	2,280	3,692	468	2,280	9,740	1,606	9,384	1,361	5,210	4,360
Chromium	mg/kg	37.3	90	30.8	32.9	28.4	2.27	32.9	10.0	0.59	13.5	1.03	26.3	35.8
Cobalt	mg/kg	-	-	4.20	7.82	3.89	0.374	7.82	12.3	0.91	11.3	0.993	5.69	6.84
Copper	mg/kg	35.7	197	12.7	13.8	11.6	0.97	13.8	**140**	20.0	**74.2**	8.42	14.2	18.8
Iron	mg/kg	21,200	43,776	14,920	24,800	13,740	1,392	24,800	**39,940**	4,494	42,300	6,387	17,700	19,900
Lead	mg/kg	35	91	1.80	2.60	1.64	0.148	2.60	2.24	0.13	2.34	0.284	2.09	1.98
Lithium	mg/kg	-	-	6.86	24.1	6.46	0.469	24.1	13.2	0.83	13.5	1.54	8.00	12.0
Manganese	mg/kg	460	1,100	169	150	154	20.7	150	402	45.4	359	38.0	194	246
Molybdenum	mg/kg	-	-	<0.50	<0.50	<0.50	0	<0.50	2.53	0.265	1.34	0.484	<0.50	<0.50
Nickel	mg/kg	16	75	13.7	24.0	12.6	1.08	24.0	7.7	0.59	9.5	0.86	14.7	22.6
Selenium	mg/kg	2	-	<0.20	<0.20	<0.20	0	<0.20	0.23	0.051	<0.20	0	<0.20	<0.20
Silver	mg/kg	0.5	-	0.16	<0.10	0.11	0.039	<0.10	0.29	0.016	0.24	0.011	<0.10	<0.10
Strontium	mg/kg	-	-	30.2	37.2	27.7	2.60	37.2	64.6	7.18	57.8	6.30	41.3	28.5
Thallium	mg/kg	-	-	0.063	0.11	0.057	0.0067	0.11	<0.050	0	<0.050	0	<0.050	0.055
Tin	mg/kg	-	-	<2.0	<2.0	<2.0	0	<2.0	2.1	0.39	<2.0	0	<2.0	<2.0
Titanium	mg/kg	-	-	868	698	815	58.1	698	1,204	253	1,216	194	866	1,090
Uranium	mg/kg	-	-	0.414	0.613	0.391	0.0317	0.613	0.642	0.106	0.599	0.0829	0.302	0.292
Vanadium	mg/kg	-	-	40.3	21.0	37.3	3.96	21.0	151	16.3	155	25.2	59.7	60.0
Zinc	mg/kg	123	315	29.3	42.6	27.1	2.23	42.6	42.9	4.07	40.9	3.36	28.7	35.0

(blue)	Value is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.
(orange)	Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Summary statistics are reported as < the highest displayed MDL if all the data used in their calculation were < MDL. Summary statistics (mean, t*SE, and maximum) were only calculated for sampling areas with replicate samples (LRef1, LNF1,and LNF2) but not for single composite samples (LRef2, LFF, and LFFF).

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Displayed reference values are the 95th percentiles of data from reference area LRef1 and are the single values available for reference area LRef2.

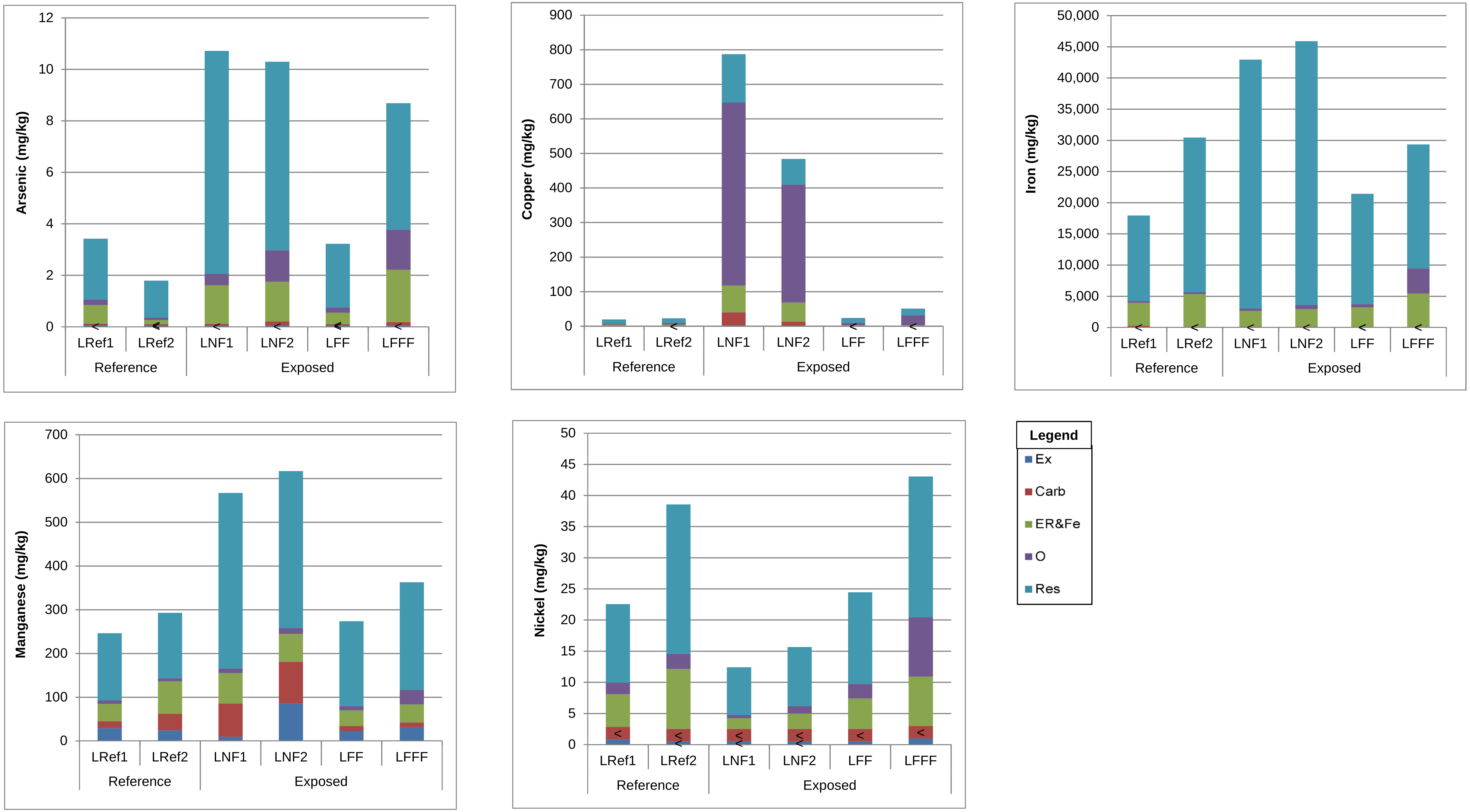


Figure 7.4: Mean concentrations of selectively extracted parameters of interest in sediment from the littoral sampling areas of Quesnel Lake, Mount Polley Mine, 2014. Selective extractions included Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe), Organic Bound Metals (O), and Residual Metals (Res).

Values < MDL are indicated with a < symbol. Mean values are plotted for areas with replicate samples (LRef1, LNF1, LNF2), single values are plotted for composite samples (LRef2, LFF, LFFF).

indicates that these forms would not be mobile under environmentally realistic conditions (SRK 2015). Therefore, sediment copper also appears to be present in Polley Lake sediments in forms that are not mobile and this immobility suggests limited concern for aquatic biota.

Shake flask tests indicated low mobility of metals associated with Quesnel Lake littoral sediments, with copper and manganese being the only metals mobilized in shake flask tests to concentrations greater than British Columbia Water Quality Guidelines (BCWQG; Appendix Table E.52; Table 7.7). As manganese was similarly elevated in shake flask tests of one of the reference areas, only copper at near-field areas appeared to be more leachable than reference and to potentially meaningful concentrations. However, as previously stated, BCWQG do not apply to sediment leachates, but are used herein as an indication of low mobility.

Acid-Base accounting results indicated that the potential for acid generation decreased with distance from the influence of the dam failure (Appendix Tables E.12 and E.53). Neutralization potential ratio (NPR; the ratio of neutralization potential to maximum potential acidity) was 10 and 13 at the near-field areas and decreased to 3.8 at the far-field area and 1.1 at the far-far-field area (Appendix Table E.12). NPR greater than 4 indicates no potential for Acid Rock Drainage (ARD; Price 1997). Decreasing NPR with distance from Hazeltine Creek indicates that acid potential associated with the impacted sediments is lower than reference and far-field sediments (i.e., the failure-influenced materials had higher neutralization potential than native sediment).

7.3 Sediment Toxicity

Sediment toxicity testing indicated no instances of significantly reduced survival or growth of the freshwater/brackish water amphipod *Hyalella azteca* relative to concurrent laboratory controls and both references (Figure 7.5; Appendix Table F.1; Appendix Figure F.5). However, a spatial pattern of increasing growth with distance from the mouth of Hazeltine Creek was apparent, likely in association with increasing sediment TOC concentrations (reduced concentrations of POIs could also play a role but do not explain highest growth at the far-far-field area). There were no instances where survival of the freshwater midge *Chironomus dilutus* was significantly reduced relative to concurrent laboratory controls and both references (Figure 7.5; Appendix Table F.1; Appendix Figure F.6). However, examination of absolute survival (non-normalized) indicated low survival at area LNF1 (45%), indicating an apparent, albeit not statistically significant, reduction of survival (Appendix Table F.8). As evident for survival, growth of *C. dilutus* was significantly reduced at area LNF1 relative to laboratory controls and both references, but

Table 7.7: Summary of leachable metals data for sediment from Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Data are based on bulk sediment [1]. Only analytes with detectable concentrations are displayed.

Sample ID	Units	BCWQG [2]			HWR [3]	Reference Value [4]		Reference			Exposed					
								LRef1 (QUL-51)		LRef2 (QUL-52) Composite	LNF1 (QUL-45)		LNF2 (QUL-49)		LFF (QUL-47) Composite	LFFF (QUL-48) Composite
		Type	Chronic	Acute		LRef1	LRef2	Mean	t*SE		Mean	t*SE	Mean	t*SE		
Aluminum	mg/L	-	-	-	-	<0.20	<0.20	<0.20	0	<0.20	0.30	0.20	<0.20	0	<0.20	<0.40
Barium	mg/L	W	1.0	-	100	0.045	0.043	0.035	0.011	0.043	0.029	0.0079	0.130	0.0482	0.019	0.097
Calcium	mg/L	-	-	-	-	14.0	93.2	11.1	3.75	93.2	19.6	5.50	75.6	38.1	23.7	111
Copper	mg/L	A	0.0055	0.015	100	<0.010	<0.010	<0.010	0	<0.010	**0.023**	0.0067	**0.015**	0.010	<0.010	<0.020
Iron	mg/L	A	-	1.0	-	0.345	0.579	0.244	0.107	0.579	0.213	0.134	0.690	0.678	0.0550	0.101
Magnesium	mg/L	-	-	-	-	2.16	4.53	1.92	0.270	4.53	2.72	0.969	9.85	5.76	2.48	10.7
Manganese	mg/L	A	1.21	2.05	-	0.254	2.02	0.110	0.138	2.02	0.036	0.0147	**2.19**	2.17	0.234	0.156
Molybdenum	mg/L	A	1.0	2.0	-	<0.030	<0.030	<0.030	0	<0.030	0.041	0.0096	0.065	0.025	<0.030	<0.060
Potassium	mg/L	-	-	-	-	3.6	2.4	2.6	0.91	2.4	3.6	0.72	4.1	1.1	<2.0	4.6
Silicon	mg/L	-	-	-	-	5.38	4.72	4.93	0.636	4.72	5.11	0.74	8.98	3.37	4.95	10.7
Sodium	mg/L	-	-	-	-	2.6	<2.0	2.2	0.38	<2.0	15.2	4.48	9.2	3.94	<2.0	4.0
Strontium	mg/L	-	-	-	-	0.0975	0.638	0.0754	0.0276	0.638	0.220	0.0545	0.666	0.321	0.144	0.610
Titanium	mg/L	-	-	-	-	0.013	0.013	0.011	0.0019	0.013	0.011	0.0026	0.014	0.0042	<0.010	<0.020

(Orange shading) Value is > one or all guidelines (values < MDL excluded from comparison). Values shown in bold text also exceed both Reference 95th Percentile values.

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Summary statistics are reported as < MDL if all the data used in their calculation were < MDL. Summary statistics (mean, t*SE, and maximum) were only calculated for sampling areas with replicate samples (LRef1, LNF1,and LNF2) but not for single composite samples (LRef2, LFF, and LFFF).

[2] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.

[3] Hazardous Waste Regulation (Government of British Columbia 1988)

[4] Displayed reference values are the 95th percentiles of data from reference area LRef1, and are the single values available for reference area LRef2.

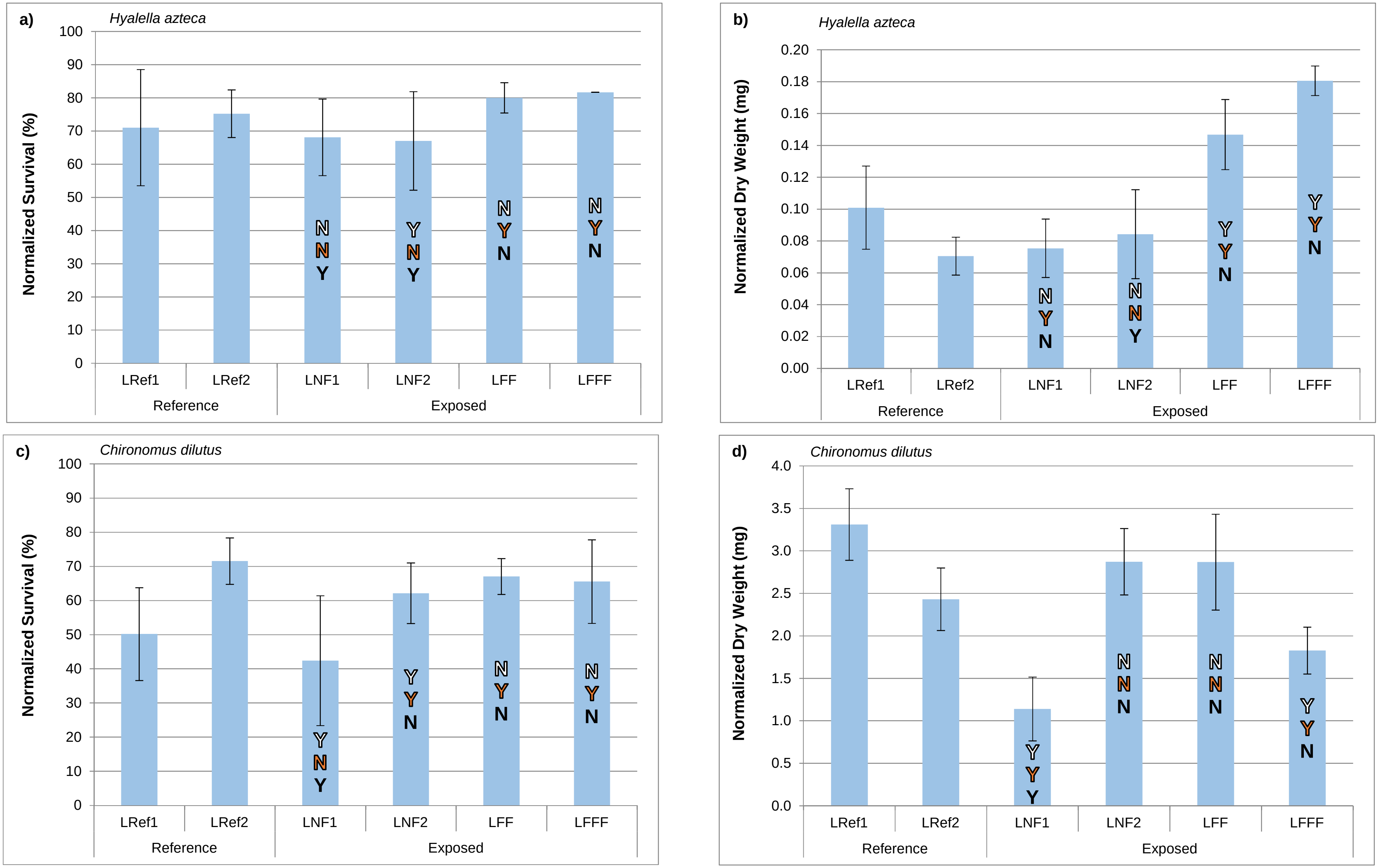


Figure 7.5: Toxicity tests of Quesnel Lake littoral sediment, Mount Polley Mine, 2014. Results for *Hyalella azteca* a) Normalized Survival (%), b) Normalized Dry Weight (mg) and *Chironomus dilutus* c) Normalized Survival (%), d) Normalized Dry Weight (mg). Error bars represent standard deviation. Letters represent significant differences (Y) or no differences (N) between and the Control (Black), Reference 1 (Orange) and Reference 2 (White) (p < 0.05). Control results are not displayed.

not at any other littoral areas (Figure 7.5; Appendix Table F.1). No consistent spatial patterns in the growth of *C. dilutus* were evident. Overall, the toxicity data indicate an apparent effect on survival and growth of *C. dilutus* at one of the two near-field littoral areas only (LNF1).

7.4 Benthic Invertebrate Community

Benthic invertebrate community samples from near-field, far-field and far-far-field littoral areas of Quesnel Lake were compared to two reference areas within Quesnel Lake (Table 4.1; Figure 4.4) in a Multiple Control-Impact (MCI) design. Samples were collected by petite ponar grab sampler at five stations per area.

7.4.1 Primary Metrics

Mean benthic organism density (individuals/m^2) of the exposed areas (near-field, far-field and far-far-field) did not differ significantly from both reference areas (Appendix Table G.15; Figure 7.6). However, taxon richness at both near-field areas (LNF-1 and LNF-2) was significantly lower than at both reference areas. A low number of taxa relative to reference can be indicative of a degraded benthic invertebrate community (Pielou 1974; Begon et. al. 1996). Neither Simpson's Diversity nor Simpson's Evenness differed at any of the exposed areas relative to both reference areas.

7.4.2 Community Composition

Dominant invertebrate taxon groups at the Quesnel Lake littoral areas were non-biting midges (Chironomidae), oligochaete worms, and amphipods (Figure 7.7; Appendix Tables G.16-17). Moderate representation (5 to 10% overall) was also indicated by clams and mussels (bivalves), snails (gastropods), leeches (Hirudinae), mites (Acari) and EPT taxa (Ephemeroptera, Plecoptera, Trichoptera; Figure 7.7; Appendix Tables G.16-G.17).

The Bray-Curtis index of dissimilarity (BC index) did not differ at any exposed area relative to both reference areas (Figure 7.8; Appendix Table G.15). However, both near-field areas differed significantly from reference area 1 (the Horsefly Bay reference), suggesting community-level differences relative to this reference that appear to be due to lower proportions of EPT taxa at LNF1 and LNF 2 (Figure 7.8). No other consistent exposure area versus reference area differences in the relative proportions of other taxon groups were observed; however, percent Chironomidae differed significantly between the two reference areas (with higher representation at the North Arm reference [71.5 ± 17.8%] than at the Horsefly Bay reference [11.5 ± 5.7%] and exposed stations that were generally intermediate; Figure 7.8; Appendix Table G.16). Correspondence Analysis axes did not

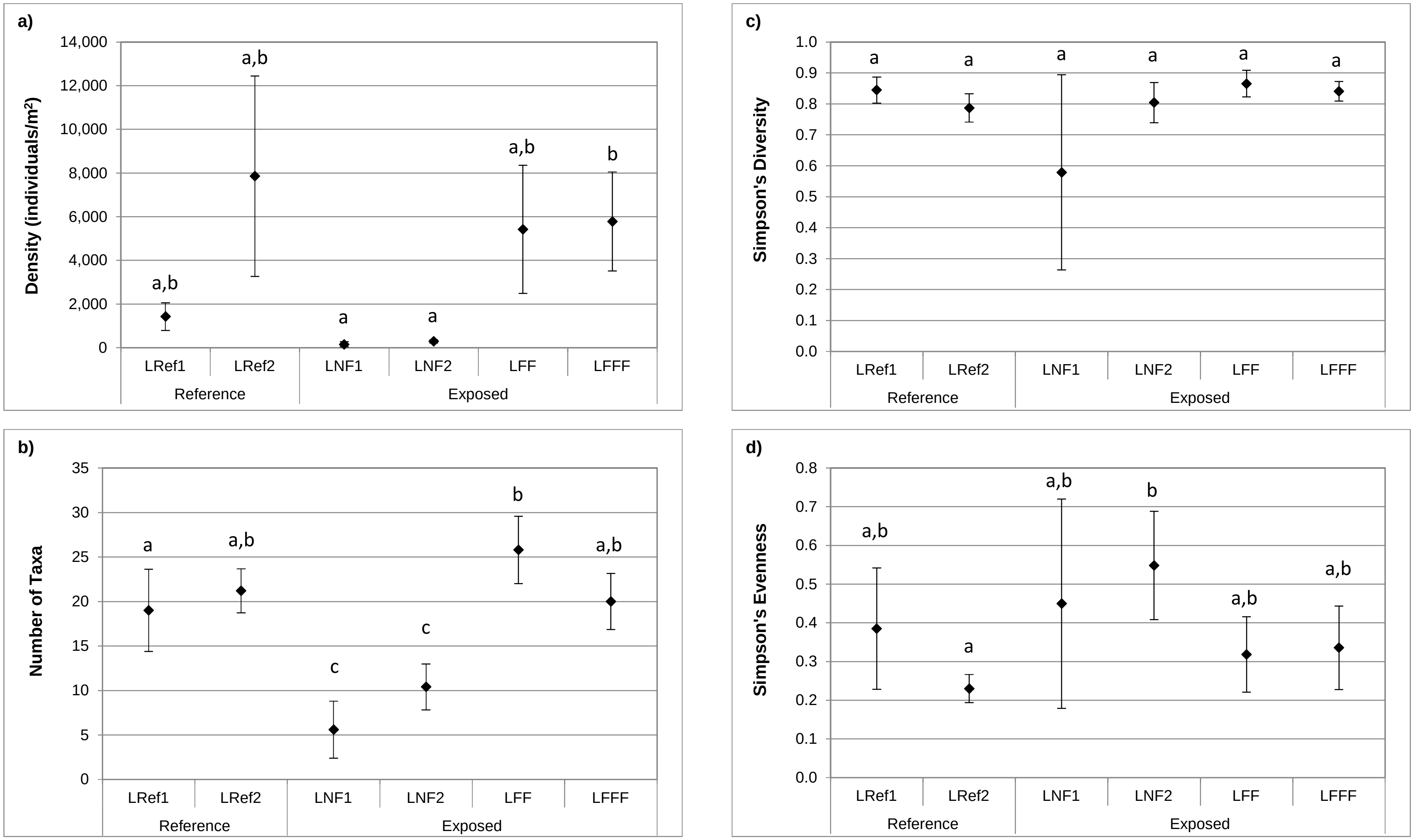


Figure 7.6: Comparison of a) Density, b) Number of Taxa, c) Simpson's Diversity and d) Simpson's Eveness, Mount Polley Mine, 2014 Quesnel littoral area comparisons. Data represents area means and 90% confidence intervals. Different letters above data points indicate areas that were significantly different ($p < 0.1$).

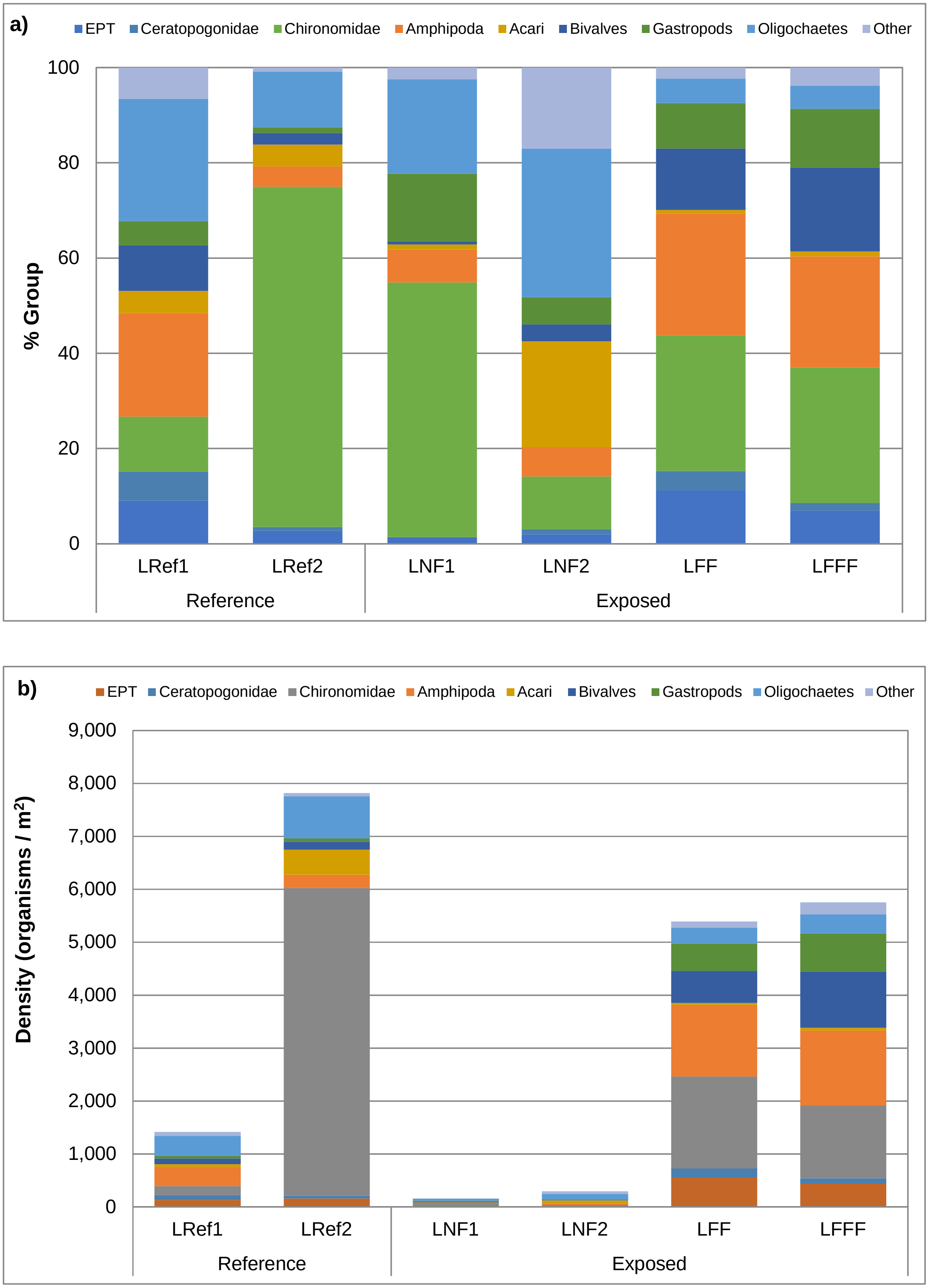
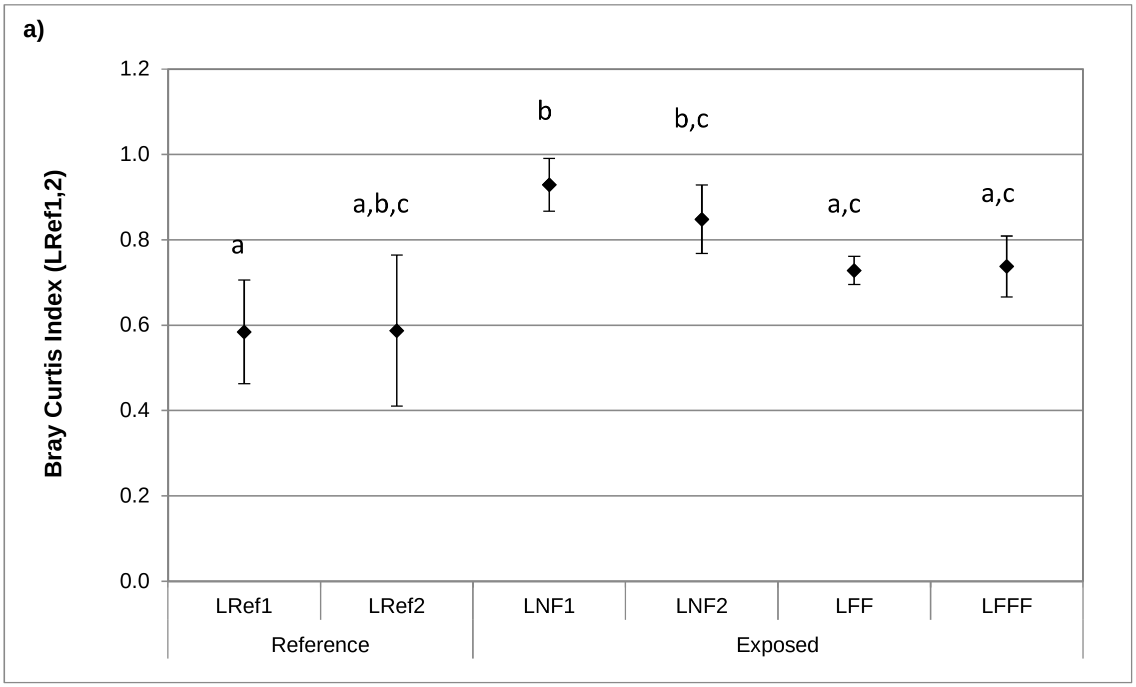


Figure 7.7: Relative mean proportions (a) and mean density (b) of major benthic invertebrate groups within Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014.



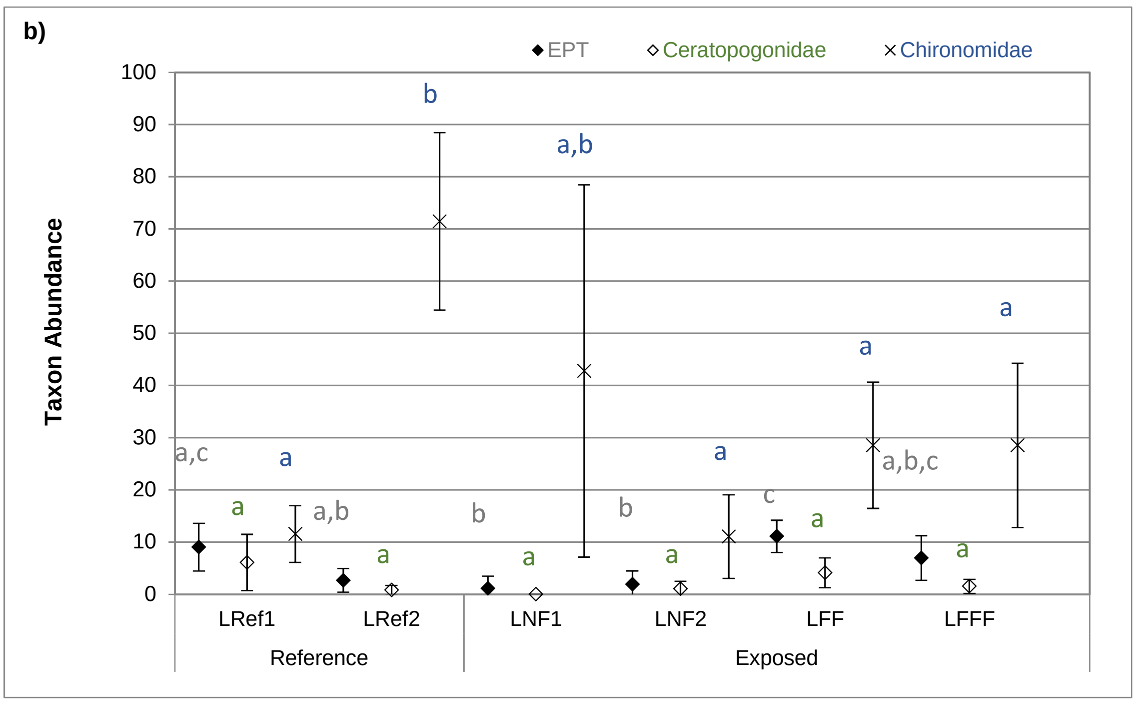
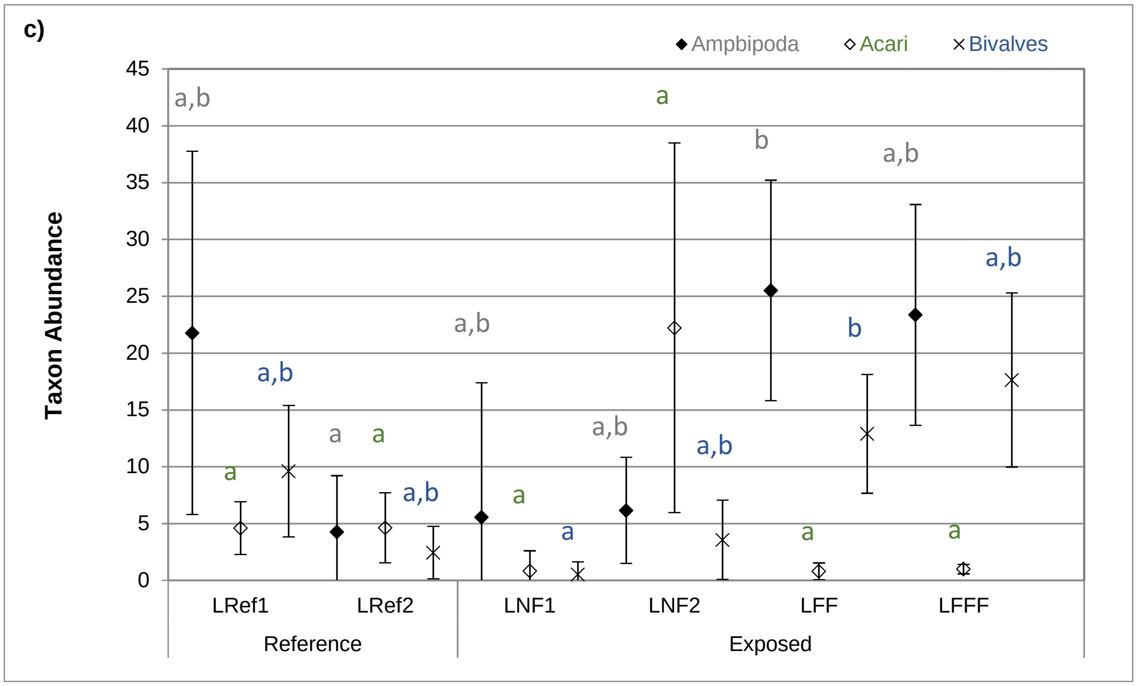


Figure 7.8: Comparison of a) Bray Curtis Index, b) Taxon Abundance (EPT, ceratopogonidae, chironomidae), c) Taxon Abundance (amphipoda, acari, bivalves) and d) CA Score, Mount Polley Mine, 2014. Quesnel littoral area comparisons. Data represents area means and 90% confidence intervals. Different letters above data points indicate areas that were significantly different ($p < 0.1$).



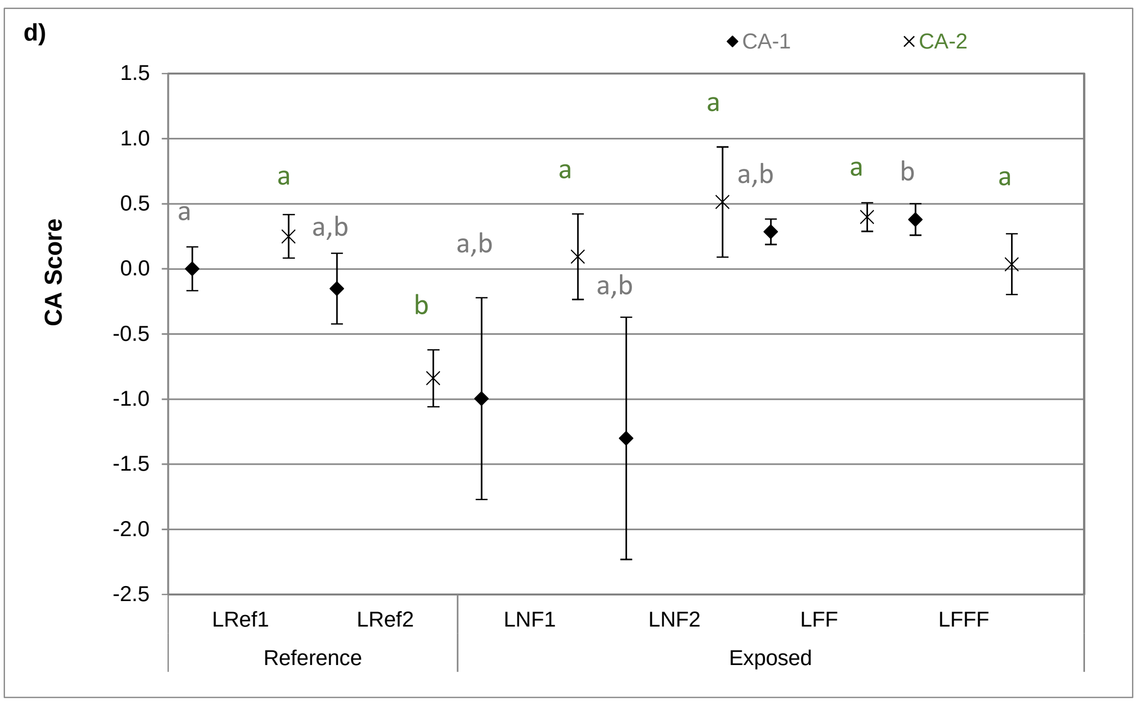


Figure 7.8: Comparison of a) Bray Curtis Index, b) Taxon Abundance (EPT, ceratopogonidae, chironomidae), c) Taxon Abundance (amphipoda, acari, bivalves) and d) CA Score, Mount Polley Mine, 2014. Quesnel littoral area comparisons. Data represents area means and 90% confidence intervals. Different letters above data points indicate areas that were significantly different ($p < 0.1$).

differ significantly at any exposed area relative to both references, supporting the findings of the BC Index (Figure 7.8). However, CA axis 2 (16.3% of community variance) did highlight a difference in community composition at the near-field areas relative to reference area 2. This represents a difference in the benthic community of reference area 2 (the North Arm reference) relative to all other areas that is best described by a greater relative abundance of non-biting and biting midges (Chironomidae and Ceratopoginidae) and fewer mites (Acari) relative to other areas (Figure 7.8; Appendix Figure G.18).

7.5 Correlation Analysis

Correlation analysis was conducted between the biological endpoints (sediment toxicity test endpoints and benthic invertebrate community endpoints) and dissolved oxygen, specific conductance, percent fines, sediment TOC content, sediment concentrations of POIs, IPs, PCA axes and selective copper extracts (Table 7.8). There were few relationships between the toxicity test endpoints and the sediment physical/chemical measures at the Bonferroni-adjusted p-level. Both survival and growth of *H. azteca* were negatively correlated with easily reducible copper, and survival of *C. dilutus* was negatively correlated with sediment PCA Axis 2 and carbonate copper (Table 7.8; Appendix Figure I.7). Sediment PCA-2 primarily represents thallium, nickel and chromium, which are not failure-related, but are higher at reference area 2 (the North Arm reference) and LFFF relative to other areas (Figure 7.2). Additional relationships significant at $p<0.01$ included positive relationships between *H. azteca* survival and growth, and *C. dilutus* survival and TOC content and nickel concentration, as well as several additional negative relationships with IPs and copper extracts (Table 7.8). Although correlation analysis is not necessarily indicative of cause, the negative relationships with carbonate copper, easily reducible copper, and the positive relationships with TOC suggest some impairment in association with plausible effect mechanisms (e.g., smothering, low TOC high POI and IP concentrations).

A substantial number of relationships between benthic invertebrate community metrics and sediment chemistry were observed at the Bonferroni-adjusted p-level (Table 7.8). Bray-Curtis index of dissimilarity was negatively correlated with dissolved oxygen, indicating greater dissimilarity at lower dissolved oxygen concentrations. Benthic invertebrate density was positively correlated with specific conductance and sediment nickel concentration and negatively correlated with molybdenum and sediment PCA Axis 2, as well as copper in the exchangeable, carbonate and easily reducible phases (Table 7.8; Appendix Figure I.7). Number of taxa was negatively correlated with a number of POIs (arsenic, copper and manganese) and IPs (barium, molybdenum, silver, sodium and

Table 7.8: Spearman's Rank Correlation results for correlation of toxicity test results and benthic invertebrate community metrics versus sediment physical characteristics, parameters of interest, indicator parameters, PCA axes scores, copper extracts (all in < 2mm sediment fraction) in Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014 [1,2.]

Physical/Chemical Parameter		Correlation Parameter	Toxicity Endpoints				Benthic Invertebrate Community Metrics															
			Hyalella azteca		*Chironomus dilutus*																	
			Normalized Survival	Normalized Growth	Normalized Survival	Normalized Growth	Density (Ind./m^2)	Number of Taxa	Simpson's D	Simpson's E	Bray Curtis Index (LRef1 and LRef2)	EPT (%)	Ceratopogonidae (%)	Chironomidae (%)	Amphipoda (%)	Acari (%)	Bivalves (%)	Gastropods (%)	Hirudinea (%)	Oligochaetes (%)	CA Axis 1 (19.0 %)	CA Axis 2 (16.3 %)
Water In-situ Measures	Dissolved Oxygen (mg/L; bottom)	Correlation Coefficient	NA	NA	NA	NA	0.443	0.576	0.316	-0.390	-0.698	0.445	0.545	0.049	0.223	0.429	0.233	-0.231	0.417	0.187	0.197	-0.170
		Sig. (2-tailed)	NA	NA	NA	NA	0.0143	0.0009	0.0887	0.0333	<0.0000	0.0138	0.0018	0.7982	0.2369	0.0179	0.2161	0.2198	0.0218	0.3220	0.2974	0.3690
	Specific Conductivity (µS/cm; bottom)	Correlation Coefficient	NA	NA	NA	NA	0.735	0.496	0.173	-0.503	-0.505	0.123	0.183	0.364	0.097	0.238	0.265	-0.021	0.063	-0.191	0.388	-0.420
		Sig. (2-tailed)	NA	NA	NA	NA	<0.0000	0.0053	0.3616	0.0046	0.0045	0.5187	0.3324	0.0478	0.6085	0.2060	0.1563	0.9111	0.7391	0.3113	0.0341	0.0207
Sediment Physical	Fines	Correlation Coefficient	-0.165	-0.214	0.086	-0.292	-0.240	-0.580	-0.311	0.329	0.546	-0.599	-0.503	-0.104	-0.363	0.275	-0.365	-0.021	-0.287	-0.029	-0.436	0.010
		Sig. (2-tailed)	0.3827	0.2553	0.6516	0.1179	0.2017	0.0008	0.0943	0.0755	0.0018	0.0005	0.0047	0.5848	0.0490	0.1419	0.0473	0.9112	0.1245	0.8784	0.0160	0.9600
	TOC	Correlation Coefficient	0.479	0.491	0.523	0.037	0.504	0.333	0.280	-0.140	-0.126	0.266	0.166	-0.093	0.396	0.234	0.511	0.331	0.249	-0.328	0.463	0.074
		Sig. (2-tailed)	0.0074	0.0059	0.0030	0.8464	0.0046	0.0726	0.1342	0.4599	0.5085	0.1560	0.3797	0.6233	0.0303	0.2135	0.0039	0.0743	0.1847	0.0769	0.0099	0.6992
Parameters of Interest	Arsenic	Correlation Coefficient	-0.253	0.026	-0.477	-0.378	-0.598	-0.672	-0.247	0.559	0.718	-0.329	-0.290	-0.263	-0.188	-0.213	-0.208	0.211	-0.217	0.017	-0.269	0.330
		Sig. (2-tailed)	0.1773	0.8911	0.0077	0.0395	0.0005	<0.0000	0.1878	0.0013	<0.0000	0.0756	0.1207	0.1606	0.3192	0.2595	0.2710	0.2622	0.2489	0.9302	0.1506	0.0750
	Copper	Correlation Coefficient	-0.240	-0.170	-0.258	-0.592	-0.535	-0.721	-0.480	0.387	0.822	-0.595	-0.576	-0.042	-0.415	-0.221	-0.409	0.036	-0.440	-0.136	-0.409	0.132
		Sig. (2-tailed)	0.2023	0.3697	0.1689	0.0006	0.0023	<0.0000	0.0072	0.0348	<0.0000	0.0005	0.0009	0.8254	0.0224	0.2402	0.0246	0.8482	0.0151	0.4722	0.0247	0.4854
	Iron	Correlation Coefficient	-0.317	-0.441	-0.028	-0.455	-0.355	-0.647	-0.517	0.211	0.663	-0.678	-0.609	0.034	-0.542	-0.016	-0.544	-0.199	-0.376	0.000	-0.495	-0.081
		Sig. (2-tailed)	0.0879	0.0147	0.8827	0.0115	0.0541	0.0001	0.0034	0.2629	0.0001	<0.0000	0.0004	0.8592	0.0020	0.9311	0.0019	0.2928	0.0403	0.9981	0.0054	0.6704
	Manganese	Correlation Coefficient	-0.336	-0.259	-0.248	-0.367	-0.460	-0.690	-0.423	0.417	0.748	-0.539	-0.465	-0.077	-0.431	-0.018	-0.446	0.015	-0.368	-0.109	-0.491	0.180
		Sig. (2-tailed)	0.0697	0.1674	0.1859	0.0461	0.0106	<0.0000	0.0199	0.0217	<0.0000	0.0021	0.0097	0.6869	0.0175	0.9255	0.0136	0.9354	0.0452	0.5654	0.0058	0.3422
	Nickel	Correlation Coefficient	0.606	0.404	0.592	0.045	0.870	0.647	0.304	-0.495	-0.501	0.455	0.349	0.237	0.422	0.071	0.511	0.181	0.317	-0.317	0.652	-0.268
		Sig. (2-tailed)	0.0004	0.0267	0.0006	0.8154	<0.0000	0.0001	0.1021	0.0055	0.0048	0.0115	0.0588	0.2065	0.0203	0.7099	0.0039	0.3381	0.0879	0.0881	0.0001	0.1514
Indicator Parameters	Barium	Correlation Coefficient	-0.325	-0.118	-0.222	-0.132	-0.641	-0.748	-0.140	0.661	0.550	-0.507	-0.369	-0.265	-0.385	0.115	-0.314	0.088	-0.338	0.142	-0.470	0.268
		Sig. (2-tailed)	0.0797	0.5336	0.2388	0.4856	0.0001	<0.0000	0.4597	0.0001	0.0017	0.0043	0.0446	0.1574	0.0359	0.5453	0.0909	0.6430	0.0678	0.4527	0.0087	0.1518
	Calcium	Correlation Coefficient	-0.254	-0.174	-0.229	-0.352	-0.554	-0.617	-0.408	0.378	0.801	-0.490	-0.405	-0.131	-0.282	-0.120	-0.404	0.004	-0.380	-0.182	-0.450	0.296
		Sig. (2-tailed)	0.1750	0.3576	0.2240	0.0561	0.0015	0.0003	0.0251	0.0395	<0.0000	0.0060	0.0265	0.4907	0.1307	0.5277	0.0270	0.9850	0.0384	0.3349	0.0125	0.1120
	Mercury	Correlation Coefficient	0.166	0.173	0.454	-0.736	0.016	-0.367	-0.357	0.161	0.452	-0.465	-0.552	0.557	-0.102	-0.504	-0.118	0.339	-0.387	-0.413	0.068	-0.331
		Sig. (2-tailed)	0.4982	0.4795	0.0510	0.0003	0.9485	0.1226	0.1331	0.5107	0.0523	0.0451	0.0143	0.0132	0.6763	0.0277	0.6313	0.1557	0.1014	0.0785	0.7818	0.1667
	Molybdenum	Correlation Coefficient	-0.370	-0.185	-0.434	-0.522	-0.663	-0.770	-0.470	0.458	0.729	-0.553	-0.572	-0.168	-0.329	-0.216	-0.388	0.109	-0.384	-0.020	-0.450	0.139
		Sig. (2-tailed)	0.0442	0.3277	0.0165	0.0031	0.0001	<0.0000	0.0088	0.0110	<0.0000	0.0015	0.0010	0.3754	0.0759	0.2523	0.0339	0.5660	0.0363	0.9166	0.0126	0.4642
	Selenium	Correlation Coefficient	-0.044	0.183	-0.340	-0.551	-0.364	-0.418	-0.423	0.140	0.613	-0.206	-0.287	-0.290	0.041	-0.289	0.020	0.245	-0.144	-0.150	-0.049	0.191
		Sig. (2-tailed)	0.8169	0.3322	0.0658	0.0016	0.0483	0.0217	0.0197	0.4602	0.0003	0.2756	0.1243	0.1197	0.8309	0.1212	0.9185	0.1911	0.4466	0.4282	0.7965	0.3132
	Silver	Correlation Coefficient	-0.231	-0.048	-0.364	-0.613	-0.559	-0.717	-0.373	0.451	0.677	-0.536	-0.586	-0.051	-0.360	-0.263	-0.284	0.153	-0.418	-0.103	-0.294	0.060
		Sig. (2-tailed)	0.2202	0.7995	0.0477	0.0003	0.0013	<0.0000	0.0424	0.0124	<0.0000	0.0023	0.0007	0.7884	0.0508	0.1595	0.1280	0.4196	0.0215	0.5870	0.1152	0.7548
	Sodium	Correlation Coefficient	-0.547	-0.596	-0.279	-0.200	-0.608	-0.723	-0.492	0.394	0.556	-0.669	-0.483	0.071	-0.647	0.019	-0.748	-0.260	-0.448	0.213	-0.754	0.047
		Sig. (2-tailed)	0.0017	0.0005	0.1350	0.2884	0.0004	<0.0000	0.0057	0.0311	0.0014	0.0001	0.0069	0.7092	0.0001	0.9204	<0.0000	0.1655	0.0131	0.2591	<0.0000	0.8057
	Strontium	Correlation Coefficient	-0.286	-0.282	-0.081	-0.334	-0.445	-0.661	-0.402	0.455	0.699	-0.596	-0.524	0.052	-0.486	-0.045	-0.502	0.029	-0.500	-0.066	-0.522	0.153
		Sig. (2-tailed)	0.1260	0.1317	0.6720	0.0713	0.0137	0.0001	0.0277	0.0115	<0.0000	0.0005	0.0030	0.7838	0.0065	0.8115	0.0047	0.8777	0.0049	0.7285	0.0031	0.4199
	Vanadium	Correlation Coefficient	-0.251	-0.041	-0.399	-0.304	-0.619	-0.609	-0.226	0.490	0.726	-0.352	-0.322	-0.300	-0.204	-0.283	-0.234	0.108	-0.187	0.040	-0.314	0.405
		Sig. (2-tailed)	0.1806	0.8315	0.0290	0.1025	0.0003	0.0004	0.2296	0.0060	<0.0000	0.0566	0.0830	0.1076	0.2797	0.1290	0.2125	0.5695	0.3216	0.8344	0.0908	0.0265
PCA Axes	PCA Axis 1 (47.1 %)	Correlation Coefficient	0.277	0.273	0.220	0.544	0.491	0.727	0.482	-0.400	-0.786	0.619	0.562	-0.002	0.470	0.124	0.484	-0.017	0.456	0.126	0.466	-0.069
		Sig. (2-tailed)	0.1388	0.1440	0.2430	0.0019	0.0059	<0.0000	0.0070	0.0286	<0.0000	0.0003	0.0012	0.9916	0.0089	0.5144	0.0068	0.9280	0.0113	0.5079	0.0094	0.7180
	PCA Axis 2 (23.5 %)	Correlation Coefficient	-0.528	-0.330	-0.665	0.046	-0.800	-0.530	-0.161	0.454	0.410	-0.234	-0.118	-0.414	-0.197	-0.099	-0.361	-0.155	-0.081	0.427	-0.506	0.364
		Sig. (2-tailed)	0.0027	0.0749	0.0001	0.8090	<0.0000	0.0026	0.3966	0.0117	0.0246	0.2133	0.5355	0.0230	0.2980	0.6018	0.0499	0.4122	0.6722	0.0185	0.0043	0.0483
	PCA Axis 3 (12.5 %)	Correlation Coefficient	0.224	0.586	-0.289	-0.139	-0.082	0.014	0.175	0.076	0.041	0.331	0.226	-0.474	0.417	-0.147	0.544	0.420	0.259	-0.062	0.421	0.212
		Sig. (2-tailed)	0.2340	0.0007	0.1208	0.4642	0.6677	0.9394	0.3553	0.6914	0.8307	0.0743	0.2304	0.0081	0.0218	0.4387	0.0019	0.0210	0.1672	0.7452	0.0206	0.2617
Copper Extracts [3]	Exchangeable	Correlation Coefficient	-0.521	-0.437	-0.500	-0.349	-0.795	-0.765	-0.479	0.458	0.693	-0.650	-0.509	-0.152	-0.545	-0.083	-0.632	-0.178	-0.446	0.227	-0.697	0.132
		Sig. (2-tailed)	0.0032	0.0156	0.0049	0.0588	<0.0000	<0.0000	0.0074	0.0109	<0.0000	0.0001	0.0041	0.4237	0.0019	0.6617	0.0002	0.3480	0.0135	0.2267	<0.0000	0.4855
	Carbonate	Correlation Coefficient	-0.642	-0.473	-0.658	-0.150	-0.896	-0.802	-0.423	0.520	0.588	-0.520	-0.397	-0.338	-0.433	0.031	-0.555	-0.186	-0.274	0.347	-0.706	0.203
		Sig. (2-tailed)	0.0001	0.0083	0.0001	0.4287	<0.0000	<0.0000	0.0200	0.0032	0.0006	0.0033	0.0300	0.0678	0.0169	0.8720	0.0014	0.3252	0.1431	0.0600	<0.0000	0.2824
	Easily Reducible	Correlation Coefficient	-0.681	-0.776	-0.352	-0.171	-0.695	-0.705	-0.589	0.279	0.500	-0.718	-0.549	0.012	-0.680	0.150	-0.825	-0.480	-0.456	0.288	-0.856	-0.082
		Sig. (2-tailed)	<0.0000	<0.0000	0.0568	0.3653	<0.0000	<0.0000	0.0006	0.1349	0.0049	<0.0000	0.0017	0.9504	<0.0000	0.4295	<0.0000	0.0073	0.0113	0.1228	<0.0000	0.6657
	Organic	Correlation Coefficient	-0.194	-0.074	-0.226	-0.565	-0.527	-0.650	-0.409	0.411	0.796	-0.544	-0.584	0.003	-0.363	-0.350	-0.350	0.129	-0.458	-0.153	-0.347	0.162
		Sig. (2-tailed)	0.3046	0.6986	0.2306	0.0011	0.0028	0.0001	0.0250	0.0239	<0.0000	0.0019	0.0007	0.9859	0.0488	0.0581	0.0579	0.4979	0.0110	0.4208	0.0601	0.3937

Significant correlation; p-value < 0.00009 (Bonferroni corrected p-value for 556 comparisons among Table 7.8 and Appendix Table I.3).

Correlation scatterplot inspected; p <0.01.

[1] Values < method detection limit (MDL) were used at the MDL for calculations. Normalized survival and growth are relative to associated laboratory contro

[2] For sampling areas where 5 toxicity field replicates were analysed for each station (Sampling areas LRef1, LNF1, and LNF2), mean survival and growth measures (of the 5 replicates per station) were used for correlations with individual sediment chemistry measures from each static

[3] Copper extract results for sampling areas LRef2, LFF, and LFFF are for a single composite sample. As a result, the single copper value available for each fraction was used in correlations with each of the 5 toxicity replicates from each of these sampling areas.

Note: n=30 for all correlations; except n=19 for correlations with mercury.

NA = Correlation was not performed between these two parameters.

strontium), as well as exchangeable, carbonate and easily reducible copper, and was positively correlated with sediment PCA 1 (which represents low concentrations of POIs and IPs; Figure 7.2). Bray-Curtis index of dissimilarity was positively correlated with a number of POIs (arsenic, copper, iron and manganese) and IPs (calcium, molybdenum, silver, strontium and vanadium), as well as exchangeable and organic copper, and was negatively correlated with sediment PCA 1 (which represents low concentrations of POIs and IPs; Figure 7.2). Although correlation does not necessarily indicate cause, most of these associations suggest adverse effects to density, taxon richness and community structure associated with elevated concentrations of POIs and IPs. This finding is further supported by a number of additional relationships, including positive relationships between percent bivalves and CA axis 1 (representing Hydrozetidae [mites], Empididae [dance flies], Chironomus [non-biting midge] and Orthocladius [non-biting midge] in the positive direction and Probezzia [Ceratopogonidae - biting midge] and Caenis [mayfly] in the negative direction; Appendix Figure I.8) and TOC content, negative relationships between the proportion of sensitive EPT taxa and iron, sodium and easily reducible copper, and negative relationships between the proportion of bivalves and sodium and easily reducible copper (Table 7.8; Appendix Figure I.7). Negative relationships between benthic invertebrate community CA axis 1 and sodium, exchangeable copper, carbonate copper and easily reducible copper (Table 7.8; Appendix Figure I.7) are equivocal due to an absence of clear tolerance differences between the taxa represented by CA axis 1.

7.6 Data Integration, Summary and Spatial Extent

Sediment collected from littoral areas of Quesnel Lake following the dam failure was characterized by increasing TOC with distance from Hazeltine Creek, near-field concentrations of copper and iron greater than SQG PELs and reference concentrations, and near-field concentrations of arsenic and manganese greater than TELs and reference but similar to or lower than pre-event concentrations recorded in Hazeltine Creek. Sediment geochemical evaluations indicated that, for most POIs and IPs, concentrations were mostly in the residual phase, a fraction that is not considered mobile or biologically available. However, copper was a notable exception, with the majority occurring in the "organic" phase (which appears to be mineral), and with concentrations in the exchangeable, carbonate and easily reducible phases at near-field areas greater than reference. Separate integrated consideration of mineralogy, sequential extraction results and mineral solubility indicates that these forms would not be mobile under environmentally realistic conditions (SRK 2015).

Sediment toxicity testing indicated no adverse effects to *H. azteca* and *C. dilutus* at far-field and far-far-field areas, but sediments collected at near-field area 1 caused reduced survival and growth of *C. dilutus* relative to reference and laboratory controls. Benthic invertebrate community assessment indicated that the benthic invertebrate community of the Quesnel Lake littoral near-field areas (near-field area 1 and near-field area 2) had lower taxon richness than both reference areas. Nonetheless, community composition, although variable among areas, was not significantly different at the exposed areas relative to both references.

Correlation analysis indicated negative relationships between survival and growth of *H. azteca* and easily reducible copper and a negative relationship between survival of *C. dilutus* and carbonate copper. Positive relationships to TOC content were apparent for the same endpoints. Correlation analysis also indicated a number of significant relationships between benthic invertebrate community metrics and sediment metal concentrations (including selective copper extracts) that suggest effects to density, taxon richness and community structure associated with elevated concentrations of tailings dam failure-associated POIs and IPs.

Overall, an impact of the dam failure was evident in sediment quality of near-field littoral areas of Quesnel Lake. As in Hazeltine Creek and Polley Lake, copper represents the analyte of greatest concern, both with respect to its absolute concentration relative to guidelines and its geochemical partitioning. Sediment toxicity testing indicated that toxicity was restricted to the near-field areas, which were also the areas of lowest TOC content and highest POI concentrations. Benthic invertebrate communities at the near-field areas had fewer taxa than both reference areas, and significant negative relationships between density, taxon richness, community composition and specific conductance and sediment metal concentrations (including selective copper extracts) suggest a failure-related effect at near-field areas. As the positive influence of TOC cannot be separated from potential negative effects due to elevated metal concentration (including copper in potentially available forms), it is uncertain whether the effects were associated with moderately lower dissolved oxygen physical (i.e., due to smothering or low TOC) or chemical, but they are nonetheless related to the tailings dam failure. Both physical observations and concentrations of POIs and IPs indicate that the spatial extent of the tailings dam failure on Quesnel Lake littoral sediment quality is restricted to near-field areas.

8.0 QUESNEL LAKE - PROFUNDAL

Sediment quality impact characterization of the profundal zone of Quesnel Lake included sediment chemistry, sediment geochemical characterization, sediment stratigraphy, toxicity testing, and benthic invertebrate community characterization (Table 4.1; Figure 4.5). Data Quality Assessment (DQA; Appendix C with supporting data in Appendix J) indicated that sediment quality data, toxicity test results and benthic invertebrate community data were of good quality and can therefore be used in the sediment quality impact characterization.

8.1 Sediment Physical and Chemical Characterization

Surficial sediment (top 5 cm) collected in the near-field and far-field profundal areas of Quesnel Lake (PNF, PFF1 [downstream; north of the Hazeltine Creek mouth], PFF2 [upstream; south of the Hazeltine Creek mouth]; Figure 4.5) was generally composed entirely of light grey or tan coloured fines that varied in consistency from fairly liquid to more consolidated. Within the far-far-field sampling area (PFFF), sediment was generally composed of a thin layer of light grey or tan-coloured fines over distinctly stratified brown silt and dark grey clay-like fines separated by a rust-coloured layer. Sediment collected in both reference areas was similar to one another, with brown or rust coloured silt present at the surface, and dark grey clay-like fines deeper in the sediment, with these layers generally separated by distinct striations.

Sediment at the four exposed areas and two reference areas in the profundal zone of Quesnel Lake were predominantly silt and clay (Table 8.1; Appendix Table E.54). Sediment at one of the reference areas, area PRef1 located in Horsefly Bay (Figure 4.5), had a higher proportion of sand than all other areas, but was still 67% silt, on average (Table 8.1). Total organic carbon ranged from a low of 0.17% at PNF (directly off the mouth of Hazeltine Creek) to 3.06% at PFFF (the far-far-field area located just south of Cedar Point; Figure 4.5). As also observed in littoral sediments of Quesnel Lake, a spatial pattern of increasing TOC (in this case from concentrations well below reference to concentrations similar to reference) was evident proceeding from the near-field area to the far-far-field area (Tables 8.1 and 8.2), associated with the input of failure-derived materials low in TOC content.

Copper was the only analyte with concentrations in Quesnel Lake profundal near-field and far-field sediment greater than guidelines (PELs) and reference concentrations (Tables 8.1 and 8.2; Figure 8.1). At the far-far-field area, copper concentrations were lower than PEL, but were greater than TEL and remained higher than reference. A number of

Table 8.1: Summary of sediment quality data for Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Metals data are based on the < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		Reference 95th Percentile [3]		Reference				Exposed							
						PRef1 (QULP-5)		PRef2 (QULP-6)		PNF (QULP-1)		PFF2 (QULP-4)		PFF1 (QULP-2)		PFFF (QULP-3)	
		TEL	PEL	PRef1	PRef2	Mean	t*SE	Mean	t*SE	Mean	t*SE	Mean	t*SE	Mean	t*SE	Mean	t*SE
Date Sampled																	
Physical Tests																	
Moisture	%	-	-	54.1	70.5	51.8	3.18	67.6	5.11	37.7	9.16	40.3	3.54	41.9	13.4	80.1	0.565
pH (1:2 soil:water)	pH	-	-	6.84	7.26	6.90	0.092	7.26		8.51	0.112	8.18	0.212	8.32	0.246	-	-
Particle Size																	
% Gravel (>2mm)	%	-	-	<0.10	<0.10	<0.10	0	<0.10	0	0.10	0.0056	<0.10	0	<0.10	0	<0.10	0
% Sand (2.0mm - 0.063mm)	%	-	-	31	13	24	9.0	7.0	6.5	7.8	16	0.26	0.20	0.37	0.43	0.56	0.10
% Silt (0.063mm - 4µm)	%	-	-	74	74	67	9.0	73	1.9	70	13	84	4.4	84	12	68	4.4
% Clay (<4µm)	%	-	-	10	27	9.1	1.5	20	7.1	23	15	16	4.5	16	12	32	4.3
Texture	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leachable Anions & Nutrients																	
pH	pH	-	-	6.82	-	6.78	0.0541	-	-	8.17	0.533	-	-	7.90	0.441	-	-
Anions and Nutrients																	
Total Nitrogen by LECO	%	-	-	0.148	0.176	0.140	0.0103	0.150	0.0317	0.023	0.0065	0.026	0.010	0.043	0.052	0.302	0.0226
Organic / Inorganic Carbon																	
Total Organic Carbon	%	-	-	2.10	2.06	2.03	0.107	1.78	0.406	0.17	0.11	0.32	0.14	0.54	0.84	3.06	0.391
Metals																	
Aluminum	mg/kg	-	-	16,160	26,520	15,260	1,183	23,080	3,655	20,940	5,646	20,140	2,445	19,640	4,984	28,400	1,197
Antimony	mg/kg	-	-	0.45	0.44	0.41	0.038	0.40	0.044	0.49	0.14	0.48	0.086	0.49	0.12	0.76	0.076
Arsenic	mg/kg	5.9	17	9.29	22.2	8.25	1.60	17.7	4.17	15.1	3.30	13.8	0.655	13.0	2.37	**54.2**	19.9
Barium	mg/kg	-	-	153	246	142	14.0	216	30.9	219	48.0	215	23.4	198	37.8	236	21.2
Beryllium	mg/kg	-	-	0.47	0.94	0.44	0.032	0.87	0.078	0.82	0.25	0.74	0.11	0.70	0.15	0.882	0.0604
Bismuth	mg/kg	-	-	<0.20	0.52	<0.20	0	0.46	0.09	<0.20	0	<0.20	0	<0.20	0	0.33	0.017
Boron	mg/kg	-	-	<10	<10	<10	0	<10	0	11	1.6	10	0.56	<10	0	<10	0
Cadmium	mg/kg	0.60	3.5	0.419	0.329	0.404	0.0224	0.317	0.0112	0.152	0.0321	0.159	0.0328	0.197	0.133	**0.705**	0.0542
Calcium	mg/kg	-	-	8,248	6,940	7,902	440	6,136	907	33,600	6,353	31,020	665	28,340	1,286	10,280	853
Chromium	mg/kg	37	90	55.9	53.4	53.7	2.70	49.0	4.92	12.6	2.51	13.6	3.13	18.6	9.96	**68.3**	6.28
Cobalt	mg/kg	-	-	14.4	25.6	14.1	0.604	23.6	2.45	18.7	4.05	15.9	2.16	16.2	5.77	27.3	1.57
Copper	mg/kg	36	197	45.9	50.0	43.7	2.88	44.7	6.29	**698**	137	**548**	50.3	**483**	125	**105**	19.2
Iron	mg/kg	21,200	43,776	30,900	111,840	29,480	1,894	83,960	29,625	35,200	14,824	24,880	2,392	27,580	7,260	62,320	6,727
Lead	mg/kg	35	91	7.12	21.9	6.65	0.593	18.8	3.38	6.79	1.85	6.18	1.24	7.33	3.77	19.4	1.88
Lithium	mg/kg	-	-	14.5	38.8	13.9	0.935	34.6	4.65	21.1	5.76	19.9	4.00	19.8	6.69	28.1	1.53
Magnesium	mg/kg	-	-	8,024	9,692	7,700	418	8,952	845	12,644	3,588	11,880	1,857	10,932	3,303	12,600	562
Manganese	mg/kg	460	1,100	571	6,960	500	81.4	4,584	2,898	766	191	727	96.7	747	324	**14,960**	6,051
Mercury	mg/kg	0.17	0.49	0.0521	0.0644	0.0490	0.00352	0.0644	0	0.0759	0.0104	0.063	0.013	0.0742	0.0243	-	-
Molybdenum	mg/kg	-	-	1.02	2.63	0.93	0.10	2.24	0.526	3.82	0.331	3.27	0.100	2.96	0.408	10.05	12.1
Nickel	mg/kg	16	75	38.7	61.2	37.3	1.59	58.2	3.35	12.1	2.92	13.2	3.15	17.2	10.0	**68.5**	5.33
Phosphorus	mg/kg	-	-	1,138	2,152	1,062	101	1,748	558	1,706	282	1,568	107	1,482	174	1,928	572
Potassium	mg/kg	-	-	1,430	3,526	1,346	145	3,118	511	1,856	361	1,804	293	1,804	531	2,838	132
Selenium	mg/kg	2.0	-	0.988	1.012	0.938	0.0598	0.84	0.21	1.04	0.27	0.91	0.11	0.92	0.49	1.67	0.309
Silver	mg/kg	0.50	-	0.21	0.20	0.19	0.023	0.17	0.032	0.33	0.048	0.26	0.031	0.28	0.091	0.35	0.019
Sodium	mg/kg	-	-	460	378	404	55.9	334	61.2	1,082	190	1,000	56.9	888	95.5	460	50.4
Strontium	mg/kg	-	-	80.5	97.2	75.2	7.92	86.6	11.2	186	41.9	198	12.0	186	16.5	126	15.0
Thallium	mg/kg	-	-	0.183	0.289	0.167	0.0199	0.276	0.0152	<0.050	0	0.051	0.0018	0.064	0.037	0.321	0.0266
Tin	mg/kg	-	-	<2.0	<2.0	<2.0	0	<2.0	0	2.2	0.31	2.1	0.10	<2.0	0	<2.0	0
Titanium	mg/kg	-	-	1,162	947	1,052	105	853	97.3	1,852	542	1,802	93.5	1,710	245	940	103
Uranium	mg/kg	-	-	1.34	3.06	1.27	0.0948	2.81	0.344	1.36	0.42	1.40	0.116	1.35	0.389	3.45	0.300
Vanadium	mg/kg	-	-	65.6	48.2	63.0	3.23	46.3	3.07	132	56.1	91.4	5.78	88.7	13.2	90.2	3.91
Zinc	mg/kg	123	315	79.3	104	74.7	4.77	94.6	9.99	67.1	15.6	60.7	9.69	61.3	23.4	120	6.14

(blue) Value is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

[1] Reported TOC, TN, pH, and moisture data are based on bulk sediment. Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Reference 95th percentile was calculated using displayed metals data for the < 2mm sediment fraction, and using displayed TOC, pH, TN, particle size and moisture data. The 5th percentile is reported for pH.

Table 8.2: Summary of sediment quality data for Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Metals data are based on the < 63µm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		Reference 95th Percentile [3]		Reference				Exposed							
						PRef1 (QULP-5)		PRef2 (QULP-6)		PNF (QULP-1)		PFF2 (QULP-4)		PFF1 (QULP-2)		PFFF (QULP-3)	
		TEL	PEL	PRef1	PRef2	Mean	t*SE	Mean	t*SE	Mean	t*SE	Mean	t*SE	Mean	t*SE	Mean	t*SE
Physical Tests																	
pH (1:2 soil:water)	pH	-	-	6.83	7.21	6.94	0.111	7.33	0.152	8.68	0.0762	8.50	0.196	8.31	0.223	7.31	0.0819
Organic / Inorganic Carbon																	
Total Organic Carbon	%	-	-	1.72	1.93	1.68	0.056	1.69	0.301	0.17	0.077	0.29	0.15	0.44	0.57	3.03	0.344
Metals																	
Aluminum	mg/kg	-	-	15,380	25,380	14,780	943	23,020	2,641	20,800	4,903	20,820	2,441	19,540	4,918	28,620	1,066
Antimony	mg/kg	-	-	0.44	0.40	0.42	0.023	0.37	0.038	0.52	0.085	0.45	0.042	0.46	0.13	0.79	0.074
Arsenic	mg/kg	5.9	17	8.51	20.9	7.75	0.856	16.9	4.41	15.4	2.49	13.7	0.69	13.2	2.04	**89.2**	61.6
Barium	mg/kg	-	-	151	220	144	8.07	195	42.6	225	44.4	220	16.6	204	40.0	265	20.4
Beryllium	mg/kg	-	-	0.44	0.90	0.41	0.028	0.83	0.075	0.79	0.20	0.72	0.069	0.69	0.16	0.84	0.059
Bismuth	mg/kg	-	-	0.15	0.51	0.14	0.0088	0.46	0.046	0.10	0.011	0.10	0.0056	0.12	0.050	0.32	0.011
Boron	mg/kg	-	-	<10	<10	<10	0	<10	0	11	0.68	11	0.68	<10	0	<10	0
Cadmium	mg/kg	0.60	3.5	0.414	0.315	0.384	0.0359	0.297	0.0321	0.164	0.0336	0.149	0.0301	0.181	0.100	**0.714**	0.0888
Calcium	mg/kg	-	-	8,034	7,392	7,742	368	6,376	1,175	33,340	5,031	32,280	1,406	27,900	1,093	10,620	572
Chromium	mg/kg	37	90	55.8	52.2	52.0	3.98	48.4	4.30	14.3	3.75	14.1	4.14	18.8	9.84	**68.1**	2.79
Cobalt	mg/kg	-	-	14.0	25.7	13.3	0.817	23.4	2.91	19.4	3.60	16.0	2.46	16.1	5.34	27.0	0.750
Copper	mg/kg	36	197	46.2	48.3	42.2	4.15	44.2	5.31	**714**	138	**550**	59.1	**481**	120	**99.5**	19.1
Iron	mg/kg	21,200	43,776	29,820	102,460	28,580	1,664	81,900	22,301	37,240	21,694	24,980	2,283	27,680	6,866	69,460	6,965
Lead	mg/kg	35	91	7.24	22.1	7.00	0.292	19.5	2.68	7.09	1.82	6.19	1.16	6.97	3.27	18.8	1.94
Lithium	mg/kg	-	-	13.8	37.4	13.1	0.643	33.7	3.30	20.5	5.23	19.9	3.08	20.3	6.50	26.7	1.92
Magnesium	mg/kg	-	-	8,036	9,344	7,666	475	8,546	807	12,958	3,178	11,980	2,310	10,938	3,155	11,860	845
Manganese	mg/kg	460	1,100	496	7,814	470	39.5	5,222	3,582	797	147	730	114	725	299	**19,052**	8,894
Mercury	mg/kg	0.17	0.49	0.0515	0.0593	0.0486	0.0030	0.0515	0.0115	0.0697	0.0093	0.0701	0.00692	0.0763	0.0217	0.140	0.0139
Molybdenum	mg/kg	-	-	0.96	2.72	0.91	0.057	2.29	0.643	3.76	0.336	3.31	0.120	2.89	0.351	11.5	13.3
Nickel	mg/kg	16	75	37.9	60.7	35.6	2.57	56.9	4.43	12.9	2.81	13.3	3.88	16.9	9.25	**67.4**	3.05
Phosphorus	mg/kg	-	-	1,126	1,776	1,094	41	1,658	172	1,706	155	1,652	215	1,506	228	2,370	653
Potassium	mg/kg	-	-	1,370	3,704	1,312	88	3,176	551	1,942	438	1,904	320	1,842	541	3,086	155
Selenium	mg/kg	2.0	-	0.94	0.91	0.86	0.091	0.76	0.19	1.07	0.220	0.89	0.12	0.94	0.43	1.67	0.277
Silver	mg/kg	0.50	-	0.203	0.189	0.188	0.0169	0.172	0.0218	0.332	0.0495	0.271	0.0247	0.261	0.0839	0.338	0.0276
Sodium	mg/kg	-	-	420	374	396	29	320	57.6	1,118	256	1,004	126	936	107	476	55.9
Strontium	mg/kg	-	-	78.1	94.3	74.6	3.93	86.7	11.7	188	36.5	198	11.7	183	15.0	133	11.5
Thallium	mg/kg	-	-	0.166	0.293	0.157	0.011	0.266	0.0278	<0.050	0	0.051	0.0024	0.0664	0.0389	0.354	0.0314
Tin	mg/kg	-	-	0.47	0.61	0.41	0.067	0.53	0.10	2.05	0.484	1.9	0.33	1.5	0.25	0.79	0.21
Titanium	mg/kg	-	-	1,084	923	1,036	58	848	67	1,946	344	1,842	312	1,464	284	919	58.3
Uranium	mg/kg	-	-	1.35	3.16	1.30	0.0633	2.90	0.303	1.43	0.354	1.36	0.152	1.34	0.350	3.36	0.291
Vanadium	mg/kg	-	-	66.3	46.6	62.2	4.42	44.7	2.87	145	84.6	90.2	7.87	90.8	12.6	87.4	3.76
Zinc	mg/kg	123	315	77.1	95.3	73.7	3.66	86.8	8.96	69.0	13.8	60.7	10.5	63.2	23.0	114	7.24

Value is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Reference 95th percentile was calculated using displayed data for the <63µm sediment fraction. The 5th percentile is reported for pH.

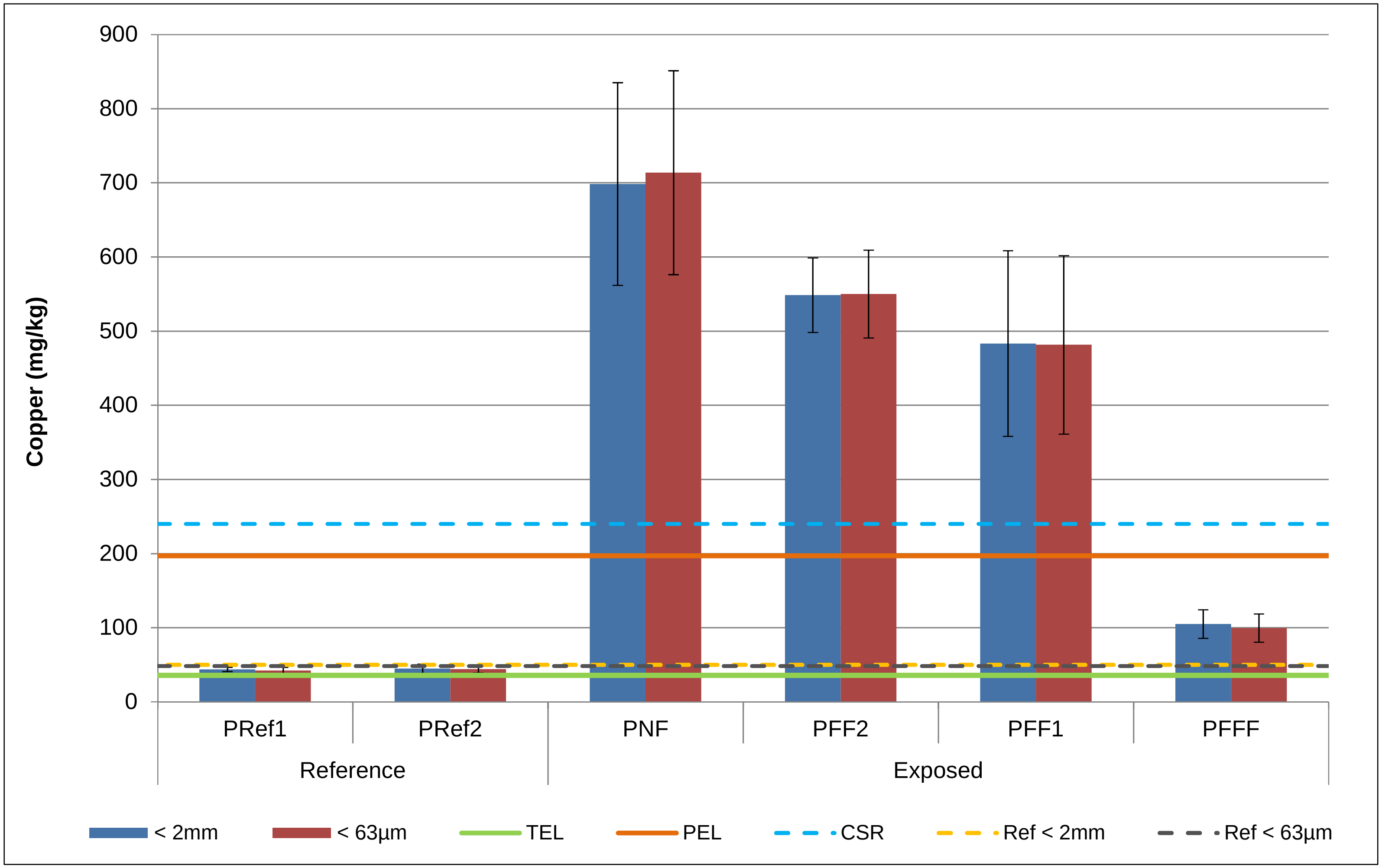


Figure 8.1: Mean copper concentrations (± t*SE) in sediment from profundal sampling areas in Quesnel Lake, Mount Polley Mine, 2014.

TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level; CSR =Contaminated Sites Regulation-Typical.
Ref < 2mm and Ref < 63 µm values are the highest 95th percentile values for each sediment fraction reported among the reference areas (PRef1 and PRef2).

additional analytes were present at the far-far-field area at concentrations greater than guidelines and reference concentrations (arsenic and manganese were greater than PELs; cadmium, chromium and nickel were greater than TEL; Tables 8.1 and 8.2), but were below reference at the near-field and far-field areas (Tables 8.1 and 8.2) and are therefore not considered to be associated with the tailings dam failure. It is notable, however, that concentrations of iron and manganese, although also elevated at one reference area (PRef 2, located at the Quesnel Lake North Arm), were both greater than SQG PELs at the far-far-field area (Tables 8.1 and 8.2). Concentrations of five additional analytes were present in Quesnel Lake profundal sediment at concentrations more than twice reference concentrations (calcium, sodium, strontium, tin and vanadium in near-field and far-field areas only; Tables 8.3 and 8.4). All of these analytes were identified as IPs based on the Hazeltine Creek, Polley Lake and/or Quesnel Lake littoral datasets. In accordance with the framework set out in Section 4.0, copper is designated as a POI and calcium, sodium, strontium and tin are designated as IPs. However, all POIs identified in the evaluations of Hazeltine Creek, Polley Lake and the Quesnel Lake littoral zone (i.e., arsenic, copper, iron, manganese and nickel; Sections 5 to 7) are also considered as part of this characterization of Quesnel Lake profundal sediment in order to track their spatial distribution.

Principal Components Analysis (PCA) distinguished sediments of the near-field exposed area and the far-field area from reference on the basis of axis 2 scores, (indicating higher clay content) and sediments of the far-far-field area from most other areas on a combination of axis 1 and 2 scores indicating greater clay and TOC content (Figure 8.2). PCA was effective in distinguishing sediments of the near-field exposed area and the far-field exposed areas from reference on the basis axis 2 scores, which, with the exception of tin, included all POIs and IPs identified above, thereby confirming their importance in explaining spatial variability. PCA was also effective in distinguishing sediments of the far-far-field area from reference and the near-field and far-field areas on the basis axis 1 scores (indicating higher concentrations of aluminum, arsenic, bismuth, cadmium, chromium, cobalt, iron, lead, manganese, nickel, potassium, thallium, uranium, zinc). Of these, cadmium, chromium and nickel were identified as occurring at concentrations greater than TELs at the far-far-field area only.

Of the POIs and IPs, copper was the most substantially elevated, with mean concentrations up to approximately 3.5 times the PEL and 16 times reference (Tables 8.1 to 8.4; Figures 8.1 to 8.4). Copper concentration was greatest at the near-field area (PNF; Figure 8.1). Unlike copper in Hazeltine Creek and Quesnel Lake littoral sediments, there

Table 8.3: Ratio of exposed mean to reference mean metal concentrations[1,2] in the < 2mm fraction of sediment from profundal sampling areas of Quesnel Lake, Mount Polley Mine, 2014. Ratios with a value > 2 are highlighted.

Sample ID	Exposed sampling area			
	PNF (QULP-1)	PFF2 (QULP-4)	PFF1 (QULP-2)	PFFF (QULP-3)
Organic / Inorganic Carbon				
Total Organic Carbon	0.1	0.2	0.3	1.5
Metals				
Aluminum	0.8	0.8	0.7	1.1
Antimony	1.1	1.1	1.1	1.7
Arsenic	0.7	0.6	0.6	2.4
Barium	0.9	0.9	0.8	1.0
Beryllium	0.9	0.8	0.7	0.9
Bismuth	0.4	0.4	0.4	0.6
Boron	1.1	1.0	1.0	1.0
Cadmium	0.5	0.5	0.6	2.1
Calcium	4.8	4.5	4.1	1.5
Chromium	0.2	0.3	0.3	1.3
Cobalt	0.7	0.6	0.6	1.1
Copper	14.0	11.0	9.7	2.1
Iron	0.3	0.2	0.2	0.6
Lead	0.3	0.3	0.3	0.9
Lithium	0.5	0.5	0.5	0.7
Magnesium	1.3	1.2	1.1	1.3
Manganese	0.1	0.1	0.1	2.1
Mercury	1.2	1.0	1.2	-
Molybdenum	1.5	1.2	1.1	3.8
Nickel	0.2	0.2	0.3	1.1
Phosphorus	0.8	0.7	0.7	0.9
Potassium	0.5	0.5	0.5	0.8
Selenium	1.0	0.9	0.9	1.7
Silver	1.7	1.3	1.4	1.7
Sodium	2.9	2.6	2.3	1.2
Strontium	1.9	2.0	1.9	1.3
Thallium	0.2	0.2	0.2	1.1
Tin	1.1	1.0	1.0	1.0
Titanium	2.0	1.9	1.8	1.0
Uranium	0.4	0.5	0.4	1.1
Vanadium	2.7	1.9	1.8	1.9
Zinc	0.6	0.6	0.6	1.2

[1] The highest mean concentration for each analyte from among the littoral reference areas (PRef1 and PRef2) was used as the reference mean for calculation of the ratio.

[2] Mean values < method detection limit (MDL) were used at the MDL for calculation of exposed to reference ratios.

Table 8.4: Ratio of exposed mean to reference mean metal concentrations[1,2] in the < 63µm fraction of sediment from profundal sampling areas of Quesnel Lake, Mount Polley Mine, 2014. Ratios with a value > 2 are highlighted.

Analyte	Exposed sampling area			
	PNF (QULP-1)	PFF2 (QULP-4)	PFF1 (QULP-2)	PFFF (QULP-3)
Organic / Inorganic Carbon				
Total Organic Carbon	0.1	0.2	0.3	1.8
Metals				
Aluminum	0.9	0.9	0.8	1.2
Antimony	1.2	1.1	1.1	1.9
Arsenic	0.9	0.8	0.8	5.3
Barium	1.2	1.1	1.0	1.4
Beryllium	1.0	0.9	0.8	1.0
Bismuth	0.2	0.2	0.3	0.7
Boron	1.1	1.1	1.0	1.0
Cadmium	0.4	0.4	0.5	1.9
Calcium	4.3	4.2	3.6	1.4
Chromium	0.3	0.3	0.4	1.3
Cobalt	0.8	0.7	0.7	1.2
Copper	16.1	12.4	10.9	2.2
Iron	0.5	0.3	0.3	0.8
Lead	0.4	0.3	0.4	1.0
Lithium	0.6	0.6	0.6	0.8
Magnesium	1.5	1.4	1.3	1.4
Manganese	0.2	0.1	0.1	3.6
Mercury	1.4	1.4	1.5	2.7
Molybdenum	1.6	1.4	1.3	5.0
Nickel	0.2	0.2	0.3	1.2
Phosphorus	1.0	1.0	0.9	1.4
Potassium	0.6	0.6	0.6	1.0
Selenium	1.2	1.0	1.1	1.9
Silver	1.8	1.4	1.4	1.8
Sodium	2.8	2.5	2.4	1.2
Strontium	2.2	2.3	2.1	1.5
Thallium	0.2	0.2	0.3	1.3
Tin	3.9	3.6	2.9	1.5
Titanium	1.9	1.8	1.4	0.9
Uranium	0.5	0.5	0.5	1.2
Vanadium	2.3	1.5	1.5	1.4
Zinc	0.8	0.7	0.7	1.3

[1] The highest mean concentration for each analyte from among the littoral reference areas (PRef1 and PRef2) was used as the reference mean for calculation of the ratio.

[2] Mean values < method detection limit (MDL) were used at the MDL for calculation of exposed to reference ratios.

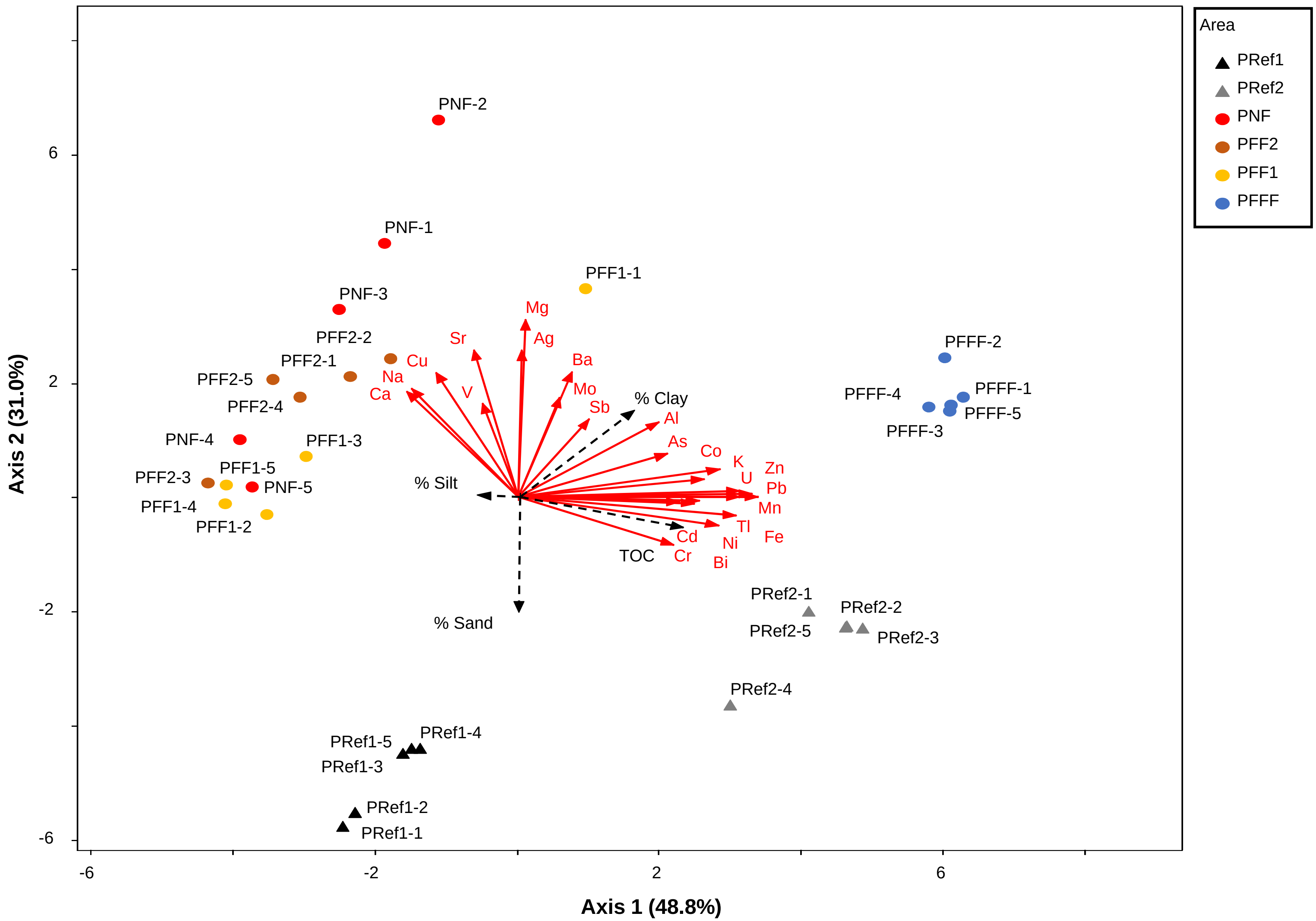


Figure 8.2: **Biplot of principal component analysis (PCA) of metal concentrations in sediment (<2 mm fraction) from Quesnel Lake profundal sampling stations, Mount Polley Mine, 2014. Vector length is proportional to the magnitude of direct correlation of metals (solid red vector lines) and indirect correlation of sediment physical characteristics (black dashed vector lines) with PCA values of each axis (Appendix Tables E.56-E.57). Only metals with significant (p-value <0.010) Spearman's correlation and r-values > 0.7 with either axis are displayed, all sediment physical characteristics are displayed [a].**

[a] Mercury was omitted from calculations due to an incomplete data set.

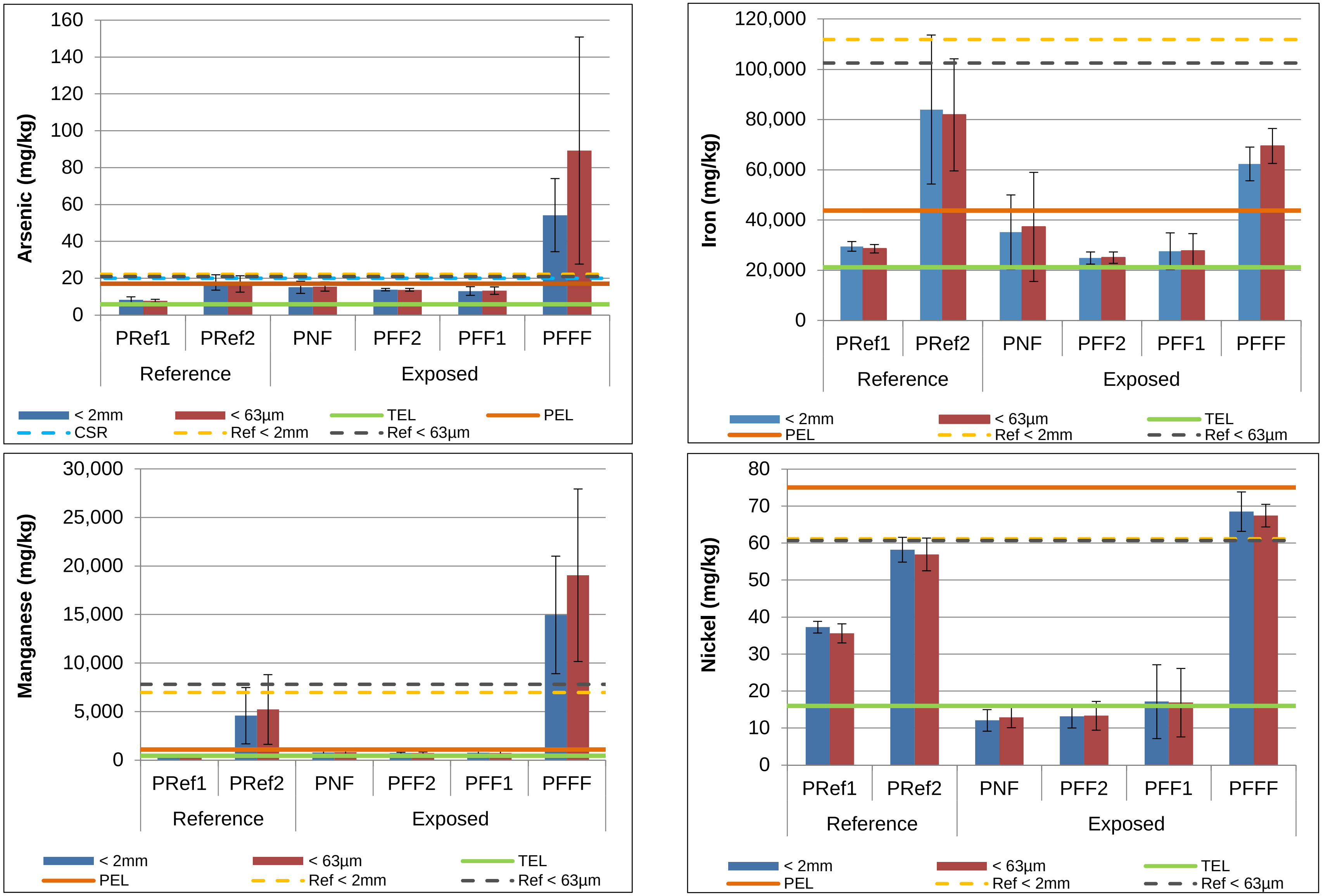


Figure 8.3: Mean metal concentrations (± t*SE) in Quesnel profundal sediment for parameters of interest identified in other sampling areas (Hazeltine Creek, Polley Lake, and Quesnel Lake littoral), Mount Polley Mine, 2014.

TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level; CSR =Contaminated Sites Regulation-Typical.

Ref < 2mm and Ref < 63 µm values are the highest 95th percentile values for each sediment fraction reported among the reference areas (PRef1 and PRef2).

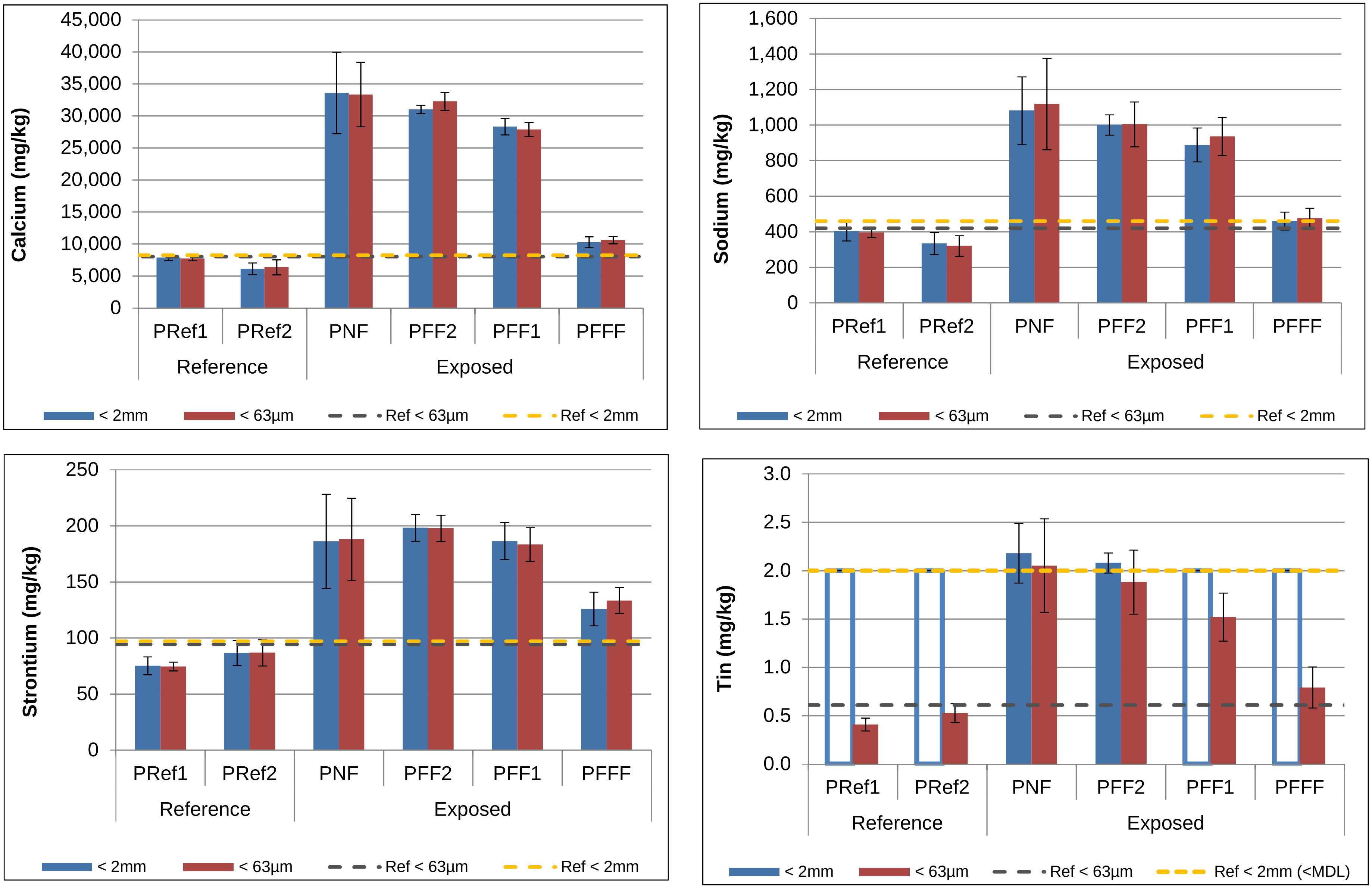


Figure 8.4: Mean metal concentrations (± t*SE) of indicator parameters in sediment from profundal sampling areas in Quesnel Lake, Mount Polley, 2014. Hollow bars indicate all values used to calculate the mean were < the method detection limit (MDL).

Ref < 2mm and Ref < 63 µm values are the highest 95th percentile values for each sediment fraction reported among the reference areas (PRef1 and PRef2).

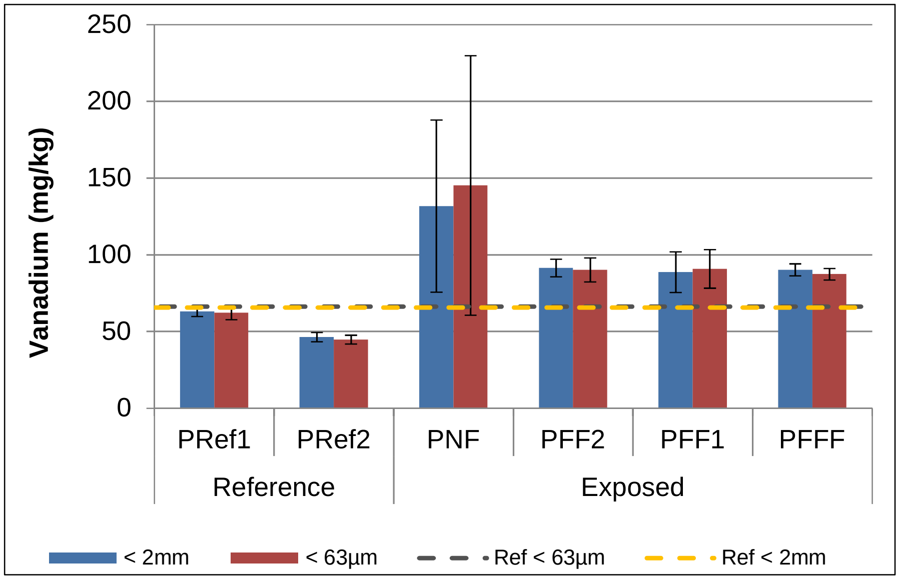


Figure 8.4: Mean metal concentrations (± t*SE) of indicator parameters in sediment from profundal sampling areas in Quesnel Lake, Mount Polley, 2014. Hollow bars indicate all values used to calculate the mean were < the method detection limit (MDL).

Ref < 2mm and Ref < 63 µm values are the highest 95th percentile values for each sediment fraction reported among the reference areas (PRef1 and PRef2).

was no clear enrichment in the <2 mm fraction relative to <63 µm fraction, presumably due to high proportion of silt and clay (≥93%; Table 8.1). Copper concentrations decreased in a step-wise manner with distance from PNF to PFFF and were lower than PEL at PFFF (Figure 8.1). Concentrations of arsenic, iron and manganese decreased with distance from PNF to PFF, but were highest at PFFF, whereas concentrations of nickel increased with distance from PNF (Figure 8.3). Similar to copper, concentrations of all IPs decreased with distance from PNF to PFFF, and with the exception of strontium, were generally similar to reference at area PFFF (Figure 8.4).

Concentrations of copper, calcium, sodium and strontium were all positively correlated with percent fines (percent silt and clay) and negatively correlated with sediment total organic carbon (TOC) content (Table 8.5; Appendix Figure E.30). This is driven by the combination of higher fines, low TOC and high concentrations of copper and IPs at the near-field and far-field areas (Appendix Figure E.30). Concentrations of iron and nickel were positively correlated with sediment TOC content, primarily driven by high concentrations of TOC and these metals at the far-far-field area and reference area 2 (Table 8.5; Appendix Figure E.30).

8.2 Sediment Geochemical Characterization

As previously indicated, there are numerous factors that affect the bioavailability of metals in sediments. While metal concentrations that are below the sediment quality guidelines generally provide a reliable indicator of an absence of effect, sediment quality results that exceed those benchmarks provide a less reliable indication that effects are probable. Geochemical characterization can assist in characterizing the potential mobility and bioavailability of metals associated with mine-influenced sediments.

Selective extractions indicated that concentrations of most POIs and IPs were primarily in the residual phase; that is, they could only be extracted by the strongest acid digest (a combination of concentrated nitric and hydrochloric acid; Table 8.6; Appendix Table E.60; Figure 8.5; Appendix Figures E.31-E.32). As previously discussed, residual metals are unlikely to be mobilized under any conditions that could realistically occur in the environment, nor in interactions with aquatic organisms (i.e., contact with the gill or ingestion) and are therefore considered not biologically available (e.g., Tessier et al. 1979; Campbell and Tessier 1996). Exceptions were observed with copper and manganese. As also observed in Hazeltine Creek, Polley Lake and Quesnel Lake littoral sediments, greatest concentrations of copper at the near-field areas occurred in the “organic” phase (Figure 8.5). As previously discussed (Section 5.2), it is likely that the “organic” phase represents mineral copper. This copper partitioning differed from that observed in

Table 8.5: Spearman's Rank Correlation results for correlation of concentrations of parameters of interest and indicator parameters (in < 2mm sediment fraction) relative to % fines (silt and clay) and total organic carbon in sediment from Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014 [1].

Metal		Correlation Parameter	Silt and Clay (%)	Total Organic Carbon (%)
Parameters of Interest	Arsenic	Correlation Coefficient	0.304	0.368
		Sig. (2-tailed)	0.1025	0.0454
	Copper	Correlation Coefficient	0.615	-0.625
		Sig. (2-tailed)	0.0003	0.0002
	Iron	Correlation Coefficient	-0.397	0.585
		Sig. (2-tailed)	0.0298	0.0007
	Manganese	Correlation Coefficient	0.295	0.428
		Sig. (2-tailed)	0.1137	0.0183
	Nickel	Correlation Coefficient	-0.236	0.925
		Sig. (2-tailed)	0.2084	<0.0000
Indicator Parameters	Calcium	Correlation Coefficient	0.591	-0.639
		Sig. (2-tailed)	0.0006	0.0001
	Sodium	Correlation Coefficient	0.635	-0.629
		Sig. (2-tailed)	0.0002	0.0002
	Strontium	Correlation Coefficient	0.744	-0.626
		Sig. (2-tailed)	<0.0000	0.0002
	Tin	Correlation Coefficient	0.350	-0.373
		Sig. (2-tailed)	0.0577	0.0421
	Vanadium	Correlation Coefficient	0.394	-0.409
		Sig. (2-tailed)	0.0312	0.0249

Significant correlation p-value < 0.003 (Bonferroni corrected p-value for 20 comparisons).

Correlation scatterplot inspected; p < 0.01.

[1] Values < method detection limit (MDL) were used at the MDL for calculations.

Note: n=30 for all correlations

Table 8.6: Summary of data for selectively extracted (Tessier extraction) metals in sediment from Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment. Only analytes with detectable concentrations are displayed[1].

Sample ID	Units	BC SQGs [2]		Reference Value [3]		Reference			Exposed					
						PRef1 (QULP-5)		PRef2 (QULP-6)	PNF (QULP-1)		PFF2 (QULP-4)	PFF1 (QULP-2)		PFFF (QULP-3)
				PRef1	PRef2	Mean	t*SE	Composite	Mean	t*SE	Composite	Mean	t*SE	Composite
Exchangeable & Adsorbed Metals														
Arsenic	mg/kg	5.9	17	0.059	<0.050	0.054	0.0056	<0.050	0.060	0.011	0.055	0.058	0.0076	0.061
Cadmium	mg/kg	0.60	3.5	0.131	0.092	0.121	0.0111	0.092	<0.050	0	<0.050	0.065	0.041	0.234
Calcium	mg/kg	-	-	2,566	3,110	2,408	192	3,110	1,738	708	1,810	2,158	1,410	4,190
Cobalt	mg/kg	-	-	0.39	0.28	0.36	0.049	0.28	<0.10	0	<0.10	0.11	0.033	0.22
Copper	mg/kg	36	197	0.77	<0.50	0.71	0.072	<0.50	4.04	0.608	2.49	1.34	0.474	<0.50
Manganese	mg/kg	460	1,100	192	466	149	42.8	466	15.3	6.03	26.7	64.4	91.5	**1,500**
Nickel	mg/kg	16	75	0.94	0.56	0.87	0.11	0.56	<0.50	0	<0.50	<0.50	0	0.62
Potassium	mg/kg	-	-	<100	<100	<100	0	<100	138	43.4	160	118	30.9	110
Strontium	mg/kg	-	-	22.2	31.2	20.5	2.14	31.2	17.5	10.4	17.0	19.7	15.0	41.5
Uranium	mg/kg	-	-	<0.050	<0.050	<0.050	0	<0.050	<0.050	0	0.054	0.066	0.044	<0.050
Carbonate Metals														
Aluminum	mg/kg	-	-	<50	<50	<50	0	<50	72	21	<50	69	7.7	<50
Arsenic	mg/kg	5.9	17	0.386	<0.050	0.308	0.106	<0.050	0.072	0.010	<0.050	0.123	0.057	0.072
Barium	mg/kg	-	-	17.7	10.9	16.7	1.14	10.9	52.6	18.6	43.1	42.6	10.1	9.50
Cadmium	mg/kg	0.60	3.5	0.057	<0.050	0.053	0.0038	<0.050	0.052	0.0061	<0.050	0.063	0.037	0.065
Calcium	mg/kg	-	-	434	495	383	50.8	495	13,380	2,120	7,680	10,810	944	620
Cobalt	mg/kg	-	-	0.96	0.13	0.84	0.19	0.13	0.28	0.10	<0.10	0.61	0.48	0.15
Copper	mg/kg	36	197	1.73	<0.50	1.58	0.272	<0.50	**48.4**	14.1	3.56	24.2	8.07	0.53
Iron	mg/kg	21,200	43,776	840	<50	684	261	<50	88	12	<50	234	115	<50
Lead	mg/kg	35	91	<0.50	<0.50	<0.50	0	<0.50	0.82	0.16	<0.50	0.75	0.17	<0.50
Manganese	mg/kg	460	1,100	47.0	215	38.6	11.8	215	104	19.0	53.9	129	76.3	**774**
Nickel	mg/kg	16	75	<2.0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	2.1	0.17	<2.0
Strontium	mg/kg	-	-	5.1	9.0	<5.0	0.056	9.0	54.1	15.6	43.2	48.8	3.15	11.9
Uranium	mg/kg	-	-	0.354	0.209	0.338	0.0307	0.209	0.081	0.038	0.053	0.161	0.172	0.251
Vanadium	mg/kg	-	-	0.94	<0.20	0.788	0.302	<0.20	<0.20	0	<0.20	0.25	0.11	<0.20
Zinc	mg/kg	123	315	2.08	<1.0	1.84	0.286	<1.0	1.3	0.32	<1.0	1.9	0.95	<1.0
Easily Reducible Metals and Iron Oxides														
Aluminum	mg/kg	-	-	999	1,200	981	20.5	1,200	1,786	408	1,510	1,648	253	1,240
Arsenic	mg/kg	5.9	17	2.54	0.58	2.14	0.549	0.58	2.57	0.647	1.86	2.15	0.267	4.59
Barium	mg/kg	-	-	24.2	82.5	23.1	1.79	82.5	32.4	13.1	24.5	29.5	10.5	88.1
Beryllium	mg/kg	-	-	<0.20	0.34	<0.20	0	0.34	0.22	0.032	<0.20	0.22	0.044	0.37
Cadmium	mg/kg	0.60	3.5	0.207	0.179	0.201	0.0076	0.179	0.062	0.012	0.064	0.069	0.036	0.36
Calcium	mg/kg	-	-	805	626	768	46.4	626	2,006	426	5,080	1,752	230	851
Chromium	mg/kg	37	90	4.09	3.84	4.00	0.122	3.84	2.00	0.400	2.23	2.60	1.08	5.97
Cobalt	mg/kg	-	-	4.74	11.1	4.70	0.0415	11.1	1.77	0.700	1.90	2.25	1.35	10.6
Copper	mg/kg	36	197	5.47	10.8	5.25	0.223	10.8	**136**	25.3	**119**	**80.4**	18.4	17.4
Iron	mg/kg	21,200	43,776	7,516	28,000	7,134	489	28,000	2,970	824	2,860	3,982	2,309	18,400
Lead	mg/kg	35	91	2.42	5.66	2.31	0.132	5.66	2.68	0.969	2.64	2.55	1.61	5.58
Manganese	mg/kg	460	1,100	112	3,670	104	8.77	3,670	81.1	30.5	120	103	67.2	**7,690**
Molybdenum	mg/kg	-	-	<0.50	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	1.2
Nickel	mg/kg	16	75	9.73	14.6	9.43	0.307	14.6	2.53	0.738	2.69	3.86	2.67	**17.7**
Phosphorus	mg/kg	-	-	108	50	93	19	50.0	187	44.4	124	157	48.9	137
Selenium	mg/kg	2	-	<0.20	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	0.21
Silver	mg/kg	0.50	-	<0.10	0.13	<0.10	0	0.13	<0.10	0	<0.10	<0.10	0	0.13
Strontium	mg/kg	-	-	8.41	15.2	8.13	0.321	15.2	26.7	7.71	32.4	33.7	5.70	18.3
Thallium	mg/kg	-	-	<0.050	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	0.065
Titanium	mg/kg	-	-	1.30	<1.0	1.2	0.19	<1.0	<1.0	0	<1.0	1.0	0.11	<1.0
Uranium	mg/kg	-	-	0.307	1.44	0.293	0.0181	1.44	0.151	0.051	0.158	0.173	0.114	2.01
Vanadium	mg/kg	-	-	9.95	6.93	9.71	0.225	6.93	7.93	1.89	6.26	8.38	4.17	12.8
Zinc	mg/kg	123	315	18.9	17.0	18.6	0.317	17.0	9.1	3.1	9.2	9.9	5.6	24
Organic Bound Metals														
Aluminum	mg/kg	-	-	1,944	1,340	1,716	232	1,340	1,506	573	878	1,221	686	2,180
Arsenic	mg/kg	5.9	17	0.768	0.252	0.691	0.0893	0.252	2.49	0.542	0.42	1.72	0.74	1.20
Barium	mg/kg	-	-	17.3	29.3	16.1	1.67	29.3	21.7	5.46	16.2	14.2	1.81	47.2
Calcium	mg/kg	-	-	1,095	226	905	181	226	2,416	525	643	1,780	483	432
Chromium	mg/kg	37	90	6.11	1.95	5.70	0.483	1.95	0.56	0.15	<0.50	1.22	1.52	4.26
Cobalt	mg/kg	-	-	1.74	1.04	1.62	0.108	1.04	2.08	0.658	1.48	1.59	0.590	1.36
Copper	mg/kg	36	197	13.5	5.75	11.3	2.08	5.75	**455**	115	**332**	**318**	125	19.2
Iron	mg/kg	21,200	43,776	1,332	921	1,161	177	921	834	186	356	563	400	980
Lead	mg/kg	35	91	0.85	2.2	0.79	0.073	2.18	1.29	0.322	0.74	1.04	0.73	1.67
Manganese	mg/kg	460	1,100	21.3	109	19.9	1.99	109	21.9	8.65	11.1	17.3	11.1	450
Molybdenum	mg/kg	-	-	0.50	0.62	<0.50	0	0.62	1.08	0.10	0.70	0.84	0.12	2.34
Nickel	mg/kg	16	75	4.39	3.18	3.96	0.397	3.18	0.80	0.23	<0.50	0.98	0.89	4.29
Selenium	mg/kg	2	-	0.79	0.43	0.71	0.095	0.43	0.83	0.27	0.71	0.85	0.54	1.22
Strontium	mg/kg	-	-	6.61	2.78	5.95	0.792	2.78	11.6	1.18	10.2	10.0	0.885	5.74
Titanium	mg/kg	-	-	7.6	22	6.2	1.3	21.6	3.6	1.1	1.2	2.8	1.3	11
Uranium	mg/kg	-	-	0.166	0.196	0.157	0.0157	0.196	0.195	0.0682	0.114	0.168	0.0741	0.338
Vanadium	mg/kg	-	-	4.47	2.77	3.90	0.645	2.77	1.97	0.538	0.64	1.67	1.43	6.23
Zinc	mg/kg	123	315	9.6	4.2	8.3	1.2	4.2	5.2	1.1	3.8	4.9	2.5	6.7
Residual Metals														
Aluminum	mg/kg	-	-	15,660	23,900	14,180	2,035	23,900	16,980	5,349	19,000	19,100	4,589	25,700
Antimony	mg/kg	-	-	0.26	0.32	0.24	0.023	0.32	0.38	0.16	0.45	0.32	0.048	0.75
Arsenic	mg/kg	5.9	17	5.87	16.4	5.16	0.875	16.4	**9.23**	2.21	**11.3**	**9.45**	1.79	**53.8**
Barium	mg/kg	-	-	89.3	85.8	80.3	10.0	85.8	96.4	12.9	126	119	21.0	103
Beryllium	mg/kg	-	-	<0.20	0.48	<0.20	0	0.48	0.54	0.14	0.53	0.46	0.029	0.42
Bismuth	mg/kg	-	-	<0.20	0.39	<0.20	0	0.39	<0.20	0	<0.20	<0.20	0	0.27
Cadmium	mg/kg	0.60	3.5	<0.050	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	0.059
Calcium	mg/kg	-	-	3,924	1,670	3,652	361	1,670	13,136	2,844	15,400	11,004	2,044	4,020
Chromium	mg/kg	37	90	47.4	49.3	44.5	3.08	49	9.8	2.4	11.8	15.7	8.11	**62.1**
Cobalt	mg/kg	-	-	7.00	12.1	6.55	0.532	12.1	14.5	3.70	13.0	12.1	3.76	14.0
Copper	mg/kg	36	197	27.9	30.2	25.8	3.41	30.2	**98.6**	35.0	**95.3**	**79.3**	39.1	**69.1**
Iron	mg/kg	21,200	43,776	22,760	53,900	21,320	1,676	53,900	29,780	12,594	22,100	23,800	5,637	47,500
Lead	mg/kg	35	91	3.89	13.1	3.50	0.447	13.1	2.44	0.928	3.26	3.00	1.27	12.7
Lithium	mg/kg	-	-	11.2	34.8	10.5	0.77	34.8	19.6	6.20	18.3	17.4	4.92	25.6
Manganese	mg/kg	460	1,100	204	377	190	13.6	377	**562**	165	**512**	448	89.5	**508**
Molybdenum	mg/kg	-	-	0.84	2.37	0.80	0.058	2.37	2.49	0.435	2.38	1.80	0.20	5.86
Nickel	mg/kg	16	75	24.0	40.7	22.8	1.47	40.7	8.9	2.6	9.9	12	6.2	**44.5**
Selenium	mg/kg	2	-	<0.20	0.25	<0.2	0	0.25	0.21	0.022	<0.20	<0.20	0	0.32
Silver	mg/kg	0.50	-	<0.10	<0.10	<0.10	0	<0.10	0.27	0.064	0.24	0.26	0.088	0.15
Strontium	mg/kg	-	-	46.1	23.0	40.2	5.74	23.0	71.7	20.4	86.3	71.9	7.54	43.3
Thallium	mg/kg	-	-	0.139	0.242	0.127	0.0134	0.242	<0.050	0	<0.050	0.055	0.014	0.218
Tin	mg/kg	-	-	<2.0	<2.0	<2.0	0	<2.0	2.5	0.69	<2.0	<2.0	0	<2.0
Titanium	mg/kg	-	-	1,160	1,160	1,050	107	1,160	1,918	747	1,800	1,650	199	1,160
Uranium	mg/kg	-	-	0.557	1.02	0.528	0.0361	1.02	0.98	0.35	0.991	0.863	0.0512	0.927
Vanadium	mg/kg	-	-	54.2	40.4	50.6	3.56	40.4	118	47.1	84.2	82.8	11.3	74.3
Zinc	mg/kg	123	315	51.3	78.6	48.1	4.48	78.6	52.9	14.4	52.1	49.7	18.7	93.7

(blue) Value is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL. Summary statistics were only calculated for sampling areas with replicate samples (PRef1, PNF,and PFF1) but not for single composite samples (PRef2, PFF2, and PFFF).

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Displayed reference values are the 95th percentiles of data from reference area PRef1 and are the single values available for reference area PRef2.

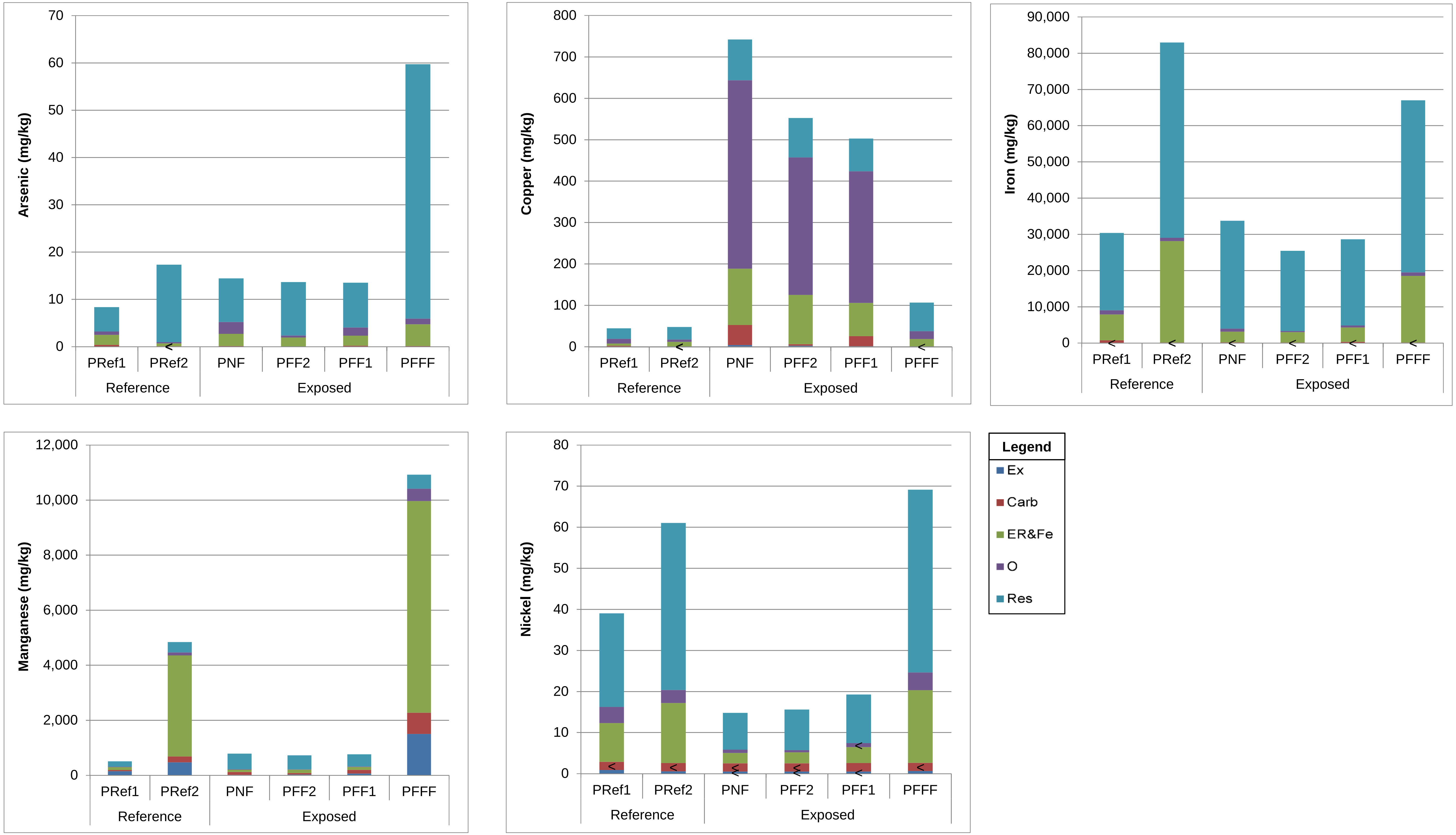


Figure 8.5: Mean concentrations of selectively extracted parameters of interest in sediment from the profundal sampling areas of Quesnel Lake, Mount Polley Mine, 2014. Selective extractions included Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe), Organic Bound Metals (O), and Residual Metals (Res).

Values < MDL are indicated with a < symbol. Mean values are plotted for areas with replicate samples (PRef1, PNF, PFF1), single values are plotted for composite samples (PRef2, PFF2, PFFF).

reference sediment (and far-field sediment), where more than approximately 60% of sediment-associated copper was in residual form (Figure 8.5; Appendix Figure E.31). Greatest concentrations of manganese at the near-field and far-field areas were in the residual phase, but at the reference and far-far-field areas, were in the easily reducible phase, possibly representing surface enriched, redox sensitive manganese oxides.

Concentrations of copper in Fractions 1 to 3 (exchangeable + carbonate bound + reducible) at near-field and far-field areas exceeded reference (Figure 8.5; Appendix Table E.60; Appendix Figure E.31). However, separate integrated consideration of mineralogy, sequential extraction results and mineral solubility indicates that these forms would not be mobile under environmentally realistic conditions (SRK 2015). Therefore, sediment copper also appears to be present in Polley Lake sediments in forms that are not mobile and this immobility suggests limited concern for aquatic biota.

Shake flask tests indicated low mobility of metals associated with Quesnel Lake profundal sediments, with copper being the only metal mobilized in shake flask tests of near-field and far-field exposed area sediment to concentrations greater than British Columbia Water Quality Guidelines (BCWQGs) and reference (Table 8.7; Appendix Table E.61). Concentrations of manganese mobilized from reference area sediments also exceeded BQWQGs and were higher still at area PFFF, although the spatial pattern in concentrations (i.e., higher concentrations at PFFF than PNF or PFF) suggest that the latter was not failure-related (Table 8.7; Appendix Table E.61). As previously stated, BCWQG do not apply to sediment leachates, but are used herein as an indication of low mobility.

Acid-Base accounting results indicated that the potential for acid generation generally increased with distance from the influence of the dam failure (Appendix Table E.12 and E.62). Neutralization potential ratio (NPR; the ratio of neutralization potential to maximum potential acidity) was 8.2 to 13 at the near-field and far-field areas and decreased to 6.4 at the far-far-field area (Appendix Table E.12). NPR greater than 4 indicates no potential for Acid Rock Drainage (ARD; Price 1997). Decreasing NPR with distance from Hazeltine Creek indicates that acid potential associated with the impacted sediments is lower than reference and far-field sediments. Lowest NPR (3.9) was observed in the reference area PRef1 located in Horsefly Bay (Appendix Table E.12).

8.3 Sediment Stratigraphy

Sediment cores for characterization of vertical stratigraphy (examination of physical and chemical changes with depth below surface) were collected from the near-field profundal

Table 8.7: Summary of leachable (Shakeflask) metals data for sediment from Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Data are based on bulk sediment [1]. Only analytes with detectable concentrations are displayed.

Sample ID	Units	BCWQG [2]			HWR [3]	Reference Value [4]		Reference			Exposed					
								PRef1 (QULP-5)		PRef2 (QULP-6)	PNF (QULP-1)		PFF2 (QULP-4)	PFF1 (QULP-2)		PFFF (QULP-3)
		Type	Chronic	Acute		PRef1	PRef2	Mean	t*SE	Composite	Mean	t*SE	Composite	Mean	t*SE	Composite
Aluminum	mg/L	-	-	-	-	<0.20	0.28	<0.20	0	0.28	0.36	0.15	0.29	0.23	0.065	0.41
Barium	mg/L	W	1.0	-	100	0.055	0.015	0.050	0.0045	0.015	0.056	0.0108	0.043	0.046	0.013	0.013
Calcium	mg/L	-	-	-	-	42.8	34.7	37.9	5.32	34.7	25.4	13.5	23.6	30.1	17.0	25.9
Copper	mg/L	A	0.0055	0.015	100	<0.010	<0.010	<0.010	0	<0.010	**0.035**	0.022	**0.050**	**0.036**	0.018	<0.010
Iron	mg/L	A	-	1	-	2.37	1.01	1.24	1.17	1.01	0.148	0.0699	0.225	0.265	0.182	0.558
Magnesium	mg/L	-	-	-	-	3.55	3.86	3.21	0.411	3.86	11.3	25.1	2.68	3.27	1.98	2.83
Manganese	mg/L	A	1.21	2.05	-	2.42	1.90	1.81	0.697	1.90	0.177	0.371	0.105	0.307	0.415	**4.78**
Molybdenum	mg/L	A	1.0	2.0	-	<0.03	<0.03	<0.03	0	<0.03	<0.03	0	<0.03	0.031	0.0033	<0.03
Potassium	mg/L	-	-	-	-	2.4	<2.0	2.2	0.20	<2.0	9.2	14.0	3.8	3.2	0.84	<2.0
Silicon	mg/L	-	-	-	-	<0.010	12.8	9.51	3.10	12.8	6.22	0.809	6.04	6.25	1.82	16.7
Sodium	mg/L	-	-	-	-	<2.0	<2.0	<2.0	0	<2.0	131	342	8.6	7.8	2.4	3.4
Strontium	mg/L	-	-	-	-	0.336	0.287	0.298	0.0442	0.287	0.284	0.143	0.248	0.284	0.168	0.221
Titanium	mg/L	-	-	-	-	0.016	0.014	0.013	0.0037	0.014	0.013	0.0043	0.015	0.014	0.0060	0.011

(Shaded) Value is > one or all guidelines (values < MDL excluded from comparison). Values shown in bold text also exceed both Reference Values (95th Percentiles).

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL. Summary statistics were only calculated for sampling areas with replicate samples (PRef1, PNF,and PFF1) but not for single composite samples (PRef2, PFF2, and PFFF).

[2] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.

[3] Hazardous Waste Regulation (Government of British Columbia 1988)

[4] Displayed reference values are the 95th percentiles of data from reference area PRef1, and are the single values available for reference area PRef2.

area in Quesnel Lake (Figure 4.5) at a station depth of 108 m. Two cores were collected; one for sediment chemistry profiling and one for pore-water chemistry profiling.

8.3.1 Sediment Core Observations

The two near-field cores were similar and showed little to no observable horizons. The top 0.5 to 1 cm of both cores was beige in colour, and the remaining core was a darker grey-brown (Appendix Figure E.33). During sediment core sectioning, no further changes in sediment characteristics were observed, but it was apparent that the sediment had high porosity such that the entire length of both sediment cores (up to 72 cm) was unconsolidated, and consisted almost entirely of event-derived material.

The lack of horizons (differences in colour and/or texture with distance from surface) in the sediment cores was consistent with the nature of the deposition (i.e., the sediment was not deposited in a seasonal or chronological nature, but more through physical settling with the larger, more dense particles settling out first). Since the smaller particles were still settling at the time of collection, there would also have been insufficient time to establish post-depositional geochemical processes (early diagenesis) which lead to concentration profile structure in sediment core horizons.

8.3.2 Sediment Chemistry Profiles

The chemistry of the top 12 cm of sediment (in 1 cm increments) was screened against BC SQGs. Copper and manganese concentrations were higher than the PEL throughout the sediment core. Although manganese was higher than the PEL (but lower than in surficial reference sediment of the Quesnel Lake North Arm; Tables 8.1 and 8.2), it was at the same order of magnitude as the PEL, while copper was approximately ten times the PEL throughout the core. Arsenic, iron, and nickel concentrations were higher than the TEL throughout the core, while zinc concentrations in sediment only exceeded the TEL in the top 1 cm of the core (Figure 8.6). A number of these analytes were identified as greater than TEL or PEL at reference areas (arsenic, copper, iron, manganese and nickel; Tables 8.1 and 8.2) and therefore the noted elevations were not entirely failure-related.

The sediment chemistry profiles for aluminum, arsenic, copper, iron, lead, manganese, nickel and zinc showed little variation in concentration with depth (Figure 8.6). This was consistent with the nature of deposition of failure-related material (i.e., with no chronological patterns or diagenesis occurring). Sediment chemistry depth profiles of metals with relatively high concentrations (aluminum, copper, iron, manganese, and to some extent zinc) showed slightly higher concentrations in surficial sediment (the top

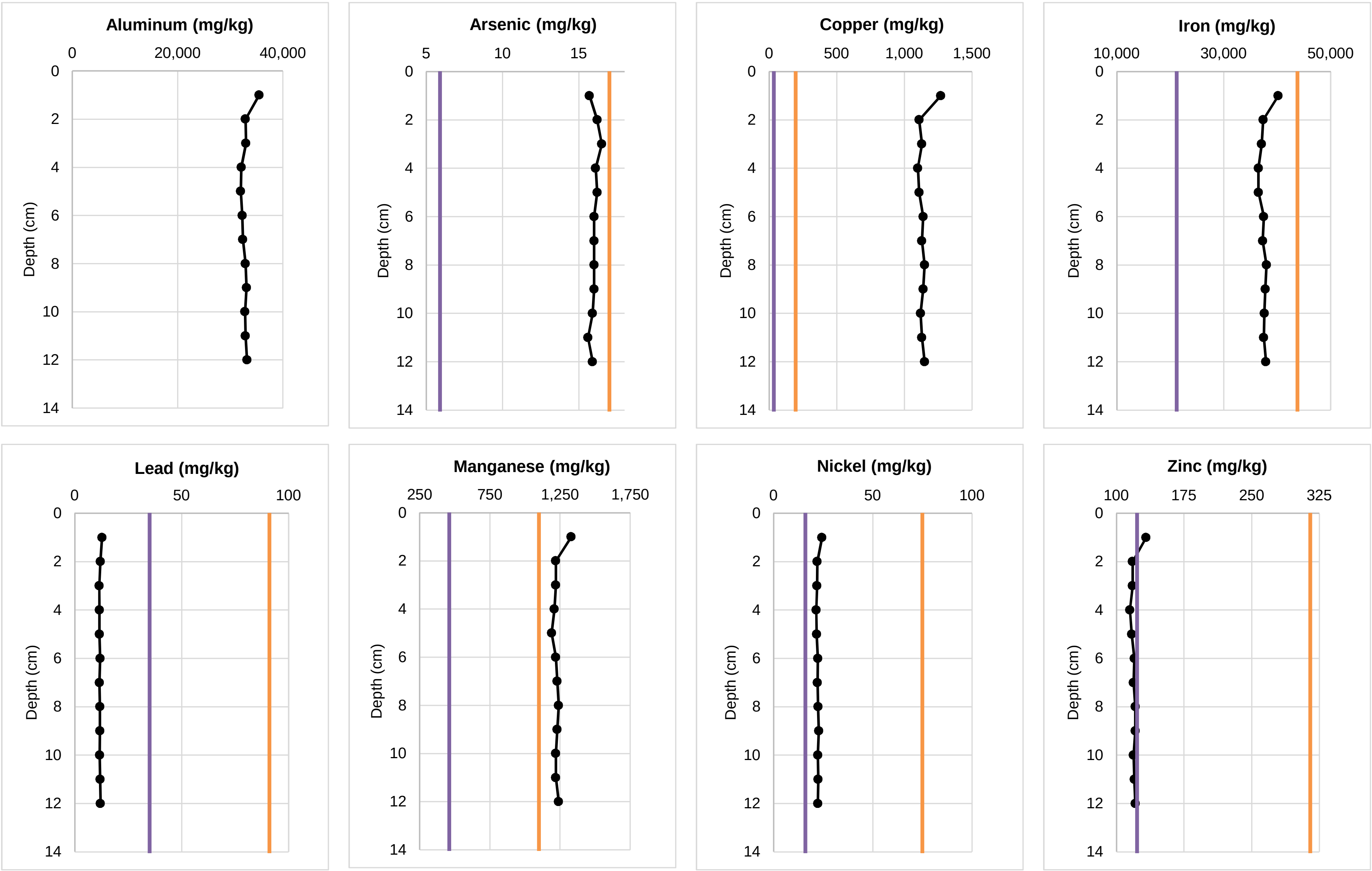


Figure 8.6: Sediment chemistry profiles of aluminum, arsenic, copper, iron, lead, manganese, nickel and zinc from the near-field station (QUL-PW-1) of Quesnel Lake, September 2014. Threshold Effect Level (TEL) is displayed in purple, while the Probable Effect Level (PEL) is in orange.

1 cm). The higher concentrations of these metals in the top-most sediment section suggested higher concentrations in the very fine particles that settled out last.

8.3.3 Sediment Pore Water Profiles

Sediment pore-water was evaluated on the basis of redox sensitive nitrogen and sulphur compounds as well as metal concentrations. Sediment pore-water profiles of nitrate and nitrite showed that there were low concentrations of nitrite evident in surficial sediment (Figure 8.7). The nitrite concentration was highest in the overlying water, suggesting that the source of nitrite was not from the sediment. It is more likely that nitrite, sourced from the overlying water, was diffusing into the mine-derived material such that by 3 cm depth there was no more detectable nitrite in sediment pore-water. If nitrite was occurring due to reduction of nitrate (i.e., sediment diagenesis), a profile of high concentrations of nitrite should also have a congruent decrease of nitrate concentration, which was not evident. The depth profile of sulphate also showed detectable concentrations throughout the core, and non-detectable concentrations of sulphide throughout the core. Therefore, there was no evidence of reducing conditions in the top 12 cm of the sediment core. This is a reasonable observation as the material collected from the streambed of Hazeltine Creek showed no evidence of reduced mineralogy such as pyrites or high levels of organic matter, but instead contained oxides and aluminosilicates (oxidized minerals; Appendix Table E.65).

The pore-water profiles of metal concentrations did not follow those of the sediment chemistry profiles (Figures 8.6 and 8.7). Metal concentrations were not highest at the top-most sediments (as with the sediment chemistry profiles), suggesting that the metals associated with clay-sized particles are less soluble than metals associated with particles from deeper in the core. Pore-water concentrations of copper, iron, lead, nickel, and to some extent, arsenic, manganese, zinc, and nitrate, showed some degree of elevation in concentration around 3 to 7 cm depth (Figure 8.7). Given the oxidizing conditions of the pore-water, it is likely that this increase was due to desorption. As silicon concentrations were also elevated from 3 to 7 cm depth, it is possible that the dissolved metals were associated with aluminosilicates which may also dissolve to some extent. Several aluminosilicate minerals were present in the tailings (e.g., feldspars, and plagioclase; SRK 2014, 2015). As the deposited materials were unconsolidated, the sediment particles were not completely compacted, and post-depositional processes would not have had enough time to establish. The increase in pore water concentrations at 3 to 7 cm depth may be a transient observation for these sediments. A separate evaluation of potential post-depositional stability indicated very low risk of metal mobilization (SRK 2015).

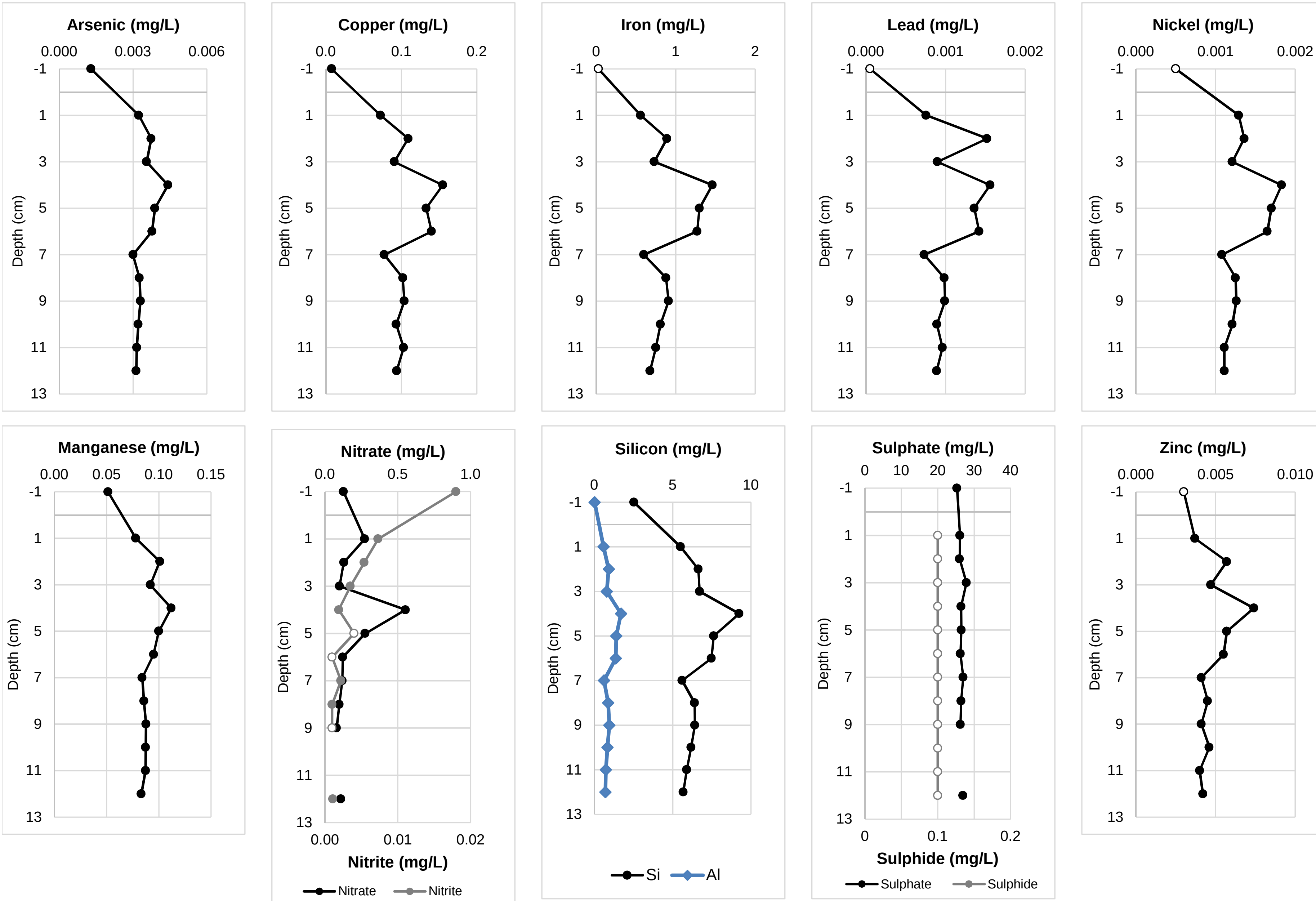


Figure 8.7: Pore water profiles of arsenic, copper, iron, lead, nickel, manganese, nitrate, nitrite, silicon, sulphate, sulphide and zinc from the near-field station (QUL-PW-2) of Quesnel Lake, September 2014. Open data markers (o) indicate that the concentration was below the Method Detection Limit (MDL).

[1] Analyte concentrations shown at a depth of -1 cm indicate concentrations in overlying water samples collected at QUL-PW-2.

8.4 Sediment Toxicity

Sediment toxicity testing indicated significantly reduced survival of the freshwater/brackish water amphipod *Hyalella azteca* only at the near-field area relative to concurrent laboratory controls and both references (Figure 8.8; Appendix Table F.1; Appendix Figure F.7). Absolute survival (i.e., non-normalized) at the near-field area was 76% and ranged from 84% to 96% at the far-field and far-far-field areas (Appendix Table F.10). Growth of *H. azteca* was significantly reduced at the upstream far-field area (PFF2; Figure 4.5) relative to laboratory controls and both references (Figure 8.8; Appendix Table F.1; Appendix Figure F.7). Survival of the freshwater midge *Chironomus dilutus* was significantly reduced relative to concurrent laboratory controls and both references at the near-field area and both far-field areas (Figure 8.8; Appendix Table F.1; Appendix Figure F.8). Absolute survival (i.e., non-normalized) was lowest at the downstream far-field station (PFF1), with survival of 58% compared to 68% at the near-field area and 76% at the upstream far-field (Appendix Table F.11). Growth of *C. dilutus* was significantly reduced at the near-field area only (area PNF) relative to laboratory controls and both references, but not at any other profundal areas (Figure 8.8; Appendix Table F.1; Appendix Figure F.8). Overall, the toxicity data indicate an apparent effect on survival of *H. azteca* and on survival and growth of *C. dilutus* at the near-field area. Reduced growth of *H. azteca* was observed at the upstream far-field area (highlighted primarily on the basis of a high growth rate in one laboratory control), and reduced survival (but not growth) of *C. dilutus* was observed at both far-field areas.

8.5 Benthic Invertebrate Community

Benthic invertebrate community samples from near-field, far-field and far-far-field profundal areas of Quesnel Lake were compared to two reference areas within Quesnel Lake (Table 4.1; Figure 4.5) in a Multiple Control-Impact (MCI) design. Samples were collected by petite ponar grab sampler at five stations per area.

8.5.1 Primary Metrics

Mean benthic organism densities (individuals/m^2) of the exposed areas (near-field, far-field and far-far-field) were significantly lower than reference area 1, but did not differ significantly from reference area 2 (40, 23 and 3.4 organisms/m^2 at the near-field, downstream far-field and upstream far-field, respectively; Figure 8.9; Appendix Tables G.22 and G.23). Taxon richness was significantly lower at the upstream far-field area than at either reference, and was supported by low diversity at this area (Figure 8.9; Appendix Tables G.22-G.23). There were no benthic invertebrates at 4 of 5 stations at

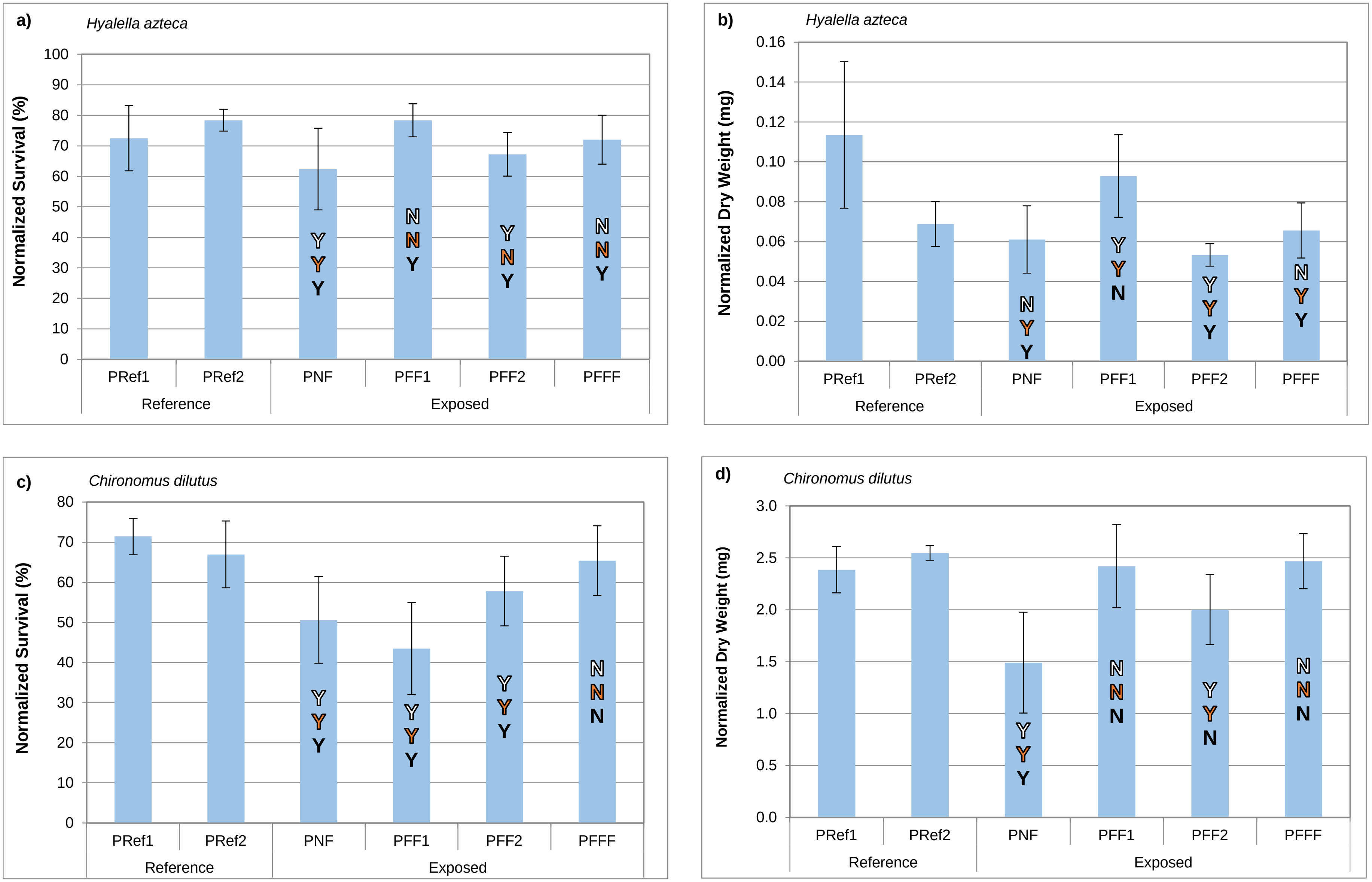


Figure 8.8: Toxicity tests results of Quesnel Lake profundal sediment on *Hyalella azteca* , a) Normalized Survival (%), b) Normalized Dry Weight (mg) and *Chironomus dilutus* c) Normalized Survival (%), d) Normalized Dry Weight (mg). Error bars represent standard deviation. Letters represent significant differences (Y) or no differences (N) between samples and the Control (Black), Reference 1 (Orange) and Reference 2 (White) ($p < 0.05$). Control results are not displayed.

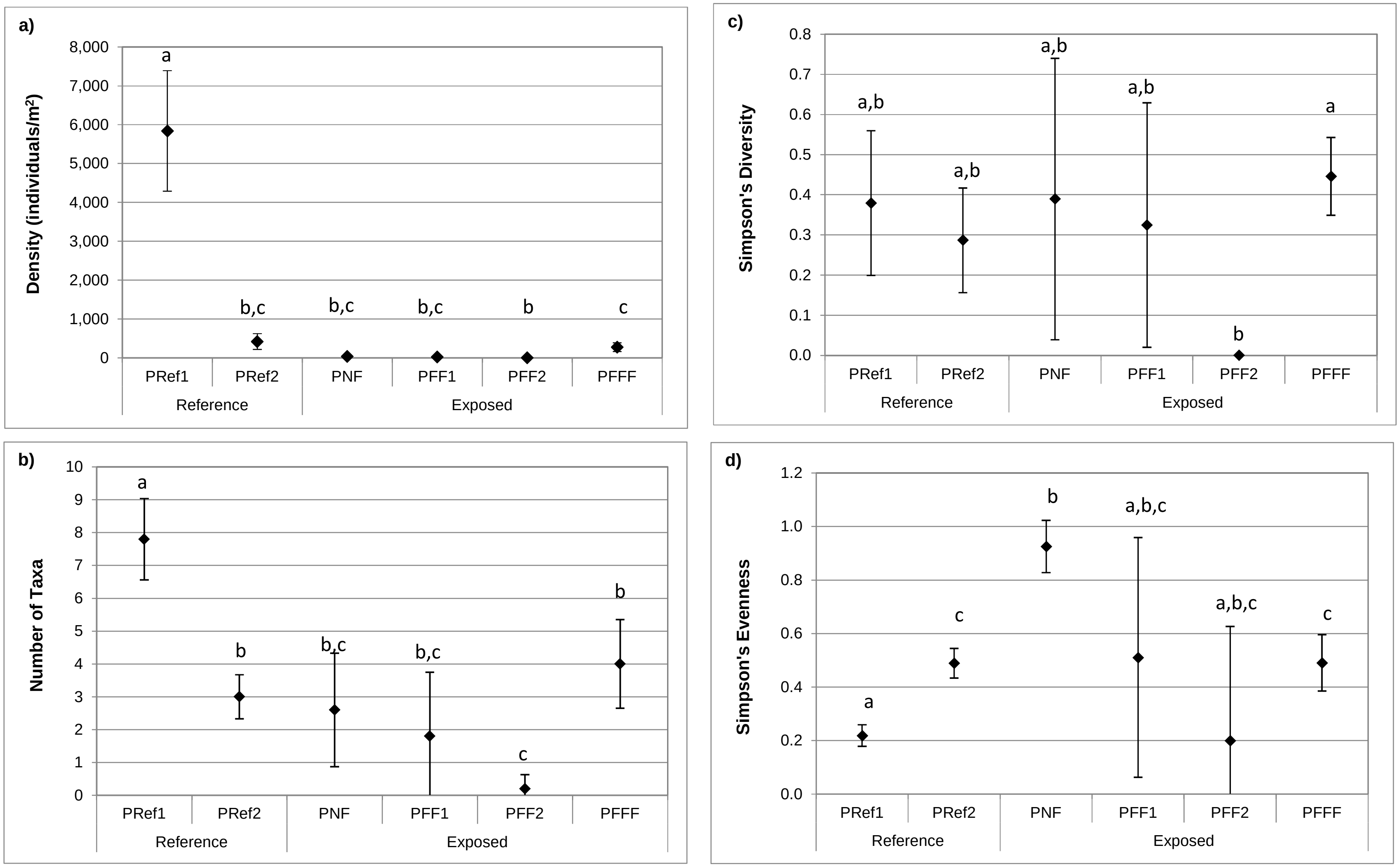


Figure 8.9: Comparison of a) Density, b) Number of Taxa, c) Simpson's Diversity and d) Simpson's Eveness, Mount Polley Mine 2014. Quesnel profundal area comparisons. Data represents area means and 90% confidence intervals. Different letters above data points indicate areas that were significantly different ($p < 0.1$).

the upstream far-field and only one chironomid species (*Heterotrissocladius*) was present at the remaining station (Appendix Tables G.23-G.24). Low number of taxa relative to reference can be indicative of a degraded benthic invertebrate community (Pielou 1974; Begon et. al. 1996). Lastly, Simpson's Evenness was significantly greater at the near-field exposed area than at both references (Figure 8.9; Appendix Table G.22). Simpson's Evenness is often lower at areas with few taxa than at areas with more taxa.

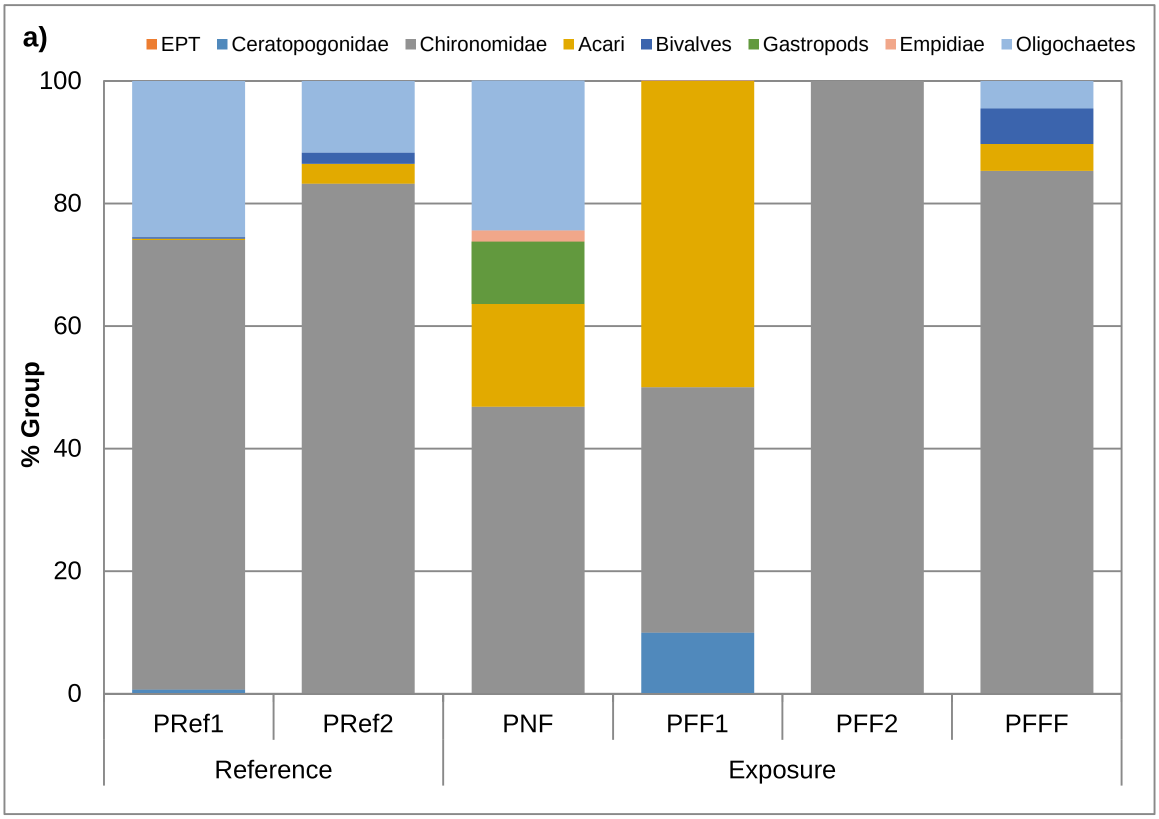
8.5.2 Community Composition

Dominant invertebrate taxon groups at the Quesnel Lake profundal areas were non-biting midges (Chironomidae), oligochaete worms, and mites (Acari), with lesser representation by biting midges (Ceratopogonidae), snails (gastropods), and clams/mussels (bivalves; Figure 8.10; Appendix Table G.23).

Bray-Curtis index of dissimilarity (BC index) was significantly greater at the near-field area and the far-field areas relative to both references (but not at the far-far-field area), indicating a difference in community composition (Figure 8.11; Appendix Table G.22). Community differences detected by the BC index are non-directional and not necessarily related to chemical exposure. That is, communities may be significantly dissimilar due to chemical effects or to natural factors (e.g., subtle habitat differences). Despite the differences detected using the BC Index, there were no statistically significant differences in the proportions of key taxa relative to both references, presumably due to high variability within areas (Figure 8.11; Appendix Table G.22). However, correspondence analysis confirmed the differences detected with BC Index, and these were largely relative to reference area 1 (Horsefly Bay), which had significantly greater CA-1 values than all other areas except the downstream far-field area (PFF1). CA axis 1 describes 41.3% of the spatial variance in benthic invertebrate community composition, with *Heterotrissocladius* (a chironomid of the sub-family Orthocladinae) providing the negative weighting and *Phaenopsectra* (a chironomid of the sub-family Chironominae) and *Bezzia*/*Palpomyia* (biting midges or no-see-ums of the family Ceratopognidae) providing the positive weighting (Appendix Table G.25). This CA axis primarily distinguishes Horsefly Bay on the basis of greater representation by the chironomid *Phaenopsectra* and the Ceratopogonids *Bezzia*/*Palpomyia* relative to other areas (Figure 8.11).

8.6 Correlation Analysis

Correlation analysis was conducted between the biological endpoints (sediment toxicity test endpoints and benthic invertebrate community endpoints) and dissolved oxygen, specific conductance, percent fines, sediment TOC content, sediment concentrations of



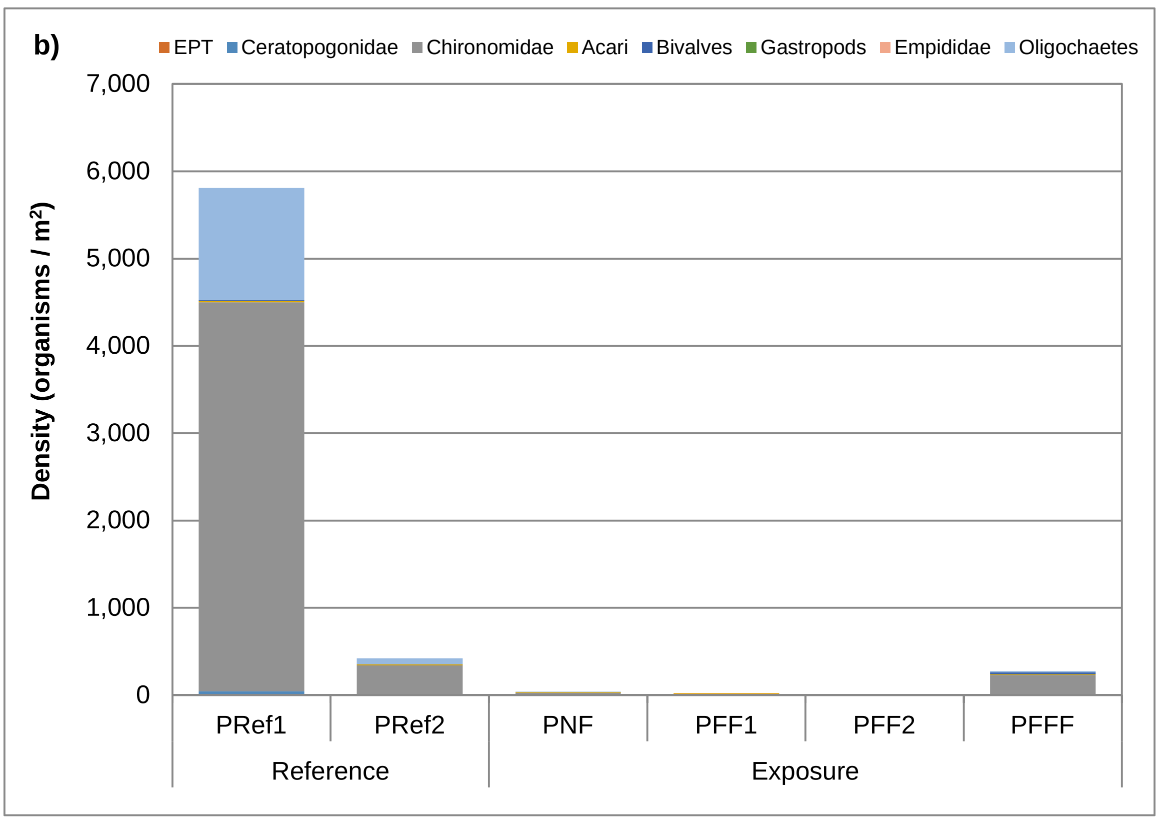


Figure 8.10: Relative mean proportions (a) and mean density (b) of major benthic invertebrate groups within profundal sampling areas of Quesnel Lake, Mount Polley Mine, 2014.

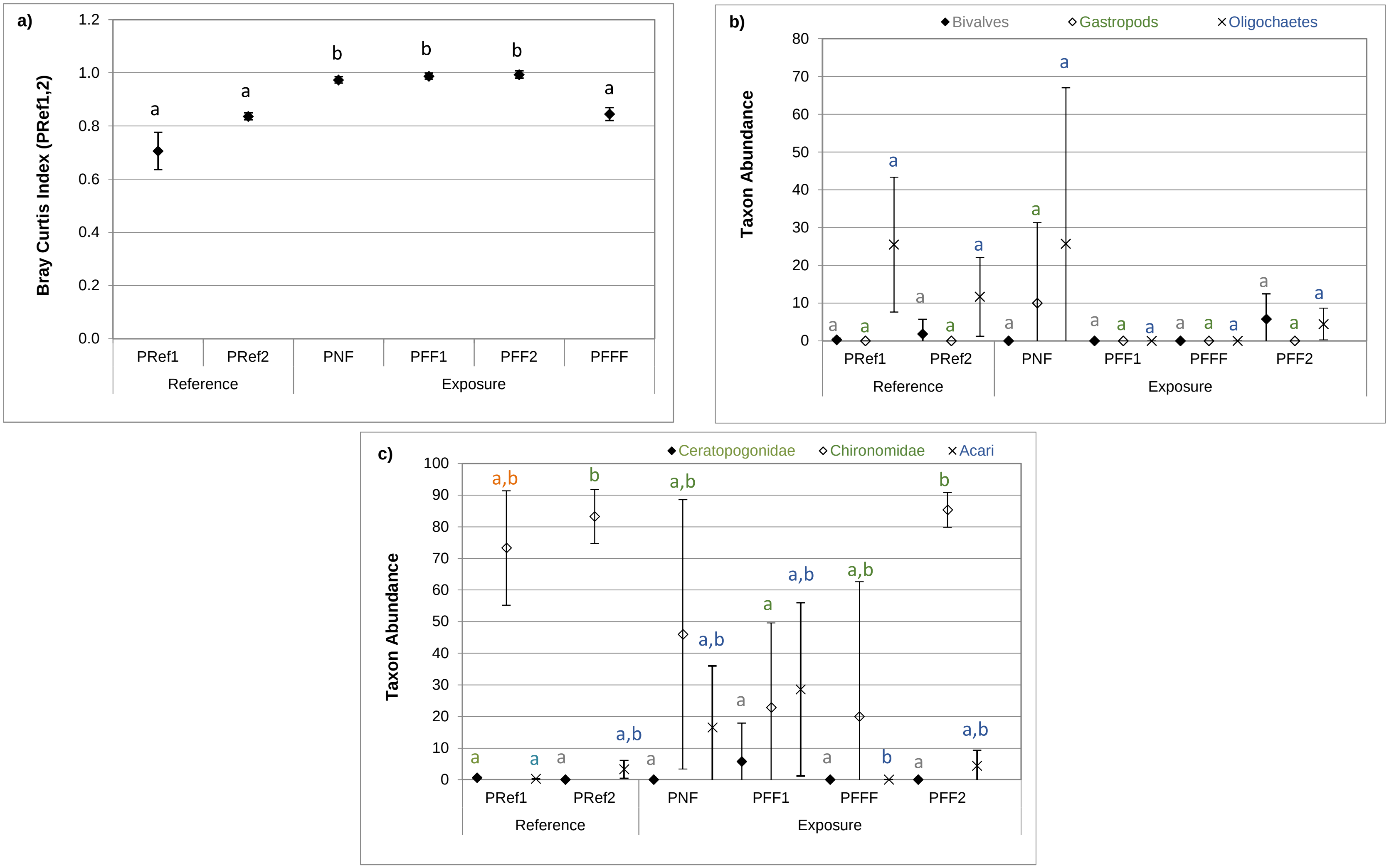


Figure 8.11: Comparison of a) Bray Curtis Index, b) Taxon Abundance (bivalves, gastropods, oligochaetes) and c) Taxon Abundance (ceratopogonidae, chironomidae, acari), Mount Polley Mine, 2014. Quesnel profundal area comparisons. Data represents area means and 90% confidence intervals. Different letters above data points indicate areas that were significantly different ($p < 0.1$).

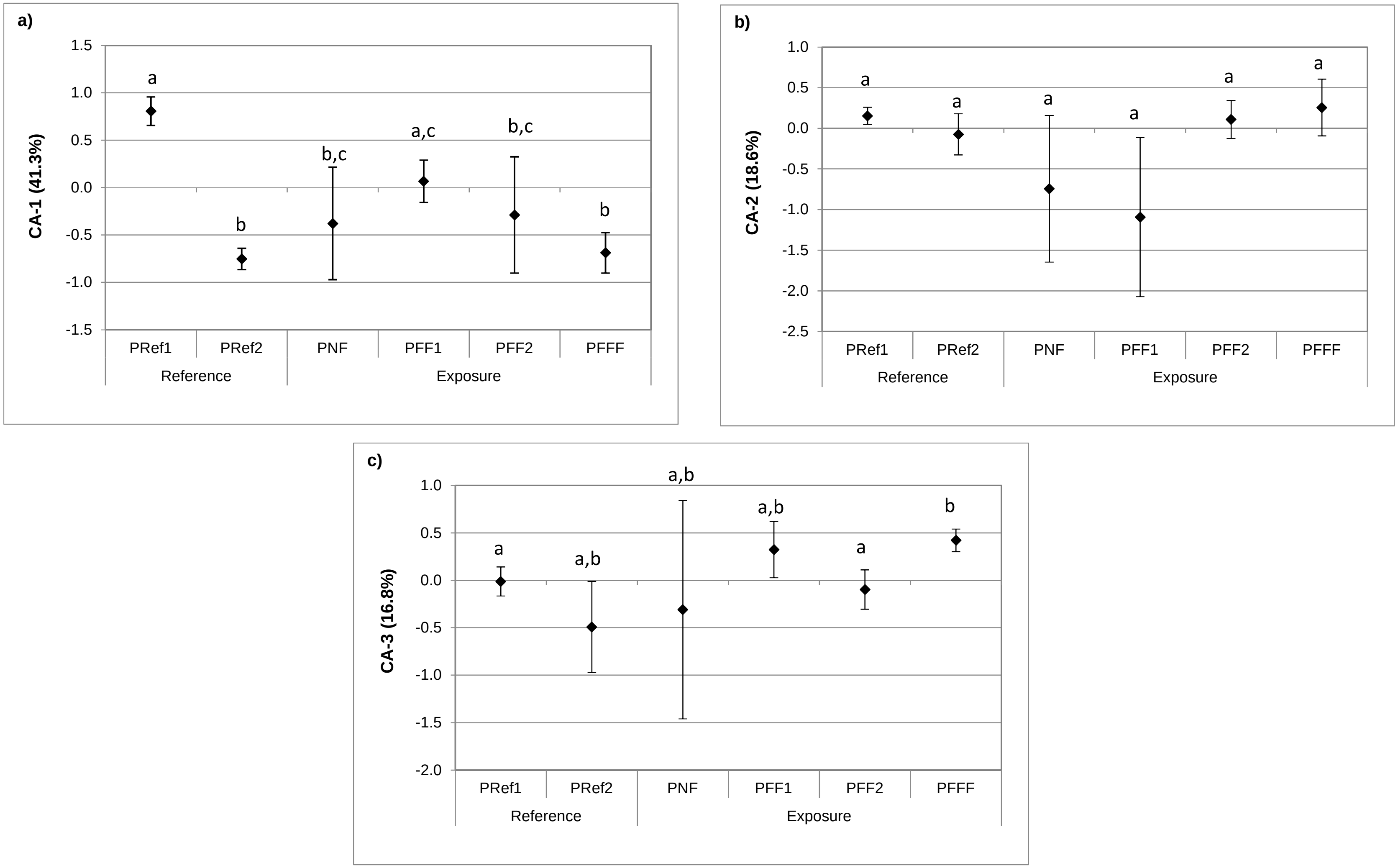


Figure 8.11: Comparison of d) CA-1 (41.3%), e) CA-2 (18.6%) and f) CA-3 (16.8%), Mount Polley Mine, 2014. Quesnel profundal area comparisons. Data represents area means and 90% confidence intervals. Different letters above data points indicate areas that were significantly different ($p < 0.1$).

POIs, IPs, PCA axes and selective copper extracts. There were no relationships between survival or growth of *H. azteca* and sediment physical or chemical characteristics at the Bonferroni-adjusted p-level; Table 8.8). Survival of *C. dilutus* was positively correlated with sediment TOC content and negatively correlated with copper in carbonate and easily reducible extracts (Table 8.8), which was similarly observed in littoral sediments (Section 7.5). Lastly, growth of *C. dilutus* was negatively correlated with copper, including copper in all four selective extracts, calcium, sodium and vanadium (Table 8.8). Although correlation does not necessarily indicate causation, the significant positive relationships to sediment TOC and the significant negative relationships between *C. dilutus* survival and growth versus POI and IP concentrations, including copper extracts suggest benefits of organic matter and/or toxic effects of metals.

A substantial number of relationships between benthic invertebrate community metrics and sediment chemistry were observed at the Bonferroni-adjusted p-level, particularly with density and Bray-Curtis index of dissimilarity (Table 8.8). Benthic invertebrate density was positively correlated with dissolved oxygen, sediment TOC and nickel concentration and negatively correlated with specific conductance, the proportion of fines, copper, calcium, sodium, strontium, as well as copper in the exchangeable, easily reducible, and organic phases (Table 8.8; Appendix Figure I.9). Number of taxa was negatively correlated with strontium and easily reducible copper (Table 8.8). Bray-Curtis index of dissimilarity was correlated with the same analytes that correlated with benthic density, but in the opposite direction indicating a consistent effect response (i.e., reduced density and increase Bray-Curtis index with low TOC and high POI concentrations; Table 8.8; Appendix Figure I.9). Percent Chironomidae were positively correlated with nickel and PCA-Axis 1 (representing the conditions at the far-far-field area and reference 2, both of which had relatively high proportions of Chironomidae; Table 8.8; Appendix Figure I.9). Lastly, benthic invertebrate community CA axis 1 was negatively correlated with arsenic and manganese (Table 8.8; Appendix Figure I.9). As previously indicated, CA axis 1 is primarily represented by the chironomid *Phaenopsectra* and the Ceratopogonids *Bezzia*/*Palpomyia* in the positive direction and the chironomid *Heterotrissocladius* in the negative direction and is mainly driven by the co-occurrence of high arsenic and manganese in the far-far-field area (not failure-related) and relatively higher associated abundance of *Heterotrissocladius* and lower abundance of *Phaenopsectra* and the Ceratopogonids (Appendix Figure I.9).

Table 8.8: Spearman's Rank Correlation results for correlation of toxicity test results and benthic invertebrate community metrics versus sediment physical characteristics, parameters of interest, indicator parameters, PCA axes scores, copper extracts (all in < 2mm sediment fraction) in Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014 [1,2].

Physical/Chemical Parameter		Correlation Parameter	*Hyalella azteca*		*Chironomus dilutus*		Benthic Invertebrate Community Metrics														
			Normalized Survival	Normalized Growth	Normalized Survival	Normalized Growth	Density (Ind./m^2)	Number of Taxa	Simpson's D	Simpson's E	Bray Curtis Index (PRef1 and PRef2)	EPT (%)	Ceratopogonidae (%)	Chironomidae (%)	Acari (%)	Bivalves (%)	Gastropods (%)	Oligochaetes (%)	CA Axis 1 (41.3 %)	CA Axis 2 (18.6 %)	CA Axis 3 (16.8 %)
Water In-Situ Measures	Dissolved Oxygen (mg/L; bottom)	Correlation Coefficient	NA	NA	NA	NA	0.685	0.535	0.388	-0.077	-0.679	0.327	0.223	0.357	0.162	0.323	-0.054	0.434	-0.157	0.238	-0.032
		Sig. (2-tailed)	NA	NA	NA	NA	<0.0000	0.0023	0.0340	0.6844	<0.0000	0.0776	0.2372	0.0527	0.3934	0.0812	0.7783	0.0165	0.4070	0.2053	0.8678
	Specific Conductivity (µS/cm; bottom)	Correlation Coefficient	NA	NA	NA	NA	-0.653	-0.460	-0.234	0.093	0.677	-0.109	-0.061	-0.645	-0.004	-0.423	0.247	-0.272	0.377	-0.459	-0.079
		Sig. (2-tailed)	NA	NA	NA	NA	0.0001	0.0105	0.2140	0.6257	<0.0000	0.5662	0.7502	0.0001	0.9836	0.0198	0.1887	0.1458	0.0397	0.0107	0.6777
Physical	Fines	Correlation Coefficient	-0.013	-0.409	-0.487	-0.232	-0.706	-0.619	-0.340	0.044	0.663	-0.358	-0.399	-0.239	-0.222	-0.100	-0.118	-0.560	-0.245	-0.036	0.037
		Sig. (2-tailed)	0.9473	0.0249	0.0063	0.2164	<0.0000	0.0003	0.0663	0.8190	0.0001	0.0522	0.0291	0.2038	0.2393	0.5988	0.5335	0.0013	0.1915	0.8494	0.8467
	TOC	Correlation Coefficient	0.159	0.246	0.694	0.525	0.718	0.605	0.308	-0.122	-0.746	0.198	0.314	0.570	0.078	0.555	-0.182	0.320	-0.173	0.514	0.218
		Sig. (2-tailed)	0.4004	0.1896	<0.0000	0.0029	<0.0000	0.0004	0.0972	0.5191	<0.0000	0.2954	0.0914	0.0010	0.6830	0.0015	0.3347	0.0848	0.3603	0.0037	0.2471
Parameter of Interest	Arsenic	Correlation Coefficient	0.109	-0.459	0.097	0.159	-0.053	-0.092	0.102	0.335	0.003	-0.403	-0.516	0.331	0.099	0.298	0.075	-0.121	-0.736	0.106	0.094
		Sig. (2-tailed)	0.5674	0.0107	0.6107	0.4003	0.7815	0.6285	0.5927	0.0701	0.9892	0.0273	0.0035	0.0739	0.6031	0.1097	0.6933	0.5229	<0.0000	0.5754	0.6197
	Copper	Correlation Coefficient	-0.419	-0.402	-0.637	-0.699	-0.776	-0.522	-0.108	0.384	0.737	-0.311	-0.357	-0.380	-0.005	-0.329	0.290	-0.512	-0.108	-0.305	0.122
		Sig. (2-tailed)	0.0211	0.0275	0.0002	<0.0000	<0.0000	0.0031	0.5691	0.0360	<0.0000	0.0942	0.0531	0.0383	0.9808	0.0763	0.1206	0.0038	0.5686	0.1007	0.5214
	Iron	Correlation Coefficient	0.128	0.050	0.490	0.385	0.575	0.497	0.400	0.325	-0.571	-0.080	-0.062	0.572	0.320	0.438	-0.075	0.331	-0.514	0.158	0.077
		Sig. (2-tailed)	0.5009	0.7912	0.0060	0.0357	0.0009	0.0052	0.0284	0.0794	0.0010	0.6734	0.7445	0.0010	0.0844	0.0155	0.6933	0.0737	0.0037	0.4057	0.6855
	Manganese	Correlation Coefficient	0.184	-0.467	0.161	0.237	0.004	-0.088	0.102	0.345	-0.048	-0.403	-0.528	0.418	0.106	0.257	0.054	-0.131	-0.803	0.127	0.095
		Sig. (2-tailed)	0.3293	0.0093	0.3964	0.2073	0.9822	0.6451	0.5911	0.0618	0.8000	0.0274	0.0027	0.0215	0.5755	0.1700	0.7783	0.4890	<0.0000	0.5046	0.6193
	Nickel	Correlation Coefficient	0.301	0.159	0.581	0.640	0.685	0.523	0.306	0.031	-0.717	0.091	0.110	0.670	0.150	0.552	-0.139	0.267	-0.428	0.461	0.162
		Sig. (2-tailed)	0.1063	0.4022	0.0008	0.0001	<0.0000	0.0030	0.1005	0.8705	<0.0000	0.6323	0.5611	0.0001	0.4291	0.0016	0.4624	0.1544	0.0182	0.0103	0.3937
Indicator Parameters	Calcium	Correlation Coefficient	-0.402	-0.426	-0.614	-0.691	-0.814	-0.576	-0.249	0.212	0.739	-0.263	-0.294	-0.500	-0.155	-0.344	0.279	-0.427	0.089	-0.250	0.037
		Sig. (2-tailed)	0.0275	0.0188	0.0003	<0.0000	<0.0000	0.0009	0.1849	0.2604	<0.0000	0.1596	0.1153	0.0049	0.4148	0.0625	0.1355	0.0186	0.6393	0.1833	0.8475
	Sodium	Correlation Coefficient	-0.383	-0.407	-0.611	-0.722	-0.783	-0.557	-0.229	0.182	0.737	-0.288	-0.259	-0.465	-0.172	-0.378	0.268	-0.466	0.056	-0.206	0.034
		Sig. (2-tailed)	0.0367	0.0257	0.0003	<0.0000	<0.0000	0.0014	0.2235	0.3364	<0.0000	0.1222	0.1668	0.0095	0.3635	0.0393	0.1517	0.0094	0.7697	0.2742	0.8571
	Strontium	Correlation Coefficient	-0.228	-0.495	-0.642	-0.592	-0.864	-0.670	-0.274	0.230	0.794	-0.395	-0.428	-0.411	-0.122	-0.335	0.268	-0.589	-0.144	-0.238	0.057
		Sig. (2-tailed)	0.2254	0.0054	0.0001	0.0006	<0.0000	0.0001	0.1436	0.2213	<0.0000	0.0306	0.0182	0.0241	0.5194	0.0705	0.1518	0.0006	0.4468	0.2059	0.7652
	Tin	Correlation Coefficient	-0.230	-0.411	-0.325	-0.551	-0.487	-0.415	-0.214	0.022	0.434	-0.133	-0.246	-0.290	-0.132	-0.246	0.400	-0.263	-0.011	-0.111	-0.136
		Sig. (2-tailed)	0.2219	0.0242	0.0797	0.0016	0.0063	0.0227	0.2571	0.9084	0.0166	0.4847	0.1895	0.1195	0.4870	0.1895	0.0287	0.1601	0.9525	0.5595	0.4739
	Vanadium	Correlation Coefficient	-0.456	-0.329	-0.468	-0.679	-0.571	-0.280	0.051	0.427	0.543	-0.234	-0.225	-0.309	0.043	-0.161	0.247	-0.369	-0.033	-0.224	0.284
		Sig. (2-tailed)	0.0112	0.0761	0.0091	<0.0000	0.0010	0.1335	0.7873	0.0185	0.0020	0.2142	0.2310	0.0968	0.8234	0.3960	0.1887	0.0448	0.8622	0.2347	0.1288
PCA Axes	Axis 1 (48.8%)	Correlation Coefficient	0.150	0.000	0.537	0.430	0.586	0.477	0.333	0.197	-0.634	-0.034	0.030	0.678	0.166	0.518	-0.032	0.246	-0.539	0.432	0.101
		Sig. (2-tailed)	0.4294	0.9981	0.0022	0.0177	0.0007	0.0076	0.0719	0.2979	0.0002	0.8565	0.8739	<0.0000	0.3792	0.0034	0.8659	0.1899	0.0021	0.0171	0.5970
	Axis 2 (31.0%)	Correlation Coefficient	-0.271	-0.581	-0.421	-0.478	-0.640	-0.441	-0.061	0.372	0.552	-0.403	-0.438	-0.156	-0.029	-0.138	0.290	-0.445	-0.342	-0.103	0.147
		Sig. (2-tailed)	0.1469	0.0008	0.0206	0.0076	0.0001	0.0147	0.7492	0.0430	0.0015	0.0274	0.0154	0.4108	0.8801	0.4686	0.1206	0.0138	0.0640	0.5888	0.4381
Copper Extracts [3]	Exchangeable	Correlation Coefficient	-0.488	-0.206	-0.584	-0.801	-0.673	-0.459	-0.243	0.158	0.654	-0.072	-0.090	-0.502	-0.128	-0.455	0.296	-0.332	0.284	-0.306	-0.086
		Sig. (2-tailed)	0.0062	0.2756	0.0007	<0.0000	<0.0000	0.0107	0.1957	0.4049	0.0001	0.7065	0.6348	0.0047	0.5018	0.0116	0.1125	0.0728	0.1277	0.1005	0.6503
	Carbonate	Correlation Coefficient	-0.373	-0.031	-0.669	-0.698	-0.637	-0.370	-0.089	0.246	0.621	-0.080	-0.054	-0.521	0.017	-0.378	0.292	-0.345	0.299	-0.366	0.112
		Sig. (2-tailed)	0.0424	0.8689	0.0001	<0.0000	0.0002	0.0442	0.6417	0.1895	0.0002	0.6753	0.7749	0.0031	0.9274	0.0397	0.1180	0.0615	0.1088	0.0468	0.5572
	Easily Reducible	Correlation Coefficient	-0.337	-0.590	-0.696	-0.650	-0.871	-0.711	-0.316	0.299	0.827	-0.387	-0.571	-0.419	-0.144	-0.389	0.270	-0.491	-0.171	-0.316	-0.052
		Sig. (2-tailed)	0.0686	0.0006	<0.0000	0.0001	<0.0000	<0.0000	0.0889	0.1091	<0.0000	0.0345	0.0010	0.0212	0.4463	0.0336	0.1491	0.0059	0.3663	0.0886	0.7841
	Organic	Correlation Coefficient	-0.426	-0.282	-0.634	-0.725	-0.715	-0.419	-0.035	0.364	0.690	-0.193	-0.196	-0.443	0.060	-0.338	0.270	-0.481	0.076	-0.357	0.205
		Sig. (2-tailed)	0.0191	0.1307	0.0002	<0.0000	<0.0000	0.0213	0.8544	0.0479	<0.0000	0.3058	0.2988	0.0143	0.7548	0.0677	0.1490	0.0072	0.6905	0.0526	0.2772

(Orange shading) Significant correlation; p-value < 0.0001 (Bonferroni corrected p-value for 432 comparisons among Table 8.8 and Appendix Table I.4).

(Grey shading) Correlation scatterplot inspected; p <0.01.

[1] Values < method detection limit (MDL) were used at the MDL for calculations. Normalized survival and growth are relative to associated laboratory control.

[2] For sampling areas where 5 toxicity field replicates were analysed for each station (Sampling areas PRef1, PNF, and PFF1), mean survival and growth measures (of the 5 replicates per station) were used for correlations with individual sediment chemistry measures from each station.

[3] Copper extract results for sampling areas PRef2, PFF2, and PFF are for a single composite sample. As a result, the single copper value available for each fraction was used in correlations with each of the 5 toxicity replicates from each of these sampling areas.

NA = Correlation was not performed between these two parameters.

Note: n=30 for all correlations.

8.7 Data Integration, Summary and Spatial Extent

As also observed in the Quesnel Lake littoral areas, sediment total organic carbon content was low in exposed areas and increased to concentrations similar to reference with distance from the mouth of Hazeltine Creek. Sediment collected from influenced profundal areas of Quesnel Lake following the dam failure was characterized by concentrations of copper greater than the SQG PEL and reference concentrations that decreased with distance from the mouth of Hazeltine Creek, and by concentrations of a number of IPs (calcium, sodium, strontium, tin and vanadium) that also decreased with distance from the mouth of Hazeltine Creek. A number of additional metals were elevated to concentrations greater than SQG TELs and reference at the far-far-field area only, which suggest that they were not failure-related. Sediment geochemical evaluations indicated that, for most POIs (including those identified on the basis of sediment quality data from Hazeltine Creek, Polley Lake and the Quesnel Lake littoral zone) and IPs, concentrations were mostly in the residual phase, a fraction that is not considered mobile or biologically available. However, copper was a notable exception, with the majority occurring in the "organic" phase (which appears to be mineral), and with concentrations in the exchangeable, carbonate and easily reducible phases at near-field and far-field areas greater than reference. Separate integrated consideration of mineralogy, sequential extraction results and mineral solubility indicates that these forms would not be mobile under environmentally realistic conditions (SRK 2015).

Sediment stratigraphy evaluation at the near-field area indicated little vertical variation in sediment chemistry; only slightly higher concentrations of a number of failure-related metals in surficial sediments. Sediment and pore-water analysis indicated that sediments were under oxidizing conditions (there was no evidence of reducing conditions), and therefore, metals are likely to remain associated with particulates. Porewater metal concentrations did not mirror sediment concentrations and were relatively elevated at 3 to 7 cm sub-surface. Sediments were not fully compacted when the cores for sediment and pore-water chemistry were collected. Separate evaluation of potential post-depositional mobility indicated very low risk of metal mobilization (SRK 2015).

Sediment toxicity testing indicated an effect on survival of *H. azteca* and on survival and growth of *C. dilutus* at the near-field area relative to reference and laboratory controls. Reduced growth of *H. azteca* was observed at the upstream far-field area (driven primarily on the basis of a high growth rate in one laboratory control), and reduced survival (but not growth) of *C. dilutus* was observed at both far-field areas. Benthic invertebrate community assessment indicated that the benthic invertebrate community of the Quesnel Lake profundal zone (including reference areas) was composed of few organisms. The upstream far-field area had no organisms present at four of five stations. Density of the near-field and far-field areas was low (<50 organisms/m^2), and the upstream far-field area had significantly lower taxon richness than both reference areas. Community composition at the near-field and far-field areas differed significantly from both references. However, compositional differences between reference areas were as large as those between exposed and reference areas.

Correlation analysis indicated some positive relationships between biological endpoints (survival and growth of the toxicity test organisms and benthic invertebrate community density, taxon richness, diversity, evenness and community composition) and dissolved oxygen (benthic invertebrate community only) and sediment total organic carbon content. There were negative relationships between the biological endpoints and specific conductance (benthic invertebrate community only) and concentrations of a number of POIs and IP, including copper in selective extracts. As the positive influence of dissolved oxygen and TOC cannot be separated from potential negative effects due to elevated POI and IP concentrations, it is uncertain whether the effects are physical or chemical, but they are nonetheless related to the tailings dam failure.

Overall, an impact of the dam failure was evident on sediment quality of the near-field and far-field profundal areas of Quesnel Lake, with sediment quality improving with distance from the source. As at other locations (Hazeltine Creek, Polley Lake, and Quesnel Lake littoral), copper represents the analyte of greatest concern, both with respect to its absolute concentration relative to guidelines and its geochemical partitioning. Sediment stratigraphy evaluation indicated that sediments were oxidizing with a slight surface enrichment resulting from depositional rather than post-depositional processes. Sediment toxicity testing indicated effects to both test organisms at the near-field area and effects to *C. dilutus* survival (but not growth) at both far-field areas. Benthic invertebrate communities at all profundal areas (including reference areas) were composed of few organisms, but density of the near-field and far-field areas was particularly low as was taxon richness at the upstream far-field area which had significantly lower taxon richness than both reference areas. Community composition at the near-field and far-field areas differed significantly from both reference areas. Most benthic invertebrate community endpoints, including community composition, differed significantly between reference areas (indicating high natural variability in Quesnel Lake profundal areas). Correlation analysis suggested that the biological effects were failure-related, but it is uncertain whether the effects were physical (due to smothering and/or low dissolved oxygen and low TOC content) or chemical. Both physical observations and concentrations of POIs and IPs indicate that spatial extent of the tailings dam failure on Quesnel Lake profundal sediment quality extends through the far-field areas and covers a substantial linear distance (on the order of 7.5 km).

9.0 QUESNEL RIVER

Impact characterization in the Quesnel River included benthic invertebrate community characterization and benthic invertebrate tissue chemistry, supported by water quality data and physical measurements (Figure 4.6). The Quesnel River is erosional and no areas of sediment deposition were identified during sampling and therefore impact characterization did not include sediment. Data Quality Assessment (DQA; Appendix C with supporting data in Appendix J) indicated that water chemistry data, benthic invertebrate community data and benthic invertebrate tissue chemistry data were of good quality and can therefore be used confidently in impact characterization. Samples were collected from three areas upstream of the Cariboo River confluence (QUR1, QUR2 and QUR3) and three areas downstream of the Cariboo River confluence (QUR4, QUR5 and QUR6), and were compared to either two or three reference areas (Cariboo River [CAR], Clearwater River [CLR] and, for tissue chemistry only (due to habitat differences), Blackwater Creek [BLC]; Figure 4.6) in a combination Multiple Control-Impact (MCI) design and gradient design (the latter evaluating conditions in relation to distance from Quesnel Lake). Samples were collected by kick net at three stations per area.

9.1 Supporting Water Quality

No physical water quality characteristics exceeded British Columbia Water Quality Guidelines for the protection of aquatic life (BCWQG) at any Quesnel River or reference areas (Table 9.1). Conductivity, hardness, pH, and total suspended solids (TSS) were highest and lowest at Blackwater Creek (BLC) and the Clearwater River (CLR) reference areas, respectively. Turbidity and total dissolved solids (TDS) were higher in the Quesnel River downstream areas (QUR4, QUR5 and QUR6) relative to the upstream areas and reference areas (Table 9.1). No anions or nutrients exceeded BCWQG at any Quesnel River or reference area. Similarly, no reference area had total or dissolved metals above BCWQG; however, Quesnel River downstream areas QUR4 and QUR5 had concentrations of chromium, copper and iron greater than BCWQG in apparent association with higher turbidity (Table 9.1). There were no instances of dissolved metal concentrations greater than BCWQG.

Principal components analysis of total metals resulted in the first two axes explaining more variation in the original dataset than by chance alone. PCA axis-1 and PCA axis-2 explained 62.0% and 31.0% of the total extracted variance, respectively (Appendix Table I.5). PCA axis-1 separated Quesnel River downstream areas from Quesnel River upstream and reference areas along a high to low metal concentration gradient consisting

Table 9.1: Water chemistry results from benthic invertebrate sampling stations on the Quesnel River, Mount Polley Mine, October 2014.

Analyte	Units	BCWQG Aquatic Life [1]		Reference			Exposed					
		Chronic	Acute	BLC	CLR	CAR	QUR1	QUR2	QUR3	QUR4	QUR5	QUR6
				24-Oct-14	23-Oct-14	19-Oct-14	15-Oct-14	16-Oct-14	17-Oct-14	26-Oct-14	26-Oct-14	19-Oct-14
Physical Tests												
Conductivity	µS/cm			187	83.4	115	106	106	106	109	114	117
Hardness (as $CaCO_3$)	mg/L			95.8	38.8	57.3	52.1	53	52.1	56.8	61.2	58.3
pH	pH	6.5 - 9.0		8.12	7.87	7.95	7.96	7.96	7.98	7.96	7.95	7.88
Total Suspended Solids (TSS)	mg/L	+ 5 [a]	+ 25 [a]	124	53	66	68	69	54	76	80	73
Total Dissolved Solids (TDS)	mg/L			4.4	<3.0	<3.0	<3.0	<3.0	<3.0	41.6	43.7	13.4
Turbidity	NTU	+2 [a]	+ 8 [a]	1.38	0.79	1.65	0.83	0.8	0.87	19.5	23.2	7.58
Anions and Nutrients												
Alkalinity, Total (as $CaCO_3$)	mg/L			102	37.7	54.2	47.9	47.9	48.2	48	47.7	56.6
Ammonia, Total (as N)	mg/L	0.882	4.59	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Chloride (Cl)	mg/L	150	600	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Fluoride (F)	mg/L		0.95	0.118	0.033	0.024	0.034	0.035	0.032	0.027	0.028	0.031
Nitrate (as N)	mg/L	3	32.8	0.0136	0.097	0.0853	0.0611	0.0615	0.0639	0.0809	0.0829	0.0741
Nitrite (as N)	mg/L	0.02	0.06	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Total Nitrogen	mg/L			0.299	0.15	0.093	0.119	0.122	0.133	0.136	0.136	0.101
Orthophosphate (Dissolved as P)	mg/L			0.0293	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P) - Total Dissolved	mg/L			0.0359	0.0021	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Phosphorus (P) - Total	mg/L		0.005 - 0.015	0.0446	0.0023	0.0024	0.0036	0.0031	0.0027	0.0342	0.035	0.0135
Sulfate (SO_4)	mg/L	218		1.84	5.93	7.93	6.29	6.25	6.32	7.31	7.98	7.63
Organic / Inorganic Carbon												
Dissolved Organic Carbon (DOC)	mg/L		+ 20% [a]	5.67	1.57	1.14	1.92	2.09	2.29	2.03	1.87	1.79
Total Metals												
Aluminum (Al)	mg/L			0.0478	0.0616	0.0803	0.0431	0.0402	0.0433	1.17	1.32	0.37
Antimony (Sb)	mg/L	0.009		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Arsenic (As)	mg/L		0.005	0.001	0.0001	0.00011	0.00015	0.00016	0.00017	0.00071	0.0008	0.00033
Barium (Ba)	mg/L	1		0.0115	0.00497	0.00678	0.00603	0.00595	0.00615	0.0173	0.0198	0.0101
Beryllium (Be)	mg/L	0.00013		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Bismuth (Bi)	mg/L			<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Boron (B)	mg/L		1.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Cadmium (Cd) [2]	mg/L	0.00011	0.00022	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000023	0.000032	0.000012
Calcium (Ca)	mg/L			18.6	13.4	19.4	17.4	17.6	17.6	19.2	19.7	19
Chromium (Cr) [3]	mg/L	0.001		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	**0.00248**	**0.00286**	0.0008
Cobalt (Co)	mg/L	0.004	0.11	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00085	0.00095	0.00029
Copper (Cu)	mg/L	0.002	0.006	<0.00050	<0.00050	<0.00050	0.00137	0.00147	0.00136	**0.00375**	**0.00399**	0.00176
Iron (Fe)	mg/L		1	0.268	0.092	0.123	0.037	0.033	0.037	**1.75**	**1.99**	0.559
Lead (Pb)	mg/L	0.004	0.024	<0.000050	0.000063	0.000111	<0.000050	<0.000050	<0.000050	0.000624	0.000731	0.00024
Lithium (Li)	mg/L			0.00133	0.00085	0.00078	0.00084	0.0008	0.00077	0.00199	0.00215	0.00119
Magnesium (Mg)	mg/L			11.7	1.77	2.51	1.94	1.98	1.98	2.84	3.18	2.62
Manganese (Mn)	mg/L	0.78	0.97	0.0285	0.00336	0.00635	0.00191	0.00184	0.00201	0.0391	0.0418	0.0139
Molybdenum (Mo)	mg/L	1	2	0.000999	0.00047	0.000126	0.000358	0.000357	0.000367	0.000331	0.000347	0.000298
Nickel (Ni) [4]	mg/L		0.025	0.001	0.00053	<0.00050	<0.00050	<0.00050	<0.00050	0.00276	0.00307	0.00106
Potassium (K)	mg/L			2.69	0.5	0.198	0.471	0.483	0.488	0.575	0.623	0.414
Selenium (Se)	mg/L	0.002		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Silicon (Si)	mg/L			9.58	1.52	1.22	1.43	1.48	1.47	3.25	3.52	1.89
Silver (Ag)	mg/L	0.00005	0.0001	<0.000010	0.00005	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Sodium (Na)	mg/L			6.87	0.76	0.452	0.947	0.953	0.97	0.842	0.916	0.766
Strontium (Sr)	mg/L			0.0886	0.0926	0.126	0.13	0.137	0.133	0.128	0.134	0.129
Thallium (Tl)	mg/L	0.0008		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.00001	0.000013	<0.000010
Tin (Sn)	mg/L			<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Titanium (Ti)	mg/L			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.057	0.065	0.02
Uranium (U)	mg/L	0.0085		0.000271	0.000182	0.000191	0.000164	0.000159	0.000164	0.000211	0.000237	0.000193
Vanadium (V)	mg/L			0.0018	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0031	0.0036	0.0011
Zinc (Zn)	mg/L	0.0075	0.033	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	0.005	0.0052	<0.0030
Dissolved Metals												
Aluminum (Al)	mg/L	0.05	0.1	<0.0030	0.0139	0.0076	0.0078	0.0077	0.008	0.009	0.0075	0.0064
Antimony (Sb)	mg/L			<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Arsenic (As)	mg/L			0.00093	<0.00010	<0.00010	0.00012	0.00013	0.00012	0.00013	0.00016	0.00015
Barium (Ba)	mg/L			0.0103	0.00451	0.00601	0.00541	0.00548	0.00557	0.00661	0.00717	0.00676
Beryllium (Be)	mg/L			<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Bismuth (Bi)	mg/L			<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Boron (B)	mg/L			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Cadmium (Cd)	mg/L	0.00011	0.00022	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Calcium (Ca)	mg/L			18.9	12.8	19	17.7	17.9	17.6	18.9	20	19.3
Chromium (Cr)	mg/L			<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L			<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Copper (Cu)	mg/L			<0.00050	<0.00050	<0.00050	0.00087	0.00086	0.00087	0.00074	0.00077	0.00069
Iron (Fe)	mg/L		0.35	0.115	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Lead (Pb)	mg/L			<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)	mg/L			0.00134	0.00072	0.00061	0.00081	0.00076	0.0008	0.0009	0.00093	0.00077
Magnesium (Mg)	mg/L			11.8	1.64	2.42	1.92	2	1.96	2.32	2.75	2.48
Manganese (Mn)	mg/L			0.00303	0.00052	0.0013	0.000206	0.00024	0.000189	0.00407	0.00411	0.00193
Molybdenum (Mo)	mg/L			0.000966	0.000402	0.000099	0.000332	0.000329	0.000323	0.000274	0.000324	0.000296
Nickel (Ni)	mg/L			0.0008	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Potassium (K)	mg/L			2.67	0.457	0.173	0.457	0.465	0.457	0.344	0.366	0.342
Selenium (Se)	mg/L			<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Silicon (Si)	mg/L			9.5	1.4	1.07	1.37	1.41	1.37	1.34	1.39	1.3
Silver (Ag)	mg/L			<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Sodium (Na)	mg/L			6.45	0.69	0.443	0.923	0.905	0.903	0.777	0.871	0.768
Strontium (Sr)	mg/L			0.0872	0.0859	0.111	0.13	0.125	0.129	0.122	0.125	0.13
Thallium (Tl)	mg/L			<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Tin (Sn)	mg/L			<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Titanium (Ti)	mg/L			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Uranium (U)	mg/L			0.000246	0.000154	0.00016	0.000152	0.000145	0.000147	0.000175	0.000187	0.000168
Vanadium (V)	mg/L			0.0014	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Zinc (Zn)	mg/L			<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030

(Shaded/bold) Concentration exceeds BCWQG for Aquatic Life.

[1] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b). All guidelines that are dependent on other parameters (ammonia, copper, fluoride, lead, manganese) were calculated based on most the conservative values observed in this dataset (hardness = 38.8 mg/L, chloride = <0.50 mg/L, pH = 8.12, and temperature = 13°C)

[2] Cadmium guideline is for dissolved cadmium concentrations (BCMOE 2015b).

[3] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.

[4] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)

[a] guidelines for turbidity, TSS and DOC are for induced values above reference or background

of titanium, cobalt, aluminum, chromium, zinc, nickel, iron, barium, lithium, manganese, and vanadium (Figure 9.1; Appendix Tables I.5-I.6). PCA axis-2 separated reference area BLC from the other eight study areas along a metals gradient consisting of silicon, magnesium, and molybdenum (Figure 9.1; Appendix Tables I.5-I.6). Principal components analysis of dissolved metals resulted in only the first axis explaining more variation in the original dataset than by chance alone, which explained 69.5% of the total extracted variance. Reference areas CLR and CAR and the upstream areas had similar PCA axis-1 values, which separate slightly from the downstream areas and greatly from reference area BLC along a metal concentration gradient consisting of barium, lithium, uranium, arsenic, and magnesium (Figure 9.2; Appendix Tables I.7-I.8).

Overall, water quality data collected at the time of benthic invertebrate community sampling demonstrated that upstream water quality was more similar to reference than downstream water quality. Although several POIs were identified in principal components analysis (e.g., iron, manganese and nickel), a number of others (including copper) and were not. In addition, copper concentrations and concentrations of the PCA axis 1 metals were higher downstream in the Quesnel River than upstream, suggesting little, if any, failure-related influence on water quality. This is consistent with the findings of a comprehensive evaluation of the impact of the tailings dam failure of receiving water quality (Golder 2015). Lastly, it was also apparent that the Blackwater Creek reference area (BLC) had a different mixture of metals and nutrients than the eight other study areas, which was likely due to the specific characteristics of its drainage basin (e.g., physiography, geology, ecosystem type).

9.2 Benthic Invertebrate Community

9.2.1 Primary Metrics

Benthic organism abundance (individuals/1 minute kick) was significantly greater at all three Quesnel River upstream areas (QUR1, QUR2 and QUR3) than at both reference areas (Table 9.2; Figure 9.3; Appendix Tables I.9-I.10). Mean benthic organism abundances at all three downstream areas (QUR4, QUR5 and QUR6) were not significantly different than reference area CLR, and only QUR4 differed significantly (lower density) from reference area CAR. Mean benthic organism abundance was highest at QUR1 (1,005 individuals/1 minute kick) and lowest at QUR4 (26 individuals/1 minute kick). Total abundance should be interpreted cautiously as differences (increase or decrease) are not necessarily an indication of impairment, and the kick and sweep method used in this study is semi-quantitative (Merritt *et al*. 2008) and best suited to assess data in terms of relative abundance.

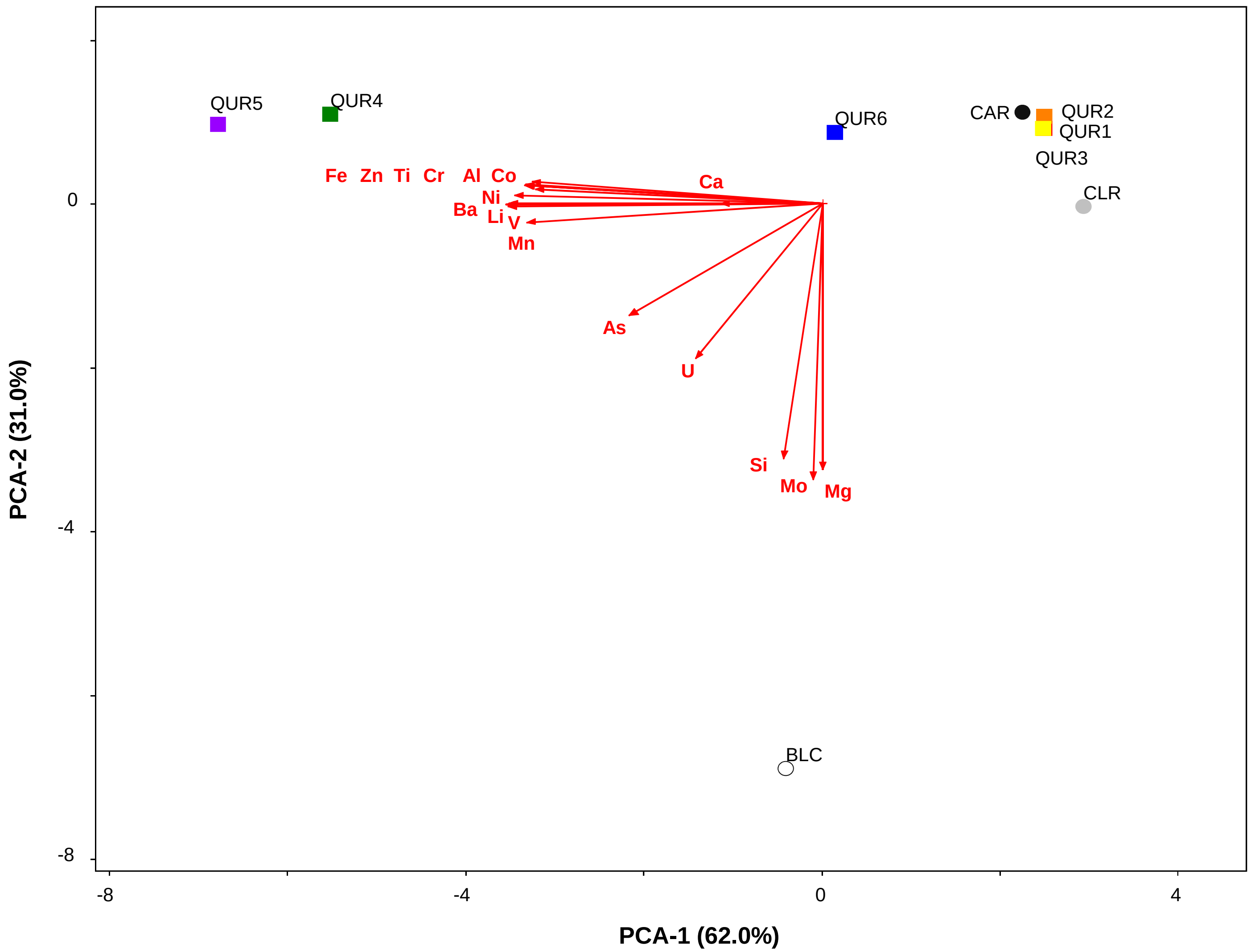


Figure 9.1: **Principal Components Analysis biplot of total aqueous metal concentrations using three reference areas and six Quesnel River areas, 3 replicates taken at each area. Reference and Quesnel River areas are depicted by circles and squares, respectively. Displayed vectors have significant ($p < 0.05$) Spearman's Rank Correlation with either PCA axis 1 or 2 (Appendix Table I.6), vector length is proportional to correlation strength. Mount Polley Mine, October 2014.**

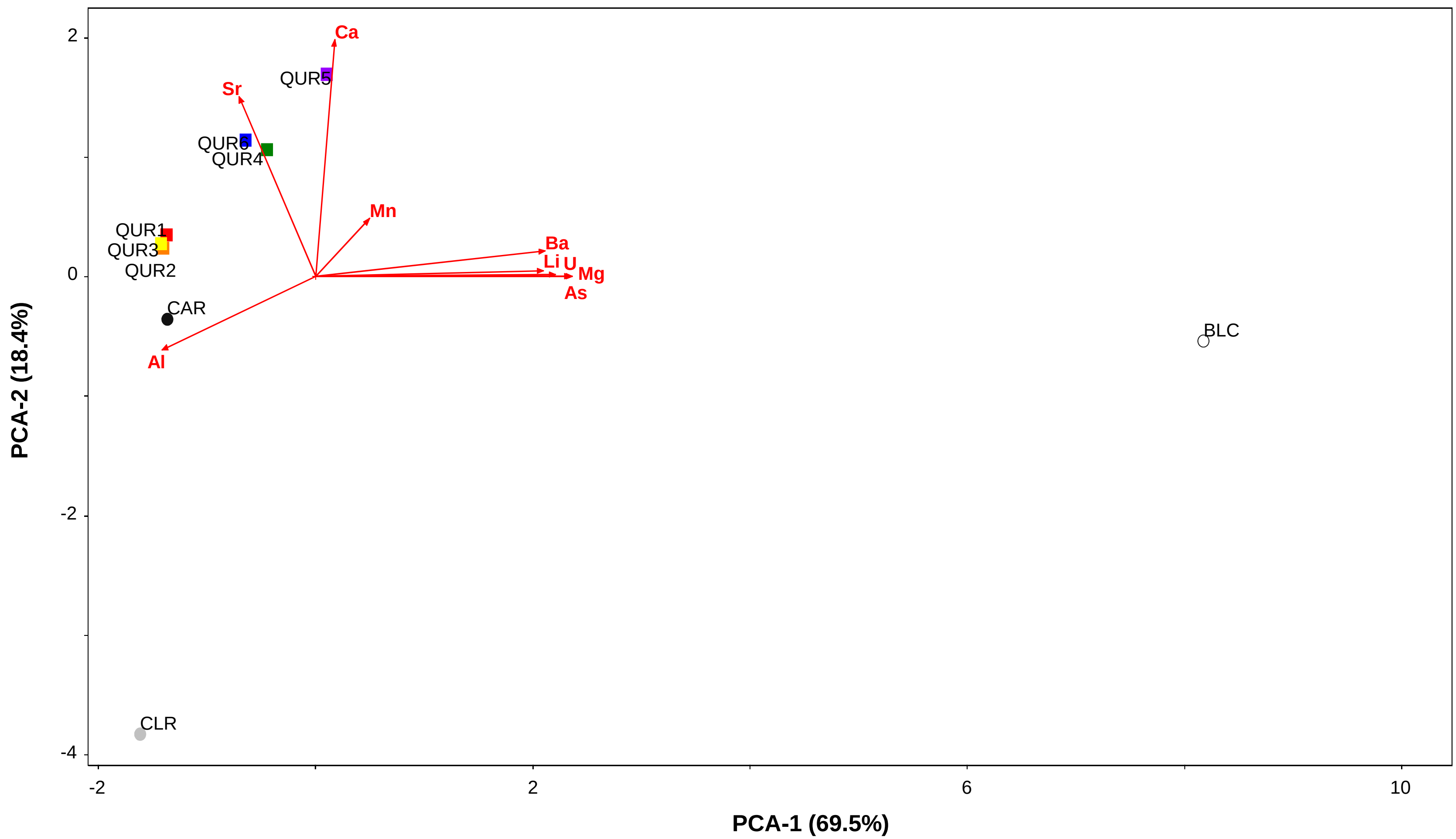


Figure 9.2: Principal Components Analysis biplot of dissolved aqueous metal concentrations using three reference areas and six Quesnel River areas, 3 replicates taken at each area. Reference and Quesnel River areas are depicted by circles and squares, respectively. Displayed vectors have significant ($p < 0.05$) Spearman's Rank Correlation with either PCA axis 1 or 2 (Appendix Table I.8), vector length is proportional to correlation strength. Mount Polley Mine, October 2014.

Table 9.2: Summary of statistical assessment of benthic invertebrate communities of Quesnel River areas with each reference area, Mount Polley Mine, 2014 (see Appendix I for all area comparisons). Magnitude of difference expressed as the number of reference standard deviations.

Endpoint			Abundance	Richness	Diversity (Simpson's)	Evenness (Simpson's)	NMS1	NMS2	Ephemeroptera (%)	Plecoptera (%)	Trichoptera (%)	Coleoptera (%)	Diptera (%)	Lepidoptera (%)	Arachnida (%)	Bivalva (%)	Gastropoda (%)	Oligocheata (%)
Difference with Reference Area CAR	Upstream	QUR1	17.9	-2.3	No	No	7.7	No	-2.1	No	No	No	4.3	No	No	No	No	No
		QUR2	11.5	No	No	No	5.9	No	-2.4	No	No	8.2	No	No	No	No	No	No
		QUR3	8.7	No	No	No	5.2	No	No	No	No	No	No	No	No	No	No	No
	Downstream	QUR4	-6.4	-9.5	No	8.4	-7.1	No	No	No	No	No	-3.9	No	No	No	No	No
		QUR5	No	-5.8	No	No	-8.5	No	3.1	No	No	No	-4.4	No	No	No	No	No
		QUR6	No	-6.9	No	No	No	No	No	No	No	No	-3.8	No	No	No	No	No
Difference with Reference Area CLR	Upstream	QUR1	22.0	No	No	No	1.4	No	No	No	No	No	1.2	No	No	No	No	No
		QUR2	16.0	No	No	No	1.3	No	No	3.7	No	No	No	No	No	No	No	No
		QUR3	13.3	No	No	No	1.3	No	No	No	No	No	No	No	No	No	No	No
	Downstream	QUR4	No	-3.2	No	No	No	No	No	5.6	No	No	No	No	No	No	No	No
		QUR5	No	No	No	No	No	No	2.4	2.0	No	No	No	No	No	No	No	No
		QUR6	No	No	No	No	No	No	No	7.1	No	No	No	No	No	No	No	No

(Grey shading) Indicates a significant difference between reference and exposed area. Values indicate the magnitude of difference as the number of reference standard deviations.

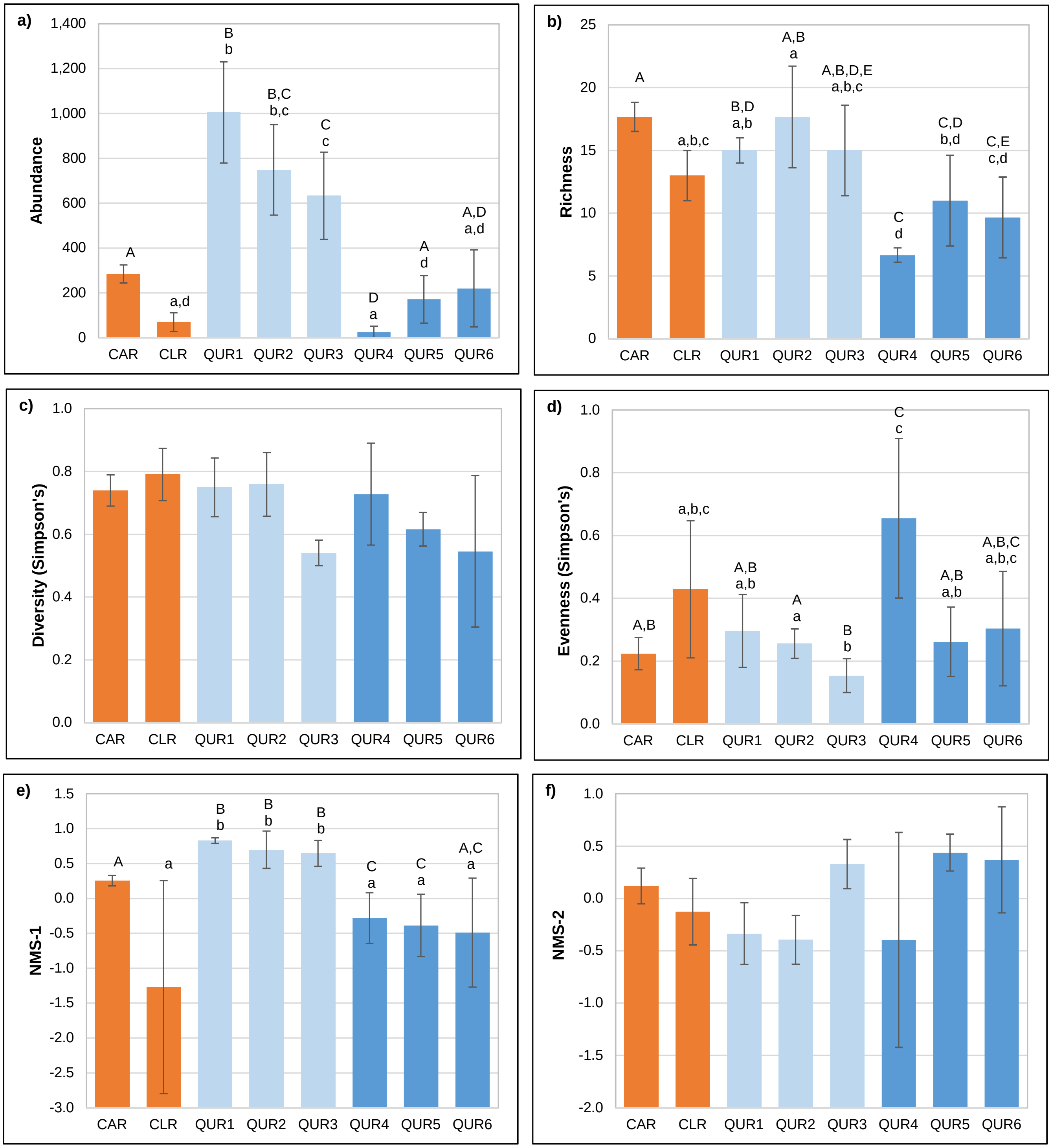


Figure 9.3: Primary benthic invertebrate metrics for Quesnel River areas (blue) and two reference areas (orange) located on Cariboo and Clearwater Rivers. Mean values ± one standard deviation are presented, Mount Polley Mine, October 2014.

Letters above whiskers identify statistical differences relating to the Cariboo River with Quesnel River ANOVA (uppercase letters) and Clearwater River with Quesnel River ANOVA (lower case letters). Areas that do not share a common letter are statistically different, and no letter indicates non-significant ANOVA. Light and dark blue colouring represents upper and lower reaches of the Quesnel River, respectively.

Mean area taxon richness of the Quesnel River upstream areas was similar to the Clearwater River reference area (CLR; Table 9.2; Figure 9.3). Upstream areas QUR2 and QUR3 were similar to the Cariboo River reference area (CAR), however upstream area QUR1 had significantly lower richness (Table 9.2; Figure 9.3). Mean area richness of all downstream areas was significantly lower than reference area CAR; however, only downstream area QUR4 had significantly different (lower) taxon richness than reference area CLR (Figure 9.3). Mean taxon richness was highest at reference area CAR (17.7) and lowest at Quesnel River downstream area QUR4 (6.7).

Mean Simpson's diversity did not differ among the nine study areas (Table 9.2; Figure 9.3). Mean Simpson's diversity was highest at reference area CLR (0.79) and lowest at Quesnel River upstream area QUR3 (0.54). Mean Simpson's evenness was similar at all Quesnel River areas relative to both reference areas with the exception that downstream area QUR4 had significantly higher evenness values than reference area CAR. Mean Simpson's evenness value was highest at downstream area QUR4 (0.65) and lowest at QUR3 (0.15).

9.2.2 Supporting Metrics

Dominant taxon groups (i.e., relative abundance ≥ 5%) encountered among all Quesnel River and reference areas included Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies) and/or Diptera (true flies; Figure 9.4), the latter of which were represented primarily by Chironomidae (non-biting midges). On average, metal-sensitive Ephemeroptera composed greater than 50% of the benthic invertebrate community at all study areas except the two upper-most Quesnel River areas (i.e., QUR1 and QUR2), where mean relative abundance of this group was less than 40% (Figure 9.4). The relative abundance of Ephemeroptera was significantly lower at the QUR1 and QUR2 areas compared to the CAR reference area (Table 9.2; Figure 9.5; Appendix Table I.11; Appendix Figure I.11). However, no significant difference in the relative abundance of this group was indicated at QUR1/QUR2 compared to the CLR reference area (Table 9.2; Figure 9.5). In addition, the absolute abundance (i.e., number of organisms per 1-minute kick sample) of Ephemeroptera was highest at the Quesnel River upstream areas. The latter two results suggested no failure-related impact to benthic invertebrates downstream of Quesnel Lake.

The relative abundance of Plecoptera, which are moderately sensitive to metals, did not differ significantly between any of the Quesnel River study areas compared to the CAR reference (Table 9.2; Figure 9.5). In contrast, Plecoptera relative abundance was significantly higher at upstream area QUR2 and all downstream areas (i.e., QUR4, QUR5

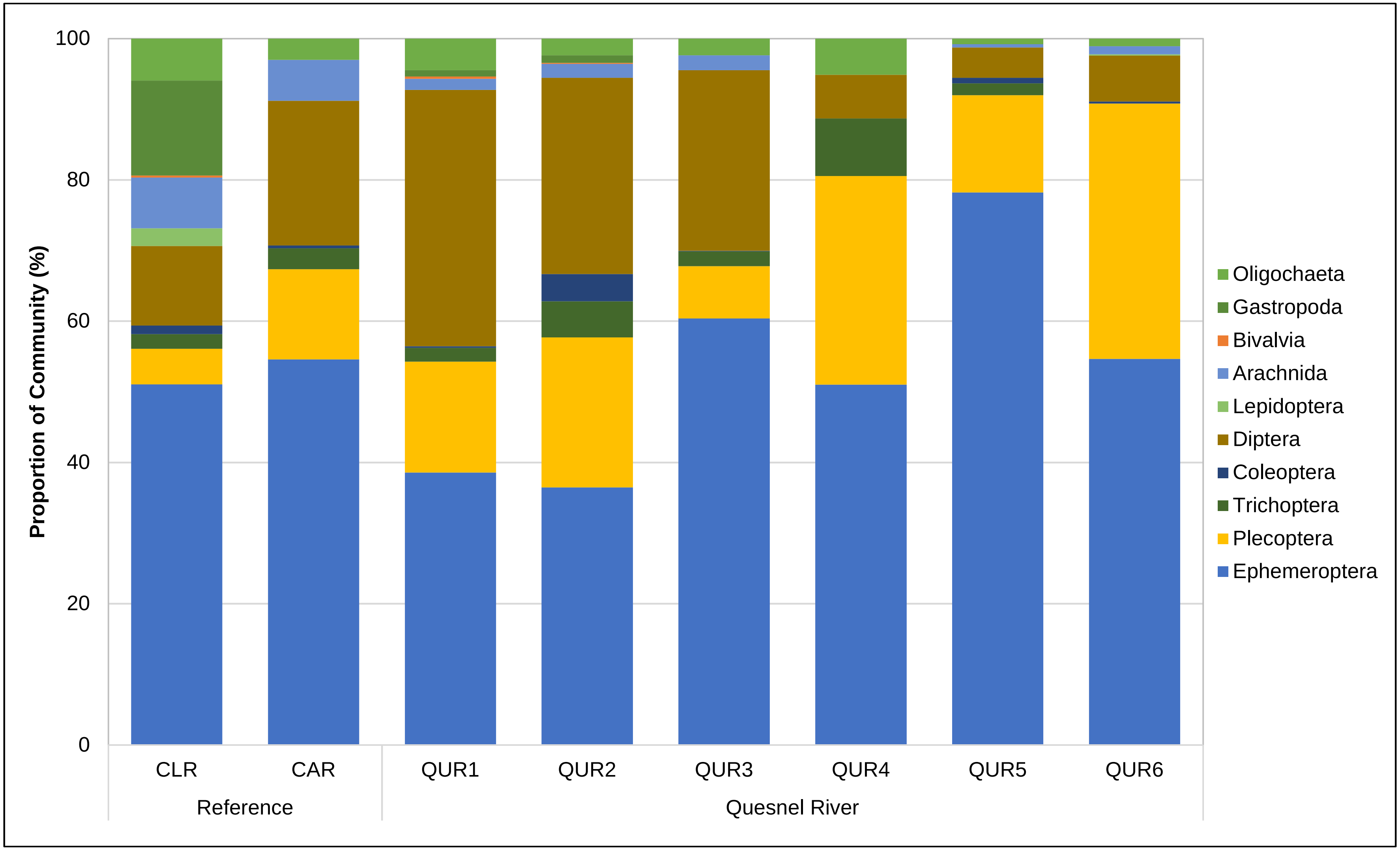


Figure 9.4: Relative mean proportions of major benthic invertebrate taxon groups within the Quesnel River and associated reference areas, Mount Polley Mine, 2014. Blackwater Creek (BLC) was not sampled for community structure as the substrate was not appropriate for comparison with the other areas.

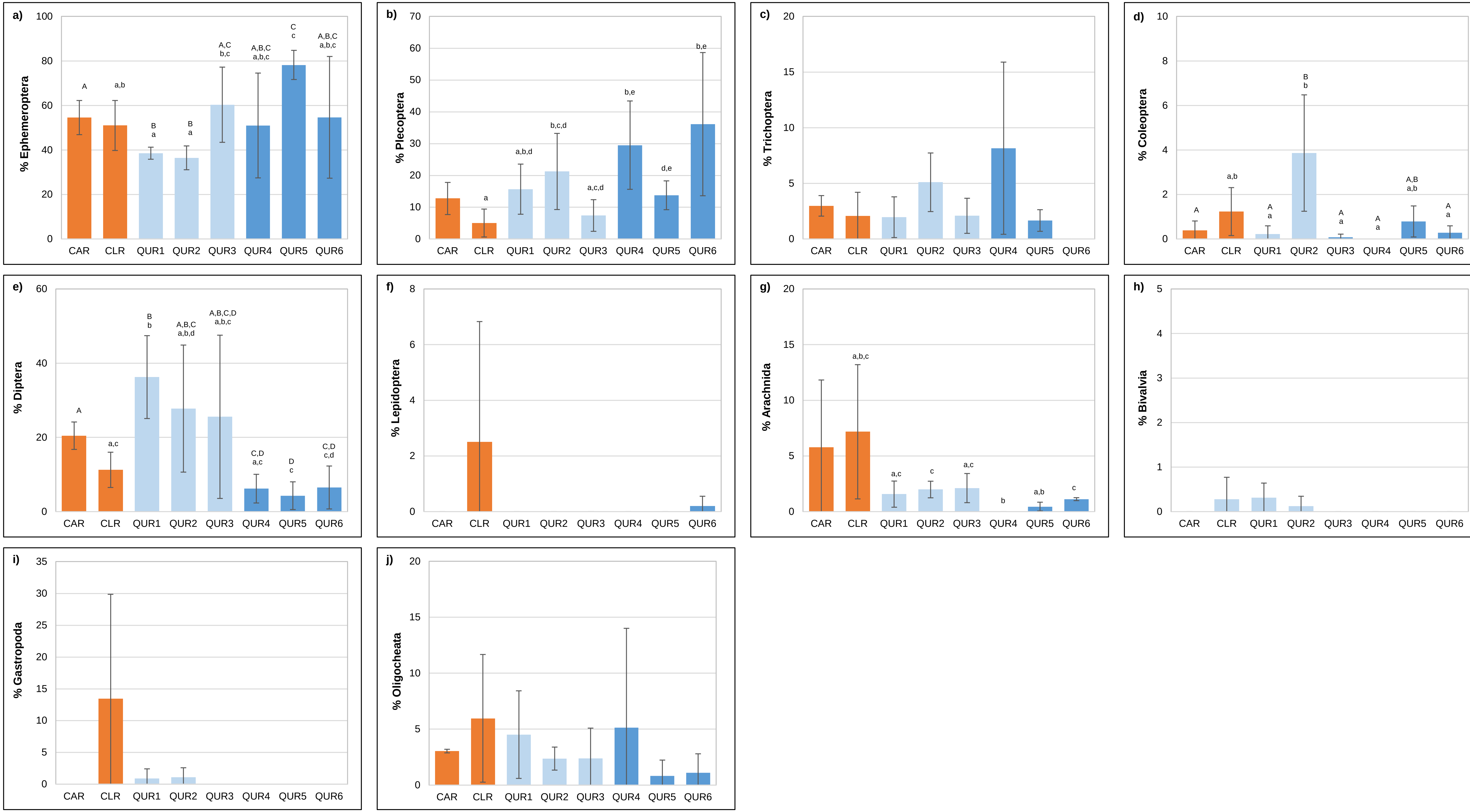


Figure 9.5: Major benthic invertebrate groups for Quesnel River areas (blue) and two reference areas (orange) located on Cariboo and Clearwater Rivers. Mean values ± one standard deviation are presented, Mount Polley Mine, October 2014.

Letters above whiskers identify statistical differences relating to the Cariboo River with Quesnel River ANOVA (uppercase letters) and Clearwater River with Quesnel River ANOVA (lower case letters). Areas that do not share a common letter are statistically different, and no letter indicates non-significant ANOVA. Light and dark blue colouring represents upper and lower reaches of the Quesnel River, respectively.

and QUR6) compared to the CLR reference area (Table 9.2; Figure 9.5; Appendix Table I.12; Appendix Figure I.12). No significant differences in the relative abundance of Trichoptera, which also show moderate sensitivity to metals, were indicated between any of the QUR upstream or downstream areas compared to either of the CAR or CLR reference areas (Table 9.2; Figure 9.5). Similar relative abundance, or significantly higher relative abundance, of moderately metal-sensitive Plecoptera and Trichoptera groups at QUR study areas compared to the reference area(s) suggested that, similar to comparisons of metal-sensitive Ephemeroptera among the study areas, no failure-related impact to benthic biota occurred in the Quesnel River.

Relative abundance of Diptera was significantly higher than reference only at the Quesnel River upstream area (QUR1; Table 9.2; Figure 9.5). Most taxa within the order Diptera are considered relatively metal tolerant. However, members of the midge tribe Tanytarsini and sub-family Diamesinae inhabiting erosional lotic habitat generally exhibit high sensitivity to metals (e.g., Barbour et al. 1999). Because the absolute abundance of Tanytarsini and Diamesinae midges was highest at Quesnel River upstream areas including QUR1, higher relative abundance of Diptera at QUR1 compared to the CAR and CLR reference areas was not consistent with a metal-related response. Although the relative abundance of Diptera also differed significantly between the Quesnel River downstream areas and the CAR reference area, higher relative abundance of this group at the upstream areas and no differences in Diptera relative abundance in downstream areas compared to the CLR reference suggested no adverse failure-related influences on this group at the Quesnel River study areas. The biggest difference between the two reference areas was the occurrence of Gastropoda and Lepidoptera at CLR and the absence at CAR (Figure 9.5).

Analysis of benthic invertebrate community structure was supported by non-metric multidimensional scaling (NMS), which resulted in a stable 2-dimensional solution (Figure 9.6), with the variation represented by the NMS axes significantly greater than that explained by chance alone (i.e., Monte Carlo p-value less than 0.05). The first two NMS axes captured the majority (i.e., 84.2%) of the total variation in the benthic invertebrate community data set. The first NMS axis (NMS-1) explained 67.3% of the total variation, with the mean NMS-1 area scores significantly greater at each of Quesnel River upstream areas (QUR1, QUR2 and QUR3) than both the Cariboo River (CAR) and Clearwater River (CLR) reference areas (Table 9.2; Figure 9.3; Appendix Table I.13). No Quesnel River downstream area had different NMS-1 area scores than either reference area, with the exception that QUR4 and QUR5 had significantly lower scores than reference area CAR

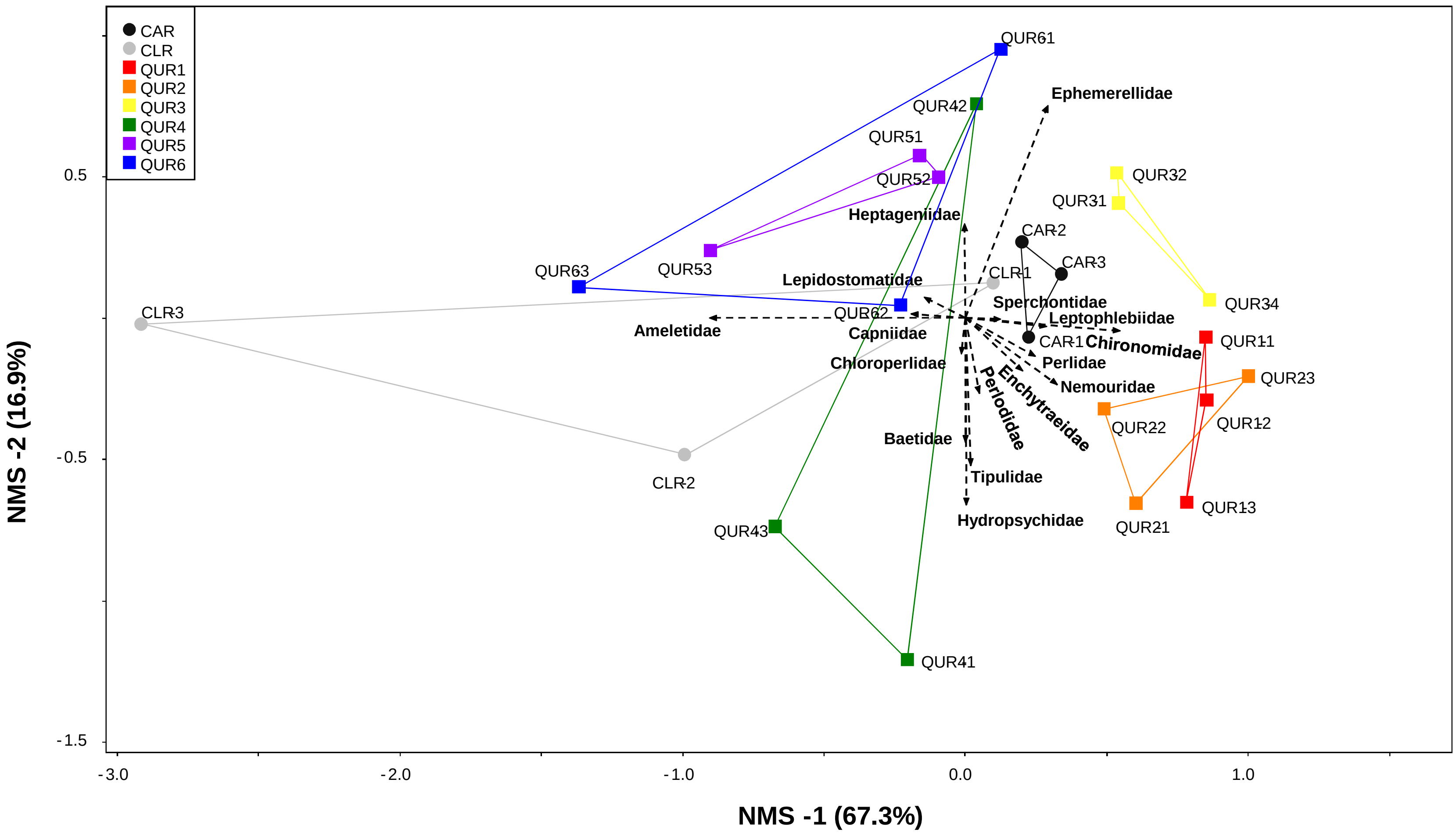


Figure 9.6: **Nonmetric multidimensional scaling biplot of benthic invertebrate community structure using two reference areas and Quesnel River areas, 3 replicates taken at each area. Family level of taxonomy employed with rare families removed if they did not occur in more than 2 of 24 samples. Displayed family vectors have significant ($p < 0.05$) Spearman's Rank Correlation with either NMS axis 1 or 2 (Appendix Table I.15), vector length is proportional to correlation strength. Convex hulls connect replicates of each area. Mount Polley Mine, October 2014.**

(Table 9.2; Figure 9.3). Taxa representing greatest positive weightings on NMS-1 included Leptophlebiidae mayflies, Perlidae and Nemouridae stoneflies, Chironomidae midges and Enchytraeidae worms (Figure 9.6), all of which were generally observed only at the Quesnel River upstream areas (i.e., QUR1, QUR2 and QUR3) and not at the downstream areas (i.e., QUR4, QUR5 and QUR6) or at either of the CAR and CLR reference areas (Appendix Tables G.30-G.31 and I.14). Ameletidae mayflies, which heavily weighted the negative scores on NMS-1 (Figure 9.6), were absent from the upstream areas (Appendix Tables G.30-G.31 and I.14). Because the taxon groups resulting in heavy positive or negative weightings on NMS-1 station scores show variable sensitivity to metals, the differences in benthic invertebrate community structure along the Quesnel River and in comparison to reference suggested by NMS-1 comparisons were not likely related to differences in metal concentrations. Rather, the indicated benthic invertebrate community differences among the Quesnel River areas and reference areas likely reflected slight differences in habitat (e.g., lakeoutlet effects, slight differences in substrate size, water velocity, etc.). The second NMS axis (NMS-2) explained 16.9% of variation in the benthic data set (Appendix Table I.13), but because no significant differences in NMS-2 station scores were indicated among the Quesnel River areas and reference areas, the NMS-2 results were not considered further.

Overall, high absolute abundance of metal-sensitive Ephemeroptera and Tanytarsini/Diamesinae midges at Quesnel River upstream areas, significantly higher relative abundance of moderately metal-sensitive Plecoptera at the Quesnel River areas compared to the CRL reference, and the general absence of significant differences in relative abundance of dominant taxon groups between Quesnel River and reference areas suggested no adverse failure-related influences to benthic dwelling invertebrates downstream of Quesnel Lake. As might be expected, there was some evidence of a lake effect, with larger proportions of filter feeding organisms (e.g., hydropsychids and Hydra; Appendix Table G.32) at the upstream areas (closer to Quesnel Lake). Rivers flowing from lakes receive lake seston (e.g., Walks and Cyr 2004) and the influence of increased seston on benthic community structure in upstream areas of such rivers has been well documented (Hoffsten 1999). These locations often also have greater periphyton biomass (Cattaneo 1996) due to factors such as flow and sediment regulation (Myers et al. 2007), seston additions (Walks and Cyr 2004), and slightly higher water temperature (Marcarelli and Wurtsbaugh 2006).

9.3 Benthic Invertebrate Tissue Quality

9.3.1 Whole Community Metals Concentration

Principal components analysis of whole community whole-body metals resulted in the first two axes explaining more variation in the original dataset than by chance alone; axes 1 and 2 explained 55.6% and 16.4% of the total extracted variance, respectively (Appendix Table I.16). Principal component axis-1 separated Quesnel River downstream areas (QUR4, QUR5 and QUR6) from upstream and reference areas along a high to low metals gradient consisting of aluminum, vanadium, iron, cobalt, cadmium, uranium, nickel, arsenic, lead, barium, chromium and titanium; Figure 9.7; Appendix Table I.17). Principal components axis-2 separated areas along a high to low gradient of copper, silver and zinc which identified Quesnel River upstream areas QUR1 and QUR2 as having elevated concentrations of these metals relative to all other areas (Figure 9.7).

Determination of which analytes had elevated concentrations in whole community benthic invertebrate tissues also involved identifying statistically significant differences among areas (Table 9.3 and Appendix Tables I.18-I.20; Appendix Figures I.13-I.15) and by comparing concentrations: 1) relative to reference area CAR; 2) within the Quesnel River upstream reach; 3) between Quesnel River upstream and downstream reaches; and 4) within the Quesnel River downstream reach. Two analytes, selenium and strontium, did not demonstrate any significant differences and patterns among areas. Consistent evidence of higher concentrations relative to CAR and decreases with distance from Quesnel Lake were observed for only three analytes that were also identified in PCA - copper, silver, and zinc (Figure 9.8). Concentrations of all other analytes demonstrated either increasing concentrations with distance or no differences. As described in Sections 5.0 to 8.0, copper was identified as the key POI and silver was identified as an IP. Zinc was not identified as either a POI or IP in Quesnel Lake sediments. The elevations of copper and silver in whole community benthic invertebrate tissues were not supported by similar elevations in other POIs and IPs and it is therefore uncertain whether they represent a failure-related influence.

9.3.2 Perlidae Metals Concentration

Principal components analysis of Perlidae whole-body metals resulted in the first two axes explaining more variation in the original dataset than by chance alone; axis-1 and -2 explained 59.9% and 23.1% of the total extracted variance, respectively (Appendix Table I.21). Principal component axis-1 separated the Quesnel River downstream areas (QUR4, QUR5 and QUR6) from the Quesnel River upstream areas and reference areas

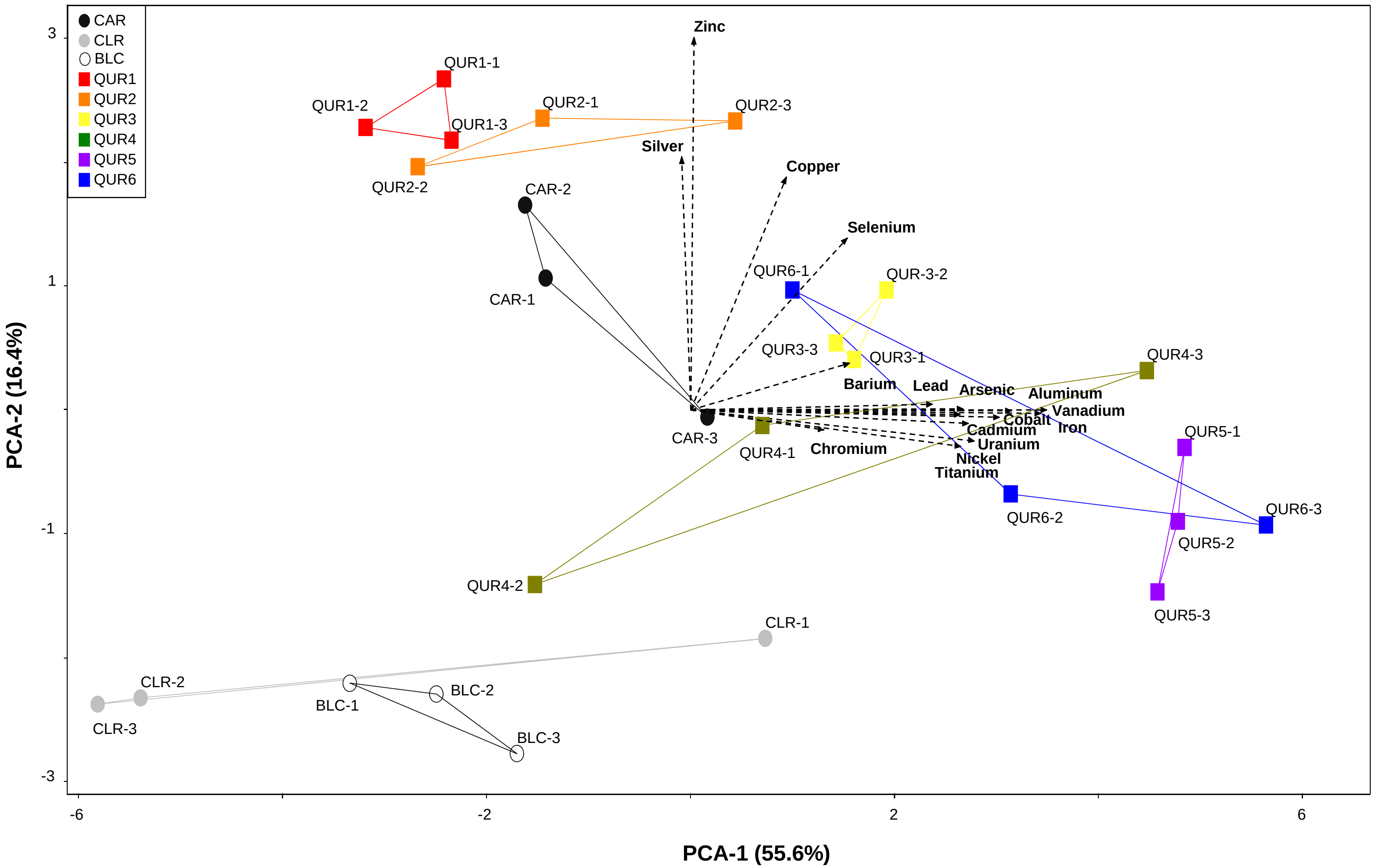


Figure 9.7: Principal Components Analysis biplot of whole benthic invertebrate community metal and metalloid tissue concentrations using three reference areas and six Quesnel River areas, 3 replicates taken at each area. Reference and Quesnel River areas area depicted by circles and squares, respectively. Displayed vectors have significant ($p < 0.05$) Spearman's Rank Correlation with either PCA axis 1 or 2 (Appendix Table I.17), vector length is proportional to correlation strength. Convex hulls connect replicates of each area. Mount Polley Mine, Quesnel River Study, October 2014.

Table 9.3: Summary of statistical assessment of whole benthic invertebrate community metal and metalloid tissue concentrations Mount Polley Mine, 2014. Magnitude of difference expressed as the number of reference standard deviations

Endpoint			Aluminum	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Nickel	Selenium	Silver	Strontium	Titanium	Uranium	Vanadium	Zinc
Difference with Reference Area CAR	Upstream	QUR1	-1.4	No	No	No	-4.8	-9.8	13.1	-3.6	-4.2	-1.3	-2.0	No	No	No	1.7	No	No	No
		QUR2	No	No	1.7	No	No	No	12.9	No	-3.3	No	-1.7	No	No	No	No	No	No	No
		QUR3	-3.5	3.1	3.1	No	3.3	12.7	18.1	No	-2.1	No	No	No	-3.8	No	12.1	No	-6.6	-1.4
	Downstream	QUR4	No	4.1	No	No	No	No	No	No	No	No	No	No	No	No	16.0	No	10.4	No
		QUR5	-3.5	5.0	2.0	15.2	No	28.6	9.0	5.6	No	No	1.9	No	-2.4	No	24.4	5.0	19.3	-2.0
		QUR6	2.9	3.6	No	10.5	No	22.5	9.4	No	No	No	No	No	-1.9	No	20.5	No	17.4	No
Difference with Reference Area CLR	Upstream	QUR1	No	2.8	No	No	No	No	5.1	No	No	No	No	1.4	7.9	No	No	No	No	3.8
		QUR2	No	8.6	32.9	No	No	No	5.1	No	1.8	1.8	No	No	5.9	No	No	No	No	3.7
		QUR3	No	10.4	55.4	2.8	No	No	6.3	No	3.3	3.9	1.3	1.4	-4.4	No	No	No	-0.7	2.0
	Downstream	QUR4	No	12.2	No	No	No	No	3.1	No	4.1	3.6	No	No	No	No	No	No	1.9	2.3
		QUR5	-0.7	14.1	38.7	18.7	No	No	4.1	2.4	6.2	4.5	2.5	1.8	No	No	No	1.5	3.2	1.5
		QUR6	1.8	11.3	32.3	13.4	No	No	4.2	2.2	5.3	3.5	2.1	1.7	3.3	No	No	No	3.0	1.7
Difference with Reference Area BLC	Upstream	QUR1	No	No	2.2	9.2	No	No	15.9	No	4.3	-5.4	-1.6	22.8	24.8	No	-1.5	11.0	No	0.0[a]
		QUR2	No	No	4.0	11.6	No	No	15.7	No	11.3	-4.7	No	24.8	19.6	No	No	19.1	No	0.0[a]
		QUR3	-2.5	1.8	5.6	28.2	No	5.3	20.0	3.3	20.1	-2.7	No	22.8	-7.5	No	2.7	37.0	-2.8	0.0[a]
	Downstream	QUR4	4.4	2.4	2.8	No	No	No	9.1	No	25.1	-2.9	No	No	No	No	No	58.3	3.0	No
		QUR5	-2.5	3.0	4.4	169.8	No	9.7	12.5	6.7	37.1	-2.1	1.5	26.8	6.9	No	7.6	106.8	6.0	0.0[a]
		QUR6	6.9	No	3.9	122.5	No	8.0	12.8	6.0	32.1	-3.0	No	26.0	12.7	No	6.0	61.8	5.3	No

(Shaded) Indicates a significant difference between reference and exposed area. Values indicate the magnitude of difference as the number of reference standard deviations.

[a] Reference area replicates all at MDL, therefore reference standard deviation is 0.

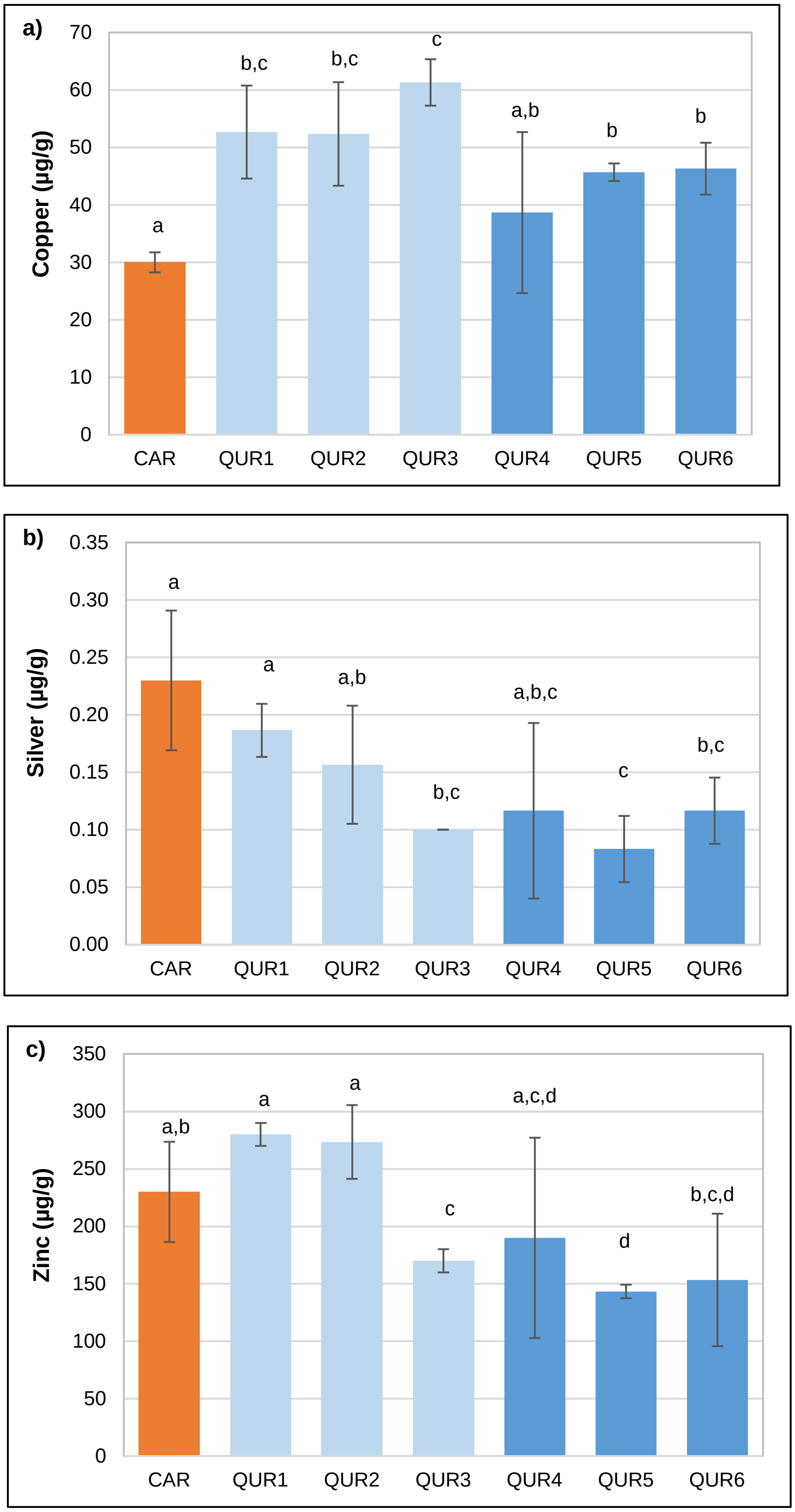


Figure 9.8: Concentrations of copper, silver and zinc in whole community benthic invertebrate tissue samples at six Quesnel River areas (blue) and one reference area CAR (orange), Mount Polley Mine, 2014.

Mean values are displayed and whiskers represent ± one standard deviation. Letters above whiskers identify statistical difference (i.e. areas that do not share a common letter are statistically different, no letter indicates non-significant ANOVA). Light and dark blue colouring represents upper and lower reaches of the Quesnel River, respectively.

along a high to low metals gradient consisting of aluminum, vanadium, iron, cobalt, uranium, nickel, arsenic, lead, barium, manganese and titanium (Figure 9.9). Principal component axis-2 separated areas along a high to low gradient of zinc, silver, selenium, cadmium and copper, which identified Quesnel River area replicate QUR6-1 as having higher concentrations of these metals and reference area BLC having lower concentrations of these metals relative to all other areas (Figure 9.9).

As with whole community tissue, determination of which analytes had elevated concentrations in Perlidae tissues involved identifying statistically significant differences among areas (Table 9.4 and Appendix Tables I.23-I.24; Appendix Figures I.16-I.17) and by comparing concentrations: 1) relative to reference area CAR; 2) within the Quesnel River upstream reach; 3) between Quesnel River upstream and downstream reaches; and 4) within the Quesnel River downstream reach. Of the metals identified in PCA, copper, selenium, silver, and zinc did not demonstrate significant differences and patterns among areas and therefore suggest no failure-related influence. Cadmium concentrations were significantly lower than the CAR reference at the two most upstream areas (QUR-1 and QUR-2) and higher downstream, also suggesting no failure-related influence.

9.4 Correlation Analysis

Correlation analysis was conducted between the benthic invertebrate community endpoints that differed among areas and 36 environmental variables. A total of 10 relationships were significant at a Bonferroni-adjusted p-level (Table 9.5). Total abundance and benthic community NMS axis-1 (Leptophlebidae mayflies, Perlidae and Nemouridae stoneflies, Chironomidae midges and Enchytraeidae worms in the positive; Ameletidae mayflies in the negative) were both positively correlated with whole community tissue metal PCA axis-2 (metals that distinguished Quesnel River upstream areas QUR1 and QUR2 including copper, selenium and silver), indicating increases in community abundance and positive NMS axis-1 values (community structure) with increasing concentrations of these metals (Table 9.5; Appendix Figure I.18). The same benthic invertebrate community endpoints were also positively correlated with periphyton thickness, indicating increased benthic abundance and relatively more of the above-noted taxa with greater periphyton thickness (indicating the benefit as a source of food and refuge). Percent Diptera (true flies) was also positively correlated with periphyton thickness (Table 9.5). The dipterans in this study are composed of the Athericidae, chironomidae, empididae, simulidae, and tipulidae; all are sessile organisms that would benefit from the refugia and food source of a thick periphyton mat.

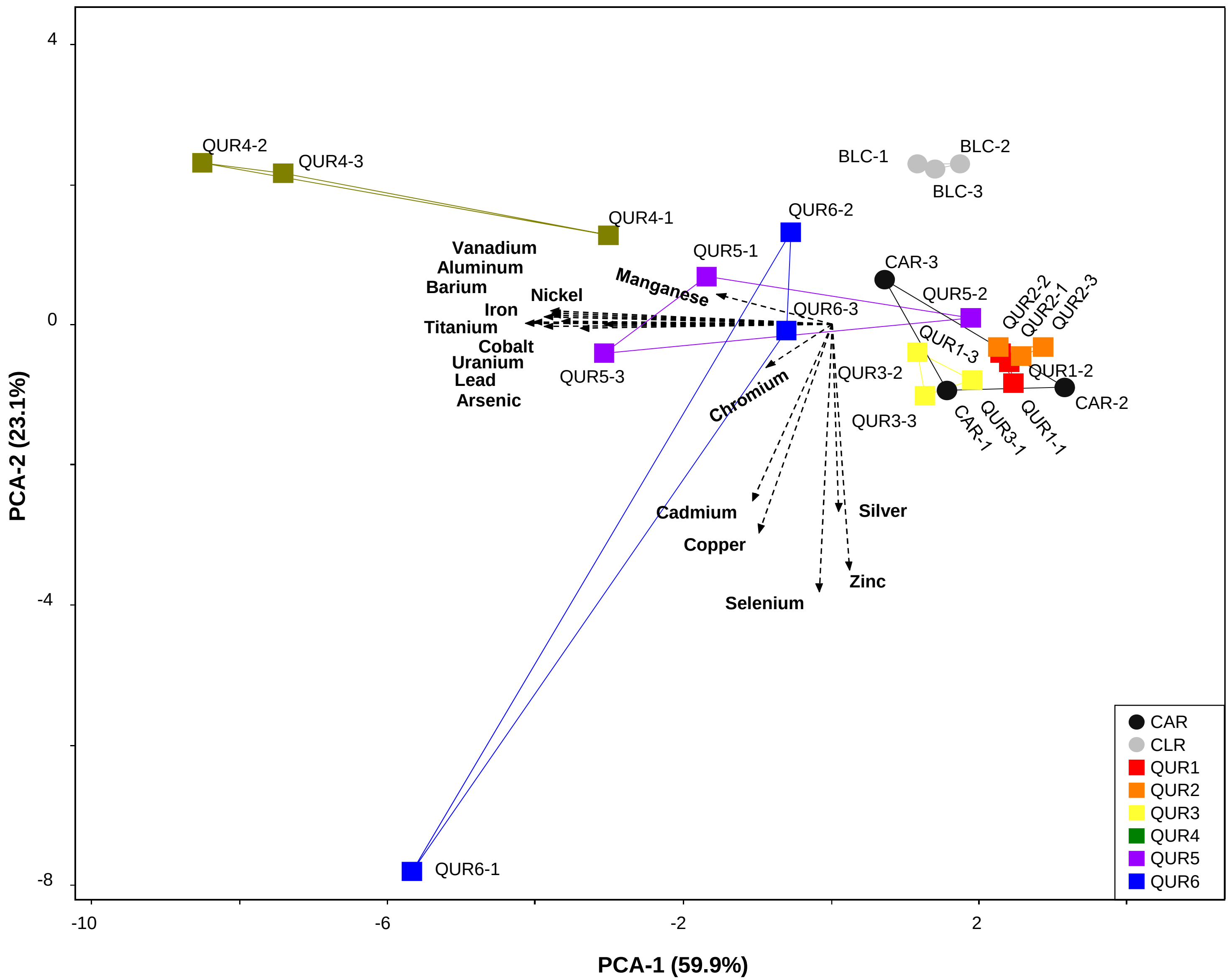


Figure 9.9: Principal Components Analysis biplot of Perlidae metal and metalloid tissue concentrations using two reference areas and six Quesnel River areas, 3 replicates taken at each area. Reference and Quesnel River areas area depicted by circles and squares, respectively. Displayed vectors have significant ($p < 0.05$) Spearman's Rank Correlation with either PCA axis 1 or 2 (Appendix Table I.22), vector length is proportional to correlation strength. Convex hulls connect replicates of each area. Mount Polley Mine, Quesnel River Study, October 2014.

Table 9.4: Summary of statistical assessment of Perlidae metal and metalloid tissue concentrations of Quesnel River areas with each reference area, Mount Polley Mine, 2014 (see Appendix I for all area comparisons). Magnitude of difference expressed as the number of reference standard deviations.

Endpoint			Aluminum	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Nickel	Selenium	Silver	Strontium	Titanium	Uranium	Vanadium	Zinc
Difference relative to the Cariboo River reference area (CAR)	Upstream	QUR1	No	No	No	-2.4	No	No	No	No	No	No	No	No	No	3.1	No	No	No	No
		QUR2	No	No	No	-1.8	No	No	No	No	No	No	-1.3	No	No	No	No	No	No	No
		QUR3	No	No	No	No	No	No	No	No	No	No	No	No	No	2.7	3.0	No	No	No
	Downstream	QUR4	5.9	10.3	5.5	No	No	7.3	No	8.3	2.0	2.8	7.0	No	No	9.6	35.6	5.9	153.9	No
		QUR5	No	No	No	3.7	No	No	No	No	No	No	No	No	No	2.7	9.2	No	No	No
		QUR6	No	No	No	No	3.0	No	No	3.8	No	No	7.0	No	No	No	13.2	No	12.0	No
Difference relative to the Blackwater Creek reference area (BLC)	Upstream	QUR1	-3.1	-2.4	-2.8	5.4	-	-6.8	No	-4.1	2.8	-6.2	-4.1	No	No	5.2	-3.7	No	-3.3	56.4
		QUR2	-4.1	-2.5	-2.9	10.6	-	-6.7	No	-4.6	No	-6.5	-4.7	No	No	No	-4.1	No	-4.0	50.6
		QUR3	No	No	No	33.3	No	No	No	No	10.5	-5.7	-2.6	No	No	4.4	No	2.9	No	49.3
	Downstream	QUR4	68.5	16.9	35.9	40.2	No	33.8	No	32.4	108.8	No	12.4	No	No	16.3	23.1	54.8	32.3	4.4
		QUR5	No	No	No	65.8	No	No	No	No	37.1	No	No	No	No	4.4	No	18.5	No	31.4
		QUR6	23.5	No	9.1	No	0.0[a]	No	No	14.6	43.8	-3.9	12.4	No	No	No	6.1	21.9	9.1	No

(shaded box) Indicates a significant difference between reference and exposed area. Values indicate the magnitude of difference as the number of reference standard deviations.

[a] Reference area replicates all at MDL, therefore reference standard deviation is 0.

Table 9.5: Spearman's Rank Correlation of benthic invertebrate endpoints found to be signicantly (p-value < 0.10) different among areas (ANOVA) with environmental variables. Mount Polley Mine, 2014

Variable Type	Environmental Variable	Statistic	Total Abundance	Richness	Evenness (Simpson's)	NMS-1	Ephemeroptera (%)	Plecoptera (%)	Coleoptera (%)	Diptera (%)	Arachnida (%)
Possible Anthropogenic Effect	cPCA1 - Whole Community Benthic Tissue, PCA Axis-1	r	-0.238	-0.446	-0.190	-0.238	0.762	0.333	-0.286	-0.619	-0.595
		p	0.570	0.268	0.651	0.570	0.028	0.420	0.493	0.102	0.120
	cPCA2 - Whole Community Benthic Tissue, PCA Axis-2	r	0.905	0.675	-0.500	0.905	-0.500	0.238	-0.095	0.833	0.095
		p	0.002	0.066	0.207	0.002	0.207	0.570	0.823	0.010	0.823
	pPCA1 - Perlidae Tissue, PCA Axis-1	r	0.893	0.909	-0.571	0.821	-0.536	-0.357	0.536	0.821	0.679
		p	0.007	0.005	0.180	0.023	0.215	0.432	0.215	0.023	0.094
	pPCA2 -Perlidae Tissue, PCA Axis-2	r	-0.464	-0.145	0.250	-0.036	-0.179	0.071	0.107	-0.429	-0.464
		p	0.294	0.756	0.589	0.939	0.702	0.879	0.819	0.337	0.294
	ConLab - Conductivity in Lab (µs/cm^{-1})	r	-0.171	-0.272	-0.049	-0.220	0.439	0.537	-0.195	-0.488	-0.464
		p	0.686	0.515	0.909	0.601	0.276	0.170	0.643	0.220	0.247
	Hard - Hardness	r	-0.240	-0.303	-0.048	-0.240	0.467	0.515	0.012	-0.623	-0.599
		p	0.568	0.466	0.910	0.568	0.243	0.192	0.978	0.099	0.117
	pHLab - pH in lab	r	0.491	0.267	-0.442	0.810	-0.209	0.086	-0.503	0.466	-0.209
		p	0.217	0.522	0.273	0.015	0.620	0.840	0.204	0.244	0.620
	TSS - Total Suspended Solids (mg/L)	r	-0.262	-0.530	0.286	-0.071	0.119	0.738	-0.119	-0.571	-0.929
		p	0.531	0.177	0.493	0.867	0.779	0.037	0.779	0.139	0.001
	TDS - Total Dissolved Solids (mg/L)	r	-0.627	-0.801	0.436	-0.464	0.436	0.491	-0.218	-0.873	-0.846
		p	0.096	0.017	0.280	0.247	0.280	0.217	0.604	0.005	0.008
	Turbidity (NTU)	r	-0.429	-0.578	0.095	-0.238	0.571	0.429	-0.429	-0.738	-0.762
		p	0.289	0.133	0.823	0.570	0.139	0.289	0.289	0.037	0.028
	Alkalinity, Total (as CaCO3)	r	0.156	0.000	-0.263	0.108	0.204	0.419	-0.491	0.036	-0.108
		p	0.713	1.000	0.528	0.799	0.629	0.301	0.217	0.933	0.799
	Fluoride (F)	r	0.571	0.349	-0.048	0.381	-0.524	-0.048	0.381	0.667	0.262
		p	0.139	0.396	0.911	0.352	0.183	0.911	0.352	0.071	0.531
	Nitrate (as N)	r	-0.762	-0.229	0.238	-0.786	0.405	-0.452	0.262	-0.643	0.286
		p	0.028	0.586	0.570	0.021	0.320	0.260	0.531	0.086	0.493
	Total Nitrogen (mg/L)	r	-0.599	-0.448	0.431	-0.419	0.084	-0.347	0.084	-0.419	-0.084
		p	0.117	0.265	0.286	0.301	0.844	0.399	0.844	0.301	0.844
	Total Phosphorus (mg/L)	r	-0.214	-0.627	0.310	-0.024	0.190	0.690	-0.310	-0.524	-0.976
		p	0.610	0.096	0.456	0.955	0.651	0.058	0.456	0.183	0.000
	SO4 - Sulfate	r	-0.238	-0.265	-0.190	-0.190	0.667	0.238	-0.238	-0.595	-0.476
		p	0.570	0.526	0.651	0.651	0.071	0.570	0.570	0.120	0.233
	DOC - Dissolved Organic Carbon (mg/L)	r	0.333	0.036	-0.238	0.571	-0.190	0.190	-0.333	0.310	-0.310
		p	0.420	0.932	0.570	0.139	0.651	0.651	0.420	0.456	0.456
	TwqPCA1 - Total Metals Water Quality PCA Axis-1	r	0.452	0.530	-0.048	0.262	-0.548	-0.452	0.310	0.762	0.738
		p	0.260	0.177	0.911	0.531	0.160	0.260	0.456	0.028	0.037
	TwqPCA2 - Total Metals Water Quality PCA Axis-2	r	0.048	0.277	-0.238	0.429	-0.238	0.238	-0.095	-0.024	-0.262
		p	0.911	0.506	0.570	0.289	0.570	0.570	0.823	0.955	0.531
	DwqPCA1 - Dissolved Water Quality PCA Axis-1	r	-0.357	-0.530	0.238	-0.167	0.310	0.595	-0.262	-0.667	-0.833
		p	0.385	0.177	0.570	0.693	0.456	0.120	0.531	0.071	0.010
	DwqPCA2 - Dissolved Water Quality PCA Axis-2	r	-0.167	-0.651	0.214	-0.095	0.405	0.619	-0.381	-0.524	-0.905
		p	0.693	0.081	0.610	0.823	0.320	0.102	0.352	0.183	0.002
	DOmg - Dissolved Oxygen (mg)	r	-0.310	-0.157	-0.167	-0.262	0.429	0.262	-0.310	-0.429	-0.143
		p	0.456	0.711	0.693	0.531	0.289	0.531	0.456	0.289	0.736
	DOp - Dissolved Oxygen (%)	r	0.357	0.398	-0.619	0.333	0.143	0.143	-0.286	0.262	0.167
		p	0.385	0.329	0.102	0.420	0.736	0.736	0.493	0.531	0.693
	ConField - Insitu Specific Conductance (µs/cm^{-1})	r	0.643	0.241	-0.357	0.381	0.071	0.381	-0.238	0.405	-0.048
		p	0.086	0.565	0.385	0.352	0.867	0.352	0.570	0.320	0.911
	pHField - Insitu pH	r	-0.120	-0.176	0.275	-0.144	-0.036	-0.455	-0.407	0.216	0.395
		p	0.778	0.677	0.509	0.734	0.933	0.257	0.317	0.608	0.333
Natural Environmental Variability	PeriP - Periphtyon Class	r	0.932	0.801	-0.562	0.932	-0.524	-0.064	0.038	0.932	0.294
		p	0.001	0.017	0.147	0.001	0.183	0.881	0.928	0.001	0.480
	Densiometer -% Canopy Cover	r	-0.381	-0.096	0.548	-0.143	-0.690	0.333	0.190	-0.095	-0.048
		p	0.352	0.820	0.160	0.736	0.058	0.420	0.651	0.823	0.911
	KickDistance	r	0.180	-0.036	0.467	0.359	-0.766	0.395	0.156	0.252	-0.359
		p	0.670	0.932	0.243	0.382	0.027	0.333	0.713	0.548	0.382
	VelAve - Average Water Velocity (m/s)	r	0.060	0.176	0.275	-0.180	-0.383	-0.132	0.826	0.132	0.263
		p	0.888	0.677	0.509	0.670	0.349	0.756	0.011	0.756	0.528
	CobAve - Average Cobble intermediate axis length (cm)	r	0.333	0.518	-0.500	0.024	0.000	-0.310	0.548	0.381	0.619
		p	0.420	0.188	0.207	0.955	1.000	0.456	0.160	0.352	0.102
	CobSD - Standard Deviation of Intermediate Axis length of Cobble	r	0.738	0.518	-0.476	0.405	-0.214	0.214	0.262	0.643	0.286
		p	0.037	0.188	0.233	0.320	0.610	0.610	0.531	0.086	0.493
	EmbedAve - Average Embeddedness of Cobble	r	-0.073	0.309	-0.512	-0.195	0.512	-0.878	0.293	-0.024	0.610
		p	0.863	0.457	0.194	0.643	0.194	0.004	0.482	0.954	0.108
	BankWid - Bankfull Width (m)	r	0.060	0.218	0.168	-0.323	-0.228	-0.156	0.371	0.275	0.659
		p	0.888	0.604	0.691	0.435	0.588	0.713	0.365	0.509	0.076
	WetWid - Wetted Width (m)	r	-0.810	-0.518	0.619	-0.905	0.143	0.048	0.190	-0.643	0.071
		p	0.015	0.188	0.102	0.002	0.736	0.911	0.651	0.086	0.867
	BaWeDep - Bank Depth Minus Wetted Depth (m)	r	-0.204	-0.588	0.443	0.000	-0.180	0.910	-0.287	-0.347	-0.874
		p	0.629	0.125	0.272	1.000	0.670	0.002	0.490	0.399	0.005
	Temp - Water Temperature (˚C)	r	0.595	0.253	-0.095	0.262	-0.357	0.357	0.119	0.595	0.190
		p	0.120	0.545	0.823	0.531	0.385	0.385	0.779	0.120	0.651

- identifies p-values less than 0.01.

- identifies p-values less than the Bonferroni corrected value of 0.0021.

Percent Arachnida (aquatic mites) was negatively correlated with total suspended solids, total phosphorus and dissolved metals PCA-2 (calcium and strontium, which were previously identified as IPs; Table 9.5). Lastly, two additional correlations with natural variables were evident – a negative correlation between NMS axis-1 and wetted width and a positive correlation between percent Plecoptera and bankfull depth minus wetted depth (river water height compared to full-water height; Table 9.5). Overall, there was some evidence of an association between benthic invertebrate density and community composition and benthic tissue concentrations of several failure-related analytes (copper, selenium and silver), however, the strongest correlations were between the relative proportion of a number of benthic organisms and periphyton thickness.

9.5 Data Integration and Summary

Water quality data collected concurrent with benthic invertebrate community and tissue samples did not indicate an influence of the tailings dam failure on water quality of the Quesnel River. In fact, concentrations of a number of POIs identified in previous sections of this report (Sections 5.0 to 8.0), including copper, were greater in the downstream areas of the Quesnel River than in the upstream areas. Benthic invertebrate community endpoints did not demonstrate impaired conditions in the Quesnel River. Benthic invertebrate abundance was higher upstream in the Quesnel River, but appeared not to be failure-related (rather, correlation analysis suggested that it may have been due to greater periphyton cover).

Some community composition differences among areas were apparent, but there were no patterns in the spatial distribution of sensitive versus tolerant organisms that were related to proximity to Quesnel Lake. In fact, metal sensitive organisms (e.g., mayflies, Tanytarsini and Diamesinae midges) were dominant throughout the Quesnel River. Three benthic invertebrate community composition endpoints: NMS axis-1, proportion of Diptera, and proportion of Arachnida were generally higher upstream in the Quesnel River (closer to Quesnel Lake) than downstream, but correlation analysis identified that, although some relationships with POIs and IPs were evident, the most likely cause of the differences was periphyton cover. Whole community samples of benthic invertebrate tissues had higher concentrations of copper, silver, selenium, strontium, and zinc than downstream, but differences among areas were generally small. These analytes have been identified as associated with the tailings dam failure (Section 5.0 to 8.0), but poor overall concordance with the full list of POIs and IPs and the absence of a spatial gradient in concentrations of these analytes suggests no influence of the tailings dam failure. In fact, several POIs and IPs (e.g., arsenic, cobalt, iron, nickel, titanium and vanadium) were present in benthic tissue at higher concentrations downstream in the Quesnel River than upstream. Metals in Perlidae (common stoneflies) provided poorer resolution of spatial differences in metal concentrations than the whole community samples.

10.0 INTEGRATED SUMMARY

This integrated summary provides the overall findings of the Mount Polley Mining Corporation (MPMC) Sediment Quality Impact Characterization, which characterized the impact of the Mount Polley tailings dam failure (August 4th 2014) on sediment quality of Polley Lake (Area 3), Hazeltine Creek (Area 4-7) and Quesnel Lake (Area 8). The characterization included basic sediment chemistry, sediment geochemistry (partitioning and leachability), sediment toxicity testing and benthic invertebrate community condition. An evaluation of benthic invertebrate community condition and benthic invertebrate tissue quality in the Quesnel River (Area 9) assisted in identifying the spatial extent of impact. This summary is presented in two sections, the first of which (Section 10.1) provides general findings associated with the entire study area, and the second of which (Section 10.2) provides slightly more detail by area.

10.1 General Findings

The physical impact of the dam failure on sediment quality was evident within the debris field in all areas (Hazeltine Creek, Polley Lake and Quesnel Lake) based on visible differences in sediment colour and/or texture relative to reference sediments as well as in very low concentrations of total organic carbon (approximately 0.5% or less at the most impacted locations).

Sediment chemical Parameters of Interest (POIs) were identified as parameters with concentrations in impacted areas of the receiving environment that exceeded sediment quality guidelines for the protection of aquatic life (SQGs) as well as reference and/or pre-event concentrations. Importantly, concentrations of a number of metals exceeded SQGs in reference areas and/or prior to the failure (arsenic, cadmium, chromium, copper, iron, manganese, mercury, nickel and selenium), indicating locally-elevated concentrations of these metals. POIs differed somewhat by area, but consistently included arsenic, copper and iron (Table 10.1). Manganese, nickel and zinc were also identified as POIs at one area each (Table 10.1). Copper and iron were the only POIs that occurred at concentrations greater than SQG probable effect levels (PELs), which indicate concentrations with a potential to adversely affect aquatic life. Copper and iron were also identified as key contaminants of potential concern based on examination of sediment quality data collected by the BCMoE (Azimuth 2014). Of the POIs, copper was identified as elevated through all sampling areas and was typically elevated to the greatest magnitude. As such, copper concentrations also served as an effective means of characterizing the spatial extent of the influence of the failure on receiving environment

Table 10.1: Weight of evidence data integration of Sediment Quality Impact Characterization, Mount Polley Mine, 2014.

Waterbody	Area	Sediment Chemistry					Toxicity Tests [2]				Benthic Invertebrate Community [3]	Waterbody weight of evidence summary description
		Basic Chemistry			Selective Extractions (Tessier)	Shakeflask and Porewater	*Hyalella azteca*		*Chironomus dilutus*			
		Parameters of Interest (POI)	Indicator Parameters (IP)	Description [1]			Survival	Growth	Survival	Growth		
Hazeltine Creek	Upper Creek (ST16)	Arsenic Copper Iron Nickel	Calcium Cobalt Molybdenum Phosphorus Silver Sodium Titanium Vanadium	Copper, iron >PEL; Arsenic >TEL	Most POIs in residual phase; Sum of exchangeable, carbonate, and easily reducible copper >TEL	Copper > acute BCWQG Selenium > chronic BCWQG	Moderately reduced (23%)	Highly reduced (8%)	Moderately reduced (40%)	No effect	-	A clear impact on sediment quality throughout Hazeltine Creek, with all areas characterized by low sediment total organic carbon (TOC), and copper and iron concentrations > PEL and pre-event concentrations. Copper was the analyte of greatest concern. No obvious spatial patterns in POIs were observed among areas, but toxicity results confirm adverse effects associated with low TOC and elevated concentrations of POIs, including exchangeable and organic copper.
	Mid Creek (ST09)			Copper, iron >PEL; Arsenic, nickel >TEL		No exceedances of BCWQG	No effect	No effect	Slightly reduced (68%)	No effect	-	
	Lower Creek (ST02)			Copper, iron >PEL; Arsenic, nickel >TEL		Copper > acute BCWQG	No effect	No effect	Slightly reduced (62%)	No effect	-	
	Lower Creek (HAC50)			Copper, iron >PEL; Arsenic >TEL	Most POIs in residual phase; Sum of exchangeable, carbonate, and easily reducible copper >PEL	Copper > chronic and acute BCWQG	Slightly reduced (70%)	Moderately reduced (41%)	Slightly reduced (80%)	Slightly reduced (63%)	-	
Polley Lake	Mid-depth, North (POL-1)	Arsenic Copper Iron Zinc	Calcium Molybdenum Sodium Strontium Tin Titanium	Copper >PEL; Arsenic, iron >TEL	Most POIs in residual phase; Sum of exchangeable, carbonate, and easily reducible POI phases do not exceed guidelines	Copper > chronic BCWQG; manganese > acute BCWQG and reference	No effect	No effect	No effect	No effect	Moderately reduced organism density (-2.9x reference SD); Slightly reduced taxon richness (-1.3x reference SD)	A clear impact on sediment quality detectable throughout Polley Lake, but more substantial at the south end. Sediment quality was characterized by copper concentrations > PEL and pre-event concentrations, and arsenic and iron concentrations > TEL. Copper was the analyte of greatest concern, and sediment stratigraphic assessment indicated a heterogenous intrusion of mine-derived material into the lake. An unequivocal impact on benthic community was observed in the south basin as well as reduced benthic density and taxon richness observed the north basin and within mid-depth areas; however, limited toxicity suggests that effects on benthic community were more associated with low dissolved oxygen and physical change (smothering and low sediment TOC) than sediment chemistry.
	Mid-depth, South (POL-2)			Copper >PEL; Arsenic, iron >TEL		Copper > acute BCWQG and reference	No effect	No effect	Slightly reduced (74%)	No effect	Moderately reduced organism density (-2.8x reference SD); Slightly reduced taxon richness (-1.7x reference SD)	
	Deep, North (P1)			Copper >PEL; Arsenic, iron, zinc >TEL		Copper > chronic BCWQG	No effect	No effect	No effect	No effect	Moderately reduced organism density (-2.3x reference SD); Moderately reduced taxon richness (-3.9x reference SD)	
	Deep, South (P2)			Copper >PEL; Arsenic, iron >TEL	Most POIs in residual phase; Sum of exchangeable, carbonate, and easily reducible copper >TEL	Copper > acute BCWQG	No effect	No effect	No effect	No effect	No benthic invertebrates present in samples, indicating a direct impact of dam breach	
Quesnel Lake Littoral	Near-field 1 (LNF1)	Arsenic Copper Iron Manganese (Nickel) [4]	Barium Calcium Mercury Molybdenum Selenium Silver Sodium Strontium Tin Vanadium	Copper, iron >PEL; Arsenic, manganese >TEL	Most POIs in residual phase; Sum of exchangeable, carbonate, and easily reducible copper >TEL	Copper > acute BCWQG and reference	No effect	No effect	No effect	Moderately reduced (34%)	No effect on organism density; highly reduced taxon richness (-6.0x reference SD)	A clear impact on sediment quality of Quesnel Lake which appeared to be restricted to near-field littoral areas. Sediment quality characterized by copper and iron concentrations > PEL and reference in near-field areas, and increasing TOC content with distance from the mouth of Hazeltine Creek. Copper was the analyte of greatest concern, and toxicity results confirm that adverse effects were limited to the near-field areas. Reduced taxon richness in near-field areas and negative relationships between benthic metrics and metal concentrations suggest mine-related effect on benthic community, although the relative influence of physical factors (smothering, low sediment TOC) versus chemical factors is unclear.
	Near-field 2 (LNF2)			Copper, iron >PEL; Arsenic, manganese >TEL		Copper, manganese > acute BCWQG and reference	No effect	No effect	No effect	No effect	No effect on organism density; moderately reduced taxon richness (-4.2x reference SD)	
	Far-field (LFF)			Iron, nickel >TEL	Most POIs in residual phase; Sum of exchangeable, carbonate, and easily reducible POI phases do not exceed guidelines	-	No effect	No effect	No effect	No effect	No effect on organism density; slightly increased taxon richness (+1.4x reference SD)	
	Far-far-field (LFFF)			Arsenic, copper, iron, nickel >TEL		-	No effect	No effect	No effect	No effect	No effect on organism density or taxon richness	
Quesnel Lake Profundal	Near-field (PNF)	Copper (Arsenic) [4] (Iron) [4] (Manganese) [4] (Nickel) [4]	Calcium Sodium Strontium Tin Vanadium	Copper >PEL; Arsenic, iron, manganese >TEL	Most POIs in residual phase; Sum of exchangeable, carbonate, and easily reducible copper >TEL	Copper > acute BCWQG and reference	Slightly reduced (80%)	No effect	Slightly reduced (71%)	Slightly reduced (59%)	Moderately reduced organism density (-3.6x reference SD); moderately reduced taxon richness (-4.0x reference SD)	A clear impact on the sediment quality of profundal areas of Quesnel Lake that covers a substantial distance (near and far-field), with sediment quality characterized by copper concentrations > PEL in near and far-field areas, and low TOC increasing with distance from Hazeltine Creek. Copper was the analyte of greatest concern and sediment stratigraphic assessment indicated very little vertical variation in sediment chemistry. Toxicity test responses were associated with low TOC and elevated copper selective extract concentrations, and confirm that effects were limited to the near and far-field areas. Reduced benthic invertebrate density and taxon richness associated with low dissolved oxygen, low TOC and higher sediment metal concentrations suggest a mine-related effect on benthic community although the relative influence of these physical and chemical factors is unclear.
	Far-field 2 (PFF2)			Copper >PEL; Arsenic, iron, manganese >TEL		Copper > acute BCWQG and reference	No effect	Moderately reduced (47%)	Slightly reduced (81%)	No effect	Moderately reduced organism density (-3.6x reference SD); highly reduced taxon richness (-5.8x reference SD)	
	Far-field 1 (PFF1)			Copper >PEL; Arsenic, iron, nickel, manganese >TEL		Copper > acute BCWQG and reference	No effect	No effect	Slightly reduced (61%)	No effect	Moderately reduced organism density (-3.6x reference SD); moderately reduced taxon richness (-4.6x reference SD)	
	Far-far-field (PFFF)			Arsenic, iron, manganese >PEL; Copper, nickel >TEL	Most POIs in residual phase; Sum of exchangeable, carbonate, and easily reducible manganese >PEL, nickel > TEL	Manganese > acute BCWQG and reference	No effect	No effect	No effect	No effect	Moderately reduced organism density (-3.4x reference SD); moderately reduced taxon richness (-2.9x reference SD)	

[1] PEL = Probable Effect Level of the British Columbia Sediment Quality Guidelines; TEL = Threshold Effect Level of the British Columbia Sediment Quality Guidelines

[2] Significant reductions in survival and growth are classed as highly reduced (<20% of control/reference result); moderately reduced (20-50% of control/reference result), or slightly reduced (> 50% of control/reference result). Results relative to control or reference are shown in parentheses and are relative to laboratory control results for Hazeltine Creek, and relative to the highest mean normalized reference result for all other waterbodies.

[3] Magnitude of significant differences in organism density(organisms/m^2) and taxon abundance relative to reference areas classed as highly reduced (< -5 SD), moderately reduced (-5 to -2 SD), and slightly reduced (> -2 SD), where SD is the standard deviation of the reference areas. Where significant differences existed with both reference areas for a given parameter, the greatest magnitude of difference is shown.

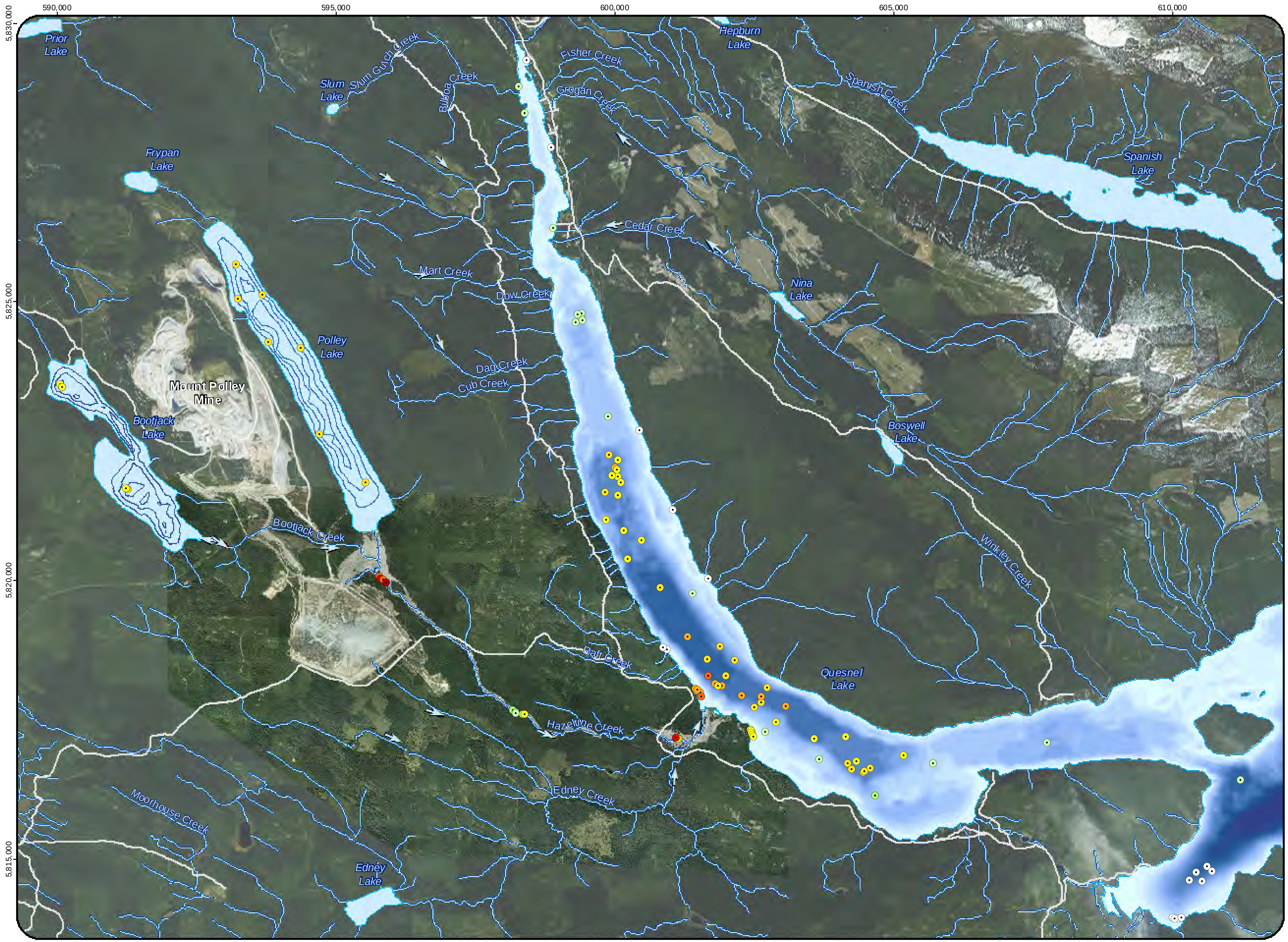
[4] Parameters not identified as POIs in this specific waterbody / dataset, but investigated due to designation as POIs in other study waterbodies

sediment quality (Figure 10.1). Several additional parameters were identified as Indicator Parameters (IPs; parameters with concentrations below SQGs or without SQGs, but with concentrations clearly influenced by the failure; Table 10.1) and served primarily to confirm the spatial extent of the influence of the failure on receiving environment sediment quality (e.g., Figure 10.2).

Geochemical evaluations identified that concentrations of most POIs were predominantly in the residual phase, which is not considered to be mobile. Exceptions were observed with copper, manganese and molybdenum. In failure-influenced sediments, greatest concentrations of copper and molybdenum were in the “organic” phase, which likely represents mineral forms (most likely chlorite [SRK 2015]; also not considered to be mobile). In several mine-influenced areas, concentrations of copper in exchangeable, carbonate and easily reducible forms were greater than reference, but separate geochemical evaluation (SRK 2015) concluded that copper mobility was limited. Partitioning of manganese also differed from most POIs. Manganese was in the residual form in most areas except for reference areas where it was in an easily reducible form, possibly representing surface enriched manganese oxides. These geochemical findings indicate that, although concentrations of several metals in sediment exceed provincial guidelines, copper and other associated metals may not be harmful to aquatic life.

Vertical patterns of sediment chemistry and sediment porewater chemistry in cores collected from areas of Polley and Quesnel lakes within the debris field indicated that sediments were generally oxidizing with the exception of interface areas (areas where event derived-materials touch native materials). In Polley Lake, there was evidence of heterogeneous intrusion of event-derived material; whereas in Quesnel Lake deep areas, sediment was vertically uniform and consistent with settling rather than intrusion. Some reduction-driven dissolution of iron oxides was evident in Polley Lake (but not Quesnel Lake), possibly due to greater heterogeneity in association with apparent intrusion. Although sediment diagenesis (chemical ageing) is a long-term process, early findings indicated that sediments were predominantly oxidizing, which suggests limited mobility of sediment-associated metals. This is consistent with separate evaluation of potential post-depositional mobility, which indicated very low risk of metal mobilization (SRK 2015).

Sediment toxicity testing indicated effects to both test organisms (the amphipod *Hyalella azteca* and the midge *Chironomus dilutus*) in Hazeltine Creek, Quesnel Lake near-field littoral areas and Quesnel Lake near-field and far-field profundal areas, as well as limited effects in Polley Lake, the Quesnel Lake littoral far-field and far-far-field areas and the Quesnel Lake profundal far-far-field area (Table 10.1). However, responses of the toxicity



Legend

Copper Concentration

- <50 mg/kg
- 50-200 mg/kg
- 200-350 mg/kg
- 350-500 mg/kg
- 500-650 mg/kg
- 650-800 mg/kg
- 800-950 mg/kg
- 950-1,100 mg/kg
- >1,100 mg/kg
- Bootjack Lake Bathymetry (5 m Intervals)
- Polley Lake Bathymetry (10 m Intervals)
- Road
- Waterbody
- Watercourse
- Water Flow Direction

Quesnel Lake Depth (m)

<0, 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, >200

Please note: Metal concentrations are based on the < 2mm fractions of sediment.

Quesnel Lake bathymetry data provided by Tetra Tech, 2014.

TETRA TECH

N W E S

0 1 2 3

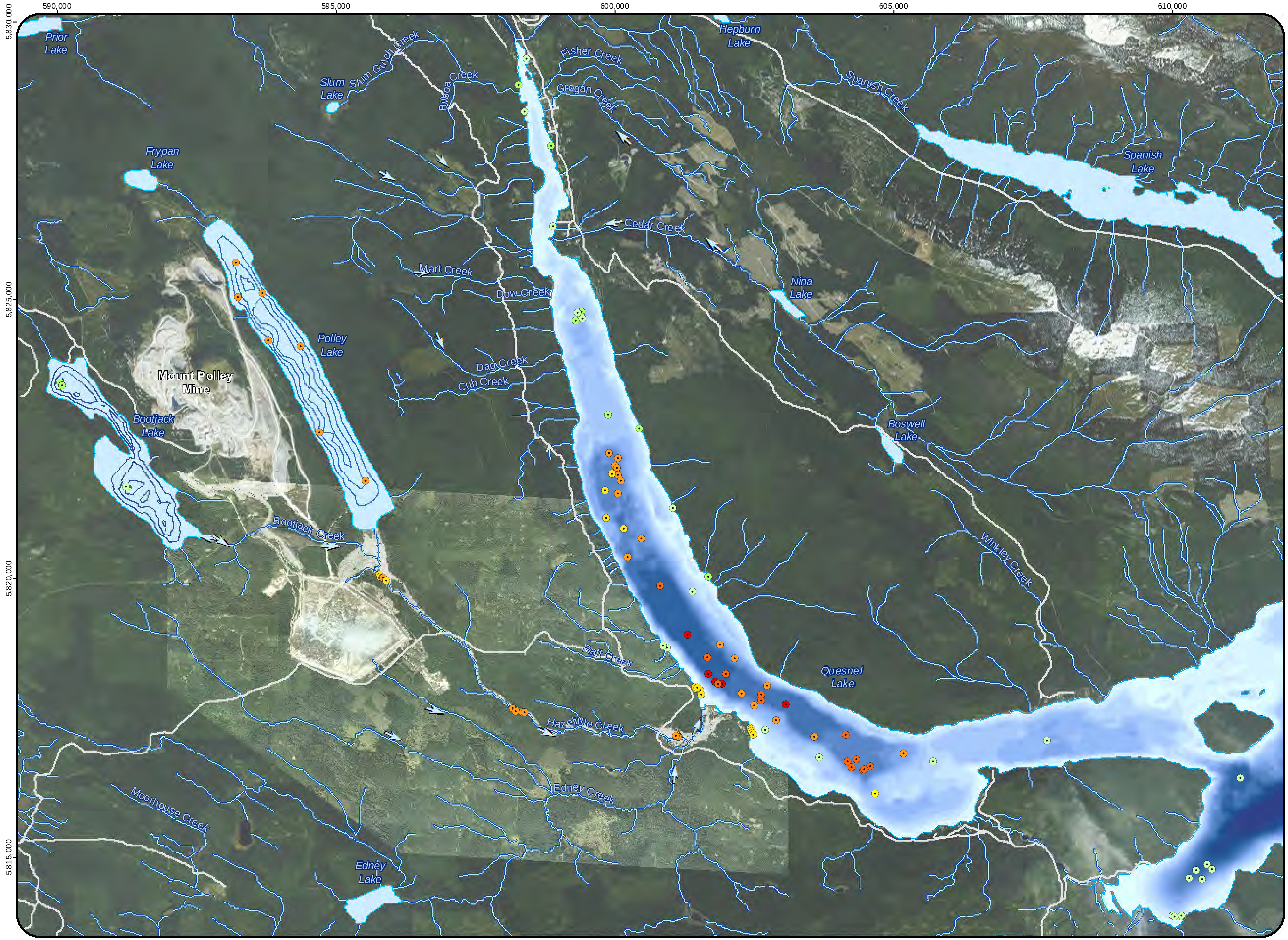
Kilometres

MAP INFORMATION
Datum: NAD 83 Map Projection: UTM Zone 10U
Data Source: Department of Natural Resources Canada. All rights reserved.
Created By: R. Sutherland
Creation Date: April 2015
Project No.: 2542

Figure 10.1: Spatial Distribution of Sediment Copper Concentrations in Quesnel Lake, Hazeltine Creek, Bootjack Lake and Polley Lake, 2014.

Created by:

minnow environmental inc.



Legend

Calcium Concentration

- <5,000 mg/kg
- 5,000-10,000 mg/kg
- 10,000-15,000 mg/kg
- 15,000-20,000 mg/kg
- 20,000-25,000 mg/kg
- 25,000-30,000 mg/kg
- 30,000-35,000 mg/kg
- >35,000 mg/kg
- Bootjack Lake Bathymetry (5 m Intervals)
- Polley Lake Bathymetry (10 m Intervals)
- Road
- Waterbody
- Watercourse
- Water Flow Direction

Quesnel Lake Depth (m)

<0, 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, >200

Please note: Metal concentrations are based on the < 2mm fractions of sediment.

Quesnel Lake bathymetry data provided by Tetra Tech, 2014.

TETRA TECH

N W E S

0 1 2 3

Kilometres

MAP INFORMATION
Datum: NAD 83 Map Projection: UTM Zone 10U
Data Source: Department of Natural Resources Canada; Esri. All rights reserved.
Created By: R. Sutherland
Creation Date: April 2015
Project No.: 2542

Figure 10.2: Spatial Distribution of Sediment Calcium Concentrations in Quesnel Lake, Hazeltine Creek, Bootjack Lake and Polley Lake, 2014.

Created by:

minnow environmental inc.

test organisms were generally quite modest (e.g., the lowest survival in Quesnel Lake beyond near-field areas was 84% for *H. azteca* and 58% for *C. dilutus*). Correlation analyses indicated some consistent relationships between survival or growth of toxicity test organisms and sediment physical and chemical variables. Specifically, there were consistent positive relationships between biological responses (survival and growth) and sediment total organic carbon, and consistent negative relationships between biological responses and concentrations of POIs and IPs, including selective copper extracts. This suggests an effect on test organism survival and growth associated with some combination of low TOC (i.e., inorganic failure-impacted sediments) and elevated POI concentrations, both of which are failure-related. The relative influence of the potential causes (low TOC and elevated POI concentrations) could not be resolved with the available data.

Benthic invertebrate community assessment indicated effects to benthic invertebrates in a number of areas, ranging from an absence of organisms (Polley Lake south basin and several stations at a far-field area in the Quesnel Lake profundal zone) to lower density and taxon richness (Hazeltine Creek, Polley Lake, Quesnel Lake littoral near-field areas, Quesnel Lake near- and far-field areas) to limited differences in community composition (Quesnel Lake littoral far- and far-far-field areas, Quesnel Lake profundal far-far-field area; Table 10.1). There were no failure-related effects to the Quesnel River benthic invertebrate community or tissue chemistry, suggesting that the spatial extent of effects associated with the dam failure lies within Quesnel Lake. Correlation analyses indicated some consistent relationships between benthic invertebrate community metrics and supporting habitat measures, sediment physical variables and chemical variables. Specifically, as also observed for the sediment toxicity data, there were consistent positive relationships between biological responses and sediment total organic carbon, and consistent negative relationships between biological responses and concentrations of POIs and IPs, including selective copper extracts. These relationships corroborate the findings of toxicity testing and suggest an effect associated with some combination of physical impact (e.g., smothering or unsuitable substrate condition), low TOC (i.e., inorganic failure-impacted sediments) and elevated POI concentrations. In Polley Lake and in Quesnel Lake deep areas, there were also consistent positive relationships with dissolved oxygen content and negative relationships with specific conductance. The relative influence of the potential causes (physical impact, low TOC, elevated POI concentrations/specific conductance and lower dissolved oxygen [deep areas only]) could not be resolved with the available data.

Overall, the MPMC tailings dam failure had a physical and chemical impact on sediment quality within the debris field in Polley Lake, Hazeltine Creek and Quesnel Lake, the former evident visually and in low TOC content and the latter most evident in elevated copper and iron, but also evident in moderately elevated concentrations of arsenic, manganese, nickel and zinc. Geochemical evaluation consistently indicated that most metals were predominantly in the residual form (associated with mineral matrices and not considered to be mobile or biologically available). Copper was a key exception, with most copper present in the “organic” phase which likely represents mineral forms and concentrations of copper in exchangeable, carbonate and easily reducible forms greater at impacted areas than reference. Separate geochemical evaluation (SRK 2015) indicated limited copper mobility. Sediment toxicity and benthic invertebrate community condition both indicated some failure-related effects. Responses, although often small in magnitude (even associated with samples representing the worst conditions such as those in Hazeltine Creek; Table 10.1), were evident in Hazeltine Creek as well as areas further from the sources but within the debris field (i.e., near-field areas of Polley and Quesnel littoral; near-field and far-field areas of Quesnel profundal). Examination of relationships between biological responses and sediment physical/chemical condition suggested that observed responses were related to physical disturbance, low TOC (i.e., inorganic failure-impacted sediments) and elevated POI concentrations. In deep areas of lakes, responses were also related to lower dissolved oxygen and higher specific conductance. The relative influence of the potential causes (physical disturbance, low TOC, low dissolved oxygen in deep lake areas, and elevated POI concentrations and specific conductance) could not be resolved with the available data. Evaluation of the spatial extent of the sediment quality impact indicated that the spatial extent remains within Quesnel Lake and is largest in the profundal zone (approximately 7.5 kilometers longitudinally).

The sediment quality impact characterization was designed and implemented as an initial response. There are a few remaining uncertainties, the most important of which are the relative influence of physical impact (e.g., smothering or unsuitable substrate condition), low total organic content, low dissolved oxygen (deep lakes area only) and elevated POI concentrations on sediment-associated biota, and the post-depositional chemical stability of newly deposited sediment in Polley and Quesnel lakes. In addition to focused monitoring of recovery, these uncertainties should be addressed.

10.2 Area-Specific Findings

Hazeltine Creek

The MPMC dam failure had an impact on sediment quality throughout Hazeltine Creek. Sediment collected from Hazeltine Creek following the dam failure had low TOC content (< 0.2%) and concentrations of copper and iron that were greater than SQG PELs and pre-event concentrations. Concentrations of arsenic and nickel were greater than SQG TELs at a subset of sample locations and only in <63 µm sediment (not <2.0 mm sediment). Copper was more substantially elevated than any other analyte, with mean concentrations up to five times the PEL and 15 times pre-event concentrations. Sediment geochemical evaluations indicated that, for most POIs and IPs, concentrations were mostly in the residual phase, a fraction that is not considered mobile or biologically available. However, calcium and copper were notable exceptions, with the majority calcium occurring in the carbonate phase and the majority of copper occurring in the "organic" phase, which likely represents mineral forms (most likely chlorite [SRK 2015]; also not considered to be mobile). Copper was also present in exchangeable, carbonate and easily reducible forms, but separate geochemical evaluation (SRK 2015) indicated limited mobility.

Sediment toxicity testing indicated some adverse effects to both test species (*H. azteca* and *C. dilutus*), but also indicated no effect at some combinations of endpoint (survival and growth) and location (e.g., no reduction in *H. azteca* survival and growth at the mid-stream area and no reduction in *C. dilutus* growth at three of four areas). Survival and growth of *C. dilutus* were weakly associated with concentrations of several POIs and IPs. Survival of *H. azteca* was positively correlated with percent fines and calcium, and growth of *H. azteca* was weakly associated percent fines and percent TOC in the positive direction, and with POIs and IPs (including exchangeable and organic copper) in the negative direction. These relationships suggest biological effects due to low TOC and elevated concentrations of failure-related metals.

Polley Lake

The MPMC dam failure had an impact on sediment quality of Polley Lake, most pronounced at the deepest sampling location on the south side of Polley Lake (nearest to the point of tailings dam failure). Sediment collected from Polley Lake following the dam failure was characterized by concentrations of copper greater than SQG PELs and pre-event concentrations, and concentrations of arsenic, iron, and zinc greater than TELs and pre-event concentrations. Copper concentrations at mid-depth areas were similar to pre-event concentrations, but concentrations in the deeper basins were higher than PELs and pre-event concentrations (approximately 3.6- and 2.4-times, respectively). Sediment geochemical evaluations indicated that, for most POIs and IPs, concentrations were mostly in the residual phase, a fraction that is not considered mobile. However, copper and molybdenum were notable exceptions, with the majority occurring in the “organic” phase, which likely represents mineral forms (most likely chlorite [SRK 2015]; also not considered to be mobile). Copper was also present in exchangeable, carbonate and easily reducible forms at concentrations greater than reference, but separate geochemical evaluation (SRK 2015) indicated limited mobility.

Sediment stratigraphy evaluation indicated that copper was elevated at the south basin at a depth of 6 to 10 cm below surface, indicating heterogeneous intrusion rather than surface influence (settling). Pore-water evaluation indicated some locally elevated metal concentrations at interfaces of mine-derived materials and native sediment. Failure-affected sediments were generally oxidizing, with sediment becoming more reducing with depth (sub-oxic but not sulphidic). Sediments were likely sufficiently reducing to drive reductive dissolution of iron oxides, but because mine-derived material is mostly mineral, this may not result in significant metal mobilization. Separate evaluation of potential post-depositional mobility indicated very low risk of metal mobilization (SRK 2015).

Sediment toxicity testing indicated no adverse effect to *H. azteca*, reduced survival of *C. dilutus* at one location (73% relative to the concurrent laboratory control at the south basin of Polley Lake; Station P2), and no effect on growth of *C. dilutus*. The benthic invertebrate community of Polley Lake had lower density and taxon richness than the reference lake (Bootjack Lake). Density and taxon richness were within the range documented in some baseline studies, but below those documented in 1999 (the only pre-event sampling with full taxonomic data available). There were no benthic organisms at the south basin of Polley Lake, indicating an impact. Benthic invertebrate community composition at the Polley Lake north basin differed dramatically from 1999, with greater proportional representation of oligochaetes and lower proportional representation of Chironomidae, whereas a similar difference was not observed at reference. As oligochaetes are pollution tolerant organisms, this suggests an impact to benthic invertebrate community composition.

Correlation analysis indicated few significant relationships between the toxicity tests results and sediment physical/chemical conditions, which is consistent with a limited biological response. Correlation analysis indicated significant relationships between several benthic invertebrate community endpoints and dissolved oxygen, specific conductance, sediment TOC content and sediment POI and IP concentrations – in general, there were indications that benthic invertebrate density and taxon richness decreased and Bray-Curtis index of dissimilarity increased with lower dissolved oxygen, lower TOC content and higher specific conductance and POI/IP concentrations, which suggests a potential failure-related effect on these metrics. A number of supporting benthic invertebrate community metrics (e.g., percent oligochaete worms and CA axes) showed similar relationships. Given the limited toxicity, the observed effects on the benthic invertebrate community were more likely due to low dissolved oxygen and physical factors (i.e., smothering and low TOC) than sediment chemistry.

Quesnel Littoral

The MPMC dam failure had an impact on sediment quality in the Quesnel Lake littoral zone, but it was spatially limited to the near-field areas (located in the debris field within approximately 1 km of the mouth of Hazeltine Creek). Sediment collected from littoral areas of Quesnel Lake following the dam failure was characterized by increasing TOC with distance from Hazeltine Creek, near-field concentrations of copper and iron greater than SQG PELs and reference concentrations, and near-field concentrations of arsenic and manganese greater than TELs and reference but lower than pre-event concentrations recorded in Hazeltine Creek. Sediment geochemical evaluations indicated that, for most POIs and IPs, concentrations were mostly in the residual phase, a fraction that is not considered mobile or biologically available. However, copper and molybdenum were notable exceptions, with the majority occurring in the “organic” phase, which likely represents mineral forms (most likely chlorite [SRK 2015]; also not considered to be mobile). Copper was also present in exchangeable, carbonate and easily reducible forms at concentrations greater than reference, but separate geochemical evaluation (SRK 2015) indicated limited mobility.

Sediment toxicity testing indicated no adverse effects to *H. azteca* and *C. dilutus* at near-field area 2, the far-field area and the far-far-field area, but sediments collected at near-field area 1 caused reduced survival and growth of *C. dilutus*. Benthic invertebrate community assessment indicated that the benthic invertebrate community of the Quesnel Lake littoral near-field areas (near-field area 1 and near-field area 2) had lower taxon richness than both reference areas. Nonetheless, community composition, although variable among areas, was not significantly different at the exposed areas relative to both references.

Correlation analysis indicated negative relationships between survival and growth of *H. azteca* and easily reducible copper and a negative relationship between survival of *C.*

dilutus and carbonate copper. Positive relationships to sediment TOC content were apparent for the same toxicity test endpoints. Correlation analysis also indicated a number of significant relationships between benthic invertebrate community metrics and sediment metal concentrations (including selective copper extracts) that suggest potential failure-related effects to density, taxon richness and community structure associated with low TOC and elevated concentrations of tailings dam failure-associated POIs and IPs. As the positive influence of TOC cannot be separated from potential negative effects due to elevated metal concentrations, it is uncertain whether the effects were physical (i.e., due to smothering or low TOC) or chemical.

Quesnel Profundal

The MPMC dam failure had an impact on sediment quality in the Quesnel Lake profundal zone that extends through the far-field areas and covers a substantial linear distance (on the order of 7.5 km longitudinally; see Figures 10.1 and 10.2). As also observed in the Quesnel Lake littoral areas, sediment total organic carbon content was low in exposed areas and increased to concentrations similar to reference with distance from the mouth of Hazeltine Creek. Sediment collected from exposed profundal areas of Quesnel Lake following the dam failure was characterized by concentrations of copper greater than the SQG PEL and reference concentrations, and by concentrations of a number of IPs (calcium, sodium, strontium and tin) that decreased with distance from the mouth of Hazeltine Creek. A number of additional metals were elevated to concentrations greater than SQG TELs and reference at the far-far-field area only (arsenic, cadmium, chromium, manganese and nickel), which suggests that their elevations were not failure-related. Sediment geochemical evaluations indicated that, for most POIs (including those identified on the basis of sediment quality data from Hazeltine Creek, Polley Lake and the Quesnel Lake littoral zone) and IPs, concentrations were mostly in the residual phase, a fraction that is not considered mobile or biologically available. However, copper and manganese were notable exceptions. The majority of copper occurred in the “organic” phase, which likely represents mineral forms (most likely chlorite [SRK 2015]; also not considered to be mobile). The majority of manganese at mine-influenced areas was in the residual form, but at reference areas was in easily reducible form, possibly representing surface enriched manganese oxides at reference areas. Copper was also present in exchangeable, carbonate and easily reducible forms at concentrations greater than reference, but separate geochemical evaluation (SRK 2015) indicated limited mobility.

Sediment stratigraphy evaluation indicated little vertical variation in sediment chemistry at a location within the debris field; only slightly higher concentrations of a number of failure-related metals in surficial sediments, possibly due to higher concentrations associated with the very fine particles that were last to settle out of the water column. Sediment and pore-water analysis indicated that sediments were under oxidizing conditions (there was no evidence of reducing conditions), and therefore, metals are likely to remain associated with particulates. Porewater metal concentrations did not mirror sediment concentrations and were relatively elevated at 3 to 7 cm sub-surface. Sediments were not fully compacted when the cores for sediment and pore-water chemistry were collected. Separate evaluation of potential post-depositional mobility indicated very low risk of metal mobilization (SRK 2015).

Sediment toxicity testing indicated an apparent effect on survival of *H. azteca* and on survival and growth of *C. dilutus* at the near-field area. Reduced growth of *H. azteca* was observed at the upstream far-field area (highlighted primarily due to a high growth rate in one laboratory control), and reduced survival (but not growth) of *C. dilutus* was observed at both far-field areas. Benthic invertebrate community assessment indicated that the benthic invertebrate community of the Quesnel Lake profundal zone (including reference areas) was composed of few organisms. The upstream far-field area was most substantially impacted; with no organisms present at four of five stations. Density of the near-field and far-field areas was particularly low (<50 organisms/m^2), and the upstream far-field area had significantly lower taxon richness than both reference areas. Community composition at the near-field and far-field areas differed significantly from both references; however, compositional differences between reference areas were as large as those between exposed and reference areas.

Correlation analysis indicated some positive relationships between biological endpoints (survival and growth of the toxicity test organisms and benthic invertebrate community endpoints) and dissolved oxygen (benthic community only) and sediment total organic carbon content, as well as negative relationships between the biological endpoints and specific conductance (benthic invertebrate community only) and concentrations of a number of POIs and IPs in sediment. The positive influence of dissolved oxygen and sediment TOC cannot be separated from potential negative effects due to elevated sediment metal concentrations (including copper in selective extracts), and it is therefore uncertain whether the effects were associated with dissolved oxygen, physical factors (i.e., due to smothering or low TOC) or sediment chemistry.

Quesnel River

Water quality data collected in the Quesnel River concurrent with benthic invertebrate community and tissue sampling did not indicate an influence of the tailings dam failure on water quality of the Quesnel River, which is consistent with the findings of a comprehensive evaluation of the impact of the tailings dam failure of receiving water quality (Golder 2015). In fact, concentrations of a number of POIs identified in Hazeltine Creek, Polley Lake and Quesnel Lake, were greater at the downstream areas of the Quesnel River than at the upstream areas (i.e., farther away from the mine).

Benthic invertebrate community endpoints did not indicate impaired conditions in the Quesnel River. Benthic invertebrate abundance was higher upstream in the Quesnel Rive than downstream, but appeared not to be failure-related, as correlation analysis suggested that it may have been due to greater periphyton cover. Some community composition differences among areas in the Quesnel River and reference rivers were apparent, but there were no patterns in the spatial distribution of sensitive versus tolerant organisms that were related to proximity to Quesnel Lake. In fact, metal sensitive organisms (e.g., mayflies, Tanytarsini and Diamesinae midges) were dominant throughout the Quesnel River. Three benthic invertebrate community composition endpoints: an ordination axis (non-metric multidimensional scaling axis-1), proportion of Diptera, and proportion of Arachnida were generally higher upstream in the Quesnel River (closer to Quesnel Lake) than downstream. Correlation analysis identified that, although some relationships with POIs and IPs were evident, the most likely cause of the differences was periphyton cover.

Whole benthic invertebrate community tissue samples had higher concentrations of copper, silver, selenium, strontium, and zinc upstream than downstream, but differences among areas were generally small. These analytes have been identified as associated with the tailings dam failure, but poor overall concordance with the full list of POIs and IPs and the absence of a spatial gradient in concentrations of these analytes in water suggests they may not be related to the tailings dam failure. In fact, several POIs and IPs (e.g., arsenic, cobalt, iron, nickel, titanium and vanadium) were present in benthic invertebrate tissue at higher concentrations downstream in the Quesnel River than upstream. Overall, this evaluation suggests that the spatial extent of biological impact associated with the MPMC dam failure did not extend to the Quesnel River.

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APPENDIX A

HISTORICAL DATA

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Table A.1: Raw sediment quality data for upper Hazeltine Creek, 1995-2013 [1].

Analyte	Units	1995 (W7) [2]								1996 (W7) [2,3]								1999 (W6) [4]					2007 (W7)				
		HKP (1996)								HKP (1997)								Beak (2000)					Minnow (2009)				
		Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Mean	Standard deviation	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Mean	Standard deviation	Rep 1	Rep 2	Rep 3	Mean	Standard deviation	UHC-1	UHC-2	UHC-3	Mean	Standard deviation
Physical Characteristics																											
Gravel (>2mm)	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.9			8.9	-	2.0	8.0	1.0	3.7	3.8
Sand (2.0mm - 0.063mm)	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	49			49	-	38	35	46	40	5.7
Silt (0.063mm - 4µm)	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31			31	-	46	43	41	43	2.5
Clay (<4µm)	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10			10	-	15	14	12	14	1.5
Total Organic Carbon	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.2			3.2	-	13	11	7.8	10.4	2.4
Metals																											
Aluminum	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12,000	13,000	10,000	11,700	1,500	14,400	14,300	16,500	15,100	1,200
Antimony	mg/kg	0.81	0.33	0.51	0.37	0.12	0.34	0.41	0.23	0.72	0.62	0.61	1.8	0.87	0.59	0.86	0.45	<0.2	<0.2	<0.2	<0.2	0	<10	<10	<10	-	-
Arsenic	mg/kg	18	6.9	3.7	25	11	2.7	11	8.6	6.8	3.2	4.1	17	5.6	5.1	7.0	5.1	2.5	3.0	3.2	2.9	0.4	<5.0	5.3	7.4	5.9	1.3
Barium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	110	110	84	101	15	115	104	156	125	27
Beryllium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.30	0.40	0.30	0.33	0.06	<0.50	<0.50	<0.50	-	-
Bismuth	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.2	<0.2	<0.2	<0.2	0	<20	<20	<20	<20	0
Boron	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.5	4.5	3.6	4.5	1.0	-	-	-	-	-
Cadmium	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0.4	0.3	0.5	2.6	0.1	0.5	0.73	0.93	0.10	0.10	0.10	0.1	0	<0.5	<0.5	<0.5	-	-
Calcium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9,470	8,910	10,600	9,700	860
Chromium	mg/kg	26	30	5	9	45	27	24	15	138	146	110	201	74	131	133	42	29	30	22	27	4.4	25	28	32	28.3	3.4
Cobalt	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.0	9.9	8.5	9.1	0.7	8.7	8.9	9.7	9.1	0.5
Copper	mg/kg	17	47	25	20	79	39	38	23	5,250	7,670	7,980	22,000	2,340	8,420	8,900	6,790	47	39	23	36.3	12.2	56	64	67	62	5.7
Iron	mg/kg	33,000	25,400	12,600	17,900	57,500	35,100	30,250	15,900	31,700	29,100	28,600	55,500	31,000	29,900	34,300	10,450	15,000	17,000	15,000	15,700	1,200	19,600	22,500	22,900	21,700	1,800
Lead	mg/kg	3	4	2	2	5	8	4	2	35	29	21	103	14	26	38	33	6.7	5.8	4.2	5.6	1.3	<30	<30	<30	-	-
Lithium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.4	12.6	14.8	13.3	1.3
Magnesium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5,520	5,780	6,430	5,900	470
Manganese	mg/kg	858	613	362	480	1,300	743	726	333	1,260	1,720	2,010	10,100	1,420	2,470	3,163	3,426	320	340	320	330	12	2,480	1,290	868	1,500	840
Mercury	mg/kg	0.025	0.046	0.046	0.051	0.11	0.047	0.053	0.027	0.088	0.047	0.066	0.092	0.07	0.092	0.076	0.018	<0.04	<0.04	<0.04	<0.04	0	0.11	0.12	0.13	0.12	0.009
Molybdenum	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.50	0.50	0.20	0.40	0.17	<4.0	<4.0	<4.0	-	-
Nickel	mg/kg	16	24	5.0	8.0	25	18	16	8.2	69	68	54	134	33	65	71	34	20	22	16	19	3.1	16	16	19	17	1.9
Phosphorus	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	860	970	1,160	997	152
Selenium	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0.6	0.4	0.6	1.4	0.5	0.5	0.67	0.37	<1.0	<1.0	<1.0	<1.0	0	<2.0	<2.0	<2.0	<2.0	0
Silver	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	<0.1	<0.1	<0.1	<0.1	0	<2.0	<2.0	<2.0	-	-
Sodium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	210	210	230	217	12
Strontium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	100	78	93	13	75	69	88	77	9.6
Thallium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.20	<0.20	<0.20	-	-	<1.0	<1.0	<1.0	-	-
Tin	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.7	0.6	0.7	0.67	0.06	<5.0	<5.0	<5.0	-	-
Titanium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	390	390	380	390	5.8	542	568	596	570	27
Uranium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.50	0.50	0.30	0.43	0.12	-	-	-	-	-
Vanadium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39	42	36	39	3.0	49.6	55.3	53.2	52.7	2.9
Zinc	mg/kg	41	53	33	29	82	51	48	19	1,010	1,610	1,580	7,880	455	2,130	2,444	2,724	51	46	35	44	8.2	50.7	57.6	53.8	54.0	3.5

[1] All values reported as < method detection limit (MDL) were used at the MDL value for calculation of summary statistics. If all reported values were < MDL, the mean is reported as < MDL.

[2] Concentrations reported in 1995 and 1996 were for the silt and clay (<63 µm) fraction only.

[3] Some unusually high sediment metal concentrations were reported for 1996 (HKP 1997) and are suspected errors.

[4] Particle fractions for these samples are as follow: gravel (>2mm), sand (2.0mm - 0.050mm), silt (0.050mm - 0.002mm), clay (<0.002mm).

[5] Summary statistics exclude data from 1996 (HKP 1997) due to suspected errors with this data.

(Shaded) Method detection limit (MDL) was > maximum reported detectable value (excluding 1996 data); value was omitted from calculation of summary statistics.

Table A.1: Raw sediment quality data for upper Hazeltine Creek, 1995-2013 [1].

Analyte	Units	2009 (W7)							2010 (W7)							2012 (W7 Pond)									
		Minnow (2011)							Minnow (2011)							Minnow (2013b)									
		Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Mean	Standard deviation	UH SED-1	UH SED-2	UH SED-3	UH SED-4	UH SED-5	Mean	Standard deviation	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Mean	Standard deviation
Physical Characteristics																									
Gravel (>2mm)	%	4.0	2.0	5.0	11	2.0	4.8	3.7	20	30	34	29	49	32	11	6.4	<0.10	<0.10	<0.10	1.8	-	-	-	1.7	2.7
Sand (2.0mm - 0.063mm)	%	45	50	76	58	62	58	12	38	63	59	65	50	55	11	39	11	19	14	22	-	-	-	21	11
Silt (0.063mm - 4µm)	%	38	39	16	27	30	30	9.4	34	5.0	6.7	5.4	0.8	10	13	47	76	71	76	66	-	-	-	67	12
Clay (<4µm)	%	13	9.0	4.0	4.0	5.0	7.0	3.9	8.3	1.8	0.8	0.5	0.7	2.4	3.3	7	12	10	9	10	-	-	-	10	1.8
Total Organic Carbon	%	7.5	8.4	7.4	7.5	8.7	7.9	0.6	7.4	0.6	0.5	0.5	0.5	1.9	3.1	8.3	12	11	13	13	10	13	10	11.3	1.7
Metals																									
Aluminum	mg/kg	-	-	-	-	-	-	-	13,900	10,200	9,220	8,120	9,710	10,200	2,190	-	-	-	11,000	14,100	14,500	13,800	14,100	13,500	1,420
Antimony	mg/kg	<10	<10	<10	<10	<10	-	-	0.37	0.26	0.26	0.18	0.21	0.26	0.07	-	-	-	0.25	0.26	0.22	0.22	0.23	0.24	0.02
Arsenic	mg/kg	5.8	<5.0	<5.0	<5.0	<5.0	5.2	0.4	6.3	5.2	5.4	3.4	4.2	4.9	1.1	-	-	-	3.3	3.8	3.6	3.5	3.7	3.6	0.2
Barium	mg/kg	117	127	83	98	97	104	18	107	68	55	47	67	69	23	-	-	-	80	103	107	97	95	96	10
Beryllium	mg/kg	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	0.38	0.26	0.25	0.20	0.22	0.26	0.07	-	-	-	0.29	0.37	0.35	0.36	0.33	0.34	0.03
Bismuth	mg/kg	-	-	-	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0
Boron	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	0.21	<0.1	<0.1	<0.1	<0.1	0.12	0.05	-	-	-	0.27	0.30	0.29	0.26	0.25	0.27	0.02
Calcium	mg/kg	-	-	-	-	-	-	-	9,000	6,070	5,290	5,140	6,180	6,340	1,560	-	-	-	11,400	11,500	11,000	12,000	9,550	11,100	930
Chromium	mg/kg	37	31	19	26	24	27	6.7	35	27	26	16	17	24.2	7.9	-	-	-	24	31	31	29	28	28.5	2.8
Cobalt	mg/kg	11	9.1	6.6	7.9	7.6	8.4	1.6	11	8.8	8.7	6.1	7.1	8.2	1.7	-	-	-	6.8	8.4	8.5	8.7	9.1	8.3	0.9
Copper	mg/kg	54	50	34	46	45	46	7.3	65	24	23	14	16	28	21	-	-	-	66	79	76	69	68	72	5.3
Iron	mg/kg	-	-	-	-	-	-	-	25,900	21,900	22,300	15,800	19,300	21,000	3,800	-	-	-	15,200	18,900	18,700	18,300	19,100	18,000	1,600
Lead	mg/kg	<30	<30	<30	<30	<30	-	-	5.3	3.4	3.4	2.8	3.0	3.6	1.0	-	-	-	4.9	5.3	5.5	5.1	4.9	5.1	0.3
Lithium	mg/kg	-	-	-	-	-	-	-	12.0	9.8	8.9	7.2	8.4	9.3	1.8	-	-	-	9.5	11.6	11.9	11.6	12.2	11.4	1.1
Magnesium	mg/kg	-	-	-	-	-	-	-	6,080	6,550	6,270	4,490	5,380	5,750	828	-	-	-	3,850	4,920	5,140	5,040	5,740	4,900	690
Manganese	mg/kg	-	-	-	-	-	-	-	708	426	743	423	479	556	157	-	-	-	817	895	772	638	445	713	177
Mercury	mg/kg	0.10	0.10	0.06	0.10	0.09	0.089	0.015	0.095	<0.050	0.078	<0.050	<0.050	0.065	0.021	-	-	-	-	-	-	-	-	-	-
Molybdenum	mg/kg	<4.0	<4.0	<4.0	<4.0	<4.0	-	-	1.6	<0.50	<0.50	<0.50	<0.50	0.71	0.47	-	-	-	1.0	1.1	0.94	0.83	1.1	0.99	0.11
Nickel	mg/kg	25	19	12	16	15	18	4.9	21	16	15	9.5	11	14	4.5	-	-	-	16	20	20	19	19	19	1.7
Phosphorus	mg/kg	-	-	-	-	-	-	-	978	777	744	614	729	768	132	-	-	-	940	996	1,080	1,050	1,050	1,020	56
Potassium	mg/kg	-	-	-	-	-	-	-	930	470	350	290	380	480	260	-	-	-	760	930	980	880	940	900	85
Selenium	mg/kg	0.54	0.79	1.1	0.60	0.77	0.77	0.23	1.8	0.29	0.28	0.26	0.33	0.59	0.67	2.1	3.3	3.5	2.8	2.9	2.3	2.2	2.1	2.6	0.56
Silver	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	-	-	-	0.11	0.12	0.12	0.11	0.10	0.11	0.01
Sodium	mg/kg	-	-	-	-	-	-	-	440	490	310	190	170	320	140	-	-	-	350	190	210	220	180	230	69
Strontium	mg/kg	-	-	-	-	-	-	-	92	47	46	35	60	56	22	-	-	-	93	101	101	97	91	97	4.4
Thallium	mg/kg	-	-	-	-	-	-	-	0.064	<0.050	<0.050	<0.050	<0.050	0.053	0.006	-	-	-	0.059	0.073	0.074	0.073	0.072	0.070	0.006
Tin	mg/kg	<5.0	<5.0	<5.0	<5.0	<5.0	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	-	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	-	-
Titanium	mg/kg	-	-	-	-	-	-	-	738	785	724	721	819	757	42.9	-	-	-	382	462	457	509	581	478	73.3
Uranium	mg/kg	-	-	-	-	-	-	-	0.76	0.38	0.35	0.34	0.37	0.44	0.18	-	-	-	0.80	0.87	0.82	0.82	0.85	0.83	0.03
Vanadium	mg/kg	63.4	58.3	49.8	56.1	51.9	55.9	5.4	75.4	65.4	66.6	47.6	57.0	62.4	11	-	-	-	37.6	45.7	45.1	46.5	51.9	45.4	5.1
Zinc	mg/kg	54.6	46.6	43.8	51.6	51.2	49.6	4.3	66.0	40.4	41.5	35.1	40.0	44.6	12	-	-	-	46.2	56.8	58.1	54.7	56.4	54.4	4.8

[1] All values reported as < method detection limit (MDL) were used at the MDL value for calculation of summary statistics. If all reported values were < MDL, the mean is reported as < MDL.

[2] Concentrations reported in 1995 and 1996 were for the silt and clay (<63 µm) fraction only.

[3] Some unusually high sediment metal concentrations were reported for 1996 (HKP 1997) and are suspected errors.

[4] Particle fractions for these samples are as follow: gravel (>2mm), sand (2.0mm - 0.050mm), silt (0.050mm - 0.002mm), clay (<0.002mm).

[5] Summary statistics exclude data from 1996 (HKP 1997) due to suspected errors with this data.

(Shaded cell) Method detection limit (MDL) was > maximum reported detectable value (excluding 1996 data); value was omitted from calculation of summary statistics.

Table A.1: Raw sediment quality data for upper Hazeltine Creek, 1995-2013 [1].

Analyte	Units	2013S (W7)										2013S (W7 Pond)									
		Minnow (2013c)										Minnow (2013c)									
		Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Mean	Standard deviation	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Mean	Standard deviation
Physical Characteristics																					
Gravel (>2mm)	%	0.4								0.4	-	0.2								0.2	-
Sand (2.0mm - 0.063mm)	%	20								20	-	23								23	-
Silt (0.063mm - 4µm)	%	71								71	-	68								68	-
Clay (<4µm)	%	8.1								8.1	-	8.9								8.9	-
Total Organic Carbon	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals																					
Aluminum	mg/kg	14,500	15,400	13,900	17,300	16,200	16,000	14,900	14,200	15,300	1,200	15,100	15,500	16,600	13,700	16,300	15,400	16,500	14,700	15,500	990
Antimony	mg/kg	0.26	0.29	0.29	0.30	0.31	0.32	0.31	0.29	0.30	0.02	0.27	0.27	0.30	0.27	0.32	0.31	0.32	0.30	0.30	0.02
Arsenic	mg/kg	4.1	4.6	3.8	5.8	5.0	4.9	4.6	4.3	4.6	0.6	3.9	4.2	4.1	3.9	4.6	4.5	4.7	4.2	4.3	0.3
Barium	mg/kg	109	121	104	133	130	123	111	114	118	10	116	124	118	109	127	120	131	118	120	6.9
Beryllium	mg/kg	0.33	0.37	0.35	0.45	0.41	0.38	0.37	0.36	0.38	0.04	0.40	0.41	0.42	0.36	0.43	0.40	0.44	0.40	0.41	0.02
Bismuth	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0
Boron	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	mg/kg	0.31	0.34	0.25	0.35	0.43	0.35	0.29	0.30	0.33	0.05	0.33	0.34	0.35	0.28	0.32	0.32	0.32	0.29	0.32	0.02
Calcium	mg/kg	10,700	13,400	10,600	13,300	13,800	12,600	11,000	11,400	12,100	1,300	11,300	13,300	11,300	10,800	12,200	11,600	13,300	11,800	12,000	927
Chromium	mg/kg	29	30	28	34	32	33	32	29	31	2.0	31	33	35	28	34	32	34	31	32	2.1
Cobalt	mg/kg	8.3	9.1	8.3	11	9.4	9.7	9.1	8.6	9.1	0.7	8.8	9.2	9.2	8.0	9.3	8.7	9.5	8.5	8.9	0.5
Copper	mg/kg	77	84	62	91	86	79	72	70	78	9.5	86	89	92	72	87	84	86	77	84	6.7
Iron	mg/kg	18,500	21,100	17,600	23,700	20,100	19,800	18,900	17,900	19,700	2,000	18,700	19,100	20,000	16,900	20,200	18,900	20,600	18,100	19,100	1,210
Lead	mg/kg	5.8	6.1	5.1	6.3	6.0	5.9	5.6	5.3	5.8	0.4	6.0	6.1	6.2	5.0	6.1	5.7	6.3	5.6	5.9	0.4
Lithium	mg/kg	10.8	12.2	12.2	14.4	14.1	12.8	12.5	12.1	12.6	1.2	12.9	13.2	14.2	12.1	13.6	13.6	14.7	12.7	13.4	0.8
Magnesium	mg/kg	4,790	5,170	4,930	5,750	5,300	5,340	5,010	5,000	5,160	302	5,060	5,500	5,500	4,520	5,390	5,350	5,570	4,990	5,240	357
Manganese	mg/kg	1,210	1,330	992	1,360	1,580	1,300	1,030	1,070	1,230	199	873	979	662	1,050	1,190	910	1,230	1,050	990	182
Mercury	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum	mg/kg	1.2	1.4	0.9	1.5	1.6	1.2	1.0	1.1	1.2	0.23	1.3	1.5	1.3	1.0	1.3	1.2	1.2	1.1	1.2	0.14
Nickel	mg/kg	20	20	18	23	22	21	20	19	20	1.7	20	21	22	18	21	20	22	19	20	1.3
Phosphorus	mg/kg	1,150	1,290	1,040	1,470	1,280	1,160	1,110	1,090	1,200	140	1,140	1,310	1,120	1,000	1,260	1,070	1,250	1,160	1,160	104
Potassium	mg/kg	870	950	820	1,300	1,070	1,070	990	850	990	157	900	970	1,050	930	1,060	970	1,080	940	988	67
Selenium	mg/kg	2.8	3.3	2.1	3.1	3.2	2.8	2.4	2.5	2.7	0.42	3.1	3.0	3.2	2.7	3.2	2.9	3.1	2.7	3.0	0.20
Silver	mg/kg	0.12	0.14	0.12	0.16	0.16	0.15	0.12	0.11	0.14	0.02	0.15	0.14	0.15	0.11	0.15	0.14	0.22	0.14	0.15	0.03
Sodium	mg/kg	190	200	190	220	200	230	200	190	200	15	190	210	190	180	200	200	220	200	199	12
Strontium	mg/kg	99	111	98	119	118	113	103	107	109	8.1	105	109	107	104	117	113	125	112	112	7.0
Thallium	mg/kg	0.067	0.075	0.062	0.086	0.089	0.076	0.076	0.067	0.075	0.009	0.078	0.071	0.080	0.068	0.082	0.078	0.080	0.069	0.076	0.006
Tin	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	-	-
Titanium	mg/kg	461	466	589	553	516	610	604	570	546	59.1	454	440	547	522	575	570	592	531	529	55.7
Uranium	mg/kg	1.1	1.2	1.0	1.2	1.4	1.2	1.0	1.1	1.2	0.13	1.1	1.1	1.1	1.0	1.3	1.1	1.3	1.1	1.12	0.09
Vanadium	mg/kg	45.7	49.3	47.4	53.4	50.0	52.8	52.1	48.6	49.9	2.7	47.9	49.2	51.3	45.5	53.2	51.0	54.2	49.0	50.2	2.8
Zinc	mg/kg	56.9	63.1	56.2	70.7	66.8	66.1	62.6	59.0	62.7	5.1	62.2	65.2	66.0	54.4	64.8	59.5	66.0	58.6	62.1	4.2

[1] All values reported as < method detection limit (MDL) were used at the MDL value for calculation of summary statistics. If all reported values were < MDL, the mean is repc

[2] Concentrations reported in 1995 and 1996 were for the silt and clay (<63 µm) fraction only.

[3] Some unusually high sediment metal concentrations were reported for 1996 (HKP 1997) and are suspected errors.

[4] Particle fractions for these samples are as follow: gravel (>2mm), sand (2.0mm - 0.050mm), silt (0.050mm - 0.002mm), clay (<0.002mm).

[5] Summary statistics exclude data from 1996 (HKP 1997) due to suspected errors with this data.

[shaded cell] Method detection limit (MDL) was > maximum reported detectable value (excluding 1996 data); value was omitted from calculation of summary statistics.

Table A.1: Raw sediment quality data for upper Hazeltine Creek, 1995-2013 [1].

Analyte	Units	2013F (USW7 Pond) Minnow (2013c)							2013F (W7 Pond) Minnow (2013c)										Summary Statistics [5]		
		Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Mean	Standard deviation	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Mean	Standard deviation	Mean	95th Percentile	Maximum
Physical Characteristics																					
Gravel (>2mm)	%	0.9					0.9	-	<0.10								<0.10	-	9.4	33	49
Sand (2.0mm - 0.063mm)	%	24					24	-	13								13	-	40	65	76
Silt (0.063mm - 4µm)	%	64					64	-	75								75	-	43	76	76
Clay (<4µm)	%	11					11	-	13								13	-	8.1	14	15
Total Organic Carbon	%	7.6	7.0	8.7	7.9	6.9	7.6	0.7	12	11	12	12	11	9	12	11	11.2	1.1	8.6	12.8	13.1
Metals																					
Aluminum	mg/kg	14,400	17,400	16,100	17,200	17,500	16,500	1,310	19,000	17,800	17,300	16,000	18,200	18,000	17,200	17,100	17,600	890	14,900	18,000	19,000
Antimony	mg/kg	0.27	0.29	0.29	0.27	0.27	0.28	0.01	0.31	0.31	0.30	0.31	0.30	0.30	0.29	0.27	0.30	0.01	0.29	0.37	0.81
Arsenic	mg/kg	3.1	3.3	3.3	3.2	2.9	3.2	0.2	3.9	4.1	3.6	4.2	3.9	3.9	4.1	4.0	4.0	0.2	5.0	8.2	25
Barium	mg/kg	106	122	120	121	98	113	11	145	138	133	127	132	125	132	127	132	6.6	111	136	156
Beryllium	mg/kg	0.36	0.44	0.41	0.42	0.39	0.40	0.03	0.46	0.46	0.46	0.41	0.43	0.43	0.43	0.40	0.44	0.02	0.38	0.46	0.46
Bismuth	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	1.5	16	20
Boron	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	5.4	5.5
Cadmium	mg/kg	0.21	0.22	0.20	0.21	0.19	0.21	0.01	0.36	0.34	0.34	0.32	0.32	0.30	0.35	0.30	0.33	0.02	0.24	0.35	0.43
Calcium	mg/kg	9,600	9,700	10,600	9,700	34,500	14,800	11,000	13,000	12,300	12,300	11,700	11,600	13,100	12,400	12,200	12,300	534	11,500	13,400	34,500
Chromium	mg/kg	36	41	39	40	35	38	2.8	41	38	37	34	39	37	36	36	37	2.0	30	40	45
Cobalt	mg/kg	9.2	10	9.5	9.8	10	9.7	0.5	10	9.5	9.6	9.2	9.6	9.4	9.1	8.8	9.4	0.4	9.0	10	11
Copper	mg/kg	77	91	82	91	67	82	10	103	91	95	94	96	89	88	87	93	5.3	66	95	103
Iron	mg/kg	20,400	24,000	22,000	24,200	26,800	23,500	2,420	23,400	22,200	22,000	19,800	22,000	21,400	21,400	20,100	21,500	1,160	21,300	29,900	57,500
Lead	mg/kg	5.7	6.5	6.2	6.6	5.2	6.0	0.6	6.9	6.4	6.7	6.4	6.6	6.4	6.3	5.9	6.4	0.3	5.4	6.7	8.0
Lithium	mg/kg	11.6	14.4	13.2	13.5	13.4	13.2	1.0	15.3	14.5	14.8	13.1	14.3	13.8	13.7	12.5	14.0	0.9	12.6	14.8	15.3
Magnesium	mg/kg	5,730	6,420	5,990	6,330	6,930	6,280	456	6,390	5,990	5,920	5,560	6,190	6,060	5,690	5,640	5,930	287	5,550	6,430	6,930
Manganese	mg/kg	343	295	361	351	355	341	27	616	716	593	458	564	552	783	605	611	100	1,050	1,350	2,480
Mercury	mg/kg	0.092	0.10	0.093	0.10	0.079	0.093	0.008	0.15	0.14	0.15	0.14	0.14	0.14	0.14	0.14	0.14	0.006	0.091	0.14	0.15
Molybdenum	mg/kg	0.93	1.0	1.1	1.0	0.89	1.0	0.09	1.1	1.1	1.1	1.5	1.0	1.0	1.1	1.1	1.1	0.17	1.0	1.5	1.6
Nickel	mg/kg	21	24	23	24	21	23	1.5	25	23	24	22	24	23	23	22	23	1.1	19	24	25
Phosphorus	mg/kg	1,150	1,370	1,290	1,250	1,040	1,220	128	1,420	1,330	1,350	1,170	1,330	1,300	1,230	1,100	1,280	105	1,130	1,380	1,470
Potassium	mg/kg	1,090	1,450	1,340	1,480	1,110	1,290	185	1,470	1,320	1,250	1,070	1,310	1,330	1,220	1,250	1,280	114	1,010	1,450	1,480
Selenium	mg/kg	1.7	1.9	2.2	2.0	1.2	1.8	0.36	3.4	2.9	3.4	3.3	3.0	2.9	3.3	3.1	3.1	0.20	2.0	3.3	3.5
Silver	mg/kg	0.11	0.12	0.11	0.12	<0.10	0.11	0.01	0.16	0.15	0.16	0.16	0.17	0.15	0.14	0.13	0.15	0.01	0.13	0.16	0.22
Sodium	mg/kg	240	250	280	280	350	280	43	260	240	230	210	300	290	230	310	260	37	240	350	490
Strontium	mg/kg	95	96	103	99	111	101	6.6	114	111	112	106	109	105	112	100	109	4.8	98	118	125
Thallium	mg/kg	0.073	0.085	0.075	0.083	0.061	0.075	0.010	0.098	0.094	0.089	0.083	0.095	0.093	0.090	0.085	0.091	0.005	0.075	0.094	0.098
Tin	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	-	-	0.67	0.70	0.70
Titanium	mg/kg	553	704	680	638	962	707	153	583	577	502	455	603	651	595	595	570	62	572	776	962
Uranium	mg/kg	0.65	0.70	0.80	0.71	0.65	0.70	0.06	1.1	1.0	1.1	1.1	1.0	1.0	1.1	1.0	1.0	0.04	0.9	1.3	1.4
Vanadium	mg/kg	51.4	58.1	56.2	55.6	65.1	57.3	5.0	55.7	55.0	52.6	50.5	54.6	55.5	51.9	52.2	53.5	1.9	52.2	65.3	75.4
Zinc	mg/kg	53.4	58.4	55.3	59.1	55.4	56.3	2.4	70.1	64.4	64.3	62.5	64.7	62.7	62.0	60.8	63.9	2.8	55.7	67.6	82.0

[1] All values reported as < method detection limit (MDL) were used at the MDL value for calculation of summary statistics. If all reported values were < MDL, the mean is reported as < MDL.

[2] Concentrations reported in 1995 and 1996 were for the silt and clay (<63 µm) fraction only.

[3] Some unusually high sediment metal concentrations were reported for 1996 (HKP 1997) and are suspected errors.

[4] Particle fractions for these samples are as follow: gravel (>2mm), sand (2.0mm - 0.050mm), silt (0.050mm - 0.002mm), clay (<0.002mm).

[5] Summary statistics exclude data from 1996 (HKP 1997) due to suspected errors with this data.

Method detection limit (MDL) was > maximum reported detectable value (excluding 1996 data); value was omitted from calculation of summary statistics.

Table A.2: Raw sediment quality data for lower Hazeltine Creek, 1995-2013 [1].

Analyte	Units	1995 (W11) [2]								1996 (W11) [2,3]								1999 (W11) [4]				
		HKP (1996)								HKP (1997)								Beak (2000)				
		Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Mean	Standard deviation	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Mean	Standard deviation	Rep 1	Rep 2	Rep 3	Mean	Standard deviation
Physical Characteristics																						
Gravel (>2mm)	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	57			57	-
Sand (2.0mm - 0.063mm)	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	34			34	-
Silt (0.063mm - 4µm)	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.0			8.0	-
Clay (<4µm)	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.0			2.0	-
Total Organic Carbon	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			-	-
Metals																						
Aluminum	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11,000	9,700	10,000	10,200	680
Antimony	mg/kg	0.61	0.65	1.85	1.05	0.78	0.72	0.94	0.47	0.60	0.36	0.63	0.77	25	0.74	4.8	10	<0.2	<0.2	<0.2	<0.2	0
Arsenic	mg/kg	9.9	10.9	8.8	8.0	10	12	9.9	1.4	4.0	5.3	13	6.9	17	9.3	9.2	5.0	6.5	8.7	6.6	7.3	1.2
Barium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	98	98	94	97	2.3
Beryllium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.30	0.30	0.30	0.30	0
Bismuth	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.20	<0.20	<0.20	<0.20	0
Boron	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.0	2.7	2.0	2.6	0.5
Cadmium	mg/kg	0.20	<0.1	0.10	<0.1	0.20	<0.1	0.13	0.05	0.20	0.20	<0.1	<0.1	<0.1	0.30	0.17	0.08	0.30	0.20	0.20	0.23	0.06
Calcium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	mg/kg	24	22	23	17	32	19	23	5.2	112	31	47	65	117	49	70	36	24	21	22	22	1.5
Cobalt	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	10	10	10	0
Copper	mg/kg	46	28	28	26	41	32	34	8.1	4,080	480	4,180	9,060	16,200	3,010	6,170	5,650	33	26	27	29	3.8
Iron	mg/kg	29,700	31,600	34,900	31,100	37,400	20,800	30,900	5,700	18,500	16,900	22,000	20,400	23,100	21,200	20,400	2,300	20,000	21,000	19,000	20,000	1,000
Lead	mg/kg	4	5	3	3	4	3	3.7	0.8	19	5	<2	16	190	12	41	73	5.8	4.9	5.5	5.4	0.5
Lithium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	mg/kg	569	814	930	694	909	657	760	0	882	513	668	1,390	1,010	634	850	320	880	1,500	810	1,060	380
Mercury	mg/kg	0.19	0.084	0.033	0.030	0.059	0.13	0.088	0.063	0.055	0.029	<0.005	0.034	0.033	0.024	0.030	0.016	<0.040	<0.040	<0.040	<0.040	0
Molybdenum	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.50	0.70	0.50	0.57	0.12
Nickel	mg/kg	13	17	17	15	26	13	17	4.8	52	16	23	32	33	26	30	12	22	20	21	21	1.0
Phosphorus	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	mg/kg	0.6	0.2	0.1	0.2	0.3	<0.1	0.25	0.19	0.2	0.2	0.4	0.8	0.8	0.3	0.5	0.3	<1	<1	<1	<1	0
Silver	mg/kg	<1	<1	<1	<1	<1	<1	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0.1	<0.1	<0.1	0.1	0
Sodium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	64	48	60	57	8.3
Thallium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.2	<0.2	<0.2	-	-
Tin	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.1	1.1	1.0	1.1	0.1
Titanium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	310	330	290	310	20
Uranium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.8	0.6	0.6	0.7	0.1
Vanadium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	37	44	37	39	4.0
Zinc	mg/kg	61	57	54	44	60	39	53	9.0	785	109	1,030	2,280	4,040	690	1,490	1,440	49	46	46	47	1.7

[1] All values reported as < method detection limit (MDL) were used at the MDL value for calculation of summary statistics. If all reported values were < MDL, the mean is reported as < MDL.

[2] concentrations reported in 1995 and 1996 were for the silt and clay (<63 µm) fraction only.

[3] some unusually high sediment metal concentrations were reported for 1996 (HKP 1997) and are suspected errors.

[4] Particle fractions for these samples are as follow: gravel (>2mm), sand (2.0mm - 0.050mm), silt (0.050mm - 0.002mm), clay (<0.002mm).

[5] Summary statistics exclude data from 1996 (HKP 1997) due to suspected errors with this data.

(grey shading) Method detection limit (MDL) was > maximum reported detectable value (excluding 1996 data); value was omitted from calculation of summary statistics.

Table A.2: Raw sediment quality data for lower Hazeltine Creek, 1995-2013 [1].

Analyte	Units	2007 (W11) Minnow (2009)					2010 (W11) Minnow (2011)							2012 (W11 mouth) Minnow (2013b)							Summary Statistics [5]			
		LHC-1	LHC-2	LHC-3	Mean	Standard deviation	LH SED-1	LH SED-2	LH SED-3	LH SED-4	LH SED-5	Mean	Standard deviation	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Mean	Standard deviation	Mean	95th Percentile	Maximum	n
Physical Characteristics																								
Gravel (>2mm)	%	1.0	3.0	<1.0	1.7	1.2	4.7	3.0	18	47	48	24	22	-	-	-	-	-	-	-	-	-	-	-
Sand (2.0mm - 0.063mm)	%	72	50	68	63	12	85	72	71	45	47	64	17	-	-	-	-	-	-	-	-	-	-	-
Silt (0.063mm - 4µm)	%	20	36	24	27	8.3	9.3	23	9.3	7.6	5.1	11	6.9	-	-	-	-	-	-	-	-	-	-	-
Clay (<4µm)	%	7.0	11	8.0	8.7	2.1	0.9	2.3	2.1	0.6	0.4	1.3	0.9	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	%	3.7	3.2	1.8	2.9	1.0	0.5	1.3	0.3	0.4	0.3	0.6	0.4	8.5	9.8	4.9	8.4	6.6	7.7	1.9	3.8	9.0	9.8	13
Metals																								
Aluminum	mg/kg	12,800	12,000	12,300	12,400	400	9,060	9,550	8,320	8,390	8,430	8,750	537	-	-	-	-	-	-	-	10,100	12,550	12,800	11
Antimony	mg/kg	<10	<10	<10	-	-	0.28	0.34	0.30	0.29	0.34	0.31	0.03	-	-	-	-	-	-	-	0.56	1.3	1.9	14
Arsenic	mg/kg	9.2	10	12	10	1.4	11	12	8.7	8.5	12	10	1.7	-	-	-	-	-	-	-	10	12	12	17
Barium	mg/kg	100	109	97	102	6.4	74	75	56	73	56	67	10	-	-	-	-	-	-	-	84	104	109	11
Beryllium	mg/kg	<0.50	<0.50	<0.50	-	-	0.27	0.30	0.26	0.26	0.27	0.27	0.02	-	-	-	-	-	-	-	0.28	0.30	0.30	8
Bismuth	mg/kg	<20	<20	<20	<20	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	-	-	-	-	-	-	-	5.6	20	20	11
Boron	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.6	3.0	3.0	3
Cadmium	mg/kg	<0.5	<0.5	<0.5	-	-	0.12	0.18	0.11	0.11	0.12	0.13	0.03	-	-	-	-	-	-	-	0.15	0.24	0.30	14
Calcium	mg/kg	6,850	7,120	6,390	6,790	369	5,270	5,780	4,980	5,440	4,780	5,250	391	-	-	-	-	-	-	-	5,830	7,030	7,120	8
Chromium	mg/kg	32	31	36	33	2.3	29	29	29	33	30	30	1.6	-	-	-	-	-	-	-	27	33	36	17
Cobalt	mg/kg	9.7	9.9	12	10	1.2	9.0	10	8.6	8.4	8.8	9.0	0.7	-	-	-	-	-	-	-	9.7	11	12	11
Copper	mg/kg	37	34	31	34	3.1	18	22	17	18	19	19	2.2	-	-	-	-	-	-	-	28	42	46	17
Iron	mg/kg	24,100	25,100	27,500	25,600	1,750	22,600	25,300	23,200	24,500	23,600	23,800	1,040	-	-	-	-	-	-	-	26,000	35,400	37,400	17
Lead	mg/kg	<30	<30	<30	-	-	4.0	4.9	4.4	4.2	4.5	4.4	0.3	-	-	-	-	-	-	-	4.3	5.6	5.8	14
Lithium	mg/kg	13	12	13	13	0.31	8.4	9.3	8.4	8.2	8.5	8.6	0.43	-	-	-	-	-	-	-	10	13	13	8
Magnesium	mg/kg	6,190	6,050	6,100	6,110	70.9	5,480	5,790	4,930	5,190	5,780	5,430	375	-	-	-	-	-	-	-	5,690	6,160	6,190	8
Manganese	mg/kg	385	1,020	1,010	805	364	605	633	401	537	512	538	90.8	-	-	-	-	-	-	-	757	1,120	1,500	17
Mercury	mg/kg	0.069	0.11	0.065	0.080	0.024	<0.050	0.052	<0.050	<0.050	<0.050	0.050	0.0009	-	-	-	-	-	-	-	0.067	0.14	0.19	17
Molybdenum	mg/kg	<4.0	<4.0	<4.0	-	-	0.62	0.78	0.59	0.53	0.63	0.63	0.09	-	-	-	-	-	-	-	0.61	0.75	0.78	8
Nickel	mg/kg	22	20	22	22	1.1	18	20	18	19	24	20	2.2	-	-	-	-	-	-	-	19	24	26	17
Phosphorus	mg/kg	-	-	-	-	-	596	733	579	713	654	655	68.4	-	-	-	-	-	-	-	655	729	733	5
Potassium	mg/kg	940	850	800	860	70.9	510	530	450	530	440	492	43.8	-	-	-	-	-	-	-	630	910	940	8
Selenium	mg/kg	<2.0	<5.0	<2.0	-	-	0.24	0.34	<0.20	0.28	0.28	0.27	0.05	1.3	1.5	0.74	1.1	0.97	1.1	0.29	0.60	1.3	1.5	19
Silver	mg/kg	<2	<2	<2	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	-	-	-	-	-	-	-	0.1	0.1	0.1	8
Sodium	mg/kg	240	220	240	233	11.5	260	200	170	220	210	212	32.7	-	-	-	-	-	-	-	220	253	260	8
Strontium	mg/kg	68	66	53	62	8.0	53	56	40	48	42	48	6.9	-	-	-	-	-	-	-	54	67	68	11
Thallium	mg/kg	<1	<1	<1	-	-	0.1	0.1	<0.05	<0.05	<0.05	0.05	0.0004	-	-	-	-	-	-	-	0.1	0.05	0.05	5
Tin	mg/kg	<5.0	<5.0	<5.0	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	-	-	-	-	-	-	-	-	-	1.1	1.1	1.1	3
Titanium	mg/kg	574	564	621	586	30	654	652	664	737	574	656	58	-	-	-	-	-	-	-	543	701	737	11
Uranium	mg/kg	-	-	-	-	-	0.4	0.6	0.4	0.4	0.4	0.4	0.09	-	-	-	-	-	-	-	0.5	0.7	0.8	8
Vanadium	mg/kg	62	64	71	66	4.8	66	71	67	78	70	70	4.8	-	-	-	-	-	-	-	61	75	78	11
Zinc	mg/kg	49	46	47	48	1.6	40	45	40	40	42	41	2.2	-	-	-	-	-	-	-	47	60	61	17

[1] All values reported as < method detection limit (MDL) were used at the MDL value for calculation of summary statistics. If all reported values were < MDL, the mean is reported as < MDL.

[2] concentrations reported in 1995 and 1996 were for the silt and clay (<63 µm) fraction only.

[3] some unusually high sediment metal concentrations were reported for 1996 (HKP 1997) and are suspected errors.

[4] Particle fractions for these samples are as follow: gravel (>2mm), sand (2.0mm - 0.050mm), silt (0.050mm - 0.002mm), clay (<0.002mm).

[5] Summary statistics exclude data from 1996 (HKP 1997) due to suspected errors with this data.

[shaded cell] Method detection limit (MDL) was > maximum reported detectable value (excluding 1996 data); value was omitted from calculation of summary statistics.

Table A.3: Raw sediment quality data for Polley Lake, 1989 - 2012 [1].

Analyte	Units	1989 [2] Imperial Metals (1990)		May-95 HKP (1996)										May-96 HKP (1997)									
		L [a]	B [a]	P1 [b]					P2 [c]					P1					P2				
				1	2	3	Mean	Standard deviation	1	2	3	Mean	Standard deviation	1	2	3	Mean	Standard deviation	1	2	3	Mean	Standard deviation
Physical Characteristics																							
% Gravel (>2mm)	%	-	-	-			-	-	-			-	-	-	-	-	-	-	-	-	-	-	-
% Sand (2.0mm - 0.063mm)	%	32	88	21			21	-	30			30	-	-	-	-	-	-	-	-	-	-	-
% Silt (0.063mm - 4µm)	%	32	8.2	50			50	-	47			47	-	-	-	-	-	-	-	-	-	-	-
% Clay (<4µm)	%	36	3.8	29			29	-	23			23	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	%	-	-	18.2	18.6	18.5	18.4	0.21	18.7	18.8	19.1	18.9	0.21	20.9	20.7	20.6	20.7	0.15	20.8	20.6	20.7	20.7	0.10
Metals																							
Aluminum	mg/kg	13,100	6,700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Antimony	mg/kg	-	-	0.74	0.89	0.81	0.81	0.08	0.90	0.74	1.1	0.90	0.17	0.72	0.86	0.78	0.79	0.07	0.81	0.84	0.87	0.84	0.03
Arsenic	mg/kg	16	2.3	5.6	5.1	6.0	5.6	0.42	5.4	6.3	5.8	5.8	0.45	5.8	5.3	4.8	5.3	0.47	6.0	4.3	3.8	4.7	1.1
Barium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Beryllium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bismuth	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boron	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	mg/kg	-	-	0.60	0.70	0.60	0.63	0.058	0.60	0.50	0.60	0.57	0.058	<0.1	0.70	<0.1	0.30	0.35	<0.1	<0.1	0.60	0.27	0.29
Calcium	mg/kg	15,900	9,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	mg/kg	61	26	59	59	59	59	0	60	63	64	62	2.1	68	69	67	68	1.0	65	66	64	65	1.0
Cobalt	mg/kg	18.4	12.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper	mg/kg	282	50	337	355	345	346	9.0	376	382	397	385	11	374	376	360	370	8.7	341	349	352	347	5.7
Iron	mg/kg	60,600	17,700	33,200	27,800	31,200	30,700	2,730	30,500	27,900	27,700	28,700	1,560	29,700	30,100	29,000	29,600	557	28,600	28,900	29,200	28,900	300
Lead	mg/kg	10	<5.0	17	19	18	18	1.0	17	11	15	14	3.1	16	15	16	16	0.6	11	13	17	14	3.1
Lithium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium	mg/kg	12,900	6,300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	mg/kg	2,140	469	1,680	1,510	1,550	1,580	89	1,880	1,400	1,770	1,680	251	1,650	1,660	1,600	1,640	32	1,540	1,550	1,560	1,550	10
Mercury	mg/kg	0.21	0.04	0.28	0.26	0.24	0.26	0.02	0.27	0.22	0.26	0.25	0.03	0.24	0.22	0.24	0.23	0.01	0.20	0.21	0.22	0.21	0.01
Molybdenum	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	mg/kg	42	14	40	38	38	39	1.2	41	40	43	41	1.5	41	44	42	42	1.5	40	36	38	38	2.0
Phosphorus	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phosphorus, Total	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	mg/kg	-	-	1.7	1.6	1.9	1.7	0.15	1.8	2.0	1.9	1.9	0.10	2.6	2.4	2.8	2.6	0.20	2.5	2.3	2.4	2.4	0.10
Silver	mg/kg	-	-	<1.0	<1.0	<1.0	-	-	<1.0	<1.0	<1.0	-	-	<0.1	<0.1	<0.1	<0.1	0	<0.1	<0.1	<0.1	<0.1	0
Sodium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfur, Total	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Titanium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	mg/kg	109	57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	mg/kg	99	46	94	96	92	94	2.0	95	98	105	99	5.1	98	99	96	98	1.5	92	94	94	93	1.2

[1] All values reported as < method detection limit (MDL) were used at the MDL value for calculation of summary statistics. If all reported values were < MDL, the mean is reported as < MDL.
[2] Station L assessed in 1989 is equivalent to station P2 assessed in following sampling years. Concentrations reported in 1989 were for the <0.149mm fraction only.
[3] Concentrations reported in October 1996 were for the silt and clay (<63µm) fraction only.
[4] Summary statistics for mid-depth areas include data from stations B (1989), PL-1 to PL-5 (May 2009), A to C (October 2009), and POL-1 to POL-5 (2012).
[a] Particle size fractions for these samples are as follows: sand (0.053mm-2.0mm), silt (0.002mm-0.053mm), clay (<0.002mm).
[b] Particle size results for this station are based on one composite sample and the size fractions are as follows: sand (2.0mm - 0.0705mm), silt (0.0705mm - 0.0041mm), clay (<0.0041mm).
[c] Particle size results for this station are based on one composite sample,and the size fractions are as follows: sand (2.0mm - 0.0675mm), silt (0.0675mm - 0.0041mm), clay (<0.0041mm)
[d] Particle size fractions for these samples are as follows: sand (2.0mm - 0.063mm), silt (0.063mm - 0.0040mm or 0.0039mm), clay (<0.0040mm or 0.0039mm)
[e] Reported sand fraction also included silt and clay fractions (< 0.002mm - 2mm).
(grey shading) Method detection limit (MDL) was > maximum detectable value for basin or mid-depth data sets; value was omitted from calculation of respective summary statistics.

Table A.3: Raw sediment quality data for Polley Lake, 1989 - 2012 [1].

Analyte	Units	Oct-96 [3]										1999										May-09						
		HKP (1997)										Beak (2000)										Minnow (2011)						
		P1 [d]					P2 [d]					P1 (0-2cm)					P2 (0-2cm)					PL						
		1	2	3	Mean	Standard deviation	1	2	3	Mean	Standard deviation	1	2	3	Mean	Standard deviation	1	2	3	Mean	Standard deviation	1	2	3	4	5	Mean	Standard deviation
Physical Characteristics																												
% Gravel (>2mm)	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0	<1.0	<1.0	<1.0	<1.0	1.0	0
% Sand (2.0mm - 0.063mm)	%	31	27	23	27	3.6	32	29	25	29	3.5	100[e]	-	-	-	-	100[e]	-	-	-	-	54	41	50	17	26	38	16
% Silt (0.063mm - 4µm)	%	57	61	59	59	2.2	55	58	63	59	4.0	-	-	-	-	-	-	-	-	-	-	37	52	44	69	63	53	13
% Clay (<4µm)	%	12	12	17	14	3.0	13	13	12	13	0.5	-	-	-	-	-	-	-	-	-	-	7.0	7.0	7.0	14	11	9.2	3.2
Total Organic Carbon	%	-	-	-	-	-	-	-	-	-	-	14.0	-	-	-	-	18.0	-	-	-	-	3.9	3.8	8.1	9.6	8.4	6.8	2.7
Metals																												
Aluminum	mg/kg	-	-	-	-	-	-	-	-	-	-	16,000	15,000	16,000	15,700	577	13,000	15,000	16,000	14,700	1,530	-	-	-	-	-	-	-
Antimony	mg/kg	0.50	1.3	0.26	0.7	0.5	0.92	1.7	0.74	1.1	0.5	<0.20	<0.20	<0.20	<0.20	0	<0.20	<0.20	<0.20	<0.20	0	<10	<10	<10	<10	<10	<10	0
Arsenic	mg/kg	4.5	4.7	4.9	4.7	0.20	4.9	6.1	6.2	5.7	0.70	8.3	9.0	7.1	8.1	0.96	5.1	5.6	5.2	5.3	0.26	10.7	<5.0	5.7	<5.0	<5.0	6.3	2.5
Barium	mg/kg	-	-	-	-	-	-	-	-	-	-	150	190	170	170	20	130	130	140	133	5.8	140	85.5	117	116	111	114	19.4
Beryllium	mg/kg	-	-	-	-	-	-	-	-	-	-	0.6	0.6	0.5	0.6	0.06	0.4	0.5	0.5	0.5	0.06	0.6	<0.5	0.5	0.5	0.5	0.5	0.05
Bismuth	mg/kg	-	-	-	-	-	-	-	-	-	-	<0.2	0.2	0.3	0.2	0.06	0.2	0.2	0.4	0.3	0.1	-	-	-	-	-	-	-
Boron	mg/kg	-	-	-	-	-	-	-	-	-	-	17	15	15	16	1.2	16	16	17	16	0.58	-	-	-	-	-	-	-
Cadmium	mg/kg	0.30	0.20	0.50	0.33	0.15	0.20	0.20	0.30	0.23	0.06	0.40	0.40	0.40	0.40	0	0.30	0.50	0.40	0.40	0.10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0
Calcium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	mg/kg	46	53	56	52	5.1	44	61	62	56	10	38	38	41	39	1.7	35	53	41	43	9.2	27	30	41	38	39	35	5.9
Cobalt	mg/kg	-	-	-	-	-	-	-	-	-	-	11	11	11	11	0	9.5	10	11	10	0.8	13	8.4	9.8	10	10	10	1.5
Copper	mg/kg	245	242	300	262	33	257	282	327	289	35	160	180	180	170	12	170	200	210	193	21	415	130	206	200	180	226	110
Iron	mg/kg	19,100	17,000	19,000	18,400	1,190	17,400	19,700	22,100	19,700	2,350	28,000	35,000	30,000	31,000	3,606	22,000	24,000	25,000	23,700	1,530	-	-	-	-	-	-	-
Lead	mg/kg	9	5	9	7.7	2.3	8.0	11	12	10	2.1	11	13	12	12	1.0	13	16	16	15	1.7	<30	<30	<30	<30	<30	<30	0
Lithium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	mg/kg	674	547	713	645	87	833	925	1,280	1,010	236	3,000	3,400	3,100	3,170	208	2,000	2,600	2,000	2,200	346	-	-	-	-	-	-	-
Mercury	mg/kg	0.30	0.18	0.21	0.23	0.058	0.16	0.19	0.20	0.18	0.018	0.20	0.20	0.21	0.20	0.01	0.23	0.24	0.24	0.24	0.01	0.16	0.075	0.15	0.15	0.15	0.14	0.04
Molybdenum	mg/kg	-	-	-	-	-	-	-	-	-	-	1.4	1.2	1.4	1.3	0.12	1.3	1.3	2.0	1.5	0.40	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	0
Nickel	mg/kg	29	31	35	32	3.1	28	38	38	35	5.8	26	26	28	27	1.2	26	37	30	31	5.6	19	17	25	25	25	22	4.1
Phosphorus	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phosphorus, Total	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	mg/kg	1.8	1.6	1.7	1.7	0.10	1.7	2.1	2.2	2.0	0.26	1.6	1.9	1.9	1.8	0.17	1.7	1.8	1.7	1.7	0.06	0.80	0.69	1.5	1.6	1.5	1.2	0.43
Silver	mg/kg	0.4	0.3	0.5	0.4	0.1	0.4	0.3	0.4	0.4	0.06	0.3	0.2	0.3	0.3	0.06	0.3	0.3	0.3	0.3	0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0
Sodium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium	mg/kg	-	-	-	-	-	-	-	-	-	-	120	110	100	110	10	97	110	110	106	7.5	-	-	-	-	-	-	-
Sulfur, Total	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,130	1,220	2,230	2,520	2,370	2,290	692
Thallium	mg/kg	-	-	-	-	-	-	-	-	-	-	<0.2	<0.2	<0.2	-	-	<0.2	<0.2	<0.2	-	-	-	-	-	-	-	-	-
Tin	mg/kg	-	-	-	-	-	-	-	-	-	-	0.5	0.6	0.5	0.5	0.06	0.8	0.8	0.7	0.8	0.06	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Titanium	mg/kg	-	-	-	-	-	-	-	-	-	-	390	400	410	400	10.0	300	360	390	350	45.8	-	-	-	-	-	-	-
Uranium	mg/kg	-	-	-	-	-	-	-	-	-	-	1.3	1.4	1.4	1.4	0.06	1.3	1.4	1.5	1.4	0.1	-	-	-	-	-	-	-
Vanadium	mg/kg	-	-	-	-	-	-	-	-	-	-	55	58	58	57	1.7	42	47	54	48	6.0	126	69	78	71	69	83	25
Zinc	mg/kg	74	73	83	77	5.5	70	84	93	82	12	62	62	62	62	0	59	67	69	65	5.3	78	50	62	60	57	61	10

[1] All values reported as < method detection limit (MDL) were used at the MDL value for calculation of summary statistics. If all reported values were < MDL, the mean is reported as < MDL.

[2] Station L assessed in 1989 is equivalent to station P2 assessed in following sampling years. Concentrations reported in 1989 were for the <0.149mm fraction only.

[3] Concentrations reported in October 1996 were for the silt and clay (<63µm) fraction only.

[4] Summary statistics for mid-depth areas include data from stations B (1989), PL-1 to PL-5 (May 2009), A to C (October 2009), and POL-1 to POL-5 (2012).

[a] Particle size fractions for these samples are as follows: sand (0.053mm-2.0mm), silt (0.002mm-0.053mm), clay (<0.002mm).

[b] Particle size results for this station are based on one composite sample and the size fractions are as follows: sand (2.0mm - 0.0705mm), silt (0.0705mm - 0.0041mm), clay (<0.0041mm).

[c] Particle size results for this station are based on one composite sample,and the size fractions are as follows: sand (2.0mm - 0.0675mm), silt (0.0675mm - 0.0041mm), clay (<0.0041mm)

[d] Particle size fractions for these samples are as follows: sand (2.0mm - 0.063mm), silt (0.063mm - 0.0040mm or 0.0039mm), clay (<0.0040mm or 0.0039mm)

[e] Reported sand fraction also included silt and clay fractions (< 0.002mm - 2mm).

(Grey shading) Method detection limit (MDL) was > maximum detectable value for basin or mid-depth data sets; value was omitted from calculation of respective summary statistics.

Table A.3: Raw sediment quality data for Polley Lake, 1989 - 2012 [1].

Analyte	Units	Oct-09							2012									Summary Statistics Basins Stations (P1,P2,L)				Summary Statistics (Mid-depth) [4]			
		Minnow (2011)							Minnow (2013b)																
		P1	P2	A,B,C					P1	P2	POL							Mean	95th Percentile	Maximum	n	Mean	95th Percentile	Maximum	n
				A	B	C	Mean	Standard deviation			1	2	3	4	5	Mean	Standard deviation								
Physical Characteristics																									
% Gravel (>2mm)	%	<1.0	<1.0	<1.0	1.0	1.0	1.0	0	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Sand (2.0mm - 0.063mm)	%	1.0	1.0	55	87	86	76	18	0.9	0.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Silt (0.063mm - 4µm)	%	56	53	36	8.0	11	18	15	88	87	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Clay (<4µm)	%	43	46	9.0	5.0	3.0	5.7	3.1	11	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	%	15.5	16.9	0.20	0.35	0.91	0.49	0.37	12.7	14.6	15.6	16.2	9.5	17.1	16.1	14.9	3.1	18.2	20.8	20.9	18	8.4	16.6	17.1	13
Metals																									
Aluminum	mg/kg	-	-	-	-	-	-	-	21,900	18,700	-	-	-	-	-	-	-	16,078	20,620	21,900	9.0	6,700	6,700	6,700	1
Antimony	mg/kg	<10	<10	<10	<10	<10	<10	0	0.46	0.43	-	-	-	-	-	-	-	0.7	1.2	1.7	26	<10	<10	<10	8
Arsenic	mg/kg	5.5	6.4	14	<5.0	<5.0	8.1	5.4	8.9	7.2	-	-	-	-	-	-	-	6.2	8.9	15.5	29	6.4	13	14	9
Barium	mg/kg	145	167	141	40.5	82.0	87.8	50.5	212	239	-	-	-	-	-	-	-	167	227	239	10	104	141	141	8
Beryllium	mg/kg	<0.5	0.58	0.52	<0.50	<0.50	0.51	0.01	0.66	0.55	-	-	-	-	-	-	-	0.54	0.63	0.66	10	0.53	0.60	0.63	8
Bismuth	mg/kg	-	-	-	-	-	-	-	<0.2	<0.2	-	-	-	-	-	-	-	0.24	0.37	0.40	8	-	-	-	0
Boron	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	17	17	6	-	-	-	0
Cadmium	mg/kg	0.67	0.63	0.74	<0.5	<0.5	0.58	0.14	0.57	0.42	-	-	-	-	-	-	-	0.42	0.69	0.70	28	0.53	0.66	0.74	8
Calcium	mg/kg	-	-	-	-	-	-	-	15,800	13,200	-	-	-	-	-	-	-	14,967	15,890	15,900	3	9,000	9,000	9,000	1
Chromium	mg/kg	37	50	18	49	28	32	16	47	41	-	-	-	-	-	-	-	54	68	69	29	33	46	49	9
Cobalt	mg/kg	9.8	11.9	13	12	7.8	11	2.7	14	12	-	-	-	-	-	-	-	12	16	18	11	11	13	13	9
Copper	mg/kg	239	313	574	35	23	211	315	369	253	-	-	-	-	-	-	-	295	380	397	29	201	510	574	9
Iron	mg/kg	-	-	-	-	-	-	-	35,100	41,000	-	-	-	-	-	-	-	28,474	39,230	60,600	27	17,700	17,700	17,700	1
Lead	mg/kg	<30	<30	<30	<30	<30	<30	0	14	12	-	-	-	-	-	-	-	13	18	19	27	<30	<30	<30	9
Lithium	mg/kg	-	-	-	-	-	-	-	18.0	13.3	-	-	-	-	-	-	-	15.7	17.8	18.0	2	-	-	-	0
Magnesium	mg/kg	-	-	-	-	-	-	-	9,380	7,560	-	-	-	-	-	-	-	9,947	12,548	12,900	3	6,300	6,300	6,300	1
Manganese	mg/kg	-	-	-	-	-	-	-	1,630	3,850	-	-	-	-	-	-	-	1,779	3,310	3,850	27	469	469	469	1
Mercury	mg/kg	0.22	0.29	0.20	<0.050	0.055	0.10	0.08	-	-	-	-	-	-	-	-	-	0.23	0.29	0.30	27	0.12	0.18	0.20	9
Molybdenum	mg/kg	4.6	5.7	5.3	<4.0	<4.0	4.4	0.75	6.3	5.6	-	-	-	-	-	-	-	3.1	6.1	6.3	10	4.2	4.8	5.3	8
Nickel	mg/kg	26	34	11	17	13	14	2.8	34	30	-	-	-	-	-	-	-	35	43	44	29	18	25	25	9
Phosphorus	mg/kg	-	-	-	-	-	-	-	1,790	3,490	-	-	-	-	-	-	-	2,640	3,405	3,490	2	-	-	-	0
Phosphorus, Total	mg/kg	-	-	-	-	-	-	-	2,680	9,390	-	-	-	-	-	-	-	6,035	9,055	9,390	2	-	-	-	0
Potassium	mg/kg	-	-	-	-	-	-	-	1,600	1,420	-	-	-	-	-	-	-	1,510	1,591	1,600	2	-	-	-	0
Selenium	mg/kg	2.5	3.7	0.52	<0.50	<0.50	0.51	0.01	6.3	6.9	5.5	4.7	2.7	5.6	6.5	5.0	1.5	2.4	5.4	6.9	28	2.5	6.0	6.5	13
Silver	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0.4	0.3	-	-	-	-	-	-	-	0.3	0.4	0.5	20	<2.0	<2.0	<2.0	8
Sodium	mg/kg	-	-	-	-	-	-	-	570	360	-	-	-	-	-	-	-	465	560	570	2	-	-	-	0
Strontium	mg/kg	-	-	-	-	-	-	-	127	117	-	-	-	-	-	-	-	111	125	127	8	-	-	-	0
Sulfur, Total	mg/kg	6,530	8,470	5,470	480	650	2,200	2,830	10,600	13,400	-	-	-	-	-	-	-	9,750	12,980	13,400	4	2,260	4,651	5,470	8
Thallium	mg/kg	-	-	-	-	-	-	-	0.11	0.10	-	-	-	-	-	-	-	0.10	0.11	0.11	2	-	-	-	0
Tin	mg/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	<2.0	<2.0	-	-	-	-	-	-	-	0.7	0.8	0.8	6	<5.0	<5.0	<5.0	8
Titanium	mg/kg	-	-	-	-	-	-	-	855	660	-	-	-	-	-	-	-	471	787	855	8	-	-	-	0
Uranium	mg/kg	-	-	-	-	-	-	-	1.2	1.1	-	-	-	-	-	-	-	1.3	1.5	1.5	8	-	-	-	0
Vanadium	mg/kg	88	93	143	127	71	114	38	112	90	-	-	-	-	-	-	-	73	111	112	11	90	137	143	9
Zinc	mg/kg	59	74	86	37	30	51	30	91	71	-	-	-	-	-	-	-	83	99	105	29	56	83	86	9

[1] All values reported as < method detection limit (MDL) were used at the MDL value for calculation of summary statistics. If all reported values were < MDL, the mean is reported as < MDL.

[2] Station L assessed in 1989 is equivalent to station P2 assessed in following sampling years. Concentrations reported in 1989 were for the <0.149mm fraction only.

[3] Concentrations reported in October 1996 were for the silt and clay (<63µm) fraction only.

[4] Summary statistics for mid-depth areas include data from stations B (1989), PL-1 to PL-5 (May 2009), A to C (October 2009), and POL-1 to POL-5 (2012).

[a] Particle size fractions for these samples are as follows: sand (0.053mm-2.0mm), silt (0.002mm-0.053mm), clay (<0.002mm).

[b] Particle size results for this station are based on one composite sample and the size fractions are as follows: sand (2.0mm - 0.0705mm), silt (0.0705mm - 0.0041mm), clay (<0.0041mm).

[c] Particle size results for this station are based on one composite sample,and the size fractions are as follows: sand (2.0mm - 0.0675mm), silt (0.0675mm - 0.0041mm), clay (<0.0041mm)

[d] Particle size fractions for these samples are as follows: sand (2.0mm - 0.063mm), silt (0.063mm - 0.0040mm or 0.0039mm), clay (<0.0040mm or 0.0039mm)

[e] Reported sand fraction also included silt and clay fractions (< 0.002mm - 2mm).

(shaded) Method detection limit (MDL) was > maximum detectable value for basin or mid-depth data sets; value was omitted from calculation of respective summary statistics.

Table A.4: Raw sediment quality data for Bootjack Lake, 1989 - 2012 [1].

Analyte	Units	1989 [2]				1995										May-96										Oct-96[3]									
		Imperial Metals (1990) [a]				HKP (1996) [b]										HKP (1997)										HKP (1997) [c]									
		LN (North Basin)	LS (South Basin)	B2	B3	B1					B2					B1					B2					B1					B2				
						1	2	3	Mean	Standard deviation	1	2	3	Mean	Standard deviation	1	2	3	Mean	Standard deviation	1	2	3	Mean	Standard deviation	1	2	3	Mean	Standard deviation	1	2	3	Mean	Standard deviation
Physical Characteristics																																			
% Gravel (>2mm)	%	-	-	-	-		-		-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Sand (2.0mm - 0.063mm)	%	27	29	7.8	76		21		21	-		14		14	-	-	-	-	-	-	-	-	-	-	-	21	22	21	21	0.2	11	11	15	12	2.1
% Silt (0.063mm - 4µm)	%	31	28	61	13		54		54	-		58		58	-	-	-	-	-	-	-	-	-	-	-	65	57	69	63	6.2	67	73	69	70	3.2
% Clay (<4µm)	%	43	43	31	11		26		26	-		29		29	-	-	-	-	-	-	-	-	-	-	-	14	22	10	15	6.0	22	16	16	18	3.4
Total Organic Carbon	%	-	-	-	-	17.9	17.9	18.1	18.0	0.1	18.6	18.5	18.5	18.5	0.1	20.4	20.2	20.6	20.4	0.2	21.3	21.5	21.7	21.5	0.2	-	-	-	-	-	-	-	-	-	-
Metals																																			
Aluminum	mg/kg	12,800	13,000	13,300	11,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Antimony	mg/kg	<0.05	<0.05	<0.05	<0.05	1.3	1.3	1.3	1.3	0.04	1.8	1.5	1.0	1.5	0.43	1.0	1.2	1.1	1.1	0.09	1.4	1.2	1.4	1.4	0.11	1.1	1.3	2.0	1.4	0.45	1.4	1.5	1.5	1.5	0.06
Arsenic	mg/kg	6.0	7.0	8.0	7.0	4.4	4.7	5.2	4.8	0.4	6.3	6.3	6.7	6.4	0.2	4.7	5.8	5.1	5.2	0.5	7.7	8.0	7.1	7.6	0.5	4.3	7.2	6.1	5.9	1.4	5.8	6.8	6.1	6.2	0.5
Barium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Beryllium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bismuth	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boron	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	mg/kg	<0.25	<0.25	<0.25	<0.25	0.4	0.4	0.4	0.40	0	0.6	0.6	0.5	0.57	0.06	<0.1	<0.1	<0.1	<0.1	0	<0.1	<0.1	<0.1	<0.1	0	0.3	0.3	0.3	0.30	0	0.4	0.3	0.2	0.30	0.10
Calcium	mg/kg	12,900	11,700	18,500	20,200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	mg/kg	51	50	42	23	42	41	43	42	1.0	44	40	46	43	3.1	45	45	45	45	0	55	54	55	55	0.6	33	36	51	40	10	32	37	32	34	2.9
Cobalt	mg/kg	16	17	18	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper	mg/kg	645	625	361	345	434	458	467	453	17.1	480	457	492	476	17.8	458	457	459	458	1.0	610	599	609	606	6.1	501	368	435	435	67	366	466	373	402	56
Iron	mg/kg	22,500	27,300	38,200	26,100	27,800	27,100	27,600	27,500	361	28,700	26,200	28,400	27,800	1,370	24,400	25,000	25,300	24,900	458	29,500	29,100	29,300	29,300	200	16,900	21,000	18,100	18,700	2,110	17,000	20,000	18,500	18,500	1,500
Lead	mg/kg	10	12	13	7.5	13	12	11	12	1.0	15	16	16	16	0.6	15	12	12	13	1.7	13	16	15	15	1.5	9.0	8.0	10	9.0	1.0	11	12	11	11	0.6
Lithium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium	mg/kg	8,800	8,600	11,200	7,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	mg/kg	540	763	858	694	835	805	840	827	18.9	933	895	921	916	19.4	710	736	744	730	17.8	923	931	920	925	5.7	525	564	562	550	22.0	646	701	707	685	33.6
Mercury	mg/kg	0.29	0.30	0.17	0.061	0.23	0.23	0.23	0.23	0	0.30	0.29	0.29	0.29	0.006	0.21	0.22	0.22	0.22	0.008	0.28	0.28	0.28	0.28	0.001	0.29	0.24	0.29	0.27	0.031	0.25	0.29	0.25	0.26	0.021
Molybdenum	mg/kg	7.3	9.4	<5.0	<5.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	mg/kg	37	38	25	16	30	29	30	30	0.6	32	30	34	32	2.0	30	30	28	29	1.2	36	36	37	36	0.6	22	25	32	26	5.1	23	27	24	25	2.1
Phosphorus	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phosphorus, Total	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	mg/kg	-	-	-	-	2.1	1.9	1.9	2.0	0.1	1.9	1.6	1.8	1.8	0.2	2.4	2.2	2.3	2.3	0.1	3.1	3.1	3.0	3.1	0.1	1.6	1.6	1.9	1.7	0.2	1.4	1.9	1.5	1.6	0.3
Silver	mg/kg	<0.25	<0.25	0.5	0.5	<1	<1	<1	-	-	<1	<1	<1	-	-	<0.1	<0.1	<0.1	<0.1	0	<0.1	<0.1	<0.1	<0.1	0	0.4	0.3	0.5	0.4	0.1	0.5	0.5	0.4	0.5	0.1
Sodium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfur, Total	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Titanium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	mg/kg	69	72	126	96	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	mg/kg	102	110	105	109	88	92	95	92	3.5	101	94	103	99	4.7	90	88	88	89	1.2	105	104	104	104	0.6	95	92	86	91	4.6	74	84	74	77	5.8

[1] All values reported as < method detection limit (MDL) were used at the MDL value for calculation of summary statistics. If all reported values were < MDL, the mean is reported as < MDL.

[2] Stations LN and LS assessed in 1989 are approximately equivalent to stations B1 and B2 assessed in following sampling years. Concentrations reported in 1989 were for the <0.149mm fraction only.

[3] Concentrations reported in October 1996 were for the silt and clay (<63µm) fraction only.

[4] Summary statistics for mid-depth areas include data from stations B2 and B3 (1989), A (2009), and BOL-1 to BOL-5 (2012). Where all values were < MDL, the 95th percentile is shown as the maximum MDL.

[a] Particle size fractions for these samples are as follows: sand (2.0mm - 0.053mm), silt (0.053mm - 0.002mm), clay (<0.002mm).

[b] Particle size results for this station are based on one composite sample and the size fractions are as follows: sand (2.0mm - 0.065mm), (0.065mm - 0.0041mm), clay (<0.0041mm).

[c] Particle size fractions for these samples are as follows: sand (2.0mm - 0.063mm), silt (0.063mm-0.0039 or 0.0038mm), clay (<0.0039 or < 0.0038mm).

[d] Reported sand fraction also included silt and clay fractions (< 0.002mm - 2.0mm).

(shaded cell) Method detection limit (MDL) was > maximum detectable value for basin or mid-depth data sets; value was omitted from calculation of respective summary statistics.

Table A.4: Raw sediment quality data for Bootjack Lake, 1989 - 2012 [1].

Analyte	Units	1999										2009			2012									Summary Statistics Basin Stations (B1, B2, LN, LS)				Summary Statistics (Mid-depth) [4]			
		Beak (2000)										Minnow (2011)			Minnow (2013b)																
		B1					B2										BOL														
		1	2	3	Mean	Standard deviation	1	2	3	Mean	Standard deviation	B1	B2	A	B1	B2	1	2	3	4	5	Mean	Standard deviation	Mean	95th Percentile	Maximum	n	Mean	95th Percentile	Maximum	n
Physical Characteristics																															
% Gravel (>2mm)	%		-		-	-		-		-	-	<1.0	<1.0	5.0	<0.10	<0.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Sand (2.0mm - 0.063mm)	%		100[d]		100[d]	-		100[d]		100[d]	-	1.0	1.0	72	1.5	0.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Silt (0.063mm - 4µm)	%		-		-	-		-		-	-	60	57	19	89	91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Clay (<4µm)	%		-		-	-		-		-	-	38	42	4.0	10	8.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	%		11.0		11.0	-		20		20	-	17.8	18.6	2.3	17.5	16.1	15.8	17.1	18.3	17.0	11.9	16.0	2.5	18.7	21.5	21.7	18	13.7	18.0	18.3	6
Metals																															
Aluminum	mg/kg	11,000	9,800	11,000	10,600	693	15,000	16,000	16,000	15,700	577	-	-	-	17,700	19,500	-	-	-	-	-	-	-	14,200	18,700	19,500	10	12,200	13,200	13,300	2
Antimony	mg/kg	<0.2	<0.2	<0.2	<0.2	0	0.2	0.2	0.2	0.2	0	<10	<10	<10	0.9	1.1	-	-	-	-	-	-	-	1.0	1.7	2.0	28	3	<10	<10	3
Arsenic	mg/kg	5.3	5.1	4.4	4.9	0.5	5.7	5.7	5.7	5.7	0	6.9	6.1	6.6	6.5	7.5	-	-	-	-	-	-	-	6.0	7.6	8.0	30	7.2	7.9	8.0	3
Barium	mg/kg	150	150	160	153	5.8	250	260	260	257	5.8	236	274	66.8	223	306	-	-	-	-	-	-	-	227	292	306	10		66.8		1
Beryllium	mg/kg	0.4	0.4	0.5	0.4	0.1	0.7	0.7	0.7	0.7	0	0.7	0.8	<0.5	0.6	0.8	-	-	-	-	-	-	-	0.6	0.8	0.8	10		<0.5		1
Bismuth	mg/kg	<0.2	0.3	0.3	0.3	0.1	0.3	<0.2	0.3	0.3	0.1	-	-	-	<0.2	<0.2	-	-	-	-	-	-	-	0.3	0.3	0.3	8	-	-	-	-
Boron	mg/kg	12	11	13	12	1.0	16	17	17	17	0.6	-	-	-	-	-	-	-	-	-	-	-	-	14	17	17	6	-	-	-	-
Cadmium	mg/kg	0.3	0.3	0.3	0.30	0	0.4	0.4	0.5	0.43	0.06	0.9	0.8	<0.5	0.4	0.5	-	-	-	-	-	-	-	0.4	0.7	0.9	30	0.3	<0.5	<0.5	3
Calcium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	11,900	8,050	-	-	-	-	-	-	-	11,100	12,800	12,900	4	19,400	20,100	20,200	2
Chromium	mg/kg	32	29	24	28	4.0	32	34	38	35	3.1	41	41	14	39	38	-	-	-	-	-	-	-	41	55	55	30	26	40	42	3
Cobalt	mg/kg	8.9	8.7	8.8	8.8	0.10	9.2	9.5	9.7	9.5	0.25	12	11	8.4	12	12	-	-	-	-	-	-	-	11	16	17	12	13	17	18	3
Copper	mg/kg	180	170	200	183	15.3	300	310	310	307	5.8	460	440	193	425	388	-	-	-	-	-	-	-	431	618	645	30	300	359	361	3
Iron	mg/kg	21,000	21,000	21,000	21,000	0	28,000	28,000	28,000	28,000	0	-	-	-	26,900	28,000	-	-	-	-	-	-	-	24,700	29,200	29,500	28	32,200	37,600	38,200	2
Lead	mg/kg	9.3	10	10	9.6	0.4	13	12	16	14	2.1	<30	<30	<30	8.0	12	-	-	-	-	-	-	-	12	16	16	28	10	13	13	2
Lithium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	11.5	12.2	-	-	-	-	-	-	-	11.9	12.2	12.2	2	-	-	-	-
Magnesium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	6,020	5,400	-	-	-	-	-	-	-	7,210	8,770	8,800	4	9,350	11,000	11,200	2
Manganese	mg/kg	670	660	630	653	20.8	1,800	1,600	1,700	1,700	100	-	-	-	1,730	1,280	-	-	-	-	-	-	-	903	1,720	1,800	28	776	850	858	2
Mercury	mg/kg	0.16	0.15	0.17	0.16	0.010	0.32	0.33	0.35	0.33	0.015	0.36	0.39	<0.050	-	-	-	-	-	-	-	-	-	0.27	0.36	0.39	28	0.09	0.16	0.17	3
Molybdenum	mg/kg	1.3	1.1	1.2	1.2	0.10	1.9	2.0	2.1	2.0	0.10	5.0	<4.0	<4.0	4.1	3.8	-	-	-	-	-	-	-	3.6	8.3	9.4	12	4.7	<5.0	<5.0	3
Nickel	mg/kg	22	21	18	20	2.1	25	26	28	26	1.5	28	29	7.8	29	29	-	-	-	-	-	-	-	29	37	38	30	16	24	25	3
Phosphorus	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	1,530	2,640	-	-	-	-	-	-	-	2,090	2,590	2,640	2	-	-	-	-
Phosphorus, Total	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	1,280	2,410	-	-	-	-	-	-	-	1,850	2,350	2,410	2	-	-	-	-
Potassium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	1,360	1,420	-	-	-	-	-	-	-	1,390	1,420	1,420	2	-	-	-	-
Selenium	mg/kg	<1.0	<1.0	<1.0	<1.0	0	1.5	1.9	1.4	1.6	0.3	2.2	2.0	<0.50	2.7	2.3	2.2	2.5	2.9	2.4	1.8	2.4	0.4	1.9	3.1	3.1	28	2.1	2.8	2.9	6
Silver	mg/kg	0.2	0.2	0.3	0.2	0.1	0.4	0.4	0.4	0.4	0	<2	<2	<2	0.4	0.4	-	-	-	-	-	-	-	0.3	0.5	0.5	22	0.5	0.5	0.5	2
Sodium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	200	210	-	-	-	-	-	-	-	205	210	210	2	-	-	-	-
Strontium	mg/kg	89	83	94	89	5.5	140	140	150	143	5.8	-	-	-	128	99	-	-	-	-	-	-	-	115	147	150	8	-	-	-	-
Sulfur, Total	mg/kg	-	-	-	-	-	-	-	-	-	-	5,830	4,320	530	7,300	5,900	-	-	-	-	-	-	-	5,840	7,090	7,300	4		530		1
Thallium	mg/kg	<0.20	<0.20	<0.20	-	-	<0.20	<0.20	<0.20	-	-	-	-	-	0.12	0.14	-	-	-	-	-	-	-	0.13	0.14	0.14	2	-	-	-	-
Tin	mg/kg	0.7	0.6	0.8	0.7	0.1	0.5	0.6	0.6	0.6	0.1	<5.0	<5.0	<5.0	<2.0	<2.0	-	-	-	-	-	-	-	0.6	0.8	0.8	6		5		1
Titanium	mg/kg	380	390	390	387	5.8	330	290	330	317	23	-	-	-	712	517	-	-	-	-	-	-	-	417	644	712	8	-	-	-	-
Uranium	mg/kg	1.4	1.3	1.6	1.4	0.2	2.7	2.9	2.9	2.8	0.1	-	-	-	2.5	2.4	-	-	-	-	-	-	-	2.2	2.9	2.9	8	-	-	-	-
Vanadium	mg/kg	40	38	41	40	1.5	42	45	45	44	1.7	75	72	61	68	76	-	-	-	-	-	-	-	57	75	76	12	94	123	126	3
Zinc	mg/kg	59	56	58	58	1.5	69	71	74	71	2.5	74	73	71	79	78	-	-	-	-	-	-	-	85	105	110	30	95	109	109	3

[1] All values reported as < method detection limit (MDL) were used at the MDL value for calculation of summary statistics. If all reported values were < MDL, the mean is reported as < MDL.

[2] Stations LN and LS assessed in 1989 are approximately equivalent to stations B1 and B2 assessed in following sampling years. Concentrations reported in 1989 were for the <0.149mm fraction only.

[3] Concentrations reported in October 1996 were for the silt and clay (<63µm) fraction only.

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[a] Particle size fractions for these samples are as follows: sand (2.0mm - 0.053mm), silt (0.053mm - 0.002mm), clay (<0.002mm).

[b] Particle size results for this station are based on one composite sample and the size fractions are as follows: sand (2.0mm - 0.065mm), (0.065mm - 0.0041mm), clay (<0.0041mm).

[c] Particle size fractions for these samples are as follows: sand (2.0mm - 0.063mm), silt (0.063mm-0.0039 or 0.0038mm), clay (<0.0039 or < 0.0038mm).

[d] Reported sand fraction also included silt and clay fractions (< 0.002mm - 2.0mm).

(Shaded cell) Method detection limit (MDL) was > maximum detectable value for basin or mid-depth data sets; value was omitted from calculation of respective summary statistics.

APPENDIX B

SAMPLE LOCATIONS AND COLLECTION DATES

CONTENTS OF APPENDIX B

Table B.1: Location and sampling dates of Sediment Quality Impact Characterization sampling stations, Mount Polley Mine, 2014 [1].

Waterbody	Area	Area #	Station	Date	UTM (Zone 10U)	
					Easting	Northing
Hazeltine Creek	Upper	ST16	ST16-S1	7-Oct-14	595769	5820069
			ST16-S2	7-Oct-14	595789	5820046
			ST16-S3	8-Oct-14	595825	5820023
			ST16-S4	8-Oct-14	595848	5820017
			ST16-S5	8-Oct-14	595899	5819968
	Middle	ST09	ST09-S1	7-Oct-14	598164	5817674
			ST09-S2	7-Oct-14	598224	5817641
			ST09-S3	7-Oct-14	598224	5817623
			ST09-S4	7-Oct-14	598340	5817610
			ST09-S5	7-Oct-14	598379	5817602
	Lower	ST02	ST02-S1	7-Oct-14	601131	5817185
			ST02-S2	7-Oct-14	601137	5817176
			ST02-S3	7-Oct-14	601141	5817162
			ST02-S4	7-Oct-14	601118	5817163
			ST02-S5	7-Oct-14	601087	5817188
Polley Lake	North Side - Mid-depth	POL-1	POL-1-01	21-Oct-14	593203	5825674
			POL-1-02	20-Oct-14	594371	5824182
			POL-1-03	20-Oct-14	593783	5824290
			POL-1-04	21-Oct-14	593242	5825062
			POL-1-05	22-Oct-14	593669	5825123
	P1 - Deep	POL-P1	POL-P1-01	9-Oct-14	593708	5824693
			POL-P1-02	9-Oct-14		
			POL-P1-03	17-Oct-14		
	South Side - Mid-depth	POL-2	POL-2-01	22-Oct-14	594689	5822625
			POL-2-02	22-Oct-14	595533	5821775
			POL-2-03	23-Oct-14	595367	5821612
			POL-2-04	23-Oct-14	595061	5822011
			POL-2-05	24-Oct-14	594932	5823054
	P2 - Deep	POL-P2	POL-P2-01	24-Oct-14	595166	5822183
			POL-P2-02	24-Oct-14		
			POL-P2-03	24-Oct-14		
Bootjack Lake	Mid-depth (Bootjack Lake)	BOL-1	BOL-1-01	22-Oct-14	591151	5821590
			BOL-1-02	22-Oct-14	591977	5820967
			BOL-1-03	22-Oct-14	591805	5821502
			BOL-1-03X	22-Oct-14	591805	5821502
			BOL-1-04	22-Oct-14	590556	5823321
			BOL-1-05	22-Oct-14	590007	5823593
	B1 - Deep (Bootjack B1)	BOL-B1	BOL-B1-01	23-Oct-14	590049	5823528
			BOL-B1-02	23-Oct-14	590085	5823479
			BOL-B1-03	23-Oct-14	590086	5823473
	B2 - Deep	BOL-B2	BOL-B2-01	22-Oct-14	591263	5821647
			BOL-B2-02	22-Oct-14	591243	5821665
			BOL-B2-03	23-Oct-14	591233	5821668
Quesnel Lake Littoral	Near-Field (LNF1)	QUL - 45	QUL-45-01	13-Aug-14	601524	5817990
			QUL-45-02	13-Aug-14	601457	5818033
			QUL-45-03	15-Aug-14	601451	5818067
			QUL-45-04	16-Aug-14	601555	5817927
			QUL-45-05	16-Aug-14	601479	5818047
	Near-Field 2 (LNF2)	QUL - 49	QUL-49-01	18-Aug-14	602436	5817331
			QUL-49-02	20-Aug-14	602443	5817311
			QUL-49-03	20-Aug-14	602447	5817278
			QUL-49-04	23-Aug-14	602461	5817240
			QUL-49-05	23-Aug-14	602478	5817209

Table B.1: Location and sampling dates of Sediment Quality Impact Characterization sampling stations, Mount Polley Mine, 2014 [1].

Waterbody	Area	Area #	Station	Date	UTM (Zone 10U)	
					Easting	Northing
Quesnel Lake Littoral	Downstream Far-Field (LFF)	QUL - 47	QUL-47-01	27-Aug-14	601680	5820049
			QUL-47-02	27-Aug-14	600441	5822695
			QUL-47-03	4-Sep-14	600932	5818778
			QUL-47-04	4-Sep-14	600861	5818809
			QUL-47-05	4-Sep-14	601035	5821268
	Downstream Far-Far-Field (LFFF)	QUL - 48	QUL-48-01	6-Sep-14	598891	5826331
			QUL-48-02	7-Sep-14	598381	5828386
			QUL-48-03	7-Sep-14	598265	5828863
			QUL-48-04	7-Sep-14	598419	5829333
			QUL-48-05	7-Sep-14	598855	5827778
	Horsefly Bay Reference (LRef1)	QUL - 51	QUL-51-01	26-Aug-14	610136	5813949
			QUL-51-02	24-Aug-14	610003	5813958
			QUL-51-03	25-Aug-14	610097	5813939
			QUL-51-04	25-Aug-14	610164	5813960
			QUL-51-05	26-Aug-14	610031	5813948
	North Arm Reference (LRef2)	QUL - 52	QUL-52-01	16-Oct-14	647854	5848682
			QUL-52-02	16-Oct-14	647665	5848694
			QUL-52-03	16-Oct-14	647575	5848716
			QUL-52-04	17-Oct-14	647456	5848899
			QUL-52-05	17-Oct-14	647381	5848955
Quesnel Lake Profundal	Near-Field (PNF)	QULP - 1	QULP-1-01	9-Sep-14	601795	5818151
			QULP-1-02	10-Sep-14	601672	5818297
			QULP-1-03	11-Sep-14	601914	5818113
			QULP-1-04	12-Sep-14	602623	5817818
			QULP-1-05	13-Sep-14	602272	5817946
	Downstream Far-Field (PFF1)	QULP-2	QULP-2-01	19-Sep-14	600001	5822025
			QULP-2-02	19-Sep-14	600054	5822165
			QULP-2-03	19-Sep-14	600055	5821871
			QULP-2-04	20-Sep-14	600032	5821992
			QULP-2-05	20-Sep-14	600101	5821772
	Downstream Far-Far-Field (PFFF)	QULP-3	QULP-3-01	15-Oct-14	599391	5824787
			QULP-3-02	15-Oct-14	599400	5824715
			QULP-3-03	15-Oct-14	599327	5824771
			QULP-3-04	15-Oct-14	599299	5824643
			QULP-3-05	16-Oct-14	599416	5824674
	Upstream Far-Field (PFF2)	QULP-4	QULP-4-01	8-Oct-14	604448	5816575
			QULP-4-02	8-Oct-14	604577	5816633
			QULP-4-03	10-Oct-14	604331	5816772
			QULP-4-04	20-Oct-14	604172	5816728
			QULP-4-05	20-Oct-14	604244	5816618
	Reference 1 (PRef1)	QULP-5	QULP-5-01	13-Sep-14	610430	5814778
			QULP-5-02	14-Sep-14	610294	5814639
			QULP-5-03	17-Sep-14	610613	5814885
			QULP-5-04	18-Sep-14	610526	5814608
			QULP-5-05	18-Sep-14	610714	5814799
	Reference 2 (PRef2)	QULP-6	QULP-6-01	17-Oct-14	633966	5827657
			QULP-6-02	18-Oct-14	634022	5827736
			QULP-6-03	18-Oct-14	634229	5827489
			QULP-6-04	18-Oct-14	634088	5827559
			QULP-6-05	20-Oct-14	634129	5827711
	Sediment Coring Station		QUL-PW	1-Sep-14	601938	5818053

Table B.1: Location and sampling dates of Sediment Quality Impact Characterization sampling stations, Mount Polley Mine, 2014 [1].

Waterbody	Area	Area #	Station	Date	UTM (Zone 10U)	
					Easting	Northing
Quesnel Lake Profundal	Spatial Impact Delineation Stations		QULP-10	5-Sep-14	601740	5817891
			QULP-11	5-Sep-14	601856	5818128
			QULP-12	5-Sep-14	601989	5818299
			QULP-13	5-Sep-14	602092	5818442
			QULP-14	5-Sep-14	602154	5818581
			QULP-15	5-Sep-14	601828	5818424
			QULP-16	5-Sep-14	601648	5818603
			QULP-17	5-Sep-14	601305	5819008
			QULP-18	5-Sep-14	600800	5819883
			QULP-19	5-Sep-14	600478	5820734
			QULP-20	5-Sep-14	600043	5821546
			QULP-21	5-Sep-14	602491	5817733
			QULP-22	5-Sep-14	602631	5817929
			QULP-23	5-Sep-14	602728	5818085
			QULP-24	5-Sep-14	603070	5817755
			QULP-25	8-Sep-14	599874	5822951
			QULP-26	8-Sep-14	599893	5822255
			QULP-27	8-Sep-14	599954	5821891
			QULP-28	8-Sep-14	599829	5821593
			QULP-29	8-Sep-14	599833	5821090
			QULP-30	8-Sep-14	600148	5820896
			QULP-31	8-Sep-14	600459	5821112
			QULP-32	8-Sep-14	600235	5820397
			QULP-33	8-Sep-14	600609	5820370
			QULP-34	8-Sep-14	601393	5819783
			QULP-35	8-Sep-14	601885	5818822
			QULP-36	8-Sep-14	602886	5817478
			QULP-37	8-Sep-14	602700	5817288
			QULP-38	8-Sep-14	603577	5817176
			QULP-39	8-Sep-14	603660	5816796
			QULP-40	8-Sep-14	604141	5817212
			QULP-41	8-Sep-14	604478	5816597
			QULP-42	9-Sep-14	611221	5816426
			QULP-43	9-Sep-14	607739	5817092
			QULP-44	9-Sep-14	606485	5816928
			QULP-45	9-Sep-14	605704	5816727
			QULP-46	9-Sep-14	605169	5816876
			QULP-47	9-Sep-14	604673	5816157
Quesnel River	Reference 1 (Blackwater Creek)		BLC	26-Oct-14	490298	5904319
	Reference 2 (Clearwater River)		CLR	22-Oct-14	705726	5738077
	Reference 3 (Cariboo River)		CAR	18-Oct-14	599224	5835783
	Quesnel River, Upstream of the fork		QUR1	15-Oct-14	595132	5830806
	Quesnel River, Upstream of the fork		QUR2	16-Oct-14	594545	5830888
	Quesnel River, Upstream of the fork		QUR3	17-Oct-14	590120	5835403
	Quesnel River, Downstream of the forks		QUR4	26-Oct-14	568954	5835483
	Quesnel River, Downstream of the forks		QUR5	25-Oct-14	553756	5852189
	Quesnel River, Downstream of the forks		QUR6	19-Oct-14	544360	5870630

[1] At sampling stations where sample collections occurred over more than one day, the initial sampling date is presented.

APPENDIX C

DATA QUALITY ASSESSMENT

APPENDIX C: DATA QUALITY ASSESSMENT

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C1.0 INTRODUCTION

Data Quality Assessment (DQA) was conducted on data collected as part of the Mount Polley Mining Corporation Sediment Quality Impact Characterization (SQIC). The objective of DQA is to define the overall quality of the data presented in the report, and, by extension, the confidence with which the data can be used to derive conclusions.

C1.1 Background

A variety of factors can influence the physical, chemical and biological measurements made in an environmental study and thus affect the accuracy and/or precision of the data. Inconsistencies in sampling or laboratory methods, use of instruments that are inadequately calibrated or which cannot measure to the desired level of accuracy or precision, and contamination of samples in the field or laboratory are just some of the potential factors that can lead to the reporting of data that do not accurately reflect actual environmental conditions. Depending on the magnitude of the problem, inaccuracy or imprecision have the potential to affect the reliability of any conclusions made from the data. Therefore, it is important to ensure that programs incorporate appropriate steps to control the non-natural sources of data variability (i.e., minimize the variability that does not reflect natural spatial and temporal variability in the environment) and thus assure the quality of the data.

Data quality as a concept is meaningful only when it relates to the intended use of the data. That is, one must know the context in which the data will be interpreted in order to establish a relevant basis for judging whether or not the data set is adequate. DQA involves comparison of actual field and laboratory measurement performance to data quality objectives (DQOs) established for a particular study, such as evaluation of method detection limits, blank sample data, data precision (based on field and laboratory duplicate samples), and data accuracy (based on matrix spike recoveries and/or analysis of standards or certified reference materials). Only trusted and certified laboratories (e.g., analytical chemistry laboratories certified by Canadian Association for Laboratory Accreditation [CALA]) were involved in the SQIC and such certified laboratories have rigorous internal quality assurance programs that ensure the highest possible quality.

DQOs were established at the outset of the SQIC that reflect reasonable and achievable performance expectations. Programs involving a large number of samples and analytes usually yield some results that exceed the DQOs. This is particularly so for multi-element scans since the analytical conditions are not necessarily optimal for every element included in the scan. Generally, scan results may be considered acceptable if no more than 20% of the parameters fail to meet the DQOs. Overall, the intent of DQA is not to reject any measurement that did not meet a DQO, but to ensure that any questionable data received more scrutiny to determine what effect, if any, this had on interpretation of results within the context of this project.

C1.2 Types of Quality Control Samples

Several types of quality control (QC) samples were assessed based on samples collected (or prepared) in the field and laboratory. These samples include the following:

- **Blanks** are samples of de-ionized water and/or appropriate reagent(s) that are handled and analyzed the same way as regular samples. These samples will reflect any contamination that occurred in the field (in the case of field or trip blanks) or the laboratory (in the case of laboratory or method blanks). Analyte concentrations should be non-detectable, although a data quality objective of twice the method detection limit allows for slight “noise” around the detection limit.

- **Field Duplicates** are replicate samples collected from a randomly selected field station using identical collection and handling methods that are then analyzed separately in the laboratory. The duplicate samples are handled and analyzed in an identical manner in the laboratory. The data from field duplicate samples reflect natural variability, as well as the variability associated with sample collection methods, and therefore provide a measure of field precision.

- **Laboratory Duplicates** are replicate sub-samples created in the laboratory from randomly selected field samples which are sub-sampled and then analyzed independently using identical analytical methods. The laboratory duplicate sample results reflect any variability introduced during laboratory sample handling and analysis and thus provide a measure of laboratory precision.

- **Spike Recovery Samples** are created in the laboratory by adding a known amount/concentration of a given analyte (or mixture of analytes) to a randomly selected test sample previously divided to create two sub-samples. The spiked and regular sub-samples are then analyzed in an identical manner. The spike recovery represents the difference between the measured spike amount (total amount in spiked sample minus amount in original sample) relative to the known spike amount (as a percentage). Two types of spike recovery samples are commonly analyzed. Spiked blanks (or blank spikes) are created using laboratory control materials whereas matrix spikes are created using field-collected samples. The analysis of spiked samples provides an indication of the accuracy of analytical results.

- **Certified Reference Materials and QC Standards** are samples containing known chemical concentrations that are processed and analyzed along with batches of environmental samples. The sample results are then compared to target results to provide a measure of analytical accuracy. The results are reported as the percent of the known amount that was recovered in the analysis.

Two types of QC were applied to sediment toxicity testing as follows:

- **The Laboratory Control** test vessel(s) associated with sediment toxicity testing do not contain any of the material to be tested, rather are composed of sand augmented with the addition of a small amount of organic matter (peat moss). Organism survival and growth in the control vessel(s) are monitored and must show adequate survival and achieve a minimum weight at the end of the test.

- **Reference Toxicant Testing** involves conducting toxicity tests concurrent with the tests of field sediments using a toxicant for which the laboratory has developed limits. The results of the reference toxicant testing should fall within the developed limits. This testing ensures that internal test systems are in check and that the sensitivity of the test organisms is within an expected range.

Two types of QC were applied to benthic invertebrate community samples as follows:

- **Organism Recovery Checks** for benthic invertebrate community samples involve the re-processing of previously sorted material from a randomly selected sample to determine the number of invertebrates that were not recovered during the original sample processing. The reprocessing is conducted by an analyst not involved in the original processing to reduce any bias. This check allows the determination of accuracy through assessment of recovery efficiency.

- **Sub-Sampling Error** is assessed for studies in which benthic invertebrate community samples require sub-sampling (due to excessive sample volume and/or invertebrate density). By comparing the numbers of benthic invertebrates recovered between at least two sub-samples, this measure provides an evaluation of how effective the sub-sampling method was in evenly dividing the original sample. Therefore, sub-sampling error provides a measure of analytical precision. The processing of entire benthic invertebrate community samples in representative sample fractions also allows an evaluation of sub-sampling accuracy.

C2.0 WATER SAMPLES

C2.1 Method Detection Limits

Method detection limits (MDLs) were examined and assessed in all cases where sample results were reported as less than the MDL. For analytes for which a water quality guideline for the protection of aquatic life is available (Table C.1), the MDL should be lower than the guideline value.

All reported MDLs for both surface water and overlying water were lower than the guideline values (Table C.2).

All reported MDLs for sediment pore-water were lower than the guideline value with the exception of mercury (11 out of 50 samples; Table C.3). It is notable that mercury was not identified as a parameter of interest (POI) in the study and that water quality guidelines for the protection of aquatic life do not specifically apply to sediment pore-water. Therefore, the observed pore-water MDL greater than the mercury guideline for surface water does not impair data interpretability or study conclusions.

C2.2 Laboratory Blank Sample Analysis

More than 1,200 laboratory blank sample results were reported (Appendix J). In several instances, alkalinity was detected above the MDL in method blanks; however, in all cases, the associated sample results were at least five times greater than the blank levels and therefore the sample results were deemed reliable by the laboratory (Appendix J). Overall, this indicates no inadvertent contamination of samples within the laboratory during analysis.

C2.3 Field Blank Sample Analysis

A substantial number of field blanks were collected in association with surface water quality sampling and are reported elsewhere (Golder 2015). A single field blank sample was associated with sediment pore-water sampling. There was a detectable level of nitrate present in the sample (0.202 mg/L; Table C.4). Although this is an unusual result, it did not affect data interpretability or study conclusions. Although water quality guidelines for the protection of aquatic life do not apply to pore-water, this result was approximately 15-times below the guideline for nitrate in surface water. Furthermore, nitrate was not identified as an analyte of concern in a separate water quality impact assessment (Golder 2015). No other analytes were detectable in the field blank.

Table C.1: British Columbia water quality guidelines for the protection of aquatic life.

Analyte		Units	British Columbia Water Quality Guidelines [a]
Anions and Nutrients	pH	pH units	6.5 - 9.0
	Alkalinity Total (as $CaCO_3$)	mg/L	< 10
	Chloride	mg/L	150/600
	Fluoride	mg/L	1.07 [b]
	Sulfate (SO_4)	mg/L	218 [b]
	Total Ammonia (as N)	mg/L	0.102 / 0.681 [c]
	Phosphorus (Total)	mg/L	-/0.005
	Nitrate (as N)	mg/L	3.0 / 32.8
	Nitrite (as N)	mg/L	0.02 / 0.06 [d]
Total Metals	Antimony	mg/L	0.009/ -
	Arsenic	mg/L	- /0.005
	Barium	mg/L	1 / -
	Beryllium	mg/L	0.00013 / -
	Boron	mg/L	- /1.2
	Chromium	mg/L	0.001/- [e]
	Cobalt	mg/L	0.004/0.11
	Copper	mg/L	0.002/0.0069 [b]
	Iron	mg/L	- /1
	Lead	mg/L	0.005/0.036 [b]
	Manganese	mg/L	0.83/1.1 [b]
	Mercury	mg/L	0.00002/- [f]
	Molybdenum	mg/L	1/2
	Nickel	mg/L	- /0.025 [b]
	Phosphorus		-/0.0050
	Selenium	mg/L	0.002/ -
	Silver	mg/L	0.00005/0.0001 [b]
	Thallium	mg/L	0.0008/-
	Uranium	mg/L	0.0085/-
	Zinc	mg/L	0.0075/0.033 [b]
Dissolved Metals	Aluminum	mg/L	0.05/0.10
	Cadmium	mg/L	0.0001/0.0003 [b]
	Iron	mg/L	-/0.35

[a] British Columbia Water Quality Guidelines (BCMOE 2015a, BCMOE 2015b); Chronic / Acute.

[b] Guideline value calculated using the lowest hardness for surface water hardness for applicable water bodies (Quesnel Lake, Quesnel River and Polley Lake) of 52 mg/L.

[c] Lowest tabulated chornic and acute ammonia guidelines based on pH and temperature reported in BCMOE (2015a).

[d] For low chloride water (< 2mg/L)

[e] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.

[f] Highest mercury guideline value; MeHg = 0.5% of THg

Table C.2: Method detection limit achieved for non-detectable results for surface water and overlying water samples. Highlighting indicates MDL that did not meet the guideline.

Analyte		Units	British Columbia Water Quality Guidelines [a]	Maximum Method Detection Limit Achieved
Anions and Nutrients	Chloride	mg/L	150/600	0.5
	Total Ammonia (as N)	mg/L	0.102 / 0.681 [c]	0.005
	Nitrite (as N)	mg/L	0.02 / 0.06 [d]	0.001
Total Metals	Antimony	mg/L	0.009/ -	0.0001
	Beryllium	mg/L	0.00013 / -	0.0001
	Boron	mg/L	- /1.2	0.01
	Chromium	mg/L	0.001/- [e]	0.0005
	Cobalt	mg/L	0.004/0.11	0.0001
	Copper	mg/L	0.002/0.0069 [b]	0.0005
	Lead	mg/L	0.005/0.036 [b]	0.00005
	Nickel	mg/L	- /0.025 [b]	0.0005
	Selenium	mg/L	0.002/ -	0.0005
	Silver	mg/L	0.00005/0.0001 [b]	0.00001
	Thallium	mg/L	0.0008/-	0.00001
	Zinc	mg/L	0.0075/0.033 [b]	0.003
Dissolved Metals	Aluminum	mg/L	0.05/0.10	0.003
	Cadmium	mg/L	0.0001/0.0003 [b]	0.00001
	Iron	mg/L	-/0.35	0.03

[a] British Columbia Water Quality Guidelines (BCMOE 2015a, BCMOE 2015b); Chronic / Acute.

[b] Guideline value calculated using the lowest hardness for surface water hardness for applicable water bodies (Quesnel Lake, Quesnel River and Polley Lake) of 52 mg/L.

[c] Lowest tabulated chornic and acute ammonia guidelines based on pH and temperature reported in BCMOE (2015a).

[d] For low chloride water (< 2mg/L)

[e] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.

[f] Highest mercury guideline value; MeHg = 0.5% of THg

Table C.3: Method detection limit achieved for non-detectable results for porewater samples. Highlighting indicates MDL that did not meet the guideline.

Analyte		Units	British Columbia Water Quality Guidelines [a]	Maximum Method Detection Limit Achieved
Anions and Nutrients	Chloride	mg/L	150/600	2
	Nitrite (as N)	mg/L	0.02 / 0.06 [c]	0.001
Total Metals	Antimony	mg/L	0.009/ -	0.0001
	Beryllium	mg/L	0.00013 / -	0.0001
	Chromium	mg/L	0.001/- e	0.0005
	Cobalt	mg/L	0.004/0.11	0.0001
	Iron	mg/L	- /1	0.06
	Lead	mg/L	0.015/0.30 [b]	0.00005
	Mercury	mg/L	0.00002/- [f]	0.0002
	Nickel	mg/L	- /0.150 [b]	0.002
	Selenium	mg/L	0.002/ -	0.0005
	Silver	mg/L	0.0015/0.0030 [b]	0.00001
	Thallium	mg/L	0.0008/-	0.00001
	Zinc	mg/L	0.15/0.17 [b]	0.012
Dissolved Metals	Aluminum	mg/L	0.05/0.10	0.003
	Cadmium	mg/L	0.00045/0.0017 [b]	0.00001
	Iron	mg/L	-/0.35	0.06

[a] British Columbia Water Quality Guidelines (BCMOE 2015a, BCMOE 2015b); Chronic / Acute.

[b] Guideline value calculated using the mean porewater hardness of 279 mg/L for applicable water bodies (Quesnel Lake, Quesnel River and Polley Lake).

[c] For low chloride water (< 2mg/L)

[d] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.

[e] Highest mercury guideline value; MeHg = 0.5% of THg

Table C.4: Results of analysis of field blank sample.
Highlighting indicates a detectable result.

Analyte	Units	Result
Physical Tests		
Hardness (as CaCO3)	mg/L	<2.2
Anions and Nutrients		
Bromide (Br)	mg/L	<0.20
Chloride (Cl)	mg/L	<2.0
Fluoride (F)	mg/L	<0.080
Nitrate (as N)	mg/L	0.20
Nitrite (as N)	mg/L	<0.0040
Sulfate (SO4)	mg/L	<2.0
Sulphide as S	mg/L	<0.10
Total Metals		
Aluminum (Al)-Total	mg/L	<0.0030
Antimony (Sb)-Total	mg/L	<0.00010
Arsenic (As)-Total	mg/L	<0.00010
Barium (Ba)-Total	mg/L	<0.00010
Beryllium (Be)-Total	mg/L	<0.00010
Bismuth (Bi)-Total	mg/L	<0.00050
Boron (B)-Total	mg/L	<0.010
Cadmium (Cd)-Total	mg/L	<0.000010
Calcium (Ca)-Total	mg/L	<0.25
Chromium (Cr)-Total	mg/L	<0.00050
Cobalt (Co)-Total	mg/L	<0.00010
Copper (Cu)-Total	mg/L	<0.00050
Iron (Fe)-Total	mg/L	<0.15
Lead (Pb)-Total	mg/L	<0.000050
Lithium (Li)-Total	mg/L	<0.00050
Magnesium (Mg)-Total	mg/L	<0.50
Manganese (Mn)-Total	mg/L	<0.00020
Molybdenum (Mo)-Total	mg/L	<0.000050
Nickel (Ni)-Total	mg/L	<0.00050
Potassium (K)-Total	mg/L	<0.050
Selenium (Se)-Total	mg/L	<0.00050
Silicon (Si)-Total	mg/L	<0.25
Silver (Ag)-Total	mg/L	<0.000010
Sodium (Na)-Total	mg/L	<0.050
Strontium (Sr)-Total	mg/L	<0.00020
Thallium (Tl)-Total	mg/L	<0.000010
Tin (Sn)-Total	mg/L	<0.00010
Titanium (Ti)-Total	mg/L	<0.050
Uranium (U)-Total	mg/L	<0.000010
Vanadium (V)-Total	mg/L	<0.0010
Zinc (Zn)-Total	mg/L	<0.0030

C2.4 Data Precision

Field Duplicate Samples

A substantial number of field duplicates were collected in association with surface water quality sampling and are reported elsewhere (Golder 2015). One duplicate water sample was collected in the field as part of the surface water sampling conducted to support benthic invertebrate community assessment of the Quesnel River. The duplicates showed excellent agreement in concentrations of all analytes except dissolved manganese (relative percent difference of 72.5%; Table C.5). Although the data quality objective of a relative percent difference (RPD) of ≤ 25% was not met for dissolved manganese, it was associated with a very low concentration (well below the range that would be of interest from the perspective of potential effects to aquatic life). RPDs for all other analytes were < 10%. Overall, the field duplicate sampling did not indicate any inconsistencies in sampling technique nor issue that could impair data interpretability.

Laboratory Duplicate Samples

A substantial number of laboratory duplicates were collected in association with surface water quality sampling and are reported elsewhere (Golder 2015). Forty laboratory duplicate analyses were associated with the pore-water samples and water samples collected to support the benthic invertebrate community assessment of the Quesnel River (Appendix J). In all cases where it was possible to calculate the relative percent difference (i.e., for all detectable results) samples met the objectives established by the laboratory, indicating excellent analytical precision.

C2.5 Data Accuracy

Over 900 analytical runs using certified reference materials were completed by the analytical laboratory and in all cases, objectives established by the laboratory were met (Appendix J). Similarly, over 1,000 results for matrix spike analyses were reported (Appendix J). In approximately 10% of the matrix spike results, the spike recovery could not be accurately calculated due to a high concentration of the analyte in the background sample. In all cases where spike recovery could be accurately calculated, recoveries met the objectives established by the laboratory (Appendix J). These data indicate excellent analytical accuracy associated with the water samples.

Table C.5: Relative percent difference (RPD) between field duplicate samples.
Highlighting indicates RPD that did not meet the objective of ≤ 25%.

Analyte	Units	QUR-2-141016 16-OCT-14	QUR-2-141016-X 16-OCT-14	Relative Percent Difference [a]
Physical Tests				
Conductivity	uS/cm	106	106	0
Hardness (as CaCO3)	mg/L	52.8	53.0	0.38
pH	pH units	7.98	7.96	0.25
Total Suspended Solids	mg/L	<3.0	<3.0	-
Total Dissolved Solids	mg/L	66	69	4.4
Turbidity	NTU	0.81	0.80	1.2
Anions and Nutrients				
Alkalinity, Total (as CaCO3)	mg/L	48	48	0.21
Ammonia, Total (as N)	mg/L	<0.0050	<0.0050	-
Chloride (Cl)	mg/L	<0.50	<0.50	-
Fluoride (F)	mg/L	0.032	0.035	9.0
Nitrate (as N)	mg/L	0.062	0.062	1.1
Nitrite (as N)	mg/L	<0.0010	<0.0010	-
Total Nitrogen	mg/L	0.12	0.12	0.82
Orthophosphate-Dissolved (as P)	mg/L	<0.0010	<0.0010	-
Phosphorus (P)-Total Dissolved	mg/L	<0.0020	<0.0020	-
Phosphorus (P)-Total	mg/L	0.0031	0.0031	0
Sulfate (SO4)	mg/L	6.3	6.3	0.16
Organic / Inorganic Carbon				
Dissolved Organic Carbon	mg/L	2.0	2.1	6.9
Total Metals				
Aluminum (Al)-Total	mg/L	0.039	0.040	2.3
Antimony (Sb)-Total	mg/L	<0.00010	<0.00010	-
Arsenic (As)-Total	mg/L	0.00017	0.00016	6.1
Barium (Ba)-Total	mg/L	0.0059	0.0060	0.34
Beryllium (Be)-Total	mg/L	<0.00010	<0.00010	-
Bismuth (Bi)-Total	mg/L	<0.00050	<0.00050	-
Boron (B)-Total	mg/L	<0.010	<0.010	-
Cadmium (Cd)-Total	mg/L	<0.000010	<0.000010	-
Calcium (Ca)-Total	mg/L	18	18	1.1
Chromium (Cr)-Total	mg/L	<0.00050	<0.00050	-
Cobalt (Co)-Total	mg/L	<0.00010	<0.00010	-
Copper (Cu)-Total	mg/L	0.0014	0.0015	4.2
Iron (Fe)-Total	mg/L	0.031	0.033	6.3
Lead (Pb)-Total	mg/L	<0.000050	<0.000050	-
Lithium (Li)-Total	mg/L	0.00081	0.00080	1.2
Magnesium (Mg)-Total	mg/L	2.0	2.0	1.5
Manganese (Mn)-Total	mg/L	0.0019	0.0018	3.2
Molybdenum (Mo)-Total	mg/L	0.00037	0.00036	2.5
Nickel (Ni)-Total	mg/L	<0.00050	<0.00050	-
Potassium (K)-Total	mg/L	0.49	0.48	1.2
Selenium (Se)-Total	mg/L	<0.00050	<0.00050	-
Silicon (Si)-Total	mg/L	1.5	1.5	1.3
Silver (Ag)-Total	mg/L	<0.000010	<0.000010	-
Sodium (Na)-Total	mg/L	0.96	0.95	0.84
Strontium (Sr)-Total	mg/L	0.13	0.14	6.8
Thallium (Tl)-Total	mg/L	<0.000010	<0.000010	-
Tin (Sn)-Total	mg/L	<0.00010	<0.00010	-
Titanium (Ti)-Total	mg/L	<0.010	<0.010	-
Uranium (U)-Total	mg/L	0.00016	0.00016	1.3
Vanadium (V)-Total	mg/L	<0.0010	<0.0010	-
Zinc (Zn)-Total	mg/L	<0.0030	<0.0030	-
Dissolved Metals				
Aluminum (Al)-Dissolved	mg/L	0.0076	0.0077	1.3
Antimony (Sb)-Dissolved	mg/L	<0.00010	<0.00010	-
Arsenic (As)-Dissolved	mg/L	0.00012	0.00013	8.0
Barium (Ba)-Dissolved	mg/L	0.0055	0.0055	0.18
Beryllium (Be)-Dissolved	mg/L	<0.00010	<0.00010	-
Bismuth (Bi)-Dissolved	mg/L	<0.00050	<0.00050	-
Boron (B)-Dissolved	mg/L	<0.010	<0.010	-
Cadmium (Cd)-Dissolved	mg/L	<0.000010	<0.000010	-
Calcium (Ca)-Dissolved	mg/L	18	18	0.56
Chromium (Cr)-Dissolved	mg/L	<0.00050	<0.00050	-
Cobalt (Co)-Dissolved	mg/L	<0.00010	<0.00010	-
Copper (Cu)-Dissolved	mg/L	0.00091	0.00086	5.6
Iron (Fe)-Dissolved	mg/L	<0.030	<0.030	-
Lead (Pb)-Dissolved	mg/L	<0.000050	<0.000050	-
Lithium (Li)-Dissolved	mg/L	0.00076	0.00076	0
Magnesium (Mg)-Dissolved	mg/L	2.0	2.0	0.50
Manganese (Mn)-Dissolved	mg/L	0.00051	0.00024	73
Molybdenum (Mo)-Dissolved	mg/L	0.00033	0.00033	0.30
Nickel (Ni)-Dissolved	mg/L	<0.00050	<0.00050	-
Potassium (K)-Dissolved	mg/L	0.47	0.47	1.7
Selenium (Se)-Dissolved	mg/L	<0.00050	<0.00050	-
Silicon (Si)-Dissolved	mg/L	1.4	1.4	0.71
Silver (Ag)-Dissolved	mg/L	<0.000010	<0.000010	-
Sodium (Na)-Dissolved	mg/L	0.93	0.91	2.8
Strontium (Sr)-Dissolved	mg/L	0.13	0.13	0.80
Thallium (Tl)-Dissolved	mg/L	<0.000010	<0.000010	-
Tin (Sn)-Dissolved	mg/L	<0.00010	<0.00010	-
Titanium (Ti)-Dissolved	mg/L	<0.010	<0.010	-
Uranium (U)-Dissolved	mg/L	0.00015	0.00015	4.1
Vanadium (V)-Dissolved	mg/L	<0.0010	<0.0010	-
Zinc (Zn)-Dissolved	mg/L	<0.0030	<0.0030	-

[a] The method detection limit (MDL) value was used in instances where values less than the MDL were reported.
RPD calculation: =(Absolute(Replicate 1 - Replicate 2))/Average(Replicate 1, Replicate 2)*100

C2.6 Holding Time and General Laboratory Flags

Several hold times were exceeded due to the combination of short optimal hold times and remote sampling (Appendix J). Analytes for which recommended hold times were exceeded included nitrate/nitrite (3-day hold time), pH (15-minute hold time), dissolved phosphorus (3-day hold time), turbidity (3-day hold time), and dissolved orthophosphate (3-day hold time). Results associated with the hold time exceedences appear not to have been affected as they were comparable to those associated with samples where hold times were met.

There were few general laboratory flags associated with the water quality data (Appendix J). Two pore-water vials arrived at the lab either empty or broken and therefore the requested analysis (anions) could not be conducted on these samples.

C3.0 SEDIMENT SAMPLES

C3.1 Method Detection Limits

Method detection limits (MDLs) were examined and assessed in all cases where sample results were reported as less than the MDL. Target MDLs for sediment sample analyses were established at levels below all potentially applicable sediment quality guidelines (Tables C.6 to C.9). Target MDLs were met from most metals in most sediment quality datasets (Table C.6 to C.9). For "total" analytes in sediment (strong acid digestion), target MDLs were generally not achieved for lead, magnesium, manganese, molybdenum, selenium, silver, strontium, and tin (Table C.6). However, concentrations of lead, magnesium, manganese, strontium, and zinc were consistently greater than the lowest achievable MDL, and therefore data interpretation was not compromised for these analytes. Of the four remaining analytes (molybdenum, selenium, silver and tin), only selenium and silver have sediment quality guidelines and the achieved MDLs were at least 5-times lower than guideline. Furthermore, concentrations of molybdenum, selenium, silver and tin were greater than the MDL in 91%, 97%, 94% and 63% of all samples, respectively. Overall, MDLs achieved for the analysis of total metals in sediment were appropriate for the study and did not adversely affect data interpretability.

MDLs associated with sediment shakeflask analyses achieved targets in the majority of samples (Table C.7) and are therefore appropriate for this study. MDLs achieved in the selective extraction analyses (SEA or "Tessier" extractions) met the target MDLs for most metals and extractants (Table C.8). Higher rates of objective exceedance were observed for the following: 1) barium, molybdenum and silver in "exchangeable" extracts; 2) chromium and silver in the "carbonate" extracts; 3) silver in the "easily reducible and iron oxide" and "organic" extracts; and 4) arsenic, barium, chromium, manganese, nickel, silver, strontium and titanium in the "residual" extracts (Table C.8). The SEA is a specialized analysis and it is therefore not surprising that some MDLs, which were developed for more routine analyses, were not achieved. For data interpretation, SEA results were primarily used to provide perspective on the relative distribution of metals among extracts (or "phases") and, in very few cases did MDLs impair interpretation. Furthermore, SEA results were particularly important for copper, for which target MDLs were met in all extracts. Overall, the cases of achieved MDLs higher than target had only a small effect on data interpretability. Lastly, all MDLs achieved in the acid base accounting (ABA) analyses were suitable for project objectives (Table C.9).

Table C.6: Laboratory method detection limits (MDLs) for basic sediment chemistry analyses relative to targets and to guidelines. Only analytes with <MDL values are reported.

Analyte		Units	BC Working Sediment Quality Guidelines [a]	Maximum Method Detection Limit Achieved
Non-metals	% Gravel	%	-	0.1
	% Sand	%	-	0.1
	Total Nitrogen	%		0.02
	Total Organic Carbon	%	-	0.1
Metals	Antimony	mg/kg	-	0.1
	Beryllium	mg/kg	-	0.2
	Bismuth	mg/kg	-	0.2
	Boron	mg/kg	-	10
	Cadmium	mg/kg	0.6/3.5	0.05
	Molybdenum	mg/kg	-	0.5
	Selenium	mg/kg	2	0.2
	Silver	mg/kg	0.5	0.1
	Thallium	mg/kg	-	0.05
	Tin	mg/kg	-	2

[a] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, BCMOE 2015b); TEL (Threshold or Lowest Effect Level) / PEL (Probable or Severe Effect Level).

Table C.7: Laboratory method detection limits (MDLs) for leachable metals analyses in sediment samples (Shakeflask analyses) relative to targets and guidelines. Only analytes with <MDL values are reported. Highlighting indicates MDLs that did not meet the guidelines.

Analyte	Units	British Columbia Water Quality Guidelines [a]	Maximum Method Detection Limit Achieved
Aluminum	mg/L	-	0.4
Antimony	mg/L	0.009/ -	0.1
Arsenic	mg/L	- /0.005	0.1
Beryllium	mg/L	0.00013/ -	0.01
Bismuth	mg/L	-	0.2
Cadmium	mg/L	0.00027/0.00081 [b,c]	0.02
Chromium	mg/L	0.001/ - [d]	0.02
Cobalt	mg/L	0.004/0.11	0.02
Copper	mg/L	0.0055/0.015 [b]	0.02
Iron	mg/L	- /1	0.03
Lead	mg/L	0.008/0.12 [b]	0.1
Manganese	mg/L	1.21/2.05 [b]	0.01
Mercury	mg/L	0.00002/ - [e]	0.00005
Molybdenum	mg/L	1/2	0.06
Nickel	mg/L	- /0.121 [b]	0.1
Phosphorus	mg/L	- /0.005	0.6
Potassium	mg/L	-	4
Selenium	mg/L	0.002/ -	0.10
Silver	mg/L	0.0015/0.0030 [b]	0.02
Sodium	mg/L	-	2
Thallium	mg/L	0.0008/ -	0.4
Tin	mg/L	-	0.1
Titanium	mg/L	-	0.02
Uranium	mg/L	0.0085/ -	1
Vanadium	mg/L	-	0.06
Zinc	mg/L	0.043/0.068 [b]	0.04

[a] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); Chronic / Acute.

[b] Guideline value calculated using the mean leachable water hardness (137 mg/L) for applicable water bodies (Quesnel Lake, Quesnel River and Polley Lake) calculated using reported leachable calcium and magnesium concentrations.

[c] Applies to dissolved cadmium guideline.

[d] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.

[e] Lowest mercury guideline value; MeHg = 0.5% of THg

Table C.8: Laboratory method detection limits (MDLs) for selectively extracted metals analyses in sediment samples (Tessier extractions) relative to targets and guidelines. Only analytes with <MDL values are reported. Bold and italicized values indicate target MDL based on guideline was not achieved.

	Analyte	Units	BC Working Sediment Quality Guidelines [a]	Maximum Method Detection Limit Achieved
Exchangeable & Adsorbed Metals	Aluminum	mg/kg	-	50
	Antimony	mg/kg	-	0.10
	Arsenic	mg/kg	5.9/17	0.050
	Barium	mg/kg	-	40
	Beryllium	mg/kg	-	0.20
	Bismuth	mg/kg	-	0.20
	Cadmium	mg/kg	0.6/3.5	0.050
	Chromium	mg/kg	37.3/90	0.50
	Cobalt	mg/kg	-	0.10
	Copper	mg/kg	35.7/197	0.50
	Iron	mg/kg	21,200/43,766	50
	Lead	mg/kg	35/91	0.50
	Lithium	mg/kg	-	5.0
	Manganese	mg/kg	460/1,100	8.0
	Molybdenum	mg/kg	-	4.0
	Nickel	mg/kg	16/75	2.0
	Phosphorus	mg/kg	-	50
	Potassium	mg/kg	-	100
	Selenium	mg/kg	2	0.20
	Silver	mg/kg	0.5	0.10
	Sodium	mg/kg	-	100
	Thallium	mg/kg	-	0.050
	Tin	mg/kg	-	2.0
	Titanium	mg/kg	-	1.0
	Uranium	mg/kg	-	0.050
	Vanadium	mg/kg	-	0.20
	Zinc	mg/kg	123/315	1.0
Carbonate Metals	Aluminum	mg/kg	-	50
	Antimony	mg/kg	-	0.10
	Arsenic	mg/kg	5.9/17	0.050
	Beryllium	mg/kg	-	0.20
	Bismuth	mg/kg	-	0.20
	Cadmium	mg/kg	0.6/3.5	0.050
	Chromium	mg/kg	37.3/90	5.0
	Cobalt	mg/kg	-	0.10
	Copper	mg/kg	35.7/197	0.50
	Iron	mg/kg	21,200/43,766	50
	Lead	mg/kg	35/91	0.50
	Lithium	mg/kg	-	5.0
	Manganese	mg/kg	460/1,100	5.0
	Molybdenum	mg/kg	-	0.50
	Nickel	mg/kg	16/75	2.0
	Phosphorus	mg/kg	-	50
	Selenium	mg/kg	2	0.20
	Silver	mg/kg	0.5	0.10
	Strontium	mg/kg	-	5.0
	Thallium	mg/kg	-	0.050
	Tin	mg/kg	-	2.0
	Titanium	mg/kg	-	5.0
	Uranium	mg/kg	-	0.050
	Vanadium	mg/kg	-	0.20
	Zinc	mg/kg	123/315	1.0

Table C.8: Laboratory method detection limits (MDLs) for selectively extracted metals analyses in sediment samples (Tessier extractions) relative to targets and guidelines. Only analytes with <MDL values are reported. Bold and italicized values indicate target MDL based on guideline was not achieved.

Analyte		Units	BC Working Sediment Quality Guidelines [a]	Maximum Method Detection Limit Achieved
Easily Reducible Metals and Iron Oxides	Antimony	mg/kg	-	0.10
	Beryllium	mg/kg	-	0.20
	Bismuth	mg/kg	-	0.20
	Cadmium	mg/kg	0.6/3.5	0.050
	Lithium	mg/kg	-	5.0
	Molybdenum	mg/kg	-	0.50
	Phosphorus	mg/kg	-	50
	Selenium	mg/kg	2	0.20
	Silver	mg/kg	0.5	0.1
	Thallium	mg/kg	-	0.050
	Tin	mg/kg	-	2.0
	Titanium	mg/kg	-	1.0
Organic Bound Metals	Antimony	mg/kg	-	0.10
	Beryllium	mg/kg	-	0.20
	Bismuth	mg/kg	-	0.20
	Cadmium	mg/kg	0.6/3.5	0.050
	Chromium	mg/kg	37.3/90	0.50
	Lead	mg/kg	35/91	0.50
	Lithium	mg/kg	-	5.0
	Molybdenum	mg/kg	-	0.50
	Nickel	mg/kg	16/75	0.50
	Selenium	mg/kg	2	0.20
	Silver	mg/kg	0.5	0.10
	Thallium	mg/kg	-	0.050
	Tin	mg/kg	-	2.0
	Titanium	mg/kg	-	1.0
Residual Metals	Antimony	mg/kg	-	0.10
	Beryllium	mg/kg	-	0.20
	Bismuth	mg/kg	-	0.20
	Cadmium	mg/kg	0.6/3.5	0.050
	Molybdenum	mg/kg	-	0.50
	Selenium	mg/kg	2	0.20
	Silver	mg/kg	0.5	0.10
	Thallium	mg/kg	-	0.050
	Tin	mg/kg	-	2.0

[a] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL (Threshold or Lowest Effect Level) / PEL (Probable or Severe Effect Level).

Table C.9: Laboratory method detection limits (MDLs) for acid base accounting, sulphur, and carbon content analyses for sediment samples.

Parameter	Units	Achieved MDL Range	
		Lower	Upper
Maximum Potential Acidity (MPA)	$tCaCO_3$/1Kt	0.30 - 0.30	2,000 - 2,000
Fizz Rating	Unity	1.0 - 1.0	4.0 - 4.0
Net Neutralization Potential (NNP)	$tCaCO_3$/1Kt	1.0 - 1.0	1,000 - 1,000
pH	Unity	0.10 - 1.0	14.0 - 1,000
Neutralization Potential (NP)	$tCaCO_3$/1Kt	0.10 - 1.0	14.0 - 1,000
Neutralization Potential Ratio (NP/MPA)	Unity	0.010 - 0.010	1,000 - 1,000
Total Sulphur (S) - Leco	%	0.010 - 0.010	50 - 50
Sulphide Sulphur (S) - Calculated Leco	%	0.010 - 0.010	40 - 50
Sulphate Sulphur (S) - Carbonate Leach	%	0.010 - 0.010	40 - 50
Inorganic Carbon (C)	%	0.010 - 0.050	13.6 - 50
Carbon Dioxide (CO_2)	%	0.050 - 0.20	13.6 - 50
Sulphate Sulphur (S) - HCl leachable	%	0.010 - 0.20	50 - 50

C3.2 Laboratory Blank Sample Analysis

All of the laboratory blank results associated with the sediment analyses of non-metals, strong acid leachable metals, shakeflask extracted metals, SEA and ABA contained very low or non-detectable analyte concentrations (Appendix J). Only nine of approximately 2,370 blank samples associated with metals analysis failed to meet the DQO of less than or two-times the MDL (Appendix J); however, all associated sample results were at least five times greater than blank levels and are therefore considered reliable. Thirty-six of the approximately 3,200 (1%) method blank results associated with Tessier extractions failed to meet the DQO (Appendix J). Of these, about half were associated with sample results which were at least five-times greater than blank levels and are therefore considered reliable. For the rest, the Limits of Reporting were adjusted by the laboratory for samples with positive hits below five-times blank level (Appendix J). Consequently, these data are considered reliable. The method blank results for this study indicate no inadvertent contamination of samples within the laboratory during sediment analysis.

C3.3 Data Precision

Field Duplicate Samples

A total of 28 field duplicate sediment samples were collected for quality assurance (Tables C.10 to C.14). Evaluation of precision associated with sediment physical characteristics indicated good precision. Several instances of relative percent difference (RPD) greater than the objective of ≤ 40% RPD were observed for percent gravel or sand and total organic carbon content, but these were always at very low concentrations (Table C.10). Therefore, the precision associated with sediment physical analyses is suitable. Results for total sediment metals indicated excellent precision. In fact, there was only one case of RPD exceedence (mercury in sample QUL-47-03; Table C.11).

A number of cases of RPD > 40% were observed in the sediment shakeflask analyses (Table C.12). In all but one sample, these were limited to one or two analytes and RPD for manganese was greater than 40% in half of the field duplicates (Table C.12). In sample QUL-51-02, target RPD was exceeded for five analytes (calcium, iron, manganese, sodium and strontium), indicating poorer precision associated with this sample. Overall the precision associated with the shakeflask tests was poorer than for total sediment metals and appeared to be poorest for manganese. Conclusions based on manganese in shakeflask tests should consider the associated precision.

Table C.10: Field replicate results for the analysis of physical characteristics and non-metal parameters in sediment samples. Highlighted values did not meet the data quality objective of ≤ 40% Relative Percent Difference (RPD).

Station ID	Units	QUL-47-03			QUL-47-03 63UM			QUL-48-04			QULP-3-05			QULP-3-05<63 UM			QULP-4-02			QULP-4-02 <63UM		
Analyte		QUL-47-03Y	QUL-47-03Z	RPD [a]	QUL-47-03Y 63UM	QUL-47-03Z 63UM	RPD [a]	QUL-48-04Y	QUL-48-04Z	RPD [a]	QULP-3-05	QULP-3-05X	RPD [a]	QULP-3-05 <63 UM	QULP-3-05X <63 UM	RPD [a]	QULP-4-02	QULP-4-02X	RPD [a]	QULP-4-02 <63UM	QULP-4-02X <63UM	RPD [a]
Moisture	%	37	37	0	-	-	-	79	78	0.76	80	80	0	-	-	-	44	44	0.45	-	-	-
pH (1:2 soil: water)	pH units	6.5	6.5	0.61	6.7	6.6	2.0	-	-	-	-	-	-	7.4	7.3	1.1	8.2	8.2	0.61	8.6	8.6	0
pH (Leachable)	pH units	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Gravel	%	<0.10	<0.10	0	-	-	-	2.3	1.4	48	<0.10	<0.10	0	-	-	-	<0.10	<0.10	0	-	-	-
% Sand	%	58	59	1.5	-	-	-	16	18	11	0.43	0.30	36	-	-	-	0.10	<0.10	0	-	-	-
% Silt	%	41	40	2.0	-	-	-	73	72	1.5	70	66	6.9	-	-	-	79	80	1.3	-	-	-
% Clay	%	1.1	0.87	20	-	-	-	8.0	8.0	0	29	34	15	-	-	-	21	20	4.4	-	-	-
Total Nitrogen	%	0.041	0.042	2.4	-	-	-	0.69	0.71	4.0	0.32	0.30	6.8	-	-	-	0.038	0.032	17	-	-	-
Total Organic Carbon	%	0.57	0.58	1.7	0.59	0.47	23	11	11	0.88	3.4	3.0	10	3.2	3.3	3.1	0.40	0.44	9.5	0.46	0.27	52

Station ID	Units	QULP-6-03			QULP-6-03 <63 UM			POL-1-03			QUL-48-04 <63UM			QUL51-02			QUL51-02 63UM			POL-1-03P 63UM		
Analyte		QULP-6-03	QULP-6-03X	RPD [a]	QULP-6-03 <63 UM	QULP-6-03X <63 UM	RPD [a]	POL-1-03P	POL-1-03PX	RPD [a]	QUL-48-04Y <63 UM	QUL-48-04Z <63 UM	RPD [a]	QUL-51-02Y	QUL-51-02Z	RPD [a]	QUL-51-02Y 63UM	QUL-51-02Z 63UM	RPD [a]	POL-1-03P 63UM	POL-1-03PX 63UM	RPD [a]
Moisture	%	68	68	0.59	-	-	-	-	-	-	-	-	-	39	36	6.2	-	-	-	-	-	-
pH (1:2 soil: water)	pH units	-	-	-	7.2	7.2	0	-	-	-	6.8	6.7	0.89	6.4	6.3	1.7	6.5	6.5	0.15	-	-	-
pH (Leachable)	pH units	-	-	-	-	-	-	-	-	-	-	-	-	6.4	7.7	19	-	-	-	-	-	-
% Gravel	%	<0.10	<0.10	0	-	-	-	<0.10	<0.10	0	-	-	-	0.51	0.52	1.9	-	-	-	-	-	-
% Sand	%	0.74	0.98	28	-	-	-	2.7	2.7	2.6	-	-	-	48	47	2.3	-	-	-	-	-	-
% Silt	%	71	70	1.1	-	-	-	92	92	0.11	-	-	-	49	50	2.4	-	-	-	-	-	-
% Clay	%	28	29	1.8	-	-	-	5.5	5.4	1.5	-	-	-	2.9	2.7	7.8	-	-	-	-	-	-
Total Nitrogen	%	0.17	0.17	3.0	-	-	-	-	-	-	-	-	-	0.058	0.056	3.5	-	-	-	-	-	-
Total Organic Carbon	%	1.8	1.9	8.1	1.7	1.9	9.4	0.68	0.63	7.6	8.8	8.6	2.5	0.69	0.69	0	0.84	0.76	10	0.44	0.37	17

Station ID	Units	POL-1-03M			POL-1-03M 63UM			POL-2-O4P			POL-2-O4P <63UM			POL-2-O4M			POL-2-O4M <63UM			BOL-1-03P		
Analyte		POL-1-03M	POL-1-03MX	RPD [a]	POL-1-03M 63UM	POL-1-03MX 63UM	RPD [a]	POL-2-O4P	POL-2-O4PX	RPD [a]	POL-2-O4P <63UM	POL-2-O4PX <63UM	RPD [a]	POL-2-O4M	POL-2-O4MX	RPD [a]	POL-2-O4M <63UM	POL-2-O4MX <63UM	RPD [a]	BOL-1-03P	BOL-1-03PX	RPD [a]
Moisture	%	70	73	4.0	-	-	-	-	-	-	-	-	-	48	46	4.3	-	-	-	-	-	-
pH (1:2 soil: water)	pH units	-	-	-	8.0	7.8	2.2	-	-	-	-	-	-	8.5	8.5	0.24	8.1	8.2	1.8	-	-	-
pH (Leachable)	pH units	7.0	6.9	1.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Gravel	%	-	-	-	-	-	-	<0.10	<0.10	0	-	-	-	-	-	-	-	-	-	<0.10	<0.10	0
% Sand	%	-	-	-	-	-	-	15	14	4.9	-	-	-	-	-	-	-	-	-	0.52	1.4	89
% Silt	%	-	-	-	-	-	-	78	79	1.4	-	-	-	-	-	-	-	-	-	89	87	2.7
% Clay	%	-	-	-	-	-	-	7.0	6.6	6.3	-	-	-	-	-	-	-	-	-	11	12	14
Total Nitrogen	%	0.15	0.12	20	-	-	-	-	-	-	-	-	-	<0.020	<0.020	0	-	-	-	-	-	-
Total Organic Carbon	%	-	-	-	-	-	-	0.48	0.57	17	0.30	0.29	3.4	-	-	-	-	-	-	19	19	1.0

Station ID	Units	BOL-1-03P 63UM			BOL-1-03M			ST02-S4			ST02-S4 <63UM			ST16-S3			ST16-S3 <63UM		
Analyte		BOL-1-03P 63UM	BOL-1-03PX 63UM	RPD [a]	BOL-1-03M	BOL-1-03MX	RPD [a]	ST02-S4	ST02-S4X	RPD [a]	ST02-S4 <63 UM	ST02-S4X <63 UM	RPD [a]	ST16-S3	ST16-S3X	RPD [a]	ST16-S3 <63 UM	ST16-S3X <63 UM	RPD [a]
Moisture	%	-	-	-	93	94	0.64	34	34	0.58	-	-	-	23	28	18	-	-	-
pH (1:2 soil: water)	pH units	-	-	-	6.5	6.5	0.15	8.4	8.5	1.4	8.3	8.5	1.8	8.9	8.9	0.34	8.8	8.7	0.80
pH (Leachable)	pH units	-	-	-	-	-	-	7.8	8.1	2.9	-	-	-	8.6	8.6	0.23	-	-	-
% Gravel	%	-	-	-	-	-	-	<0.10	0.20	67	-	-	-	<0.10	<0.10	0	-	-	-
% Sand	%	-	-	-	-	-	-	23	34	39	-	-	-	66	67	2.9	-	-	-
% Silt	%	-	-	-	-	-	-	65	55	16	-	-	-	34	32	6.0	-	-	-
% Clay	%	-	-	-	-	-	-	12	11	15	-	-	-	0.42	0.52	21	-	-	-
Total Nitrogen	%	-	-	-	1.9	1.5	20	<0.020	<0.020	0	-	-	-	<0.020	<0.020	0	-	-	-
Total Organic Carbon	%	18	19	5.8	-	-	-	0.17	<0.10	70	0.16	0.15	6.5	<0.10	<0.10	0	<0.10	<0.10	0

[a] The method detection limit (MDL) value was used in instances where values less than the MDL were reported. RPD calculation: =(Absolute(Replicate 1 - Replicate 2))/Average(Replicate 1, Replicate 2)*100

Table C.11: Field replicate results for the analysis of metals in sediment samples. Highlighted values did not meet the data quality objective of ≤ 40% Relative Percent Difference (RPD).

Station ID	Units	QUL-47-03			QUL-47-03 63UM			QUL-48-04			QUL-48-04 <63UM			QUL51-02			QUL51-02 63UM		
Analyte		QUL-47-03Y	QUL-47-03Z	RPD [a]	QUL-47-03Y 63UM	QUL-47-03Z 63UM	RPD [a]	QUL-48-04Y	QUL-48-04Z	RPD [a]	QUL-48-04Y <63 UM	QUL-48-04Z <63 UM	RPD [a]	QUL-51-02Y	QUL-51-02Z	RPD [a]	QUL-51-02Y 63UM	QUL-51-02Z 63UM	RPD [a]
Aluminum	mg/kg	13,300	12,800	3.8	15,100	14,200	6.1	19,000	18,000	5.4	19,600	19,400	1.0	10,200	10,200	0	12,100	12,600	4.0
Antimony	mg/kg	0.20	0.21	4.9	0.23	0.24	4.3	1.1	1.1	2.7	1.0	0.96	4.1	0.21	0.20	4.9	0.24	0.24	0
Arsenic	mg/kg	4.8	4.6	5.7	4.8	4.6	3.6	13	13	0.76	14	13	5.8	3.1	3.0	2.3	3.2	3.3	4.3
Barium	mg/kg	77	74	4.4	70	70	1.0	81	89	8.6	82	86	4.2	95	94	0.85	133	132	0.75
Beryllium	mg/kg	0.31	0.29	6.7	0.33	0.35	5.9	0.55	0.54	1.8	0.54	0.55	1.8	0.24	0.25	4.1	0.31	0.30	3.3
Bismuth	mg/kg	<0.20	<0.20	0	<0.10	<0.10	0	<0.20	<0.20	0	0.16	0.16	0	<0.20	<0.20	0	<0.10	<0.10	0
Boron	mg/kg	<10	<10	0	<10	<10	0	<10	<10	0	<10	<10	0	<10	<10	0	<10	<10	0
Cadmium	mg/kg	0.090	0.081	11	0.11	0.095	10	0.62	0.64	4.5	0.62	0.59	4.8	0.20	0.21	3.4	0.25	0.24	2.1
Calcium	mg/kg	8,720	8,340	4.5	9,970	10,100	1.3	15,800	16,200	2.5	14,800	15,000	1.3	6,130	5,730	6.7	7,000	6,400	9.0
Chromium	mg/kg	44	43	0.92	67	71	5.9	54	54	0.74	56	55	1.6	38	37	1.9	47	49	3.5
Cobalt	mg/kg	10	9.7	6.4	11	10	1.0	17	16	5.6	15	15	3.3	8.3	8.2	1.6	8.9	9.1	2.0
Copper	mg/kg	25	24	4.9	33	32	0.92	69	71	2.9	74	70	4.7	20	20	1.0	26	28	4.1
Iron	mg/kg	26,400	24,800	6.3	33,100	33,600	1.5	29,400	28,400	3.5	32,700	31,100	5.0	17,600	18,000	2.2	21,900	22,100	0.91
Lead	mg/kg	3.6	3.4	7.4	4.9	4.9	0.61	15	16	5.7	17	17	0	3.3	3.0	10	5.0	4.8	5.3
Lithium	mg/kg	11	11	0	11	11	0	18	18	0.56	19	19	2.6	9.6	8.6	11	8.9	7.3	20
Magnesium	mg/kg	6,540	6,290	3.9	7,460	7,230	3.1	9,860	9,020	8.9	9,670	9,310	3.8	5,290	5,330	0.75	6,320	6,460	2.2
Manganese	mg/kg	329	317	3.7	388	383	1.3	288	263	9.1	292	270	7.8	218	217	0.46	245	255	4.0
Mercury	mg/kg	-	-	-	0.055	0.17	104	-	-	-	0.11	0.11	1.9	-	-	-	0.029	0.030	1.0
Molybdenum	mg/kg	<0.50	<0.50	0	0.44	0.44	0	2.2	2.3	5.8	2.1	2.2	4.6	0.53	0.50	5.8	0.67	0.63	6.2
Nickel	mg/kg	24	23	5.2	28	29	3.2	50	50	0	51	50	1.2	21	21	1.0	27	27	2.2
Phosphorus	mg/kg	948	936	1.3	1,310	1,350	3.0	693	658	5.2	741	721	2.7	897	929	3.5	1,210	1,160	4.2
Potassium	mg/kg	980	940	4.2	940	900	4.3	1,270	1,250	1.6	1,480	1,470	0.68	780	760	2.6	920	960	4.3
Selenium	mg/kg	<0.20	<0.20	0	0.21	0.18	15	7.2	7.8	7.3	6.7	6.8	1.3	0.32	0.33	3.1	0.45	0.43	4.5
Silver	mg/kg	<0.10	<0.10	0	0.055	0.052	5.6	0.25	0.26	3.9	0.28	0.27	1.5	<0.10	<0.10	0	0.12	0.10	14
Sodium	mg/kg	450	430	4.5	440	420	4.7	230	220	4.4	280	260	7.4	320	320	0	390	430	9.8
Strontium	mg/kg	105	93	12	93	89	4.1	92	96	4.1	96	96	0.10	49	46	7.3	59	53	11
Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	0.15	0.13	7.9	0.15	0.15	1.4	0.095	0.080	17	0.10	0.094	10
Tin	mg/kg	<2.0	<2.0	0	0.40	0.48	18	2.5	2.2	13	3.0	2.3	28	<2.0	<2.0	0	0.45	0.32	34
Titanium	mg/kg	1,090	1,060	2.8	1,340	1,310	2.3	848	809	4.7	857	822	4.2	925	908	1.9	987	1,050	6.2
Uranium	mg/kg	0.62	0.59	5.8	0.90	0.92	1.8	2.3	2.4	2.5	2.2	2.2	0.90	0.70	0.67	3.5	0.90	0.87	3.7
Vanadium	mg/kg	86	83	3.3	111	112	0.90	71	67	5.8	70	65	8.0	46	46	0	55	57	3.2
Zinc	mg/kg	43	42	3.5	52	53	2.7	86	85	1.1	83	82	0.85	44	44	1.4	53	54	2.6

[a] The method detection limit (MDL) value was used in instances where values less than the MDL were reported. RPD calculation: =(Absolute(Replicate 1 - Replicate 2))/Average(Replicate 1, Replicate 2)*100

Table C.11: Field replicate results for the analysis of metals in sediment samples. Highlighted values did not meet the data quality objective of ≤ 40% Relative Percent Difference (RPD).

Station ID	Units	QULP-4-02			QULP-4-02 <63UM			QULP-3-05			QULP-6-03			QULP-3-05 <63 UM			POL-1-03M		
Analyte		**QULP-4-02**	**QULP-4-02X**	**RPD [a]**	**QULP-4-02 <63UM**	**QULP-4-02X <63UM**	**RPD [a]**	**QULP-3-05**	**QULP-3-05X**	**RPD [a]**	**QULP-6-03**	**QULP-6-03X**	**RPD [a]**	**QULP-3-05 <63 UM**	**QULP-3-05X <63 UM**	**RPD [a]**	**POL-1-03M**	**POL-1-03MX**	**RPD [a]**
Aluminum	mg/kg	22,600	23,000	1.8	22,900	25,100	9.2	28,100	28,700	2.1	26,900	25,200	6.5	25,800	26,100	1.2	20,500	19,800	3.5
Antimony	mg/kg	0.53	0.51	3.8	0.46	0.47	2.2	0.81	0.86	6.0	0.45	0.45	0	0.40	0.42	4.9	0.51	0.50	2.0
Arsenic	mg/kg	14	14	2.9	14	14	0.73	48	45	7.9	16	18	14	19	19	0.53	11	11	1.8
Barium	mg/kg	238	242	1.7	229	228	0.44	231	253	9.1	193	175	9.8	168	179	6.3	228	233	2.2
Beryllium	mg/kg	0.86	0.76	12	0.78	0.78	0	0.88	0.91	3.4	0.95	0.94	1.1	0.91	0.93	2.2	0.71	0.67	5.8
Bismuth	mg/kg	<0.20	<0.20	0	0.11	0.10	9.5	0.34	0.33	3.0	0.53	0.52	1.9	0.52	0.52	0	<0.20	<0.20	0
Boron	mg/kg	10	<10	0	11	11	0	<10	<10	0	<10	<10	0	<10	<10	0	11	<10	9.5
Cadmium	mg/kg	0.19	0.19	1.1	0.17	0.19	9.3	0.70	0.72	3.4	0.31	0.32	3.1	0.31	0.32	3.2	0.15	0.13	9.3
Calcium	mg/kg	30,800	30,500	1.0	31,700	29,900	5.8	9,800	9,870	0.71	5,390	5,310	1.5	5,720	5,920	3.4	25,000	23,600	5.8
Chromium	mg/kg	17	17	3.0	18	20	8.6	69	70	1.4	54	55	1.8	53	55	4.1	15	16	3.8
Cobalt	mg/kg	18	19	2.7	18	19	4.3	27	26	2.3	25	25	2.0	25	25	2.0	15	16	2.0
Copper	mg/kg	596	609	2.2	589	601	2.0	123	119	3.3	50	52	2.9	49	52	5.6	539	536	0.56
Iron	mg/kg	26,700	27,000	1.1	27,000	27,600	2.2	61,600	62,400	1.3	55,800	57,800	3.5	60,200	61,900	2.8	25,200	25,300	0.40
Lead	mg/kg	7.6	7.4	2.7	7.4	7.3	1.0	20	20	0	22	23	1.8	23	24	3.5	6.3	6.5	2.2
Lithium	mg/kg	25	24	7.0	23	22	3.5	30	30	1.0	39	38	2.3	38	41	5.8	19	18	5.0
Magnesium	mg/kg	13,900	13,900	0	14,400	14,300	0.70	12,800	12,300	4.0	9,720	10,100	3.8	9,520	9,900	3.9	10,300	10,400	1.0
Manganese	mg/kg	835	822	1.6	826	849	2.7	11,300	11,300	0	7,000	7,240	3.4	7,930	7,940	0.13	792	771	2.7
Mercury	mg/kg	-	-	-	0.074	0.080	7.2	-	-	-	-	-	-	0.059	0.061	3.1	-	-	-
Molybdenum	mg/kg	3.3	3.1	5.3	3.3	3.1	7.2	5.0	4.8	3.7	2.4	2.4	1.7	2.6	2.5	1.2	3.8	3.7	2.4
Nickel	mg/kg	17	17	1.2	17	18	4.0	69	68	1.7	61	63	2.9	61	63	2.3	13	13	1.6
Phosphorus	mg/kg	1,450	1,440	0.69	1,350	1,370	1.5	1,690	1,700	0.59	1,160	1,300	11	1,440	1,370	5.0	1,260	1,220	3.2
Potassium	mg/kg	2,050	2,060	0.49	2,240	2,280	1.8	2,790	3,020	7.9	3,600	3,400	5.7	3,780	3,910	3.4	2,490	2,460	1.2
Selenium	mg/kg	0.97	1.0	4.0	0.94	1.0	8.2	1.9	1.9	2.1	0.85	0.89	4.6	0.76	0.85	11	1.5	1.5	2.7
Silver	mg/kg	0.28	0.27	3.6	0.27	0.27	0.37	0.37	0.36	2.7	0.20	0.20	0	0.19	0.21	11	0.24	0.25	4.1
Sodium	mg/kg	1,010	990	2.0	1,130	1,140	0.88	460	510	10	370	350	5.6	380	360	5.4	1,410	1,580	11
Strontium	mg/kg	212	200	5.8	213	196	8.3	116	114	1.7	77	79	2.2	85	83	3.2	253	242	4.4
Thallium	mg/kg	0.053	0.052	1.9	0.054	0.052	3.8	0.33	0.33	0	0.29	0.27	5.3	0.30	0.30	2.3	<0.050	<0.050	0
Tin	mg/kg	<2.0	<2.0	0	2.0	1.8	6.3	<2.0	<2.0	0	<2.0	<2.0	0	0.61	0.58	5.0	<2.0	<2.0	0
Titanium	mg/kg	1,760	1,670	5.2	2,040	2,090	2.4	861	1,020	17	821	796	3.1	824	847	2.8	1,500	1,260	17
Uranium	mg/kg	1.5	1.4	6.4	1.4	1.4	1.4	3.5	3.6	2.8	2.9	3.0	4.7	3.1	3.2	2.6	1.2	1.1	5.3
Vanadium	mg/kg	92	93	0.86	92	95	3.4	89	90	1.7	48	48	0.21	47	48	2.3	97	94	3.8
Zinc	mg/kg	70	73	3.8	69	78	11	123	121	1.6	104	108	3.8	97	101	4.1	58	60	3.2

[a] The method detection limit (MDL) value was used in instances where values less than the MDL were reported. RPD calculation: =(Absolute(Replicate 1 - Replicate 2))/Average(Replicate 1, Replicate 2)*100

Table C.11: Field replicate results for the analysis of metals in sediment samples. Highlighted values did not meet the data quality objective of ≤ 40% Relative Percent Difference (RPD).

Station ID	Units	POL-1-03M			POL-2-O4M			POL-2-O4M <63UM			BOL-1-03M			ST02-S4			ST16-S3		
Analyte		**POL-1-03M 63UM**	**POL-1-03MX 63UM**	**RPD [a]**	**POL-2-O4M**	**POL-2-O4MX**	**RPD [a]**	**POL-2-O4M <63UM**	**POL-2-O4MX <63UM**	**RPD [a]**	**BOL-1-03M**	**BOL-1-03MX**	**RPD [a]**	**ST02-S4**	**ST02-S4X**	**RPD [a]**	**ST16-S3**	**ST16-S3X**	**RPD [a]**
Aluminum	mg/kg	19,900	20,400	2.5	17,600	19,500	10	19,400	18,500	4.7	20,600	21,300	3.3	15,800	15,200	3.9	11,700	11,600	0.86
Antimony	mg/kg	0.47	0.40	16	0.49	0.49	0	0.49	0.50	2.0	1.0	1.1	2.9	0.46	0.40	14	0.34	0.39	14
Arsenic	mg/kg	12	12	5.9	12	13	6.2	14	14	0	6.8	6.8	0.15	11	11	1.9	12	12	4.2
Barium	mg/kg	236	233	1.3	209	204	2.4	220	209	5.1	223	224	0.45	164	164	0	117	114	2.6
Beryllium	mg/kg	0.74	0.71	4.1	0.72	0.76	5.4	0.71	0.80	12	0.78	0.72	8.0	0.57	0.53	7.3	0.57	0.51	11
Bismuth	mg/kg	<0.10	<0.10	0	<0.20	<0.20	0	<0.10	<0.10	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
Boron	mg/kg	11	<10	9.5	<10	10	0	10	11	9.5	19	18	5.4	-	-	-	-	-	-
Cadmium	mg/kg	0.10	0.10	0.99	0.11	0.11	3.6	0.11	0.11	2.8	0.54	0.54	0.74	0.17	0.18	5.1	0.14	0.16	19
Calcium	mg/kg	28,000	26,600	5.1	30,300	33,000	8.5	31,400	31,700	0.95	10,700	10,300	3.8	26,200	25,100	4.3	25,800	25,200	2.4
Chromium	mg/kg	11	11	0.89	10	11	5.9	11	17	39	42	43	1.4	21	20	4.9	11	12	2.6
Cobalt	mg/kg	14	15	4.1	15	16	5.9	16	16	0	12	13	2.4	16	16	0.64	15	14	1.4
Copper	mg/kg	540	558	3.3	549	572	4.1	529	569	7.3	463	467	0.86	559	565	1.1	964	884	8.7
Iron	mg/kg	26,200	24,200	7.9	42,500	48,300	13	50,100	46,700	7.0	25,000	25,500	2.0	49,200	48,600	1.2	62,900	63,300	0.63
Lead	mg/kg	5.7	6.0	4.8	4.9	5.1	3.2	5.3	5.2	1.1	12	12	2.5	6.0	6.2	3.6	5.7	4.9	15
Lithium	mg/kg	17	18	4.7	14	15	3.4	15	17	12	15	14	8.3	17	17	0.59	14	14	2.9
Magnesium	mg/kg	9,510	10,500	9.9	9,200	9,590	4.2	9,010	9,760	8.0	5,620	5,850	4.0	9,970	9,260	7.4	7,200	7,040	2.2
Manganese	mg/kg	666	656	1.5	632	653	3.3	683	681	0.29	822	822	0	659	630	4.5	553	568	2.7
Mercury	mg/kg	0.070	0.069	0.57	-	-	-	0.066	0.067	2.3	0.40	0.39	1.8	0.093	0.075	22	0.097	0.10	5.8
Molybdenum	mg/kg	3.5	3.3	3.8	3.6	3.8	5.2	3.5	3.8	8.6	5.0	4.9	2.8	3.0	2.9	4.1	5.1	4.6	8.7
Nickel	mg/kg	9.9	11	13	8.2	8.6	3.7	8.8	13	37	31	32	2.9	16	17	1.8	6.6	6.7	1.8
Phosphorus	mg/kg	1,520	1,410	7.5	1,660	1,890	13	1,790	1,920	7.0	1,320	1,370	3.7	1,260	1,190	5.7	1,490	1,380	7.7
Potassium	mg/kg	1,950	1,800	8.0	1,780	1,770	0.56	2,020	1,830	9.9	1,630	1,660	1.8	1,580	1,540	2.6	880	890	1.1
Selenium	mg/kg	1.1	1.2	1.7	0.96	1.1	9.9	1.1	1.1	0	3.0	3.1	3.7	0.850	0.840	1.2	1.1	1.1	3.7
Silver	mg/kg	0.24	0.23	6.4	0.27	0.30	11	0.27	0.29	10	0.44	0.48	8.7	0.27	0.26	3.8	0.47	0.45	4.3
Sodium	mg/kg	1,200	1,150	4.3	1,170	1,080	8.0	1,290	1,140	12	220	230	4.4	790	790	0	690	690	0
Strontium	mg/kg	255	268	5.0	221	233	5.3	224	229	2.2	121	113	6.8	153	153	0	104	99.1	4.8
Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	0.17	0.15	11	0.051	<0.050	2.0	<0.050	<0.050	0
Tin	mg/kg	1.6	1.3	20	<2.0	2.1	4.9	2.0	2.2	13	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
Titanium	mg/kg	1,550	1,250	21	1,700	1,820	6.8	1,810	1,740	3.9	558	567	1.6	1,480	1,260	16	1,040	1,120	7.4
Uranium	mg/kg	1.1	0.94	16	1.2	1.4	12	1.3	1.3	1.5	2.9	2.9	2.1	0.98	0.90	8.5	0.90	0.90	0
Vanadium	mg/kg	100	91	9.0	166	189	13	189	186	1.6	67	68	0.44	175	168	4.1	242	249	2.9
Zinc	mg/kg	51	53	3.8	50	51	3.2	52	51	1.6	82	82	0	59	60	1.0	55	57	3.6

[a] The method detection limit (MDL) value was used in instances where values less than the MDL were reported. RPD calculation: =(Absolute(Replicate 1 - Replicate 2))/Average(Replicate 1, Replicate 2)*100

Table C.11: Field replicate results for the analysis of metals in sediment samples. Highlighted values did not meet the data quality objective of ≤ 40% Relative Percent Difference (RPD).

Station ID	Units	ST02-S4 <63UM			ST16-S3 <63UM		
Analyte		ST02-S4 <63 UM	ST02-S4X <63 UM	RPD [a]	ST16-S3 <63 UM	ST16-S3X <63 UM	RPD [a]
Aluminum	mg/kg	17,600	18,100	2.8	10,800	11,500	6.3
Antimony	mg/kg	0.47	0.48	2.1	0.32	0.31	3.2
Arsenic	mg/kg	12	12	2.4	15	15	0.68
Barium	mg/kg	184	180	2.2	104	124	18
Beryllium	mg/kg	0.53	0.57	7.3	0.47	0.47	0
Bismuth	mg/kg	0.11	0.12	8.7	<0.10	<0.10	0
Boron	mg/kg	<10	<10	0	<10	<10	0
Cadmium	mg/kg	0.19	0.22	14	0.17	0.15	17
Calcium	mg/kg	28,600	28,600	0	28,000	27,600	1.4
Chromium	mg/kg	28	29	3.2	23	22	6.3
Cobalt	mg/kg	20	20	4.0	25	22	9.4
Copper	mg/kg	513	565	9.6	677	677	0
Iron	mg/kg	68,400	69,500	1.6	142,000	128,000	10
Lead	mg/kg	7.6	8.1	7.1	6.5	6.4	0.93
Lithium	mg/kg	17	18	4.6	12	12	4.1
Magnesium	mg/kg	10,800	11,100	2.7	6,420	6,830	6.2
Manganese	mg/kg	725	771	6.1	628	630	0.32
Mercury	mg/kg	0.073	0.076	3.9	0.077	0.078	1.2
Molybdenum	mg/kg	2.7	2.7	0.37	4.7	4.3	9.3
Nickel	mg/kg	22	23	5.3	11	11	2.8
Phosphorus	mg/kg	1,510	1,550	2.6	2,440	2,410	1.2
Potassium	mg/kg	1,560	1,760	12	810	880	8.3
Selenium	mg/kg	0.99	1.0	4.0	1.4	1.4	2.9
Silver	mg/kg	0.27	0.30	9.8	0.43	0.42	3.3
Sodium	mg/kg	780	790	1.3	560	570	1.8
Strontium	mg/kg	150	155	3.3	86	92	6.9
Thallium	mg/kg	0.051	0.066	26	<0.050	<0.050	0
Tin	mg/kg	1.1	1.5	27	1.1	1.2	8.5
Titanium	mg/kg	1,370	1,500	9.1	1,060	1,190	12
Uranium	mg/kg	1.1	1.1	5.5	1.1	1.1	0
Vanadium	mg/kg	244	240	1.7	552	490	12
Zinc	mg/kg	69	74	7.3	70	68	2.3

[a] The method detection limit (MDL) value was used in instances where values less than the MDL were reported. RPD calculation: =(Absolute(Replicate 1 - Replicate 2))/Average(Replicate 1, Replicate 2)*100

Table C.12: Field replicate results for the analysis of leachable metals in sediment samples (Shakeflask analyses). Highlighted values did not meet the data quality objective of≤ 40% Relative Percent Difference (RPD).

Station ID	Units	BOL-1-03P			POL-1-03M			ST02-S4			POL-2-O4P			ST16-S3			QUL51-02		
Analyte		BOL-1-03P	BOL-1-03PX	RPD [a]	POL-1-03M	POL-1-03MX	RPD [a]	ST02-S4	ST02-S4X	RPD [a]	POL-2-O4P	POL-2-O4PX	RPD [a]	ST16-S3	ST16-S3X	RPD [a]	QUL-51-02Y	QUL-51-02Z	RPD [a]
Aluminum	mg/L	1.2	1.1	13	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
Antimony	mg/L	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
Arsenic	mg/L	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
Barium	mg/L	0.11	0.11	8.2	0.11	0.12	14	0.066	0.057	15	0.049	0.048	2.1	0.035	0.036	2.8	0.054	0.052	3.8
Beryllium	mg/L	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0
Bismuth	mg/L	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
Cadmium	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Calcium	mg/L	27	28	6.5	182	200	9.4	44	31	36	50	67	29	13	13	0.77	12	38	102
Chromium	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Cobalt	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Copper	mg/L	0.019	0.019	0	<0.010	<0.010	0	0.032	0.020	46	<0.010	<0.010	0	0.051	0.055	7.5	<0.010	0.013	26
Iron	mg/L	0.33	0.29	13	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	0.113	0.118	4.3	0.117	<0.030	118
Lead	mg/L	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0.0
Magnesium	mg/L	3.8	3.9	4.2	19	22	13	6.2	4.6	29	6.2	7.2	15	1.5	1.6	2.0	2.9	4.1	33
Manganese	mg/L	0.0695	0.0382	58	4.4	5.9	29	0.75	0.44	53	0.0061	<0.0050	20	0.0389	0.0361	7.5	0.22	0.0193	168
Mercury	mg/L	<0.000050	<0.000050	0	<0.000050	<0.000050	0	<0.000050	<0.000050	0	<0.000050	<0.000050	0	<0.000050	<0.000050	0	<0.000050	<0.000050	0
Molybdenum	mg/L	<0.030	<0.030	0	0.075	0.062	19	0.038	<0.030	24	0.053	<0.030	55	<0.030	<0.030	0	<0.030	<0.030	0
Nickel	mg/L	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
Phosphorus	mg/L	<0.30	<0.30	0	<0.30	<0.30	0	<0.30	<0.30	0	<0.30	<0.30	0	<0.30	<0.30	0	<0.30	<0.30	0
Potassium	mg/L	<2.0	<2.0	0	6.6	7.1	7.3	4.0	3.4	16	3.9	3.6	0	<2.0	2.0	0	3.2	4.6	36
Selenium	mg/L	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
Silicon	mg/L	26	24	7.9	8.37	9.12	8.6	7.06	6.43	9.3	8.2	7.7	6.2	4.3	4.8	10	7.0	6.2	12
Silver	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0.0
Sodium	mg/L	3.4	3.4	0	16	17	11	12	9.2	29	10	8.4	17	3.0	3.3	9.5	4.3	9.6	76
Strontium	mg/L	0.27	0.28	3.2	1.4	1.6	13	0.49	0.34	35	0.40	0.53	28	0.16	0.17	5.5	0.0821	0.37	127
Thallium	mg/L	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
Tin	mg/L	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0
Titanium	mg/L	0.023	0.022	4.4	0.019	0.02	5.1	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Uranium	mg/L	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
Vanadium	mg/L	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0
Zinc	mg/L	<0.020	<0.020	0	<0.020	<0.020	0	<0.020	<0.020	0	<0.020	<0.020	0	<0.020	<0.020	0	<0.020	<0.020	0

[a] The method detection limit (MDL) value was used in instances where values less than the MDL were reported. RPD calculation: =(Absolute(Replicate 1 - Replicate 2))/Average(Replicate 1, Replicate 2)*100

Table C.13: Field replicate results for the analysis of selectively extracted metals in sediment samples (Tessier extractions). Highlighted values did not meet the data quality objective of ≤ 40% Relative Percent Difference (RPD).

Station ID		Units	POL-1-03M			POL-2-O4M			BOL-1-03M		
Analyte			POL-1-03M	POL-1-03MX	RPD [a]	POL-2-O4M	POL-2-O4MX	RPD [a]	BOL-1-03M	BOL-1-03MX	RPD [a]
Exchangeable & Adsorbed Metals	Aluminum	mg/kg	<50	<50	0	<50	<50	0	<50	<50	0
	Antimony	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Arsenic	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	0.065	0.070	7.4
	Barium	mg/kg	<15	<15	0	<15	<15	0	115	114	0.87
	Beryllium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	0.17	0.16	4.3
	Calcium	mg/kg	2,270	2,510	10	1,310	1,250	4.7	7,870	7,710	2.1
	Chromium	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
	Cobalt	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	0.34	0.36	5.7
	Copper	mg/kg	2.1	1.2	52	0.57	0.61	6.8	0.70	0.60	15
	Iron	mg/kg	<50	<50	0	<50	<50	0	<50	<50	0
	Lead	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
	Lithium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Manganese	mg/kg	104	119	13	47	34	32	234	281	18
	Molybdenum	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<0.50	<0.50	0
	Nickel	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
	Phosphorus	mg/kg	<50	<50	0	<50	<50	0	<50	<50	0
	Potassium	mg/kg	100	120	18	<100	<100	0	190	190	0
	Selenium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Silver	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Sodium	mg/kg	<100	<100	0	<100	<100	0	<100	<100	0
	Strontium	mg/kg	22	25	12	13	12	8.1	75	72	3.1
	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Titanium	mg/kg	<1.0	<1.0	0	<1.0	<1.0	0	<1.0	<1.0	0
	Uranium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Vanadium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Zinc	mg/kg	<1.0	<1.0	0	<1.0	<1.0	0	1.6	1.6	0
Carbonate Metals	Aluminum	mg/kg	<50	<50	0	89	78	13	<50	<50	0
	Antimony	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Arsenic	mg/kg	<0.050	0.055	9.5	0.17	0.14	22	0.12	0.13	0.80
	Barium	mg/kg	61	67	8.9	63	52	19	32	35	9.8
	Beryllium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	<0.050	<0.050	0	<0.050	0.053	5.8	0.083	0.083	0
	Calcium	mg/kg	7,910	7,700	2.7	11,000	11,100	0.90	900	961	6.6
	Chromium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Cobalt	mg/kg	<0.10	<0.10	0	0.20	0.18	11	0.25	0.30	18
	Copper	mg/kg	1.1	1.1	0	32	29	13	2.0	1.8	10
	Iron	mg/kg	<50	<50	0	301	250	19	53	72	30
	Lead	mg/kg	<0.50	<0.50	0	1.0	0.93	9.2	0.56	0.63	12
	Lithium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Manganese	mg/kg	77	81	5.5	109	94	15	127	127	0
	Molybdenum	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
	Nickel	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Phosphorus	mg/kg	<50	<50	0	<50	<50	0	<50	<50	0
	Selenium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Silver	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Strontium	mg/kg	99	109	10	83	70	17	9.7	11	7.9
	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Titanium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Uranium	mg/kg	0.072	0.078	8.0	<0.050	0.072	36	0.50	0.56	12
	Vanadium	mg/kg	<0.20	0.20	0	0.54	0.47	14	0.40	0.40	0
	Zinc	mg/kg	<1.0	<1.0	0	1.1	<1.0	9.5	3.2	3.6	12
Easily Reducible Metals and Iron Oxides	Aluminum	mg/kg	2,300	2,450	6.3	2,030	1,780	13	1,050	1,040	1.0
	Antimony	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Arsenic	mg/kg	1.5	1.6	6.0	1.6	1.6	3.7	1.0	1.0	2.0
	Barium	mg/kg	31	33	7.2	25	24	3.7	46	45	3.3
	Beryllium	mg/kg	0.21	0.26	21	<0.20	<0.20	0	0.32	0.33	3.1
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	0.18	0.20	6.8
	Calcium	mg/kg	2,350	2,000	16	1,610	1,610	0	736	720	2.2
	Chromium	mg/kg	2.6	2.8	6.0	1.7	1.5	8.2	2.2	2.2	1.4
	Cobalt	mg/kg	1.5	1.6	7.7	1.0	0.91	13	1.5	1.4	6.3
	Copper	mg/kg	12	11	14	23	38	48	5.6	5.3	6.6
	Iron	mg/kg	2,940	3,210	8.8	1,940	1,750	10	4,200	4,140	1.4
	Lead	mg/kg	2.3	2.5	6.6	1.3	1.2	10	2.5	2.5	3.2
	Lithium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Manganese	mg/kg	119	125	4.9	55	46	18	199	171	15
	Molybdenum	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
	Nickel	mg/kg	1.9	2.3	17	1.0	0.88	16	3.4	3.4	1.8
	Phosphorus	mg/kg	84	120	35	141	182	25	73	92	23
	Selenium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Silver	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Strontium	mg/kg	40	41	1.0	43	43	0.70	8.5	8.2	2.9
	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Titanium	mg/kg	1.1	1.0	9.5	<1.0	<1.0	0	<1.0	<1.0	0
	Uranium	mg/kg	0.15	0.16	6.0	0.11	0.096	14	0.53	0.52	0.19
	Vanadium	mg/kg	9.5	11	12	6.0	5.4	11	10	10	1.0
	Zinc	mg/kg	8.5	9.2	7.9	5.0	4.4	13	16	16	2.5

Table C.13: Field replicate results for the analysis of selectively extracted metals in sediment samples (Tessier extractions). Highlighted values did not meet the data quality objective of ≤ 40% Relative Percent Difference (RPD).

	Station ID	Units	POL-1-03M			POL-2-O4M			BOL-1-03M		
Analyte			POL-1-03M	POL-1-03MX	RPD [a]	POL-2-O4M	POL-2-O4MX	RPD [a]	BOL-1-03M	BOL-1-03MX	RPD [a]
Organic Bound Metals	Aluminum	mg/kg	1,190	1,230	3.3	951	808	16	5,180	5,160	0.39
	Antimony	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Arsenic	mg/kg	0.41	0.43	4.7	0.27	0.29	5.0	2.3	2.3	3.5
	Barium	mg/kg	17	18	8.5	15	13	17	12	12	5.9
	Beryllium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	0.10	0.10	1.0
	Calcium	mg/kg	843	863	2.3	749	676	10	698	683	2.2
	Chromium	mg/kg	1.4	1.5	9.8	<0.50	<0.50	0	19	18	0.54
	Cobalt	mg/kg	1.6	1.6	5.0	1.6	1.5	3.8	5.8	5.8	0.69
	Copper	mg/kg	500	472	5.8	472	441	6.8	396	396	0
	Iron	mg/kg	419	392	6.7	295	300	1.7	5,640	5,390	4.5
	Lead	mg/kg	0.86	0.86	0	0.54	0.51	5.7	1.7	1.6	7.8
	Lithium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Manganese	mg/kg	15	15	0.67	9.8	8.4	15	63	60	4.7
	Molybdenum	mg/kg	1.3	1.7	23	1.2	1.1	9.9	4.4	4.5	0.67
	Nickel	mg/kg	1.1	1.1	1.8	<0.50	<0.50	0	14	14	1.4
	Selenium	mg/kg	1.2	1.2	4.2	0.89	0.79	12	3.1	3.1	1.6
	Silver	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Strontium	mg/kg	12	11	5.2	12	11	5.2	6.8	6.9	1.2
	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Titanium	mg/kg	2.8	7.6	92	1.3	1.6	21	9.7	8.3	16
	Uranium	mg/kg	0.15	0.14	4.8	0.11	0.11	8.2	1.4	1.4	0.7
	Vanadium	mg/kg	2.3	3.6	43	0.84	0.71	17	27	27	0
	Zinc	mg/kg	4.4	4.3	2.3	4.1	4.2	2.4	24	24	1.3
Residual Metals	Aluminum	mg/kg	22,100	20,200	9.0	16,500	15,200	8.2	15,000	15,300	2.0
	Antimony	mg/kg	0.40	0.39	2.5	0.38	0.32	17	0.72	0.74	2.7
	Arsenic	mg/kg	9.6	9.6	0.10	11	11	0.92	4.2	4.3	0.47
	Barium	mg/kg	157	164	4.4	116	107	8.1	69	68	1.7
	Beryllium	mg/kg	0.53	0.52	1.9	0.59	0.53	10.7	<0.20	<0.20	0
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Calcium	mg/kg	11,900	12,600	5.7	15,800	15,100	4.5	1,660	1,680	1.2
	Chromium	mg/kg	15	12	20	8.8	8.2	7.1	22	22	1.4
	Cobalt	mg/kg	16	13	20	13	13	3.8	4.7	4.8	1.1
	Copper	mg/kg	127	101	23	84	77	7.7	74	76	2.0
	Iron	mg/kg	22,900	21,800	4.9	40,800	43,500	6.4	15,200	15,300	0.66
	Lead	mg/kg	4.0	3.5	15	2.5	2.2	13	6.8	7.0	3.8
	Lithium	mg/kg	21	16	23	15	13	9.4	11	10	1.9
	Manganese	mg/kg	580	490	17	468	459	1.9	147	148	0.68
	Molybdenum	mg/kg	0.60	1.1	57	2.2	2.2	1.8	0.92	0.94	2.2
	Nickel	mg/kg	12	9.7	24	7.3	7.0	4.2	14	14	0.73
	Selenium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Silver	mg/kg	0.25	0.24	4.1	0.27	0.25	7.7	0.45	0.47	4.3
	Strontium	mg/kg	80	77	3.5	90	82	8.8	26	26	3.5
	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	0.068	0.075	9.8
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Titanium	mg/kg	2,010	1,710	16	1,630	1,480	9.6	786	778	1.0
	Uranium	mg/kg	0.86	0.85	1.1	0.89	0.82	8.8	0.50	0.43	14
	Vanadium	mg/kg	85	85	0.12	164	172	4.8	31	31	0.65
	Zinc	mg/kg	59	48	21	42	40	5.4	35	35	0.28

[a] The method detection limit (MDL) value was used in instances where values less than the MDL were reported. RPD calculation: =(Absolute(Replicate 1 - Replicate 2))/Average(Replicate 1, Replicate 2)*100

Table C.13: Field replicate results for the analysis of selectively extracted metals in sediment samples (Tessier extractions). Highlighted values did not meet the data quality objective of ≤ 40% Relative Percent Difference (RPD).

	Station ID	Units	ST02-S4			ST16-S3			QUL-51-02		
Analyte			ST02-S4	ST02-S4X	RPD [a]	ST16-S3	ST16-S3X	RPD [a]	QUL-51-02Y	QUL-51-02Z	RPD [a]
Exchangeable & Adsorbed Metals	Aluminum	mg/kg	<50	<50	0	<50	<50	0	<50	<50	0
	Antimony	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Arsenic	mg/kg	0.052	<0.050	3.9	<0.050	<0.050	0	<0.050	<0.050	0
	Barium	mg/kg	<27	<29	7.1	<21	<21	0	<40	<40	0
	Beryllium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	0.060	0.056	6.9
	Calcium	mg/kg	1,280	1,360	6.1	707	710	0.42	938	857	9.0
	Chromium	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
	Cobalt	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	0.27	0.22	20
	Copper	mg/kg	4.6	3.9	17	5.1	5.7	11	0.82	0.84	2.4
	Iron	mg/kg	<50	<50	0	<50	<50	0	<50	<50	0
	Lead	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
	Lithium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Manganese	mg/kg	27	28	2.5	<7.0	<7.0	0	18	17	10
	Molybdenum	mg/kg	<1.0	<0.90	11	<0.90	<0.90	0	<0.50	<0.50	0
	Nickel	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	0.71	0.60	17
	Phosphorus	mg/kg	<50	<50	0	<50	<50	0	<50	<50	0
	Potassium	mg/kg	<100	110	9.5 [a]	<100	<100	0	<100	<100	0
	Selenium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Silver	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Sodium	mg/kg	<100	<100	0	<100	<100	0	<100	<100	0
	Strontium	mg/kg	13	14	7.5	5.7	5.9	3.6	6.0	5.4	11
	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Titanium	mg/kg	<1.0	<1.0	0	<1.0	<1.0	0	<1.0	<1.0	0
	Uranium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Vanadium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Zinc	mg/kg	<1.0	<1.0	0	<1.0	<1.0	0	<1.0	<1.0	0
Carbonate Metals	Aluminum	mg/kg	<50	<50	0	<50	<50	0	<50	<50	0
	Antimony	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Arsenic	mg/kg	0.084	<0.050	51	<0.050	<0.050	0	0.077	0.065	17
	Barium	mg/kg	29	28	3.5	18	18	0.57	11	11	0.89
	Beryllium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Calcium	mg/kg	11,600	8,030	36	7,800	7,520	3.7	122	121	0.82
	Chromium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Cobalt	mg/kg	0.24	<0.10	82	<0.10	<0.10	0	0.19	0.18	5.4
	Copper	mg/kg	66	17	119	19	19	0	1.2	1.2	6.7
	Iron	mg/kg	109	<50	74	<50	<50	0	221	234	5.7
	Lead	mg/kg	1.0	<0.50	69	<0.50	<0.50	0	<0.50	<0.50	0
	Lithium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Manganese	mg/kg	97	60	47	55	53	3.5	<5.0	<5.0	0
	Molybdenum	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
	Nickel	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Phosphorus	mg/kg	<50	<50	0	<50	<50	0	<50	<50	0
	Selenium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Silver	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Strontium	mg/kg	45	32	34	13	13	0.80	<5.0	<5.0	0
	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Titanium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Uranium	mg/kg	0.051	<0.050	2.0	<0.050	<0.050	0	0.085	0.086	1.2
	Vanadium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Zinc	mg/kg	1.2	<1.0	18	<1.0	<1.0	0	<1.0	1.0	0
Easily Reducible Metals and Iron Oxides	Aluminum	mg/kg	1,230	1,010	20	719	717	0.28	709	704	0.71
	Antimony	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Arsenic	mg/kg	1.3	1.1	19	0.99	0.96	3.2	0.59	0.54	8.5
	Barium	mg/kg	17	17	1.8	11	11	2.8	12	12	0.83
	Beryllium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	<0.050	0.062	21	<0.050	<0.050	0	0.082	0.085	3.6
	Calcium	mg/kg	1,720	5,440	104	2,070	2,060	0.48	447	412	8.1
	Chromium	mg/kg	2.6	2.4	4.4	1.5	1.5	1.4	2.7	2.7	1.1
	Cobalt	mg/kg	2.1	2.2	4.2	0.69	0.67	2.9	2.1	2.1	0
	Copper	mg/kg	105	139	28	101	102	1.0	3.5	3.4	2.6
	Iron	mg/kg	3,180	3,120	1.9	2,350	2,230	5.2	4,000	3,840	4.1
	Lead	mg/kg	2.2	3.3	41	2.2	2.0	6.2	1.1	0.97	11
	Lithium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Manganese	mg/kg	84	119	34	49	49	0.81	35	34	1.7
	Molybdenum	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
	Nickel	mg/kg	4.3	4.2	4.0	0.66	0.70	5.9	5.0	4.9	2.2
	Phosphorus	mg/kg	136	86	45	97	116	18	92	89	3.3
	Selenium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Silver	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Strontium	mg/kg	19	26	34	14	13	2.2	5.4	4.7	13
	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Titanium	mg/kg	1.3	1.0	26	<1.0	<1.0	0	1.1	1.1	0
	Uranium	mg/kg	0.096	0.11	15	0.073	0.068	7.1	0.087	0.081	7.1
	Vanadium	mg/kg	8.0	7.7	3.4	7.5	7.1	6.2 [a]	4.9	5.0	0.61
	Zinc	mg/kg	8.1	8.1	0	4.3	4.1	4.8	12	11	2.6

Table C.13: Field replicate results for the analysis of selectively extracted metals in sediment samples (Tessier extractions). Highlighted values did not meet the data quality objective of ≤ 40% Relative Percent Difference (RPD).

	Station ID	Units	ST02-S4			ST16-S3			QUL-51-02		
Analyte			ST02-S4	ST02-S4X	RPD [a]	ST16-S3	ST16-S3X	RPD [a]	QUL-51-02Y	QUL-51-02Z	RPD [a]
Organic Bound Metals	Aluminum	mg/kg	877	749	16	403	414	2.7	628	640	1.9
Organic Bound Metals	Antimony	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
Organic Bound Metals	Arsenic	mg/kg	1.2	0.88	27	1.1	1.1	0	0.20	0.21	1.5
Organic Bound Metals	Barium	mg/kg	12	12	5.0	6.7	7.3	8.4	6.0	7.3	20
Organic Bound Metals	Beryllium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
Organic Bound Metals	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
Organic Bound Metals	Cadmium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
Organic Bound Metals	Calcium	mg/kg	927	1,130	20	877	821	6.6	488	471	3.5
Organic Bound Metals	Chromium	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	2.1	2.1	1.4
Organic Bound Metals	Cobalt	mg/kg	1.3	1.3	3.9	1.2	1.0	15	1.6	1.7	6.7
Organic Bound Metals	Copper	mg/kg	309	304	1.6	596	647	8.2	2.98	2.89	3.1
Organic Bound Metals	Iron	mg/kg	575	426	30	589	553	6.3	256	252	1.6
Organic Bound Metals	Lead	mg/kg	0.76	0.83	8.8	0.89	0.92	3.3	<0.50	<0.50	0
Organic Bound Metals	Lithium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
Organic Bound Metals	Manganese	mg/kg	13	12	2.4	6.7	6.4	4.6	6.8	6.9	1.5
Organic Bound Metals	Molybdenum	mg/kg	0.73	0.63	15	1.4	1.6	9.3	<0.50	<0.50	0
Organic Bound Metals	Nickel	mg/kg	0.80	0.76	5.1	<0.50	<0.50	0	2.1	2.2	2.8
Organic Bound Metals	Selenium	mg/kg	0.56	0.54	3.6	0.57	0.58	1.7	0.23	0.24	4.3
Organic Bound Metals	Silver	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
Organic Bound Metals	Strontium	mg/kg	9.4	11	19	7.6	8.4	11	2.9	2.8	3.9
Organic Bound Metals	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
Organic Bound Metals	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
Organic Bound Metals	Titanium	mg/kg	1.9	1.8	5.4	1.2	1.2	0	11	21	65
Organic Bound Metals	Uranium	mg/kg	0.082	0.090	9.3	0.076	0.075	1.3	0.069	0.061	12
Organic Bound Metals	Vanadium	mg/kg	1.1	0.98	13	0.64	0.59	8.1	2.0	2.3	12
Organic Bound Metals	Zinc	mg/kg	4.3	4.8	11	4.7	5.0	6.2	3.5	3.9	11
Residual Metals	Aluminum	mg/kg	12,900	14,200	9.6	10,100	9,810	2.9	8,370	8,740	4.3
Residual Metals	Antimony	mg/kg	0.28	0.33	16	0.19	0.22	15	0.19	0.19	0
Residual Metals	Arsenic	mg/kg	7.4	8.5	14	9.2	9.3	0.65	2.1	2.1	0.97
Residual Metals	Barium	mg/kg	80	94	15	75	81	8.0	42	42	0.48
Residual Metals	Beryllium	mg/kg	0.35	0.34	2.9	0.37	0.37	0	<0.20	<0.20	0
Residual Metals	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
Residual Metals	Cadmium	mg/kg	<0.050	<0.050	0	0.072	0.061	17	<0.050	<0.050	0
Residual Metals	Calcium	mg/kg	8,670	8,720	0.58	11,400	11,500	0.87	3,660	3,980	8.4
Residual Metals	Chromium	mg/kg	16	19	13	10	10	1.9	31	32	2.2
Residual Metals	Cobalt	mg/kg	11	13	10	13	13	0.78	4.1	4.2	2.4
Residual Metals	Copper	mg/kg	80	100	22	211	187	12	12	12	0.82
Residual Metals	Iron	mg/kg	41,400	44,500	7.2	56,100	57,900	3.2	13,400	13,400	0
Residual Metals	Lead	mg/kg	2.0	2.6	24	1.9	2.0	5.2	1.8	1.8	0
Residual Metals	Lithium	mg/kg	14	15	6.3	11	11	0.90	5.4	6.0	11
Residual Metals	Manganese	mg/kg	381	400	4.9	424	425	0.24	139	143	2.8
Residual Metals	Molybdenum	mg/kg	2.2	1.8	18	2.6	3.5	32	<0.50	<0.50	0
Residual Metals	Nickel	mg/kg	11	12	9.5	5.9	5.8	1.7	13	14	2.2
Residual Metals	Selenium	mg/kg	0.22	0.21	4.7	0.52	0.47	10	<0.20	<0.20	0
Residual Metals	Silver	mg/kg	0.19	0.20	5.1	0.33	0.33	0	<0.10	<0.10	0
Residual Metals	Strontium	mg/kg	55	57	3.9	46	52	12	30	33	8.5
Residual Metals	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	0.060	0.057	5.1
Residual Metals	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
Residual Metals	Titanium	mg/kg	1,250	1,310	4.7	1,020	1,050	2.9	803	815	1.5
Residual Metals	Uranium	mg/kg	0.60	0.65	7.7	0.62	0.67	7.4	0.42	0.42	0.72
Residual Metals	Vanadium	mg/kg	153	159	3.8	226	230	1.8	37	38	3.8
Residual Metals	Zinc	mg/kg	43	50	15	47	48	1.3	29	29	1.0

[a] The method detection limit (MDL) value was used in instances where values less than the MDL were reported. RPD calculation: =(Absolute(Replicate 1 - Replicate 2))/Average(Replicate 1, Replicate 2)*100

Table C.14: Field duplicate results for the analysis of acid base accounting, sulphur, and carbon content in sediment samples. Highlighted values did not meet the data quality objective of ≤ 40% Relative Percent Difference (RPD).

Station ID	Units	ST02-S4			ST16-S3			POL-1-03P			POL-2-04P			BOL-1-03P			QUL-51-02		
Analyte		ST02-S4	ST02-S4X	RPD [a]	ST16-S3	ST16-S3X	RPD [a]	POL-1-03P	POL-1-03PX	RPD [a]	POL-2-04P	POL-2-04PX	RPD [a]	BOL-1-03P	BOL-1-03PX	RPD [a]	QUL-51-02Y	QUL-51-02Z	RPD [a]
Maximum Potential Acidity (MPA)	$tCaCO_3/1Kt$	4.1	4.1	0	7.8	6.9	12	4.7	4.7	0	4.4	4.1	7.1	27	28	1.1	1.3	1.3	0
Fizz Rating	Unity	2.0	2.0	0	2.0	2.0	0	2.0	2.0	0	2.0	2.0	0	1.0	1.0	0	1.0	1.0	0
Net Neutralization Potential (NNP)	$tCaCO_3/1Kt$	41	42	2.4	26	28	7.4	39	39	0	40	39	2.5	-19	-20	5.1	5.0	4.0	22
pH	Unity	7.6	7.8	2.6	7.4	7.9	6.5	7.8	7.9	1.3	44	8.1	0	NSS	NSS	-	5.4	5.4	0
Neutralization Potential (NP)	$tCaCO_3/1Kt$	45	46	2.2	34	35	2.9	44	44	0	8.1	43	137	8.0	8.0	0	6.0	5.0	18
Neutralization Potential Ratio (NP/MPA)	Unity	11	11	2.1	4.4	5.1	16	9.4	9.4	0	10	11	5.0	0.29	0.29	0	4.8	4.0	18
Total Sulphur (S) - Leco	%	0.13	0.13	0	0.25	0.22	13	0.15	0.15	0	0.14	0.13	7.4	0.87	0.88	1.1	0.040	0.040	0
Sulphide Sulphur (S) - Calculated Leco	%	0.13	0.12	8.0	0.24	0.21	13	0.15	0.15	0	<0.010	0.13	171	0.84	0.85	1.2	0.040	0.030	29
Sulphate Sulphur (S) - Carbonate Leach	%	<0.010	0.010	0	0.010	0.010	0	<0.010	<0.010	0	NSS	<0.010	-	0.030	0.030	0	<0.010	0.010	0
Inorganic Carbon (C)	%	0.45	0.46	2.2	0.36	0.33	8.7	0.35	0.36	2.8	0.14	0.28	67	<0.050	<0.050	0	0.050	0.050	0
Carbon Dioxide (CO_2)	%	1.7	1.7	0	1.3	1.2	8.0	1.3	1.3	0	0.33	1.0	101	<0.20	<0.20	0	0.20	0.20	0
Sulphate Sulphur (S) - HCl leachable	%	0.020	0.020	0	0.030	0.020	40	0.020	<0.010	67	1.2	0.040	187	NSS	NSS	-	<0.010	0.010	0

NSS = non-sufficient sample

[a] The method detection limit (MDL) value was used in instances where values less than the MDL were reported. RPD calculation: =(Absolute(Replicate 1 - Replicate 2))/Average(Replicate 1, Replicate 2)*100

As with the analysis of total metals, field precision associated with the SEA results indicated good precision; there were few combinations of metal and extractant with precision that did not meet the target (Table C.13). Most exceedences occurred in a single set of duplicates (ST-02-S4), suggesting greater spatial variability at that location. In three instances, precision associated with copper analyes did not meet the objective: 1) "exchangeable and adsorbed" copper in replicates from POL-1-03M; 2) "easily reducible and iron oxide" copper in replicates from POL-2-04M; and 3) "carbonate" copper in replicates from ST02-S4 (Table C.13). Precision associated with the analyses of copper is of particular interest to the program because copper is the primary analyte affected by and indicative of mine influence. However, because the RPD exceedences occurred in only one of five samples in each case, it does not indicate a systematic issue and therefore does not adversely affect data interpretability. The observed variability likely represents real small scale differences in sediment (and sediment was particularly heterogeneous in Polley Lake). Lastly, field precision associated with the ABA testing was excellent in all samples but one – the duplicates collected at station POL-2-04P (Table C.14). At this station, neutralization potential, sulphide sulphur, inorganic carbon, carbon dioxide and sulphate sulphur all failed to meet the objective. It is notable that reducing conditions were observed at this station, which may have contributed to variability. Nonetheless, the result does not adversely affect data interpretation because neutralization potential ratios (NPR) were well above those at reference locations and well above levels considered indicative of acid generating potential.

Laboratory Duplicate Samples

All of the laboratory duplicate results associated with the sediment analyses of strong acid leachable metals, shakeflask extracted metals, SEA and ABA showed excellent agreement (Tables C.15 to C.19). Laboratory precision associated with the non-metals data (particle size, organic carbon and nitrogen) was excellent, meeting the data quality objective in all cases (Table C.15). In the strong acid leachable metal analyses, mercury and arsenic each failed to meet the objective (≤ 35% RPD) in only one out of 24 duplicate analyses (Table C.16), indicating excellent laboratory precision. Similarly, in the shakeflask analyses, only three instances of RPD exceedance were observed, and only one (iron in sample QUL-51-02) was particularly high (86%; Table C.17), indicating good analytical precision overall. In the SEA analyses, laboratory precision was also good, with few exceedances of the objective for laboratory precision observed, and with most of those in only two of 17 samples (Table C.18). Notably, none of the objective excedeences were for copper, the primary analyte affected by and indicative of mine

Table C.15: Laboratory duplicate results for the analysis of physical characteristics and non-metal parameters in sediment samples. Highlighted values did not meet the data quality objective of ≤ 35% Relative Percent Difference (RPD).

Sample ID	Units	BOL-1-02P 63UM			BOL-B1-01M			BOL-B2-01M			BOL-B1-03M <63UM			HAC50 (2MM-125UM)			ST16-S4			ST09-S3			ST02-S1		
Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Moisture	%	-	-	-	94	93	0.43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH (1:2 soil: water)	pH units	-	-	-	-	-	-	6.2	6.2	0	6.2	6.2	0	8.2	8.3	1.2	9.1	9.0	1.1	-	-	-	-	-	-
pH (Leachable)	pH units	-	-	-	-	-	-	-	-	-	-	-	-	8.5	8.4	0.83	-	-	-	-	-	-	8.6	8.7	0.46
% Gravel	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.10	<0.10	0	-	-	-
% Sand	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.4	5.4	0.19	-	-	-
% Silt	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	82	82	0.24	-	-	-
% Clay	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	13	1.6	-	-	-
Total Nitrogen	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	%	18	18	2.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carbon by Combustion	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Sample ID	Units	POL-2-O4P			ST02-S4			ST16-S5			ST16-S4 <63 UM			POL-2-O3M			POL-P2-O2M			POL-2-O1P			POL-2-O5P <63UM		
Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Moisture	%	-	-	-	-	-	-	-	-	-	-	-	-	88	88	0	-	-	-	-	-	-	-	-	-
pH (1:2 soil: water)	pH units	-	-	-	-	-	-	-	-	-	-	-	-	7.9	7.9	0.63	-	-	-	-	-	-	-	-	-
pH (Leachable)	pH units	7.9	7.8	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Gravel	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Sand	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Silt	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Clay	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen	%	-	-	-	<0.020	<0.020	0	<0.020	<0.020	0	-	-	-	-	-	-	1.3	1.3	2.3	-	-	-	-	-	-
Total Organic Carbon	%	-	-	-	0.17	0.18	5.7	<0.10	<0.10	0	<0.10	<0.10	0	-	-	-	-	-	-	1.9	2.0	8.2	0.56	0.56	0
Carbon by Combustion	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Sample ID	Units	POL-P1-01P <63UM			POL-1-05M			POL-1-02P 63UM			POL-P2-PW-8			QUL-PW-1-12			QUL51-01			QUL51-05			QUL49-05		
Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Moisture	%	-	-	-	61	65	7.3	-	-	-	-	-	-	-	-	-	80	81	1.5	48	49	0.62	-	-	-
pH (1:2 soil: water)	pH units	-	-	-	-	-	-	-	-	-	8.0	8.0	0	8.3	8.2	0.61	-	-	-	-	-	-	-	-	-
pH (Leachable)	pH units	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Gravel	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.10	<0.10	0
% Sand	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	93	92	1.1
% Silt	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.9	7.8	13
% Clay	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.52	0.58	11
Total Nitrogen	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	%	12	11	0.9	-	-	-	1.2	1.2	3.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carbon by Combustion	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Sample ID	Units	QUL51-02 63UM			QUL49-04			QUL51-03 63UM			QUL-45-02			QUL45-03			QUL49-02			QUL49-03			QUL49-02-63UM		
Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Moisture	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH (1:2 soil: water)	pH units	-	-	-	-	-	-	6.9	6.9	0.14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH (Leachable)	pH units	7.0	7.0	0.43	-	-	-	-	-	-	8.5	8.5	0.12	8.3	8.3	0.84	-	-	-	6.9	7.0	1.3	-	-	-
% Gravel	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.10	<0.10	0	-	-	-	-	-	-
% Sand	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.6	10	5.3	-	-	-	-	-	-
% Silt	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	84	83	0.72	-	-	-	-	-	-
% Clay	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.8	6.9	2.5	-	-	-	-	-	-
Total Nitrogen	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.13	0.13	0.76	-	-	-	-	-	-
Total Organic Carbon	%	-	-	-	2.6	2.6	1.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.72	0.72	0
Carbon by Combustion	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[a] The method detection limit (MDL) value was used in instances where values less than the MDL were reported. RPD calculation: =(Absolute(Replicate 1 - Replicate 2))/Average(Replicate 1, Replicate 2)*100

Table C.15: Laboratory duplicate results for the analysis of physical characteristics and non-metal parameters in sediment samples. Highlighted values did not meet the data quality objective of ≤ 35% Relative Percent Difference (RPD).

Sample ID	Units	QUL51-03			QUL51-02			QUL51-04			QUL51-01			QUL49-04			QUL51-04 63UM			QUL-47-04			QUL-47-01		
Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Moisture	%	40	46	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43	47	9.0	-	-	-
pH (1:2 soil: water)	pH units	-	-	-	6.4	6.3	0.31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.9	6.9	1.0
pH (Leachable)	pH units	-	-	-	-	-	-	-	-	-	6.1	6.1	0.16	-	-	-	-	-	-	-	-	-	-	-	-
% Gravel	%	-	-	-	-	-	-	0.74	0.74	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Sand	%	-	-	-	-	-	-	66	67	0.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Silt	%	-	-	-	-	-	-	29	29	1.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Clay	%	-	-	-	-	-	-	4.2	4.2	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen	%	-	-	-	-	-	-	-	-	-	-	-	-	0.037	0.039	5.3	-	-	-	-	-	-	-	-	-
Total Organic Carbon	%	-	-	-	-	-	-	-	-	-	-	-	-	0.93	0.88	5.5	1.4	1.4	2.2	-	-	-	-	-	-
Carbon by Combustion	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Sample ID	Units	QUL-47			QUL-47-04 63UM			QUL-48-01			QULP-1-01			QUL-48-02 <63UM			QUL-48-03			QUL-48			QUL-47-03X		
Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Moisture	%	-	-	-	-	-	-	66	65	1.7	-	-	-	-	-	-	-	-	-	-	-	-	40	40	0
pH (1:2 soil: water)	pH units	-	-	-	-	-	-	-	-	-	8.6	8.6	0.70	6.3	6.4	1.4	-	-	-	-	-	-	6.5	6.5	0.15
pH (Leachable)	pH units	-	-	-	-	-	-	-	-	-	7.4	7.5	0.80	-	-	-	-	-	-	-	-	-	-	-	-
% Gravel	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.2	4.2	0	-	-	-	-	-	-
% Sand	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	38	38	1.1	-	-	-	-	-	-
% Silt	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	55	55	0.36	-	-	-	-	-	-
% Clay	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.7	3.3	19	-	-	-	-	-	-
Total Nitrogen	%	0.097	0.11	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.38	0.41	5.8	-	-	-
Total Organic Carbon	%	2.1	2.2	0.93	0.59	0.58	1.7	-	-	-	-	-	-	-	-	-	-	-	-	5.6	5.9	5.4	-	-	-
Carbon by Combustion	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Sample ID	Units	QUL-51-02X			QUL-47-03Y 63UM			QULP-4-05			QULP-4 (COMPOSITE)			QULP-6 (COMPOSITE)			QULP-A			QULP-22 <63UM			QULP-22		
Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Moisture	%	-	-	-	-	-	-	40	40	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH (1:2 soil: water)	pH units	-	-	-	6.7	6.6	1.0	-	-	-	-	-	-	-	-	-	8.8	8.8	0.23	8.6	8.7	0.81	-	-	-
pH (Leachable)	pH units	-	-	-	-	-	-	-	-	-	8.1	8.2	0.37	-	-	-	-	-	-	-	-	-	-	-	-
% Gravel	%	<0.10	<0.10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.10	<0.10	0
% Sand	%	50	50	1.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.3	3.8	14
% Silt	%	48	47	0.42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	86	85	0.70
% Clay	%	2.8	2.3	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	11	0
Total Nitrogen	%	-	-	-	-	-	-	-	-	-	-	-	-	0.15	0.15	0.66	-	-	-	-	-	-	-	-	-
Total Organic Carbon	%	-	-	-	-	-	-	-	-	-	-	-	-	1.8	1.8	1.1	-	-	-	-	-	-	-	-	-
Carbon by Combustion	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Sample ID	Units	QULP-19			QULP-19<63UM			QULP-1-03			QULP-1-05			QULP-1-04			QULP-1-05-63UM			QULP-26			QULP-5-05		
Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Moisture	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60	61	1.8	-	-	-
pH (1:2 soil: water)	pH units	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.9	6.8	1.2
pH (Leachable)	pH units	-	-	-	-	-	-	-	-	-	8.4	8.4	0.24	-	-	-	-	-	-	-	-	-	-	-	-
% Gravel	%	-	-	-	-	-	-	<0.10	<0.10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Sand	%	-	-	-	-	-	-	0.22	0.28	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Silt	%	-	-	-	-	-	-	75	75	0.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Clay	%	-	-	-	-	-	-	25	25	1.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen	%	0.031	0.029	6.7	-	-	-	-	-	-	-	-	-	<0.020	<0.020	0	-	-	-	-	-	-	-	-	-
Total Organic Carbon	%	0.38	0.40	5.1	0.22	0.20	10	-	-	-	-	-	-	-	-	-	0.15	0.17	13	-	-	-	-	-	-
Carbon by Combustion	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.50	0.50	0.0	-	-	-	-	-	-

[a] The method detection limit (MDL) value was used in instances where values less than the MDL were reported. RPD calculation: =(Absolute(Replicate 1 - Replicate 2))/Average(Replicate 1, Replicate 2)*100

Table C.15: Laboratory duplicate results for the analysis of physical characteristics and non-metal parameters in sediment samples. Highlighted values did not meet the data quality objective of ≤ 35% Relative Percent Difference (RPD).

Sample ID	Units	QULP-46			QULP-2-05			QULP-5-02			QULP-2-02			QULP-39			QULP-42 <63UM			QULP-5-02 <63UM			QULP-4-01 <63UM		
Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Moisture	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH (1:2 soil: water)	pH units	8.2	8.2	0.73	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH (Leachable)	pH units	-	-	-	-	-	-	6.7	6.7	0.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Gravel	%	-	-	-	<0.10	<0.10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Sand	%	-	-	-	0.19	0.23	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Silt	%	-	-	-	87	87	0.57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Clay	%	-	-	-	13	12	4.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen	%	-	-	-	-	-	-	-	-	-	0.028	0.030	6.9	0.27	0.26	2.6	-	-	-	-	-	-	-	-	-
Total Organic Carbon	%	-	-	-	-	-	-	-	-	-	0.35	0.36	2.8	-	-	-	2.1	2.1	0	1.7	1.7	0.59	0.35	0.43	21
Carbon by Combustion	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Sample ID	Units	QULP-3-03 <63UM			QULP-3-01			QULP-6-03X			QULP-34			QULP-17			QULP-27 <63UM			BOL-1-01P		
Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Moisture	%	-	-	-	-	-	-	-	-	-	77	77	0.52	-	-	-	-	-	-	92	93	0.54
pH (1:2 soil: water)	pH units	7.3	7.3	0.28	-	-	-	-	-	-	7.4	7.4	0.40	-	-	-	-	-	-	-	-	-
pH (Leachable)	pH units	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Gravel	%	-	-	-	<0.10	<0.10	0	-	-	-	-	-	-	<0.10	<0.10	0	-	-	-	-	-	-
% Sand	%	-	-	-	0.61	0.78	24	-	-	-	-	-	-	0.13	0.14	7.4	-	-	-	-	-	-
% Silt	%	-	-	-	63	63	0	-	-	-	-	-	-	79	79	0.13	-	-	-	-	-	-
% Clay	%	-	-	-	37	37	0	-	-	-	-	-	-	21	21	1.0	-	-	-	-	-	-
Total Nitrogen	%	-	-	-	0.27	0.25	7.2	-	-	-	-	-	-	<0.020	0.020	0	-	-	-	-	-	-
Total Organic Carbon	%	-	-	-	2.5	2.4	4.9	1.9	1.9	1.6	-	-	-	0.36	0.32	12	1.2	1.2	0	-	-	-
Carbon by Combustion	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[a] The method detection limit (MDL) value was used in instances where values less than the MDL were reported. RPD calculation: =(Absolute(Replicate 1 - Replicate 2))/Average(Replicate 1, Replicate 2)*100

Table C.16: Laboratory duplicate results for the analysis of metals in sediment samples. Highlighted values did not meet the data quality objective of ≤ 35% relative percent difference (RPD).

Sample ID	Units	BOL-1-04M <63UM			BOL-B2-01M			HAC50 (2MM-125UM)			ST16-S4			POL-2-O3M			POL-P2-O3M <63UM		
Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Aluminum	mg/kg	9,000	9,000	0	19,900	19,300	3.3	21,000	20,600	1.6	12,500	12,500	0.30	25,900	25,300	2.4	22,200	21,200	4.2
Antimony	mg/kg	0.42	0.44	4.6	1.0	0.91	9.9	0.40	0.46	14	0.40	0.34	17	0.69	0.68	0.40	0.43	0.45	3.6
Arsenic	mg/kg	2.8	2.8	1.6	6.5	6.3	4.1	13	13	0.70	12	12	0.70	11	11	1.8	14	14	1.9
Barium	mg/kg	109	110	1.7	270	259	4.0	215	226	4.8	118	121	3.3	231	231	0.10	229	233	1.8
Beryllium	mg/kg	0.30	0.31	2.8	0.75	0.71	5.9	0.71	0.75	5.8	0.54	0.54	0.40	0.79	0.85	7.0	0.82	0.82	0.80
Bismuth	mg/kg	<0.10	<0.10	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.10	<0.10	0
Boron	mg/kg	<10	<10	0	-	-	-	-	-	-	<10	<10	0	18	17	2.2	10	11	5.0
Cadmium	mg/kg	0.20	0.21	3.7	0.43	0.43	0.70	0.16	0.17	1.5	0.17	0.17	1.5	0.37	0.38	2.9	0.13	0.17	26
Calcium	mg/kg	5,300	5,150	2.8	8,050	7,540	6.5	28,600	30,500	6.6	25,600	26,200	2.5	21,500	22,700	5.2	34,500	33,200	4.1
Chromium	mg/kg	21	20	9.2	37	34	11	11	11	2.7	11	11	1.8	37	37	0.50	13	17	23
Cobalt	mg/kg	5.5	5.5	0.50	12	12	4.9	20	20	0.50	14	14	0.20	20	20	0.70	20	19	3.6
Copper	mg/kg	173	174	0.30	372	357	4.2	950	900	5.5	895	863	3.7	606	618	1.9	683	666	2.6
Iron	mg/kg	12,600	12,300	2.1	32,200	30,200	6.4	46,400	46,300	0.20	62,300	62,400	0.30	30,700	31,100	1.2	37,100	36,200	2.4
Lead	mg/kg	5.2	5.1	1.1	11	10	5.5	6.7	6.8	2.2	4.9	5.3	7.0	7.6	7.6	1.0	5.3	5.2	1.4
Lithium	mg/kg	6.7	6.7	0.70	13	12	13	19	20	4.9	13	14	4.4	22	23	7.6	21	21	0.40
Magnesium	mg/kg	2,830	2,850	0.50	5,270	4,960	6.0	13,400	13,400	0.10	8,000	7,650	4.5	13,100	13,400	2.5	13,300	13,000	2.6
Manganese	mg/kg	376	374	0.40	1,700	1,670	1.6	828	867	4.7	569	571	0.50	814	845	3.8	750	746	0.50
Mercury	mg/kg	0.13	0.13	0.50	-	-	-	0.079	0.084	5.8	-	-	-	-	-	-	0.071	0.072	1.5
Molybdenum	mg/kg	1.4	1.5	3.6	3.2	2.9	9.5	4.1	5.0	20	4.2	4.3	2.3	8.3	8.8	6.9	4.0	4.2	5.5
Nickel	mg/kg	15	14	9.9	28	27	3.3	9.9	10	1.9	6.8	6.8	0.50	30	30	0.80	12	14	12
Phosphorus	mg/kg	636	628	1.3	2,770	2,730	1.5	1,390	1,410	1.1	1,390	1,440	3.4	1,020	1,070	4.7	1,700	1,690	0.60
Potassium	mg/kg	740	750	0.40	1,590	1,440	9.6	1,950	1,890	3.3	940	960	2.7	2,080	1,990	4.2	1,980	2,160	8.6
Selenium	mg/kg	1.2	1.2	2.2	3.0	2.8	6.4	1.2	1.2	1.4	1.1	1.1	2.0	3.3	3.3	0.80	1.0	1.0	0.40
Silver	mg/kg	0.17	0.17	2.9	0.40	0.40	0.40	0.36	0.39	9.9	0.44	0.42	5.8	0.38	0.38	0.40	0.30	0.31	2.3
Sodium	mg/kg	120	130	3.1	220	210	5.4	1,370	1,380	0.60	740	730	1.5	1,030	1,040	1.2	1,200	1,290	7.0
Strontium	mg/kg	61	61	0.20	99	90	8.9	181	196	8.1	102	106	3.5	194	199	2.6	234	227	3.3
Thallium	mg/kg	0.063	0.061	4.3	0.13	0.12	9.1	<0.050	<0.050	0	<0.050	<0.050	0	0.083	0.076	8.6	<0.050	<0.050	0
Tin	mg/kg	0.68	0.53	24	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	2.0	2.1	4.0
Titanium	mg/kg	382	388	1.6	518	451	14	1,730	1,740	0.90	1,150	1,190	3.9	1,280	1,210	5.8	1,670	1,780	6.7
Uranium	mg/kg	1.0	1.0	0.40	2.3	2.2	6.5	1.2	1.2	3.1	0.88	0.88	0.10	1.7	1.7	1.6	1.3	1.3	1.5
Vanadium	mg/kg	34	34	0.70	76	69	9.4	172	171	0.80	244	245	0.40	106	107	0.60	144	143	0.70
Zinc	mg/kg	36	36	0.50	78	75	4.1	74	75	0.90	52	55	5.4	92	93	1.5	66	69	4.0
Zirconium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[a] RPDs were calculated by laboratory, see ALS Laboratory Reports in Appendix J

[b] Duplicate results outside ALS DQO due to sample heterogeneity.

Table C.16: Laboratory duplicate results for the analysis of metals in sediment samples. Highlighted values did not meet the data quality objective of ≤ 35% relative percent difference (RPD).

Sample ID	Units	POL-P2-PW-8			QUL-PW-1-12			QUL50-01-63UM			QUL-49-05 63UM			QUL51-02			QUL-47-01		
Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Aluminum	mg/kg	28,000	26,500	5.4	33,200	32,600	1.8	13,000	13,800	5.6	15,400	15,400	0	9,770	9,990	2.2	9,890	9,380	5.3
Antimony	mg/kg	0.67	0.66	0.90	0.64	0.63	2.5	0.23	0.23	0.80	0.42	0.44	3.7	0.20	0.19	6.4	0.41	0.36	13
Arsenic	mg/kg	12	11	2.1	16	16	1.2	3.8	4.2	10	12	12	3.6	3.1	3.2	0.60	3.1	3.1	0.20
Barium	mg/kg	247	240	2.5	313	304	3.1	73	78	6.3	164	162	1.5	98	96	1.7	50	50	0.1
Beryllium	mg/kg	0.90	0.86	4.0	1.2	1.1	3.9	0.28	0.34	18	0.59	0.58	2.2	0.23	0.24	4.0	0.34	0.29	16
Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.20	<0.20	0	<0.20	<0.20	0
Boron	mg/kg	-	-	-	-	-	-	<10	<10	0	<10	<10	0	<10	<10	0	<10	<10	0
Cadmium	mg/kg	0.33	0.34	3.8	0.25	0.24	1.9	0.18	0.21	15	0.13	0.13	0.70	0.22	0.24	6.5	0.30	0.27	10
Calcium	mg/kg	25,600	24,700	3.7	33,000	32,800	0.60	6,430	6,670	3.6	26,400	26,200	0.80	5,110	5,180	1.4	11,700	11,100	5.1
Chromium	mg/kg	35	34	4.8	21	20	2.4	39	40	2.4	19	19	2.6	36	37	4.0	26	25.3	2.9
Cobalt	mg/kg	23	23	0	32	32	1.0	10	11	7.8	17	16	4.1	8.4	8.6	2.8	8.6	8.2	5.2
Copper	mg/kg	695	689	0.80	1,150	1,140	0.80	26	29	9.3	485	472	2.5	20	21	2.5	28	27	4.8
Iron	mg/kg	30,400	30,900	1.8	37,900	37,300	1.5	26,200	27,300	4.3	67,800	64,600	4.9	17,700	18,600	4.7	17,300	16,600	4.5
Lead	mg/kg	8.1	8.2	1.3	12	12	1.3	6.1	6.6	7.0	5.4	5.2	4.7	3.2	3.3	3.8	4.8	4.7	1.6
Lithium	mg/kg	26	25	3.3	39	39	1.1	16	18	9.8	14	14	0.70	8.5	8.7	2.6	11	10	9.2
Magnesium	mg/kg	15,900	15,600	1.8	23,800	23,600	0.60	6,630	7,070	6.4	8,150	8,110	0.50	5,300	5,460	2.9	4,960	4,560	8.4
Manganese	mg/kg	928	899	3.2	1,240	1,220	1.7	521	567	8.5	617	623	0.90	212	224	5.5	251	232	7.8
Mercury	mg/kg	0.11	0.11	7.2	0.11	0.11	0.60	0.090	0.062	37	0.065	0.063	3.8	0.024	0.025	0.20	0.069	0.067	3.9
Molybdenum	mg/kg	6.9	6.7	3.4	4.4	4.3	2.0	0.67	0.73	8.4	3.0	2.7	9.3	0.50	0.51	0.70	<0.50	<0.50	0
Nickel	mg/kg	29	29	1.3	22	22	0.10	27	29	9.1	13	13	2.4	22	22	1.6	24	23	5.4
Phosphorus	mg/kg	1,070	1,150	7.4	1,090	1,090	0.30	896	836	7.0	1,620	1,650	1.6	881	842	4.5	392	434	10
Potassium	mg/kg	2,370	2,230	5.9	3,030	3,000	1.0	910	990	7.7	1,450	1,470	1.9	710	750	5.3	630	610	3.0
Selenium	mg/kg	3.0	2.9	4.5	1.6	1.5	2.3	0.51	0.57	12	0.83	0.71	15	0.33	0.34	3.4	1.4	1.3	3.0
Silver	mg/kg	0.38	0.39	1.3	0.44	0.41	5.6	0.083	0.095	13	0.26	0.24	5.2	<0.10	<0.10	0	0.10	<0.10	0
Sodium	mg/kg	1,080	1,130	4.5	1,490	1,450	2.8	200	220	8.4	810	780	3.2	260	260	1.1	130	140	7.0
Strontium	mg/kg	203	195	4.2	243	240	1.3	60	63	5.0	152	156	2.1	39	39	0.0	56	55	1.9
Thallium	mg/kg	0.073	0.071	3.1	<0.050	<0.050	0	0.083	0.094	12	<0.050	<0.050	0	0.10	0.093	7.4	0.054	0.054	0.50
Tin	mg/kg	<2.0	<2.0	0	2.4	5.0	-	0.41	0.43	4.7	1.4	1.5	5.0	<2.0	<2.0	0	<2.0	<2.0	0
Titanium	mg/kg	1,600	1,370	16	2,380	2,300	3.3	738	768	4.0	1,550	1,600	3.5	847	847	0.10	802	770	4.1
Uranium	mg/kg	1.9	1.9	0.30	1.6	1.5	2.4	0.98	1.0	2.1	1.0	1.1	1.0	0.60	0.63	5.6	1.3	1.3	0.80
Vanadium	mg/kg	115	110	4.4	124	122	1.5	61	62	2.3	256	241	5.8	44	45	3.6	46	43	6.7
Zinc	mg/kg	97	95	2.2	121	120	0.60	62	65	5.0	55	53	3.5	46	48	3.4	37	35	6.4
Zirconium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[a] RPDs were calculated by laboratory, see ALS Laboratory Reports in Appendix J

[b] Duplicate results outside ALS DQO due to sample heterogeneity.

Table C.16: Laboratory duplicate results for the analysis of metals in sediment samples. Highlighted values did not meet the data quality objective of ≤ 35% relative percent difference (RPD).

Sample ID	Units	QULP-1-01			QUL-47-03X			QULP-4-04 63UM			QULP-A			QULP-21 <63UM			QULP-25		
Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Aluminum	mg/kg	24,100	23,500	2.5	12,800	12,800	0.30	19,800	19,900	0.80	20,800	20,900	0.80	13,700	13,200	4.0	28,400	29,300	3.2
Antimony	mg/kg	0.55	0.53	4.3	0.23	0.21	9.1	0.47	0.46	1.8	0.47	0.47	0.50	0.38	0.33	13	0.88	0.93	5.7
Arsenic	mg/kg	16	16	0.40	4.6	4.7	3.9	14	14	2.1	14	14	2.3	12	12	2.6	22	26	16
Barium	mg/kg	234	234	0.10	78	75	3.5	213	208	2.6	220	223	1.5	159	158	0.20	188	199	5.6
Beryllium	mg/kg	0.91	0.91	0.40	0.32	0.32	0.30	0.74	0.71	4.5	0.80	0.79	1.3	0.59	0.54	9.2	0.88	0.97	9.6
Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.10	<0.10	0	<0.20	<0.20	0	<0.10	<0.10	0	0.35	0.34	1.8
Boron	mg/kg	12	11	3.2	<10	<10	0	10	<10	0	11	11	5.0	<10	<10	0	<10	<10	0
Cadmium	mg/kg	0.17	0.17	4.6	0.084	0.098	15	0.14	0.15	9.0	0.14	0.14	0.90	0.14	0.13	6.7	0.63	0.74	16
Calcium	mg/kg	35,600	35,400	0.8	8,420	8,210	2.5	32,600	31,900	2.3	32,300	33,500	3.4	26,900	26,100	3.0	10,300	11,200	7.8
Chromium	mg/kg	13	13	2.2	43	41	5.4	13	13	5.3	11	11	1.1	16	15	3.9	69	72	4.4
Cobalt	mg/kg	21	20	0.20	9.9	10	0.60	16	16	0.50	17	17	2.1	17	17	0.30	26	28	6.4
Copper	mg/kg	749	748	0.10	26	26	1.1	534	549	2.9	609	608	0.10	535	532	0.50	112	119	6.6
Iron	mg/kg	28,900	28,600	1.2	25,400	24,400	4.0	25,000	24,400	2.3	25,600	26,000	1.5	70,900	70,600	0.40	53,800	56,600	5.0
Lead	mg/kg	7.4	7.3	1.1	3.7	3.5	4.3	5.9	5.7	3.3	6.0	6.0	0.10	4.8	4.7	1.2	21	22	5.3
Lithium	mg/kg	25	24	3.5	10	10	2.7	20	19	3.0	21	22	2.8	14	14	0.50	31	33	5.6
Magnesium	mg/kg	14,900	14,500	2.9	6,550	6,320	3.7	11,200	10,800	3.6	12,300	12,100	1.4	8,120	7,980	1.8	12,600	13,100	3.4
Manganese	mg/kg	860	852	0.90	328	322	1.8	711	694	2.5	738	743	0.70	556	536	3.7	19,400	21,000	7.8
Mercury	mg/kg	-	-	-	-	-	-	0.070	0.071	2.1	0.067	0.068	1.6	0.069	0.069	0.90	0.20	0.19	4.9
Molybdenum	mg/kg	3.9	4.1	3.6	<0.50	<0.50	0	3.4	3.4	0.70	3.3	3.5	5.7	3.5	3.6	1.5	6.4	7.4	14
Nickel	mg/kg	13	14	1.8	23	23	2.1	12	12	0.80	11	11	4.3	11	11	2.0	64	69	7.3
Phosphorus	mg/kg	1,610	1,550	3.7	945	850	11	1,790	1,780	0.90	1,510	1,480	1.7	1,820	1,820	0.40	1,260	1,350	6.5
Potassium	mg/kg	2,070	2,070	0.10	970	920	5.8	1,740	1,640	6.0	2,130	2,110	1.1	1,230	1,210	1.5	3,000	3,040	1.6
Selenium	mg/kg	1.2	1.1	7.5	0.21	<0.20	0	0.93	0.91	1.7	0.89	0.87	1.9	0.95	1.0	7.2	1.8	1.8	3.2
Silver	mg/kg	0.34	0.33	1.9	<0.10	<0.10	0	0.27	0.26	0.90	0.27	0.27	1.9	0.28	0.29	5.8	0.35	0.38	6.8
Sodium	mg/kg	1,150	1,190	3.2	410	420	1.4	900	850	5.4	1,260	1,270	0.80	720	710	1.0	520	540	3.0
Strontium	mg/kg	208	204	1.9	100	93	7.5	195	190	2.7	195	202	3.5	142	137	3.0	123	132	7.0
Thallium	mg/kg	<0.050	<0.050	0	0.052	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0.0	0.33	0.33	1.5
Tin	mg/kg	2.2	2.2	3.4	<2.0	<2.0	0	1.8	1.7	5.6	<2.0	2.1	0	1.3	1.2	3.7	<2.0	<2.0	0
Titanium	mg/kg	2,100	2,070	1.5	1,070	1,030	4.1	1,760	1,650	6.3	1,930	2,010	3.8	1,170	1,090	7.3	1,010	1,020	1.0
Uranium	mg/kg	1.5	1.5	1.9	0.60	0.57	5.4	1.4	1.3	9.2	1.3	1.4	4.6	1.0	1.0	2.7	3.5	3.9	11
Vanadium	mg/kg	106	105	0.60	83	81	3.2	93	91	2.2	98	99	1.6	261	259	0.80	91	95	4.3
Zinc	mg/kg	75	75	0.50	43	42	3.0	58	56	3.4	62	60	3.1	53	52	1.8	122	128	4.8
Zirconium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[a] RPDs were calculated by laboratory, see ALS Laboratory Reports in Appendix J

[b] Duplicate results outside ALS DQO due to sample heterogeneity.

Table C.16: Laboratory duplicate results for the analysis of metals in sediment samples. Highlighted values did not meet the data quality objective of ≤ 35% relative percent difference (RPD).

Sample ID	Units	QULP-2-01 <63UM			QULP-5-05			QULP-39 <63UM			QULP-3-03 <63UM			QULP-34			QULP-27 <63UM		
Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Aluminum	mg/kg	26,500	26,200	1.0	16,000	15,900	0.50	23,800	24,000	1.1	27,900	28,600	2.4	26,000	26,000	0	24,900	25,700	3.3
Antimony	mg/kg	0.64	0.63	0.70	0.45	0.51	12	0.73	0.71	2.2	0.82	0.93	12	0.77	0.77	0.60	0.61	0.64	5.6
Arsenic	mg/kg	16	16	0.90	9.3	8.9	4.2	60	39	42 [b]	115	99	15	16	16	0.60	16	16	2.4
Barium	mg/kg	261	254	2.8	146	147	0.20	197	196	0.50	239	239	0.10	185	178	4.2	239	254	6.1
Beryllium	mg/kg	0.92	0.94	2.4	0.43	0.45	5.3	0.76	0.78	2.8	0.85	0.86	1.4	0.86	0.89	3.9	0.93	0.91	2.2
Bismuth	mg/kg	0.19	0.19	3.0	<0.20	<0.20	0	0.30	0.29	4.4	0.32	0.34	4.1	0.31	0.32	3.3	0.19	0.18	3.2
Boron	mg/kg	<10	<10	0	<10	<10	0	<10	<10	0	<10	<10	0	<10	<10	0	<10	<10	0
Cadmium	mg/kg	0.32	0.33	3.8	0.42	0.42	0.60	0.58	0.58	0.50	0.69	0.65	5.4	0.59	0.58	2.2	0.37	0.35	3.7
Calcium	mg/kg	28,700	28,600	0.30	8,200	8,170	0.40	9,680	9,530	1.6	10,600	10,300	2.9	9,270	9,940	7.0	25,500	25,200	1.1
Chromium	mg/kg	32	32	1.8	54	53	1.4	64	74	15	67	70	3.8	65	65	0	37	36	0.70
Cobalt	mg/kg	24	24	0.20	14	14	0.70	23	23	2.0	26	26	2.0	24	24	0.70	22	22	1.4
Copper	mg/kg	643	647	0.60	45	45	1.4	71	73	3.4	85	83	2.5	90	89	1.4	498	474	5.0
Iron	mg/kg	36,300	36,300	0.10	30,200	30,300	0.40	57,000	51,700	9.7	70,000	66,100	5.8	49,800	50,000	0.50	39,000	38,700	0.90
Lead	mg/kg	12	12	1.5	7.2	7.2	0.80	18	18	1.1	19	20	4.2	21	22	3.0	12	12	0.50
Lithium	mg/kg	30	30	0.20	14	14	1.7	27	27	0.20	28	28	0.30	29	31	8.5	30	29	3.0
Magnesium	mg/kg	15,400	15,300	0.30	7,800	7,750	0.60	10,200	10,300	0.40	11,700	11,800	1.0	11,400	11,200	1.8	14,000	14,000	0.20
Manganese	mg/kg	1,150	1,160	0.80	579	572	1.2	19,500	21,200	8.4	22,400	20,300	9.9	6,610	6,620	0.10	1,370	1,440	5.1
Mercury	mg/kg	0.11	0.11	2.4	0.049	0.050	1.7	0.15	0.15	1.3	0.14	0.14	0.30	0.15	0.18	18	0.10	0.11	5.4
Molybdenum	mg/kg	3.4	3.4	1.0	1.0	1.0	0.40	6.4	6.6	4.3	7.1	6.6	7.0	3.9	3.9	0.40	3.2	3.2	1.5
Nickel	mg/kg	30	30	0.80	38	38	1.4	59	66	10	66	68	2.3	62	61	1.5	35	35	0.60
Phosphorus	mg/kg	1,260	1,190	5.2	1,140	1,100	3.1	1,760	1,360	25	2,210	2,170	1.8	1,260	1,210	3.6	1,310	1,300	0.90
Potassium	mg/kg	2,590	2,510	3.0	1,430	1,380	3.7	2,660	2,650	0.40	2,920	3,160	7.8	2,720	2,810	3.0	2,670	2,610	2.4
Selenium	mg/kg	1.5	1.5	1.1	0.98	1.04	6.3	1.6	1.5	5.4	1.7	1.7	0.30	1.3	1.3	0.40	1.5	1.4	5.9
Silver	mg/kg	0.37	0.38	2.9	0.21	0.21	0.40	0.28	0.28	0.70	0.32	0.36	10	0.30	0.31	3.2	0.32	0.36	11
Sodium	mg/kg	1,030	990	4.1	400	410	1.8	380	390	2.3	430	460	7.8	390	410	4.3	920	900	2.4
Strontium	mg/kg	199	199	0.10	80	80	1.0	121	116	4.0	130	128	1.3	105	114	8.0	189	181	4.3
Thallium	mg/kg	0.12	0.12	4.1	0.18	0.18	4.7	0.29	0.30	0.90	0.34	0.33	3.1	0.30	0.31	3.8	0.15	0.15	5.2
Tin	mg/kg	1.8	1.7	5.0	<2.0	<2.0	0	0.83	0.75	10	0.69	0.71	1.8	6.1	5.7	5.6	2.2	2.1	5.1
Titanium	mg/kg	1,810	1,740	3.7	1,190	1,150	3.2	870	885	1.7	927	946	2.0	972	967	0.50	1,730	1,670	3.7
Uranium	mg/kg	1.8	1.9	1.6	1.3	1.3	0.70	2.9	2.9	1.2	3.1	3.3	5.3	3.1	3.2	2.6	2.0	2.1	3.5
Vanadium	mg/kg	104	104	0.10	63	62	0.90	78	79	0.80	89	86	4.4	85	85	0.10	101	100	1.1
Zinc	mg/kg	95	96	0.70	75	74	0.90	99	99	0.10	112	112	0.30	112	111	0.60	92	93	0.60
Zirconium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	1.6	1.8	9.7	-	-	-

[a] RPDs were calculated by laboratory, see ALS Laboratory Reports in Appendix J

[b] Duplicate results outside ALS DQO due to sample heterogeneity.

Table C.17: Laboratory duplicate results for the analysis of leachable metals in sediment samples (Shakeflask analyses). Highlighted values did not meet the data quality objective of ≤ 35% Relative Percent Difference (RPD).

Sample ID	Units	HAC50 (2MM-125UM)			ST02-S1			POL-2-O4P			QUL51-02 63UM			QUL-45-02			QUL45-03		
Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Aluminum	mg/L	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	0.27	0.28	5.4	<0.20	<0.20	0
Antimony	mg/L	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
Arsenic	mg/L	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
Barium	mg/L	0.038	0.035	7.7	0.027	0.028	2.2	0.036	0.037	2.2	0.043	0.043	0.70	0.031	0.031	1.1	0.027	0.028	3.3
Beryllium	mg/L	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0
Bismuth	mg/L	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
Cadmium	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0.0	<0.010	<0.010	0
Calcium	mg/L	49	73	39 [b]	14	14	0.80	41	39	3.0	93	92	1.4	24	24	0.30	23	22	1.2
Chromium	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Cobalt	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Copper	mg/L	0.012	0.015	18	0.011	0.012	5.4	0.017	0.017	1.2	<0.010	<0.010	0	0.014	0.014	2.9	0.021	0.023	7.9
Iron	mg/L	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	0.58	0.23	86 [b]	0.19	0.23	18	0.11	0.14	23
Lead	mg/L	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
Magnesium	mg/L	5.0	7.2	35	2.3	2.3	0.10	4.9	4.8	1.6	4.5	4.4	2.1	3.5	3.4	0.80	3.2	3.2	1.1
Manganese	mg/L	0.029	0.035	21	0.017	0.017	1.2	<0.0050	<0.0050	0	2.0	1.9	7.2	0.038	0.040	4.5	0.050	0.050	1.4
Mercury	mg/L	<0.000050	<0.000050	0	<0.000050	<0.000050	0	<0.000050	<0.000050	0	<0.000050	<0.000050	0	<0.000050	<0.000050	0	<0.000050	<0.000050	0
Molybdenum	mg/L	0.10	0.14	27	<0.030	<0.030	0	0.040	0.047	16	<0.030	<0.030	0	0.051	0.053	4.2	0.045	0.046	1.5
Nickel	mg/L	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
Phosphorus	mg/L	<0.30	<0.30	0	<0.30	<0.30	0	<0.30	<0.30	0	<0.30	<0.30	0	<0.30	<0.30	0	<0.30	<0.30	0
Potassium	mg/L	11	13	19	2.1	2.1	1.6	3.1	3.1	0.30	2.4	2.5	3.1	4.5	4.4	0.60	3.6	3.7	0.30
Selenium	mg/L	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
Silicon	mg/L	6.0	6.3	4.6	4.0	4.1	2.0	6.1	6.3	3.2	4.7	4.8	1.6	5.7	5.7	0.20	5.1	5.2	2.2
Silver	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Sodium	mg/L	42	51	18	5.0	5.0	0.30	8.0	7.9	0.70	<2.0	<2.0	0	21	21	1.2	16	16	0.60
Strontium	mg/L	0.63	0.92	37 [b]	0.16	0.16	0.30	0.34	0.34	2.1	0.64	0.63	0.60	0.27	0.27	0.40	0.25	0.25	1.0
Thallium	mg/L	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
Tin	mg/L	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0
Titanium	mg/L	<0.010	0.014	0	<0.010	<0.010	0	<0.010	<0.010	0	0.013	0.013	0.80	0.011	0.011	4.7	<0.010	<0.010	0
Uranium	mg/L	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
Vanadium	mg/L	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0
Zinc	mg/L	<0.020	<0.020	0	<0.020	<0.020	0	<0.020	<0.020	0	<0.020	<0.020	0	<0.020	<0.020	0	<0.020	<0.020	0

[a] RPDs were calculated by laboratory, see ALS Laboratory Reports in Appendix J
[b] Duplicate results outside ALS DQO due to sample heterogeneity.

Table C.17: Laboratory duplicate results for the analysis of leachable metals in sediment samples (Shakeflask analyses). Highlighted values did not meet the data quality objective of ≤ 35% Relative Percent Difference (RPD).

Sample ID	Units	QUL49-03			QUL51-01			QULP-1-01			QULP-4 (COMPOSITE)			QULP-1-05		
Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Aluminum	mg/L	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	0.29	0.25	14	0.35	0.35	1.0
Antimony	mg/L	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
Arsenic	mg/L	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
Barium	mg/L	0.15	0.14	2.1	0.034	0.034	0.90	0.069	0.067	3.3	0.043	0.042	2.5	0.046	0.042	8.0
Beryllium	mg/L	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0
Bismuth	mg/L	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
Cadmium	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Calcium	mg/L	85	83	3.3	14	14	0.50	43	40	6.5	24	23	0.60	18	17	3.7
Chromium	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Cobalt	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Copper	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	0.050	0.042	19	0.054	0.048	12
Iron	mg/L	0.75	0.67	12	0.36	0.39	6.2	0.097	0.12	22	0.23	0.20	13	0.19	0.15	22
Lead	mg/L	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
Magnesium	mg/L	12	11	3.3	2.1	2.1	0.80	47	46	2.8	2.7	2.7	0.40	1.9	1.8	5.1
Manganese	mg/L	2.6	2.5	4.5	0.043	0.044	1.1	0.71	0.66	7.6	0.11	0.10	1.7	0.045	0.040	14
Mercury	mg/L	<0.000050	<0.000050	0	<0.000050	<0.000050	0	<0.000050	<0.000050	0	<0.000050	<0.000050	0	<0.000050	<0.000050	0
Molybdenum	mg/L	0.096	0.095	1.2	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0
Nickel	mg/L	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
Phosphorus	mg/L	<0.30	<0.30	0	<0.30	<0.30	0	<0.30	<0.30	0	<0.30	<0.30	0	<0.30	<0.30	0
Potassium	mg/L	5.1	5.1	0.60	3.8	3.9	0.80	29	29	3.0	3.8	3.8	0	3.4	3.1	9.6
Selenium	mg/L	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
Silicon	mg/L	11	11	0.10	5.2	5.3	0.80	5.2	5.2	0.70	6.0	6.0	1.1	6.0	5.5	8.6
Silver	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Sodium	mg/L	14	14	1.6	<2.0	<2.0	0	624	605	3.1	8.6	8.6	0.20	6.3	5.8	8.1
Strontium	mg/L	0.83	0.81	2.8	0.099	0.099	0.30	0.47	0.45	3.9	0.25	0.25	0.40	0.20	0.19	6.6
Thallium	mg/L	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
Tin	mg/L	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0
Titanium	mg/L	0.015	0.016	0.60	0.013	0.015	12	<0.010	<0.010	0	0.015	0.013	16	0.014	0.013	5.3
Uranium	mg/L	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
Vanadium	mg/L	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0
Zinc	mg/L	<0.020	<0.020	0	<0.020	<0.020	0	<0.020	<0.020	0	<0.020	<0.020	0	<0.020	<0.020	0

[a] RPDs were calculated by laboratory, see ALS Laboratory Reports in Appendix J
[b] Duplicate results outside ALS DQO due to sample heterogeneity.

Table C.18: Laboratory duplicate results for the analysis of selectively extracted metals in sediment samples (Tessier extractions). Highlighted values did not meet the data quality objective of ≤ 35% Relative Percent Difference (RPD).

	Sample ID	Units	BOL-1-01P			BOL-B2-03M			BOL-1-02M			BOL-1-05M			HAC50 (2MM-125UM)		
	Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Exchangeable & Adsorbed Metals	Aluminum	mg/kg	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0
	Antimony	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Arsenic	mg/kg	0.058	0.057	1.8	0.089	0.088	0.30	0.063	0.069	9.6	0.052	<0.050	0	0.058	0.057	2.4
	Barium	mg/kg	103	109	5.4	136	137	0.60	115	116	0.60	85	83	2.7	<35	<35	0
	Beryllium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	0.23	0.24	5.2	0.18	0.18	1.1	0.11	0.13	12	0.13	0.12	1.7	<0.050	<0.050	0
	Calcium	mg/kg	5,710	6,050	5.8	5,410	5,320	1.7	6,480	6,130	5.6	5,850	5,800	0.80	1,860	1,830	2.1
	Chromium	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
	Cobalt	mg/kg	0.69	0.71	3.0	0.56	0.56	0.60	0.22	0.22	1.3	0.23	0.22	2.2	<0.10	<0.10	0
	Copper	mg/kg	2.3	2.9	24	3.8	3.4	11	0.52	0.63	20	0.72	0.75	3.8	4.0	3.7	7.0
	Iron	mg/kg	<50	<50	0	204	194	4.7	<50	<50	0	<50	<50	0	<50	<50	0
	Lead	mg/kg	<0.50	0.51	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
	Lithium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Manganese	mg/kg	434	464	6.8	941	939	0.2	382	389	1.6	358	333	7.4	10	10	0.90
	Molybdenum	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<1.1	<1.1	0
	Nickel	mg/kg	<1.0	<1.0	0	0.89	0.91	2.1	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
	Phosphorus	mg/kg	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0
	Potassium	mg/kg	120	130	8.2	160	160	1.9	190	190	1.1	120	120	0.40	180	180	0.90
	Selenium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Silver	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Sodium	mg/kg	<100	<100	0	<100	<100	0	<100	<100	0	<100	<100	0	160	160	0.70
	Strontium	mg/kg	58	62	7.5	56	53	6.3	64	61	4.6	53	52	2.2	24	24	1.0
	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Titanium	mg/kg	<1.0	<1.0	0	<1.0	<1.0	0	<1.0	<1.0	0	<1.0	<1.0	0	<1.0	<1.0	0
	Uranium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Vanadium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Zinc	mg/kg	3.4	3.9	15	2.8	2.8	1.8	1.1	1.1	2.0	1.3	1.3	1.2	<1.0	<1.0	0
Carbonate Metals	Aluminum	mg/kg	59	64	8.3	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0
	Antimony	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Arsenic	mg/kg	0.25	0.23	8.9	0.18	0.17	8.6	0.16	0.16	3.3	0.093	0.092	1.2	<0.050	<0.050	0
	Barium	mg/kg	40	43	6.0	42	42	1.4	37	36	1.8	27	27	1.4	54	53	0.90
	Beryllium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0.0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	0.086	0.087	0.40	0.055	0.056	1.8	0.078	0.082	4.6	<0.050	<0.050	0	<0.050	<0.050	0
	Calcium	mg/kg	799	880	9.6	682	671	1.6	890	870	2.3	645	683	5.7	8,710	8,660	0.50
	Chromium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Cobalt	mg/kg	0.44	0.48	11	0.26	0.26	1.4	0.24	0.23	3.1	0.19	0.19	3.7	<0.10	<0.10	0
	Copper	mg/kg	6.3	6.5	2.8	2.4	2.4	1.6	1.9	2.1	8.1	2.4	2.6	7.0	18	18	1.4
	Iron	mg/kg	425	438	3.1	510	489	4.1	336	318	5.3	82	84	2.3	<50	<50	0
	Lead	mg/kg	1.9	1.8	7.2	0.63	0.61	2.7	0.73	0.69	6.0	<0.50	<0.50	0	<0.50	<0.50	0
	Lithium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Manganese	mg/kg	127	139	9.5	178	174	2.4	134	131	3.0	139	145	4.5	54	54	0.30
	Molybdenum	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
	Nickel	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Phosphorus	mg/kg	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0
	Selenium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Silver	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Strontium	mg/kg	9.2	10	8.9	8.6	8.3	3.6	9.5	9.1	4.2	7.2	7.4	2.5	48	45	5.8
	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Titanium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Uranium	mg/kg	0.72	0.75	5.1	0.56	0.55	1.9	0.54	0.51	5.7	0.43	0.43	0.70	<0.050	<0.050	0
	Vanadium	mg/kg	2.1	2.1	0.60	1.2	1.1	4.6	1.1	1.1	0.10	0.34	0.34	1.7	<0.20	<0.20	0
	Zinc	mg/kg	4.9	5.2	5.6	3.2	3.2	0.90	3.7	3.5	2.9	2.7	2.9	5.6	<1.0	<1.0	0
Organic Bound Metals	Aluminum	mg/kg	4,870	4,880	0.20	4,560	4,510	1.3	4,300	4,200	2.4	3,370	3,350	0.40	1,000	1,000	0.20
	Antimony	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Arsenic	mg/kg	2.4	2.3	2.4	1.9	1.8	5.8	2.0	2.0	0	2.1	2.1	0.40	1.5	1.4	3.8
	Barium	mg/kg	13	12	8.9	16	16	0.30	13	12	4.5	17	16	3.9	17	18	2.1
	Beryllium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	0.067	0.065	3.4	0.054	0.056	3.1	0.069	0.065	6.2	<0.050	<0.050	0	<0.050	<0.050	0
	Calcium	mg/kg	616	560	9.6	296	312	5.3	452	444	1.9	776	786	1.3	1,300	1,260	3.2
	Chromium	mg/kg	17	17	0.90	15	14	2.2	16	16	1.5	14	14	1.1	<0.50	<0.50	0
	Cobalt	mg/kg	5.6	5.5	1.7	5.4	5.3	0.60	5.0	4.9	2.7	4.4	4.4	0.20	1.6	1.6	0.60
	Copper	mg/kg	334	327	2.0	305	304	0.20	281	283	0.80	277	271	2.3	516	512	0.70
	Iron	mg/kg	4,870	4,870	0.10	4,060	3,900	3.9	3,610	3,530	2.2	3,500	3,420	2.2	563	566	0.50
	Lead	mg/kg	2.3	2.3	0.10	0.88	0.81	8.3	1.2	1.2	2.8	0.70	0.72	2.6	0.96	1.0	8.5
	Lithium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Manganese	mg/kg	48	48	0.90	58	57	1.1	44	42	3.1	51	50	2.0	14	15	2.3
	Molybdenum	mg/kg	4.1	4.0	3.2	3.4	3.4	1.2	3.1	2.9	5.4	3.5	3.6	3.1	1.0	1.0	4.5
	Nickel	mg/kg	13	12	1.1	11	11	0.30	12	12	2.9	10	10	0.20	<0.50	<0.50	0
	Selenium	mg/kg	2.9	2.8	2.3	2.7	2.6	2.3	2.5	2.5	2.3	2.4	2.5	3.4	0.78	0.79	1.4
	Silver	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Strontium	mg/kg	6.1	5.9	4.4	5.1	5.2	0.70	5.3	5.1	3.0	6.3	6.4	2.3	12	12	0.70
	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Titanium	mg/kg	7.1	7.5	5.4	24	5.9	120 [b]	207	203	2.1	218	215	1.5	1.8	1.6	9.2
	Uranium	mg/kg	1.0	1.1	1.6	0.76	0.75	1.6	0.89	0.91	2.5	0.84	0.84	0.30	0.13	0.13	2.2
	Vanadium	mg/kg	30	30	1.6	26	25	3.0	24	23	2.2	22	22	0.10	0.91	0.92	1.3
	Zinc	mg/kg	20	20	1.1	19	18	1.7	18	18	2.1	18	18	3.1	5.2	5.1	3.8
Residual Metals	Aluminum	mg/kg	14,300	14,600	1.9	16,100	15,400	4.8	15,300	15,000	2.3	13,200	12,900	2.1	18,700	19,500	4.2
	Antimony	mg/kg	0.98	0.98	0	0.84	0.84	0.50	0.75	0.76	1.4	0.62	0.63	0.90	0.39	0.35	9.7
	Arsenic	mg/kg	4.5	4.5	0.20	4.7	4.6	1.7	3.6	3.5	3.1	3.9	3.9	0.20	11	11	0.60
	Barium	mg/kg	59	63	6.6	81	77	4.3	61	61	0.30	47	48	2.8	99	105	6.6
	Beryllium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	0.64	0.56	12
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Calcium	mg/kg	1,500	1,570	4.2	1,760	1,760	0.10	1,790	1,730	3.6	3,930	3,860	1.8	14,600	15,000	2.7
	Chromium	mg/kg	20	20	0.20	22	22	1.6	23	22	2.0	19	19	0.50	9.0	9.4	4.1
	Cobalt	mg/kg	4.5	4.5	0.10	5.0	5.0	0.70	4.8	4.8	0.30	4.3	4.4	1.3	17	17	1.7
	Copper	mg/kg	73	72	1.2	77	76	1.7	73	73	0.60	66	68	3.0	185	188	1.8
	Iron	mg/kg	13,800	14,000	0.80	16,000	15,700	2.4	14,900	14,700	1.5	13,800	13,900	0.10	43,400	43,100	0.6
	Lead	mg/kg	8.1	8.0	1.4	6.8	6.6	3.0	6.1	6.3	2.9	3.8	4.0	4.6	2.8	2.9	4.1
	Lithium	mg/kg	10	9.8	1.1	9.1	9.0	0.20	9.2	8.9	3.3	9.2	9.1	1.5	22	23	0.80
	Manganese	mg/kg	140	140	0.50	153	152	0.90	152	149	1.9	191	190	0.40	661	651	1.6
	Molybdenum	mg/kg	0.83	0.88	5.6	0.69	0.76	9.2	<0.50	<0.50	0	<0.50	<0.50	0	2.9	2.9	1.8
	Nickel	mg/kg	13	12	0.90	14	14	1.5	14	14	0.30	10	10	0.60	8.5	8.8	3.4
	Selenium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	0.25	0.25	0
	Silver	mg/kg	0.41	0.42	1.7	0.38	0.38	1.0	0.40	0.39	2.3	0.23	0.24	3.4	0.29	0.30	4.0
	Strontium	mg/kg	25	26	3.9	24	24	1.2	24	24	0.70	60	59	2.7	95	91	4.3
	Thallium	mg/kg	0.066	0.070	4.8	0.063	0.060	4.5	0.066	0.068	3.6	0.058	0.054	7.8	<0.050	<0.050	0
	Tin	mg/kg	12	10	14	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	2.0	<2.0	0
	Titanium	mg/kg	688	703	2.2	670	693	3.3	569	551	3.2	727	727	0	1,860	1,760	5.6
	Uranium	mg/kg	0.34	0.35	3.0	0.41	0.39	4.7	0.40	0.40	0	0.38	0.42	8.8	0.94	0.92	2.0
	Vanadium	mg/kg	28	29	2.0	32	33	1.1	31	31	2.2	35	35	1.4	169	169	0.10
	Zinc	mg/kg	33	33	1.1	38	37	1.5	36	36	0.30	31	32	1.7	60	61	1.9

[a] RPDs were calculated by laboratory, see ALS Laboratory Reports in Appendix J
[b] Duplicate results outside ALS DQO due to sample heterogeneity.

Table C.18: Laboratory duplicate results for the analysis of selectively extracted metals in sediment samples (Tessier extractions). Highlighted values did not meet the data quality objective of ≤ 35% Relative Percent Difference (RPD).

	Sample ID	Units	ST09-S3			ST09-S4			POL-P2-O3M			POL-P2-O3P			POL-2-02M		
	Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Exchangeable & Adsorbed Metals	Aluminum	mg/kg	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0
	Antimony	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Arsenic	mg/kg	0.057	0.050	12	<0.050	<0.050	0	0.066	0.067	0.50	0.076	0.082	6.4	0.053	<0.050	0
	Barium	mg/kg	<24	23	2.1	<23	<23	0	<22	<22	0	16	16	0.40	<18	<18	0
	Beryllium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	0.063	0.073	14	<0.050	<0.050	0
	Calcium	mg/kg	1,380	1,420	2.7	1,130	1,130	0.20	1,760	1,770	0.40	5,990	6,160	2.7	2,350	2,320	1.2
	Chromium	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
	Cobalt	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Copper	mg/kg	0.93	0.95	2.0	1.1	1.0	1.3	1.7	1.8	6.0	1.1	1.1	2.4	0.78	0.78	0.20
	Iron	mg/kg	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0
	Lead	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
	Lithium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Manganese	mg/kg	28	28	2.3	21	21	3.1	16	16	1.1	46	46	0.40	38	39	0.80
	Molybdenum	mg/kg	<1.0	0.71	0.70	<0.90	<0.90	0	<2.0	<2.0	0	1.9	2.0	7.3	<2.0	<2.0	0
	Nickel	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
	Phosphorus	mg/kg	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0
	Potassium	mg/kg	<100	<100	0	<100	<100	0	150	150	2.4	170	160	1.2	130	130	0.10
	Selenium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Silver	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Sodium	mg/kg	<100	<100	0	<100	<100	0	<100	<100	0	200	200	2.6	<100	<100	0
	Strontium	mg/kg	10	11	2.3	7.52	7.81	3.8	22	22	1.1	49	51	4.2	23	21	5.6
	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Titanium	mg/kg	<1.0	<1.0	0	<1.0	<1.0	0	<1.0	<1.0	0	<1.0	<1.0	0	<1.0	<1.0	0
	Uranium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	0.075	0.075	0.10	<0.050	<0.050	0
	Vanadium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	0.22	0.30	30	0.35	0.36	3.6	<0.20	<0.20	0
	Zinc	mg/kg	<1.0	<1.0	0	<1.0	<1.0	0	<1.0	<1.0	0	<1.0	<1.0	0	<1.0	<1.0	0
Carbonate Metals	Aluminum	mg/kg	<50	<50	0	<50	<50	0	103	98	4.3	70	71	1.6	<50	<50	0
	Antimony	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Arsenic	mg/kg	0.073	0.068	7.2	<0.050	<0.050	0	0.13	0.14	12	0.31	0.37	17	<0.050	<0.050	0
	Barium	mg/kg	21	21	0.30	15	15	1.0	70	66	5.3	48	49	1.1	64	64	0.30
	Beryllium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	0.12	0.12	3.0	<0.050	<0.050	0
	Calcium	mg/kg	18,600	18,300	1.6	8,090	8,000	1.1	14,500	13,200	9.0	8,550	8,720	2.0	8,000	7,550	5.8
	Chromium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Cobalt	mg/kg	0.24	0.20	15	<0.10	<0.10	0	0.24	0.24	0.30	0.56	0.59	4.5	<0.10	<0.10	0
	Copper	mg/kg	13	13	2.5	3.0	3.1	3.2	42	42	0.10	25	27	8.5	0.94	1.2	21
	Iron	mg/kg	113	112	1.2	<50	<50	0	184	177	3.5	160	162	1.0	<50	<50	0
	Lead	mg/kg	1.2	1.2	1.2	<0.50	<0.50	0	0.90	0.92	2.2	5.3	3.6	38 [b]	<0.50	<0.50	0
	Lithium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Manganese	mg/kg	119	119	0.50	48	50	3.4	96	92	4.0	143	142	0.60	54	55	1.7
	Molybdenum	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
	Nickel	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Phosphorus	mg/kg	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0
	Selenium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Silver	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Strontium	mg/kg	94	94	0.10	39	40	3.0	74	66	11	53	53	1.9	86	85	1.2
	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Titanium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Uranium	mg/kg	0.070	0.070	0.10	<0.050	<0.050	0	0.061	0.060	2.0	0.40	0.40	0.80	0.073	0.080	8.5
	Vanadium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	0.38	0.41	7.4	3.4	3.3	4.7	<0.20	<0.20	0
	Zinc	mg/kg	<1.0	<1.0	0	<1.0	<1.0	0	<1.0	1.0	0	4.2	4.3	3.4	<1.0	<1.0	0
Organic Bound Metals	Aluminum	mg/kg	827	841	1.6	550	1,010	59 [b]	1,110	1,130	1.9	3,550	3,550	0.20	1,210	1,240	3.1
	Antimony	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Arsenic	mg/kg	0.66	0.67	2.2	0.68	0.50	32 [b]	0.31	0.29	8.2	0.85	0.89	5.2	0.39	0.45	15
	Barium	mg/kg	7.1	7.1	0.4	6.4	7.3	13	17	17	0.10	14	9.7	37 [b]	22	23	2.5
	Beryllium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Calcium	mg/kg	1,190	1,220	2.3	1,130	854	28	644	678	5.1	1,480	1,480	0.50	931	929	0.20
	Chromium	mg/kg	0.67	0.66	2.2	<0.50	0.72	0	<0.50	<0.50	0	10	9.8	2.6	1.5	1.5	4.5
	Cobalt	mg/kg	1.1	1.1	0.90	0.96	1.0	6.8	1.8	1.8	2.2	4.2	4.1	2.9	1.8	1.8	0.30
	Copper	mg/kg	102	107	4.9	189	193	2.2	472	480	1.8	565	552	2.4	530	521	1.7
	Iron	mg/kg	378	382	1.0	314	332	5.8	387	386	0.40	3,510	3,460	1.4	399	436	8.8
	Lead	mg/kg	0.92	0.94	1.9	0.78	0.80	3.3	0.57	0.60	5.2	29	1.2	184 [b]	0.80	0.83	2.7
	Lithium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Manganese	mg/kg	12	12	0.40	8.7	8.5	3.2	13	13	2.0	47	47	0.40	13	13	0.9
	Molybdenum	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	1.1	1.1	6.2	2.7	2.5	5.9	1.3	1.0	25
	Nickel	mg/kg	1.3	1.3	0.70	0.73	2.4	107 [b]	<0.50	<0.50	0	6.5	6.4	1.0	1.6	1.2	28
	Selenium	mg/kg	0.26	0.26	0.70	0.27	0.31	13	0.91	0.90	1.3	2.6	2.5	3.8	1.1	1.2	1.0
	Silver	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Strontium	mg/kg	6.1	6.1	0.10	9.0	8.4	7.3	10	11	2.8	14	13	6.4	14	15	5.6
	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Titanium	mg/kg	1.6	1.7	4.8	1.6	1.7	8.2	<1.0	2.1	71 [b]	3.6	3.9	8.9	2.4	1.8	29
	Uranium	mg/kg	0.085	0.086	1.2	0.072	0.079	9.8	0.13	0.13	5.3	0.44	0.44	0.40	0.16	0.15	12
	Vanadium	mg/kg	1.1	1.1	4.5	0.78	0.73	6.4	0.92	0.89	3.3	15	15	1.6	1.7	1.3	24
	Zinc	mg/kg	4.5	4.8	6.7	4.0	6.8	52 [b]	4.5	4.5	0.60	13	12	5.8	4.8	4.7	2.7
Residual Metals	Aluminum	mg/kg	14,100	15,000	6.6	11,900	11,800	0.90	19,300	19,800	2.5	23,900	22,500	5.9	19,000	21,100	11
	Antimony	mg/kg	0.27	0.29	8.3	0.26	0.26	2.5	0.41	0.39	6.3	1.0	0.55	61 [b]	0.39	0.38	3.0
	Arsenic	mg/kg	6.0	6.1	1.3	6.1	6.4	3.8	11	11	1.2	10	9.6	5.4	9.7	11	10
	Barium	mg/kg	52	57	8.7	57	60	4.2	116	110	5.0	120	120	0.20	154	180	16
	Beryllium	mg/kg	0.24	0.25	2.5	0.25	0.25	1.7	0.63	0.60	3.9	0.52	0.48	7.2	0.52	0.57	9.5
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Calcium	mg/kg	3,960	4,160	4.9	5,770	5,960	3.3	15,600	15,400	1.3	9,800	9,230	5.9	12,700	14,400	12
	Chromium	mg/kg	31	31	1.4	23	23	0.10	8.4	8.2	2.4	21	20	5.4	11	12	11
	Cobalt	mg/kg	9.0	9.2	2.7	7.9	8.0	1.3	17	17	0.60	17	16	5.5	14	15	10
	Copper	mg/kg	36	36	0.70	58	57	2.0	105	104	1.5	137	131	4.8	97	111	13
	Iron	mg/kg	36,300	36,700	1.1	33,500	32,900	1.9	33,900	33,400	1.5	25,400	24,400	4.3	35,400	38,800	9.2
	Lead	mg/kg	2.5	2.6	3.0	2.3	2.4	0.90	2.4	2.4	0.10	50	5.5	160 [b]	3.0	3.2	5.7
	Lithium	mg/kg	20	20	1.3	14	14	0	20	20	0.10	24	22	5.2	15	16	8.4
	Manganese	mg/kg	282	281	0.30	263	263	0.10	598	585	2.3	551	527	4.5	465	512	9.7
	Molybdenum	mg/kg	1.2	1.1	4.0	1.3	1.6	17	2.5	2.3	6.7	1.7	1.7	4.4	1.7	2.1	22
	Nickel	mg/kg	20	21	3.2	14	14	1.0	9.0	8.7	3.3	16	16	5.3	9	10	11
	Selenium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Silver	mg/kg	<0.10	<0.10	0	0.13	0.13	4.4	0.29	0.29	2.4	0.40	0.40	1.1	0.25	0.27	9.0
	Strontium	mg/kg	31	30	3.1	37	38	3.0	88	83	4.9	66	63	3.8	81	87	6.3
	Thallium	mg/kg	0.075	0.080	5.8	0.057	0.060	4.9	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	149	16.1	161 [b]	<2.0	<2.0	0
	Titanium	mg/kg	982	1,060	7.6	917	859	6.5	1,940	1,880	3.1	2,050	1,950	4.8	1,720	1,850	7.5
	Uranium	mg/kg	0.51	0.54	5.4	0.59	0.59	0.20	0.91	0.89	2.3	0.78	0.73	6.0	0.88	0.94	6.2
	Vanadium	mg/kg	88	91	3.1	101	100	0.30	137	135	1.4	85	80	5.7	138	154	11
	Zinc	mg/kg	51	52	2.1	42	41	0.70	54	54	0	62	60	3.7	47	52	9.3

[a] RPDs were calculated by laboratory, see ALS Laboratory Reports in Appendix J

[b] Duplicate results outside ALS DQO due to sample heterogeneity.

Table C.18: Laboratory duplicate results for the analysis of selectively extracted metals in sediment samples (Tessier extractions). Highlighted values did not meet the data quality objective of ≤ 35% Relative Percent Difference (RPD).

	Sample ID	Units	QUL-45-02			QUL45-05			QUL49-03			QUL-47			QULP-1-01		
	Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Exchangeable & Adsorbed Metals	Aluminum	mg/kg	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0
	Antimony	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Arsenic	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	0.059	0.066	12	<0.050	<0.050	0	0.061	0.070	14
	Barium	mg/kg	17	15	9.8	<15	<15	0	<25	<25	0	<15	<15	0	<15	<15	0
	Beryllium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	0.052	0.051	1.3	<0.050	<0.050	0	0.11	0.11	2.8
	Calcium	mg/kg	1,500	1,350	10	1,140	1,100	3.6	3,070	3,200	4.2	2,010	2,110	4.9	3,700	3,900	5.1
	Chromium	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
	Cobalt	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	0.11	0.12	7.2	0.21	0.23	10	0.47	0.50	6.2
	Copper	mg/kg	1.9	1.6	16	2.1	1.8	15	0.85	1.1	23	<0.50	0.52	0	<0.50	<0.50	0
	Iron	mg/kg	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0
	Lead	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
	Lithium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Manganese	mg/kg	10	8.9	12	8.4	7.8	7.7	96	103	6.9	23	24	6.1	31	34	7.3
	Molybdenum	mg/kg	<0.60	0.54	5.8	0.58	0.55	3.7	0.75	0.75	0.50	<0.50	<0.50	0	<0.50	<0.50	0
	Nickel	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	0.51	0.54	6.1	0.98	1.0	3.7
	Phosphorus	mg/kg	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0
	Potassium	mg/kg	110	<100	0	<100	<100	0	<100	<100	0	<100	<100	0	<100	<100	0
	Selenium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Silver	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Sodium	mg/kg	<100	<100	0	<100	<100	0	<100	<100	0	<100	<100	0	<100	<100	0
	Strontium	mg/kg	15	13	13	12	12	5.5	26	27	4.0	12	12	4.9	22	23	5.0
	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Titanium	mg/kg	<1.0	<1.0	0	<1.0	<1.0	0	<1.0	<1.0	0	<1.0	<1.0	0	<1.0	<1.0	0
	Uranium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Vanadium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Zinc	mg/kg	<1.0	<1.0	0	<1.0	<1.0	0	<1.0	<1.0	0	<1.0	<1.0	0	<1.0	<1.0	0
Carbonate Metals	Aluminum	mg/kg	70	73	3.9	53	51	4.1	<50	<50	0	<50	<50	0	<50	<50	0
	Antimony	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Arsenic	mg/kg	0.060	0.061	2.7	<0.050	0.065	0	0.18	0.16	7.6	<0.050	<0.050	0	0.12	0.15	15
	Barium	mg/kg	32	31	2.7	24	24	1.5	35	35	0.30	4.8	5.0	3.7	7.7	7.5	2.3
	Beryllium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	0.052	0	<0.050	<0.050	0	<0.050	<0.050	0
	Calcium	mg/kg	8,900	8,970	0.80	7,970	7,770	2.5	8,420	8,220	2.4	178	187	4.9	454	445	1.9
	Chromium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Cobalt	mg/kg	0.30	0.25	17	0.23	0.26	11	0.53	0.49	7.3	0.23	0.24	3.1	0.37	0.37	0.70
	Copper	mg/kg	35	35	0.20	35	34	1.1	9.3	8.9	4.3	<0.50	<0.50	0	<0.50	<0.50	0.0
	Iron	mg/kg	96	89	8.1	70	68	3.1	73	67	7.8	<50	<50	0	<50	<50	0
	Lead	mg/kg	0.53	0.53	0.60	<0.50	<0.50	0	0.78	0.76	3.5	<0.50	<0.50	0	<0.50	<0.50	0
	Lithium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Manganese	mg/kg	81	74	8.3	73	72	1.4	104	101	3.5	12	12	5.4	11	11	0.20
	Molybdenum	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0	<0.50	<0.50	0
	Nickel	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Phosphorus	mg/kg	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0	<50	<50	0
	Selenium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Silver	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Strontium	mg/kg	46	46	0.90	32	32	1.5	37	36	2.8	<5.0	<5.0	0	<5.0	<5.0	0
	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Titanium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Uranium	mg/kg	0.055	0.056	1.2	<0.050	<0.050	0	0.20	0.20	1.5	0.12	0.13	5.4	0.26	0.25	1.8
	Vanadium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	0.37	0.32	14	<0.20	<0.20	0	<0.20	<0.20	0
	Zinc	mg/kg	1.0	<1.0	0	<1.0	<1.0	0	1.7	1.7	3.7	<1.0	<1.0	0	1.5	1.4	5.5
Organic Bound Metals	Aluminum	mg/kg	886	843	4.9	640	653	1.9	1,450	1,400	3.2	1,110	1,080	2.4	3,110	3,220	3.3
	Antimony	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Arsenic	mg/kg	0.28	0.27	3.1	0.55	0.81	37 [b]	1.5	1.5	1.7	0.20	0.19	4.5	1.6	1.8	12
	Barium	mg/kg	11	10	4.5	7.9	8.2	3.6	16	16	0.30	2.5	2.4	4.0	7.4	7.8	6.0
	Beryllium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	0.052	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Calcium	mg/kg	630	617	2.1	669	824	21	1,410	1,400	0.8	665	700	5.0	916	912	0.40
	Chromium	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0	2.5	2.5	2.2	3.3	3.2	3.7	12	12	5.3
	Cobalt	mg/kg	1.4	1.4	5.1	1.1	1.1	0.50	1.6	1.6	1.9	1.3	1.2	2.9	4.1	4.2	2.9
	Copper	mg/kg	561	548	2.4	487	511	4.8	387	372	3.8	6.6	6.1	7.0	29	30	3.5
	Iron	mg/kg	365	345	5.4	342	379	10	766	789	3.0	531	552	3.8	4,000	4,150	3.5
	Lead	mg/kg	0.67	0.65	3.6	0.57	0.66	15	0.97	0.94	3.1	<0.50	<0.50	0	2.2	2.3	3.0
	Lithium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0	<5.0	<5.0	0
	Manganese	mg/kg	13	11	9.2	8.3	8.4	0.70	17	16	3.2	10	9.9	1.1	34	34	1.0
	Molybdenum	mg/kg	0.76	0.79	4.1	1.1	1.1	2.2	1.5	1.7	14	<0.50	<0.50	0	0.67	0.70	3.5
	Nickel	mg/kg	0.51	<0.50	0	<0.50	<0.50	0	1.4	1.4	2.3	2.4	2.3	4.5	9.5	9.9	3.3
	Selenium	mg/kg	0.78	0.83	6.4	0.62	0.62	0.60	0.82	0.78	4.7	0.27	0.26	3.6	1.8	1.9	10
	Silver	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
	Strontium	mg/kg	9.3	9.0	3.0	9.0	9.3	3.5	14	14	3.3	3.2	3.2	0	5.0	5.1	1.7
	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0.0
	Titanium	mg/kg	1.4	1.5	4.3	1.7	2.3	26	6.7	8.4	23	12	10	16	22	21	4.1
	Uranium	mg/kg	0.080	0.069	15	0.064	0.079	21	0.20	0.19	4.2	0.070	0.072	3.7	0.25	0.26	4.9
	Vanadium	mg/kg	0.59	0.59	0.90	0.70	0.79	13	4.1	4.1	0.20	2.7	3.0	10	10	11	1.3
	Zinc	mg/kg	4.0	4.1	2.2	3.9	3.9	0.90	5.5	5.0	11	2.9	2.7	5.4	14	15	0.90
Residual Metals	Aluminum	mg/kg	12,900	12,700	1.6	12,500	12,100	3.2	15,000	14,900	0.70	9,930	9,990	0.70	13,000	13,200	1.6
	Antimony	mg/kg	0.25	0.28	10	0.30	0.30	0.70	0.34	0.35	2.6	0.13	0.12	5.6	0.42	0.46	9.6
	Arsenic	mg/kg	8.9	8.8	0.40	8.6	8.2	4.0	7.9	7.9	0.10	2.5	2.2	11	4.9	5.3	8.2
	Barium	mg/kg	78	78	0.10	86	89	3.0	105	105	0.40	31	30	4.6	32	34	4.6
	Beryllium	mg/kg	0.38	0.39	3.5	0.41	0.39	4.7	0.42	0.41	3.2	<0.20	<0.20	0	<0.20	<0.20	0
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0
	Calcium	mg/kg	8,700	8,940	2.7	9,740	9,360	4.0	9,900	9,950	0.60	5,210	5,050	3.1	4,360	4,350	0.10
	Chromium	mg/kg	9.4	11	16	11	12	8.2	14	14	0.20	26	26	0.60	36	37	1.9
	Cobalt	mg/kg	13	12	4.4	12	11	1.2	12	12	2.4	5.7	5.7	0.70	6.84	6.88	0.60
	Copper	mg/kg	141	137	2.6	119	122	2.9	86	85	0.70	14	14	1.3	19	19	2.1
	Iron	mg/kg	35,400	35,300	0.10	40,600	40,200	0.90	37,900	37,900	0.10	17,700	17,500	1.0	19,900	19,700	1.3
	Lead	mg/kg	2.3	2.2	4.5	2.2	2.2	1.2	2.7	2.6	3.3	2.1	2.0	2.5	2.0	2.1	6.0
	Lithium	mg/kg	14	13	2.4	13	12	3.4	16	15	2.8	8.0	8.1	1.2	12	12	0.40
	Manganese	mg/kg	397	392	1.1	377	371	1.5	403	408	1.2	194	195	0.60	246	244	0.90
	Molybdenum	mg/kg	2.5	2.9	14	2.4	2.4	2.5	1.4	1.2	14	<0.50	<0.50	0	<0.50	<0.50	0
	Nickel	mg/kg	8.1	8.1	0.50	7.7	7.6	0.30	11	10	1.5	15	15	0.90	23	23	2.0
	Selenium	mg/kg	0.21	0.22	5.4	0.20	0.24	17	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
	Silver	mg/kg	0.28	0.28	1.4	0.28	0.30	7.2	0.25	0.26	2.3	<0.10	<0.10	0	<0.10	0.12	0
	Strontium	mg/kg	58	59	1.8	67	68	0.30	62	62	0.50	41	40	4.1	29	30	5.7
	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	<0.050	<0.050	0	0.055	0.066	19
	Tin	mg/kg	<2.0	<2.0	0	2.7	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
	Titanium	mg/kg	1,000	1,110	10	1,230	1,230	0.40	1,320	1,390	4.9	866	870	0.50	1,090	1,110	1.3
	Uranium	mg/kg	0.57	0.61	6.9	0.63	0.63	1.0	0.66	0.68	2.3	0.30	0.29	5.2	0.29	0.31	6.3
	Vanadium	mg/kg	133	134	1.1	156	155	0.70	138	139	0.20	60	59	0.80	60	61	1.2
	Zinc	mg/kg	44	42	6.4	40	40	0.40	46	46	0.10	29	29	0.80	35	35	0.40

[a] RPDs were calculated by laboratory, see ALS Laboratory Reports in Appendix J
[b] Duplicate results outside ALS DQO due to sample heterogeneity.

Table C.18: Laboratory duplicate results for the analysis of selectively extracted metals in sediment samples (Tessier extractions). Highlighted values did not meet the data quality objective of ≤ 35% Relative Percent Difference (RPD).

	Sample ID	Units	QUL-51-02X			QULP-6 (COMPOSITE)		
Analyte			Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Exchangeable & Adsorbed Metals	Aluminum	mg/kg	<50	<50	0	<50	<50	0
	Antimony	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0
	Arsenic	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0
	Barium	mg/kg	<30	<30	0	<12	<12	0
	Beryllium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	0.058	0.051	13	0.092	0.10	9.1
	Calcium	mg/kg	956	1,020	6.4	3,110	3,350	7.2
	Chromium	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0
	Cobalt	mg/kg	0.22	0.20	9.4	0.28	0.27	0.20
	Copper	mg/kg	0.54	0.52	2.9	<0.50	<0.50	0
	Iron	mg/kg	<50	<50	0	<50	<50	0
	Lead	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0
	Lithium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0
	Manganese	mg/kg	26	25	2.5	466	478	2.5
	Molybdenum	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0
	Nickel	mg/kg	0.56	0.56	1.3	0.56	0.55	1.2
	Phosphorus	mg/kg	<50	<50	0	<50	<50	0
	Potassium	mg/kg	<100	<100	0	<100	<100	0
	Selenium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0
	Silver	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0
	Sodium	mg/kg	<100	<100	0	<100	<100	0
	Strontium	mg/kg	6.1	6.3	3.7	31	34	8.2
	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0
	Titanium	mg/kg	<1.0	<1.0	0	<1.0	<1.0	0
	Uranium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0
	Vanadium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0
	Zinc	mg/kg	<1.0	<1.0	0	<1.0	<1.0	0
Carbonate Metals	Aluminum	mg/kg	<50	<50	0	<50	<50	0
	Antimony	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0
	Arsenic	mg/kg	0.054	<0.050	0	<0.050	<0.050	0
	Barium	mg/kg	11	11	0.60	11	11	2.9
	Beryllium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0
	Calcium	mg/kg	364	344	5.6	495	478	3.6
	Chromium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0
	Cobalt	mg/kg	0.21	0.21	0.30	0.13	0.13	3.9
	Copper	mg/kg	1.1	1.0	2.5	<0.50	<0.50	0
	Iron	mg/kg	273	257	5.9	<50	<50	0
	Lead	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0
	Lithium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0
	Manganese	mg/kg	5.3	5	5.1	215	216	0.60
	Molybdenum	mg/kg	<0.50	<0.50	0	<0.50	<0.50	0
	Nickel	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0
	Phosphorus	mg/kg	<50	<50	0	<50	<50	0
	Selenium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0
	Silver	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0
	Strontium	mg/kg	<5.0	<5.0	0	9	8.9	0.80
	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0
	Titanium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0
	Uranium	mg/kg	0.087	0.087	0.40	0.21	0.23	7.1
	Vanadium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0
	Zinc	mg/kg	<1.0	<1.0	0	<1.0	<1.0	0
Organic Bound Metals	Aluminum	mg/kg	635	628	1.2	1,340	1,300	3.3
	Antimony	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0
	Arsenic	mg/kg	0.22	0.23	7.2	0.25	0.25	1.6
	Barium	mg/kg	6.7	5.8	15	29	30	1.9
	Beryllium	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0
	Bismuth	mg/kg	<0.20	<0.20	0	<0.20	<0.20	0
	Cadmium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0
	Calcium	mg/kg	561	646	14	226	212	6.4
	Chromium	mg/kg	2	2.0	2.1	2.0	1.9	1.9
	Cobalt	mg/kg	1.6	1.4	9.4	1.0	1.0	0.70
	Copper	mg/kg	3.0	2.9	3.9	5.8	5.7	0.60
	Iron	mg/kg	299	291	2.5	921	891	3.4
	Lead	mg/kg	<0.50	<0.50	0	2.2	2.3	3.0
	Lithium	mg/kg	<5.0	<5.0	0	<5.0	<5.0	0
	Manganese	mg/kg	7.4	7.4	0.10	109	109	0.20
	Molybdenum	mg/kg	<0.50	<0.50	0	0.62	0.54	15
	Nickel	mg/kg	2.1	2.0	6.1	3.2	3.1	3.8
	Selenium	mg/kg	0.23	0.24	4.8	0.43	0.48	9.7
	Silver	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0
	Strontium	mg/kg	4.0	3.6	11	2.8	2.8	0
	Thallium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0
	Titanium	mg/kg	25	26	5.1	22	18	16
	Uranium	mg/kg	0.060	0.062	4.1	0.20	0.20	3.8
	Vanadium	mg/kg	2.4	2.4	2.6	2.8	2.7	1.6
	Zinc	mg/kg	3.6	3.4	4.0	4.2	4.1	2.1
Residual Metals	Aluminum	mg/kg	7,820	8,050	2.9	23,900	21,800	9.4
	Antimony	mg/kg	0.19	0.19	1.0	0.32	0.33	4.1
	Arsenic	mg/kg	2.1	2.3	4.9	16	17	2.5
	Barium	mg/kg	37	39	5.3	86	86	0.30
	Beryllium	mg/kg	<0.20	<0.20	0	0.48	0.46	4.4
	Bismuth	mg/kg	<0.20	<0.20	0	0.39	0.39	1.8
	Cadmium	mg/kg	<0.050	<0.050	0	<0.050	<0.050	0
	Calcium	mg/kg	3,270	3,160	3.5	1,670	1,620	3.4
	Chromium	mg/kg	29	31	5.5	49	47	4.3
	Cobalt	mg/kg	4.2	4.2	0.30	12	12	1.4
	Copper	mg/kg	13	13	0.80	30	30	0.80
	Iron	mg/kg	13,100	13,000	0.80	53,900	54,300	0.60
	Lead	mg/kg	1.8	1.8	1.5	13	13	2.6
	Lithium	mg/kg	5.5	5.4	2.5	35	32	8.1
	Manganese	mg/kg	132	134	1.8	377	371	1.5
	Molybdenum	mg/kg	<0.50	<0.50	0	2.4	2.4	2.9
	Nickel	mg/kg	14	14	0.20	41	40	2.0
	Selenium	mg/kg	<0.20	<0.20	0	0.25	0.28	10
	Silver	mg/kg	<0.10	<0.10	0	<0.10	<0.10	0
	Strontium	mg/kg	30	27	11	23	21	6.9
	Thallium	mg/kg	0.065	0.063	2.5	0.24	0.23	4.6
	Tin	mg/kg	<2.0	<2.0	0	<2.0	<2.0	0
	Titanium	mg/kg	677	690	2.0	1,160	1,140	1.9
	Uranium	mg/kg	0.36	0.37	2.6	1.0	1.0	2.5
	Vanadium	mg/kg	34	35	2.8	40	39	2.8
	Zinc	mg/kg	28	29	3.5	79	77	2.0

[a] RPDs were calculated by laboratory, see ALS Laboratory Reports in Appendix J

[b] Duplicate results outside ALS DQO due to sample heterogeneity.

Table C.19: Laboratory duplicate results for the analysis of acid base accounting, sulphur, and carbon content in sediment samples. Highlighted values did not meet the data quality objective of ≤ 35% Relative Percent Difference (RPD).

Sample ID	Units	QUL-45-02			POL-2-O5P			QUL45-05			QUL49-03			QUL49-05			QUL-47		
Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Maximum Potential Acidity (MPA)	$tCaCO_3$/1Kt	4.4	4.4	0	-	-	-	3.8	3.8	0	2.8	2.8	0	3.1	3.1	0	3.1	3.1	0
Fizz Rating	Unity	2.0	2.0	0	-	-	-	2.0	2.0	0	2.0	2.0	0	2.0	2.0	0	1.0	1.0	0
Net Neutralization Potential (NNP)	$tCaCO_3$/1Kt	41	42	2.4	-	-	-	35	35	0	32	32	0	33	33	0	9.0	9.0	0
pH	Unity	8.2	8.2	0	8.0	8.0	0	8.3	8.3	0	7.6	7.6	0	7.6	7.6	0	6.9	6.9	0
Neutralization Potential (NP)	$tCaCO_3$/1Kt	45	46	2.2	-	-	-	39	39	0	35	35	0	36	36	0	12	12	0
Neutralization Potential Ratio (NP/MPA)	Unity	10	11	2.1	-	-	-	10	10	0	12	12	0	12	12	0	3.8	3.8	0
Total Sulphur (S) - Leco	%	0.14	0.14	0	-	-	-	-	-	-	-	-	-	0.10	0.10	0	-	-	-
Sulphide Sulphur (S) - Calculated Leco	%	0.11	0.12	8.7	-	-	-	-	-	-	-	-	-	0.090	0.090	0	-	-	-
Sulphate Sulphur (S) - Carbonate Leach	%	0.030	0.020	40	-	-	-	-	-	-	<0.010	0.010	0	0.010	0.010	0	<0.010	<0.010	0
Inorganic Carbon (C)	%	0.35	0.34	2.9	-	-	-	-	-	-	-	-	-	0.34	0.29	16	-	-	-
Carbon Dioxide (CO_2)	%	1.3	1.3	0.0	-	-	-	-	-	-	-	-	-	1.2	1.1	8.7	-	-	-
Sulphate Sulphur (S) - HCl leachable	%	0.010	0.020	67	-	-	-	0.020	0.010	67	<0.010	0.010	0	0.010	<0.010	0	0.020	0.010	67

Sample ID	Units	QULP-1-02			QULP-1-05			QULP-5-01			QULP-2-05			ST02-S2			ST09-S1		
Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Maximum Potential Acidity (MPA)	$tCaCO_3$/1Kt	4.4	4.1	7.1	5.0	5.0	0	2.2	2.2	0	3.1	2.5	21	3.8	3.8	0	-	-	-
Fizz Rating	Unity	2.0	2.0	0	2.0	2.0	0	1.0	1.0	0	2.0	2.0	0	2.0	2.0	0	-	-	-
Net Neutralization Potential (NNP)	$tCaCO_3$/1Kt	53	53	0	37	38	2.7	7.0	7.0	0	36	37	2.7	47	48	2.1	-	-	-
pH	Unity	8.3	8.3	0	-	-	-	6.2	6.2	0	7.8	7.8	0	7.7	7.7	0	-	-	-
Neutralization Potential (NP)	$tCaCO_3$/1Kt	57	57	0	42	43	2.4	9.0	9.0	0	39	39	0	51	52	1.9	-	-	-
Neutralization Potential Ratio (NP/MPA)	Unity	13	14	7.4	8.4	8.6	2.4	4.1	4.1	0	12	16	22	14	14	2.0	-	-	-
Total Sulphur (S) - Leco	%	0.14	0.13	7.4	-	-	-	-	-	-	0.10	0.080	22	-	-	-	-	-	-
Sulphide Sulphur (S) - Calculated Leco	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulphate Sulphur (S) - Carbonate Leach	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Inorganic Carbon (C)	%	0.52	0.52	0	-	-	-	-	-	-	-	-	-	-	-	-	0.64	0.63	1.6
Carbon Dioxide (CO_2)	%	1.9	1.9	0	-	-	-	-	-	-	-	-	-	-	-	-	2.3	2.3	0
Sulphate Sulphur (S) - HCl leachable	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Sample ID	Units	ST09-S2			ST09-S4			QUL-48-04Z			BOL-B1-01P			BOL-B2-03P			BOL-1-03 M		
Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Maximum Potential Acidity (MPA)	$tCaCO_3$/1Kt	-	-	-	-	-	-	1.9	1.9	0	24	24	0	-	-	-	24	24	0
Fizz Rating	Unity	-	-	-	-	-	-	2.0	2.0	0	1.0	1.0	0	-	-	-	1.0	1.0	0
Net Neutralization Potential (NNP)	$tCaCO_3$/1Kt	-	-	-	-	-	-	13	13	0	-16	-15	6.5	-	-	-	-16	-15	6.5
pH	Unity	-	-	-	-	-	-	7.4	7.4	0	5.5	5.5	0	-	-	-	5.5	5.5	0
Neutralization Potential (NP)	$tCaCO_3$/1Kt	-	-	-	-	-	-	15	15	0	8.0	9.0	12	-	-	-	8.0	9.0	12
Neutralization Potential Ratio (NP/MPA)	Unity	-	-	-	-	-	-	8.0	8.0	0	0.34	0.38	11	-	-	-	0.34	0.38	11
Total Sulphur (S) - Leco	%	-	-	-	0.10	0.10	0	-	-	-	-	-	-	-	-	-	-	-	-
Sulphide Sulphur (S) - Calculated Leco	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulphate Sulphur (S) - Carbonate Leach	%	-	-	-	-	-	-	<0.010	<0.010	0	-	-	-	-	-	-	-	-	-
Inorganic Carbon (C)	%	0.63	0.61	3.2	-	-	-	0.080	0.080	0	-	-	-	-	-	-	-	-	-
Carbon Dioxide (CO_2)	%	2.3	2.2	4.4	-	-	-	0.30	0.30	0	-	-	-	-	-	-	-	-	-
Sulphate Sulphur (S) - HCl leachable	%	-	-	-	0.030	0.020	40	<0.010	<0.010	0	-	-	-	0.11	0.10	9.5	-	-	-

Sample ID	Units	POL-P1-01M			POL-1-05P			POL-2-02P		
Analyte		Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]	Replicate 1	Replicate 2	RPD [a]
Maximum Potential Acidity (MPA)	$tCaCO_3$/1Kt	-	-	-	-	-	-	4.1	4.1	0
Fizz Rating	Unity	-	-	-	-	-	-	2.0	2.0	0
Net Neutralization Potential (NNP)	$tCaCO_3$/1Kt	-	-	-	-	-	-	37	38	2.7
pH	Unity	-	-	-	-	-	-	8.2	7.9	3.7
Neutralization Potential (NP)	$tCaCO_3$/1Kt	-	-	-	-	-	-	41	42	2.4
Neutralization Potential Ratio (NP/MPA)	Unity	-	-	-	-	-	-	10	10	2.4
Total Sulphur (S) - Leco	%	-	-	-	-	-	-	0.13	0.13	0
Sulphide Sulphur (S) - Calculated Leco	%	-	-	-	-	-	-	0.13	0.13	0
Sulphate Sulphur (S) - Carbonate Leach	%	-	-	-	-	-	-	<0.01	<0.01	0
Inorganic Carbon (C)	%	0.27	0.27	0	-	-	-	0.33	0.25	28
Carbon Dioxide (CO_2)	%	1.0	1.0	0	-	-	-	1.2	0.90	29
Sulphate Sulphur (S) - HCl leachable	%	-	-	-	0.060	0.050	18	-	-	-

[a] The method detection limit (MDL) value was used in instances where values less than the MDL were reported. RPD calculation: =(Absolute(Replicate 1 - Replicate 2))/Average(Replicate 1, Replicate 2)*100

influence. However, the laboratory failed to provide duplicate sample results for the easily reducible/iron oxide extracts. Laboratory precision associated with ABA was good, with exceedances of the objective restricted to sulphur determinations near the limit of analytical precision. Specifically, in all five instances where RPD was greater than the objective of 35%, the differences were by only one unit (Table C.19). Overall, laboratory precision achieved in this study was good and did not adversely affect data interpretability.

C3.4 Data Accuracy

Recoveries of all analytes in quality control standards associated with non-metals (approximately 210 analyses) and metals (approximately 6,800 metal results) met the respective DQOs (Appendix J). Thirty of the approximately 3,100 Tessier extraction metal results (<1%) failed to meet the laboratory's DQO for laboratory control samples (Appendix J). The analytical laboratory reported that the results are considered acceptable (Appendix J). Furthermore, barium, the only analyte which failed to meet the DQO, is not a parameter of interest or an indicator parameter in this study. Of the 305 QC Standard analyses associated with ABA analysis, the DQO was not met for only one inorganic carbon analysis and one carbon dioxide analysis (Appendix J). Recoveries of all leachable matrix spikes were also within the DQO range (Appendix J). Overall, these data indicate excellent analytical accuracy associated with the analysis of sediment samples.

C3.5 Holding Time and General Laboratory Flags

Most laboratory reports indicated no concerns as to the quality of the data reported. Several issues were flagged for sediment samples, largely relating to holding times that were exceeded for several analytes: pH, organic carbon, mercury, moisture content, total nitrogen (Appendix J). Hold times were exceeded for these analytes because the analytical laboratory did not complete all required analyses in the original run and were prompted for the additional data after initial data review. For one sample (from POL-2), shake flask metals and acid base accounting could not be completed due to limited sample volumes in sediment core sections. No issues were identified regarding the parameters of interest or indicator parameters associated with this study.

C4.0 SEDIMENT TOXICITY TESTING

C4.1 Laboratory Controls

Survival of both test organisms (*Hyalella azteca* and *Chironomus dilutus*) in laboratory controls met quality control objectives in all cases (>80% survival and >70% survival, respectively; Nautilus 2015 in Appendix J). Growth of *C. dilutus* met the quality control objective of ≥0.6 mg per individual at test completion; however growth of *H. azteca* did not quite meet the quality control objective of ≥0.1 mg per individual (Nautilus 2015 in Appendix J). Nautilus (2015) note that the *H. azteca* used in this testing typically grow to approximately 0.1 mg, but that growth in some controls was marginally lower (0.08 to 0.09 mg). The latter weights round to 0.1 mg, the level of measurement precision specified in the method. Furthermore, the laboratory ran mesh controls to determine if there was any evidence that control sediment was limiting growth. This investigation indicated that there was no evidence of growth limitation and therefore the laboratory concluded that the tests performed appropriately.

C4.2 Reference Toxicants

All reference toxicant testing results feel within the historical mean range (mean ± 2 standard deviations) and therefore the sensitivity of test organisms was considered to be appropriate.

C5.0 BENTHIC MACROINVERTEBRATE COMMUNITY SAMPLES

C5.1 Organism Recovery

The objective for percent organism recovery was met for all eleven samples that were re-sorted (Table C.20). Average recovery was 98.7%, compared to an acceptability objective of 90%. This indicates excellent organism recovery.

C5.2 Subsampling Precision

Due to modest benthic invertebrate densities, the majority of samples (93 of 111) were processed in their entirety (Table C.21). Evaluation of subsampling precision was completed on three of the 18 samples that were not processed in their entirety. All benthic invertebrate community sub-sampling met the DQO of 20%, with a precision range of 0.6 to 12.7% (Table C.22). This indicates excellent subsampling precision.

Table C.20: Benthic invertebrate community organism recovery. Highlighted values did not meet data quality objective of sort recoveries of ≥ 90%.

Sample ID	Number of Organisms Recovered (initial sort)	Number of Organisms in Re-sort	Percent Recovery
QUL45-1	25	1	96.0%
QUL49-5	38	0	100%
QUL51-5	39	2	94.9%
QULP-1-5	181	0	100%
QULP-2-4	67	0	100%
QULP-3-3	108	0	100%
QULP-4-4	307	0	100%
QULP-6-2	87	0	100%
QUR2-R2	441	5	98.9%
QUR5-R1	154	3	98.1%
CAR-R1	243	4	98.4%
		Average % Recovery	98.7%

Table C.21: Percent of sample sorted and the total number of invertebrates recovered from the sampled fraction.

Sample ID	% Sampled	# Invertebrates
QUL45-1	100%	25
QUL45-2	100%	12
QUL45-3	100%	38
QUL45-4	100%	1
QUL45-5	100%	24
QUL47-1	100%	480
QUL47-2	100%	664
QUL49-1	100%	44
QUL49-2	100%	49
QUL49-3	100%	21
QUL49-4	100%	37
QUL49-5	100%	38
QUL51-1	100%	234
QUL51-2	100%	240
QUL51-3	100%	292
QUL51-4	100%	206
QUL51-5	100%	39
QULP-1-1	100%	16
QULP-1-2	100%	384
QULP-1-3	100%	10
QULP-1-4	100%	202
QULP-1-5	100%	181
QULP-2-1	100%	32
QULP-2-2	100%	221
QULP-2-3	100%	43
QULP-2-4	100%	67
QULP-2-5	100%	134
QULP-5-1	50%	363
QULP-5-2	50%	721
QULP-5-3	50%	565
QULP-5-4	100%	879
QULP-5-5	75%	1,019
QUL47-3	100%	218
QUL47-4	100%	1,260
QUL47-5	100%	795
QUL-48-1	100%	809
QUL-48-2	100%	271
QUL-48-3	50%	550
QUL-48-4	50%	417
QUL-48-5	75%	452
QUL-52-1	50%	467
QUL-52-2	50%	398
QUL-52-3	25%	472
QUL-52-4	100%	476
QUL-52-5	56%	371
QULP-3-1	100%	188
QULP-3-2	100%	63
QULP-3-3	100%	108
QULP-3-4	100%	74
QULP-3-5	100%	136
QULP-4-1	100%	410
QULP-4-2	100%	108
QULP-4-3	100%	109
QULP-4-4	100%	307
QULP-4-5	100%	151

Sample ID	% Sampled	# Invertebrates
QULP-6-1	100%	149
QULP-6-2	100%	87
QULP-6-3	100%	104
QULP-6-4	100%	144
QULP-6-5	100%	57
POL-P1-1	100%	351
POL-P1-2	100%	156
POL-P1-3	100%	352
POL-1-1	100%	709
POL-1-2	100%	3,004
POL-1-3	100%	437
POL-1-4	100%	529
POL-1-5	100%	1,705
POL-2-1	100%	256
POL-2-2	100%	857
POL-2-3	100%	1,501
POL-2-4	100%	3,013
POL-2-5	100%	405
POL-P2-1	100%	1,001
POL-P2-2	100%	1,001
POL-P2-3	100%	1,101
BOL-1-1	100%	1,625
BOL-1-2	100%	530
BOL-1-3	100%	609
BOL-1-4	100%	468
BOL-1-5	100%	458
BOL-B1-1	100%	1,617
BOL-B1-2	100%	1,877
BOL-B1-3	100%	1,839
BOL-B2-1	100%	716
BOL-B2-2	100%	736
BOL-B2-3	100%	996
QUR1-R1	30%	327
QUR1-R2	37%	326
QUR1-R3	25%	322
QUR2-R1	100%	552
QUR2-R2	50%	441
QUR2-R3	27%	341
QUR3-R1	100%	446
QUR3-R2	50%	416
QUR3-R3	47%	323
QUR4-R1	100%	13
QUR4-R2	100%	55
QUR4-R3	100%	14
QUR5-R1	100%	154
QUR5-R2	100%	287
QUR5-R3	100%	79
QUR6-R1	100%	415
QUR6-R2	100%	85
QUR6-R3	100%	166
CAR-R1	100%	243
CAR-R2	100%	310
CAR-R3	100%	318
CLR-R1	100%	118
CLR-R2	100%	41
CLR-R3	100%	54

Table C.22: Benthic invertebrate community sub-sampling precision. Highlighted values did not meet data quality objective of subsampling error ≤ 20%.

Sample ID	Number of Organisms in Fraction				Actual Density	Precision (%)	
	1	2	3	4		min	max
QULP-5-3	410	386	-	-	796	5.9	5.9
QUR1-R3	316	339	362	360	1,377	0.55	13
QUL-52-1	414	435	-	-	849	4.8	4.8

C6.0 BENTHIC MACROINVERTEBRATE TISSUE SAMPLES

C6.1 Method Detection Limits

Due to very small sample volumes, the achieved MDLs for benthic macroinvertebrate tissue samples did not always meet the target MDL (Table C.23). However, most analytes (19 of 25) were detected in the tissue samples and all six of the analytes that were not detected in tissue samples met their target MDL. Therefore, even though some target MDLs were not met due to small sample volumes, data interpretability was not affected.

C6.2 Laboratory Duplicate Samples

One replicate digest of a benthic invertebrate tissue sample and one replicate of an anonymous sample were prepared for analysis of laboratory precision. The data quality objective of ≤30% relative percent difference (RPD) was met for all analytes except aluminum, iron, lead, nickel, strontium, and vanadium (Table C.24). The absolute differences between duplicates for lead, strontium and vanadium were small, particularly considering that the concentrations were approaching the MDL (i.e., within ten-times the MDL). Furthermore, all of the RPDs were within laboratory limits, which the laboratory assesses on a case-by-case basis (Appendix J). Overall, relatively close agreement was achieved between laboratory duplicate samples indicating that reported sample results were associated with good analytical precision.

C6.3 Data Accuracy

Recoveries of all analytes in quality control standards run concurrent with the benthic macroinvertebrate tissue samples met the data quality objective of 70% -130% (Table C.25). These data indicate excellent analytical accuracy associated with the analysis of benthic invertebrate tissue samples.

Table C.23: Laboratory method detection limits (MDLs) for benthic invertebrate tissue sample analyses. Light grey highlighted values indicate target MDL was not achieved.

Analyte	Units	Target MDL	Achieved MDL Range			% of Achieved MDLs That Exceeded Either Target MDL
Moisture	%	0.010	0.01	-	0.01	0
Aluminum	µg/g dw	20	50	-	2,000	100
Antimony	µg/g dw	1.0	0.2	-	1.0	0
Arsenic	µg/g dw	0.50	0.10	-	0.50	0
Barium	µg/g dw	0.50	0.10	-	5.0	80
Beryllium	µg/g dw	0.10	0.02	-	0.10	0
Boron	µg/g dw	10	2.0	-	10	0
Cadmium	µg/g dw	0.10	0.02	-	1.0	2.0
Chromium	µg/g dw	5.0	1.0	-	5.0	0
Cobalt	µg/g dw	0.10	0.020	-	0.10	0
Copper	µg/g dw	0.50	0.10	-	5.0	86
Iron	µg/g dw	20	50	-	2,000	100
Lead	µg/g dw	0.10	0.02	-	0.10	0
Manganese	µg/g dw	1.0	2.0	-	10	100
Molybdenum	µg/g dw	1.0	0.2	-	1.0	0
Nickel	µg/g dw	0.50	0.10	-	5.0	7.8
Selenium	µg/g dw	0.50	0.10	-	0.50	0
Silver	µg/g dw	0.10	0.02	-	0.10	0
Strontium	µg/g dw	1.0	0.20	-	10	76
Thallium	µg/g dw	0.50	0.10	-	0.50	0
Tin	µg/g dw	0.50	0.10	-	0.50	0
Titanium	µg/g dw	0.50	0.50	-	5.0	98
Uranium	µg/g dw	0.050	0.010	-	0.050	0
Vanadium	µg/g dw	1.0	0.20	-	10.0	25
Zinc	µg/g dw	5.0	1.0	-	50	96

Table C.24: Laboratory duplicate results for the analysis of metals in benthic invertebrate tissues. Highlighted values did not meet the data quality objective of ≤ 30% Relative Percent Difference (RPD).

SRC Group #	Units	MDL [a]	2014-12351			2014-12351		
Sample ID			BLC-R1C			Anonymous [b]		
Analyte			Replicate 1	Replicate 2	RPD [c]	Replicate 1	Replicate 2	RPD [c]
Moisture	%	-	-	-	-	79	77	2.7
Aluminum	µg/g dw	200	1,000	1,400	33	-	-	-
Antimony	µg/g dw	1.0	<0.2	<0.2	0	-	-	-
Arsenic	µg/g dw	0.50	4.2	5	17	-	-	-
Barium	µg/g dw	5.0	17	21	21	-	-	-
Beryllium	µg/g dw	0.10	0.030	0.040	29	-	-	-
Boron	µg/g dw	10	4.0	3.0	29	-	-	-
Cadmium	µg/g dw	0.10	0.33	0.37	11	-	-	-
Chromium	µg/g dw	5.0	4.0	5.0	22	-	-	-
Cobalt	µg/g dw	0.10	2.0	2.4	18	-	-	-
Copper	µg/g dw	5.0	18	19	5.4	-	-	-
Iron	µg/g dw	200	2,000	2,800	33	-	-	-
Lead	µg/g dw	0.10	0.29	0.41	34	-	-	-
Manganese	µg/g dw	10	420	470	11	-	-	-
Molybdenum	µg/g dw	1.0	1.4	1.5	6.9	-	-	-
Nickel	µg/g dw	0.50	8.4	12	35	-	-	-
Selenium	µg/g dw	0.50	0.60	0.70	15	-	-	-
Silver	µg/g dw	0.10	0.040	0.040	0	-	-	-
Strontium	µg/g dw	10	13	19	38	-	-	-
Thallium	µg/g dw	0.50	<0.1	<0.1	0	-	-	-
Tin	µg/g dw	0.50	<0.1	<0.1	0	-	-	-
Titanium	µg/g dw	5.0	110	140	24	-	-	-
Uranium	µg/g dw	0.050	0.11	0.14	24	-	-	-
Vanadium	µg/g dw	1.0	4.6	6.6	36	-	-	-
Zinc	µg/g dw	50	90	100	11	-	-	-

[a] MDL - Method Detection Limit.

[b] Anonymous samples belong to other SRC file numbers or clients.

[c] The method detection limit (MDL) value was used in instances where values less than the MDL were reported.

RPD calculation: =(Absolute(Replicate 1 - Replicate 2))/Average(Replicate 1, Replicate 2)*100

Table C.25: Laboratory analyses of certified reference materials and quality control standards associated with the analysis of metals in benthic invertebrate tissues. Highlighted values did not meet the data quality objective of 70-130% recovery.

Analyte	Units	Target	Measured Result	Target Achieved?	% Recovery
Aluminum	µg/g dw	1,200	1,370	yes	114
Arsenic	µg/g dw	6.8	8.1	yes	119
Cadmium	µg/g dw	0.31	0.31	yes	100
Chromium	µg/g dw	1.9	1.9	yes	101
Copper	µg/g dw	16	15	yes	96
Iron	µg/g dw	341	332	yes	97
Lead	µg/g dw	0.42	0.37	yes	90
Manganese	µg/g dw	2.9	3.0	yes	103
Nickel	µg/g dw	1.4	1.3	yes	97
Selenium	µg/g dw	3.6	4.3	yes	119
Silver	µg/g dw	0.024	0.023	yes	98
Zinc	µg/g dw	52	50	yes	96

C7.0 DATA QUALITY STATEMENT

The quality of data for this project was generally good and was adequate to serve the project objectives. Any conclusions based on concentrations of mercury in sediment porewater and manganese in shakeflask tests should consider flags associated with the method detection limit and field precision, respectively. No other issues were identified that had the potential to affect data interpretability.

C8.0 REFERENCES

Golder (Golder Associates). 2015. Mount Polley Tailings Storage Facility Breach – Surface Water Quality Impact Assessment. Prepared for the Mount Polley Mining Corporation. May 2015.

Nautilus (Nautilus Environmental Inc.). 2015. Freshwater Sediment Toxicity Testing conducted for the Mount Polley Mining Corporation – Samples Collected August – October 2014. Prepared for the Mount Polley Mining Corporation. May 2015.

APPENDIX D

SUPPORTING IN-SITU DATA

CONTENTS OF APPENDIX D

TABLES

FIGURES

Table D.1: Supporting in situ water quality measurements at sediment and benthic invertebrate sampling stations within lakes, Mount Polley Mine, 2014 [1].

Waterbody	Area	Station	UTM		Station Depth (m)	Date	Time (24 hr)	Secchi Depth (m)	Water Column Bottom								Water Column Surface							
			Easting (Zone 10U)	Northing (Zone 10U)					Temperature (˚C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	pH	Specific Conductance (µS/cm)	Turbidity	Turbidity Units	Total Dissolved Solids (mg/L)	Temperature (˚C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	pH	Specific Conductance (µS/cm)	Turbidity	Turbidity Units	Total Dissolved Solids (mg/L)
Hazeltine Creek	ST02	ST02-S1	601131	5817185	-	-	-	> depth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ST02-S2	601137	5817176	-	-	-	> depth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ST02-S3	601141	5817162	< 0.5	7-Oct-14	-	> depth	11.7	9.84	90.8	8.22	213.0	852	FNU	138	shallow	-	-	-	-	-	-	-
		ST02-S4	601118	5817163	-	-	-	> depth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ST02-S5	601087	5817188	-	-	-	> depth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ST09	ST09-S1	598164	5817674	< 0.5	7-Oct-14	-	> depth	13.5	9.29	89.3	8.38	208.0	531	FNU	135	shallow	-	-	-	-	-	-	-
		ST09-S2	598224	5817641	-	-	-	> depth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ST09-S3	598224	5817623	-	-	-	> depth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ST09-S4	598340	5817610	-	-	-	> depth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ST09-S5	598379	5817602	-	-	-	> depth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ST16	ST16-S1	595769	5820069	< 0.5	7-Oct-14	-	> depth	16.0	8.43	85.7	8.29	864.0	193	FNU	562	shallow	-	-	-	-	-	-	-
		ST16-S2	595789	5820046	-	-	-	> depth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ST16-S3	595825	5820023	-	-	-	> depth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ST16-S4	595848	5820017	-	-	-	> depth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ST16-S5	595899	5819968	-	-	-	> depth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bootjack Lake	BOL-1	BOL-1-01	591151	5821590	13.0	22-Oct-14	10:50	3.42	9.44	8.82	77.1	6.85	108.5	-1.10	FNU	70	9.43	8.96	78.3	6.88	108.4	-1.17	FNU	70
		BOL-1-02	591977	5820967	11.4	22-Oct-14	11:50	3.34	9.43	8.83	77.3	7.08	108.4	-0.87	FNU	70	9.45	8.85	77.4	7.08	108.4	-1.02	FNU	70
		BOL-1-03	591805	5821502	10.6	22-Oct-14	12:40	3.01	9.43	8.77	76.6	7.18	108.3	-1.00	FNU	70	9.44	8.96	78.5	7.28	108.3	-1.12	FNU	70
		BOL-1-04	590556	5823321	11.1	22-Oct-14	13:30	3.13	9.41	9.47	82.7	7.41	107.6	0.06	FNU	70	9.46	9.58	83.8	7.41	107.6	-0.52	FNU	70
		BOL-1-05	590007	5823593	11.2	22-Oct-14	14:00	3.00	9.45	9.62	84.1	7.50	107.6	-0.44	FNU	70	9.47	9.63	84.3	7.51	107.6	-0.41	FNU	70
	BOL-B1	BOL-B1-01	590049	5823528	16.8	23-Oct-14	16:30	3.20	8.81	9.69	83.4	7.77	90.6	2.02	NTU	-	8.91	9.67	83.5	7.76	90.8	1.76	NTU	-
		BOL-B1-02	590085	5823479	16.0	24-Oct-14	10:00	3.02	8.68	9.59	82.3	7.53	90.6	1.50	NTU	-	8.87	9.66	83.3	7.66	90.7	1.82	NTU	-
		BOL-B1-03	590086	5823473	16.0	24-Oct-14	10:45	3.22	8.71	9.64	82.7	7.62	90.6	1.47	NTU	-	8.84	9.68	83.4	7.70	90.7	1.90	NTU	-
	BOL-B2	BOL-B2-01	591263	5821647	16.2	22-Oct-14	15:55	3.09	9.43	8.80	76.9	7.28	108.3	-1.18	FNU	70	9.44	8.85	77.4	7.38	108.4	-1.09	FNU	70
		BOL-B2-02	591243	5821665	16.2	22-Oct-14	16:50	3.15	9.44	8.84	77.3	7.25	108.3	-1.07	FNU	70	9.43	8.88	77.6	7.39	108.3	-1.22	FNU	70
		BOL-B2-03	591233	5821668	16.2	24-Oct-14	8:30	3.40	9.09	8.99	77.8	7.21	91.5	1.26	NTU	-	9.08	9.07	98.6	7.63	91.6	1.18	NTU	-
Polley Lake	POL-1	POL-1-01	593203	5825674	18.3	21-Oct-14	14:05	2.02	10.1	7.37	65.4	7.79	252.7	4.23	NTU	164	10.2	7.91	70.4	7.84	250.8	3.25	NTU	163
		POL-1-02	594371	5824182	18.6	20-Oct-14	11:05	1.87	8.82	0.47	4.2	7.40	317.7	5.73	NTU	-	9.97	6.39	56.9	7.80	270.3	2.38	NTU	-
		POL-1-03	593783	5824290	19.6	20-Oct-14	15:07	1.69	8.43	0.82	7.1	7.37	336.4	6.24	NTU	-	10.2	7.12	63.4	7.94	265.9	2.33	NTU	-
		POL-1-04	593242	5825062	18.6	21-Oct-14	16:30	2.13	9.64	4.54	39.0	7.60	268.2	2.62	NTU	174	10.1	7.79	69.2	7.88	251.0	2.43	FNU	163
		POL-1-05	593669	5825123	19.0	23-Oct-14	10:47	2.57	9.06	0.50	4.6	7.40	277.7	4.91	FNU	181	9.66	7.19	63.3	7.85	247.7	2.19	FNU	161
	POL-2	POL-2-01	594689	5822625	18.7	23-Oct-14	13:10	2.05	9.06	1.01	8.7	7.46	276.5	4.65	FNU	180	9.52	5.64	49.4	7.76	257.0	2.25	FNU	167
		POL-2-02	595533	5821775	20.5	23-Oct-14	13:44	1.69	8.81	0.89	7.7	7.45	280.3	4.55	FNU	182	9.37	4.44	38.6	7.63	263.7	2.82	FNU	171
		POL-2-03	595367	5821612	24.2	23-Oct-14	15:58	2.08	8.84	0.35	3.0	7.42	282.4	4.89	FNU	184	9.46	4.97	43.3	7.67	260.5	2.82	FNU	169
		POL-2-04	595061	5822011	19.8	23-Oct-14	16:33	1.92	8.96	0.79	6.9	7.46	278.6	4.98	FNU	181	9.49	5.84	50.8	7.75	255.2	2.34	FNU	166
		POL-2-05	594932	5823054	19.9	24-Oct-14	14:00	2.99	9.14	4.32	37.6	7.60	267.7	3.45	NTU	-	9.33	6.51	56.5	7.76	255.2	1.98	NTU	-
	POL-P1	POL-P1-01	593708	5824693	27.7	9-Oct-14	10:53	2.79	8.31	0.30	2.6	7.13	301.7	29.8	NTU	196	12.1	9.00	83.8	8.58	216.1	1.41	NTU	140
		POL-P1-02			27.7	17-Oct-14	12:20	1.95	8.24	0.37	3.2	7.35	290.2	6.18	NTU	189	10.4	7.72	69.2	8.09	219.2	1.33	NTU	143
		POL-P1-03			27.7	17-Oct-14	15:51	1.95	8.24	0.37	3.2	7.35	290.2	6.18	NTU	189	10.4	7.72	69.2	8.09	219.2	1.33	NTU	143
	POL-P2	POL-P2-01	595166	5822183	29.3	24-Oct-14	15:15	2.44	8.57	0.55	4.8	7.45	302.6	6.55	NTU	-	9.42	6.57	58.0	7.83	257.2	2.19	NTU	-
		POL-P2-02			29.3	24-Oct-14	16:05	2.44	8.57	0.55	4.8	7.45	302.6	6.55	NTU	-	9.42	6.57	58.0	7.83	257.2	2.19	NTU	-
		POL-P2-03			29.3	24-Oct-14	16:55	2.44	8.57	0.55	4.8	7.45	302.6	6.55	NTU	-	9.42	6.57	58.0	7.83	257.2	2.19	NTU	-
Quesnel Lake (Littoral)	QUL-45 (LNF1)	QUL-45-01	601524	5817990	1.4	14-Aug-14	15:00	1.4	20.5	8.70	96.7	7.87	97.5	-	-	63	shallow	-	-	-	-	-	-	-
		QUL-45-02	601457	5818033	1.1	14-Aug-14	14:09	1.1	20.6	8.56	95.5	7.78	98.0	-	-	64	shallow	-	-	-	-	-	-	-
		QUL-45-03	601451	5818067	1.4	15-Aug-14	13:35	1.4	21.4	8.52	96.4	7.95	99.7	-	-	65	shallow	-	-	-	-	-	-	-
		QUL-45-04	601555	5817927	0.9	16-Aug-14	12:37	0.9	20.2	8.58	94.9	8.00	98.9	-	-	64	shallow	-	-	-	-	-	-	-
		QUL-45-05	601479	5818047	1.1	16-Aug-14	15:45	1.1	20.6	8.98	99.9	8.26	98.7	-	-	64	shallow	-	-	-	-	-	-	-
	QUL-47 (LFF)	QUL-47-01	601680	5820049	1.5	27-Aug-14	13:10	> depth	18.7	9.06	97.0	8.09	102.0	0.37	NTU	66	18.7	9.07	97.1	8.14	102.4	0.29	NTU	67
		QUL-47-02	600441	5822695	1.5	27-Aug-14	15:10	> depth	18.8	9.16	98.2	8.15	101.6	0.38	NTU	66	18.8	9.12	97.9	8.19	101.6	0.42	NTU	66
		QUL-47-03	600932	5818778	1.5	4-Sep-14	12:00	> depth	17.7	9.17	96.2	8.04	102.9	-2.25	FNU	67	17.7	9.18	96.3	7.91	103.0	-2.34	FNU	67
		QUL-47-04	600861	5818809	1.5	4-Sep-14	13;00	> depth	17.8	9.21	96.8	8.16	101.8	-2.17	FNU	66	18.0	9.08	95.9	8.14	102.0	-2.30	FNU	66
		QUL-47-05	601035	5821268	1.6	4-Sep-14	14:15	> depth	17.2	9.13	94.9	8.10	101.6	-2.07	FNU	66	18.0	9.05	95.6	8.11	101.9	-2.54	FNU	66

Table D.1: Supporting in situ water quality measurements at sediment and benthic invertebrate sampling stations within lakes, Mount Polley Mine, 2014 [1].

Waterbody	Area	Station	UTM		Station Depth (m)	Date	Time (24 hr)	Secchi Depth (m)	Water Column Bottom								Water Column Surface							
			Easting (Zone 10U)	Northing (Zone 10U)					Temperature (˚C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	pH	Specific Conductance (µS/cm)	Turbidity	Turbidity Units	Total Dissolved Solids (mg/L)	Temperature (˚C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	pH	Specific Conductance (µS/cm)	Turbidity	Turbidity Units	Total Dissolved Solids (mg/L)
Quesnel Lake (Littoral)	QUL-48 (LFFF)	QUL-48-01	598891	5826331	1.3	6-Sep-14	14:23	> depth	17.8	8.97	94.5	8.13	107.4	-	-	71	18.1	8.92	94.7	8.13	108.2	-	-	70
		QUL-48-02	598381	5828386	1.6	7-Sep-14	9:28	> depth	16.8	8.96	92.2	7.38	109.4	0.69	NTU	-	17.2	8.90	92.5	7.49	107.4	0.62	NTU	-
		QUL-48-03	598265	5828863	1.4	7-Sep-14	11:19	> depth	17.3	8.93	93.0	7.81	107.9	0.65	NTU	-	17.3	8.95	93.3	7.84	107.8	0.60	NTU	-
		QUL-48-04	598419	5829333	1.6	7-Sep-14	12:43	> depth	17.1	9.00	93.3	7.85	108.3	0.68	NTU	-	17.1	8.99	93.2	7.90	108.4	0.76	NTU	-
		QUL-48-05	598855	5827778	1.3	7-Sep-14	14:22	> depth	17.8	9.05	95.1	7.83	108.6	1.20	NTU	-	17.8	9.04	95.1	7.94	108.4	0.78	NTU	-
	QUL-49 (LNF2)	QUL-49-01	602436	5817331	1.8	18-Aug-14	14:18	> depth	20.4	9.01	99.8	8.24	99.0	-	-	64	20.4	9.01	99.8	8.23	99.0	-	-	64
		QUL-49-02	602443	5817311	1.3	18-Aug-14	16:20	> depth	20.5	8.87	98.6	8.25	98.7	-	-	64	20.6	8.82	98.1	8.23	96.2	-	-	63
		QUL-49-03	602447	5817278	1.8	20-Aug-14	10:28	> depth	19.7	8.91	97.3	7.95	101.5	-	-	-	19.7	8.94	97.6	7.87	101.6	-	-	-
		QUL-49-04	602461	5817240	1.5	20-Aug-14	14:08	> depth	19.1	8.80	95.7	8.02	102.2	-	-	66	20.2	8.66	95.6	8.04	102.5	-	-	67
		QUL-49-05	602478	5817209	1.4	23-Aug-14	14:45	> depth	17.9	9.07	95.5	8.09	101.0	2.96	NTU	66	18.8	8.95	96.2	8.14	101.2	2.32	NTU	66
	QUL-51 (LRef1)	QUL-51-01	610136	5813949	1.4	26-Aug-14	13:54	> depth	18.6	11.6	124	8.92	100.3	1.52	NTU	65	18.8	11.4	123	8.83	100.7	0.60	NTU	65
		QUL-51-02	610003	5813958	1.5	24-Aug-14	15:15	> depth	18.9	13.7	147	9.33	101.9	1.34	NTU	66	19.4	11.7	128	9.09	102.2	0.47	NTU	66
		QUL-51-03	610097	5813939	1.4	25-Aug-14	12:52	> depth	18.0	10.8	114	8.96	102.0	0.91	NTU	66	18.0	10.8	114	8.98	101.9	0.96	NTU	-
		QUL-51-04	610164	5813960	1.5	25-Aug-14	14:47	> depth	18.0	10.9	115	8.96	101.8	0.97	NTU	66	18.3	9.71	103	8.54	103.7	0.78	NTU	67
		QUL-51-05	610031	5813948	1.4	26-Aug-14	11:42	> depth	18.4	11.0	117	8.78	103.2	0.85	NTU	67	18.4	10.2	109	8.56	103.7	0.63	NTU	67
	QUL-52 (LRef2)	QUL-52-01	647854	5848682	1.2	16-Oct-14	-	> depth	9.94	12.3	109	8.28	111.8	2.67	NTU	-	10.6	12.0	107	8.37	108.9	1.55	NTU	-
		QUL-52-02	647665	5848694	1.1	16-Oct-14	16:24	> depth	8.82	10.6	90.9	7.65	115.4	1.71	NTU	-	8.82	10.6	90.9	7.72	115.3	1.79	NTU	-
		QUL-52-03	647575	5848716	1.3	16-Oct-14	17:04	> depth	8.80	10.5	90.8	7.79	116.1	1.81	NTU	-	8.82	10.5	90.8	7.95	116.1	1.55	NTU	-
		QUL-52-04	647456	5848899	1.0	17-Oct-14	9:07	> depth	9.63	9.92	87.4	7.41	113.8	1.20	NTU	-	9.63	9.89	87.0	7.50	114.1	1.00	NTU	-
		QUL-52-05	647381	5848955	1.2	17-Oct-14	9:57	> depth	10.5	10.00	89.8	7.63	110.7	0.54	NTU	-	10.6	10.0	89.9	7.70	110.5	1.00	NTU	-
Quesnel Lake (Profundal)	QULP-1 (PNF)	QULP-1-01	601795	5818151	106	9-Sep-14	11:45	3.00	6.72	6.42	52.5	8.00	168.8	90.0	NTU	110	15.5	9.36	93.9	8.08	103.8	1.33	NTU	67
		QULP-1-02	601672	5818297	109	10-Sep-14	11:55	1.75	6.86	6.12	50.3	8.06	167.1	94.4	NTU	109	13.2	9.77	93.3	7.89	104.5	1.97	NTU	68
		QULP-1-03	601914	5818113	104	11-Sep-14	14:15	3.20	7.04	5.24	43.8	8.06	172.3	126	NTU	112	11.8	9.87	91.2	7.98	104.1	1.47	NTU	68
		QULP-1-04	602623	5817818	104	13-Sep-14	-	4.77	7.09	5.13	42.7	8.09	176.3	137	NTU	1.5	13.9	9.62	93.1	7.89	105.0	0.20	NTU	68
		QULP-1-05	602272	5817946	107	13-Sep-14	12:36	5.87	6.99	7.21	59.2	8.15	156.5	111	NTU	102	14.6	9.62	94.6	8.14	104.6	0.27	NTU	68
	QULP-2 (PFF1)	QULP-2-01	600001	5822025	95.5	19-Sep-14	9:12	9.25	6.68	5.86	47.9	7.91	168.5	85.2	NTU	110	14.8	9.53	94.1	8.11	103.5	0.36	NTU	67
		QULP-2-02	600054	5822165	85.1	19-Sep-14	12:13	8.50	6.62	6.79	55.4	8.04	160.5	70.8	NTU	104	15.6	9.47	95.2	8.16	103.8	0.25	NTU	67
		QULP-2-03	600055	5821871	95.8	19-Sep-14	14:56	9.15	6.65	5.99	49.0	8.02	166.7	90.3	NTU	108	15.7	9.42	94.9	8.16	103.7	0.33	NTU	67
		QULP-2-04	600032	5821992	93.8	20-Sep-14	11:22	9.37	6.66	5.96	48.7	7.90	167.7	90.2	NTU	109	15.1	9.50	94.4	8.02	103.8	0.47	NTU	67
		QULP-2-05	600101	5821772	90.5	20-Sep-14	14:43	9.03	6.63	6.33	51.6	7.91	164.9	95.5	NTU	107	15.8	9.49	95.0	8.07	103.9	0.40	NTU	68
	QULP-3 (PFFF)	QULP-3-01	599391	5824787	52.1	15-Oct-14	12:15	5.47	6.10	8.21	66.2	7.55	104.3	30.2	NTU	-	12.3	9.72	90.9	7.63	79.9	0.49	NTU	-
		QULP-3-02	599400	5824715	58.1	15-Oct-14	14:16	4.97	6.07	8.26	66.5	7.44	102.7	28.4	NTU	-	12.4	9.71	90.8	7.78	80.0	0.59	NTU	-
		QULP-3-03	599327	5824771	48.0	15-Oct-14	15:42	5.50	6.08	8.27	66.6	7.51	103.3	29.1	NTU	-	12.4	9.72	91.0	7.77	79.9	0.83	NTU	-
		QULP-3-04	599299	5824643	50.4	16-Oct-14	16:30	5.08	6.05	8.51	68.5	7.51	101.2	27.8	NTU	-	12.4	9.74	91.1	7.81	80.0	1.79	NTU	-
		QULP-3-05	599416	5824674	57.7	16-Oct-14	13:24	3.75	6.12	8.10	65.2	7.86	120.0	27.9	NTU	78	12.3	9.77	91.2	-	94.1	0.64	NTU	61
	QULP-4 (PFF2)	QULP-4-01	604448	5816575	94.0	8-Oct-14	11:45	3.87	6.53	0.63	5.2	8.09	202.9	222	NTU	132	13.1	9.74	92.7	7.90	90.6	1.14	NTU	59
		QULP-4-02	604577	5816633	94.2	8-Oct-14	13:46	4.39	6.63	5.80	47.3	7.84	135.7	83.4	NTU	-	13.3	9.69	92.6	8.07	90.1	1.84	NTU	-
		QULP-4-03	604331	5816772	91	20-Oct-14	12:42	3.48	6.55	5.77	46.9	4.52	160.8	44.7	FNU	105	11.3	9.86	90.0	7.77	111.3	1.81	FNU	72
		QULP-4-04	604172	5816728	92	20-Oct-14	13:57	2.87	6.43	6.55	53.1	7.63	154.4	42.3	FNU	100	11.3	9.92	90.7	7.82	111.1	1.76	FNU	72
		QULP-4-05	604244	5816618	91	20-Oct-14	15:51	2.61	6.49	6.27	51.0	7.65	157.1	48.9	FNU	102	11.3	9.96	91.1	7.82	111.3	4.02	FNU	72
	QULP-5 (PRef1)	QULP-5-01	610430	5814778	115	17-Sep-14	14:32	8.85	4.61	10.8	83.8	7.71	115.6	7.30	NTU	75	15.2	9.51	94.7	8.04	105.1	0.33	NTU	68
		QULP-5-02	610294	5814639	108	14-Sep-14	12:28	9.13	4.61	2.14	14.9	7.71	118.8	10.5	NTU	77	14.9	9.68	95.7	8.09	106.4	0.16	NTU	69
		QULP-5-03	610613	5814885	117	17-Sep-14	10:52	8.35	4.48	10.8	83.8	7.48	117.3	6.50	NTU	76	15.1	9.50	94.4	7.92	107.1	0.34	NTU	70
		QULP-5-04	610526	5814608	107	18-Sep-14	10:34	7.97	4.63	10.5	81.3	7.52	117.7	8.31	NTU	77	15.0	9.47	94.0	7.89	106.0	0.39	NTU	69
		QULP-5-05	610714	5814799	103	18-Sep-14	12:58	7.65	4.57	10.8	83.5	7.61	114.8	7.48	NTU	75	15.2	9.51	94.8	7.98	104.5	0.39	NTU	68
	QULP-6 (PRef2)	QULP-6-01	633966	5827657	91	18-Sep-14	13:50	6.92	3.84	10.5	80.1	7.39	115.2	-0.07	FNU	75	11.4	10.1	92.2	7.72	109.6	0.02	FNU	71
		QULP-6-02	634022	5827736	99	18-Oct-14	11:03	8.11	3.84	10.4	79.0	7.06	114.8	-0.50	FNU	75	11.2	10.1	92.1	7.66	108.6	0.00	FNU	71
		QULP-6-03	634229	5827489	91	18-Oct-14	13:10	8.01	3.86	10.6	80.8	7.61	114.7	1.43	FNU	75	11.3	10.1	92.0	7.80	109.2	0.03	FNU	71
		QULP-6-04	634088	5827559	90	18-Oct-14	15:03	7.06	3.83	10.5	80.1	7.40	115.3	-0.10	FNU	75	11.5	10.1	92.2	7.71	109.7	0.02	FNU	71
		QULP-6-05	634129	5827711	94	20-Oct-14	9:41	6.67	3.19	10.6	80.4	6.97	114.5	-0.06	FNU	74	10.6	10.2	91.4	7.27	110.5	0.16	FNU	72

[1] Where in-situ measures were recoreded in the field on multiple sampling days or at multiple sampling depths, those recorded at the depth closest to the benthic sampling depth (bottom), and on the day that benthic sampling was completed are presented in this table.

Table D.2: Habitat and in-situ supporting data associated with river sampling sites, Mount Polley Mine, 2014.

Station ID		**BLC**	**CLR**	**CAR**	**QUR1**	**QUR2**	**QUR3**	**QUR4**	**QUR5**	**QUR6**
Waterbody		Blackwater Creek	Clearwater River	Cariboo River	Quesnel River, upstream of the forks	Quesnel River, upstream of the forks	Quesnel River, upstream of the forks	Quesnel River, downstream of the forks	Quesnel River, downstream of the forks	Quesnel River, downstream of the forks
Ref vs Exp		Reference	Reference	Reference	Mine-exposed	Mine-exposed	Mine-exposed	Mine-exposed	Mine-exposed	Mine-exposed
Date Sampled		26-Oct-14	22-Oct-14	18-Oct-14	15-Oct-14	16-Oct-14	17-Oct-14	26-Oct-14	25-Oct-14	19-Oct-14
UTMs, Zone 10U	UTMs - E	490298	705726	599224	595132	594545	590120	568954	553756	544360
	UTMs - N	5904319	5738077	5835783	5830806	5830888	5835403	5835483	5852189	5870630
Samplers' Initials		JT, AM	JT, AM	JT, AM	JT, AM	JT, AM	JT, AM	JT, AM	JT, AM	JT, AM
Macrophyte Coverage (%)		0	0	0	0	0	0	0	0	0
Periphyton Coverage		4	1	3	5	4	3	1	1	1
Water Colour/Clarity		slight brown colour clear	colourless clear	colourless clear in jar, but turbidity visible in river	clear transparent	colourless clear	colourless clear	colourless turbid	colourless clear in jar, but turbidity visible in river	colourless in jar turbid
Bankfull Width (m)		45	200	64	57	57	56	~50	~45	94
Wetted Width (m)		34	195	57	38	50	47	~60	~53	80
Bankfull-Wetted Depth (m)		1.1	1.12	1.12	1.2	1.52	1.17	1.94	1.41	1.9
In-Situ Water Quality:										
Temperature (°C)		3.8	11	10.9	12.2	12.3	12	9.5	9.4	12.5
Dissolved Oxygen (mg/L)		11.76	9.26	11.21	9.21	9.96	10.31	10.33	9.98	10.38
Dissolved Oxygen (%)		79.4	89.4	110.2	95.4	101.1	104.6	97	92.9	104.4
Specific Conductance (µS/cm)		134.8	57.6	112.1	116.0	105.5	109.2	75.8	80.3	117.7
Lab Conductivity (µS/cm)		187	83.4	115	106.0	106.0	106.0	109	114	117
pH		8.08	8.23	7.49	7.83	7.43	7.87	7.68	7.43	7.67

[grey shading] - field probe not calibrating conductivity properly.

Table D.3: Channel depth and velocity data associated with river benthic invertebrate sampling areas, Mount Polley Mine, 2014.

Replicate	1	2	3	mean
BLC				
Kick Distance (m)	no community collected			
Kick Time (m)				
Velocity (m/s)				
CLR				
Kick Distance (m)	1.25	3	2	2.1
Kick Time (m)	1	1	1	1
Velocity (m/s)	0.20	0.31	0.23	0.25
CAR				
Kick Distance (m)	2	2	1.5	1.8
Kick Time (m)	1	1	1	1
Velocity (m/s)	0.15	0.17	0.27	0.20
QUR1				
Kick Distance (m)	4	4	3	3.7
Kick Time (m)	1	1	1	1
Velocity (m/s)	0.16	0.25	0.29	0.23
QUR2				
Kick Distance (m)	3	3	2	2.7
Kick Time (m)	1	1	1	1
Velocity (m/s)	0.26	0.31	0.13	0.23
QUR3				
Kick Distance (m)	1.25	2	1.25	1.5
Kick Time (m)	1	1	1	1
Velocity (m/s)	0.25	0.11	0.16	0.17
QUR4				
Kick Distance (m)	1.25	2.25	3	2.2
Kick Time (m)	1	1	1	1
Velocity (m/s)	0.21	0.15	0.18	0.18
QUR5				
Kick Distance (m)	1.25	2	3	2.1
Kick Time (m)	1	1	1	1
Velocity (m/s)	0.24	0.19	0.27	0.23
QUR6				
Kick Distance (m)	2	2	2	2.0
Kick Time (m)	1	1	1	1
Velocity (m/s)	0.18	0.18	0.30	0.22

Table D.4: Substrate size and embeddedness at river benthic invertebrate sampling areas, Mount Polley Mine, 2014.

Pebble Size (cm)										Embeddedness
BLC										
6.5	s/g	11.5	8.2	8.5	7.3	13.1	7	10.5	7.2	0.25
10.4	5	5.9	10	16.3	7.8	3.5	8.5	8.6	14.5	0.75
10.4	9.6	8.4	7.2	13.6	9.8	7	8.4	8.9	9.4	0.25
9.9	9.2	8.6	s/g	5.4	8.4	8.6	8.5	9.5	10.1	0.75
18.1	s/g	8.9	6.1	7.5	11.8	8.5	3.7	9.4	13.3	0.5
9.9	6.9	11	10	5.9	4	10.9	7.8	14.8	9	0.25
15.4	7.4	10.2	10.5	11.7	13.7	13	9.3	8.1	15.7	0.25
6.2	11.4	8.3	7.5	7.8	14.9	s/g	5.4	10.8	7.5	0.5
12.7	7.4	7.2	9	15.5	16.2	4.8	s/g	10.4	9.3	0.25
10.6	10.7	14.1	15.2	s/g	6.8	9	8.5	14.2	9.9	0.5
	Mean Pebble Size:		9.62766	Std Deviation:		3.06834	Mean Embeddedness:			0.425
CLR										
13.8	12.4	14.2	9.9	15.6	15.4	17.1	9.9	8.7	5.4	0.75
7.8	19.2	27.4	13.4	17.4	6.7	13.3	8.2	8.4	11.6	0.5
14.8	10.1	15.5	6.1	29.5	11.7	7.3	13.1	7.2	3.4	0.25
12.6	11.4	38.6	5.5	12.7	8.9	7.9	6.5	14.4	8.4	0.25
15.5	11.6	18	i/s/g	21.1	22.6	17.6	8.5	7.9	11	0.75
11.5	19.1	16	i/s/g	7.1	17	20.5	11.4	17.9	19.5	0.5
23.3	9.2	13.6	22.4	8.3	11.6	38.7	22.2	18.9	9.8	0.5
7.2	7.4	11.5	6.5	17.6	13.6	18.4	9.5	17.3	9.9	0.75
7.2	i/s/g	21.5	5.5	11.9	17.6	14.8	18	6.3	18	0.75
12.5	13.2	10.5	i/s/g	9.9	7.6	9.1	4	22.2	18.4	0.75
	Mean Pebble Size:		13.5448	Std Deviation:		6.52616	Mean Embeddedness:			0.575
CAR										
14.8	32.2	22.3	12.5	13.2	7.4	13.6	32.7	i/g	41.4	0.5
8.4	19.7	12.3	22.6	13.9	13.9	14.2	12.5	22.4	5.5	0.75
6.6	9.2	12.8	8.2	20.4	9.2	12.4	16.3	14.4	14.5	0.5
9	11.5	11.9	4.5	11.2	8.3	8.5	19.5	10.6	11.2	0.5
8.3	10.4	6.1	5.7	10.8	13.9	15	2.5	12.1	13.9	0.25
14.4	13.2	5.9	i/s	11.6	14.2	12.4	13.4	11.9	18.4	0.75
i/s	5.5	15.1	12.5	16.5	15.4	9.9	11.9	6.4	6.9	0.5
i/s	20.1	17.5	10.8	9.7	7.6	17.5	17.5	11.5	14.6	0.25
12.1	13.5	9.8	5.4	17.7	14.5	12.1	30	41.1	5.5	0.75
6.2	13.5	10.5	7	i/s	10.4	20.9	9.5	13.3	12.1	0.5
	Mean Pebble Size:		13.3874	Std Deviation:		6.84054	Mean Embeddedness:			0.525
QUR1										
6.2	10.3	10.7	5.9	4.3	9.2	15.3	7.2	7.5	4.6	0.25
8.9	6.8	16.6	9.4	13.7	20.1	9.4	7	7.3	8.9	0.5
15.5	15.9	7.4	7.3	9.4	9.4	6.9	4.9	11.6	6.3	0
9.8	10.5	18.9	7.5	10.4	16.4	14.8	4	7.1	9.9	0.75
10.1	17.2	3.9	9.8	9.9	10.9	12.5	7	17.5	18.2	0.75
15.1	15.1	8.4	13.2	18.3	9.5	13.8	13.9	19.6	15.4	0.25
7.7	5.5	9.3	7.4	12	16.8	8	6.4	15.5	18.5	0.5
23.2	17.4	20.4	21.3	19.9	13.5	8	13.4	42.4	15.1	0.75
3	10.6	22.7	14.1	11.1	18.9	18	8.3	11.4	17.4	0.5
21.4	36.5	4.1	9.3	6.2	7	34.5	30	11.4	7.6	0.5
	Mean Pebble Size:		12.577	Std Deviation:		6.89026	Mean Embeddedness:			0.475
QUR2										
19	8.2	6.9	13.4	4.5	20.5	40	10.5	11.4	8.1	0.75
i/g	8.5	15.4	37.6	7	5.4	10.6	45.3	8	6.5	0.75
3.3	4.8	11.5	21.4	11.5	6	7	20.1	11.8	11.6	0.25
22.1	4.5	5.2	3.9	10	5.6	20.2	30	8.9	6.4	0.25
15.1	7.2	12.2	9.4	i/g	5	5.5	5.4	25	17.1	0.5
5.4	50.5	3.2	12.4	18.3	7.5	7.1	4.5	26.4	5.6	0.75
13.8	i/g	36.5	17.2	18.4	10.2	6.8	6.5	21.2	3.4	0.75
11.8	9.2	7.3	5.2	16.3	20.2	68	6.5	7.1	19.3	0.25
27.3	19.1	38.9	13.8	105.1	10.7	13.9	23.1	7.4	11	0.25
6.4	21.6	17.3	11.6	34.8	7.2	11.3	51.9	17.1	82	0.5
	Mean Pebble Size:		16.4103	Std Deviation:		16.4033	Mean Embeddedness:			0.5

Table D.4: Substrate size and embeddedness at river benthic invertebrate sampling areas, Mount Polley Mine, 2014.

Pebble Size (cm)										Embeddedness
QUR3										
21.5	6.4	27.3	5.5	12.4	6.3	22.4	6.2	19.6	11.7	0.75
37.3	14.7	4.9	13.1	7.2	16.9	22.6	9.4	10	14.1	1
7.2	17.6	22.5	11.5	12.5	6.5	18.1	19.4	28.5	7.2	0.75
16.4	7.5	11	40.4	16.8	13.7	11.6	9.7	16.4	15.5	0.5
12.3	10	13.4	10.5	9	33.1	16.4	23.9	9.3	20	0.5
14.7	17	16.1	13.6	11.9	11.8	6.5	20.9	15.4	8.1	0.25
3.9	14.4	6.6	12.8	13.8	27.2	6.6	17.8	22	13.6	0.5
36.5	14.4	22.4	21.1	5.9	9.9	30	13.2	7.3	24.5	0.5
10.4	10	16.6	5.4	13.2	13.4	16.5	5.9	10.5	17.1	0.75
12.2	15.2	19.5	50.4	10.6	20.2	8.1	19	14.5	15.4	0.75
Mean Pebble Size:			15.214	Std Deviation:		8.12918	Mean Embeddedness:			0.625
QUR4										
14.5	12.9	8	10	11.6	5.4	8.6	15.7	4.9	5.5	0.75
5.6	5	12.7	7.5	9.7	11.3	s/g	3.9	9.8	8.2	0.25
10.9	7.2	17.6	10.1	23.5	8.4	12.5	9.9	12.3	9.7	0.75
4.9	8.6	6.8	12.5	5.9	13.8	s/g	9.5	16.3	9.2	0.5
4.4	9.8	27.7	12.6	17	s/g	6.5	25.1	13.5	17.8	0.25
14.2	31.9	6.4	7.2	8	15.9	10.5	12.5	9.6	9.4	0.25
20.5	6.7	5.9	11.8	4.6	13	5.5	6.9	19.9	5.5	0.5
9.4	21	7.2	7.8	8.8	14.2	15.6	8.6	9.4	12.6	0.75
8.7	10.9	9.9	10.1	10.6	9.4	11.9	6.5	8.1	12	0.25
7.4	23.3	g	5.5	10.2	5.7	5.8	20.2	10.9	15.4	0.5
Mean Pebble Size:			11.0188	Std Deviation:		5.34719	Mean Embeddedness:			0.475
QUR5										
12.3	11.2	12.3	6.2	26.9	9.8	13	7.1	13.1	10.4	0.75
17.2	11.1	16.5	9.6	16.2	9	6.3	8.5	14.2	12.4	0.25
12.5	14.7	26.2	8.4	9.6	15.5	10.1	8.3	20.4	20.2	0.5
12.1	15.9	15.2	9.4	15.4	15.5	8.3	8.4	11.1	10.2	0.75
18	12.1	12.4	9.5	9.8	10.6	10.4	17.9	12.8	11.5	0.5
12.5	15.2	12.6	32.2	11	6.1	10.1	15.4	3.2	11.1	0.5
12.1	12.2	10.1	17.5	10.2	13.4	8.4	11.5	11.4	14.9	0.5
10.6	11.7	9.4	9.5	18.6	14.1	27.7	9.1	14.2	20.4	0.75
8.2	14.2	14.7	22.7	10.1	10	9.3	8.2	7.5	15.9	0.5
10	16.5	7.4	9.3	10.9	5.1	7.9	37.7	9.6	8.5	0.5
Mean Pebble Size:			12.758	Std Deviation:		5.44723	Mean Embeddedness:			0.55
QUR6										
11.6	20.9	7.8	6	8	7.8	11.4	14.5	8.7	12.4	0
10.8	10.8	18.2	6.3	15.5	s	9.1	18.4	16.5	11.4	0.5
4.3	20.5	0.7	3.5	s	10.3	66	9.3	10.2	10.3	0.25
17.6	16.3	13.9	11.2	13.7	19	24.4	6.3	13.1	9.8	0.5
11.4	15.1	25.9	25.2	11.4	23.4	15	19.2	11.2	8.6	0.75
36.9	21.5	9.4	9.9	8.6	9.9	11.5	13	8.3	43.3	0.5
7.9	i/s	16.2	9.8	3.4	10.5	14.2	9.9	9.5	7.3	0.5
19.5	9.8	21.2	5.8	4.4	9.4	13.1	9.9	17.3	7.5	0.75
19.6	7.6	11.5	15.4	16.1	4.2	12.4	11.5	12.2	5.5	0.5
12.6	20.5	20.2	8.6	9.6	18.7	s/g	14.4	9.5	17.2	0.5
Mean Pebble Size:			13.5323	Std Deviation:		8.51993	Mean Embeddedness:			0.475

Table D.5: Densiometer readings at river benthic invertebrate sampling areas, Mount Polley Mine, 2014.

Site	Upstream (%)	Downstream (%)	Left Bank[a] (%)	Right Bank[a] (%)	Average
BLC	0	0	0	0	0
CLR	32	15	0	84	32.8
CAR	22	0	89	0	27.8
QUR1	6	8	0	50	16
QUR2	32	6	90	6	33.5
QUR3	0	0	32	0	8
QUR4	17	31	0	90	34.5
QUR5	0	3	0	50	13.3
QUR6	16	8	62	0	21.5

[a] Facing upstream.

Figure D.1: Habitat of sampled reference areas, Mount Polley Mine, Quesnel River Survey, October 2014.

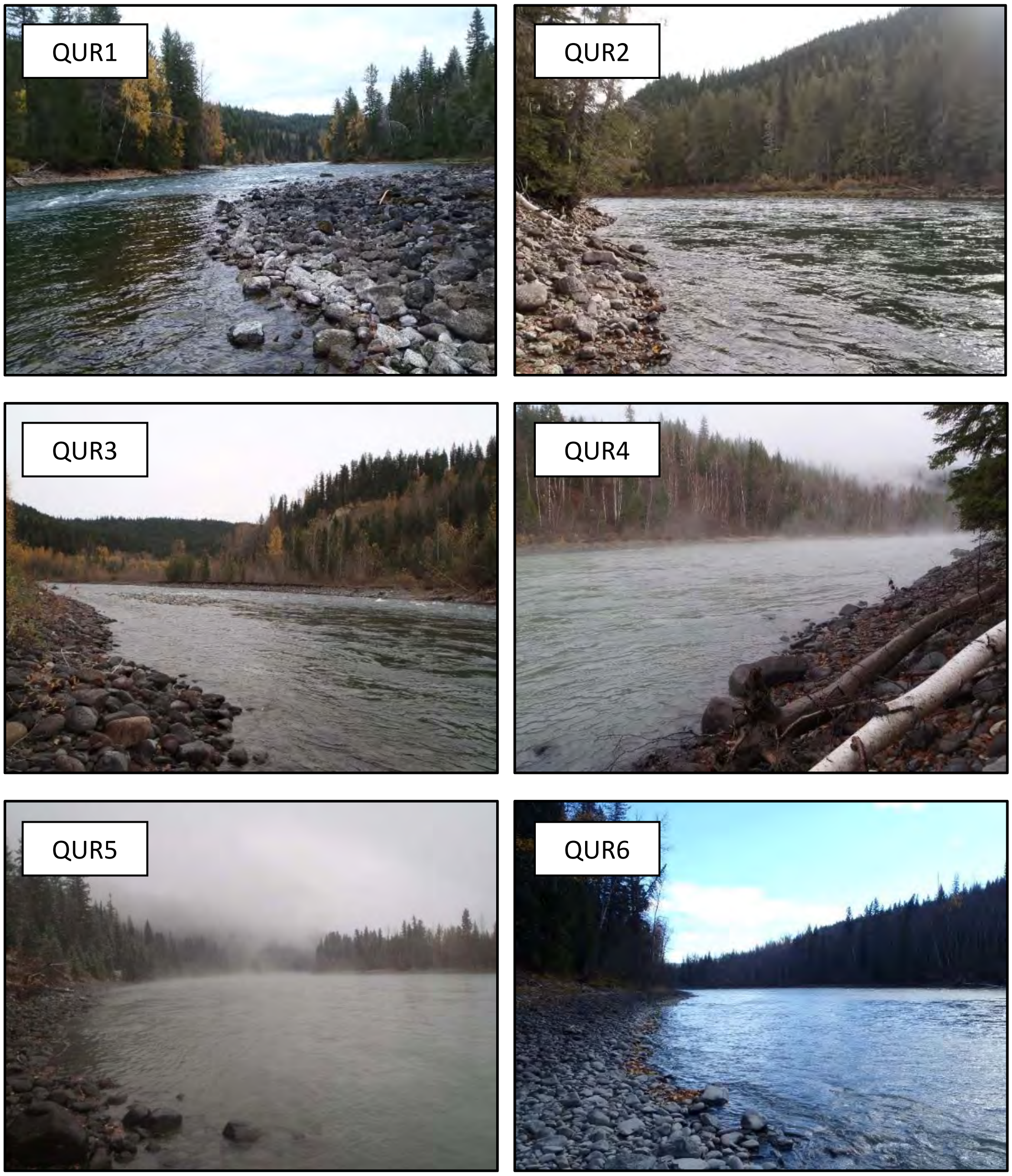

Figure D.2: Habitat of sampled mine-exposed areas along the Quesnel River, Mount Polley Mine,Quesnel River Survey, October 2014.

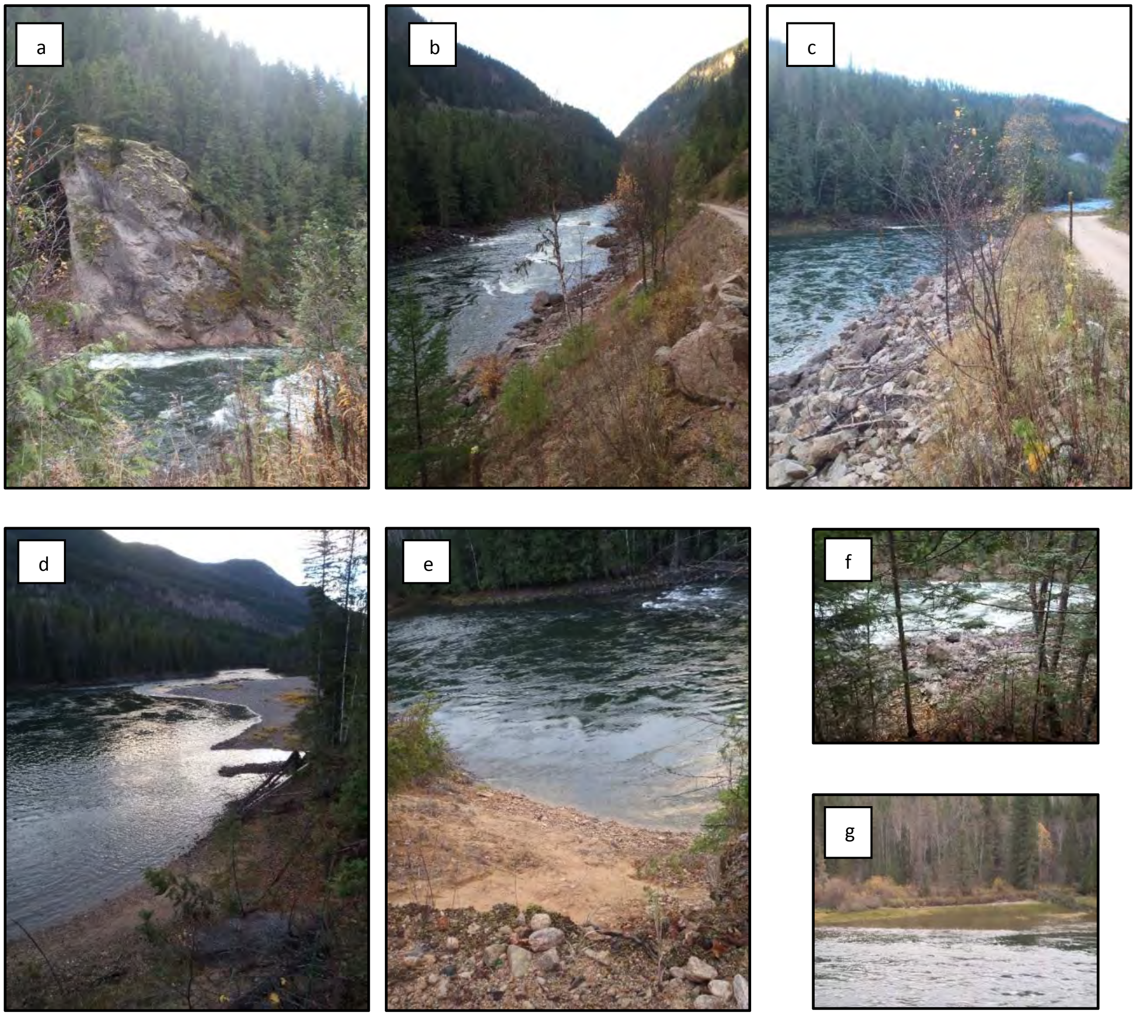

Figure D.3: Examples of unsuitable habitat on the Clearwater River, Mount Polley Mine, Quesnel River Study, October 2014 [1].

[1] A large extent of the Clearwater River was fairly channelized, with steep bedrock (a) or cobble/boulder (b, c, f) banks. At these areas, there was a steep drop-off which prevented kick sampling at 0.5 m deep, the velocity was far too fast (>0.3 m/s), and the substrate was often too large. One or two areas of the Clearwater River had cobble, however the substrate was smaller cobble with a large sand content than what was found on the Quesnel River. The water velocity was also far too high (d). A few areas were sandy with a steep and slumping bank (e). Two sections were observed that were slow-flowing back eddies with substrate that was either sandy/mucky or very small cobble (g).

APPENDIX E

SEDIMENT QUALITY

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TABLES

FIGURES

Figure E.33: Photographs of sediment cores collected from Quesnel Lake profundal near-field (QUL-PW-1) for profiles of sediment and pore-water chemistry

Table E.1: Raw sediment quality data for Hazeltine Creek, Mount Polley Mine, 2014. Metals data are based on the <2mm fraction of sediment [1].

Analyte	Units	BC SQG [2]		CSR [3]		Historic Hazeltine Creek 95th Percentile [4]		Lower Hazeltine Creek (ST02)												
Sample ID		TEL	PEL	Sensitive	Typical	Lower Creek	Upper Creek	ST02-S1	ST02-S2	ST02-S3	ST02-S4	ST02-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								**7-Oct-14**	**7-Oct-14**	**7-Oct-14**	**7-Oct-14**	**7-Oct-14**							
Physical Tests																			
Moisture	%	-	-	-	-	-	-	25.8	27.0	32.6	34.1	24.7	28.8	27.0	24.7	34.1	4.23	1.89	5.25
pH (1:2 soil:water)	pH	-	-	-	-	-	-	8.65	8.62	8.29	8.35	8.62	8.51	8.62	8.29	8.65	0.172	0.077	0.213
Particle Size																			
% Gravel (>2mm)	%	-	-	-	-	-	33	<0.10	0.24	<0.10	<0.10	<0.10	0.13	<0.10	<0.10	0.24	0.063	0.028	0.078
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	-	65	47.0	32.9	8.63	22.8	40.9	30.4	32.9	8.6	47.0	15.2	6.80	18.9
% Silt (0.063mm - 4µm)	%	-	-	-	-	-	76	49.7	59.3	79.7	65.0	49.4	60.6	59.3	49.4	79.7	12.6	5.61	15.6
% Clay (<4µm)	%	-	-	-	-	-	14	3.28	7.53	11.7	12.3	9.75	8.91	9.75	3.28	12.3	3.66	1.64	4.54
Texture	-	-	-	-	-	-	-	Sandy loam	Silt loam	Silt	Silt loam	Sandy loam	-	-	-	-	-	-	-
Leachable Anions & Nutrients																			
pH	pH	-	-	-	-	-	-	8.62	8.48	8.09	7.84	8.80	8.37	8.48	7.84	8.80	0.393	0.176	0.488
Anions and Nutrients																			
Total Nitrogen by LECO	%	-	-	-	-	-	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0
Organic / Inorganic Carbon																			
Total Organic Carbon	%	-	-	-	-	9.0	12.8	<0.10	0.17	0.16	0.17	<0.10	0.14	0.16	<0.10	0.17	0.037	0.016	0.046
Metals																			
Aluminum	mg/kg	-	-	-	-	12,550	18,000	11,400	13,900	16,200	15,800	18,000	15,060	15,800	11,400	18,000	2,512	1,123	3,118
Antimony	mg/kg	-	-	-	-	1.3	0.37	0.42	0.39	0.47	0.46	0.45	0.44	0.45	0.39	0.47	0.033	0.015	0.041
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	10.4	9.06	10.8	10.8	12.5	10.7	10.8	9.06	**12.5**	1.23	0.55	1.53
Barium	mg/kg	-	-	-	-	104	136	113	113	150	164	198	148	150	113	198	36.1	16.1	44.8
Beryllium	mg/kg	-	-	-	-	0.30	0.46	0.50	0.42	0.54	0.57	0.73	0.55	0.54	0.42	0.73	0.11	0.051	0.14
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Boron	mg/kg	-	-	-	-	3.0	5.4	<10	<10	<10	<10	10	10	<10	<10	10	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	0.185	0.199	0.182	0.171	0.214	0.190	0.185	0.171	0.214	0.0166	0.0074	0.0207
Calcium	mg/kg	-	-	-	-	7,030	13,400	24,600	26,000	28,800	26,200	29,700	27,060	26,200	24,600	29,700	2,116	946	2,627
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	18.8	26.6	27.4	21.0	11.4	21.0	21.0	11.4	27.4	6.51	2.91	8.08
Cobalt	mg/kg	-	-	-	-	11.0	10.4	14.6	12.8	15.5	15.6	17.3	15.2	15.5	12.8	17.3	1.64	0.734	2.04
Copper	mg/kg	35.7	197	120	240	42.0	94.6	645	383	376	559	978	**588**	**559**	**376**	**978**	247	110	306
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	61,100	41,000	53,500	49,200	50,900	**51,140**	**50,900**	**41,000**	**61,100**	7,270	3,251	9,025
Lead	mg/kg	35	91	57	110	5.6	6.7	5.57	6.33	7.28	6.02	6.27	6.29	6.27	5.57	7.28	0.627	0.280	0.779
Lithium	mg/kg	-	-	-	-	12.9	14.8	13.2	16.5	20.3	17.0	19.4	17.3	17.0	13.2	20.3	2.78	1.24	3.45
Magnesium	mg/kg	-	-	-	-	6,160	6,430	7,220	8,080	9,650	9,970	11,100	9,204	9,650	7,220	11,100	1,548	692	1,921
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	542	542	618	659	738	620	618	542	738	83.1	37.2	103
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.140	0.145	0.0834	0.0590	0.0633	0.0929	0.0975	0.0792	0.0834	0.0590	0.0975	0.0173	0.0077	0.0215
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	3.19	1.87	2.59	3.01	5.85	3.30	3.01	1.87	5.85	1.51	0.676	1.88
Nickel	mg/kg	16	75	-	-	24	24	12.7	21.7	22.0	16.4	8.40	16.2	16.4	8.4	22.0	5.85	2.62	7.27
Phosphorus	mg/kg	-	-	-	-	729	1,380	1,320	1,140	1,310	1,260	1,540	1,314	1,310	1,140	1,540	145	64.9	180
Potassium	mg/kg	-	-	-	-	910	1,450	1,040	1,360	1,710	1,580	1,840	1,506	1,580	1,040	1,840	315	141	391
Selenium	mg/kg	2	-	-	-	1.3	3.3	0.95	0.62	0.74	0.85	1.29	0.89	0.85	0.62	1.29	0.26	0.11	0.32
Silver	mg/kg	0.5	-	-	-	0.10	0.16	0.35	0.22	0.26	0.27	0.40	0.30	0.27	0.22	0.40	0.073	0.033	0.091
Sodium	mg/kg	-	-	-	-	253	350	620	540	650	790	1,270	774	650	540	1,270	292	130	362
Strontium	mg/kg	-	-	-	-	67	118	113	141	162	153	173	148	153	113	173	23.0	10.3	28.6
Thallium	mg/kg	-	-	-	-	0.051	0.094	0.062	0.073	0.075	0.051	<0.050	0.062	0.062	<0.050	0.075	0.012	0.0053	0.015
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	701	776	1,080	1,140	1,400	1,480	1,780	1,376	1,400	1,080	1,780	282	126	350
Uranium	mg/kg	-	-	-	-	0.73	1.26	0.896	0.936	1.11	0.983	1.12	1.01	0.98	0.90	1.12	0.102	0.045	0.126
Vanadium	mg/kg	-	-	-	-	75	65.3	230	130	174	175	201	182	175	130	230	37.0	16.6	46.0
Zinc	mg/kg	123	315	200	380	60.2	67.6	54.3	56.4	62.9	59.1	67.8	60.1	59.1	54.3	67.8	5.37	2.40	6.67

[1] Reported TOC, TN, pH and moisture data are based on bulk sediment. Data < method detection limit (MDL) were used at the MDL for calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

(Blue) Value is > TEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

(Orange) Value is > PEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

Table E.1: Raw sediment quality data for Hazeltine Creek, Mount Polley Mine, 2014. Metals data are based on the <2mm fraction of sediment [1].

Analyte	Units	BC SQG [2]		CSR [3]		Historic Hazeltine Creek 95th Percentile [4]		Mid Hazeltine Creek (ST09)												
Sample ID		**TEL**	**PEL**	**Sensitive**	**Typical**	**Lower Creek**	**Upper Creek**	**ST09-S1**	**ST09-S2**	**ST09-S3**	**ST09-S4**	**ST09-S5**	**Mean**	**Median**	**Minimum**	**Maximum**	**Standard Deviation**	**Standard Error**	**t*SE**
Date Sampled								**7-Oct-14**	**7-Oct-14**	**7-Oct-14**	**7-Oct-14**	**7-Oct-14**							
Physical Tests																			
Moisture	%	-	-	-	-	-	-	27.1	27.8	30.6	27.8	30.3	28.7	27.8	27.1	30.6	1.61	0.719	2.00
pH (1:2 soil:water)	pH	-	-	-	-	-	-	8.47	8.59	8.52	8.59	8.56	8.55	8.56	8.47	8.59	0.051	0.023	0.064
Particle Size																			
% Gravel (>2mm)	%	-	-	-	-	-	33	<0.10	<0.10	<0.10	<0.10	0.43	0.17	<0.10	<0.10	0.43	0.15	0.066	0.18
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	-	65	29.2	32.8	5.40	27.3	22.0	23.3	27.3	5.40	32.8	10.8	4.81	13.4
% Silt (0.063mm - 4µm)	%	-	-	-	-	-	76	63.9	60.9	81.8	65.4	69.3	68.3	65.4	60.9	81.8	8.15	3.65	10.1
% Clay (<4µm)	%	-	-	-	-	-	14	6.82	6.29	12.8	7.25	8.28	8.29	7.25	6.29	12.8	2.63	1.17	3.26
Texture	-	-	-	-	-	-	-	Silt loam	Silt loam	Silt	Silt loam	Silt loam	-	-	-	-	-	-	-
Leachable Anions & Nutrients																			
pH	pH	-	-	-	-	-	-	8.37	8.31	8.13	8.45	8.24	8.30	8.31	8.13	8.45	0.122	0.055	0.152
Anions and Nutrients																			
Total Nitrogen by LECO	%	-	-	-	-	-	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0
Organic / Inorganic Carbon																			
Total Organic Carbon	%	-	-	-	-	9.0	12.8	0.20	0.15	0.17	0.19	0.16	0.17	0.17	0.15	0.20	0.021	0.009	0.026
Metals																			
Aluminum	mg/kg	-	-	-	-	12,550	18,000	12,900	12,700	16,600	13,300	14,300	13,960	13,300	12,700	16,600	1,599	715	1,986
Antimony	mg/kg	-	-	-	-	1.3	0.37	0.31	0.35	0.39	0.34	0.34	0.35	0.34	0.31	0.39	0.029	0.013	0.036
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	7.53	7.24	7.83	7.80	8.45	7.77	7.80	7.24	8.45	0.45	0.20	0.56
Barium	mg/kg	-	-	-	-	104	136	93.7	96.0	114	102	115	104	102	93.7	115	9.94	4.44	12.3
Beryllium	mg/kg	-	-	-	-	0.30	0.46	0.36	0.38	0.44	0.43	0.49	0.42	0.43	0.36	0.49	0.051	0.023	0.064
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Boron	mg/kg	-	-	-	-	3.0	5.4	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	0.173	0.163	0.194	0.192	0.168	0.178	0.173	0.163	0.194	0.0142	0.0063	0.0176
Calcium	mg/kg	-	-	-	-	7,030	13,400	25,800	26,500	29,700	28,800	28,400	27,840	28,400	25,800	29,700	1,632	730	2,026
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	25.1	23.4	34.1	26.2	26.8	27.1	26.2	23.4	34.1	4.11	1.84	5.10
Cobalt	mg/kg	-	-	-	-	11.0	10.4	11.8	11.2	14.2	12.4	14.1	12.7	12.4	11.2	14.2	1.36	0.606	1.68
Copper	mg/kg	35.7	197	120	240	42.0	94.6	276	313	188	298	355	**286**	**298**	**188**	**355**	61.9	27.7	76.9
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	36,000	32,400	41,400	40,100	48,400	**39,660**	**40,100**	**32,400**	**48,400**	6,036	2,699	7,493
Lead	mg/kg	35	91	57	110	5.6	6.7	5.82	6.57	8.39	6.86	6.72	6.87	6.72	5.82	8.39	0.939	0.420	1.17
Lithium	mg/kg	-	-	-	-	12.9	14.8	15.7	16.6	25.5	17.3	20.8	19.2	17.3	15.7	25.5	4.03	1.80	5.00
Magnesium	mg/kg	-	-	-	-	6,160	6,430	7,640	7,270	9,710	7,820	8,580	8,204	7,820	7,270	9,710	968	433	1,202
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	483	460	548	504	537	506	504	460	548	36.7	16.4	45.5
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.140	0.145	0.0478	0.0510	0.0794	0.0502	0.0614	0.0580	0.0510	0.0478	0.0794	0.0131	0.0058	0.0162
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	1.49	1.86	1.27	1.98	2.00	1.72	1.86	1.27	2.00	0.32	0.15	0.40
Nickel	mg/kg	16	75	-	-	24	24	21.4	20.4	30.8	21.6	22.6	23.4	21.6	20.4	**30.8**	4.23	1.89	5.25
Phosphorus	mg/kg	-	-	-	-	729	1,380	1,030	954	1,010	1,150	1,100	1,049	1,030	954	1,150	77.0	34.4	95.6
Potassium	mg/kg	-	-	-	-	910	1,450	1,330	1,250	1,700	1,290	1,370	1,388	1,330	1,250	1,700	180	80.5	224
Selenium	mg/kg	2	-	-	-	1.3	3.3	0.49	0.51	0.41	0.50	0.56	0.49	0.50	0.41	0.56	0.054	0.024	0.067
Silver	mg/kg	0.5	-	-	-	0.10	0.16	0.16	0.20	0.15	0.17	0.21	0.18	0.17	0.15	0.21	0.026	0.012	0.032
Sodium	mg/kg	-	-	-	-	253	350	420	490	390	460	480	448	460	390	490	42.1	18.8	52.2
Strontium	mg/kg	-	-	-	-	67	118	139	147	170	159	153	154	153	139	170	11.8	5.27	14.6
Thallium	mg/kg	-	-	-	-	0.051	0.094	0.060	0.062	0.096	0.062	0.069	0.070	0.062	0.060	0.096	0.015	0.0067	0.019
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	701	776	998	976	1,070	1,030	1,070	1,029	1,030	976	1,070	42.2	18.9	52.4
Uranium	mg/kg	-	-	-	-	0.73	1.26	0.738	0.793	0.986	0.895	0.879	0.86	0.88	0.74	0.99	0.096	0.043	0.12
Vanadium	mg/kg	-	-	-	-	75	65.3	103	91.7	96.2	117	148	111	103	91.7	148	22.7	10.1	28.2
Zinc	mg/kg	123	315	200	380	60.2	67.6	50.9	50.2	67.8	53.8	60.3	56.6	53.8	50.2	67.8	7.42	3.32	9.22

[1] Reported TOC, TN, pH and moisture data are based on bulk sediment. Data < method detection limit (MDL) were used at the MDL for calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

(blue) Value is > TEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

Table E.1: Raw sediment quality data for Hazeltine Creek, Mount Polley Mine, 2014. Metals data are based on the <2mm fraction of sediment [1].

Analyte	Units	BC SQG [2]		CSR [3]		Historic Hazeltine Creek 95th Percentile [4]		Upper Hazeltine Creek (ST16)												
Sample ID		TEL	PEL	Sensitive	Typical	Lower Creek	Upper Creek	ST16-S1	ST16-S2	ST16-S3	ST16-S4	ST16-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								**7-Oct-14**	**7-Oct-14**	**7-Oct-14**	**7-Oct-14**	**7-Oct-14**							
Physical Tests																			
Moisture	%	-	-	-	-	-	-	28.1	19.9	22.9	28.0	28.1	25.4	28.0	19.9	28.1	3.80	1.70	4.72
pH (1:2 soil:water)	pH	-	-	-	-	-	-	8.67	8.76	8.87	9.11	8.96	8.87	8.87	8.67	9.11	0.172	0.077	0.213
Particle Size																			
% Gravel (>2mm)	%	-	-	-	-	-	33	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	-	65	70.7	73.6	65.5	61.4	76.6	69.6	70.7	61.4	76.6	6.13	2.74	7.61
% Silt (0.063mm - 4µm)	%	-	-	-	-	-	76	28.8	26.0	34.1	38.0	23.0	30.0	28.8	23.0	38.0	6.07	2.71	7.53
% Clay (<4µm)	%	-	-	-	-	-	14	0.55	0.46	0.42	0.54	0.38	0.47	0.46	0.38	0.55	0.074	0.033	0.092
Texture	-	-	-	-	-	-	-	Loamy sand	Loamy sand	Loamy sand	Sandy loam	Loamy sand	-	-	-	-	-	-	-
Leachable Anions & Nutrients																			
pH	pH	-	-	-	-	-	-	8.52	8.62	8.60	8.54	8.52	8.56	8.54	8.52	8.62	0.047	0.021	0.058
Anions and Nutrients																			
Total Nitrogen by LECO	%	-	-	-	-	-	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0
Organic / Inorganic Carbon																			
Total Organic Carbon	%	-	-	-	-	9.0	12.8	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Metals																			
Aluminum	mg/kg	-	-	-	-	12,550	18,000	11,200	11,900	11,700	12,500	12,500	11,960	11,900	11,200	12,500	555	248	689
Antimony	mg/kg	-	-	-	-	1.3	0.37	0.31	0.37	0.34	0.40	0.85	0.45	0.37	0.31	0.85	0.22	0.10	0.28
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	10.6	11.4	11.6	11.6	11.7	11.4	11.6	10.6	11.7	0.45	0.20	0.56
Barium	mg/kg	-	-	-	-	104	136	109	105	117	118	98.6	110	109	98.6	118	8.18	3.66	10.2
Beryllium	mg/kg	-	-	-	-	0.30	0.46	0.57	0.50	0.57	0.54	0.94	0.62	0.57	0.50	0.94	0.18	0.080	0.22
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20	0.64	0.29	<0.20	<0.20	0.64	0	0	0
Boron	mg/kg	-	-	-	-	3.0	5.4	<10	<10	<10	<10	10	10	<10	<10	10	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	0.131	0.164	0.136	0.167	0.180	0.156	0.164	0.131	0.180	0.0211	0.0094	0.0262
Calcium	mg/kg	-	-	-	-	7,030	13,400	24,100	24,000	25,800	25,600	22,700	24,440	24,100	22,700	25,800	1,278	571	1,586
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	8.90	10.6	11.2	11.4	9.56	10.3	10.6	8.90	11.4	1.07	0.480	1.33
Cobalt	mg/kg	-	-	-	-	11.0	10.4	12.5	13.2	14.6	14.3	13.4	13.6	13.4	12.5	14.6	0.851	0.381	1.06
Copper	mg/kg	35.7	197	120	240	42.0	94.6	877	988	964	895	1,230	**991**	**964**	**877**	**1,230**	141	63.3	176
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	48,700	52,400	62,900	62,300	49,900	**55,240**	**52,400**	**48,700**	**62,900**	6,853	3,065	8,508
Lead	mg/kg	35	91	57	110	5.6	6.7	4.36	4.51	5.70	4.93	6.41	5.18	4.93	4.36	6.41	0.861	0.385	1.07
Lithium	mg/kg	-	-	-	-	12.9	14.8	12.0	12.8	13.6	13.0	12.9	12.9	12.9	12.0	13.6	0.573	0.256	0.711
Magnesium	mg/kg	-	-	-	-	6,160	6,430	6,760	7,390	7,200	8,000	7,660	7,402	7,390	6,760	8,000	468	209	581
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	511	554	553	569	569	551	554	511	569	23.8	10.6	29.5
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.140	0.145	0.0993	0.108	0.0972	0.101	0.104	0.102	0.101	0.0972	0.108	0.00422	0.00189	0.00524
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	6.04	4.63	5.05	4.24	5.46	5.08	5.05	4.24	6.04	0.703	0.314	0.872
Nickel	mg/kg	16	75	-	-	24	24	6.15	6.63	6.62	6.84	6.57	6.56	6.62	6.15	6.84	0.253	0.113	0.314
Phosphorus	mg/kg	-	-	-	-	729	1,380	1,240	1,290	1,490	1,390	1,190	1,320	1,290	1,190	1,490	120	53.9	149
Potassium	mg/kg	-	-	-	-	910	1,450	850	850	880	940	880	880	880	850	940	36.7	16.4	45.6
Selenium	mg/kg	2	-	-	-	1.3	3.3	1.04	1.04	1.11	1.10	1.15	1.09	1.10	1.04	1.15	0.048	0.021	0.059
Silver	mg/kg	0.5	-	-	-	0.10	0.16	0.44	0.46	0.47	0.44	0.61	0.48	0.46	0.44	**0.61**	0.072	0.032	0.089
Sodium	mg/kg	-	-	-	-	253	350	720	700	690	740	770	724	720	690	770	32.1	14.4	39.8
Strontium	mg/kg	-	-	-	-	67	118	98	99	104	102	90	98.6	99.1	90.0	104	5.37	2.40	6.67
Thallium	mg/kg	-	-	-	-	0.051	0.094	<0.050	<0.050	<0.050	<0.050	0.291	0.098	<0.050	<0.050	0.291	0.11	0.048	0.13
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	701	776	983	1,060	1,040	1,150	1,070	1,061	1,060	983	1,150	60.3	27.0	74.8
Uranium	mg/kg	-	-	-	-	0.73	1.26	0.792	0.876	0.898	0.881	0.972	0.88	0.88	0.79	0.97	0.0642	0.0287	0.0797
Vanadium	mg/kg	-	-	-	-	75	65.3	186	206	242	244	203	216	206	186	244	25.6	11.5	31.8
Zinc	mg/kg	123	315	200	380	60.2	67.6	50.5	57.2	54.5	52.2	53.2	53.5	53.2	50.5	57.2	2.52	1.13	3.13

[1] Reported TOC, TN, pH and moisture data are based on bulk sediment. Data < method detection limit (MDL) were used at the MDL for calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

(blue) Value is > TEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

Table E.2: Raw sediment quality data for Hazeltine Creek, Mount Polley Mine, 2014. Data are based on the <63µm fraction of sediment [1].

Analyte	Units	BC SQG [2]		CSR [3]		Historic Hazeltine Creek 95th Percentile [4]		Lower Hazeltine Creek (ST02)												
Sample ID		TEL	PEL	Sensitive	Typical	Lower Creek	Upper Creek	ST02-S1	ST02-S2	ST02-S3	ST02-S4	ST02-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14							
Physical Tests																			
pH (1:2 soil:water)	pH							8.64	8.64	8.48	8.33	8.68	8.55	8.64	8.33	8.68	0.147	0.066	0.182
Organic / Inorganic Carbon																			
Total Organic Carbon	%	-	-			9.0	12.8	0.10	0.10	0.12	0.16	<0.10	0.12	0.10	<0.10	0.16	0.026	0.012	0.032
Metals																			
Aluminum	mg/kg	-	-	-	-	12,550	18,000	13,300	15,100	16,800	17,600	20,800	16,720	16,800	13,300	20,800	2,817	1,260	3,498
Antimony	mg/kg	-	-	-	-	1.3	0.37	0.37	0.32	0.41	0.47	0.44	0.40	0.41	0.32	0.47	0.059	0.026	0.073
Arsenic	mg/kg	5.9	17	11	20	12	8.2	12.4	8.68	10.3	12.1	15.0	11.7	**12.1**	8.68	**15.0**	2.38	1.06	2.95
Barium	mg/kg	-	-	-	-	104	136	134	109	143	184	259	166	143	109	259	58.7	26.2	72.9
Beryllium	mg/kg	-	-	-	-	0.30	0.46	0.41	0.33	0.49	0.53	0.70	0.49	0.49	0.33	0.70	0.14	0.062	0.17
Bismuth	mg/kg	-	-	-	-	20	16	0.11	0.11	0.13	0.11	<0.10	0.11	0.11	<0.10	0.13	0.011	0.0049	0.014
Boron	mg/kg	-	-	-	-	3.0	5.4	<10	<10	<10	<10	11	10	<10	<10	11	0.45	0.20	0.56
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	0.182	0.233	0.209	0.187	0.143	0.191	0.187	0.143	0.233	0.0335	0.0150	0.0416
Calcium	mg/kg	-	-	-	-	7,030	13,400	27,700	23,600	28,200	28,600	31,300	27,880	28,200	23,600	31,300	2,769	1,238	3,438
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	31.2	36.2	31.8	28.0	14.6	28.4	31.2	14.6	36.2	8.23	3.68	10.2
Cobalt	mg/kg	-	-	-	-	11	10	18.8	14.2	16.7	19.5	22.6	18.4	18.8	14.2	22.6	3.14	1.41	3.90
Copper	mg/kg	35.7	197	120	240	42.0	94.6	394	178	307	513	851	**449**	**394**	**178**	**851**	256	115	318
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	89,000	46,100	57,200	68,400	69,200	**65,980**	**68,400**	**46,100**	**89,000**	15,957	7,136	19,810
Lead	mg/kg	35	91	57	110	5.6	6.7	7.75	6.97	8.26	7.58	7.09	7.53	7.58	6.97	8.26	0.522	0.234	0.648
Lithium	mg/kg	-	-	-	-	12.9	14.8	12.6	14.0	20.0	17.0	17.8	16.3	17.0	12.6	20.0	2.98	1.33	3.69
Magnesium	mg/kg	-	-	-	-	6,160	6,430	8,300	8,940	10,400	10,800	13,700	10,428	10,400	8,300	13,700	2,097	938	2,603
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	632	549	633	725	839	676	633	549	839	111	49.4	137
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.140	0.145	0.0660	0.0468	0.0572	0.0732	0.0832	0.0653	0.0660	0.0468	0.0832	0.0141	0.0063	0.0175
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	2.31	1.17	1.92	2.70	4.10	2.44	2.31	1.17	4.10	1.09	0.486	1.35
Nickel	mg/kg	16	75	-	-	24	24	21.0	30.8	27.7	21.9	11.0	22.5	21.9	11.0	**30.8**	7.60	3.40	9.43
Phosphorus	mg/kg	-	-	-	-	729	1,380	1,670	1,230	1,360	1,510	1,880	1,530	1,510	1,230	1,880	256	114	317
Potassium	mg/kg	-	-	-	-	910	1,450	1,180	1,320	1,470	1,560	2,140	1,534	1,470	1,180	2,140	368	165	457
Selenium	mg/kg	2	-	-	-	1.3	3.3	0.98	0.58	0.68	0.99	1.20	0.89	0.98	0.58	1.20	0.25	0.11	0.31
Silver	mg/kg	0.5	-	-	-	0.10	0.16	0.251	0.119	0.197	0.273	0.378	0.244	0.251	0.119	0.378	0.096	0.043	0.119
Sodium	mg/kg	-	-	-	-	253	350	520	390	540	780	1,360	718	540	390	1,360	386	172	479
Strontium	mg/kg	-	-	-	-	67	118	131	132	148	150	164	145	148	131	164	13.8	6.16	17.1
Thallium	mg/kg	-	-	-	-	0.05	0.094	0.053	0.066	0.081	0.051	<0.050	0.060	0.053	<0.050	0.081	0.013	0.0059	0.017
Tin	mg/kg	-	-	-	-	1.1	0.70	1.02	0.59	0.81	1.14	1.87	1.09	1.02	0.59	1.87	0.49	0.22	0.60
Titanium	mg/kg	-	-	-	-	701	776	1,320	993	1,050	1,370	1,810	1,309	1,320	993	1,810	325	145	403
Uranium	mg/kg	-	-	-	-	0.73	1.26	1.14	0.808	0.997	1.06	1.24	1.05	1.06	0.808	1.24	0.163	0.073	0.202
Vanadium	mg/kg	-	-	-	-	74.5	65.3	329	131	176	244	266	229	244	131	329	77.5	34.6	96.2
Zinc	mg/kg	123	315	200	380	60.2	67.6	65.2	63.3	68.9	68.9	74.5	68.2	68.9	63.3	74.5	4.29	1.92	5.33

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

Values is > TEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

Value is > PEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

Table E.2: Raw sediment quality data for Hazeltine Creek, Mount Polley Mine, 2014. Data are based on the <63µm fraction of sediment [1].

Analyte	Units	BC SQG [2]		CSR [3]		Historic Hazeltine Creek 95th Percentile [4]		Mid Hazeltine Creek (ST09)											
Sample ID		TEL	PEL	Sensitive	Typical	Lower Creek	Upper Creek	ST09-S1	ST09-S2	ST09-S3	ST09-S4	ST09-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14							
Physical Tests																			
pH (1:2 soil:water)	pH							8.63	8.48	8.47	8.55	8.54	8.53	8.54	8.47	8.63	0.064	0.029	0.080
Organic / Inorganic Carbon																			
Total Organic Carbon	%	-	-			9.0	12.8	0.12	0.11	0.19	0.16	0.19	0.15	0.16	0.11	0.19	0.038	0.017	0.047
Metals																			
Aluminum	mg/kg	-	-	-	-	12,550	18,000	13,900	14,000	17,400	13,200	15,600	14,820	14,000	13,200	17,400	1,689	755	2,097
Antimony	mg/kg	-	-	-	-	1.3	0.37	0.40	0.31	0.36	0.31	0.35	0.35	0.35	0.31	0.40	0.038	0.017	0.047
Arsenic	mg/kg	5.9	17	11	20	12	8.2	7.49	7.30	7.59	7.29	8.32	7.60	7.49	7.29	8.32	0.42	0.19	0.53
Barium	mg/kg	-	-	-	-	104	136	92.1	94.2	111	89.2	113	100	94.2	89.2	113	11.2	5.01	13.9
Beryllium	mg/kg	-	-	-	-	0.30	0.46	0.35	0.36	0.36	0.31	0.38	0.35	0.36	0.31	0.38	0.026	0.012	0.032
Bismuth	mg/kg	-	-	-	-	20	16	0.13	0.11	0.14	0.12	0.12	0.12	0.12	0.11	0.14	0.011	0.0051	0.014
Boron	mg/kg	-	-	-	-	3.0	5.4	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	0.192	0.175	0.177	0.191	0.194	0.186	0.191	0.175	0.194	0.00904	0.00404	0.0112
Calcium	mg/kg	-	-	-	-	7,030	13,400	30,500	28,800	28,500	28,200	28,600	28,920	28,600	28,200	30,500	909	407	1,129
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	32.6	29.6	35.8	30.4	31.6	32.0	31.6	29.6	35.8	2.41	1.08	2.99
Cobalt	mg/kg	-	-	-	-	11	10	13.6	12.5	14.4	12.9	14.5	13.6	13.6	12.5	14.5	0.887	0.397	1.10
Copper	mg/kg	35.7	197	120	240	42.0	94.6	152	172	152	158	227	**172**	**158**	**152**	**227**	31.7	14.2	39.4
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	45,000	40,200	42,800	44,100	47,800	**43,980**	**44,100**	**40,200**	**47,800**	2,799	1,252	3,474
Lead	mg/kg	35	91	57	110	5.6	6.7	7.68	7.49	8.31	7.07	7.72	7.65	7.68	7.07	8.31	0.448	0.200	0.556
Lithium	mg/kg	-	-	-	-	12.9	14.8	16.9	15.3	21.7	14.9	18.4	17.4	16.9	14.9	21.7	2.76	1.23	3.42
Magnesium	mg/kg	-	-	-	-	6,160	6,430	8,390	8,120	9,940	8,100	9,160	8,742	8,390	8,100	9,940	796	356	988
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	515	493	559	485	541	519	515	485	559	31.3	14.0	38.9
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.140	0.145	0.0375	0.0377	0.0392	0.0381	0.0445	0.0394	0.0381	0.0375	0.0445	0.00293	0.00131	0.00363
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	1.22	1.31	1.21	0.96	1.42	1.22	1.22	0.96	1.42	0.17	0.076	0.21
Nickel	mg/kg	16	75	-	-	24	24	28.3	26.1	32.6	25.5	27.5	**28.0**	**27.5**	**25.5**	**32.6**	2.80	1.25	3.48
Phosphorus	mg/kg	-	-	-	-	729	1,380	1,170	1,140	1,030	1,180	1,190	1,142	1,170	1,030	1,190	65.3	29.2	81.1
Potassium	mg/kg	-	-	-	-	910	1,450	1,250	1,280	1,600	1,160	1,420	1,342	1,280	1,160	1,600	172	76.8	213
Selenium	mg/kg	2	-	-	-	1.3	3.3	0.43	0.41	0.40	0.46	0.52	0.44	0.43	0.40	0.52	0.048	0.022	0.060
Silver	mg/kg	0.5	-	-	-	0.10	0.16	0.141	0.159	0.129	0.134	0.176	0.148	0.141	0.129	0.176	0.0194	0.0087	0.0241
Sodium	mg/kg	-	-	-	-	253	350	330	370	360	290	410	352	360	290	410	44.9	20.1	55.8
Strontium	mg/kg	-	-	-	-	67	118	169	152	160	153	158	158	158	152	169	6.80	3.04	8.45
Thallium	mg/kg	-	-	-	-	0.05	0.094	0.072	0.072	0.098	0.069	0.078	0.078	0.072	0.069	0.098	0.012	0.0053	0.015
Tin	mg/kg	-	-	-	-	1.1	0.70	0.59	0.79	0.58	0.48	0.76	0.64	0.59	0.48	0.79	0.13	0.059	0.16
Titanium	mg/kg	-	-	-	-	701	776	953	949	1,060	881	1,030	975	953	881	1,060	71.1	31.8	88.3
Uranium	mg/kg	-	-	-	-	0.73	1.26	0.854	0.872	0.899	0.839	0.899	0.873	0.872	0.839	0.899	0.027	0.012	0.033
Vanadium	mg/kg	-	-	-	-	74.5	65.3	124	111	100	125	138	120	124	100	138	14.54	6.50	18.0
Zinc	mg/kg	123	315	200	380	60.2	67.6	59.0	55.0	67.8	54.9	62.0	59.7	59.0	54.9	67.8	5.40	2.41	6.70

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

Values is > TEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

Value is > PEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

Table E.2: Raw sediment quality data for Hazeltine Creek, Mount Polley Mine, 2014. Data are based on the <63µm fraction of sediment [1].

Analyte	Units	BC SQG [2]		CSR [3]		Historic Hazeltine Creek 95th Percentile [4]		Upper Hazeltine Creek (ST16)											
Sample ID		TEL	PEL	Sensitive	Typical	Lower Creek	Upper Creek	ST16-S1	ST16-S2	ST16-S3	ST16-S4	ST16-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14							
Physical Tests																			
pH (1:2 soil:water)	pH							8.48	8.63	8.80	8.73	8.63	8.65	8.63	8.48	8.80	0.121	0.054	0.150
Organic / Inorganic Carbon																			
Total Organic Carbon	%	-	-			9.0	12.8	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Metals																			
Aluminum	mg/kg	-	-	-	-	12,550	18,000	10,400	10,600	10,800	11,000	10,300	10,620	10,600	10,300	11,000	286	128	356
Antimony	mg/kg	-	-	-	-	1.3	0.37	0.27	0.33	0.32	0.29	0.33	0.31	0.32	0.27	0.33	0.027	0.012	0.033
Arsenic	mg/kg	5.9	17	11	20	12	8.2	14.9	14.5	14.8	13.9	15.3	**14.7**	**14.8**	**13.9**	**15.3**	0.52	0.23	0.65
Barium	mg/kg	-	-	-	-	104	136	112	107	104	121	102	109	107	102	121	7.60	3.40	9.43
Beryllium	mg/kg	-	-	-	-	0.30	0.46	0.44	0.48	0.47	0.50	0.49	0.48	0.48	0.44	0.50	0.023	0.010	0.029
Bismuth	mg/kg	-	-	-	-	20	16	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Boron	mg/kg	-	-	-	-	3.0	5.4	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	0.157	0.154	0.174	0.162	0.153	0.160	0.157	0.153	0.174	0.00857	0.00383	0.0106
Calcium	mg/kg	-	-	-	-	7,030	13,400	26,400	27,900	28,000	27,400	28,100	27,560	27,900	26,400	28,100	702	314	872
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	21.8	23.0	23.1	20.6	25.6	22.8	23.0	20.6	25.6	1.86	0.831	2.31
Cobalt	mg/kg	-	-	-	-	11	10	23.9	23.9	24.6	21.6	25.8	24.0	23.9	21.6	25.8	1.53	0.685	1.90
Copper	mg/kg	35.7	197	120	240	42.0	94.6	678	670	677	664	748	**687**	**677**	**664**	**748**	34.3	15.4	42.6
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	135,000	140,000	142,000	124,000	153,000	**138,800**	**140,000**	**124,000**	**153,000**	10,569	4,727	13,121
Lead	mg/kg	35	91	57	110	5.6	6.7	6.00	6.23	6.46	6.26	6.69	6.33	6.26	6.00	6.69	0.260	0.116	0.323
Lithium	mg/kg	-	-	-	-	12.9	14.8	10.6	11.9	12.3	12.1	12.3	11.8	12.1	10.6	12.3	0.713	0.319	0.885
Magnesium	mg/kg	-	-	-	-	6,160	6,430	6,640	6,380	6,420	6,840	6,580	6,572	6,580	6,380	6,840	185	82.6	229
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	622	633	628	601	644	626	628	601	644	15.9	7.13	19.8
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.140	0.145	0.0794	0.0780	0.0772	0.0760	0.0742	0.0770	0.0772	0.0742	0.0794	0.00198	0.00088	0.00245
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	5.19	4.49	4.72	4.22	4.69	4.66	4.69	4.22	5.19	0.356	0.159	0.442
Nickel	mg/kg	16	75	-	-	24	24	10.9	10.8	11.0	10.4	12.3	11.1	10.9	10.4	12.3	0.719	0.322	0.893
Phosphorus	mg/kg	-	-	-	-	729	1,380	2,620	2,290	2,440	2,340	2,520	2,442	2,440	2,290	2,620	133	59.7	166
Potassium	mg/kg	-	-	-	-	910	1,450	750	780	810	840	790	794	790	750	840	33.6	15.0	41.7
Selenium	mg/kg	2	-	-	-	1.3	3.3	1.36	1.43	1.40	1.19	1.52	1.38	1.40	1.19	1.52	0.121	0.054	0.151
Silver	mg/kg	0.5	-	-	-	0.10	0.16	0.415	0.470	0.430	0.393	0.522	0.446	0.430	0.393	**0.522**	0.0509	0.0228	0.0632
Sodium	mg/kg	-	-	-	-	253	350	530	540	560	590	540	552	540	530	590	23.9	10.7	29.6
Strontium	mg/kg	-	-	-	-	67	118	85	83	86	90	85	85.7	84.6	83.3	90.4	2.8	1.2	3.4
Thallium	mg/kg	-	-	-	-	0.05	0.094	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	1.1	0.70	1.03	1.23	1.12	1.17	1.12	1.13	1.12	1.03	1.23	0.0737	0.0330	0.0915
Titanium	mg/kg	-	-	-	-	701	776	1,010	1,090	1,060	1,090	1,040	1,058	1,060	1,010	1,090	34.2	15.3	42.5
Uranium	mg/kg	-	-	-	-	0.73	1.26	0.984	1.07	1.05	0.985	1.09	1.04	1.05	0.98	1.09	0.049	0.022	0.061
Vanadium	mg/kg	-	-	-	-	74.5	65.3	529	534	552	475	622	542	534	475	622	53.0	23.7	65.8
Zinc	mg/kg	123	315	200	380	60.2	67.6	69.8	69.6	69.6	67.5	74.1	70.1	69.6	67.5	74.1	2.42	1.08	3.00

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

(Blue) Values is > TEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

(Orange) Value is > PEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

Table E.3: PCA results displaying; eigen value, percent variance explained, Monte Carlo randomization p-values of axis significance, and station scores for < 2mm sediment from Hazeltine Creek sampling stations, Mount Polley Mine, 2014. Data were Log (X+1) transformed prior to analysis [a].

	Axis 1	Axis 2
Eigenvalue	14.0	9.8
% Variance explained	46.6	32.7
Monte Carlo p	0.0001	0.0001
ST-02-S1	-1.7	1.05
ST-02-S2	2.6	0.23
ST-02-S3	1.5	-4.2
ST-02-S4	-0.31	-3.4
ST-02-S5	-2.6	-7.5
ST-09-S1	4.1	3.3
ST-09-S2	4.2	3.5
ST-09-S3	5.7	-2.2
ST-09-S4	3.9	1.1
ST-09-S5	3.0	-0.35
ST-16-S1	-3.7	3.7
ST-16-S2	-3.6	1.9
ST-16-S3	-3.9	1.2
ST-16-S4	-3.7	0.68
ST-16-S5	-5.5	0.92

[a] Boron and tin were omitted from PCA calculations due to a lack of variability in the data set (all values for each analyte were the same).

Table E.4: PCA axis scores Spearman correlation with sediment metal concentrations (A) and sediment physical characteristics (B) for Hazeltine Creek sediment (< 2mm fraction), Mount Polley Mine, 2014. Data were Log_{10} (X+1) transformed prior to analysis.

A)

Metal	Spearman Correlation Coefficient [a]		P-Value [b]	
	PCA Axis-1 (46.6%)	PCA Axis-2 (32.7%)	PCA Axis-1 (46.6%)	PCA Axis-2 (32.7%)
Aluminum	0.536	-0.799	0.039	0.000
Antimony	-0.284	-0.693	0.306	0.004
Arsenic	-0.877	-0.352	0.000	0.198
Barium	-0.248	-0.781	0.372	0.001
Beryllium	-0.822	-0.309	0.000	0.263
Bismuth	-0.433	0.000	0.107	1.000
Cadmium	0.343	-0.646	0.211	0.009
Calcium	0.657	-0.585	0.008	0.022
Chromium	0.835	-0.454	0.000	0.089
Cobalt	-0.377	-0.761	0.166	0.001
Copper	-0.932	0.000	0.000	1.000
Iron	-0.771	-0.246	0.001	0.376
Lead	0.629	-0.486	0.012	0.066
Lithium	0.689	-0.661	0.004	0.007
Magnesium	0.300	-0.911	0.277	0.000
Manganese	-0.535	-0.719	0.040	0.003
Mercury	-0.846	-0.046	0.000	0.869
Molybdenum	-0.911	0.043	0.000	0.879
Nickel	0.857	-0.450	0.000	0.092
Phosphorus	-0.750	-0.271	0.001	0.328
Potassium	0.572	-0.798	0.026	0.000
Selenium	-0.935	-0.095	0.000	0.737
Silver	-0.978	0.104	0.000	0.713
Sodium	-0.804	-0.236	0.000	0.398
Strontium	0.663	-0.654	0.007	0.008
Thallium	0.434	-0.318	0.106	0.249
Titanium	-0.215	-0.900	0.441	0.000
Uranium	-0.100	-0.857	0.723	0.000
Vanadium	-0.911	-0.029	0.000	0.919
Zinc	0.130	-0.831	0.643	0.000

[a] Highlighted cells indicate Spearman correlation coefficient > 0.7 or < -0.7.

[b] Highlighted cells indicate Spearman correlation with p value < 0.1.

B)

Physical Characteristic	Spearman Correlation		P-Value	
	PCA Axis-1 (46.6%)	PCA Axis-2 (32.7%)	PCA Axis-1 (46.6%)	PCA Axis-2 (32.7%)
% Sand	-0.814	0.500	0.000	0.058
% Silt	0.832	-0.446	0.000	0.095
% Clay	0.682	-0.679	0.005	0.005
Total Organic Carbon	0.806	-0.146	0.000	0.604

Table E.5: PCA results displaying; eigen value, percent variance explained, Monte Carlo randomization p-values of axis significance, and station scores for < 63µm sediment from Hazeltine Creek sampling stations, Mount Polley Mine, 2014. Data were Log (X+1) transformed prior to analysis.

	Axis 1	Axis 2
Eigenvalue	19.3	8.6
% Variance explained	60.3	26.9
Monte Carlo p	0.0001	0.0001
ST-02-S1	-0.78	-0.48
ST-02-S2	4.0	1.5
ST-02-S3	2.4	-2.4
ST-02-S4	-1.0	-3.7
ST-02-S5	-5.2	-8.0
ST-09-S1	5.0	0.26
ST-09-S2	4.3	1.1
ST-09-S3	5.5	-1.4
ST-09-S4	4.9	2.1
ST-09-S5	3.8	-0.49
ST-16-S1	-4.7	3.1
ST-16-S2	-4.8	2.1
ST-16-S3	-4.5	2.1
ST-16-S4	-4.1	2.0
ST-16-S5	-5.0	2.0

Table E.6: PCA axis scores Spearman correlation with sediment metal concentrations (A) and sediment physical characteristics (B) for Hazeltine Creek sediment (< 63µm fraction), Mount Polley Mine, 2014. Data were Log_{10} (X+1) transformed prior to analysis.

A)

Metal	Spearman Correlation Coefficient [a]		P-Value [b]	
	PCA Axis-1 (60.3%)	PCA Axis-2 (26.9%)	PCA Axis-1 (60.3%)	PCA Axis-2 (26.9%)
Aluminum	0.354	-0.904	0.196	0.000
Antimony	0.004	-0.840	0.990	0.000
Arsenic	-0.946	0.179	0.000	0.524
Barium	-0.382	-0.639	0.160	0.010
Beryllium	-0.791	-0.293	0.000	0.289
Bismuth	0.882	-0.466	0.000	0.080
Boron	-0.433	-0.433	0.107	0.107
Cadmium	0.743	-0.271	0.002	0.328
Calcium	0.242	-0.617	0.386	0.014
Chromium	0.825	-0.293	0.000	0.289
Cobalt	-0.903	0.277	0.000	0.318
Copper	-0.988	0.191	0.000	0.495
Iron	-0.882	0.396	0.000	0.143
Lead	0.607	-0.779	0.016	0.001
Lithium	0.524	-0.831	0.045	0.000
Magnesium	0.311	-0.918	0.260	0.000
Manganese	-0.786	-0.309	0.001	0.262
Mercury	-0.932	0.189	0.000	0.499
Molybdenum	-0.879	0.343	0.000	0.211
Nickel	0.826	-0.445	0.000	0.096
Phosphorus	-0.900	0.450	0.000	0.092
Potassium	0.371	-0.914	0.173	0.000
Selenium	-0.946	0.375	0.000	0.168
Silver	-0.904	0.343	0.000	0.211
Sodium	-0.832	-0.183	0.000	0.514
Strontium	0.604	-0.657	0.017	0.008
Thallium	0.869	-0.469	0.000	0.078
Tin	-0.902	-0.023	0.000	0.934
Titanium	-0.574	-0.440	0.025	0.101
Uranium	-0.795	-0.223	0.000	0.423
Vanadium	-0.896	0.432	0.000	0.108
Zinc	-0.848	0.013	0.000	0.965

[a] Highlighted cells indicate Spearman correlation coefficient > 0.7 or < -0.7.
[b] Highlighted cells indicate Spearman correlation with p value < 0.1.

B)

Physical Characteristic	Spearman Correlation		P-Value	
	PCA Axis-1 (60.3%)	PCA Axis-2 (26.9%)	PCA Axis-1 (60.3%)	PCA Axis-2 (26.9%)
% Silt	0.793	-0.596	0.000	0.019
% Clay	0.493	-0.789	0.062	0.000
Total Organic Carbon	0.707	-0.443	0.003	0.098

Table E.7: Raw selectively extracted (Tessier extraction) metals data for sediment from Hazeltine Creek, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Analyte	Units	BC WSQG [2]		CSR [3]		Historic Hazeltine Creek 95th Percentile [4] (total metal concentration)		Lower Hazeltine Creek (ST02)											
Sample ID		TEL	PEL	Sensitive	Typical	Lower Creek	Upper Creek	ST02-S1	ST02-S2	ST02-S3	ST02-S4	ST02-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14							
Exchangeable & Adsorbed Metals																			
Aluminum	mg/kg	-	-	-	-	12,550	18,000	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Antimony	mg/kg	-	-	-	-	1.3	0.37	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	0.056	<0.050	<0.050	0.052	<0.050	0.052	<0.050	<0.050	0.056	0.0026	0.0012	0.0032
Barium	mg/kg	-	-	-	-	104	136	<20	<21	<25	<27	<34	<34	<25	<20	<34	5.6	2.5	6.9
Beryllium	mg/kg	-	-	-	-	0.30	0.46	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Calcium	mg/kg	-	-	-	-	7,030	13,400	873	1,060	1,270	1,280	1,300	1,157	1,270	873	1,300	186	83.2	231
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Cobalt	mg/kg	-	-	-	-	11.0	10.4	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Copper	mg/kg	35.7	197	120	240	42.0	94.6	2.44	1.09	2.24	4.57	5.32	3.13	2.44	1.09	5.32	1.75	0.784	2.18
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Lead	mg/kg	35	91	57	110	5.6	6.7	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Lithium	mg/kg	-	-	-	-	12.9	14.8	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	10.1	16.5	27.7	27.3	7.6	17.8	16.5	7.60	27.7	9.40	4.20	11.7
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0
Nickel	mg/kg	16	75	-	-	24	24	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Phosphorus	mg/kg	-	-	-	-	729	1,380	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Potassium	mg/kg	-	-	-	-	910	1,450	<100	<100	<100	<100	160	112	<100	<100	160	26.8	12.0	33.3
Selenium	mg/kg	2	-	-	-	1.3	3.3	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	mg/kg	0.5	-	-	-	0.10	0.16	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Sodium	mg/kg	-	-	-	-	253	350	<100	<100	<100	<100	110	102	<100	<100	110	4.47	2.00	5.55
Strontium	mg/kg	-	-	-	-	67.1	118	7.45	7.89	12.0	12.8	18.5	11.7	12.0	7.45	18.5	4.48	2.00	5.56
Thallium	mg/kg	-	-	-	-	0.051	0.094	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	701	776	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0
Uranium	mg/kg	-	-	-	-	0.73	1.26	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Vanadium	mg/kg	-	-	-	-	75	65	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Zinc	mg/kg	123	315	200	380	60.2	67.6	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0
Carbonate Metals																			
Aluminum	mg/kg	-	-	-	-	12,550	18,000	<50	<50	<50	<50	69	54	<50	<50	69	8.5	3.8	11
Antimony	mg/kg	-	-	-	-	1.3	0.37	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	0.058	<0.050	0.068	0.084	0.075	0.067	0.068	<0.050	0.084	0.013	0.0060	0.017
Barium	mg/kg	-	-	-	-	104	136	17.1	16.3	26.2	29.4	37.5	25.3	26.2	16.3	37.5	8.87	3.97	11.0
Beryllium	mg/kg	-	-	-	-	0.30	0.46	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Calcium	mg/kg	-	-	-	-	7,030	13,400	11,400	7,980	14,000	11,600	11,000	11,196	11,400	7,980	14,000	2,148	960	2,666
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Cobalt	mg/kg	-	-	-	-	11.0	10.4	0.16	<0.10	0.24	0.24	0.17	0.18	0.17	<0.10	0.24	0.059	0.027	0.074
Copper	mg/kg	35.7	197	120	240	42.0	94.6	36.8	4.05	39.2	66.4	64.5	42.2	39.2	4.05	66.4	25.4	11.4	31.5
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	104	<50	100	109	91	90.8	100	<50	109	23.7	10.6	29.5
Lead	mg/kg	35	91	57	110	5.6	6.7	0.81	<0.50	1.01	1.03	0.74	0.82	0.81	<0.50	1.03	0.22	0.10	0.27
Lithium	mg/kg	-	-	-	-	12.9	14.8	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	76.9	48.1	109	97.1	88.1	83.8	88.1	48.1	109	23.2	10.4	28.8
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Nickel	mg/kg	16	75	-	-	24	24	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Phosphorus	mg/kg	-	-	-	-	729	1,380	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Selenium	mg/kg	2	-	-	-	1.3	3.3	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	mg/kg	0.5	-	-	-	0.10	0.16	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Strontium	mg/kg	-	-	-	-	67	118	37.1	38.8	56.9	44.6	33.5	42.2	38.8	33.5	56.9	9.15	4.09	11.4
Thallium	mg/kg	-	-	-	-	0.051	0.094	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	701	776	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Uranium	mg/kg	-	-	-	-	0.73	1.26	<0.050	<0.050	0.064	0.051	<0.050	0.053	<0.050	<0.050	0.064	0.0062	0.0028	0.0077
Vanadium	mg/kg	-	-	-	-	75	65.3	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Zinc	mg/kg	123	315	200	380	60.2	67.6	<1.0	<1.0	<1.0	1.2	1.0	1.0	<1.0	<1.0	1.2	0.089	0.040	0.11

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

(Blue) Value is > TEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

(Orange) Value is > PEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

Table E.7: Raw selectively extracted (Tessier extraction) metals data for sediment from Hazeltine Creek, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Analyte	Units	BC WSQG [2]		CSR [3]		Historic Hazeltine Creek 95th Percentile [4] (total metal concentration)		Lower Hazeltine Creek (ST02)											
Sample ID		TEL	PEL	Sensitive	Typical	Lower Creek	Upper Creek	ST02-S1	ST02-S2	ST02-S3	ST02-S4	ST02-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14							
Easily Reducible Metals and Iron Oxides																			
Aluminum	mg/kg	-	-	-	-	12,550	18,000	902	657	1,140	1,230	1,460	1,078	1,140	657	1,460	309	138	383
Antimony	mg/kg	-	-	-	-	1.3	0.37	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	0.962	0.550	1.04	1.30	1.68	1.11	1.04	0.55	1.68	0.419	0.187	0.520
Barium	mg/kg	-	-	-	-	104	136	11.7	11.3	18.0	16.9	16.9	15.0	16.9	11.3	18.0	3.19	1.43	3.96
Beryllium	mg/kg	-	-	-	-	0.30	0.46	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	0.054	0.086	0.063	<0.050	0.056	0.062	0.056	<0.050	0.086	0.014	0.0064	0.018
Calcium	mg/kg	-	-	-	-	7,030	13,400	1,520	7,800	1,890	1,720	1,460	2,878	1,720	1,460	7,800	2,757	1,233	3,422
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	1.87	2.40	2.70	2.55	1.67	2.24	2.40	1.67	2.70	0.446	0.199	0.553
Cobalt	mg/kg	-	-	-	-	11.0	10.4	1.42	2.55	2.60	2.12	1.26	1.99	2.12	1.26	2.60	0.625	0.279	0.775
Copper	mg/kg	35.7	197	120	240	42.0	94.6	55.1	37.6	73.4	105	136	81.4	73.4	37.6	**136**	39.4	17.6	48.9
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	2,410	2,780	3,360	3,180	2,750	2,896	2,780	2,410	3,360	376	168	467
Lead	mg/kg	35	91	57	110	5.6	6.7	1.71	2.98	2.62	2.21	1.86	2.28	2.21	1.71	2.98	0.527	0.236	0.654
Lithium	mg/kg	-	-	-	-	12.9	14.8	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	55.4	130	92.4	84.1	60.1	84.4	84.1	55.4	130	29.9	13.4	37.1
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Nickel	mg/kg	16	75	-	-	24	24	3.09	6.34	5.90	4.32	1.09	4.15	4.32	1.09	6.34	2.14	0.959	2.66
Phosphorus	mg/kg	-	-	-	-	729	1,380	142	58	136	136	149	124	136	58	149	37	17	46
Selenium	mg/kg	2	-	-	-	1.3	3.3	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	mg/kg	0.5	-	-	-	0.10	0.16	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Strontium	mg/kg	-	-	-	-	67	118	13.8	29.8	18.5	18.5	21.6	20.4	18.5	13.8	29.8	5.93	2.65	7.36
Thallium	mg/kg	-	-	-	-	0.051	0.094	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	701	776	1.4	1.3	1.4	1.3	<1.0	1.3	1.3	<1.0	1.4	0.16	0.073	0.20
Uranium	mg/kg	-	-	-	-	0.73	1.26	0.072	0.091	0.101	0.096	0.090	0.090	0.091	0.072	0.101	0.011	0.0049	0.014
Vanadium	mg/kg	-	-	-	-	75	65.3	5.93	4.88	7.23	7.99	8.78	6.96	7.23	4.88	8.78	1.57	0.701	1.95
Zinc	mg/kg	123	315	200	380	60.2	67.6	6.0	7.2	8.6	8.1	6.5	7.3	7.2	6.0	8.6	1.1	0.48	1.3
Organic Bound Metals																			
Aluminum	mg/kg	-	-	-	-	12,550	18,000	593	603	859	877	911	769	859	593	911	157	70.2	195
Antimony	mg/kg	-	-	-	-	1.3	0.37	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	1.40	0.781	0.987	1.15	1.86	1.24	1.15	0.781	1.86	0.416	0.186	0.517
Barium	mg/kg	-	-	-	-	104	136	8.03	7.06	10.7	11.8	14.1	10.3	10.7	7.06	14.1	2.85	1.27	3.54
Beryllium	mg/kg	-	-	-	-	0.30	0.46	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Calcium	mg/kg	-	-	-	-	7,030	13,400	860	1,030	898	927	1,270	997	927	860	1,270	165	73.9	205
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Cobalt	mg/kg	-	-	-	-	11.0	10.4	1.18	1.09	1.37	1.26	1.44	1.27	1.26	1.09	1.44	0.141	0.0630	0.175
Copper	mg/kg	35.7	197	120	240	42.0	94.6	416	260	218	309	606	**362**	**309**	**218**	**606**	155	69.4	193
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	733	362	593	575	782	609	593	362	782	164	73.4	204
Lead	mg/kg	35	91	57	110	5.6	6.7	1.15	0.82	0.89	0.76	1.00	0.92	0.89	0.76	1.15	0.15	0.069	0.19
Lithium	mg/kg	-	-	-	-	12.9	14.8	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	9.1	10.6	13.0	12.7	13.7	11.8	12.7	9.1	13.7	1.9	0.85	2.4
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	0.72	<0.50	<0.50	0.73	1.26	0.74	0.72	<0.50	1.26	0.31	0.14	0.39
Nickel	mg/kg	16	75	-	-	24	24	0.65	0.97	1.10	0.80	<0.50	0.80	0.80	<0.50	1.1	0.24	0.11	0.30
Selenium	mg/kg	2	-	-	-	1.3	3.3	0.50	0.35	0.47	0.56	0.77	0.53	0.50	0.35	0.77	0.15	0.069	0.19
Silver	mg/kg	0.5	-	-	-	0.10	0.16	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Strontium	mg/kg	-	-	-	-	67	118	7.83	8.46	7.69	9.40	11.6	9.00	8.46	7.69	11.6	1.60	0.72	1.99
Thallium	mg/kg	-	-	-	-	0.051	0.094	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	701	776	1.5	1.5	2.0	1.9	1.9	1.8	1.9	1.5	2.0	0.24	0.11	0.30
Uranium	mg/kg	-	-	-	-	0.73	1.26	0.082	0.082	0.095	0.082	0.104	0.089	0.082	0.082	0.104	0.010	0.0045	0.013
Vanadium	mg/kg	-	-	-	-	74.5	65.3	0.80	0.85	1.12	1.12	1.07	0.992	1.07	0.80	1.12	0.15	0.069	0.19
Zinc	mg/kg	123	315	200	380	60.2	67.6	4.5	5.5	4.5	4.3	4.6	4.7	4.5	4.3	5.5	0.47	0.21	0.58

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

(blue) Values is > TEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

Table E.7: Raw selectively extracted (Tessier extraction) metals data for sediment from Hazeltine Creek, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Analyte	Units	BC WSQG [2]		CSR [3]		Historic Hazeltine Creek 95th Percentile [4] (total metal concentration)		Lower Hazeltine Creek (ST02)												
Sample ID		**TEL**	**PEL**	**Sensitive**	**Typical**	**Lower Creek**	**Upper Creek**	**ST02-S1**	**ST02-S2**	**ST02-S3**	**ST02-S4**	**ST02-S5**	**Mean**	**Median**	**Minimum**	**Maximum**	**Standard Deviation**	**Standard Error**	**t*SE**
Date Sampled								**7-Oct-14**	**7-Oct-14**	**7-Oct-14**	**7-Oct-14**	**7-Oct-14**							
Residual Metals																			
Aluminum	mg/kg	-	-	-	-	12,550	18,000	10,100	12,500	13,500	12,900	15,100	12,820	12,900	10,100	15,100	1,814	811	2,252
Antimony	mg/kg	-	-	-	-	1.3	0.37	0.21	0.31	0.27	0.28	0.32	0.28	0.28	0.21	0.32	0.043	0.019	0.054
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	7.81	7.56	7.97	7.39	8.75	7.90	7.81	7.39	8.75	0.527	0.236	0.654
Barium	mg/kg	-	-	-	-	104	136	64.3	67.5	75.5	80.4	106	78.7	75.5	64.3	106	16.5	7.39	20.5
Beryllium	mg/kg	-	-	-	-	0.30	0.46	0.30	0.29	0.29	0.35	0.45	0.34	0.30	0.29	0.45	0.068	0.031	0.085
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Calcium	mg/kg	-	-	-	-	7,030	13,400	8,410	6,860	7,630	8,670	11,800	8,674	8,410	6,860	11,800	1,886	843	2,341
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	16.1	25.1	23.0	16.4	8.60	17.8	16.4	8.60	25.1	6.52	2.91	8.09
Cobalt	mg/kg	-	-	-	-	11.0	10.4	11.0	9.56	11.4	11.3	14.2	11.5	11.3	9.56	14.2	1.68	0.753	2.09
Copper	mg/kg	35.7	197	120	240	42.0	94.6	129	89.8	60.9	79.5	163	**104**	89.8	60.9	**163**	41.1	18.4	51.1
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	50,700	38,900	47,200	41,400	45,000	**44,640**	**45,000**	**38,900**	**50,700**	4,660	2,084	5,785
Lead	mg/kg	35	91	57	110	5.6	6.7	2.37	2.73	2.33	2.02	2.13	2.32	2.33	2.02	2.73	0.272	0.122	0.338
Lithium	mg/kg	-	-	-	-	12.9	14.8	10.8	15.7	15.9	13.8	15.2	14.3	15.2	10.8	15.9	2.11	0.944	2.62
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	355	311	356	381	503	381	356	311	503	72.6	32.5	90.1
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	2.83	1.51	1.89	2.16	2.88	2.25	2.16	1.51	2.88	0.596	0.266	0.739
Nickel	mg/kg	16	75	-	-	24	24	8.9	15.1	14.9	11.0	6.60	11.3	11.0	6.60	15.1	3.72	1.66	4.62
Selenium	mg/kg	2	-	-	-	1.3	3.3	0.41	0.21	0.20	0.22	0.31	0.27	0.22	0.20	0.41	0.090	0.040	0.11
Silver	mg/kg	0.5	-	-	-	0.10	0.16	0.25	0.18	0.15	0.19	0.32	0.22	0.19	0.15	0.32	0.068	0.030	0.084
Strontium	mg/kg	-	-	-	-	67	118	40.3	43.1	44.1	54.6	75.7	51.6	44.1	40.3	75.7	14.5	6.50	18.1
Thallium	mg/kg	-	-	-	-	0.051	0.094	<0.050	0.057	<0.050	<0.050	<0.050	0.051	<0.050	<0.050	0.057	0.0031	0.0014	0.0039
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	701	776	922	993	1,090	1,250	1,730	1,197	1,090	922	1,730	322	144	400
Uranium	mg/kg	-	-	-	-	0.73	1.26	0.543	0.620	0.578	0.597	0.739	0.615	0.597	0.543	0.739	0.0746	0.0334	0.0926
Vanadium	mg/kg	-	-	-	-	74.5	65.3	195	125	165	153	185	165	165	125	195	27.6	12.3	34.2
Zinc	mg/kg	123	315	200	380	60.2	67.6	41.7	49.1	47.7	43.0	49.5	46.2	47.7	41.7	49.5	3.61	1.61	4.48

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

(blue) Values is > TEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

Table E.7: Raw selectively extracted (Tessier extraction) metals data for sediment from Hazeltine Creek, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Analyte	Units	BC WSQG [2]		CSR [3]		Historic Hazeltine Creek 95th Percentile [4] (total metal concentration)		Mid Hazeltine Creek (ST09)											
Sample ID		TEL	PEL	Sensitive	Typical	Lower Creek	Upper Creek	ST09-S1	ST09-S2	ST09-S3	ST09-S4	ST09-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14							
Exchangeable & Adsorbed Metals																			
Aluminum	mg/kg	-	-	-	-	12,550	18,000	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Antimony	mg/kg	-	-	-	-	1.3	0.37	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	<0.050	<0.050	0.057	<0.050	<0.050	0.051	<0.050	<0.050	0.057	0.0031	0.0014	0.0039
Barium	mg/kg	-	-	-	-	104	136	<19	<19	<24	<23	<24	<24	<23	<19	<24	2.6	1.2	3.2
Beryllium	mg/kg	-	-	-	-	0.30	0.46	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Calcium	mg/kg	-	-	-	-	7,030	13,400	1,060	1,020	1,380	1,130	1,240	1,166	1,130	1,020	1,380	146	65.2	181
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Cobalt	mg/kg	-	-	-	-	11.0	10.4	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Copper	mg/kg	35.7	197	120	240	42.0	94.6	0.86	0.88	0.93	1.05	1.39	1.02	0.93	0.86	1.39	0.22	0.098	0.27
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Lead	mg/kg	35	91	57	110	5.6	6.7	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Lithium	mg/kg	-	-	-	-	12.9	14.8	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	19.7	19.9	28.4	20.5	21.9	22.1	20.5	19.7	28.4	3.64	1.63	4.51
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	<1.0	<1.0	<1.0	<0.90	<0.90	<1.0	<1.0	<0.90	<1.0	0.055	0.024	0.068
Nickel	mg/kg	16	75	-	-	24	24	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Phosphorus	mg/kg	-	-	-	-	729	1,380	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Potassium	mg/kg	-	-	-	-	910	1,450	<100	<100	<100	<100	<100	<100	<100	<100	<100	0.0	0.0	0.0
Selenium	mg/kg	2	-	-	-	1.3	3.3	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	mg/kg	0.5	-	-	-	0.10	0.16	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Sodium	mg/kg	-	-	-	-	253	350	<100	<100	<100	<100	<100	<100	<100	<100	<100	0.00	0.00	0.00
Strontium	mg/kg	-	-	-	-	67.1	118	7.78	7.23	10.4	7.52	9.28	8.44	7.78	7.23	10.4	1.35	0.604	1.68
Thallium	mg/kg	-	-	-	-	0.051	0.094	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	701	776	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0
Uranium	mg/kg	-	-	-	-	0.73	1.26	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Vanadium	mg/kg	-	-	-	-	75	65	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Zinc	mg/kg	123	315	200	380	60.2	67.6	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0
Carbonate Metals																			
Aluminum	mg/kg	-	-	-	-	12,550	18,000	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Antimony	mg/kg	-	-	-	-	1.3	0.37	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	<0.050	<0.050	0.073	<0.050	<0.050	0.055	<0.050	<0.050	0.073	0.010	0.0046	0.013
Barium	mg/kg	-	-	-	-	104	136	15.1	15.2	21.1	14.5	18.9	17.0	15.2	14.5	21.1	2.89	1.29	3.59
Beryllium	mg/kg	-	-	-	-	0.30	0.46	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Calcium	mg/kg	-	-	-	-	7,030	13,400	16,700	15,900	18,600	8,090	8,180	13,494	15,900	8,090	18,600	4,989	2,231	6,194
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Cobalt	mg/kg	-	-	-	-	11.0	10.4	0.19	0.18	0.24	<0.10	<0.10	0.16	0.18	<0.10	0.24	0.061	0.027	0.076
Copper	mg/kg	35.7	197	120	240	42.0	94.6	15.7	14.3	13.3	2.98	3.63	10.0	13.3	2.98	15.7	6.16	2.75	7.65
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	112	112	113	<50	<50	87.4	112	<50	113	34.1	15.3	42.4
Lead	mg/kg	35	91	57	110	5.6	6.7	0.97	0.97	1.17	<0.50	<0.50	0.82	0.97	<0.50	1.17	0.31	0.14	0.38
Lithium	mg/kg	-	-	-	-	12.9	14.8	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	94.5	92.8	119	48.4	53.9	81.7	92.8	48.4	119	29.8	13.3	37.0
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Nickel	mg/kg	16	75	-	-	24	24	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Phosphorus	mg/kg	-	-	-	-	729	1,380	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Selenium	mg/kg	2	-	-	-	1.3	3.3	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	mg/kg	0.5	-	-	-	0.10	0.16	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Strontium	mg/kg	-	-	-	-	67	118	80.1	75.0	93.7	39.0	41.2	65.8	75.0	39.0	93.7	24.4	10.9	30.4
Thallium	mg/kg	-	-	-	-	0.051	0.094	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	701	776	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Uranium	mg/kg	-	-	-	-	0.73	1.26	<0.050	<0.050	0.070	<0.050	<0.050	0.054	<0.050	<0.050	0.070	0.0089	0.0040	0.011
Vanadium	mg/kg	-	-	-	-	75	65.3	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Zinc	mg/kg	123	315	200	380	60.2	67.6	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

(blue) Value is > TEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

Table E.7: Raw selectively extracted (Tessier extraction) metals data for sediment from Hazeltine Creek, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Analyte	Units	BC WSQG [2]		CSR [3]		Historic Hazeltine Creek 95th Percentile [4] (total metal concentration)		Mid Hazeltine Creek (ST09)											
Sample ID		TEL	PEL	Sensitive	Typical	Lower Creek	Upper Creek	ST09-S1	ST09-S2	ST09-S3	ST09-S4	ST09-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14							
Easily Reducible Metals and Iron Oxides																			
Aluminum	mg/kg	-	-	-	-	12,550	18,000	828	862	963	596	711	792	828	596	963	142	63.4	176
Antimony	mg/kg	-	-	-	-	1.3	0.37	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	0.615	0.618	0.670	0.523	0.524	0.590	0.615	0.523	0.670	0.0645	0.0289	0.0801
Barium	mg/kg	-	-	-	-	104	136	10.7	10.5	14.1	10.4	13.6	11.9	10.7	10.4	14.1	1.83	0.818	2.27
Beryllium	mg/kg	-	-	-	-	0.30	0.46	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	0.071	0.069	0.068	0.077	0.075	0.072	0.071	0.068	0.077	0.0039	0.0017	0.0048
Calcium	mg/kg	-	-	-	-	7,030	13,400	2,120	2,160	2,180	9,100	8,370	4,786	2,180	2,120	9,100	3,614	1,616	4,487
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	2.30	2.44	2.86	2.20	2.53	2.47	2.44	2.20	2.86	0.254	0.114	0.315
Cobalt	mg/kg	-	-	-	-	11.0	10.4	2.63	2.73	3.79	2.69	3.04	2.98	2.73	2.63	3.79	0.482	0.215	0.598
Copper	mg/kg	35.7	197	120	240	42.0	94.6	30.9	30.5	30.5	31.2	42.2	33.1	30.9	30.5	42.2	5.12	2.29	6.35
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	2,930	3,060	3,770	2,980	3,370	3,222	3,060	2,930	3,770	351	157	436
Lead	mg/kg	35	91	57	110	5.6	6.7	2.35	2.56	3.06	3.69	3.88	3.11	3.06	2.35	3.88	0.673	0.301	0.836
Lithium	mg/kg	-	-	-	-	12.9	14.8	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	75.4	77.8	97.8	116	126	98.6	97.8	75.4	126	22.5	10.1	27.9
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Nickel	mg/kg	16	75	-	-	24	24	8.45	6.66	9.12	6.36	6.90	7.50	6.90	6.36	9.12	1.21	0.543	1.51
Phosphorus	mg/kg	-	-	-	-	729	1,380	95	87	94	<50	<50	75	87	<50	95	23	10	29
Selenium	mg/kg	2	-	-	-	1.3	3.3	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	mg/kg	0.5	-	-	-	0.10	0.16	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Strontium	mg/kg	-	-	-	-	67	118	11.7	12.7	14.2	42.3	37.7	23.7	14.2	11.7	42.3	15.0	6.70	18.6
Thallium	mg/kg	-	-	-	-	0.051	0.094	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	701	776	1.6	1.6	1.4	1.5	1.6	1.5	1.6	1.4	1.6	0.089	0.040	0.11
Uranium	mg/kg	-	-	-	-	0.73	1.26	0.064	0.070	0.089	0.084	0.093	0.080	0.084	0.064	0.093	0.012	0.0056	0.015
Vanadium	mg/kg	-	-	-	-	75	65.3	4.77	4.92	5.94	4.47	5.48	5.12	4.92	4.47	5.94	0.589	0.263	0.731
Zinc	mg/kg	123	315	200	380	60.2	67.6	7.4	7.9	9.6	7.1	7.7	7.9	7.7	7.1	9.6	1.0	0.44	1.2
Organic Bound Metals																			
Aluminum	mg/kg	-	-	-	-	12,550	18,000	651	677	827	550	659	673	659	550	827	99.4	44.5	123
Antimony	mg/kg	-	-	-	-	1.3	0.37	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	0.645	0.990	0.655	0.682	0.436	0.682	0.655	0.436	0.990	0.198	0.0887	0.246
Barium	mg/kg	-	-	-	-	104	136	6.36	6.67	7.11	6.40	8.28	6.96	6.67	6.36	8.28	0.794	0.355	0.986
Beryllium	mg/kg	-	-	-	-	0.30	0.46	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Calcium	mg/kg	-	-	-	-	7,030	13,400	593	1,060	1,190	1,130	868	968	1,060	593	1,190	242	108	301
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	<0.50	<0.50	0.67	<0.50	<0.50	0.53	<0.50	<0.50	0.67	0.076	0.034	0.094
Cobalt	mg/kg	-	-	-	-	11.0	10.4	0.96	0.91	1.09	0.96	1.10	1.0	0.96	0.91	1.10	0.086	0.038	0.11
Copper	mg/kg	35.7	197	120	240	42.0	94.6	199	209	102	189	217	**183**	**199**	**102**	**217**	46.6	20.8	57.8
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	427	402	378	314	355	375	378	314	427	43.5	19.4	54.0
Lead	mg/kg	35	91	57	110	5.6	6.7	0.76	0.83	0.92	0.78	0.85	0.83	0.83	0.76	0.92	0.063	0.028	0.078
Lithium	mg/kg	-	-	-	-	12.9	14.8	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	9.1	9.4	11.6	8.7	9.8	9.7	9.4	8.7	11.6	1.13	0.50	1.40
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.00	0.00	0.00
Nickel	mg/kg	16	75	-	-	24	24	0.93	0.85	1.27	0.73	0.78	0.91	0.85	0.73	1.3	0.21	0.10	0.27
Selenium	mg/kg	2	-	-	-	1.3	3.3	0.27	0.37	0.26	0.27	0.33	0.30	0.27	0.26	0.37	0.048	0.021	0.060
Silver	mg/kg	0.5	-	-	-	0.10	0.16	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Strontium	mg/kg	-	-	-	-	67	118	5.62	7.27	6.09	9.01	9.41	7.48	7.27	5.62	9.41	1.70	0.76	2.11
Thallium	mg/kg	-	-	-	-	0.051	0.094	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	701	776	1.8	1.8	1.6	1.6	1.8	1.7	1.8	1.6	1.8	0.11	0.049	0.14
Uranium	mg/kg	-	-	-	-	0.73	1.26	0.075	0.084	0.085	0.072	0.060	0.075	0.075	0.060	0.085	0.010	0.0046	0.013
Vanadium	mg/kg	-	-	-	-	74.5	65.3	0.82	0.92	1.11	0.78	0.84	0.89	0.84	0.78	1.11	0.13	0.059	0.16
Zinc	mg/kg	123	315	200	380	60.2	67.6	4.1	4.0	4.5	4.0	4.2	4.2	4.1	4.0	4.5	0.21	0.093	0.26

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996).
[4] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

(blue) Values is > TEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.
(orange) Value is > PEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

Table E.7: Raw selectively extracted (Tessier extraction) metals data for sediment from Hazeltine Creek, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Analyte	Units	BC WSQG [2]		CSR [3]		Historic Hazeltine Creek 95th Percentile [4] (total metal concentration)		Mid Hazeltine Creek (ST09)											
Sample ID		TEL	PEL	Sensitive	Typical	Lower Creek	Upper Creek	ST09-S1	ST09-S2	ST09-S3	ST09-S4	ST09-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								**7-Oct-14**	**7-Oct-14**	**7-Oct-14**	**7-Oct-14**	**7-Oct-14**							
Residual Metals																			
Aluminum	mg/kg	-	-	-	-	12,550	18,000	11,100	10,600	14,100	11,900	14,100	12,360	11,900	10,600	14,100	1,655	740	2,054
Antimony	mg/kg	-	-	-	-	1.3	0.37	0.22	0.22	0.27	0.26	0.30	0.25	0.26	0.22	0.30	0.034	0.015	0.043
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	6.08	5.45	5.97	6.14	7.42	6.21	6.08	5.45	7.42	0.728	0.326	0.904
Barium	mg/kg	-	-	-	-	104	136	51.2	55.4	52.0	57.0	74.0	57.9	55.4	51.2	74.0	9.30	4.16	11.5
Beryllium	mg/kg	-	-	-	-	0.30	0.46	0.24	0.25	0.24	0.25	0.29	0.25	0.25	0.24	0.29	0.021	0.0093	0.026
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Calcium	mg/kg	-	-	-	-	7,030	13,400	5,390	4,690	3,960	5,770	6,790	5,320	5,390	3,960	6,790	1,074	480	1,333
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	21.3	20.1	31.0	22.9	26.1	24.3	22.9	20.1	31.0	4.38	1.96	5.44
Cobalt	mg/kg	-	-	-	-	11.0	10.4	7.87	7.47	8.96	7.94	9.83	8.41	7.94	7.47	9.83	0.96	0.43	1.20
Copper	mg/kg	35.7	197	120	240	42.0	94.6	52.1	54.1	36.2	57.7	67.1	53.4	54.1	36.2	67.1	11.2	5.02	13.9
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	33,100	29,000	36,300	33,500	39,600	34,300	33,500	29,000	**39,600**	3,945	1,764	4,898
Lead	mg/kg	35	91	57	110	5.6	6.7	2.12	2.06	2.48	2.34	2.59	2.32	2.34	2.06	2.59	0.227	0.102	0.282
Lithium	mg/kg	-	-	-	-	12.9	14.8	13.5	13.8	20.1	14.2	17.6	15.8	14.2	13.5	20.1	2.90	1.30	3.60
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	260	245	282	263	319	274	263	245	319	28.5	12.7	35.4
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	1.52	1.38	1.15	1.32	1.65	1.40	1.38	1.15	1.65	0.191	0.085	0.237
Nickel	mg/kg	16	75	-	-	24	24	13.2	13.0	20.3	13.7	15.8	15.2	13.7	13.0	20.3	3.06	1.37	3.80
Selenium	mg/kg	2	-	-	-	1.3	3.3	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	mg/kg	0.5	-	-	-	0.10	0.16	0.12	0.13	<0.10	0.13	0.15	0.13	0.13	<0.10	0.15	0.018	0.0081	0.023
Strontium	mg/kg	-	-	-	-	67	118	31.7	31.1	30.9	36.5	43.6	34.8	31.7	30.9	43.6	5.45	2.44	6.77
Thallium	mg/kg	-	-	-	-	0.051	0.094	<0.050	0.063	0.075	0.057	0.070	0.063	0.063	<0.050	0.075	0.010	0.0045	0.012
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	701	776	822	792	982	917	1,100	923	917	792	1,100	125	55.8	155
Uranium	mg/kg	-	-	-	-	0.73	1.26	0.548	0.453	0.511	0.590	0.627	0.546	0.548	0.453	0.627	0.0678	0.0303	0.0841
Vanadium	mg/kg	-	-	-	-	74.5	65.3	98.5	84.8	88.3	101	124	99.3	98.5	84.8	124	15.4	6.87	19.1
Zinc	mg/kg	123	315	200	380	60.2	67.6	38.9	37.7	50.8	41.6	50.4	43.9	41.6	37.7	50.8	6.30	2.82	7.82

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

(blue) Values is > TEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

Table E.7: Raw selectively extracted (Tessier extraction) metals data for sediment from Hazeltine Creek, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Analyte	Units	BC WSQG [2]		CSR [3]		Historic Hazeltine Creek 95th Percentile [4] (total metal concentration)		Upper Hazeltine Creek (ST16)												
Sample ID		TEL	PEL	Sensitive	Typical	Lower Creek	Upper Creek	ST16-S1	ST16-S2	ST16-S3	ST16-S4	ST16-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14							
Exchangeable & Adsorbed Metals																			
Aluminum	mg/kg	-	-	-	-	12,550	18,000	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Antimony	mg/kg	-	-	-	-	1.3	0.37	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Barium	mg/kg	-	-	-	-	104	136	<20	<20	<21	<21	<19	<21	<20	<19	<21	0.8	0.4	1.0
Beryllium	mg/kg	-	-	-	-	0.30	0.46	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Calcium	mg/kg	-	-	-	-	7,030	13,400	697	693	707	769	669	707	697	669	769	37.4	16.7	46.4
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Cobalt	mg/kg	-	-	-	-	11.0	10.4	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Copper	mg/kg	35.7	197	120	240	42.0	94.6	4.80	4.76	5.10	5.15	4.86	4.93	4.86	4.76	5.15	0.179	0.080	0.222
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Lead	mg/kg	35	91	57	110	5.6	6.7	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Lithium	mg/kg	-	-	-	-	12.9	14.8	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	<8.0	<8.0	<7.0	<8.0	<7.0	<8.0	<8.0	<7.0	<8.0	0.55	0.24	0.68
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	<0.90	<0.90	<0.90	<0.90	<0.90	<0.90	<0.90	<0.90	<0.90	0	0	0
Nickel	mg/kg	16	75	-	-	24	24	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Phosphorus	mg/kg	-	-	-	-	729	1,380	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Potassium	mg/kg	-	-	-	-	910	1,450	<100	<100	<100	<100	<100	<100	<100	<100	<100	0	0	0
Selenium	mg/kg	2	-	-	-	1.3	3.3	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	mg/kg	0.5	-	-	-	0.10	0.16	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Sodium	mg/kg	-	-	-	-	253	350	<100	<100	<100	<100	<100	<100	<100	<100	<100	0	0	0
Strontium	mg/kg	-	-	-	-	67.1	118	6.09	5.98	5.68	6.91	6.03	6.14	6.03	5.68	6.91	0.460	0.206	0.570
Thallium	mg/kg	-	-	-	-	0.051	0.094	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	701	776	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0
Uranium	mg/kg	-	-	-	-	0.73	1.26	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Vanadium	mg/kg	-	-	-	-	75	65	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Zinc	mg/kg	123	315	200	380	60.2	67.6	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0
Carbonate Metals																			
Aluminum	mg/kg	-	-	-	-	12,550	18,000	<50	<50	<50	<50	<50	<50	<50	<50	<50	0.0	0.0	0
Antimony	mg/kg	-	-	-	-	1.3	0.37	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Barium	mg/kg	-	-	-	-	104	136	15.2	15.4	17.5	17.3	13.0	15.7	15.4	13.0	17.5	1.83	0.82	2.27
Beryllium	mg/kg	-	-	-	-	0.30	0.46	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Calcium	mg/kg	-	-	-	-	7,030	13,400	7,540	7,630	7,800	7,670	7,310	7,590	7,630	7,310	7,800	182	81.5	226
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Cobalt	mg/kg	-	-	-	-	11.0	10.4	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Copper	mg/kg	35.7	197	120	240	42.0	94.6	16.5	17.4	18.6	18.2	15.6	17.3	17.4	15.6	18.6	1.23	0.55	1.52
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Lead	mg/kg	35	91	57	110	5.6	6.7	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Lithium	mg/kg	-	-	-	-	12.9	14.8	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	53.4	54.8	54.7	53.8	52.5	53.8	53.8	52.5	54.8	0.956	0.427	1.19
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Nickel	mg/kg	16	75	-	-	24	24	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Phosphorus	mg/kg	-	-	-	-	729	1,380	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Selenium	mg/kg	2	-	-	-	1.3	3.3	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	mg/kg	0.5	-	-	-	0.10	0.16	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Strontium	mg/kg	-	-	-	-	67	118	11.8	12.0	12.6	13.2	11.8	12.3	12.0	11.8	13.2	0.610	0.273	0.757
Thallium	mg/kg	-	-	-	-	0.051	0.094	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	701	776	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Uranium	mg/kg	-	-	-	-	0.73	1.26	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Vanadium	mg/kg	-	-	-	-	75	65.3	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Zinc	mg/kg	123	315	200	380	60.2	67.6	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996).
[4] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

(blue) Value is > TEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.
(orange) Value is > PEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

Table E.7: Raw selectively extracted (Tessier extraction) metals data for sediment from Hazeltine Creek, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Analyte	Units	BC WSQG [2]		CSR [3]		Historic Hazeltine Creek 95th Percentile [4] (total metal concentration)		Upper Hazeltine Creek (ST16)											
Sample ID		TEL	PEL	Sensitive	Typical	Lower Creek	Upper Creek	ST16-S1	ST16-S2	ST16-S3	ST16-S4	ST16-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14							
Easily Reducible Metals and Iron Oxides																			
Aluminum	mg/kg	-	-	-	-	12,550	18,000	665	635	719	762	705	697	705	635	762	49.1	22.0	60.9
Antimony	mg/kg	-	-	-	-	1.3	0.37	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	0.925	0.880	0.993	0.993	0.846	0.927	0.925	0.846	0.993	0.0661	0.0296	0.0821
Barium	mg/kg	-	-	-	-	104	136	10.0	9.27	11.0	12.6	9.52	10.5	10.0	9.27	12.6	1.36	0.607	1.69
Beryllium	mg/kg	-	-	-	-	0.30	0.46	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	0.058	0.053	<0.050	<0.050	<0.050	0.052	<0.050	<0.050	0.058	0.0035	0.0016	0.0043
Calcium	mg/kg	-	-	-	-	7,030	13,400	2,280	2,040	2,070	2,610	2,530	2,306	2,280	2,040	2,610	260	116	322
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	1.20	1.16	1.45	1.47	1.15	1.29	1.20	1.15	1.47	0.160	0.072	0.199
Cobalt	mg/kg	-	-	-	-	11.0	10.4	0.64	0.64	0.69	0.67	0.68	0.66	0.67	0.64	0.69	0.023	0.010	0.029
Copper	mg/kg	35.7	197	120	240	42.0	94.6	84.2	82.9	101	97.5	97.1	92.5	**97.1**	82.9	**101**	8.36	3.74	10.4
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	2,140	2,120	2,350	2,400	2,290	2,260	2,290	2,120	2,400	125	55.9	155
Lead	mg/kg	35	91	57	110	5.6	6.7	2.12	1.97	2.15	2.25	1.80	2.06	2.12	1.80	2.25	0.176	0.079	0.218
Lithium	mg/kg	-	-	-	-	12.9	14.8	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	49.3	47.9	49.4	53.9	52.5	50.6	49.4	47.9	53.9	2.50	1.12	3.10
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Nickel	mg/kg	16	75	-	-	24	24	0.60	0.67	0.66	0.68	0.66	0.65	0.66	0.60	0.68	0.031	0.014	0.039
Phosphorus	mg/kg	-	-	-	-	729	1,380	109	112	97	112	96	105	109	96	112	8.0	3.6	10
Selenium	mg/kg	2	-	-	-	1.3	3.3	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	mg/kg	0.5	-	-	-	0.10	0.16	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Strontium	mg/kg	-	-	-	-	67	118	12.9	11.7	13.5	14.2	12.6	13.0	12.9	11.7	14.2	0.942	0.421	1.17
Thallium	mg/kg	-	-	-	-	0.051	0.094	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	701	776	1.1	<1.0	<1.0	<1.0	1.2	1.1	<1.0	<1.0	1.2	0.089	0.040	0.11
Uranium	mg/kg	-	-	-	-	0.73	1.26	0.083	0.069	0.073	0.074	0.063	0.072	0.073	0.063	0.083	0.0073	0.0033	0.0091
Vanadium	mg/kg	-	-	-	-	75	65.3	6.63	6.73	7.53	7.59	7.30	7.16	7.30	6.63	7.59	0.449	0.201	0.558
Zinc	mg/kg	123	315	200	380	60.2	67.6	4.1	4.0	4.3	4.3	4.2	4.2	4.2	4.0	4.3	0.13	0.058	0.16
Organic Bound Metals																			
Aluminum	mg/kg	-	-	-	-	12,550	18,000	428	405	403	438	417	418	417	403	438	15.0	6.69	18.6
Antimony	mg/kg	-	-	-	-	1.3	0.37	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	1.05	1.01	1.10	1.15	0.995	1.06	1.05	0.995	1.15	0.064	0.029	0.080
Barium	mg/kg	-	-	-	-	104	136	6.75	6.28	6.74	8.00	5.97	6.75	6.74	5.97	8.00	0.773	0.346	0.960
Beryllium	mg/kg	-	-	-	-	0.30	0.46	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Calcium	mg/kg	-	-	-	-	7,030	13,400	891	707	877	914	719	822	877	707	914	100	44.8	124
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Cobalt	mg/kg	-	-	-	-	11.0	10.4	1.04	0.99	1.16	1.10	0.99	1.06	1.04	0.99	1.16	0.074	0.033	0.091
Copper	mg/kg	35.7	197	120	240	42.0	94.6	609	607	596	595	664	**614**	**607**	**595**	**664**	28.5	12.8	35.4
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	522	517	589	544	524	539	524	517	589	29.7	13.3	36.8
Lead	mg/kg	35	91	57	110	5.6	6.7	0.85	1.19	0.89	0.90	0.96	0.96	0.90	0.85	1.19	0.14	0.061	0.17
Lithium	mg/kg	-	-	-	-	12.9	14.8	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	6.4	6.3	6.7	6.9	6.6	6.6	6.6	6.3	6.9	0.24	0.11	0.30
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	1.92	1.44	1.43	1.58	1.54	1.58	1.54	1.43	1.92	0.20	0.089	0.25
Nickel	mg/kg	16	75	-	-	24	24	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Selenium	mg/kg	2	-	-	-	1.3	3.3	0.59	0.54	0.57	0.55	0.56	0.56	0.56	0.54	0.59	0.019	0.0086	0.024
Silver	mg/kg	0.5	-	-	-	0.10	0.16	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Strontium	mg/kg	-	-	-	-	67	118	8.78	7.60	7.58	8.72	7.44	8.02	7.60	7.44	8.78	0.666	0.298	0.827
Thallium	mg/kg	-	-	-	-	0.051	0.094	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	701	776	1.4	1.1	1.2	1.1	1.1	1.2	1.1	1.1	1.4	0.13	0.058	0.16
Uranium	mg/kg	-	-	-	-	0.73	1.26	0.075	0.070	0.076	0.077	0.074	0.074	0.075	0.070	0.077	0.0027	0.0012	0.0034
Vanadium	mg/kg	-	-	-	-	74.5	65.3	0.62	0.57	0.64	0.64	0.59	0.61	0.62	0.57	0.64	0.031	0.014	0.039
Zinc	mg/kg	123	315	200	380	60.2	67.6	5.0	4.8	4.7	4.5	4.6	4.7	4.7	4.5	5.0	0.19	0.086	0.24

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

(Blue) Values is > TEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

(Orange) Value is > PEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

Table E.7: Raw selectively extracted (Tessier extraction) metals data for sediment from Hazeltine Creek, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Analyte	Units	BC WSQG [2]		CSR [3]		Historic Hazeltine Creek 95th Percentile [4] (total metal concentration)		Upper Hazeltine Creek (ST16)											
Sample ID		TEL	PEL	Sensitive	Typical	Lower Creek	Upper Creek	ST16-S1	ST16-S2	ST16-S3	ST16-S4	ST16-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								**7-Oct-14**	**7-Oct-14**	**7-Oct-14**	**7-Oct-14**	**7-Oct-14**							
Residual Metals																			
Aluminum	mg/kg	-	-	-	-	12,550	18,000	9,900	9,260	10,100	10,500	11,200	10,192	10,100	9,260	11,200	720	322	894
Antimony	mg/kg	-	-	-	-	1.3	0.37	0.21	0.19	0.19	0.19	0.27	0.21	0.19	0.19	0.27	0.035	0.015	0.043
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	8.95	8.68	9.22	9.11	10.1	9.21	9.11	8.68	10.1	0.536	0.240	0.666
Barium	mg/kg	-	-	-	-	104	136	80.3	73.9	74.6	87.4	81.7	79.6	80.3	73.9	87.4	5.55	2.48	6.89
Beryllium	mg/kg	-	-	-	-	0.30	0.46	0.38	0.34	0.37	0.37	0.38	0.37	0.37	0.34	0.38	0.016	0.0073	0.020
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	<0.050	0.057	0.072	<0.050	0.074	0.061	0.057	<0.050	0.074	0.012	0.0052	0.015
Calcium	mg/kg	-	-	-	-	7,030	13,400	11,700	10,100	11,400	11,400	12,600	11,440	11,400	10,100	12,600	896	401	1,112
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	8.7	9.2	10.2	10.1	9.9	9.62	9.90	8.70	10.2	0.65	0.29	0.80
Cobalt	mg/kg	-	-	-	-	11.0	10.4	11.6	11.7	12.7	12.8	12.4	12.2	12.4	11.6	12.8	0.559	0.250	0.695
Copper	mg/kg	35.7	197	120	240	42.0	94.6	187	244	211	171	302	**223**	**211**	**171**	**302**	52.0	23.3	64.6
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	47,800	48,700	56,100	56,300	55,100	**52,800**	**55,100**	**47,800**	**56,300**	4,190	1,874	5,202
Lead	mg/kg	35	91	57	110	5.6	6.7	1.88	2.15	1.86	1.94	1.93	1.95	1.93	1.86	2.15	0.116	0.052	0.144
Lithium	mg/kg	-	-	-	-	12.9	14.8	11.5	10.5	11.1	11.3	11.4	11.2	11.3	10.5	11.5	0.397	0.178	0.493
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	410	392	424	417	448	418	417	392	448	20.5	9.16	25.4
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	3.02	3.04	2.57	2.86	3.97	3.09	3.02	2.57	3.97	0.526	0.235	0.653
Nickel	mg/kg	16	75	-	-	24	24	5.2	5.4	5.9	5.8	5.5	5.56	5.50	5.20	5.90	0.29	0.13	0.36
Selenium	mg/kg	2	-	-	-	1.3	3.3	0.45	0.52	0.52	0.44	0.56	0.50	0.52	0.44	0.56	0.051	0.023	0.064
Silver	mg/kg	0.5	-	-	-	0.10	0.16	0.32	0.34	0.33	0.30	0.36	0.33	0.33	0.30	0.36	0.022	0.010	0.028
Strontium	mg/kg	-	-	-	-	67	118	51.6	43.8	46.2	50.3	53.5	49.1	50.3	43.8	53.5	3.99	1.78	4.95
Thallium	mg/kg	-	-	-	-	0.051	0.094	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	701	776	1,000	867	1,020	1,070	1,170	1,025	1,020	867	1,170	110	49.3	137
Uranium	mg/kg	-	-	-	-	0.73	1.26	0.617	0.549	0.623	0.648	0.722	0.632	0.623	0.549	0.722	0.0624	0.0279	0.0774
Vanadium	mg/kg	-	-	-	-	74.5	65.3	190	200	226	226	223	213	223	190	226	16.9	7.54	20.9
Zinc	mg/kg	123	315	200	380	60.2	67.6	46.8	46.0	47.0	46.8	50.4	47.4	46.8	46.0	50.4	1.72	0.769	2.14

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

(blue) Values is > TEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

Table E.8: Raw leachable metals data for sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Data are based on bulk sediment [1].

Analyte	Units	BCWQG [2]			HWR [3]	Lower Hazeltine Creek (ST02)											
Sample ID						ST02-S1	ST02-S2	ST02-S3	ST02-S4	ST02-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled		Type	Chronic	Acute		7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14							
Leachable Metals																	
Aluminum	mg/L	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Antimony	mg/L	W	0.009	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Arsenic	mg/L	A	-	0.0050	2.5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Barium	mg/L	W	1.0	-	100	0.027	0.020	0.052	0.066	0.035	0.040	0.035	0.020	0.066	0.019	0.0084	0.023
Beryllium	mg/L	W	0.00013	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0	0	0
Bismuth	mg/L	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Cadmium	mg/L	A	0.00027	0.00081	0.50	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Calcium	mg/L	-	-	-	-	13.6	16.0	29.0	44.1	17.9	24.1	17.9	13.6	44.1	12.6	5.65	15.7
Chromium [4]	mg/L	W	0.001	-	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Cobalt	mg/L	A	0.0040	0.11	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Copper	mg/L	A	0.0055	0.015	100	0.011	<0.010	0.014	0.032	<0.010	0.015	0.011	<0.010	0.032	0.0094	0.0042	0.012
Iron	mg/L	A	-	1.0	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0
Lead	mg/L	A	0.008	0.12	5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Magnesium	mg/L	-	-	-	-	2.26	2.51	4.54	6.20	1.98	3.50	2.51	1.98	6.20	1.82	0.812	2.26
Manganese	mg/L	A	1.21	2.05	-	0.0166	0.0215	0.204	0.751	0.0105	0.201	0.0215	0.0105	0.751	0.318	0.142	0.395
Mercury	mg/L	A	0.00002	-	0.1	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0	0	0
Molybdenum	mg/L	A	1	2	-	<0.030	<0.030	<0.030	0.038	0.080	0.042	<0.030	<0.030	0.080	0.022	0.010	0.027
Nickel [5]	mg/L	W	-	0.121	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Phosphorus	mg/L	A	-	0.0050-0.015	-	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0	0	0
Potassium	mg/L	-	-	-	-	2.1	<2.0	3.5	4.0	6.6	3.6	3.5	<2.0	6.6	1.9	0.84	2.3
Selenium	mg/L	A	0.002	-	1	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Silicon	mg/L	-	-	-	-	4.04	4.09	5.82	7.06	5.30	5.26	5.30	4.04	7.06	1.27	0.566	1.57
Silver	mg/L	A	0.0015	0.003	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Sodium	mg/L	-	-	-	-	5.0	3.7	9.1	12.3	29.7	12	9.1	3.7	30	10	4.7	13
Strontium	mg/L	-	-	-	-	0.162	0.147	0.319	0.489	0.316	0.287	0.316	0.147	0.489	0.140	0.0624	0.173
Thallium	mg/L	W	0.0008	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Tin	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0
Titanium	mg/L	-	-	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Uranium	mg/L	W	0.0085	-	10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Vanadium	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0
Zinc	mg/L	A	0.043	0.068	500	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.
[2] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.
[3] Hazardous Waste Regulation (Government of British Columbia 1988)
[4] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.
[5] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)
(orange) Value is > one or all guidelines (values < MDL excluded from comparison).

Table E.8: Raw leachable metals data for sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Data are based on bulk sediment [1].

Analyte	Units	BCWQG [2]			HWR [3]	Mid Hazeltine Creek (ST09)											
Sample ID						ST09-S1	ST09-S2	ST09-S3	ST09-S4	ST09-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled		Type	Chronic	Acute		7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14							
Leachable Metals																	
Aluminum	mg/L	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Antimony	mg/L	W	0.009	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Arsenic	mg/L	A	-	0.0050	2.5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Barium	mg/L	W	1.0	-	100	0.021	0.020	0.033	0.018	0.029	0.024	0.021	0.018	0.033	0.0065	0.0029	0.0080
Beryllium	mg/L	W	0.00013	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0	0	0
Bismuth	mg/L	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Cadmium	mg/L	A	0.00027	0.00081	0.50	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Calcium	mg/L	-	-	-	-	19.9	18.3	26.4	17.3	21.5	20.7	19.9	17.3	26.4	3.57	1.60	4.44
Chromium [4]	mg/L	W	0.001	-	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Cobalt	mg/L	A	0.0040	0.11	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Copper	mg/L	A	0.0055	0.015	100	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Iron	mg/L	A	-	1.0	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0
Lead	mg/L	A	0.008	0.12	5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Magnesium	mg/L	-	-	-	-	3.15	2.97	4.12	2.59	3.37	3.24	3.15	2.59	4.12	0.569	0.254	0.706
Manganese	mg/L	A	1.21	2.05	-	0.0234	0.0276	0.0402	0.0244	0.0352	0.0302	0.0276	0.0234	0.0402	0.00727	0.00325	0.00903
Mercury	mg/L	A	0.00002	-	0.1	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0	0	0
Molybdenum	mg/L	A	1	2	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0
Nickel [5]	mg/L	W	-	0.121	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Phosphorus	mg/L	A	-	0.0050-0.015	-	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0	0	0
Potassium	mg/L	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Selenium	mg/L	A	0.002	-	1	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Silicon	mg/L	-	-	-	-	4.21	4.21	4.55	3.95	3.92	4.17	4.21	3.92	4.55	0.254	0.114	0.316
Silver	mg/L	A	0.0015	0.003	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Sodium	mg/L	-	-	-	-	6.6	3.9	4.2	3.5	5.2	4.7	4.2	3.5	6.6	1.2	0.56	1.5
Strontium	mg/L	-	-	-	-	0.189	0.169	0.243	0.154	0.208	0.1926	0.189	0.154	0.243	0.0348	0.0156	0.0432
Thallium	mg/L	W	0.0008	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Tin	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0
Titanium	mg/L	-	-	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Uranium	mg/L	W	0.0085	-	10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Vanadium	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0
Zinc	mg/L	A	0.043	0.068	500	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.
[2] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.
[3] Hazardous Waste Regulation (Government of British Columbia 1988)
[4] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.
[5] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)
(orange box) Value is > one or all guidelines (values < MDL excluded from comparison).

Table E.8: Raw leachable metals data for sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Data are based on bulk sediment [1].

Analyte	Units	BCWQG [2]			HWR [3]	Upper Hazeltine Creek (ST16)											
Sample ID						ST16-S1	ST16-S2	ST16-S3	ST16-S4	ST16-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled		Type	Chronic	Acute		7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14							
Leachable Metals																	
Aluminum	mg/L	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Antimony	mg/L	W	0.009	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Arsenic	mg/L	A	-	0.0050	2.5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Barium	mg/L	W	1.0	-	100	0.025	0.024	0.035	0.034	0.024	0.028	0.025	0.024	0.035	0.0056	0.0025	0.0069
Beryllium	mg/L	W	0.00013	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0	0	0
Bismuth	mg/L	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Cadmium	mg/L	A	0.00027	0.00081	0.50	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Calcium	mg/L	-	-	-	-	19.1	15.6	12.9	16.1	18.6	16.5	16.1	12.9	19.1	2.50	1.12	3.11
Chromium [4]	mg/L	W	0.001	-	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Cobalt	mg/L	A	0.0040	0.11	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Copper	mg/L	A	0.0055	0.015	100	0.055	0.043	0.051	0.038	0.022	0.042	0.043	0.022	0.055	0.013	0.0058	0.016
Iron	mg/L	A	-	1.0	-	0.164	0.114	0.113	0.062	0.032	0.097	0.113	0.032	0.164	0.051	0.023	0.064
Lead	mg/L	A	0.008	0.12	5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Magnesium	mg/L	-	-	-	-	2.88	2.44	1.52	2.13	2.74	2.34	2.44	1.52	2.88	0.543	0.243	0.674
Manganese	mg/L	A	1.21	2.05	-	0.0547	0.0438	0.0389	0.0462	0.0477	0.0463	0.0462	0.0389	0.0547	0.00578	0.00258	0.00717
Mercury	mg/L	A	0.00002	-	0.1	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0	0	0
Molybdenum	mg/L	A	1	2	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0
Nickel [5]	mg/L	W	-	0.121	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Phosphorus	mg/L	A	-	0.0050-0.015	-	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0	0	0
Potassium	mg/L	-	-	-	-	3.0	2.6	<2.0	3.4	3.6	2.9	3.0	<2.0	3.6	0.64	0.29	0.80
Selenium	mg/L	A	0.002	-	1	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Silicon	mg/L	-	-	-	-	4.27	4.34	4.30	4.67	4.42	4.40	4.34	4.27	4.67	0.161	0.0720	0.200
Silver	mg/L	A	0.0015	0.003	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Sodium	mg/L	-	-	-	-	12.2	9.2	3.0	8.9	12.5	9.2	9.2	3.0	12.5	3.8	1.7	4.7
Strontium	mg/L	-	-	-	-	0.252	0.202	0.159	0.219	0.254	0.217	0.219	0.159	0.254	0.0393	0.0176	0.0488
Thallium	mg/L	W	0.0008	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Tin	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0
Titanium	mg/L	-	-	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Uranium	mg/L	W	0.0085	-	10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Vanadium	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0
Zinc	mg/L	A	0.043	0.068	500	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.
[2] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.
[3] Hazardous Waste Regulation (Government of British Columbia 1988)
[4] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.
[5] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)
Value is > one or all guidelines (values < MDL excluded from comparison).

Table E.9: Porewater metals data for sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014 [1].

Analyte	Units	BCWQG [2]			Lower Hazeltine Creek (ST02)											
Sample ID		Type	Chronic	Acute	ST02-S1	ST02-S2	ST02-S3	ST02-S4	ST02-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled					7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14							
Physical Tests																
Hardness (as CaCO3)	mg/L	-	-	-	200	176	280	403	533	318	280	176	533	149	66.7	185
Total Metals																
Aluminum	mg/L	-	-	-	0.205	0.0579	0.0320	0.0051	0.458	0.1516	0.0579	0.0051	0.458	0.188	0.0840	0.233
Antimony	mg/L	W	0.01	-	0.00116	0.00119	0.00052	0.00013	0.00112	0.00082	0.00112	0.00013	0.00119	0.00048	0.00021	0.00059
Arsenic	mg/L	A	-	0.005	0.00161	0.00142	0.00122	0.00829	0.00389	0.00329	0.00161	0.00122	0.00829	0.00300	0.00134	0.00372
Barium	mg/L	W	1	-	0.0701	0.0579	0.0949	0.0878	0.0363	0.0694	0.0701	0.0363	0.0949	0.0235	0.0105	0.0292
Beryllium	mg/L	W	0.0001	-	<0.00020	<0.00020	<0.00010	<0.00010	<0.00040	<0.00040	<0.00020	<0.00010	<0.00040	0.00012	0.000055	0.00015
Bismuth	mg/L	-	-	-	<0.0010	<0.0010	<0.00050	<0.00050	<0.0020	<0.0020	<0.0010	<0.00050	<0.0020	0.00061	0.00027	0.00076
Boron	mg/L	A	-	1.2	0.038	0.038	0.062	0.078	0.190	0.081	0.062	0.038	0.190	0.063	0.028	0.078
Cadmium [4]	mg/L	A	0.00045	0.0017	0.000043	<0.000020	<0.000010	0.000079	0.000048	0.000040	0.000043	<0.000010	0.000079	0.000027	0.000012	0.000033
Calcium	mg/L	-	-	-	66.1	57.0	88.3	131	181	105	88	57.0	181	51.4	23.0	63.8
Chromium [5]	mg/L	W	0.001	-	0.00056	<0.00050	<0.00050	<0.00050	<0.00050	0.00051	<0.00050	<0.00050	0.00056	0.000027	0.000012	0.000033
Cobalt	mg/L	A	0.004	0.11	0.00053	<0.00020	<0.00010	0.00429	0.00140	0.00130	0.00053	<0.00010	0.00429	0.0017	0.00078	0.0022
Copper	mg/L	A	0.011	0.028	0.0123	0.0099	0.0126	0.0131	0.0627	0.0221	0.0126	0.0099	0.0627	0.0227	0.0102	0.0282
Iron	mg/L	A	-	1	0.310	0.078	<0.060	0.106	0.350	0.181	0.106	<0.060	0.350	0.138	0.062	0.171
Lead	mg/L	A	0.015	0.30	0.00018	<0.00010	<0.000050	0.000074	0.00023	0.00013	0.00010	<0.000050	0.00023	0.000076	0.000034	0.000094
Lithium	mg/L	-	-	-	0.00220	0.00180	0.00345	0.00389	0.0159	0.00545	0.00345	0.00180	0.0159	0.00591	0.00264	0.00733
Magnesium	mg/L	-	-	-	10.7	9.49	17.1	22.5	21.8	16.3	17.1	9.49	22.5	6.06	2.71	7.53
Manganese	mg/L	A	1.8	3.6	0.143	0.00424	0.0359	2.84	0.258	0.656	0.143	0.00424	2.840	1.22	0.548	1.52
Mercury	mg/L	A	0.00002	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00020	<0.00020	<0.00010	<0.00010	<0.00020	0.000045	0.000020	0.000056
Molybdenum	mg/L	A	1	2	0.0151	0.0238	0.0134	0.0173	0.264	0.0667	0.0173	0.0134	0.264	0.110	0.0494	0.137
Nickel [6]	mg/L	W	-	0.15	0.00300	0.00170	0.00330	0.00604	<0.0020	0.00321	0.00300	0.00170	0.00604	0.00172	0.00077	0.00213
Potassium	mg/L	-	-	-	1.93	1.64	3.77	4.51	14.1	5.19	3.77	1.64	14.1	5.13	2.29	6.36
Selenium	mg/L	A	0.002	-	0.00139	0.00272	0.00086	0.00060	<0.00050	0.0012	0.00086	<0.00050	0.0027	0.00091	0.00041	0.0011
Silicon	mg/L	-	-	-	4.58	3.80	3.91	10.3	5.08	5.53	4.58	3.80	10.3	2.71	1.21	3.37
Silver	mg/L	A	0.0015	0.0030	0.000025	<0.000020	0.000017	<0.000010	<0.000040	0.000022	<0.000020	<0.000010	<0.000040	0.000011	0.0000050	0.000014
Sodium	mg/L	-	-	-	9.79	10.2	23.3	27.6	141	42.4	23.3	9.8	141	55.7	24.9	69.1
Strontium	mg/L	-	-	-	0.535	0.475	0.943	1.37	2.49	1.16	0.943	0.475	2.49	0.825	0.369	1.02
Thallium	mg/L	W	0.0008	-	<0.000020	<0.000020	<0.000010	<0.000010	<0.000040	<0.000040	<0.000020	<0.000010	<0.000040	0.000012	0.000005	0.000015
Tin	mg/L	-	-	-	0.00022	<0.00020	<0.00010	<0.00010	<0.00040	0.00020	<0.00020	<0.00010	<0.00040	0.00012	0.000055	0.00015
Titanium	mg/L	-	-	-	0.020	<0.020	<0.020	<0.020	0.042	0.024	<0.020	<0.020	0.042	0.0098	0.0044	0.012
Uranium	mg/L	W	0.01	-	0.00479	0.00654	0.00662	0.00389	0.00328	0.00502	0.00479	0.00328	0.00662	0.00152	0.00068	0.00189
Vanadium	mg/L	-	-	-	0.0027	0.0031	0.0013	<0.0010	<0.0040	0.0024	0.0027	<0.0010	<0.0040	0.0013	0.00056	0.0016
Zinc	mg/L	A	0.15	0.17	<0.0060	<0.0060	<0.0030	<0.0030	<0.012	<0.012	<0.0060	<0.0030	<0.012	0.0037	0.0016	0.0046
Dissolved Metals																
Aluminum	mg/L	A	0.05	0.10	<0.0030	<0.0030	<0.0030	<0.0030	0.0141	0.0052	<0.0030	<0.0030	0.0141	0.0050	0.0022	0.0062
Antimony	mg/L	-	-	-	0.00106	0.00114	0.00052	0.00011	0.00112	0.00079	0.0011	0.00011	0.00114	0.00046	0.00020	0.00057
Arsenic	mg/L	-	-	-	0.00130	0.00129	0.00113	0.00761	0.00381	0.00303	0.00130	0.00113	0.00761	0.00279	0.00125	0.00347
Barium	mg/L	-	-	-	0.0631	0.0553	0.0921	0.0844	0.0300	0.0650	0.0631	0.0300	0.0921	0.0247	0.0110	0.0306
Beryllium	mg/L	-	-	-	<0.00020	<0.00020	<0.00010	<0.00010	<0.00040	<0.00040	<0.00020	<0.00010	<0.00040	0.00012	0.000055	0.00015
Bismuth	mg/L	-	-	-	<0.0010	<0.0010	<0.00050	<0.00050	<0.0020	<0.0020	<0.0010	<0.00050	<0.0020	0.00061	0.00027	0.00076
Boron	mg/L	-	-	-	0.034	0.036	0.060	0.074	0.185	0.078	0.060	0.034	0.185	0.062	0.028	0.077
Cadmium	mg/L	A	0.00045	0.0017	0.000024	<0.000020	<0.000010	0.000070	0.000048	0.000034	0.000024	<0.000010	0.000070	0.000024	0.000011	0.000030
Calcium	mg/L	-	-	-	63.3	55.3	84.7	126	178	101	84.7	55.3	178	50.8	22.7	63.1
Chromium	mg/L	-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0	0	0
Cobalt	mg/L	-	-	-	0.00023	<0.00020	<0.00010	0.00415	0.00099	0.0011	0.00023	<0.00010	0.0042	0.0017	0.00077	0.0021
Copper	mg/L	-	-	-	0.00862	0.00848	0.00989	0.0109	0.0326	0.0141	0.00989	0.00848	0.0326	0.0104	0.00465	0.0129
Iron	mg/L	A	-	0.35	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	0	0	0
Lead	mg/L	-	-	-	<0.00010	<0.00010	<0.000050	<0.000050	<0.00020	<0.00020	<0.00010	<0.000050	<0.00020	0.000061	0.000027	0.000076
Lithium	mg/L	-	-	-	0.0019	0.0017	0.0035	0.0037	0.0157	0.0053	0.0035	0.0017	0.0157	0.0059	0.0026	0.0073
Magnesium	mg/L	-	-	-	10.1	9.13	16.6	21.5	21.3	15.7	16.6	9.13	21.5	5.92	2.65	7.35
Manganese	mg/L	-	-	-	0.0916	0.00041	0.0191	2.77	0.234	0.62	0.092	0.00041	2.77	1.2	0.54	1.5
Mercury	mg/L	-	-	-	<0.00020	<0.00020	<0.00010	<0.00010	<0.00020	<0.00020	<0.00020	<0.00010	<0.00020	0.000055	0.000024	0.000068
Molybdenum	mg/L	-	-	-	0.0142	0.0228	0.0132	0.0163	0.259	0.0651	0.0163	0.0132	0.2590	0.108	0.0485	0.135
Nickel	mg/L	-	-	-	0.0024	0.0018	0.0029	0.0059	<0.0020	0.0030	0.0024	0.0018	0.0059	0.0017	0.0008	0.0021
Potassium	mg/L	-	-	-	1.82	1.63	3.69	4.37	13.7	5.04	3.69	1.63	13.7	4.98	2.23	6.18
Selenium	mg/L	-	-	-	0.00126	0.00256	0.00077	0.00054	<0.00050	0.0011	0.00077	<0.00050	0.0026	0.00086	0.00038	0.0011
Silicon	mg/L	-	-	-	3.98	3.58	3.74	9.88	4.05	5.05	3.98	3.58	9.88	2.71	1.21	3.36
Silver	mg/L	-	-	-	<0.000020	<0.000020	<0.000010	<0.000010	<0.000040	<0.000040	<0.000020	<0.000010	<0.000040	0.000012	0.0000055	0.000015
Sodium	mg/L	-	-	-	9.26	9.74	23.2	25.3	139	41.3	23.2	9.26	139	55.1	24.6	68.4
Strontium	mg/L	-	-	-	0.505	0.459	0.903	1.27	2.45	1.12	0.903	0.459	2.45	0.814	0.364	1.01
Thallium	mg/L	-	-	-	<0.000020	<0.000020	<0.000010	<0.000010	<0.000040	<0.000040	<0.000020	<0.000010	<0.000040	0.000012	0.0000055	0.000015
Tin	mg/L	-	-	-	<0.00020	<0.00020	<0.00010	<0.00010	<0.00040	<0.00040	<0.00020	<0.00010	<0.00040	0.00012	0.000055	0.00015
Titanium	mg/L	-	-	-	<0.020	<0.020	<0.020	<0.020	0.020	0.020	0.020	<0.020	0.020	0	0	0
Uranium	mg/L	-	-	-	0.00459	0.00634	0.00633	0.00368	0.00323	0.00483	0.00459	0.00323	0.00634	0.00146	0.00065	0.00181
Vanadium	mg/L	-	-	-	<0.0020	0.0026	0.0011	<0.0010	<0.0040	0.0021	<0.0020	<0.0010	<0.0040	0.0012	0.00055	0.0015
Zinc	mg/L	-	-	-	0.0039	0.0044	<0.0030	<0.0030	<0.0040	0.0037	0.0039	<0.0030	0.0044	0.00063	0.00028	0.00078

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < highest MDL if all the data used in their calculation were < MDL. Medians are reported as the < MDL value closest to calculated median if all data are < MDL (relevant for sample sizes of 4).

[2] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.

[3] Insufficient porewater volume to analyse total or dissolved metals in sample ST16-04 or to analyse total metal concentrations in samples ST16-S2, ST16-S3 or ST16-S5.

[4] Displayed guideline value is for dissolved cadium.

[5] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.

[6] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)

(orange shading) Value is > one or all guidelines (values < MDL excluded from comparison).

Table E.9: Porewater metals data for sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014 [1].

Analyte	Units	BCWQG [2]			Mid Hazeltine Creek (ST09)											
Sample ID		Type	Chronic	Acute	ST09-S1	ST09-S2	ST09-S3	ST09-S4	ST09-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled					7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14							
Physical Tests																
Hardness (as CaCO3)	mg/L	-	-	-	289	166	204	157	193	202	193	157	289	52.4	23.4	65.0
Total Metals																
Aluminum	mg/L	-	-	-	0.0105	0.0361	0.0917	0.0258	0.0362	0.0401	0.0361	0.0105	0.0917	0.0307	0.0137	0.0381
Antimony	mg/L	W	0.01	-	0.00074	0.00111	0.00068	0.00087	0.00073	0.00083	0.00074	0.00068	0.00111	0.00017	0.000078	0.00022
Arsenic	mg/L	A	-	0.005	0.00102	0.00132	0.00118	0.00103	0.00104	0.00112	0.00104	0.00102	0.00132	0.000130	0.000058	0.000162
Barium	mg/L	W	1	-	0.0889	0.0447	0.0589	0.0406	0.0547	0.0576	0.0547	0.0406	0.0889	0.0190	0.00850	0.0236
Beryllium	mg/L	W	0.0001	-	<0.00010	<0.00010	<0.00020	<0.00010	<0.00010	<0.00020	<0.00010	<0.00010	<0.00020	0.000045	0.000020	0.000056
Bismuth	mg/L	-	-	-	<0.00050	<0.00050	<0.0010	<0.00050	<0.00050	<0.0010	<0.00050	<0.00050	<0.0010	0.00022	0.00010	0.00028
Boron	mg/L	A	-	1.2	0.051	0.034	0.037	0.028	0.038	0.038	0.037	0.028	0.051	0.0084	0.0038	0.010
Cadmium [4]	mg/L	A	0.00045	0.0017	0.000020	<0.000010	<0.000020	<0.000010	<0.000010	0.000014	<0.000010	<0.000010	0.000020	0.0000055	0.0000024	0.0000068
Calcium	mg/L	-	-	-	94.6	54.9	64.8	51.2	60.5	65.2	60.5	51.2	94.6	17.2	7.71	21.4
Chromium [5]	mg/L	W	0.001	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0	0	0
Cobalt	mg/L	A	0.004	0.11	<0.00010	<0.00010	<0.00020	<0.00010	<0.00010	<0.00020	<0.00010	<0.00010	<0.00020	0.000045	0.000020	0.000056
Copper	mg/L	A	0.011	0.028	0.00933	0.0107	0.0077	0.0103	0.00965	0.0095	0.0097	0.0077	0.0107	0.0012	0.00052	0.0014
Iron	mg/L	A	-	1	<0.060	<0.060	0.136	<0.060	<0.060	0.075	<0.060	<0.060	0.136	0.034	0.015	0.042
Lead	mg/L	A	0.015	0.30	<0.000050	<0.000050	0.00016	<0.000050	<0.000050	0.000072	<0.000050	<0.000050	0.00016	0.000049	0.000022	0.000061
Lithium	mg/L	-	-	-	0.00208	0.00160	0.00160	0.00128	0.00138	0.00159	0.00160	0.00128	0.00208	0.000308	0.000138	0.000383
Magnesium	mg/L	-	-	-	16.2	9.76	11.1	8.22	10.3	11.1	10.3	8.22	16.2	3.03	1.36	3.76
Manganese	mg/L	A	1.8	3.6	0.00535	0.00326	0.0156	0.00431	0.00676	0.00706	0.00535	0.00326	0.0156	0.00495	0.00221	0.00614
Mercury	mg/L	A	0.00002	-	<0.00010	<0.00010	<0.00010	<0.00020	<0.00020	<0.00020	<0.00010	<0.00010	<0.00020	0.000055	0.000024	0.000068
Molybdenum	mg/L	A	1	2	0.0461	0.0226	0.0123	0.0176	0.0250	0.0247	0.0226	0.0123	0.0461	0.0129	0.00577	0.0160
Nickel [6]	mg/L	W	-	0.15	0.00196	0.00179	0.0022	0.00132	0.00209	0.00187	0.00196	0.00132	0.00220	0.000344	0.000154	0.000427
Potassium	mg/L	-	-	-	2.50	1.63	1.66	1.37	1.82	1.80	1.66	1.37	2.50	0.425	0.190	0.528
Selenium	mg/L	A	0.002	-	0.00138	0.00219	0.00089	0.00214	0.00088	0.0015	0.0014	0.00088	0.0022	0.00064	0.00029	0.0008
Silicon	mg/L	-	-	-	3.95	3.86	4.04	3.35	3.16	3.67	3.86	3.16	4.04	0.39	0.18	0.49
Silver	mg/L	A	0.0015	0.0030	<0.000010	<0.000010	<0.000020	0.000011	<0.000010	0.000012	<0.000010	<0.000010	<0.000020	0.0000044	0.0000020	0.0000054
Sodium	mg/L	-	-	-	25.0	10.9	9.79	9.31	12.2	13.4	10.9	9.31	25.0	6.56	2.93	8.14
Strontium	mg/L	-	-	-	0.840	0.471	0.540	0.410	0.499	0.552	0.499	0.410	0.840	0.168	0.0750	0.208
Thallium	mg/L	W	0.0008	-	<0.000010	<0.000010	<0.000020	<0.000010	<0.000010	<0.000020	<0.000010	<0.000010	<0.000020	0.0000045	0.0000020	0.0000056
Tin	mg/L	-	-	-	<0.00010	<0.00010	<0.00020	<0.00010	<0.00010	<0.00020	<0.00010	<0.00010	<0.00020	0.000045	0.000020	0.000056
Titanium	mg/L	-	-	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0
Uranium	mg/L	W	0.01	-	0.00422	0.00525	0.00475	0.00434	0.00430	0.00457	0.00434	0.00422	0.00525	0.000431	0.000193	0.000535
Vanadium	mg/L	-	-	-	0.0014	0.0023	<0.0020	0.0018	0.0015	0.0018	0.0018	0.0014	0.0023	0.00037	0.00016	0.00046
Zinc	mg/L	A	0.15	0.17	<0.0030	<0.0030	<0.0060	<0.0030	<0.0030	<0.0060	<0.0030	<0.0030	<0.0060	0.0013	0.00060	0.0017
Dissolved Metals																
Aluminum	mg/L	A	0.05	0.10	<0.0030	<0.0030	0.0055	<0.0030	<0.0030	0.0035	<0.0030	<0.0030	0.0055	0.0011	0.00050	0.0014
Antimony	mg/L	-	-	-	0.00069	0.00100	0.00065	0.00082	0.00073	0.00078	0.00073	0.00065	0.00100	0.00014	0.000062	0.00017
Arsenic	mg/L	-	-	-	0.00096	0.00122	0.00105	0.00099	0.00100	0.00104	0.00100	0.00096	0.00122	0.00010	0.000046	0.00013
Barium	mg/L	-	-	-	0.0854	0.0427	0.0578	0.0390	0.0547	0.0559	0.0547	0.0390	0.0854	0.0183	0.00817	0.0227
Beryllium	mg/L	-	-	-	<0.00010	<0.00010	<0.00020	<0.00010	<0.00010	<0.00020	<0.00010	<0.00010	<0.00020	0.000045	0.000020	0.000056
Bismuth	mg/L	-	-	-	<0.00050	<0.00050	<0.0010	<0.00050	<0.00050	<0.0010	<0.00050	<0.00050	<0.0010	0.00022	0.00010	0.00028
Boron	mg/L	-	-	-	0.047	0.032	0.036	0.027	0.037	0.036	0.036	0.027	0.047	0.0074	0.0033	0.0092
Cadmium	mg/L	A	0.00045	0.0017	0.000020	<0.000010	<0.000020	<0.000010	0.000013	0.000015	0.000013	<0.000010	<0.000020	0.0000051	0.0000023	0.0000063
Calcium	mg/L	-	-	-	90.3	51.4	63.6	49.5	60.6	63.1	60.6	49.5	90.3	16.3	7.31	20.3
Chromium	mg/L	-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0	0	0
Cobalt	mg/L	-	-	-	<0.00010	<0.00010	<0.00020	<0.00010	<0.00010	<0.00020	<0.00010	<0.00010	<0.00020	0.000045	0.000020	0.000056
Copper	mg/L	-	-	-	0.00839	0.00946	0.00595	0.00899	0.00836	0.00823	0.00839	0.00595	0.00946	0.00135	0.000605	0.00168
Iron	mg/L	A	-	0.35	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	0	0	0
Lead	mg/L	-	-	-	<0.000050	<0.000050	<0.00010	<0.000050	<0.000050	<0.00010	<0.000050	<0.000050	<0.00010	0.000022	0.000010	0.000028
Lithium	mg/L	-	-	-	0.00193	0.00151	0.00160	0.00126	0.00139	0.00154	0.00151	0.00126	0.00193	0.000254	0.000113	0.000315
Magnesium	mg/L	-	-	-	15.3	9.14	10.9	8.01	10.2	10.7	10.2	8.01	15.3	2.79	1.25	3.46
Manganese	mg/L	-	-	-	0.00171	0.000401	0.000990	0.000390	0.000311	0.000760	0.000401	0.000311	0.00171	0.000596	0.000267	0.000740
Mercury	mg/L	-	-	-	<0.00010	<0.00010	<0.00020	<0.00010	<0.00010	<0.00020	<0.00010	<0.00010	<0.00020	0.000045	0.000020	0.000056
Molybdenum	mg/L	-	-	-	0.0431	0.0210	0.0119	0.0165	0.0246	0.0234	0.0210	0.0119	0.0431	0.0120	0.00536	0.0149
Nickel	mg/L	-	-	-	0.00195	0.00163	0.00200	0.00127	0.00188	0.00175	0.00188	0.00127	0.00200	0.000302	0.000135	0.000375
Potassium	mg/L	-	-	-	2.41	1.57	1.63	1.31	1.81	1.75	1.63	1.31	2.41	0.412	0.184	0.512
Selenium	mg/L	-	-	-	0.00128	0.00200	0.00079	0.00206	0.00083	0.00139	0.00128	0.00079	0.00206	0.000614	0.000274	0.000762
Silicon	mg/L	-	-	-	3.80	3.54	3.82	3.22	3.09	3.49	3.54	3.09	3.82	0.332	0.148	0.412
Silver	mg/L	-	-	-	<0.000010	<0.000010	<0.000020	<0.000010	<0.000010	<0.000020	<0.000010	<0.000010	<0.000020	0.0000045	0.0000020	0.0000056
Sodium	mg/L	-	-	-	23.5	10.4	9.90	8.79	12.4	13.0	10.4	8.79	23.5	6.01	2.69	7.47
Strontium	mg/L	-	-	-	0.780	0.430	0.514	0.386	0.504	0.523	0.504	0.386	0.780	0.153	0.069	0.190
Thallium	mg/L	-	-	-	<0.000010	<0.000010	<0.000020	<0.000010	<0.000010	<0.000020	<0.000010	<0.000010	<0.000020	0.0000045	0.0000020	0.0000056
Tin	mg/L	-	-	-	<0.00010	<0.00010	<0.00020	<0.00010	<0.00010	<0.00020	<0.00010	<0.00010	<0.00020	0.000045	0.000020	0.000056
Titanium	mg/L	-	-	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0
Uranium	mg/L	-	-	-	0.00396	0.00495	0.00461	0.00408	0.00428	0.00438	0.00428	0.00396	0.00495	0.000404	0.000181	0.000502
Vanadium	mg/L	-	-	-	0.0012	0.0019	<0.0020	0.0015	0.0013	0.0016	0.0015	0.0012	<0.0020	0.00036	0.00016	0.00044
Zinc	mg/L	-	-	-	<0.0030	<0.0030	0.0041	<0.0030	<0.0030	0.0032	<0.0030	<0.0030	0.0041	0.00049	0.00022	0.00061

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < highest MDL if all the data used in their calculation were < MDL. Medians are reported as the < MDL value closest to calculated median if all data are < MDL (relevant for sample sizes of 4).

[2] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.

[3] Insufficient porewater volume to analyse total or dissolved metals in sample ST16-04 or to analyse total metal concentrations in samples ST16-S2, ST16-S3 or ST16-S5.

[4] Displayed guideline value is for dissolved cadium.

[5] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.

[6] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)

(orange shading) Value is > one or all guidelines (values < MDL excluded from comparison).

Table E.9: Porewater metals data for sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014 [1].

Analyte	Units	BCWQG [2]			Upper Hazeltine Creek (ST16) [3]										
Sample ID		Type	Chronic	Acute	ST16-S1	ST16-S2	ST16-S3	ST16-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled					7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14							
Physical Tests															
Hardness (as CaCO3)	mg/L	-	-	-	463	-	-	-	463				-	-	-
Total Metals															
Aluminum	mg/L	-	-	-	0.0376	-	-	-	0.0376				-	-	-
Antimony	mg/L	W	0.01	-	0.00206	-	-	-	0.00206				-	-	-
Arsenic	mg/L	A	-	0.005	0.00245	-	-	-	0.00245				-	-	-
Barium	mg/L	W	1	-	0.0439	-	-	-	0.0439				-	-	-
Beryllium	mg/L	W	0.0001	-	<0.00020	-	-	-	<0.00020				-	-	-
Bismuth	mg/L	-	-	-	<0.0010	-	-	-	<0.0010				-	-	-
Boron	mg/L	A	-	1.2	0.110	-	-	-	0.110				-	-	-
Cadmium [4]	mg/L	A	0.00045	0.0017	<0.000020	-	-	-	<0.000020				-	-	-
Calcium	mg/L	-	-	-	145	-	-	-	145				-	-	-
Chromium [5]	mg/L	W	0.001	-	<0.00050	-	-	-	<0.00050				-	-	-
Cobalt	mg/L	A	0.004	0.11	0.00157	-	-	-	0.00157				-	-	-
Copper	mg/L	A	0.011	0.028	0.0485	-	-	-	0.0485				-	-	-
Iron	mg/L	A	-	1	<0.060	-	-	-	<0.060				-	-	-
Lead	mg/L	A	0.015	0.30	<0.00010	-	-	-	<0.00010				-	-	-
Lithium	mg/L	-	-	-	0.0083	-	-	-	0.00830				-	-	-
Magnesium	mg/L	-	-	-	25.1	-	-	-	25.1				-	-	-
Manganese	mg/L	A	1.8	3.6	0.438	-	-	-	0.438				-	-	-
Mercury	mg/L	A	0.00002	-	<0.00010	-	-	-	<0.00010				-	-	-
Molybdenum	mg/L	A	1	2	0.133	-	-	-	0.1330				-	-	-
Nickel [6]	mg/L	W	-	0.15	0.0019	-	-	-	0.00190				-	-	-
Potassium	mg/L	-	-	-	7.57	-	-	-	7.57				-	-	-
Selenium	mg/L	A	0.002	-	0.00249	-	-	-	0.0025				-	-	-
Silicon	mg/L	-	-	-	5.70	-	-	-	5.70				-	-	-
Silver	mg/L	A	0.0015	0.0030	<0.000020	-	-	-	<0.000020				-	-	-
Sodium	mg/L	-	-	-	69.0	-	-	-	69.0				-	-	-
Strontium	mg/L	-	-	-	1.75	-	-	-	1.75				-	-	-
Thallium	mg/L	W	0.0008	-	<0.000020	-	-	-	<0.000020				-	-	-
Tin	mg/L	-	-	-	<0.00020	-	-	-	<0.00020				-	-	-
Titanium	mg/L	-	-	-	<0.020	-	-	-	<0.020				-	-	-
Uranium	mg/L	W	0.01	-	0.00408	-	-	-	0.00408				-	-	-
Vanadium	mg/L	-	-	-	<0.0020	-	-	-	<0.0020				-	-	-
Zinc	mg/L	A	0.15	0.17	<0.0060	-	-	-	<0.0060				-	-	-
Dissolved Metals															
Aluminum	mg/L	A	0.05	0.10	0.0060	0.0059	0.0087	0.0109	0.0079	0.0074	0.0059	0.0109	0.0024	0.0012	0.0038
Antimony	mg/L	-	-	-	0.00195	0.00237	0.00206	0.00249	0.00222	0.00222	0.00195	0.00249	0.000254	0.000127	0.000404
Arsenic	mg/L	-	-	-	0.00225	0.00313	0.00252	0.00282	0.00268	0.00267	0.00225	0.00313	0.000380	0.000190	0.000604
Barium	mg/L	-	-	-	0.0420	0.0301	0.0702	0.0417	0.0460	0.0419	0.0301	0.0702	0.0171	0.00853	0.0271
Beryllium	mg/L	-	-	-	<0.00020	<0.00010	<0.00010	<0.00050	<0.00050	<0.00020	<0.00010	<0.00050	0.00019	0.000095	0.00030
Bismuth	mg/L	-	-	-	<0.0010	<0.00050	<0.00050	<0.0025	<0.0025	<0.0010	<0.00050	<0.0025	0.00095	0.00047	0.0015
Boron	mg/L	-	-	-	0.106	0.093	0.035	0.103	0.084	0.098	0.035	0.11	0.033	0.017	0.053
Cadmium	mg/L	A	0.00045	0.0017	<0.000020	<0.000010	0.000052	<0.000050	0.000033	<0.000050	<0.000010	0.000052	0.000021	0.000011	0.000034
Calcium	mg/L	-	-	-	145	111	67.8	94.3	105	103	67.8	145	32.3	16.2	51.4
Chromium	mg/L	-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0	0	0
Cobalt	mg/L	-	-	-	0.00147	0.00062	0.00104	<0.00050	0.00091	0.00083	<0.00050	0.00147	0.00044	0.00022	0.00070
Copper	mg/L	-	-	-	0.0352	0.0148	0.121	0.0074	0.0446	0.0250	0.0074	0.121	0.052	0.026	0.083
Iron	mg/L	A	-	0.35	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	0	0	0
Lead	mg/L	-	-	-	<0.00010	<0.000050	<0.000050	0.00061	0.00020	<0.00010	<0.000050	0.00061	0.00027	0.00014	0.00043
Lithium	mg/L	-	-	-	0.00790	0.00691	0.00418	0.00800	0.00675	0.00741	0.00418	0.00800	0.00178	0.000890	0.00283
Magnesium	mg/L	-	-	-	24.6	24.0	8.73	19.8	19.3	21.9	8.73	24.6	7.35	3.68	11.7
Manganese	mg/L	-	-	-	0.395	0.122	0.391	0.0172	0.231	0.257	0.0172	0.395	0.192	0.0958	0.305
Mercury	mg/L	-	-	-	<0.00020	<0.00010	<0.00010	<0.00010	<0.00020	<0.00010	<0.00010	<0.00020	0.000050	0.000025	0.000080
Molybdenum	mg/L	-	-	-	0.124	0.108	0.0432	0.117	0.0981	0.113	0.0432	0.124	0.0371	0.0186	0.0591
Nickel	mg/L	-	-	-	0.00180	0.00127	0.00099	<0.0025	0.0016	0.0015	0.0010	<0.0025	0.00066	0.00033	0.0011
Potassium	mg/L	-	-	-	7.27	6.28	3.33	7.35	6.06	6.78	3.33	7.35	1.88	0.941	2.99
Selenium	mg/L	-	-	-	0.00239	0.00260	0.00202	0.00200	0.00225	0.00221	0.00200	0.00260	0.00029	0.00015	0.00047
Silicon	mg/L	-	-	-	5.60	5.37	5.82	5.00	5.45	5.49	5.00	5.82	0.350	0.175	0.557
Silver	mg/L	-	-	-	<0.000020	<0.000010	<0.000010	<0.000050	<0.000050	<0.000020	<0.000010	<0.000050	0.000019	0.0000095	0.000030
Sodium	mg/L	-	-	-	65.1	56.3	10.6	59.3	47.8	57.8	10.6	65.1	25.1	12.5	39.9
Strontium	mg/L	-	-	-	1.66	1.43	0.750	1.40	1.31	1.42	0.750	1.66	0.391	0.195	0.622
Thallium	mg/L	-	-	-	<0.000020	<0.000010	<0.000010	<0.000050	<0.000050	<0.000020	<0.000010	<0.000050	0.000019	0.0000095	0.000030
Tin	mg/L	-	-	-	<0.00020	<0.00010	<0.00010	<0.00050	<0.00050	<0.00020	<0.00010	<0.00050	0.00019	0.000095	0.00030
Titanium	mg/L	-	-	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0
Uranium	mg/L	-	-	-	0.00384	0.00363	0.00141	0.00231	0.00280	0.00297	0.00141	0.00384	0.00115	0.00057	0.00182
Vanadium	mg/L	-	-	-	<0.0020	0.0017	0.0016	<0.0050	0.0026	0.0019	0.0016	<0.0050	0.0016	0.00081	0.0026
Zinc	mg/L	-	-	-	0.0055	<0.0030	0.0048	<0.0050	0.0046	0.0049	<0.0030	0.0055	0.0011	0.00055	0.0017

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < highest MDL if all the data used in their calcul were < MDL. Medians are reported as the < MDL value closest to calculated median if all data are < MDL (relevant for sample sizes of 4).

[2] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based

[3] Insufficient porewater volume to analyse total or dissolved metals in sample ST16-04 or to analyse total metal concentrations in samples ST16-S2, ST16-S3 or ST16-S5.

[4] Displayed guideline value is for dissolved cadium.

[5] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.

[6] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)

(orange) Value is > one or all guidelines (values < MDL excluded from comparison).

Table E.10: Reference values and condition-specific guidelines for the protection of aquatic life in shakeflask test water from all waterbodies, and porewater from Hazeltine Creek.

A) Selected Reference Values (Mean Values)

Analyte	Units	Leachable Metals [a] (All waterbodies)	Pore water (Hazeltine Creek)
Hardness	(mg/L)	137	279

[a] Hardness of leachable metals was calculated from reported calcium and magnesium concentrations using the equation Hardness (mg/L $CaCO_3$) = 2.497*[Ca (mg/L)] + 4.118*[Mg (mg/L)]

B) Condition-Specific Guidelines

Analyte	Jurisdiction	Approved or Working	Chronic or Acute	Condition or Equation	Applicable Guideline: Leacheable Metals (All water bodies)		Applicable Guideline: Porewater (Hazeltine Creek)	
					ug/L	mg/L	ug/L	mg/L
Cadmium (Dissolved)	BC	Approved	Long - Term	e^(0.736*(ln(hardness))-4.943)	0.267	0.000267	0.450	0.000450
			Short - Term	e^(1.03*(ln(hardness))-5.274)	0.813	0.0008	1.69	0.0017
Copper	BC	Approved	30-day average	0.04*hardness	5.48	0.005	11.2	0.011
			Maximum	0.094*hardness + 2	14.9	0.0149	28.2	0.028
Lead	BC	Approved	30-day average	3.31+ e^(1.273(ln(hardness))-4.704)	8.1	0.0081	15.1	0.0151
			Maximum	e^(1.273(ln(hardness))-1.46)	122	0.122	301	0.301
Manganese	BC	Approved	30-day average	0.0044*hardness - 0.605	1,208	1.21	1,833	1.83
			Maximum	0.01102*hardness + 0.54	2,050	2.05	3,615	3.61
Nickel [b]	BC	Working	Maximum	when hardness ≤ 60: 25 ug/L	-	-	-	-
				when hardness 60 - 180 mg/L; e^(0.76(ln(hardness))+1.06)	121	0.121	-	-
				when hardness ≥ 180 mg/L; 150 ug/L	-	-	150	0.150
Mercury [c]	BC	Approved	30-day average	when MeHg = 0.5% of THg; 0.02 ug/L	0.02	0.00002	0.02	0.00002
				when MeHg = 1.0% of THg; 0.01 ug/L	-	-	-	-
				when MeHg = 8.0% of THg; 0.00125 ug/L	-	-	-	-
Silver	BC	Approved	Condition:	H < 100 mg/L / H > 100 mg/L				
			30-day average	0.05 / 1.5	1.50	0.00150	1.5	0.0015
			Maximum	0.1 / 3	3.0	0.0030	3.0	0.0030
Zinc	BC	Approved	30-day average	when hardness <90: 7.5 ug/L				
				when hardness >90; 7.5 + 0.75 * (hardness-90)	42.8	0.043	149	0.149
			Maximum	when hardness <90: 33 ug/L				
				when hardness >90; 33 + 0.75 * (hardness-90)	68.3	0.0683	175	0.175

[b] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)

[c] Highest mercury guideline value used for application to mercury; MeHg = 0.5% of THg

Table E.11: Raw acid base accounting, sulphur, and carbon content data for sediment from sampling areas in Hazeltine Creek, Mount Polley, 2014 [1].

Parameter	Units	Lower Hazeltine Creek (ST02)											
Sample ID		ST02-S1	ST02-S2	ST02-S3	ST02-S4	ST02-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Sampling Date		7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14							
Maximum Potential Acidity (MPA)	tCaCO3/1Kt	6.3	3.8	3.8	4.1	5.3	4.7	4.1	3.8	6.3	1.1	0.49	1.4
Fizz Rating	Unity	2	2	2	2	2	2	2	2	2	0	0	0
Net Neutralization Potential (NNP)	tCaCO3/1Kt	37	47	44	41	38	41	41	37	47	4.2	1.9	5.2
pH	Unity	7.8	7.7	7.6	7.6	7.7	7.7	7.7	7.6	7.8	0.084	0.037	0.10
Neutralization Potential (NP)	tCaCO3/1Kt	43	51	48	45	43	46	45	43	51	3.5	1.5	4.3
Neutralization Potential Ratio (NP/MPA)	Unity	6.88	13.6	12.8	11.08	8.09	10.5	11.1	6.88	13.6	2.92	1.31	3.63
Total Sulphur (S) - Leco	%	0.20	0.12	0.12	0.13	0.17	0.15	0.13	0.12	0.2	0.036	0.016	0.044
Sulphide Sulphur (S) - Calculated Leco	%	0.19	0.11	0.11	0.13	0.15	0.14	0.13	0.11	0.19	0.033	0.015	0.042
Sulphate Sulphur (S) - Carbonate Leach	%	0.01	0.01	0.01	<0.01	0.02	0.01	0.01	<0.01	0.02	0.004	0.002	0.006
Inorganic Carbon (C)	%	0.45	0.55	0.51	0.45	0.4	0.47	0.45	0.40	0.55	0.058	0.026	0.073
Carbon Dioxide (CO2)	%	1.7	2.0	1.9	1.7	1.5	1.8	1.7	1.5	2.0	0.19	0.087	0.24
Sulphate Sulphur (S) - HCl leachable	%	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.004	0.002	0.006

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Summary statistics are reported as < MDL if all the data used in their calculation were < MDL.

[shaded] Indicates Neutralization Potential Ratio > 4; no potential for Acid Rock Drainage (Price 1997)

Table E.11: Raw acid base accounting, sulphur, and carbon content data for sediment from sampling areas in Hazeltine Creek, Mount Polley, 2014 [1].

Parameter	Units	Mid Hazeltine Creek (ST09)											
Sample ID		ST09-S1	ST09-S2	ST09-S3	ST09-S4	ST09-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Sampling Date		7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14							
Maximum Potential Acidity (MPA)	tCaCO3/1Kt	3.1	2.8	2.5	3.1	3.8	3.1	3.1	2.5	3.8	0.48	0.22	0.60
Fizz Rating	Unity	2	2	2	2	2	2	2	2	2	0	0	0
Net Neutralization Potential (NNP)	tCaCO3/1Kt	54	52	57	54	50	53	54	50	57	2.6	1.2	3.2
pH	Unity	7.8	7.9	7.8	7.7	7.8	7.8	7.8	7.7	7.9	0.071	0.032	0.088
Neutralization Potential (NP)	tCaCO3/1Kt	57	55	59	57	54	56	57	54	59	1.9	0.87	2.4
Neutralization Potential Ratio (NP/MPA)	Unity	18.2	19.6	23.6	18.2	14.4	18.8	18.2	14.4	23.6	3.30	1.48	4.10
Total Sulphur (S) - Leco	%	0.1	0.09	0.08	0.1	0.12	0.10	0.1	0.08	0.12	0.01	0.007	0.02
Sulphide Sulphur (S) - Calculated Leco	%	0.1	0.08	0.08	0.1	0.11	0.09	0.1	0.08	0.11	0.01	0.006	0.02
Sulphate Sulphur (S) - Carbonate Leach	%	<0.01	0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	0.01	0	0	0
Inorganic Carbon (C)	%	0.64	0.63	0.48	0.61	0.61	0.59	0.61	0.48	0.64	0.065	0.029	0.081
Carbon Dioxide (CO2)	%	2.3	2.3	1.7	2.2	2.3	2.2	2.3	1.7	2.3	0.26	0.12	0.32
Sulphate Sulphur (S) - HCl leachable	%	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.03	0.004	0.002	0.006

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Summary statistics are reported as < MDL if all the data used in their calculation were < MDL.

[shaded cell] Indicates Neutralization Potential Ratio > 4; no potential for Acid Rock Drainage (Price 1997)

Table E.11: Raw acid base accounting, sulphur, and carbon content data for sediment from sampling areas in Hazeltine Creek, Mount Polley, 2014 [1].

Parameter	Units	Upper Hazeltine Creek (ST16)											
Sample ID		ST16-S1	ST16-S2	ST16-S3	ST16-S4	ST16-S5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Sampling Date		7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14	7-Oct-14							
Maximum Potential Acidity (MPA)	tCaCO3/1Kt	7.5	6.3	7.8	6.9	6.9	7.1	6.9	6.3	7.8	0.58	0.26	0.73
Fizz Rating	Unity	2	2	2	2	2	2	2	2	2	0	0	0
Net Neutralization Potential (NNP)	tCaCO3/1Kt	27	28	26	29	28	28	28	26	29	1.1	0.51	1.4
pH	Unity	7.7	7.4	7.4	7.5	7.3	7.5	7.4	7.3	7.7	0.15	0.07	0.19
Neutralization Potential (NP)	tCaCO3/1Kt	34	34	34	36	35	35	34	34	36	0.89	0.40	1.1
Neutralization Potential Ratio (NP/MPA)	Unity	4.53	5.44	4.35	5.24	5.09	4.93	5.09	4.35	5.44	0.47	0.21	0.58
Total Sulphur (S) - Leco	%	0.24	0.2	0.25	0.22	0.22	0.23	0.22	0.20	0.25	0.019	0.0087	0.024
Sulphide Sulphur (S) - Calculated Leco	%	0.23	0.19	0.24	0.21	0.2	0.21	0.21	0.19	0.24	0.021	0.0093	0.026
Sulphate Sulphur (S) - Carbonate Leach	%	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.004	0.002	0.006
Inorganic Carbon (C)	%	0.33	0.32	0.36	0.34	0.35	0.34	0.34	0.32	0.36	0.016	0.0071	0.020
Carbon Dioxide (CO2)	%	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.2	1.3	0.055	0.024	0.068
Sulphate Sulphur (S) - HCl leachable	%	0.03	0.02	0.03	0.03	0.02	0.03	0.03	0.02	0.03	0.005	0.002	0.007

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Summary statistics are reported as < MDL if all the data used in their calculation were < MDL.

[shaded] Indicates Neutralization Potential Ratio > 4; no potential for Acid Rock Drainage (Price 1997)

Table E.12: Summary of neutralization potential ratio of sediment, Mount Polley Mine, 2014.

Waterbody		Sampling Area	Neutralization Potential Ratio (NP/MPA)	
			Mean	t*SE
Hazeltine Creek	Upper	ST16	4.9	0.58
	Mid	ST09	19	4.1
	Lower	ST02	10	3.6
Polley and Bootjack Lakes	Mid-depth	BOL-1 (Reference)	0.44	0.15
		POL-1 (North)	6.1	3.0
		POL-2 (South)	9.9	3.5
	Basins	BOL-B1 (Reference)	0.38	0.087
		BOL-B2 (Reference)	0.23	0.057
		POL-P1 [1] (North)	2.3	-
		POL-P2 (South)	1.5	2.0
Quesnel Lake Littoral	Reference	LRef1 (QUL-51)	5.6	0.70
		LRef2 Composite (QUL-52)	8.0	-
	Exposed	LNF1 (QUL-45)	10	2.3
		LNF2 (QUL-49)	13	1.0
		LFF Composite (QUL-47)	3.8	-
		LFFF Composite (QUL-48)	1.1	-
Quesnel Lake Profundal	Reference	PRef1 (QULP-5)	3.9	0.56
		PRef2 Composite (QULP-6)	9.6	-
	Exposed	PNF (QULP-1)	13	6.0
		PFF2 Composite (QULP-4)	8.2	-
		PFF1 (QULP-2)	11	2.1
		PFFF Composite (QULP-3)	6.4	-

[Shaded box] Indicates Neutralization Potential Ratio > 4; no potential for Acid Rock Drainage (Price 1997)

[1] Results are based on one sample (POL-P1-01); sample volume was insufficient to perform analyses on other samples from this area.

Table E.13: Raw selectively extracted (Tessier extraction) metals data for Hazeltine Creek size-fractioned sediment sample HAC50, Mount Polley Mine, 2014.

Analyte	Units	BC SQG [1]		CSR [2]		Historic Hazeltine Creek 95th Percentile [3] (total metal concentration)		HAC50			
Size Fraction		TEL	PEL	Sensitive	Typical	Lower Creek	Upper Creek	<25µm	63µm - 25µm	125µm - 63µm	2mm - 125µm
Date Sampled								23-Aug-14	23-Aug-14	23-Aug-14	23-Aug-14
Exchangeable & Adsorbed Metals											
Aluminum	mg/kg	-	-	-	-	12,550	18,000	<50	<50	<50	<50
Antimony	mg/kg	-	-	-	-	1.3	0.37	<0.10	<0.10	<0.10	<0.10
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	0.064	0.077	0.058	0.058
Barium	mg/kg	-	-	-	-	104	136	<50	<45	<40	<35
Beryllium	mg/kg	-	-	-	-	0.30	0.46	<0.20	<0.20	<0.20	<0.20
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	<0.050	<0.050	<0.050	<0.050
Calcium	mg/kg	-	-	-	-	7,030	13,400	1,930	1,830	1,810	1,860
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	<0.50	<0.50	<0.50	<0.50
Cobalt	mg/kg	-	-	-	-	11.0	10.4	<0.10	<0.10	<0.10	<0.10
Copper	mg/kg	35.7	197	120	240	42.0	94.6	2.78	4.24	4.51	4.01
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	<50	<50	<50	<50
Lead	mg/kg	35	91	57	110	5.6	6.7	<0.50	<0.50	<0.50	<0.50
Lithium	mg/kg	-	-	-	-	12.9	14.8	<5.0	<5.0	<5.0	<5.0
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	11.5	10.7	10.5	10.3
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	<1.1	<1.2	<1.2	<1.1
Nickel	mg/kg	16	75	-	-	24	24	<0.50	<0.50	<0.50	<0.50
Phosphorus	mg/kg	-	-	-	-	729	1,380	<50	<50	<50	<50
Potassium	mg/kg	-	-	-	-	910	1,450	260	250	200	180
Selenium	mg/kg	2	-	-	-	1.3	3.3	0.24	<0.20	<0.20	<0.20
Silver	mg/kg	0.5	-	-	-	0.10	0.16	<0.10	<0.10	<0.10	<0.10
Sodium	mg/kg	-	-	-	-	253	350	210	210	190	160
Strontium	mg/kg	-	-	-	-	67.1	118	30.0	27.9	24.6	24.1
Thallium	mg/kg	-	-	-	-	0.051	0.094	<0.050	<0.050	<0.050	<0.050
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0
Titanium	mg/kg	-	-	-	-	701	776	<1.0	<1.0	<1.0	<1.0
Uranium	mg/kg	-	-	-	-	0.73	1.26	<0.050	<0.050	<0.050	<0.050
Vanadium	mg/kg	-	-	-	-	75	65	<0.20	<0.20	<0.20	<0.20
Zinc	mg/kg	123	315	200	380	60.2	67.6	5.1	<1.0	<1.0	<1.0
Carbonate Metals											
Aluminum	mg/kg	-	-	-	-	12,550	18,000	<50	<50	<50	<50
Antimony	mg/kg	-	-	-	-	1.3	0.37	<0.10	<0.10	<0.10	<0.10
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	<0.050	<0.050	<0.050	<0.050
Barium	mg/kg	-	-	-	-	104	136	62.5	58.6	52.6	53.8
Beryllium	mg/kg	-	-	-	-	0.30	0.46	<0.20	<0.20	<0.20	<0.20
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	<0.050	<0.050	<0.050	<0.050
Calcium	mg/kg	-	-	-	-	7,030	13,400	8,250	8,890	8,510	8,710
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	<5.0	<5.0	<5.0	<5.0
Cobalt	mg/kg	-	-	-	-	11.0	10.4	<0.10	<0.10	<0.10	<0.10
Copper	mg/kg	35.7	197	120	240	42.0	94.6	22.9	19.6	18.1	18.4
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	<50	<50	<50	<50
Lead	mg/kg	35	91	57	110	5.6	6.7	<0.50	<0.50	<0.50	<0.50
Lithium	mg/kg	-	-	-	-	12.9	14.8	<5.0	<5.0	<5.0	<5.0
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	52.0	52.8	52.5	54.4
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	<0.50	<0.50	<0.50	<0.50
Nickel	mg/kg	16	75	-	-	24	24	<2.0	<2.0	<2.0	<2.0
Phosphorus	mg/kg	-	-	-	-	729	1,380	<50	<50	<50	<50
Selenium	mg/kg	2	-	-	-	1.3	3.3	<0.20	<0.20	<0.20	<0.20
Silver	mg/kg	0.5	-	-	-	0.10	0.16	<0.10	<0.10	<0.10	<0.10
Strontium	mg/kg	-	-	-	-	67	118	56.7	53.1	48.1	48.2
Thallium	mg/kg	-	-	-	-	0.051	0.094	<0.050	<0.050	<0.050	<0.050
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0
Titanium	mg/kg	-	-	-	-	701	776	<5.0	<5.0	<5.0	<5.0
Uranium	mg/kg	-	-	-	-	0.73	1.26	<0.050	<0.050	<0.050	<0.050
Vanadium	mg/kg	-	-	-	-	75	65.3	<0.20	<0.20	<0.20	<0.20
Zinc	mg/kg	123	315	200	380	60.2	67.6	16.5	<1.0	<1.0	<1.0
Easily Reducible Metals and Iron Oxides											
Aluminum	mg/kg	-	-	-	-	12,550	18,000	1,910	1,800	1,570	1,740
Antimony	mg/kg	-	-	-	-	1.3	0.37	<0.10	<0.10	<0.10	<0.10
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	1.75	1.66	1.54	1.87
Barium	mg/kg	-	-	-	-	104	136	32.1	25.2	19.6	21.7
Beryllium	mg/kg	-	-	-	-	0.30	0.46	0.26	0.24	0.23	<0.20
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	0.072	0.076	0.076	0.073
Calcium	mg/kg	-	-	-	-	7,030	13,400	8,180	6,680	5,710	4,910
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	2.69	2.42	2.09	2.19
Cobalt	mg/kg	-	-	-	-	11.0	10.4	2.14	1.98	1.67	1.82
Copper	mg/kg	35.7	197	120	240	42.0	94.6	**344**	**301**	**243**	**252**
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	4,040	4,050	3,410	3,600
Lead	mg/kg	35	91	57	110	5.6	6.7	3.84	3.51	3.09	3.11
Lithium	mg/kg	-	-	-	-	12.9	14.8	<5.0	<5.0	<5.0	<5.0
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	137	129	111	115
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	0.51	<0.50	<0.50	<0.50
Nickel	mg/kg	16	75	-	-	24	24	1.92	1.52	1.29	1.50
Phosphorus	mg/kg	-	-	-	-	729	1,380	104	77	84	111
Selenium	mg/kg	2	-	-	-	1.3	3.3	<0.20	<0.20	<0.20	<0.20
Silver	mg/kg	0.5	-	-	-	0.10	0.16	<0.10	<0.10	<0.10	<0.10
Strontium	mg/kg	-	-	-	-	67	118	30.0	26.8	23.0	22.7
Thallium	mg/kg	-	-	-	-	0.051	0.094	<0.050	<0.050	<0.050	<0.050
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0
Titanium	mg/kg	-	-	-	-	701	776	1.3	<1.0	<1.0	1.0
Uranium	mg/kg	-	-	-	-	0.73	1.26	0.193	0.187	0.165	0.161
Vanadium	mg/kg	-	-	-	-	75	65.3	12.7	12.5	10.7	11.3
Zinc	mg/kg	123	315	200	380	60.2	67.6	41.9	12.0	9.9	10.6

[1] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[2] Contaminated Sites Regulation (Government of British Columbia 1996).
[3] Historic sediment metal concentrations are based predominantly on bulk sediment samples.
(blue) Value is > TEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.
(orange) Value is > PEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

Table E.13: Raw selectively extracted (Tessier extraction) metals data for Hazeltine Creek size-fractioned sediment sample HAC50, Mount Polley Mine, 2014.

Analyte	Units	BC SQG [1]		CSR [2]		Historic Hazeltine Creek 95th Percentile [3] (total metal concentration)		HAC50			
Size Fraction		**TEL**	**PEL**	**Sensitive**	**Typical**	**Lower Creek**	**Upper Creek**	**<25µm**	**63µm - 25µm**	**125µm - 63µm**	**2mm - 125µm**
Date Sampled								23-Aug-14	23-Aug-14	23-Aug-14	23-Aug-14
Organic Bound Metals											
Aluminum	mg/kg	-	-	-	-	12,550	18,000	1,220	1,130	1,060	1,000
Antimony	mg/kg	-	-	-	-	1.3	0.37	<0.10	<0.10	<0.10	<0.10
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	2.10	1.71	1.98	1.49
Barium	mg/kg	-	-	-	-	104	136	25.0	22.4	20.3	17.1
Beryllium	mg/kg	-	-	-	-	0.30	0.46	<0.20	<0.20	<0.20	<0.20
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	<0.050	<0.050	<0.050	<0.050
Calcium	mg/kg	-	-	-	-	7,030	13,400	1,670	1,420	1,460	1,300
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	<0.50	<0.50	<0.50	<0.50
Cobalt	mg/kg	-	-	-	-	11.0	10.4	2.00	1.86	1.68	1.63
Copper	mg/kg	35.7	197	120	240	42.0	94.6	**421**	**446**	**480**	**516**
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	723	700	600	563
Lead	mg/kg	35	91	57	110	5.6	6.7	1.07	1.15	1.21	0.96
Lithium	mg/kg	-	-	-	-	12.9	14.8	<5.0	<5.0	<5.0	<5.0
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	17.1	15.7	14.4	14.3
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	0.81	0.90	0.90	1.04
Nickel	mg/kg	16	75	-	-	24	24	<0.50	<0.50	<0.50	<0.50
Selenium	mg/kg	2	-	-	-	1.3	3.3	0.89	0.83	0.77	0.78
Silver	mg/kg	0.5	-	-	-	0.10	0.16	<0.10	<0.10	<0.10	<0.10
Strontium	mg/kg	-	-	-	-	67	118	10.9	12.9	12.4	12.0
Thallium	mg/kg	-	-	-	-	0.051	0.094	<0.050	<0.050	<0.050	<0.050
Tin	mg/kg	-	-	-	-	1.1	0.70	<2.0	<2.0	<2.0	<2.0
Titanium	mg/kg	-	-	-	-	701	776	1.8	1.3	1.7	1.8
Uranium	mg/kg	-	-	-	-	0.73	1.26	0.147	0.142	0.138	0.125
Vanadium	mg/kg	-	-	-	-	74.5	65.3	1.06	0.98	0.96	0.91
Zinc	mg/kg	123	315	200	380	60.2	67.6	5.1	4.5	5.0	5.2
Residual Metals											
Aluminum	mg/kg	-	-	-	-	12,550	18,000	22,600	20,800	18,400	18,700
Antimony	mg/kg	-	-	-	-	1.3	0.37	0.56	0.40	0.29	0.39
Arsenic	mg/kg	5.9	17	11	20	12.1	8.2	**13.2**	11.9	10.4	10.8
Barium	mg/kg	-	-	-	-	104	136	112	107	98.2	98.6
Beryllium	mg/kg	-	-	-	-	0.30	0.46	0.68	0.63	0.56	0.64
Bismuth	mg/kg	-	-	-	-	20	16	<0.20	<0.20	<0.20	<0.20
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.24	0.35	<0.050	<0.050	<0.050	<0.050
Calcium	mg/kg	-	-	-	-	7,030	13,400	17,700	16,300	13,600	14,600
Chromium	mg/kg	37.3	90	56	110	33.1	40.1	12.7	10.1	8.9	9.0
Cobalt	mg/kg	-	-	-	-	11.0	10.4	21.2	20.0	17.9	17.0
Copper	mg/kg	35.7	197	120	240	42.0	94.6	**164**	**157**	**181**	**185**
Iron	mg/kg	21,200	43,776	-	-	35,400	29,900	**54,200**	**48,900**	**41,900**	**43,400**
Lead	mg/kg	35	91	57	110	5.6	6.7	3.60	3.17	3.24	2.80
Lithium	mg/kg	-	-	-	-	12.9	14.8	25.8	24.6	22.9	22.4
Manganese	mg/kg	460	1,100	-	-	1,120	1,350	771	731	629	661
Molybdenum	mg/kg	-	-	-	-	0.75	1.5	2.99	2.73	2.75	2.88
Nickel	mg/kg	16	75	-	-	24	24	11.6	10.1	9.0	8.5
Selenium	mg/kg	2	-	-	-	1.3	3.3	0.21	0.22	0.23	0.25
Silver	mg/kg	0.5	-	-	-	0.10	0.16	0.30	0.30	0.28	0.29
Strontium	mg/kg	-	-	-	-	67	118	95.5	84.3	74.4	94.8
Thallium	mg/kg	-	-	-	-	0.051	0.094	<0.050	<0.050	<0.050	<0.050
Tin	mg/kg	-	-	-	-	1.1	0.70	2.9	2.1	<2.0	2.0
Titanium	mg/kg	-	-	-	-	701	776	2,520	1,790	1,390	1,860
Uranium	mg/kg	-	-	-	-	0.73	1.26	1.27	0.960	0.781	0.940
Vanadium	mg/kg	-	-	-	-	74.5	65.3	205	187	156	169
Zinc	mg/kg	123	315	200	380	60.2	67.6	72.4	68.1	63.2	60.2

[1] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[2] Contaminated Sites Regulation (Government of British Columbia 1996).

[3] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

(blue) Value is > TEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed both upper and lower Hazeltine Creek Historic 95th Percentile values.

Table E.14: Raw leachable metals data for Hazeltine Creek size-fractioned sediment sample HAC50, Mount Polley Mine, 2014.

Analyte	Units	BCWQG [1]			HWR [2]	HAC50			
Size Fraction						<25µm	63µm - 25µm	125µm - 63µm	2mm - 125µm
Date Sampled		Type	Chronic	Acute		23-Aug-14	23-Aug-14	23-Aug-14	23-Aug-14
Leachable Metals									
Aluminum	mg/L	-	-	-	-	<0.20	<0.20	<0.20	<0.20
Antimony	mg/L	W	0.009	-	-	<0.050	<0.050	<0.050	<0.050
Arsenic	mg/L	A	-	0.0050	2.5	<0.050	<0.050	<0.050	<0.050
Barium	mg/L	W	1.0	-	100	0.039	0.037	0.037	0.038
Beryllium	mg/L	W	0.00013	-	-	<0.0050	<0.0050	<0.0050	<0.0050
Bismuth	mg/L	-	-	-	-	<0.10	<0.10	<0.10	<0.10
Cadmium	mg/L	A	0.00027	0.00081	0.50	<0.010	<0.010	<0.010	<0.010
Calcium	mg/L	-	-	-	-	21.1	22.0	30.0	49.1
Chromium [3]	mg/L	W	0.001	-	5	<0.010	<0.010	<0.010	<0.010
Cobalt	mg/L	A	0.0040	0.11	-	<0.010	<0.010	<0.010	<0.010
Copper	mg/L	A	0.0055	0.015	100	0.017	0.014	0.014	0.012
Iron	mg/L	A	-	1.0	-	<0.030	<0.030	<0.030	<0.030
Lead	mg/L	A	0.008	0.12	5	<0.050	<0.050	<0.050	<0.050
Magnesium	mg/L	-	-	-	-	2.75	2.67	3.37	5.01
Manganese	mg/L	A	1.21	2.05	-	0.0155	0.0123	0.0167	0.0286
Mercury	mg/L	A	0.00002	-	0.1	<0.000050	<0.000050	<0.000050	<0.000050
Molybdenum	mg/L	A	1	2	-	0.122	0.130	0.135	0.103
Nickel [4]	mg/L	W	-	0.121	-	<0.050	<0.050	<0.050	<0.050
Phosphorus	mg/L	A	-	0.0050-0.015	-	<0.30	<0.30	<0.30	<0.30
Potassium	mg/L	-	-	-	-	10.2	9.5	9.6	10.5
Selenium	mg/L	A	0.002	-	1	<0.050	<0.050	<0.050	<0.050
Silicon	mg/L	-	-	-	-	6.35	6.67	6.23	5.99
Silver	mg/L	A	0.0015	0.003	5	<0.010	<0.010	<0.010	<0.010
Sodium	mg/L	-	-	-	-	48.7	46.6	46.7	42.4
Strontium	mg/L	-	-	-	-	0.355	0.356	0.426	0.634
Thallium	mg/L	W	0.0008	-	-	<0.20	<0.20	<0.20	<0.20
Tin	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030
Titanium	mg/L	-	-	-	-	<0.010	<0.010	<0.010	<0.010
Uranium	mg/L	W	0.0085	-	10	<0.50	<0.50	<0.50	<0.50
Vanadium	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030
Zinc	mg/L	A	0.043	0.068	500	<0.020	<0.020	<0.020	<0.020

[1] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.
[2] Hazardous Waste Regulation (Government of British Columbia 1988)
[3] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.
[4] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)
(orange) Value is > one or all guidelines (values < MDL excluded from comparison).

Table E.15: Raw sediment quality data for mid-depth stations in Polley Lake, Mount Polley Mine, 2014. Metals data are based on the <2mm fraction of sediment[1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		POL-1 (North Polley Lake)												
		TEL	PEL	Sensitive	Typical	Historical Polley Mid-depth 95th Percentile [5]	Bootjack 2014 Mid-depth 95th Percentile (<2mm)	POL-1-01	POL-1-02	POL-1-03	POL-1-04	POL-1-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								21-Oct-14	20-Oct-14	21-Oct-14	21-Oct-14	22-Oct-14							
Physical Tests [6]																			
Moisture	%	-	-	-	-	-	94.1	69.3	71.9	70.4	55.3	60.5	65.5	69.3	55.3	71.9	7.22	3.23	8.96
pH (1:2 soil:water)	pH	-	-	-	-	-	6.3	-	-	-	-	-	-	-	-	-	-	-	-
Particle Size [7]																			
% Gravel (>2mm)	%	-	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	-	7.8	1.03	1.13	2.73	1.16	4.66	2.14	1.16	1.03	4.66	1.57	0.704	1.95
% Silt (0.063mm - 4µm)	%	-	-	-	-	-	88.1	91.3	93.2	91.8	91.5	89.8	91.5	91.5	89.8	93.2	1.22	0.544	1.51
% Clay (<4µm)	%	-	-	-	-	-	15.6	7.71	5.65	5.52	7.33	5.57	6.36	5.65	5.52	7.71	1.07	0.479	1.33
Texture	-	-	-	-	-	-	-	Silt	Silt	Silt	Silt	Silt	-	-	-	-	-	-	-
Leachable Anions & Nutrients [6]																			
pH	pH	-	-	-	-	-	6.0	7.13	6.97	7.01	7.17	7.17	7.09	7.13	6.97	7.17	0.0938	0.0420	0.116
Anions and Nutrients [6]																			
Total Nitrogen by LECO	%	-	-	-	-	-	1.9	0.236	0.525	0.148	0.047	0.065	0.204	0.148	0.047	0.525	0.194	0.087	0.241
Organic / Inorganic Carbon [7]																			
Total Organic Carbon	%	-	-	-	-	16.6	18.9	7.33	2.63	0.68	1.35	3.69	3.14	2.63	0.68	7.33	2.62	1.17	3.25
Metals [6]																			
Aluminum	mg/kg	-	-	-	-	6,700	21,160	25,400	21,600	20,500	22,500	20,700	22,140	21,600	20,500	25,400	1,988	889	2,468
Antimony	mg/kg	-	-	-	-	<10	1.02	0.49	0.47	0.51	0.52	0.48	0.49	0.49	0.47	0.52	0.021	0.0093	0.026
Arsenic	mg/kg	5.9	17	11	20	12.9	6.65	11.4	11.3	11.3	12.5	11.3	11.6	11.3	11.3	12.5	0.53	0.24	0.65
Barium	mg/kg	-	-	-	-	141	233	248	221	228	259	237	239	237	221	259	15.2	6.82	18.9
Beryllium	mg/kg	-	-	-	-	0.60	0.77	0.78	0.74	0.71	0.76	0.71	0.74	0.74	0.71	0.78	0.031	0.014	0.038
Bismuth	mg/kg	-	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Boron	mg/kg	-	-	-	-	-	19	12	12	11	11	11	11	11	11	12	0.55	0.24	0.68
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.656	0.531	0.166	0.178	0.147	0.114	0.144	0.150	0.147	0.114	0.178	0.0244	0.0109	0.030
Calcium	mg/kg	-	-	-	-	9,000	10,660	26,900	26,200	25,000	29,000	27,500	26,920	26,900	25,000	29,000	1,489	666	1,848
Chromium	mg/kg	37.3	90	56	110	45.7	41.9	20.3	23.1	15.3	12.2	15.2	17.2	15.3	12.2	23.1	4.39	1.96	5.45
Cobalt	mg/kg	-	-	-	-	13.0	12.4	19.0	16.2	15.2	17.0	15.7	16.6	16.2	15.2	19.0	1.49	0.665	1.85
Copper	mg/kg	35.7	197	120	240	510	450	625	522	539	567	555	**562**	**555**	**522**	**625**	39	18	49
Iron	mg/kg	21,200	43,776	-	-	17,700	25,820	26,900	27,800	25,200	26,000	27,000	**26,580**	**26,900**	25,200	**27,800**	1,001	448	1,243
Lead	mg/kg	35	91	57	110	<30	12.0	7.73	7.11	6.34	6.23	6.39	6.76	6.39	6.23	7.73	0.644	0.288	0.799
Lithium	mg/kg	-	-	-	-	-	14.8	23.7	19.2	18.5	21.0	18.6	20.2	19.2	18.5	23.7	2.20	0.98	2.73
Magnesium	mg/kg	-	-	-	-	6,300	6,340	14,400	11,300	10,300	12,200	11,200	11,880	11,300	10,300	14,400	1,561	698	1,938
Manganese	mg/kg	460	1,100	-	-	469	968	891	848	792	759	836	825	836	759	891	51.1	22.9	63.5
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.182	0.392	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum	mg/kg	-	-	-	-	4.85	4.63	3.11	3.41	3.76	3.23	3.44	3.39	3.41	3.11	3.76	0.247	0.110	0.306
Nickel	mg/kg	16	75	-	-	25.1	30.5	17.2	17.0	12.7	11.4	12.6	14.2	12.7	11.4	17.2	2.72	1.21	3.37
Phosphorus	mg/kg	-	-	-	-	-	1,426	1,290	1,490	1,260	1,410	1,410	1,372	1,410	1,260	1,490	95.0	42.5	118
Potassium	mg/kg	-	-	-	-	-	1,626	2,450	2,230	2,490	2,640	2,670	2,496	2,490	2,230	2,670	176	78.7	219
Selenium	mg/kg	2	-	-	-	5.99	2.94	1.61	1.75	1.52	1.05	1.39	1.46	1.52	1.05	1.75	0.266	0.119	0.33
Silver	mg/kg	0.5	-	-	-	<2.0	0.44	0.27	0.30	0.24	0.24	0.25	0.26	0.25	0.24	0.30	0.025	0.011	0.032
Sodium	mg/kg	-	-	-	-	-	228	1,350	1,050	1,410	1,440	1,390	1,328	1,390	1,050	1,440	159	71.0	197
Strontium	mg/kg	-	-	-	-	-	121	234	213	253	258	246	241	246	213	258	18.0	8.03	22.3
Thallium	mg/kg	-	-	-	-	-	0.161	<0.050	0.052	<0.050	<0.050	<0.050	0.050	<0.050	<0.050	0.052	0.00089	0.00040	0.0011
Tin	mg/kg	-	-	-	-	<5.0	<2.0	<2.0	<2.0	<2.0	2.0	<2.0	2.0	<2.0	<2.0	2.0	0	0	0
Titanium	mg/kg	-	-	-	-	-	698	1,890	1,500	1,500	1,790	1,670	1,670	1,670	1,500	1,890	174	77.7	216
Uranium	mg/kg	-	-	-	-	-	2.84	1.25	1.28	1.16	1.18	1.19	1.21	1.19	1.16	1.28	0.0507	0.0227	0.0629
Vanadium	mg/kg	-	-	-	-	137	73.6	96.3	99.6	97.1	99.8	104	99.4	100	96.3	104	3.01	1.35	3.74
Zinc	mg/kg	123	315	200	380	82.9	81.6	73.5	65.1	57.9	61.9	59.5	63.6	61.9	57.9	73.5	6.17	2.76	7.66

[1] Reported TOC, TN, pH and moisture data are based on bulk sediment. Data < method detection limit (MDL) were used at the MDL for calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] The 5th percentile is reported for pH.

[5] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

[6] Samples were collected using a sediment corer.

[7] Samples were collected using a petite ponar.

Value is > TEL. Values shown in bold text also exceed both Reference values.

Value is > PEL. Values shown in bold text also exceed both Reference values.

Table E.15: Raw sediment quality data for mid-depth stations in Polley Lake, Mount Polley Mine, 2014. Metals data are based on the <2mm fraction of sediment[1].

Sample ID	Units	BC SQGs[2]		CSR[3]		Reference Value[4]		POL-2 (South Polley Lake)											
		TEL	PEL	Sensitive	Typical	Historical Polley Mid-depth 95th Percentile[5]	Bootjack 2014 Mid-depth 95th Percentile (<2mm)	POL-2-01	POL-2-02	POL-2-O3	POL-2-O4	POL-2-O5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								22-Oct-14	22-Oct-14	24-Oct-14	24-Oct-14	24-Oct-14							
Physical Tests[6]																			
Moisture	%	-	-	-	-	-	94.1	58.9	61.0	87.9	47.9	54.5	62.0	58.9	47.9	87.9	15.3	6.84	19.0
pH (1:2 soil:water)	pH	-	-	-	-	-	6.3	-	-	7.94	8.49	8.30	8.24	8.30	7.94	8.49	0.279	0.161	0.694
Particle Size[7]																			
% Gravel (>2mm)	%	-	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	-	7.8	22.8	22.0	12.5	14.7	6.97	15.8	14.7	6.97	22.8	6.66	2.98	8.27
% Silt (0.063mm - 4µm)	%	-	-	-	-	-	88.1	73.7	74.7	78.6	78.3	87.7	78.6	78.3	73.7	87.7	5.53	2.47	6.86
% Clay (<4µm)	%	-	-	-	-	-	15.6	3.49	3.39	8.94	7.02	5.34	5.64	5.34	3.39	8.94	2.38	1.06	2.95
Texture	-	-	-	-	-	-	-	Silt loam	Silt loam	Silt	Silt loam	Silt	-	-	-	-	-	-	-
Leachable Anions & Nutrients[6]																			
pH	pH	-	-	-	-	-	6.0	7.16	7.34	8.34[6]	7.85[6]	7.39[6]	7.62	7.39	7.16	8.34	0.48	0.214	0.59
Anions and Nutrients[6]																			
Total Nitrogen by LECO	%	-	-	-	-	-	1.9	0.189	0.174	0.664	<0.020	0.077	0.225	0.174	<0.020	0.664	0.255	0.114	0.317
Organic / Inorganic Carbon[7]																			
Total Organic Carbon	%	-	-	-	-	16.6	18.9	1.88	0.48	0.20	0.48	1.06	0.82	0.48	0.20	1.88	0.67	0.30	0.83
Metals[6]																			
Aluminum	mg/kg	-	-	-	-	6,700	21,160	18,400	22,800	25,900	17,600	19,800	20,900	19,800	17,600	25,900	3,426	1,532	4,254
Antimony	mg/kg	-	-	-	-	<10	1.02	0.42	0.52	0.69	0.49	0.50	0.52	0.50	0.42	0.69	0.10	0.045	0.12
Arsenic	mg/kg	5.9	17	11	20	12.9	6.65	11.2	12.4	10.7	12.4	12.7	11.9	12.4	10.7	12.7	0.876	0.392	1.09
Barium	mg/kg	-	-	-	-	141	233	189	253	231	209	230	222	230	189	253	24.3	10.9	30.2
Beryllium	mg/kg	-	-	-	-	0.60	0.77	0.64	0.76	0.79	0.72	0.70	0.72	0.72	0.64	0.79	0.058	0.026	0.072
Bismuth	mg/kg	-	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Boron	mg/kg	-	-	-	-	-	19	11	12	18	<10	10	12	11	<10	18	3.3	1.5	4
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.656	0.531	0.138	0.125	0.369	0.109	0.122	0.173	0.125	0.109	0.369	0.110	0.049	0.137
Calcium	mg/kg	-	-	-	-	9,000	10,660	25,500	28,700	21,500	30,300	30,400	27,280	28,700	21,500	30,400	3,790	1,695	4,705
Chromium	mg/kg	37.3	90	56	110	45.7	41.9	18.5	16.3	37.0	9.99	11.1	18.6	16.3	10.0	37.0	10.9	4.9	13.5
Cobalt	mg/kg	-	-	-	-	13.0	12.4	15.4	17.6	20.0	14.9	15.5	16.7	15.5	14.9	20.0	2.13	0.95	2.6
Copper	mg/kg	35.7	197	120	240	510	450	520	614	606	549	574	**573**	**574**	**520**	**614**	39.2	17.5	48.7
Iron	mg/kg	21,200	43,776	-	-	17,700	25,820	42,900	39,200	30,700	42,500	31,200	**37,300**	**39,200**	**30,700**	**42,900**	5,975	2,672	7,417
Lead	mg/kg	35	91	57	110	<30	12.0	5.54	6.09	7.57	4.90	5.48	5.92	5.54	4.90	7.57	1.02	0.45	1.26
Lithium	mg/kg	-	-	-	-	-	14.8	16.0	18.7	21.7	14.3	16.3	17.4	16.3	14.3	21.7	2.87	1.28	3.56
Magnesium	mg/kg	-	-	-	-	6,300	6,340	9,530	10,900	13,100	9,200	10,900	10,726	10,900	9,200	13,100	1,537	688	1,909
Manganese	mg/kg	460	1,100	-	-	469	968	763	689	814	632	758	731	758	632	814	71.1	31.8	88.2
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.182	0.392	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum	mg/kg	-	-	-	-	4.85	4.63	3.29	3.78	8.25	3.59	3.55	4.49	3.59	3.29	8.25	2.11	0.94	2.62
Nickel	mg/kg	16	75	-	-	25.1	30.5	12.9	12.7	29.6	8.24	9.97	14.7	12.7	8.24	29.6	8.56	3.83	10.6
Phosphorus	mg/kg	-	-	-	-	-	1,426	1,580	1,280	1,020	1,660	1,610	1,430	1,580	1,020	1,660	273	122	339
Potassium	mg/kg	-	-	-	-	-	1,626	1,910	2,580	2,080	1,780	1,860	2,042	1,910	1,780	2,580	320	143	398
Selenium	mg/kg	2	-	-	-	5.99	2.94	1.40	1.32	3.30	0.96	1.12	1.62	1.32	0.96	3.30	0.95	0.43	1.19
Silver	mg/kg	0.5	-	-	-	<2.0	0.44	0.28	0.28	0.38	0.27	0.28	0.30	0.28	0.27	0.38	0.046	0.021	0.06
Sodium	mg/kg	-	-	-	-	-	228	980	1,550	1,030	1,170	1,190	1,184	1,170	980	1,550	223	100	277
Strontium	mg/kg	-	-	-	-	-	121	190	252	194	221	240	219	221	190	252	27.4	12.2	34.0
Thallium	mg/kg	-	-	-	-	-	0.161	<0.050	<0.050	0.083	<0.050	<0.050	0.057	<0.050	<0.050	0.083	0.015	0.0066	0.018
Tin	mg/kg	-	-	-	-	<5.0	<2.0	<2.0	2.2	<2.0	<2.0	<2.0	2.0	<2.0	<2.0	2.2	0.089	0.040	0.11
Titanium	mg/kg	-	-	-	-	-	698	1,530	1,900	1,280	1,700	1,710	1,624	1,700	1,280	1,900	233	104	289
Uranium	mg/kg	-	-	-	-	-	2.84	1.19	1.54	1.72	1.21	1.23	1.38	1.23	1.19	1.72	0.239	0.107	0.297
Vanadium	mg/kg	-	-	-	-	137	73.6	164	151	106	166	120	141	151	106	166	27.0	12.1	33.5
Zinc	mg/kg	123	315	200	380	82.9	81.6	55.7	60.6	91.7	49.7	55.0	62.5	55.7	49.7	91.7	16.8	7.49	20.8

[1] Reported TOC, TN, pH and moisture data are based on bulk sediment. Data < method detection limit (MDL) were used at the MDL for calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] The 5th percentile is reported for pH.

[5] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

[6] Samples were collected using a sediment corer.

[7] Samples were collected using a petite ponar.

(Blue) Value is > TEL. Values shown in bold text also exceed both Reference values.

(Orange) Value is > PEL. Values shown in bold text also exceed both Reference values.

Table E.16: Raw sediment quality data for deep lake stations P1 and P2 in Polley Lake, Mount Polley Mine, 2014. Metals data are based on the <2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		P1 (North-Deep Lake)										P2 (South-Deep Lake)									
		TEL	PEL	Sensitive	Typical	Historical Polley Deep 95th Percentile [5]	Bootjack 2014 Deep 95th Percentile (< 2 mm)	POL-P1-01	POL-P1-02	POL-P1-03	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	POL-P2-O1	POL-P2-O2	POL-P2-O3	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								9-Oct-14	9-Oct-14	18-Oct-14								24-Oct-14	24-Oct-14	24-Oct-14							
Physical Tests [6]																											
Moisture	%	-	-	-	-	-	93.8	85.8	90.5	87.0	87.8	87.0	85.8	90.5	2.44	1.41	6.07	84.0	87.1	50.5	73.9	84.0	50.5	87.1	20.3	11.7	50.4
pH (1:2 soil:water)	pH	-	-	-	-	-	6.01	7.73	7.66	-	7.70	7.70	7.66	7.73	0.049	0.035	0.44	7.86	7.91	8.57	8.11	7.91	7.86	8.57	0.40	0.23	0.98
Particle Size [7]																											
% Gravel (>2mm)	%	-	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	-	21	0.38	0.41	0.28	0.36	0.38	0.28	0.41	0.068	0.039	0.17	0.63	1.1	0.48	0.74	0.63	0.48	1.1	0.33	0.19	0.82
% Silt (0.063mm - 4µm)	%	-	-	-	-	-	84	84	78	78	80	78	78	84	3.3	1.9	8.1	79	81	78	79	79	78	81	1.4	0.79	3.4
% Clay (<4µm)	%	-	-	-	-	-	17	16	22	22	20	22	16	22	3.2	1.9	8.0	21	18	21	20	21	18	21	1.7	0.97	4.2
Texture	-	-	-	-	-	-	-	Silt	Silt loam	Silt loam	-	-	-	-	-	-	-	Silt loam	Silt loam	Silt loam	-	-	-	-	-	-	-
Leachable Anions & Nutrients [6]																											
pH	pH	-	-	-	-	-	5.81	6.91	6.92	7.08	7.00	7.00	6.91	7.08	0.12	0.085	1.08	6.91 [6]	7.05 [6]	7.18 [6]	7.05	7.05	6.91	7.18	0.14	0.078	0.34
Anions and Nutrients [6]																											
Total Nitrogen by LECO	%	-	-	-	-	-	1.68	-	-	0.63	0.63				-	-	-	0.41	1.30	0.04	0.58	0.41	0.04	1.30	0.65	0.37	1.61
Organic / Inorganic Carbon [7]																											
Total Organic Carbon	%	-	-	-	-	20.8	17.4	11.9	11.5	10.1	11.2	11.5	10.1	11.9	0.945	0.546	2.35	11.2	10.9	7.40	9.83	10.9	7.40	11.2	2.11	1.22	5.25
Metals [6]																											
Aluminum	mg/kg	-	-	-	-	20,620	19,900	25,300	27,000	27,500	26,600	27,000	25,300	27,500	1,153	666	2,865	28,300	28,300	23,400	26,667	28,300	23,400	28,300	2,829	1,633	7,028
Antimony	mg/kg	-	-	-	-	1.2	1.0	0.68	0.77	0.72	0.72	0.72	0.68	0.77	0.045	0.026	0.11	0.71	0.67	0.51	0.63	0.67	0.51	0.71	0.11	0.061	0.26
Arsenic	mg/kg	5.9	17	11	20	8.9	7.1	10.8	10.6	12.6	**11.3**	**10.8**	**10.6**	**12.6**	1.10	0.64	2.74	13.4	10.9	13.9	**12.7**	**13.4**	**10.9**	**13.9**	1.61	0.93	3.99
Barium	mg/kg	-	-	-	-	227	280	186	224	261	224	224	186	261	37.5	21.7	93.2	291	229	246	255	246	229	291	32.0	18.5	79.6
Beryllium	mg/kg	-	-	-	-	0.63	0.77	0.73	0.74	0.90	0.79	0.74	0.73	0.90	0.10	0.06	0.24	1.05	0.87	0.84	0.92	0.87	0.84	1.05	0.11	0.07	0.28
Bismuth	mg/kg	-	-	-	-	0.4	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Boron	mg/kg	-	-	-	-	17	17	21.00	17.00	15	18	17	15	21	3.0551	1.7638	7.590	16	23	11	17	16	11	23	6.0	3.5	15
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.69	0.48	0.428	0.358	0.302	0.363	0.358	0.302	0.428	0.0631	0.0364	0.157	0.33	0.40	0.14	0.29	0.33	0.14	0.40	0.14	0.080	0.34
Calcium	mg/kg	-	-	-	-	15,890	10,750	19,800	17,600	24,800	20,733	19,800	17,600	24,800	3,690	2,130	9,166	31,000	23,400	36,100	30,167	31,000	23,400	36,100	6,391	3,690	15,877
Chromium	mg/kg	37.3	90	56	110	67.6	39.0	44.0	38.9	30.1	37.7	38.9	30.1	44.0	7.03	4.06	17.5	28.2	46.3	10.5	28.3	28.2	10.5	46.3	17.9	10.3	44.5
Cobalt	mg/kg	-	-	-	-	16.4	12.1	18.7	19.3	21.7	19.9	19.3	18.7	21.7	1.59	0.917	3.94	25.2	19.9	20.8	22.0	20.8	19.9	25.2	2.84	1.64	7.0
Copper	mg/kg	35.7	197	120	240	380	442	520	636	735	**630**	**636**	**520**	**735**	108	62	267	814	565	718	**699**	**718**	**565**	**814**	126	72.5	312
Iron	mg/kg	21,200	43,776	-	-	39,230	31,750	33,100	29,500	30,900	31,167	30,900	29,500	33,100	1,815	1,048	4,508	33,100	33,900	36,800	34,600	33,900	33,100	36,800	1,947	1,124	4,836
Lead	mg/kg	35	91	57	110	17.7	11.7	7.75	8.40	9.20	8.45	8.40	7.75	9.20	0.726	0.419	1.80	8.51	7.61	5.65	7.26	7.61	5.65	8.51	1.46	0.84	3.63
Lithium	mg/kg	-	-	-	-	17.8	13.5	18.8	17.5	25.2	20.5	18.8	17.5	25.2	4.12	2.38	10.2	27.7	24.2	21.5	24.5	24.2	21.5	27.7	3.11	1.79	7.7
Magnesium	mg/kg	-	-	-	-	12,548	5,930	11,900	12,900	14,700	13,167	12,900	11,900	14,700	1,419	819	3,525	17,800	12,800	14,300	14,967	14,300	12,800	17,800	2,566	1,481	6,374
Manganese	mg/kg	460	1,100	-	-	3,310	1,678	923	865	981	923	923	865	981	58.0	33.5	144	1,110	821	795	909	821	795	1,110	175	101	434
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.29	0.34	0.147	0.137	-	0.142	0.142	0.137	0.147	0.0071	0.0050	0.064	-	-	-	-	-	-	-	-	-	-
Molybdenum	mg/kg	-	-	-	-	6.1	3.5	8.66	7.11	6.48	7.42	7.11	6.48	8.66	1.12	0.65	2.79	6.93	8.69	4.02	6.55	6.93	4.02	8.69	2.36	1.36	5.86
Nickel	mg/kg	16	75	-	-	42.6	28.0	34.8	31.2	24.1	30.0	31.2	24.1	34.8	5.44	3.14	13.5	24.5	36.2	11.0	23.9	24.5	11.0	36.2	12.6	7.28	31.3
Phosphorus	mg/kg	-	-	-	-	3,405	2,755	1,100	960	1,100	1,053	1,100	960	1,100	80.8	46.7	201	1,170	1,230	1,670	1,357	1,230	1,170	1,670	273	158	678
Potassium	mg/kg	-	-	-	-	1,591	1,555	2,130	2,400	2,690	2,407	2,400	2,130	2,690	280	162	696	2,430	2,310	2,100	2,280	2,310	2,100	2,430	167	96.4	415
Selenium	mg/kg	2	-	-	-	5.37	3.05	3.71	4.05	2.80	3.52	3.71	2.80	4.05	0.646	0.373	1.61	2.41	4.03	1.08	2.51	2.41	1.08	4.03	1.48	0.853	3.67
Silver	mg/kg	0.5	-	-	-	0.41	0.41	0.39	0.35	0.36	0.37	0.36	0.35	0.39	0.021	0.012	0.052	0.40	0.45	0.31	0.39	0.40	0.31	0.45	0.071	0.041	0.18
Sodium	mg/kg	-	-	-	-	560	220	850	1,200	1,360	1,137	1,200	850	1,360	261	151	648	1,220	930	1,250	1,133	1,220	930	1,250	177	102	439
Strontium	mg/kg	-	-	-	-	125	122	148	195	227	190	195	148	227	39.7	22.9	98.7	226	181	235	214	226	181	235	28.9	16.7	71.9
Thallium	mg/kg	-	-	-	-	0.11	0.15	0.096	0.087	0.067	0.083	0.087	0.067	0.10	0.015	0.009	0.037	0.064	0.097	<0.050	0.070	0.064	<0.050	0.097	0.024	0.014	0.060
Tin	mg/kg	-	-	-	-	0.8	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	2.30	<2.0	2.40	2.23	2.30	<2.0	2.40	0.208	0.120	0.517
Titanium	mg/kg	-	-	-	-	787	669	1,230	1,370	1,580	1,393	1,370	1,230	1,580	176	102	438	1,940	1,390	2,100	1,810	1,940	1,390	2,100	372	215	925
Uranium	mg/kg	-	-	-	-	1.47	2.51	1.90	1.58	1.49	1.66	1.58	1.49	1.90	0.215	0.124	0.535	1.68	2.18	1.46	1.77	1.68	1.46	2.18	0.369	0.213	0.917
Vanadium	mg/kg	-	-	-	-	111	76.0	121	106	109	112	109	106	121	7.94	4.58	19.72	120	122	142	128	122	120	142	12.2	7.02	30.2
Zinc	mg/kg	123	315	200	380	99.0	80.7	94.5	90.2	87.7	90.8	90.2	87.7	94.5	3.44	1.99	8.54	101	97.9	70.6	89.8	97.9	70.6	101	16.7	9.66	41.6

[1] Reported TOC, TN, pH and moisture data are based on bulk sediment. Data < method detection limit (MDL) were used at the MDL for calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] The 5th percentile is reported for pH.

[5] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

[6] Samples were collected using a sediment corer.

[7] Samples were collected using a petite ponar.

(blue shading) Value is > TEL. Values shown in bold text also exceed both Reference values.

(orange shading) Value is > PEL. Values shown in bold text also exceed both Reference values.

Table E.17: Raw sediment quality data for mid-depth stations in Polley Lake, Mount Polley Mine, 2014. Data are based on the <63µm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		POL-1 (North Polley Lake)											
		TEL	PEL	Sensitive	Typical	Historical Polley Mid-depth 95th Percentile [5]	Bootjack 2014 Mid-depth 95th Percentile (<63 µm)	POL-1-01	POL-1-02	POL-1-03	POL-1-04	POL-1-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								21-Oct-14	20-Oct-14	21-Oct-14	21-Oct-14	22-Oct-14							
Physical Tests [6]																			
pH (1:2 soil:water)	pH	-	-	-	-	-	6.19	8.02	7.86	7.98	8.37	8.25	-	-	-	-	-	-	-
Organic / Inorganic Carbon [7]																			
Total Organic Carbon	%	-	-	-	-	16.6	18.2	5.26	1.22	0.44	1.11	1.37	1.88	1.22	0.44	5.26	1.92	0.86	2.39
Metals [6]																			
Aluminum	mg/kg	-	-	-	-	6,700	19,600	23,600	20,500	19,900	22,900	20,700	21,520	20,700	19,900	23,600	1,625	727	2,018
Antimony	mg/kg	-	-	-	-	<10	1.05	0.46	0.45	0.47	0.47	0.43	0.46	0.46	0.43	0.47	0.017	0.0075	0.021
Arsenic	mg/kg	5.9	17	11	20	12.9	6.65	11.5	11.7	12.3	12.4	12.3	12.0	12.3	11.5	12.4	0.410	0.183	0.509
Barium	mg/kg	-	-	-	-	141	259	249	229	236	244	268	245	244	229	268	14.9	6.64	18.4
Beryllium	mg/kg	-	-	-	-	0.60	0.78	0.77	0.71	0.74	0.81	0.68	0.74	0.74	0.68	0.81	0.051	0.023	0.063
Bismuth	mg/kg	-	-	-	-	-	0.17	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Boron	mg/kg	-	-	-	-	-	17	11	11	11	11	<10	11	11	<10	11	0.45	0.20	0.56
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.656	0.497	0.117	0.112	0.102	0.138	0.104	0.115	0.112	0.102	0.138	0.0144	0.0064	0.0179
Calcium	mg/kg	-	-	-	-	9,000	10,740	28,900	29,800	28,000	28,300	30,000	29,000	28,900	28,000	30,000	886	396	1,100
Chromium	mg/kg	37.3	90	56	110	45.7	47.8	13.3	12.5	11.2	11.2	10.5	11.7	11.2	10.5	13.3	1.13	0.51	1.41
Cobalt	mg/kg	-	-	-	-	13.0	12.1	17.1	14.2	14.3	16.5	14.7	15.4	14.7	14.2	17.1	1.34	0.601	1.67
Copper	mg/kg	36	197	120	240	510	424	556	505	540	564	531	**539**	**540**	**505**	**564**	23.1	10.3	28.7
Iron	mg/kg	21,200	43,776	-	-	17,700	25,220	23,600	24,100	26,200	24,900	27,600	**25,280**	24,900	23,600	**27,600**	1,627	728	2,020
Lead	mg/kg	35	91	57	110	<30	11.8	6.29	5.39	5.68	6.06	5.31	5.75	5.68	5.31	6.29	0.423	0.189	0.525
Lithium	mg/kg	-	-	-	-	-	14.5	22.7	17.1	16.7	21.1	16.9	18.9	17.1	16.7	22.7	2.80	1.25	3.48
Magnesium	mg/kg	-	-	-	-	6,300	6,146	12,700	10,100	9,510	12,100	10,300	10,942	10,300	9,510	12,700	1,379	617	1,712
Manganese	mg/kg	460	1,100	-	-	469	912	735	687	666	714	706	702	706	666	735	26.3	11.8	32.7
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.182	0.362	0.0758	0.0772	0.0698	0.0670	0.0702	0.0720	0.0702	0.0670	0.0772	0.0043	0.0019	0.0054
Molybdenum	mg/kg	-	-	-	-	4.85	5.21	3.07	3.21	3.45	3.17	3.28	3.24	3.21	3.07	3.45	0.142	0.0634	0.176
Nickel	mg/kg	16	75	-	-	25.1	34.0	12.4	10.6	9.90	10.8	9.50	10.6	10.6	9.5	12.4	1.11	0.50	1.38
Phosphorus	mg/kg	-	-	-	-	-	1,452	1,220	1,580	1,520	1,390	1,490	1,440	1,490	1,220	1,580	141	63.0	175
Potassium	mg/kg	-	-	-	-	-	1,514	2,150	1,820	1,950	2,300	2,080	2,060	2,080	1,820	2,300	184	82.4	229
Selenium	mg/kg	2	-	-	-	5.99	2.76	1.09	1.17	1.14	1.00	0.94	1.07	1.09	0.94	1.17	0.096	0.043	0.12
Silver	mg/kg	0.5	-	-	-	<2.0	0.419	0.236	0.258	0.241	0.226	0.235	0.239	0.236	0.226	0.258	0.0118	0.0053	0.0147
Sodium	mg/kg	-	-	-	-	-	228	1,210	1,020	1,200	1,360	1,130	1,184	1,200	1,020	1,360	124	55.6	154
Strontium	mg/kg	-	-	-	-	-	116	266	234	255	287	251	259	255	234	287	19.6	8.77	24.3
Thallium	mg/kg	-	-	-	-	-	0.14	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	<5.0	6.9	1.77	1.67	1.63	1.97	1.69	1.75	1.69	1.63	1.97	0.135	0.060	0.168
Titanium	mg/kg	-	-	-	-	-	655	1,790	1,670	1,550	1,760	1,710	1,696	1,710	1,550	1,790	93.7	41.9	116
Uranium	mg/kg	-	-	-	-	-	2.59	1.15	1.14	1.11	1.13	1.13	1.13	1.13	1.11	1.15	0.0148	0.0066	0.0184
Vanadium	mg/kg	-	-	-	-	137	69.0	90.0	95.1	99.7	97.6	108	98.1	98	90.0	108	6.62	2.96	8.22
Zinc	mg/kg	123	315	200	380	82.9	80.1	62.3	52.1	51.3	59.9	52.5	55.6	52.5	51.3	62.3	5.09	2.28	6.32

[1] Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] The 5th percentile is reported for pH.

[5] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

[6] Samples were collected using a sediment corer.

[7] Samples were collected using a petite ponar.

(blue) Value is > TEL. Values shown in bold text also exceed both Reference values.

(orange) Value is > PEL. Values shown in bold text also exceed both Reference values.

Table E.17: Raw sediment quality data for mid-depth stations in Polley Lake, Mount Polley Mine, 2014. Data are based on the <63µm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		POL-2 (SouthPolley Lake)												
		TEL	PEL	Sensitive	Typical	Historical Polley Mid-depth 95th Percentile [5]	Bootjack 2014 Mid-depth 95th Percentile (<63 µm)	POL-2-01	POL-2-02	POL-2-O3	POL-2-O4	POL-2-O5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								22-Oct-14	22-Oct-14	24-Oct-14	24-Oct-14	24-Oct-14							
Physical Tests [6]																			
pH (1:2 soil:water)	pH	-	-	-	-	-	6.19	7.99	8.27	7.64	8.09	7.96	7.99	7.99	7.64	8.27	0.230	0.103	0.286
Organic / Inorganic Carbon [7]																			
Total Organic Carbon	%	-	-	-	-	16.6	18.2	0.99	0.37	0.18	0.30	0.56	0.48	0.37	0.18	1.0	0.32	0.14	0.39
Metals [6]																			
Aluminum	mg/kg	-	-	-	-	6,700	19,600	18,100	21,600	25,300	19,400	20,200	20,920	20,200	18,100	25,300	2,758	1,233	3,424
Antimony	mg/kg	-	-	-	-	<10	1.05	0.43	0.49	0.58	0.49	0.50	0.50	0.49	0.43	0.58	0.054	0.024	0.067
Arsenic	mg/kg	5.9	17	11	20	12.9	6.65	12.5	12.7	11.5	13.6	13.0	12.7	12.7	11.5	**13.6**	0.770	0.344	0.956
Barium	mg/kg	-	-	-	-	141	259	213	234	264	220	229	232	229	213	264	19.6	8.78	24.4
Beryllium	mg/kg	-	-	-	-	0.60	0.78	0.66	0.80	0.85	0.71	0.71	0.75	0.71	0.66	0.85	0.077	0.034	0.096
Bismuth	mg/kg	-	-	-	-	-	0.17	<0.10	<0.10	0.12	<0.10	<0.10	0.10	<0.10	<0.10	0.12	0.0089	0.0040	0.011
Boron	mg/kg	-	-	-	-	-	17	10	11	13	10	11	11	11	10	13	1.2	0.55	1.5
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.656	0.497	0.118	0.094	0.284	0.110	0.119	0.145	0.118	0.094	0.284	0.078	0.035	0.097
Calcium	mg/kg	-	-	-	-	9,000	10,740	31,300	29,500	23,300	31,400	30,700	29,240	30,700	23,300	31,400	3,406	1,523	4,228
Chromium	mg/kg	37.3	90	56	110	45.7	47.8	13.7	12.1	27.9	11.3	10.0	15.0	12.1	10.0	27.9	7.33	3.28	9.11
Cobalt	mg/kg	-	-	-	-	13.0	12.1	16.1	17.0	21.1	16.1	15.3	17.1	16.1	15.3	21.1	2.30	1.03	2.86
Copper	mg/kg	36	197	120	240	510	424	506	546	658	529	542	**556**	**542**	506	**658**	59.0	26.4	73.3
Iron	mg/kg	21,200	43,776	-	-	17,700	25,220	52,700	45,600	30,300	50,100	32,500	**42,240**	**45,600**	**30,300**	**52,700**	10,246	4,582	12,720
Lead	mg/kg	35	91	57	110	<30	11.8	5.13	5.35	7.57	5.27	5.26	5.72	5.27	5.13	7.57	1.04	0.46	1.29
Lithium	mg/kg	-	-	-	-	-	14.5	16.1	16.5	23.4	14.6	16.0	17.3	16.1	14.6	23.4	3.47	1.55	4.31
Magnesium	mg/kg	-	-	-	-	6,300	6,146	9,120	10,200	13,800	9,010	10,100	10,446	10,100	9,010	13,800	1,953	873	2,424
Manganese	mg/kg	460	1,100	-	-	469	912	665	686	833	683	725	718	686	665	833	67.7	30.3	84.0
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.182	0.362	0.0713	0.0708	0.121	0.0658	0.0693	0.0796	0.0708	0.0658	0.121	0.0232	0.0104	0.0288
Molybdenum	mg/kg	-	-	-	-	4.85	5.21	3.26	3.36	6.66	3.45	3.41	4.03	3.41	3.26	6.66	1.47	0.66	1.83
Nickel	mg/kg	16	75	-	-	25.1	34.0	10.3	9.98	23.1	8.76	8.98	12.2	10.0	8.76	23.1	6.11	2.73	7.6
Phosphorus	mg/kg	-	-	-	-	-	1,452	1,880	1,450	889	1,790	1,600	1,522	1,600	889	1,880	391	175	486
Potassium	mg/kg	-	-	-	-	-	1,514	1,580	2,190	2,310	2,020	1,900	2,000	2,020	1,580	2,310	282	126	351
Selenium	mg/kg	2	-	-	-	5.99	2.76	1.13	1.11	2.53	1.06	1.05	1.38	1.11	1.05	2.53	0.646	0.289	0.802
Silver	mg/kg	0.5	-	-	-	<2.0	0.419	0.267	0.262	0.334	0.265	0.265	0.279	0.265	0.262	0.334	0.0310	0.0139	0.0385
Sodium	mg/kg	-	-	-	-	-	228	930	1,310	1,240	1,290	1,230	1,200	1,240	930	1,310	155	69.1	192
Strontium	mg/kg	-	-	-	-	-	116	220	259	216	224	232	230	224	216	259	17.2	7.67	21.3
Thallium	mg/kg	-	-	-	-	-	0.14	<0.050	<0.050	0.065	<0.050	<0.050	0.053	<0.050	<0.050	0.065	0.0067	0.0030	0.0083
Tin	mg/kg	-	-	-	-	<5.0	6.9	1.66	2.06	1.85	1.95	2.04	1.91	1.95	1.66	2.06	0.164	0.0732	0.203
Titanium	mg/kg	-	-	-	-	-	655	1,620	1,940	1,450	1,810	1,860	1,736	1,810	1,450	1,940	199	88.8	247
Uranium	mg/kg	-	-	-	-	-	2.59	1.17	1.30	1.37	1.31	1.27	1.28	1.30	1.17	1.37	0.0733	0.0328	0.0911
Vanadium	mg/kg	-	-	-	-	137	69.0	204	179	102	189	126	160	179	102	204	43.8	19.6	54.3
Zinc	mg/kg	123	315	200	380	82.9	80.1	51.8	54.6	85.8	51.8	53.0	59.4	53.0	51.8	85.8	14.8	6.62	18.4

[1] Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] The 5th percentile is reported for pH.

[5] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

[6] Samples were collected using a sediment corer.

[7] Samples were collected using a petite ponar.

(blue) Value is > TEL. Values shown in bold text also exceed both Reference values.

(orange) Value is > PEL. Values shown in bold text also exceed both Reference values.

Table E.18: Raw sediment quality data for deep lake stations P1 and P2 in Polley Lake, Mount Polley Mine, 2014. Data are based on the <63µm fraction of sediment[1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		P1 (North-Deep Lake)										P2 (South-Deep Lake)									
		TEL	PEL	Sensitive	Typical	Historical Polley Deep 95th Percentile [5]	Bootjack 2014 Deep 95th Percentile (< 63 µm)	POL-P1-01	POL-P1-02	POL-P1-03	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	POL-P2-O1	POL-P2-O2	POL-P2-O3	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								9-Oct-14	9-Oct-14	18-Oct-14								24-Oct-14	24-Oct-14	24-Oct-14							
Physical Tests [6]																											
pH (1:2 soil:water)	pH	-	-	-	-	-	5.98	-	-	7.81	7.81				-	-	-	7.62	7.58	8.58	7.93	7.62	7.58	8.58	0.566	0.327	1.41
Organic / Inorganic Carbon [7]																											
Total Organic Carbon	%	-	-	-	-	20.8	16.5	11.5	9.02	6.94	9.15	9.02	6.94	11.5	2.28	1.32	5.67	9.93	8.67	4.42	7.67	8.67	4.42	9.93	2.89	1.67	7.17
Metals [6]																											
Aluminum	mg/kg	-	-	-	-	20,620	18,525	26,700	26,500	27,700	26,967	26,700	26,500	27,700	643	371	1,597	27,200	22,900	22,200	24,100	22,900	22,200	27,200	2,707	1,563	6,726
Antimony	mg/kg	-	-	-	-	1.2	0.86	0.99	0.92	0.71	0.87	0.92	0.71	0.99	0.15	0.084	0.36	0.57	0.66	0.43	0.55	0.57	0.43	0.66	0.12	0.067	0.29
Arsenic	mg/kg	5.9	17	11	20	8.9	6.4	12.0	12.1	13.0	**12.4**	**12.1**	**12.0**	**13.0**	0.551	0.318	1.37	13.2	10.8	13.8	**12.6**	**13.2**	**10.8**	**13.8**	1.59	0.917	3.94
Barium	mg/kg	-	-	-	-	227	248	262	292	309	288	292	262	309	23.8	13.7	59.1	296	238	229	254	238	229	296	36.4	21.0	90.3
Beryllium	mg/kg	-	-	-	-	0.63	0.70	0.83	0.91	0.99	0.91	0.91	0.83	0.99	0.080	0.046	0.20	0.94	0.81	0.82	0.86	0.82	0.81	0.94	0.072	0.042	0.18
Bismuth	mg/kg	-	-	-	-	0.37	0.15	0.18	0.14	0.12	0.15	0.14	0.12	0.18	0.031	0.018	0.076	0.11	0.14	<0.10	0.12	0.11	<0.10	0.14	0.021	0.012	0.052
Boron	mg/kg	-	-	-	-	17	17	18	16	14	16	16	14	18	2.0	1.2	5.0	12	20	10	14	12	10	20	5.3	3.1	13
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.69	0.40	0.360	0.273	0.193	0.275	0.273	0.193	0.360	0.0835	0.0482	0.208	0.218	0.353	0.132	0.234	0.218	0.132	0.353	0.111	0.064	0.277
Calcium	mg/kg	-	-	-	-	15,890	10,925	22,200	22,400	29,400	24,667	22,400	22,200	29,400	4,100	2,367	10,187	32,000	21,900	34,500	29,467	32,000	21,900	34,500	6,671	3,852	16,573
Chromium	mg/kg	37.3	90	56	110	67.6	98.5	43.5	39.6	23.6	35.6	39.6	23.6	43.5	10.5	6.09	26.2	18.9	104	13.3	45.4	18.9	13.3	**104**	50.8	29.3	126
Cobalt	mg/kg	-	-	-	-	16.4	11.7	19.8	19.4	22.2	20.5	19.8	19.4	22.2	1.51	0.874	3.76	25.1	18.7	20.0	21.3	20.0	18.7	25.1	3.38	1.95	8.40
Copper	mg/kg	35.7	197	120	240	380	380	641	714	811	**722**	**714**	**641**	**811**	85.3	49.2	212	850	534	683	**689**	**683**	**534**	**850**	158	91.3	393
Iron	mg/kg	21,200	43,776	-	-	39,230	28,300	30,600	28,100	30,100	29,600	30,100	28,100	30,600	1,323	764	3,286	30,500	30,500	37,100	32,700	30,500	30,500	37,100	3,811	2,200	9,467
Lead	mg/kg	35	91	57	110	17.7	10.4	10.1	9.62	9.35	9.69	9.62	9.35	10.1	0.380	0.219	0.944	7.69	7.57	5.30	6.85	7.57	5.30	7.69	1.35	0.78	3.35
Lithium	mg/kg	-	-	-	-	17.8	12.1	22.8	22.9	27.2	24.3	22.9	22.8	27.2	2.51	1.45	6.24	28.6	22.0	21.3	24.0	22.0	21.3	28.6	4.03	2.33	10.0
Magnesium	mg/kg	-	-	-	-	12,548	5,538	12,900	13,600	15,400	13,967	13,600	12,900	15,400	1,290	745	3,204	18,100	11,600	13,300	14,333	13,300	11,600	18,100	3,371	1,946	8,375
Manganese	mg/kg	460	1,100	-	-	3,310	1,498	866	752	923	847	866	752	923	87.1	50.3	216	1,020	796	750	855	796	750	1,020	144	83	359
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.29	0.28	0.133	0.110	0.107	0.117	0.110	0.107	0.133	0.0142	0.0082	0.0353	0.103	0.137	0.071	0.104	0.103	0.071	0.137	0.0330	0.0190	0.0819
Molybdenum	mg/kg	-	-	-	-	6.05	4.32	7.59	7.47	5.53	6.86	7.47	5.53	7.59	1.16	0.668	2.87	5.11	7.82	3.95	5.63	5.11	3.95	7.82	1.99	1.15	4.93
Nickel	mg/kg	16	75	-	-	43	75	35.3	31.0	21.1	29.1	31.0	21.1	35.3	7.28	4.20	18.1	18.6	71.8	12.1	34.2	18.6	12.1	71.8	32.8	18.9	81.4
Phosphorus	mg/kg	-	-	-	-	3,405	2,605	999	934	1120	1,018	999	934	1,120	94.4	54.5	235	1,050	1,200	1,700	1,317	1,200	1,050	1,700	340	196	846
Potassium	mg/kg	-	-	-	-	1,591	1,368	2410	2370	2580	2,453	2,410	2,370	2,580	112	64.4	277	2,430	1,920	1,980	2,110	1,980	1,920	2,430	279	161	693
Selenium	mg/kg	2	-	-	-	5.37	2.60	3.73	3.69	2.47	3.30	3.69	2.47	3.73	0.716	0.413	1.78	1.93	3.46	1.02	2.14	1.93	1.02	3.46	1.23	0.712	3.06
Silver	mg/kg	0.5	-	-	-	0.41	0.38	0.378	0.327	0.357	0.354	0.357	0.327	0.378	0.0256	0.0148	0.0637	0.359	0.358	0.298	0.338	0.358	0.298	0.359	0.0349	0.0202	0.0868
Sodium	mg/kg	-	-	-	-	560	245	1120	1320	1360	1,267	1,320	1,120	1,360	129	74.2	319	1,360	870	1,200	1,143	1,200	870	1,360	250	144	621
Strontium	mg/kg	-	-	-	-	125	134	215	256	276	249	256	215	276	31.1	18.0	77.3	230	177	234	214	230	177	234	31.8	18.4	79.0
Thallium	mg/kg	-	-	-	-	0.11	0.13	0.106	0.079	0.060	0.082	0.079	0.060	0.11	0.023	0.013	0.057	<0.050	0.096	<0.050	0.065	<0.050	<0.050	0.096	0.027	0.015	0.066
Tin	mg/kg	-	-	-	-	0.8	1.4	4.68	2.53	1.93	3.05	2.53	1.93	4.68	1.45	0.83	3.59	2.17	1.81	2.04	2.01	2.04	1.81	2.17	0.182	0.105	0.453
Titanium	mg/kg	-	-	-	-	787	784	1550	1640	1790	1,660	1,640	1,550	1,790	121	70.0	301	2,060	1,230	1,670	1,653	1,670	1,230	2,060	415	240	1,032
Uranium	mg/kg	-	-	-	-	1.5	2.1	1.51	1.37	1.34	1.41	1.37	1.34	1.51	0.0907	0.0524	0.225	1.30	1.91	1.25	1.49	1.30	1.25	1.91	0.367	0.212	0.913
Vanadium	mg/kg	-	-	-	-	111	66.9	108	101	106	105	106	101	108	3.61	2.08	8.96	107	109	144	120	109	107	144	20.8	12.01	51.7
Zinc	mg/kg	123	315	200	380	99	98	220	151	82.7	**151**	**151**	82.7	**220**	68.7	39.6	171	90.1	117	65.9	91.0	90.1	65.9	117	25.6	14.8	63.5

[1] Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] The 5th percentile is reported for pH.

[5] Historic sediment metal concentrations are based predominantly on bulk sediment samples.

[6] Samples were collected using a sediment corer.

[7] Samples were collected using a petite ponar.

(blue) Value is > TEL. Values shown in bold text also exceed both Reference values.

(orange) Value is > PEL. Values shown in bold text also exceed both Reference values.

Table E.19: Raw sediment quality data for mid-depth areas of Bootjack Lake, Mount Polley Mine, 2014. Data are based on the <2mm fraction of sediment [1].

Analyte	Units	BC SQGs [2]		Contaminated Sites Regulation [3]		Historic 95th Percentile	Mid-depth Area (BOL-1)												
Sample ID							BOL-1-01	BOL-1-02	BOL-1-03	BOL-1-04	BOL-1-05	Mean	Median	Minimum	Maximum	95th Percentile [6]	Standard Deviation	Standard Error	t*SE
Date Sampled		TEL	PEL	Sensitive	Typical		23-Oct-14	23-Oct-14	23-Oct-14	23-Oct-14	23-Oct-14								
Physical Tests [4]																			
Moisture	%	-	-	-	-	-	93.8	94.2	93.2	92.5	92.9	93.3	93.2	92.5	94.2	94.1	0.68	0.31	0.85
pH (1:2 soil:water)	pH	-	-	-	-	-	6.35	6.47	6.52	6.30	6.53	6.43	6.47	6.30	6.53	6.31	0.10	0.046	0.13
Particle Size [5]																			
% Gravel (>2mm)	%	-	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	-	0.8	1.2	0.52	0.96	9.4	2.6	0.96	0.52	9.4	7.8	3.8	1.7	4.8
% Silt (0.063mm - 4µm)	%	-	-	-	-	-	84	84	89	84	82	85	84	82	89	88	2.7	1.2	3.3
% Clay (<4µm)	%	-	-	-	-	-	16	14	11	15	8.8	13	14	9	16	16	3.1	1.4	3.8
Texture	-	-	-	-	-	-	Silt	Silt	Silt	Silt	Silt	-	-	-	-	-	-	-	-
Leachable Anions & Nutrients [5]																			
pH	pH	-	-	-	-	-	5.93	6.08	6.13	6.05	6.10	6.06	6.08	5.93	6.13	5.95	0.077	0.035	0.096
Anions and Nutrients [4]																			
Total Nitrogen by LECO	%	-	-	-	-	-	1.82	1.78	1.88	1.66	1.31	1.69	1.78	1.31	1.88	1.87	0.23	0.10	0.28
Organic / Inorganic Carbon [5]																			
Total Organic Carbon	%	-	-	-	-	18.0	17.5	18.6	19.0	17.2	16.1	17.7	17.5	16.1	19.0	18.9	1.16	0.52	1.44
Metals [4]																			
Aluminum	mg/kg	-	-	-	-	13,200	21,300	20,300	20,600	19,700	17,000	19,780	20,300	17,000	21,300	21,160	1,657	741	2,058
Antimony	mg/kg	-	-	-	-	<10	1.00	0.88	1.03	0.94	0.88	0.95	0.94	0.88	1.03	1.02	0.068	0.031	0.085
Arsenic	mg/kg	5.9	17	11	20	7.9	6.04	5.97	6.78	6.02	6.12	6.19	6.04	5.97	6.78	6.65	0.34	0.15	0.42
Barium	mg/kg	-	-	-	-	67	234	229	223	212	190	218	223	190	234	233	17.5	7.81	21.7
Beryllium	mg/kg	-	-	-	-	<0.5	0.71	0.74	0.78	0.65	0.53	0.68	0.71	0.53	0.78	0.77	0.097	0.044	0.12
Bismuth	mg/kg	-	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Boron	mg/kg	-	-	-	-	-	17	17	19	16	16	17	17	16	19	19	1.2	0.5	1.5
Cadmium	mg/kg	0.60	3.5	2.2	4.2	<0.50	0.493	0.449	0.540	0.483	0.289	0.451	0.483	0.289	0.540	0.531	0.096	0.043	0.119
Calcium	mg/kg	-	-	-	-	20,100	9,420	9,620	10,700	10,500	10,000	10,048	10,000	9,420	10,700	10,660	550	246	683
Chromium	mg/kg	37	90	56	110	40	39.8	40.2	42.2	40.5	33.9	39.3	**40.2**	33.9	**42.2**	**41.9**	3.16	1.42	3.93
Cobalt	mg/kg	-	-	-	-	17	12.3	11.5	12.3	12.4	10.0	11.7	12.3	10.0	12.4	12.4	1.04	0.46	1.29
Copper	mg/kg	36	197	120	240	359	391	373	463	400	337	**393**	**391**	**337**	**463**	**450**	46.1	20.6	57.2
Iron	mg/kg	21,200	43,776	-	-	37,600	25,500	24,500	25,000	25,900	20,900	24,360	25,000	20,900	25,900	25,820	2,004	896	2,489
Lead	mg/kg	35	91	57	110	13	11.4	11.2	12.0	11.8	5.59	10.4	11.4	5.59	12.0	12.0	2.71	1.21	3.36
Lithium	mg/kg	-	-	-	-	-	13.7	13.4	15.1	13.8	10.7	13.3	13.7	10.7	15.1	14.8	1.61	0.72	2.00
Magnesium	mg/kg	-	-	-	-	11,000	5,540	5,480	5,620	6,520	4,990	5,630	5,540	4,990	6,520	6,340	555	248	689
Manganese	mg/kg	460	1,100	-	-	850	1,000	827	822	832	839	**864**	832	822	**1,000**	**968**	76.3	34.1	94.7
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.16	0.370	0.335	0.398	0.321	0.221	**0.329**	**0.335**	**0.221**	**0.398**	**0.392**	0.067	0.030	0.084
Molybdenum	mg/kg	-	-	-	-	<5.0	3.12	2.98	4.99	2.79	3.17	3.41	3.12	2.79	4.99	4.63	0.90	0.40	1.11
Nickel	mg/kg	16	75	-	-	24	29.2	29.6	30.7	28.0	22.3	**28.0**	**29.2**	22.3	**30.7**	**30.5**	3.31	1.48	4.11
Phosphorus	mg/kg	-	-	-	-	-	1,370	1,360	1,320	1,440	1,090	1,316	1,360	1,090	1,440	1,426	134	59.7	166
Potassium	mg/kg	-	-	-	-	-	1,580	1,610	1,630	1,570	1,190	1,516	1,580	1,190	1,630	1,626	184	82.2	228
Selenium	mg/kg	2.0	-	-	-	2.78	2.71	2.58	2.95	2.89	2.26	2.68	2.71	2.26	**2.95**	**2.94**	0.28	0.12	0.34
Silver	mg/kg	0.50	-	-	-	0.5	0.42	0.39	0.44	0.41	0.32	0.40	0.41	0.32	0.44	0.44	0.046	0.021	0.057
Sodium	mg/kg	-	-	-	-	-	220	230	220	220	190	216	220	190	230	228	15.2	6.78	18.8
Strontium	mg/kg	-	-	-	-	-	109	109	121	120	115	115	115	109	121	121	5.76	2.58	7.15
Thallium	mg/kg	-	-	-	-	-	0.134	0.141	0.166	0.139	0.106	0.137	0.139	0.106	0.166	0.161	0.021	0.0096	0.027
Tin	mg/kg	-	-	-	-	5.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	-	532	540	558	708	660	600	558	532	708	698	79.5	35.5	98.6
Uranium	mg/kg	-	-	-	-	-	2.51	2.43	2.92	2.37	1.91	2.43	2.43	1.91	2.92	2.84	0.361	0.161	0.448
Vanadium	mg/kg	-	-	-	-	123	72.8	67.3	67.4	73.8	64.6	69.2	67.4	64.6	73.8	73.6	3.94	1.76	4.89
Zinc	mg/kg	123	315	200	380	109	79.9	77.7	82.0	78.4	66.2	76.8	78.4	66.2	82.0	81.6	6.17	2.76	7.66

[1] Reported TOC, TN, pH, and moisture data are based on bulk sediment. Data < method detection limit (MDL) were used at the MDL for calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996).
[4] Samples were collected using a sediment corer.
[5] Samples were collected using a petite ponar.
[6] The 5th percentile is reported for pH.

(blue)	Value is > TEL. Values shown in bold text also exceed Historic 95th Percentile value.
(orange)	Value is > PEL. Values shown in bold text also exceed Historic 95th Percentile value.

Table E.20: Raw sediment quality data for the deep areas of Bootjack Lake, Mount Polley Mine, 2014. Data are based on the <2mm fraction of sediment[1].

Analyte	Units	BC SQGs [2]		Contaminated Sites Regulation [3]		Historic 95th Percentile	BOL-B1 (North)										BOL-B2 (South)										Pooled B1 and B2 95th Percentile [6]
							BOL-B1-01	BOL-B1-02	BOL-B1-03	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	BOL-B2-01	BOL-B2-02	BOL-B2-03	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	
Date Sampled		TEL	PEL	Sensitive	Typical		23-Oct-14	23-Oct-14	23-Oct-14								23-Oct-14	23-Oct-14	23-Oct-14								
Physical Tests [4]																											
Moisture	%	-	-	-	-	-	93.6	93.4	93.4	93.5	93.4	93.4	93.6	0.12	0.067	0.29	93.9	93.3	92.9	93.4	93.3	92.9	93.9	0.50	0.29	1.25	93.8
pH (1:2 soil:water)	pH	-	-	-	-	-	6.64	6.30	6.44	6.46	6.44	6.30	6.64	0.17	0.10	0.42	6.21	5.99	6.08	6.09	6.08	5.99	6.21	0.11	0.064	0.27	6.01
Particle Size [5]																											
% Gravel (>2mm)	%	-	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
% Sand (2.0mm -	%	-	-	-	-	-	27	2.3	4.2	11	4.2	2.3	27	14	8.0	34	0.48	0.41	0.59	0.49	0.48	0.41	0.59	0.091	0.052	0.23	21
% Silt (0.063mm - 4µm)	%	-	-	-	-	-	64	83	83	77	83	64	83	11	6.6	28	84	84	82	83	84	82	84	1.0	0.58	2.5	84
% Clay (<4µm)	%	-	-	-	-	-	9.2	14	13	12	13	9.18	14	2.6	1.5	6.5	16	15	17	16	16	15	17	0.91	0.52	2.3	17
Texture	-	-	-	-	-	-	Silt loam	Silt	Silt	-	-	-	-	-	-	-	Silt	Silt	Silt	-	-	-	-	-	-	-	-
Leachable Anions & Nutrients [5]																											
pH	pH	-	-	-	-	-	6.07	5.92	5.88	5.96	5.92	5.88	6.07	0.10	0.06	0.25	5.91	5.94	5.79	5.88	5.91	5.79	5.94	0.08	0.05	0.20	5.81
Anions and Nutrients [4]																											
Total Nitrogen by LECO	%	-	-	-	-	-	1.54	1.70	1.60	1.61	1.60	1.54	1.70	0.081	0.047	0.20	1.59	1.48	1.55	1.54	1.55	1.48	1.59	0.056	0.032	0.138	1.68
Organic / Inorganic Carbon [5]																											
Total Organic Carbon	%	-	-	-	-	18.0	9.98	17.0	16.3	14.4	16.3	9.98	17.0	3.87	2.23	9.61	17.5	16.7	16.5	16.9	16.7	16.5	17.5	0.53	0.31	1.31	17.4
Metals [4]																											
Aluminum	mg/kg	-	-	-	-	18,700	18,300	19,300	18,800	18,800	18,800	18,300	19,300	500	289	1,242	19,900	18,800	19,900	19,533	19,900	18,800	19,900	635	367	1,578	19,900
Antimony	mg/kg	-	-	-	-	1.7	0.90	0.86	0.85	0.87	0.86	0.85	0.90	0.026	0.015	0.066	1.01	0.89	1.03	0.98	1.01	0.89	1.03	0.076	0.044	0.19	1.03
Arsenic	mg/kg	5.9	17	11	20	7.6	6.16	5.60	5.79	5.85	5.79	5.60	6.16	0.28	0.16	0.71	6.52	6.61	7.23	6.79	6.61	6.52	7.23	0.39	0.22	0.96	7.08
Barium	mg/kg	-	-	-	-	292	203	191	186	193	191	186	203	8.74	5.04	21.7	270	233	283	262	270	233	283	25.9	15.0	64.4	280
Beryllium	mg/kg	-	-	-	-	0.77	0.65	0.69	0.62	0.65	0.65	0.62	0.69	0.035	0.020	0.087	0.75	0.73	0.78	0.75	0.75	0.73	0.78	0.025	0.015	0.063	0.77
Bismuth	mg/kg	-	-	-	-	0.30	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Boron	mg/kg	-	-	-	-	17	17	17	16	17	17	16	17	0.58	0.33	1.4	17	12	16	15	16	12	17	2.6	1.5	6.6	17
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.72	0.405	0.455	0.434	0.431	0.434	0.405	0.455	0.025	0.014	0.062	0.434	0.484	0.481	0.466	0.481	0.434	0.484	0.028	0.016	0.070	0.483
Calcium	mg/kg	-	-	-	-	12,800	10,600	10,800	10,600	10,667	10,600	10,600	10,800	115	66.7	287	8,050	7,720	7,960	7,910	7,960	7,720	8,050	171	98.5	424	10,750
Chromium	mg/kg	37	90	56	110	55	36.8	38.4	39.2	38.1	38.4	36.8	39.2	1.22	0.71	3.04	37.3	32.5	37.4	35.7	37.3	32.5	37.4	2.80	1.62	6.96	39.0
Cobalt	mg/kg	-	-	-	-	16	11.9	12.0	12.1	12.0	12.0	11.9	12.1	0.10	0.058	0.25	12.1	11.6	12.0	11.9	12.0	11.6	12.1	0.26	0.15	0.66	12.1
Copper	mg/kg	36	197	120	240	618	397	438	443	426	438	397	443	25.2	14.6	62.7	372	378	379	376	378	372	379	3.79	2.19	9.41	442
Iron	mg/kg	21,200	43,776	-	-	29,200	25,900	24,000	24,900	24,933	24,900	24,000	25,900	950	549	2,361	32,200	25,400	30,400	**29,333**	**30,400**	25,400	**32,200**	3,523	2,034	8,753	**31,750**
Lead	mg/kg	35	91	57	110	16	7.44	8.18	7.55	7.72	7.55	7.44	8.18	0.40	0.23	0.99	11.0	11.8	11.5	11.4	11.5	11.0	11.8	0.40	0.23	1.0	11.7
Lithium	mg/kg	-	-	-	-	12.2	13.5	12.9	13.1	13.2	13.1	12.9	13.5	0.31	0.18	0.76	13.4	11.3	12.4	12.4	12.4	11.3	13.4	1.05	0.61	2.61	13.5
Magnesium	mg/kg	-	-	-	-	8,770	5,960	5,670	5,840	5,823	5,840	5,670	5,960	146	84	362	5,270	5,060	5,480	5,270	5,270	5,060	5,480	210	121	522	5,930
Manganese	mg/kg	460	1,100	-	-	1,720	1,130	899	1,020	1,016	1,020	899	1,130	116	67	287	1,700	1,040	1,610	1,450	1,610	1,040	1,700	358	207	889	1,678
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.36	0.240	0.290	0.275	0.268	0.275	0.240	0.290	0.026	0.015	0.064	0.334	0.323	0.342	0.333	0.334	0.323	0.342	0.010	0.0055	0.024	0.340
Molybdenum	mg/kg	-	-	-	-	8.26	3.44	3.14	3.46	3.35	3.44	3.14	3.46	0.18	0.10	0.45	3.22	3.56	3.45	3.41	3.45	3.22	3.56	0.17	0.10	0.43	3.54
Nickel	mg/kg	16	75	-	-	37	27.1	27.5	27.7	27.4	27.5	27.1	27.7	0.31	0.18	0.76	27.8	27.0	28.0	27.6	27.8	27.0	28.0	0.53	0.31	1.31	28.0
Phosphorus	mg/kg	-	-	-	-	2,590	1,280	1,220	1,240	1,247	1,240	1,220	1,280	30.6	17.6	75.9	2,770	1,600	2,710	2,360	2,710	1,600	2,770	659	380	1,637	2,755
Potassium	mg/kg	-	-	-	-	1,420	1,370	1,390	1,420	1,393	1,390	1,370	1,420	25.2	14.5	62.5	1,590	1,240	1,450	1,427	1,450	1,240	1,590	176	102	438	1,555
Selenium	mg/kg	2.0	-	-	-	3.07	2.95	2.80	3.08	2.94	2.95	2.80	**3.08**	0.14	0.081	0.35	2.96	2.45	2.73	2.71	2.73	2.45	2.96	0.26	0.15	0.63	3.05
Silver	mg/kg	0.50	-	-	-	0.5	0.38	0.40	0.41	0.40	0.40	0.38	0.41	0.015	0.0088	0.038	0.40	0.40	0.41	0.40	0.40	0.40	0.41	0.0058	0.0033	0.014	0.41
Sodium	mg/kg	-	-	-	-	210	220	220	210	217	220	210	220	5.77	3.33	14.3	220	190	210	207	210	190	220	15.3	8.8	37.9	220
Strontium	mg/kg	-	-	-	-	147	120	123	120	121	120	120	123	1.73	1.00	4.30	98.5	95.5	98.7	97.6	98.5	95.5	98.7	1.79	1.03	4.45	122
Thallium	mg/kg	-	-	-	-	0.14	0.122	0.149	0.121	0.131	0.122	0.121	0.149	0.016	0.009	0.039	0.130	0.124	0.134	0.129	0.130	0.124	0.134	0.0050	0.0029	0.013	0.145
Tin	mg/kg	-	-	-	-	0.8	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	644	669	667	654	663	667	654	669	8.14	4.70	20.2	518	365	486	456	486	365	518	80.7	46.6	200	669
Uranium	mg/kg	-	-	-	-	2.9	2.19	2.49	2.51	2.40	2.49	2.19	2.51	0.179	0.103	0.445	2.33	2.30	2.32	2.32	2.32	2.30	2.33	0.015	0.0088	0.038	2.51
Vanadium	mg/kg	-	-	-	-	75	66.8	68.9	68.7	68.1	68.7	66.8	68.9	1.16	0.67	2.88	76.1	68.2	75.8	73.4	75.8	68.2	76.1	4.48	2.58	11.1	76.0
Zinc	mg/kg	123	315	200	380	105	78.2	79.7	81.0	79.6	79.7	78.2	81.0	1.40	0.81	3.48	77.7	76.3	79.5	77.8	77.7	76.3	79.5	1.60	0.93	3.99	80.7

[1] Reported TOC, TN, pH and moisture data are based on bulk sediment. Data < method detection limit (MDL) were used at the MDL for calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] Samples were collected using a sediment corer.

[5] Samples were collected using a petite ponar.

[6] The 5th percentile is reported for pH.

(blue) Value is > TEL. Values shown in bold text also exceed Historic 95th Percentile value.

(orange) Value is > PEL. Values shown in bold text also exceed Historic 95th Percentile value.

Table E.21: Raw sediment quality data for mid-depth areas of Bootjack Lake, Mount Polley Mine, 2014. Data are based on the <63µm fraction of sediment [1].

Analyte	Units	BC SQGs [2]		Contaminated Sites Regulation [3]		Historic 95th Percentile	Mid-depth Area (BOL-1)												
Sample ID							BOL-1-01	BOL-1-02	BOL-1-03	BOL-1-04	BOL-1-05	Mean	Median	Minimum	Maximum	95th Percentile [6]	Standard Deviation	Standard Error	t*SE
Date Sampled		TEL	PEL	Sensitive	Typical		23-Oct-14	23-Oct-14	23-Oct-14	23-Oct-14	23-Oct-14								
Physical Tests [4]																			
pH (1:2 soil:water)	pH	-	-	-	-	-	6.24	6.18	6.33	6.22	6.21	6.24	6.22	6.18	6.33	6.19	0.06	0.025	0.07
Organic / Inorganic Carbon [5]																			
Total Organic Carbon	%	-	-	-	-	18.0	17.6	17.5	18.3	16.6	14.8	17.0	17.5	14.8	18.3	18.2	1.35	0.60	1.68
Metals [4]																			
Aluminum	mg/kg	-	-	-	-	13,200	16,700	19,700	19,200	18,800	15,600	18,000	18,800	15,600	19,700	19,600	1,762	788	2,188
Antimony	mg/kg	-	-	-	-	<10	0.81	0.88	1.08	0.91	0.87	0.91	0.88	0.81	1.08	1.05	0.10	0.045	0.13
Arsenic	mg/kg	5.9	17	11	20	7.9	5.27	5.74	6.76	5.89	6.22	5.98	5.89	5.27	6.76	6.65	0.56	0.25	0.69
Barium	mg/kg	-	-	-	-	67	222	247	262	211	194	227	222	194	262	259	27.4	12.2	34.0
Beryllium	mg/kg	-	-	-	-	<0.5	0.63	0.75	0.79	0.69	0.55	0.68	0.69	0.55	0.79	0.78	0.095	0.043	0.12
Bismuth	mg/kg	-	-	-	-	-	0.14	0.14	0.18	0.14	0.12	0.14	0.14	0.12	0.18	0.17	0.022	0.010	0.027
Boron	mg/kg	-	-	-	-	-	13	17	14	15	14	15	14	13	17	17	1.5	0.7	1.9
Cadmium	mg/kg	0.60	3.5	2.2	4.2	<0.50	0.407	0.468	0.504	0.467	0.290	0.427	0.467	0.290	0.504	0.497	0.0842	0.0377	0.105
Calcium	mg/kg	-	-	-	-	20,100	7,970	10,000	8,700	10,900	10,100	9,534	10,000	7,970	10,900	10,740	1,177	527	1,462
Chromium	mg/kg	37	90	56	110	40	34.2	48.0	42.4	47.1	38.7	**42.1**	**42.4**	34.2	**48.0**	**47.8**	5.79	2.59	7.18
Cobalt	mg/kg	-	-	-	-	17	10.3	11.1	12.0	12.1	9.7	11.0	11.1	9.70	12.1	12.1	1.05	0.47	1.30
Copper	mg/kg	36	197	120	240	359	322	352	434	385	309	**360**	352	309	**434**	**424**	50.5	22.6	62.7
Iron	mg/kg	21,200	43,776	-	-	37,600	21,800	23,600	24,500	25,400	21,700	23,400	23,600	21,700	25,400	25,220	1,636	731	2,030
Lead	mg/kg	35	91	57	110	13	9.76	11.6	11.5	11.9	5.87	10.1	11.5	5.87	11.9	11.8	2.52	1.13	3.13
Lithium	mg/kg	-	-	-	-	-	11.1	13.1	14.9	13.1	10.7	12.6	13.1	10.7	14.9	14.5	1.71	0.76	2.12
Magnesium	mg/kg	-	-	-	-	11,000	4,760	5,370	5,360	6,340	5,020	5,370	5,360	4,760	6,340	6,146	599	268	744
Manganese	mg/kg	460	1,100	-	-	850	824	799	744	801	934	820	801	744	**934**	**912**	70.0	31.3	86.9
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.16	0.299	0.318	0.373	0.313	0.218	**0.304**	**0.313**	**0.218**	**0.373**	**0.362**	0.056	0.025	0.069
Molybdenum	mg/kg	-	-	-	-	<5.0	2.85	4.21	5.46	3.67	3.78	3.99	3.78	2.85	5.46	5.21	0.96	0.43	1.19
Nickel	mg/kg	16	75	-	-	24	25.5	34.3	31.4	32.7	24.9	**29.8**	**31.4**	**24.9**	**34.3**	**34.0**	4.29	1.92	5.33
Phosphorus	mg/kg	-	-	-	-	-	1,230	1,350	1,420	1,460	1,180	1,328	1,350	1,180	1,460	1,452	120	53.8	149
Potassium	mg/kg	-	-	-	-	-	1,290	1,530	1,450	1,410	1,090	1,354	1,410	1,090	1,530	1,514	171	76.5	212
Selenium	mg/kg	2.0	-	-	-	2.78	2.24	2.63	2.78	2.68	2.12	2.49	2.63	2.12	**2.78**	2.76	0.291	0.130	0.362
Silver	mg/kg	0.50	-	-	-	0.5	0.325	0.388	0.425	0.395	0.287	0.364	0.388	0.287	0.425	0.419	0.056	0.025	0.070
Sodium	mg/kg	-	-	-	-	-	220	220	220	220	230	222	220	220	230	228	4.47	2.00	5.55
Strontium	mg/kg	-	-	-	-	-	91.0	101	107	117	113	106	107	91.0	117	116	10.3	4.59	12.7
Thallium	mg/kg	-	-	-	-	-	0.122	0.134	0.145	0.126	0.108	0.127	0.126	0.108	0.145	0.143	0.0138	0.0062	0.0171
Tin	mg/kg	-	-	-	-	5.0	4.87	5.88	6.98	3.95	6.53	5.64	5.88	3.95	6.98	6.89	1.23	0.55	1.53
Titanium	mg/kg	-	-	-	-	-	466	517	534	581	674	554	534	466	674	655	78.5	35.1	97.4
Uranium	mg/kg	-	-	-	-	-	2.01	2.36	2.65	2.27	1.76	2.21	2.27	1.76	2.65	2.59	0.34	0.15	0.42
Vanadium	mg/kg	-	-	-	-	123	62.0	64.3	65.1	69.9	65.5	65.4	65.1	62.0	69.9	69.0	2.88	1.29	3.57
Zinc	mg/kg	123	315	200	380	109	65.6	76.7	74.5	81.0	61.8	71.9	74.5	61.8	81.0	80.1	7.97	3.57	9.90

[1] Data < method detection limit (MDL) were used at the MDL for calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] Samples were collected using a sediment corer.

[5] Samples were collected using a petite ponar.

[6] The 5th percentile is reported for pH.

(blue)	Value is > TEL. Values shown in bold text also exceed Historic 95th Percentile value.
(orange)	Value is > PEL. Values shown in bold text also exceed Historic 95th Percentile value.

Table E.22: Raw sediment quality data for the deep areas of Bootjack Lake, Mount Polley Mine, 2014. Data are based on the <63um fraction of sediment [1].

Analyte	Units	BC SQGs [2]		Contaminated Sites Regulation [3]		Historic 95th Percentile	BOL-B1 (North)										BOL-B2 (South)										Pooled B1 and B2 95th Percentile [6]
Sample ID							BOL-B1-01	BOL-B1-02	BOL-B1-03	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	BOL-B2-01	BOL-B2-02	BOL-B2-03	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	
Date Sampled		TEL	PEL	Sensitive	Typical		23-Oct-14	23-Oct-14	23-Oct-14								23-Oct-14	23-Oct-14	23-Oct-14								
Physical Tests [4]																											
pH (1:2 soil:water)	pH	-	-	-	-	-	6.32	6.12	6.19	6.21	6.19	6.12	6.32	0.10	0.059	0.25	6.08	5.98	5.98	6.01	5.98	5.98	6.08	0.058	0.033	0.14	5.98
Organic / Inorganic Carbon [5]																											
Total Organic Carbon	%	-	-	-	-	18.0	11.8	14.8	14.4	13.7	14.4	11.8	14.8	1.63	0.94	4.05	16.8	15.7	14.7	15.7	15.7	14.7	16.8	1.05	0.61	2.61	16.5
Metals [4]																											
Aluminum	mg/kg	-	-	-	-	18,700	18,600	16,900	16,500	17,333	16,900	16,500	18,600	1,115	644	2,770	18,000	18,300	16,800	17,700	18,000	16,800	18,300	794	458	1,972	18,525
Antimony	mg/kg	-	-	-	-	1.7	0.84	0.81	0.78	0.81	0.81	0.78	0.84	0.030	0.017	0.075	0.74	0.86	0.80	0.80	0.80	0.74	0.86	0.06	0.03	0.15	0.86
Arsenic	mg/kg	5.9	17	11	20	7.6	6.40	5.63	5.83	5.95	5.83	5.63	6.40	0.40	0.23	0.99	5.89	6.25	6.12	6.09	6.12	5.89	6.25	0.18	0.11	0.45	6.36
Barium	mg/kg	-	-	-	-	292	216	193	189	199	193	189	216	14.6	8.41	36.2	236	250	242	243	242	236	250	7.0	4.1	17	248
Beryllium	mg/kg	-	-	-	-	0.8	0.62	0.66	0.52	0.60	0.62	0.52	0.66	0.072	0.042	0.18	0.68	0.70	0.69	0.69	0.69	0.68	0.70	0.01	0.01	0.02	0.70
Bismuth	mg/kg	-	-	-	-	0.3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	0.11	0.15	0.14	0.13	0.14	0.11	0.15	0.021	0.012	0.052	0.15
Boron	mg/kg	-	-	-	-	17	17	16	15	16	16	15	17	1.0	0.58	2.5	13	13	14	13	13	13	14	0.6	0.3	1.4	17
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.72	0.319	0.374	0.358	0.350	0.358	0.319	0.374	0.028	0.016	0.070	0.381	0.407	0.395	0.394	0.395	0.381	0.407	0.013	0.008	0.032	0.404
Calcium	mg/kg	-	-	-	-	12,800	11,000	10,700	9,630	10,443	10,700	9,630	11,000	720	416	1,789	7,410	7,830	7,020	7,420	7,410	7,020	7,830	405	234	1,006	10,925
Chromium	mg/kg	37	90	56	110	55	38.1	42.8	38.5	39.8	38.5	38.1	42.8	2.61	1.50	6.47	35.4	117	33.4	**61.9**	35.4	33.4	**117**	47.7	27.5	119	**98**
Cobalt	mg/kg	-	-	-	-	16	10.9	10.4	10.3	10.5	10.4	10.3	10.9	0.32	0.19	0.80	10.9	11.9	10.20	11.0	10.9	10.2	11.9	0.85	0.49	2.12	11.7
Copper	mg/kg	36	197	120	240	618	372	363	375	370	372	363	375	6.24	3.61	15.5	333	381	305	340	333	305	381	38	22.2	95	380
Iron	mg/kg	21,200	43,776	-	-	29,200	26,200	22,200	23,100	23,833	23,100	22,200	26,200	2,098	1,212	5,213	29,000	25,300	25,500	26,600	25,500	25,300	29,000	2,081	1,201	5,170	28,300
Lead	mg/kg	35	91	57	110	16	6.65	6.86	6.16	6.56	6.65	6.16	6.86	0.36	0.21	0.89	9.67	10.5	10.1	10.1	10.1	9.67	10.5	0.42	0.24	1.03	10.4
Lithium	mg/kg	-	-	-	-	12.2	12.2	11.8	9.90	11.3	11.8	9.90	12.2	1.23	0.71	3.05	11.0	11.2	11.1	11.1	11.1	11.0	11.2	0.10	0.06	0.25	12.1
Magnesium	mg/kg	-	-	-	-	8,770	5,570	5,100	5,440	5,370	5,440	5,100	5,570	243	140	603	5,000	5,060	4,410	4,823	5,000	4,410	5,060	359	207	892	5,538
Manganese	mg/kg	460	1,100	-	-	1,720	1,090	860	910	953	910	860	1,090	121	69.8	301	1,580	1,080	1,250	1,303	1,250	1,080	1,580	254	147	632	1,498
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.36	0.185	0.201	0.188	0.191	0.188	0.185	0.201	0.0085	0.0049	0.021	0.234	0.240	0.292	0.255	0.240	0.234	0.292	0.032	0.018	0.079	0.279
Molybdenum	mg/kg	-	-	-	-	8.3	3.43	3.26	2.97	3.22	3.26	2.97	3.43	0.233	0.134	0.578	2.88	4.62	3.35	3.62	3.35	2.88	4.62	0.90	0.52	2.24	4.32
Nickel	mg/kg	16	75	-	-	37	27.0	29.9	26.6	27.8	27.0	26.6	29.9	1.80	1.04	4.47	27.8	89.5	25.6	**47.6**	27.8	25.6	**89.5**	36.3	20.9	90.1	**74.6**
Phosphorus	mg/kg	-	-	-	-	2,590	1,420	1,180	1,270	1,290	1,270	1,180	1,420	121	70	301	2,730	1,760	2,230	2,240	2,230	1,760	2,730	485	280	1,205	2,605
Potassium	mg/kg	-	-	-	-	1,420	1,400	1,190	1,270	1,287	1,270	1,190	1,400	106	61	263	1,240	1,260	1,260	1,253	1,260	1,240	1,260	11.5	6.67	28.7	1,368
Selenium	mg/kg	2.0	-	-	-	3.07	2.63	2.31	2.50	2.48	2.50	2.31	2.63	0.16	0.09	0.40	2.52	2.40	2.18	2.37	2.40	2.18	2.52	0.172	0.100	0.428	2.60
Silver	mg/kg	0.50	-	-	-	0.5	0.34	0.32	0.32	0.33	0.32	0.32	0.34	0.0090	0.0052	0.022	0.36	0.39	0.32	0.36	0.36	0.32	0.39	0.032	0.018	0.080	0.38
Sodium	mg/kg	-	-	-	-	210	250	220	230	233	230	220	250	15.3	8.8	37.9	180	190	200	190	190	180	200	10.0	5.77	24.8	245
Strontium	mg/kg	-	-	-	-	147	136	127	111	125	127	111	136	12.7	7.3	31.5	88.1	97.3	81.2	88.9	88.1	81.2	97.3	8.08	4.66	20.1	134
Thallium	mg/kg	-	-	-	-	0.14	0.106	0.105	0.113	0.108	0.106	0.105	0.113	0.0044	0.0025	0.011	0.101	0.131	0.112	0.115	0.112	0.101	0.131	0.015	0.009	0.038	0.127
Tin	mg/kg	-	-	-	-	0.8	0.55	0.47	0.44	0.49	0.47	0.44	0.55	0.057	0.033	0.14	0.38	1.2	1.47	1.0	1.2	0.38	1.5	0.57	0.33	1.4	1.4
Titanium	mg/kg	-	-	-	-	644	776	691	786	751	776	691	786	52.2	30.1	130	386	397	439	407	397	386	439	28.0	16.1	69.5	784
Uranium	mg/kg	-	-	-	-	2.9	2.02	1.96	2.07	2.02	2.02	1.96	2.07	0.055	0.032	0.14	1.91	2.02	1.87	1.93	1.91	1.87	2.02	0.078	0.045	0.19	2.06
Vanadium	mg/kg	-	-	-	-	75	67.9	62.2	63.2	64.4	63.2	62.2	67.9	3.04	1.76	7.56	63.7	63.3	64.0	63.7	63.7	63.3	64.0	0.35	0.20	0.87	66.9
Zinc	mg/kg	123	315	200	380	105	69.9	65.7	69.3	68.3	69.3	65.7	69.9	2.27	1.31	5.64	68.7	108	65.6	80.8	68.7	65.6	108	23.6	13.6	58.7	98.5

[1] Data < method detection limit (MDL) were used at the MDL for calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996).

[4] Samples were collected using a sediment corer.

[5] Samples were collected using a petite ponar.

[6] The 5th percentile is reported for pH.

(blue) Value is > TEL. Values shown in bold text also exceed Historic 95th Percentile value.

(orange) Value is > PEL. Values shown in bold text also exceed Historic 95th Percentile value.

Table E.23: PCA results displaying; eigen value, percent variance explained, Monte Carlo randomization p-values of axis significance, and station scores for < 2mm sediment from Polley and Bootjack mid-depth sampling stations, Mount Polley Mine, 2014. Data were Log (X+1) transformed prior to analysis [a].

			Axis 1	Axis 2
Eigenvalue			18.6	5.6
% Variance explained			62.2	18.7
Monte Carlo p			0.0001	0.0001
Polley Lake	North	POL-1-01	-2.8	2.9
		POL-1-02	-1.8	0.49
		POL-1-03	-2.7	-0.10
		POL-1-04	-3.9	0.88
		POL-1-05	-3.1	0.04
	South	POL-2-01	-2.7	-2.9
		POL-2-02	-4.1	1.2
		POL-2-O3	0.52	5.2
		POL-2-O4	-4.2	-3.4
		POL-2-O5	-3.6	-1.6
Bootjack Lake		BOL-1-01	6.0	0.50
		BOL-1-02	5.7	-0.14
		BOL-1-03	6.0	1.5
		BOL-1-04	5.4	-0.70
		BOL-1-05	5.3	-3.9

[a] Bismuth and mercury were omitted from PCA calculations due to a lack of variability in the data set (all values for each analyte were the same), or an incomplete data set.

Table E.24: PCA axis scores Spearman correlation with sediment metal concentrations (A) and sediment physical characteristics (B) for Polley and Bootjack Lake sediment (< 2mm fraction) from mid-depth stations, Mount Polley Mine, 2014. Data were Log_{10} (X+1) transformed prior to analysis.

A)

Metal	Spearman Correlation Coefficient [a]		P-Value [b]	
	PCA Axis-1 (62.2%)	PCA Axis-2 (18.7%)	PCA Axis-1 (62.2%)	PCA Axis-2 (18.7%)
Aluminum	-0.079	0.939	0.781	0.000
Antimony	0.666	0.201	0.007	0.474
Arsenic	-0.902	0.090	0.000	0.751
Barium	-0.282	0.707	0.308	0.003
Beryllium	-0.074	0.864	0.794	0.000
Boron	0.829	0.462	0.000	0.083
Cadmium	0.961	0.271	0.000	0.328
Calcium	-0.939	-0.011	0.000	0.970
Chromium	0.911	0.264	0.000	0.341
Cobalt	-0.581	0.599	0.023	0.018
Copper	-0.725	0.518	0.002	0.048
Iron	-0.696	-0.025	0.004	0.930
Lead	0.764	0.550	0.001	0.034
Lithium	-0.496	0.679	0.060	0.005
Magnesium	-0.550	0.572	0.033	0.026
Manganese	0.657	0.196	0.008	0.483
Molybdenum	-0.307	0.300	0.265	0.277
Nickel	0.896	0.365	0.000	0.181
Phosphorus	-0.332	-0.484	0.226	0.067
Potassium	-0.654	0.454	0.008	0.089
Selenium	0.907	0.329	0.000	0.232
Silver	0.815	0.086	0.000	0.760
Sodium	-0.810	0.297	0.000	0.282
Strontium	-0.811	0.229	0.000	0.412
Thallium	0.899	0.079	0.000	0.778
Tin	-0.371	0.247	0.173	0.374
Titanium	-0.931	0.129	0.000	0.648
Uranium	0.754	0.191	0.001	0.495
Vanadium	-0.796	-0.064	0.000	0.820
Zinc	0.782	0.571	0.001	0.026

[a] Highlighted cells indicate Spearman correlation coefficient > 0.7 or < -0.7.
[b] Highlighted cells indicate Spearman correlation with p value < 0.1.

B)

Physical Characteristic	Spearman Correlation Coefficient		P-Value	
	PCA Axis-1 (62.2%)	PCA Axis-2 (18.7%)	PCA Axis-1 (62.2%)	PCA Axis-2 (18.7%)
% Sand	-0.593	-0.375	0.020	0.168
% Silt	0.057	0.282	0.840	0.308
% Clay	0.764	0.175	0.001	0.533
Total Organic Carbon	0.735	-0.039	0.002	0.889

Table E.25: PCA results displaying; eigen value, percent variance explained, Monte Carlo randomization p-values of axis significance, and station scores for < 2mm sediment from Polley and Bootjack deep sampling stations, Mount Polley Mine, 2014. Data were Log (X+1) transformed prior to analysis [a].

			Axis 1	Axis 2
Eigenvalue			18.1	6.2
% Variance explained			60.3	20.6
Monte Carlo p			0.0001	0.0001
Polley Lake	North Basin	POL-P1-01	-1.8	-2.9
		POL-P1-02	-2.5	-1.8
		POL-P1-03	-4.4	-0.41
	South Basin	POL-P2-O1	-5.5	-0.60
		POL-P2-O2	-2.6	-3.9
		POL-P2-O3	-6.5	6.1
Bootjack Lake	North Basin	BOL-B1-01	3.3	0.58
		BOL-B1-02	3.7	0.059
		BOL-B1-03	3.5	0.007
	South Basin	BOL-B2-01	4.0	0.74
		BOL-B2-02	4.5	1.44
		BOL-B2-03	4.2	0.69

[a] Boron, bismuth and mercury were omitted from PCA calculations due to a lack of variability in the data set (all values for each analyte were the same), or an incomplete data set.

Table E.26: PCA axis scores Spearman correlation with sediment metal concentrations (A) and sediment physical characteristics (B) for Polley and Bootjack Lake sediment (< 2mm fraction) from deep lake stations, Mount Polley Mine, 2014. Data were Log_{10} (X+1) transformed prior to analysis [a].

A)

Metal	Spearman Correlation Coefficient [a]		P-Value [b]	
	PCA Axis-1 (60.3%)	PCA Axis-2 (20.6%)	PCA Axis-1 (60.3%)	PCA Axis-2 (20.6%)
Aluminum	-0.699	-0.629	0.011	0.028
Antimony	0.846	0.469	0.001	0.124
Arsenic	-0.783	-0.217	0.003	0.499
Barium	-0.126	0.308	0.696	0.330
Beryllium	-0.581	-0.172	0.047	0.594
Boron	0.068	-0.653	0.833	0.021
Cadmium	0.967	0.301	0.000	0.341
Calcium	-0.970	-0.413	0.000	0.182
Chromium	0.266	-0.615	0.404	0.033
Cobalt	-0.891	-0.463	0.000	0.129
Copper	-0.930	-0.510	0.000	0.090
Iron	-0.658	-0.189	0.020	0.556
Lead	0.524	0.168	0.080	0.602
Lithium	-0.930	-0.538	0.000	0.071
Magnesium	-0.965	-0.497	0.000	0.101
Manganese	0.573	0.343	0.051	0.276
Molybdenum	-0.615	-0.699	0.033	0.011
Nickel	0.294	-0.559	0.354	0.059
Phosphorus	0.480	0.802	0.114	0.002
Potassium	-0.755	-0.608	0.005	0.036
Selenium	0.063	-0.666	0.846	0.018
Silver	0.471	-0.160	0.123	0.618
Sodium	-0.928	-0.370	0.000	0.236
Strontium	-0.956	-0.392	0.000	0.207
Thallium	0.909	0.308	0.000	0.331
Tin	-0.650	0.237	0.022	0.459
Titanium	-0.993	-0.392	0.000	0.208
Uranium	0.811	0.210	0.001	0.513
Vanadium	-0.755	-0.378	0.005	0.226
Zinc	-0.434	-0.951	0.159	0.000

[a] Highlighted cells indicate Spearman correlation coefficient > 0.7 or < -0.7.

[b] Highlighted cells indicate Spearman correlation with p value < 0.1.

B)

Physical Characteristic	Spearman Correlation		P-Value	
	PCA Axis-1 (60.3%)	PCA Axis-2 (20.6%)	PCA Axis-1 (60.3%)	PCA Axis-2 (20.6%)
% Sand	0.133	0.056	0.680	0.862
% Silt	0.650	0.224	0.022	0.484
% Clay	-0.650	-0.294	0.022	0.354
Total Organic Carbon	0.818	0.196	0.001	0.542

Table E.27: PCA results displaying; eigen value, percent variance explained, Monte Carlo randomization p-values of axis significance, and station scores for < 63µm sediment from Polley and Bootjack mid-depth sampling stations, Mount Polley Mine 2014. Data were Log (X+1) transformed prior to analysis.

			Axis 1	Axis 2
Eigenvalue			22.6	6.7
% Variance explained			70.6	21.1
Monte Carlo p			0.0001	0.0001
Polley Lake	North	POL-1-01	-3.2	0.24
		POL-1-02	-2.6	0.86
		POL-1-03	-2.8	1.0
		POL-1-04	-3.4	0.74
		POL-1-05	-2.7	2.1
	South	POL-2-01	-2.7	1.5
		POL-2-02	-3.8	0.70
		POL-2-O3	-4.1	-8.5
		POL-2-O4	-3.5	1.4
		POL-2-O5	-3.5	0.94
Bootjack Lake		BOL-1-01	6.4	-1.0
		BOL-1-02	6.6	0.15
		BOL-1-03	6.3	-2.1
		BOL-1-04	6.4	-0.18
		BOL-1-05	6.6	2.2

Table E.28 PCA axis scores Spearman correlation with sediment metal concentrations (A) and sediment physical characteristics (B) for Polley and Bootjack Lake sediment (< 63µm fraction) from mid-depth stations, Mount Polley Mine, 2014. Data were Log_{10} (X+1) transformed prior to analysis.

A)

Metal	Spearman Correlation Coefficient [a]		P-Value [b]	
	PCA Axis-1 (70.6%)	PCA Axis-2 (21.1%)	PCA Axis-1 (70.6%)	PCA Axis-2 (21.1%)
Aluminum	-0.804	-0.100	0.000	0.723
Antimony	-0.687	-0.293	0.005	0.290
Arsenic	-0.762	0.508	0.001	0.053
Barium	-0.726	0.054	0.002	0.849
Beryllium	-0.857	-0.100	0.000	0.722
Bismuth	-0.433	-0.433	0.107	0.107
Boron	-0.690	-0.211	0.004	0.450
Cadmium	0.375	-0.650	0.168	0.009
Calcium	-0.600	0.643	0.018	0.010
Chromium	0.418	-0.663	0.121	0.007
Cobalt	-0.908	-0.066	0.000	0.815
Copper	-0.904	-0.089	0.000	0.752
Iron	-0.796	0.311	0.000	0.260
Lead	-0.722	-0.211	0.002	0.451
Lithium	-0.688	-0.048	0.005	0.864
Magnesium	-0.769	-0.048	0.001	0.864
Manganese	-0.777	0.100	0.001	0.723
Mercury	0.654	-0.643	0.008	0.010
Molybdenum	-0.854	0.270	0.000	0.331
Nickel	0.389	-0.789	0.152	0.000
Phosphorus	-0.554	0.511	0.032	0.052
Potassium	-0.874	-0.038	0.000	0.894
Selenium	0.284	-0.749	0.305	0.001
Silver	-0.802	0.118	0.000	0.674
Sodium	-0.941	0.092	0.000	0.745
Strontium	-0.650	0.364	0.009	0.182
Thallium	0.488	-0.689	0.065	0.004
Tin	-0.875	0.261	0.000	0.348
Titanium	-0.754	0.439	0.001	0.101
Uranium	-0.831	-0.147	0.000	0.602
Vanadium	-0.738	0.483	0.002	0.068
Zinc	-0.854	-0.105	0.000	0.708

[a] Highlighted cells indicate Spearman correlation coefficient > 0.7 or < -0.7.
[b] Highlighted cells indicate Spearman correlation with p value < 0.1.

B)

Physical Characteristic	Spearman Correlation		P-Value	
	PCA Axis-1 (70.6%)	PCA Axis-2 (21.1%)	PCA Axis-1 (70.6%)	PCA Axis-2 (21.1%)
% Silt	0.132	-0.011	0.639	0.970
% Clay	0.557	-0.629	0.031	0.012
Total Organic Carbon	0.864	-0.279	0.000	0.315

Table E.29: PCA results displaying; eigen value, percent variance explained, Monte Carlo randomization p-values of axis significance, and station scores for < 63µm sediment from Polley and Bootjack deep sampling stations, Mount Polley Mine, 2014. Data were Log (X+1) transformed prior to analysis.

			Axis 1	Axis 2
Eigenvalue			17.8	8.4
% Variance explained			55.7	26.4
Monte Carlo p			0.0001	0.0001
Polley Lake	North Basin	POL-P1-01	-4.4	-2.3
		POL-P1-02	-4.2	-0.34
		POL-P1-03	-4.2	1.7
	South Basin	POL-P2-O1	-4.0	2.8
		POL-P2-O2	-2.6	-2.0
		POL-P2-O3	-2.3	5.5
Bootjack Lake	North Basin	BOL-B1-01	2.0	-1.2
		BOL-B1-02	2.8	-1.0
		BOL-B1-03	3.1	-0.86
	South Basin	BOL-B2-01	3.1	-2.1
		BOL-B2-02	1.8	-4.3
		BOL-B2-03	8.8	4.1

Table E.30: PCA axis scores Spearman correlation with sediment metal concentrations (A) and sediment physical characteristics (B) for Polley and Bootjack Lake sediment (< 63µm fraction) from deep stations, Mount Polley Mine, 2014. Data were Log_{10} (X+1) transformed prior to analysis.

A)

Metal	Spearman Correlation Coefficient [a]		P-Value [b]	
	PCA Axis-1 (55.7%)	PCA Axis-2 (26.4%)	PCA Axis-1 (55.7%)	PCA Axis-2 (26.4%)
Aluminum	-0.951	0.063	0.000	0.846
Antimony	-0.273	-0.699	0.391	0.011
Arsenic	-0.804	0.308	0.002	0.331
Barium	-0.881	-0.098	0.000	0.762
Beryllium	-0.916	0.126	0.000	0.697
Bismuth	-0.706	-0.571	0.010	0.052
Boron	-0.348	-0.580	0.268	0.048
Cadmium	0.238	-0.888	0.457	0.000
Calcium	-0.776	0.427	0.003	0.167
Chromium	-0.196	-0.832	0.542	0.001
Cobalt	-0.876	0.189	0.000	0.556
Copper	-0.853	0.280	0.000	0.379
Iron	-0.725	0.042	0.008	0.897
Lead	-0.538	-0.692	0.071	0.013
Lithium	-0.916	0.168	0.000	0.602
Magnesium	-0.825	0.371	0.001	0.236
Manganese	0.028	-0.545	0.931	0.067
Mercury	0.510	-0.790	0.090	0.002
Molybdenum	-0.909	-0.210	0.000	0.513
Nickel	-0.252	-0.874	0.430	0.000
Phosphorus	0.657	-0.210	0.020	0.513
Potassium	-0.895	0.196	0.000	0.542
Selenium	-0.406	-0.629	0.191	0.028
Silver	-0.594	-0.657	0.042	0.020
Sodium	-0.834	0.368	0.001	0.240
Strontium	-0.846	0.357	0.001	0.255
Thallium	0.309	-0.794	0.328	0.002
Tin	-0.937	0.042	0.000	0.897
Titanium	-0.783	0.413	0.003	0.183
Uranium	0.288	-0.705	0.364	0.010
Vanadium	-0.755	0.084	0.005	0.795
Zinc	-0.783	-0.469	0.003	0.124

[a] Highlighted cells indicate Spearman correlation coefficient > 0.7 or < -0.7.

[b] Highlighted cells indicate Spearman correlation with p value < 0.1.

B)

Physical Characteristic	Spearman Correlation Coefficient		P-Value	
	PCA Axis-1 (55.7%)	PCA Axis-2 (26.4%)	PCA Axis-1 (55.7%)	PCA Axis-2 (26.4%)
% Silt	0.308	-0.594	0.331	0.042
% Clay	-0.615	0.524	0.033	0.080
Total Organic Carbon	0.664	-0.517	0.018	0.085

Table E.31: PCA results displaying; eigen value, percent variance explained, Monte Carlo randomization p-values of axis significance, and station scores for sediment from Polley Lake deep stations collected in 2012 and 2014 [a,b], Mount Polley Mine. Data were Log (X+1) transformed prior to analysis.

			Axis 1	**Axis 2**
Eigenvalue			17.3	7.5
% Variance explained			59.6	25.9
Monte Carlo p			0.0001	0.0006
2014	North	POL-P1-01	0.36	2.2
		POL-P1-02	-0.67	1.6
		POL-P1-03	-2.7	0.34
	South	POL-P2-O1	-4.2	0.23
		POL-P2-O2	-1.1	2.8
		POL-P2-O3	-3.9	-5.5
2012		P1-2012	4.6	0.82
		P2-2012	7.6	-2.6

[a] Metals data for samples collected in 2012 and 2014 are based on the < 2mm and bulk sediment fractions, respectively.
[b] PCA calculations are based on a reduced set of metals to match those reported in historical 2012 data.

Table E.32: PCA axis scores Spearman correlation with sediment metal concentrations (A) and sediment physical characteristics (B) for sediment from Polley Lake deep stations collected in 2012, and 2014, Mount Polley Mine, 2014. Data were Log10 (X+1) transformed prior to analysis.

A)

Metal	Spearman Correlation Coefficient [a]		P-Value [b]	
	PCA Axis-1 (59.6%)	PCA Axis-2 (25.9%)	PCA Axis-1 (59.6%)	PCA Axis-2 (25.9%)
Aluminum	-0.707	0.419	0.050	0.301
Antimony	-0.500	0.333	0.207	0.420
Arsenic	-0.952	-0.262	0.000	0.531
Barium	-0.714	-0.643	0.047	0.086
Beryllium	-0.929	0.000	0.001	1.000
Cadmium	0.833	0.500	0.010	0.207
Calcium	-0.952	-0.262	0.000	0.531
Chromium	0.738	0.690	0.037	0.058
Cobalt	-0.976	-0.167	0.000	0.693
Copper	-0.952	-0.214	0.000	0.610
Iron	0.323	-0.479	0.435	0.230
Lead	0.500	-0.167	0.207	0.693
Lithium	-0.857	0.000	0.007	1.000
Magnesium	-0.952	-0.214	0.000	0.610
Manganese	0.500	-0.238	0.207	0.570
Molybdenum	-0.048	0.905	0.911	0.002
Nickel	0.524	0.881	0.183	0.004
Phosphorus	0.347	-0.467	0.399	0.243
Potassium	-0.690	0.238	0.058	0.570
Selenium	0.905	0.286	0.002	0.493
Silver	-0.072	0.683	0.866	0.062
Sodium	-0.881	-0.238	0.004	0.570
Strontium	-0.905	-0.310	0.002	0.456
Thallium	0.766	0.635	0.027	0.091
Tin	-0.733	-0.655	0.039	0.078
Titanium	-0.976	-0.286	0.000	0.493
Uranium	-0.405	0.714	0.320	0.047
Vanadium	-0.524	0.119	0.183	0.779
Zinc	-0.190	0.619	0.651	0.102

[a] Highlighted cells indicate Spearman correlation coefficient > 0.7 or < -0.7.

[b] Highlighted cells indicate Spearman correlation with p value < 0.1.

B)

Physical Characteristic	Spearman Correlation Coefficient		P-Value	
	PCA Axis-1 (59.6%)	PCA Axis-2 (25.9%)	PCA Axis-1 (59.6%)	PCA Axis-2 (25.9%)
% Sand	0.238	0.095	0.570	0.823
% Silt	0.643	0.071	0.086	0.867
% Clay	-0.643	-0.071	0.086	0.867
Total Organic Carbon	0.857	0.143	0.007	0.736

Table E.33: PCA results displaying; eigen value, percent variance explained, Monte Carlo randomization p-values of axis significance, and station scores for sediment from Polley Lake deep stations collected in 2009, 2012 and 2014 [a,b,] Mount Polley Mine. Data were Log (X+1) transformed prior to analysis.

			Axis 1	Axis 2
Eigenvalue			9.8	3.9
% Variance explained			61.5	24.4
Monte Carlo p			0.0001	0.014
2014	North	POL-P1-01	-0.93	-1.6
		POL-P1-02	-1.11	-1.0
		POL-P1-03	-2.2	0.19
	South	POL-P2-O1	-3.2	0.05
		POL-P2-O2	-1.6	-1.9
		POL-P2-O3	-3.5	4.5
2012		P1-2012	0.7	-1.73
		P2-2012	1.6	-0.9
2009		P1-2009	5.7	2.0
		P2-2009	4.6	0.35

[a] Metals data for samples collected in 2009 and 2012 are based on bulk sediment and data for samples collected in 2014 are on <2mm fractions.

[b] A reduced set of analytes was used for this analysis due to the inclusion of data from 2009 which reported results for fewer analytes than reported in 2012 and 2014.

Table E.34: PCA axis scores Spearman correlation with sediment metal concentrations (A) and sediment physical characteristics (B) for sediment from Polley Lake deep stations collected in 2009, 2012, and 2014, Mount Polley Mine, 2014. Data were Log10 (X+1) transformed prior to analysis.

A)

Metal	Spearman Correlation Coefficient [a]		P-Value [b]	
	PCA Axis-1 (61.5%)	PCA Axis-2 (24.4%)	PCA Axis-1 (61.5%)	PCA Axis-2 (24.4%)
Antimony	0.267	0.413	0.455	0.235
Arsenic	-0.988	0.006	0.000	0.987
Barium	-0.830	0.042	0.003	0.907
Beryllium	-0.915	-0.139	0.000	0.701
Cadmium	0.939	-0.127	0.000	0.726
Chromium	0.624	-0.564	0.054	0.090
Cobalt	-0.964	-0.067	0.000	0.855
Copper	-0.939	0.006	0.000	0.987
Lead	0.790	0.231	0.007	0.521
Molybdenum	-0.248	-0.782	0.489	0.008
Nickel	0.406	-0.806	0.244	0.005
Selenium	0.462	-0.705	0.179	0.023
Silver	0.506	-0.067	0.136	0.854
Tin	0.212	0.795	0.556	0.006
Vanadium	-0.782	-0.261	0.008	0.467
Zinc	-0.394	-0.733	0.260	0.016

[a] Highlighted cells indicate Spearman correlation coefficient > 0.7 or < -0.7.

[b] Highlighted cells indicate Spearman correlation with p value < 0.1.

B)

Physical Characteristic	Spearman Correlation Coefficient		P-Value	
	PCA Axis-1 (61.5%)	PCA Axis-2 (24.4%)	PCA Axis-1 (61.5%)	PCA Axis-2 (24.4%)
% Sand	0.486	0.154	-0.109	0.763
% Silt	-0.139	0.701	-0.661	0.038
% Clay	0.952	0.000	0.018	0.960
Total Organic Carbon	0.139	0.701	0.661	0.038

Table E.35: Raw selectively extracted (Tessier extraction) metals data for sediment from Polley Lake mid-depth sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1,2].

Analyte	Units	BC SQGs [3]		Contaminated Sites Regulation [4]		Bootjack Reference Mid-depth 95th Percentile	POL-1 (Northern Polley Lake)												POL-2 (Southern Polley Lake)											
							POL-1-01	POL-1-02	POL-1-03	POL-1-04	POL-1-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	POL-2-01	POL-2-02	POL-2-O3	POL-2-O4	POL-2-O5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled		TEL	PEL	Sensitive	Typical		21-Oct-14	20-Oct-14	21-Oct-14	21-Oct-14	22-Oct-14								22-Oct-14	22-Oct-14	24-Oct-14	24-Oct-14	24-Oct-14							
Exchangeable & Adsorbed Metals																														
Aluminum	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	0.065	<0.050	0.054	<0.050	<0.050	<0.050	0.051	<0.050	<0.050	0.054	0.0018	0.00080	0.0022	<0.050	0.053	0.050	<0.050	0.052	0.051	0.050	<0.050	0.053	0.0014	0.00063	0.0018
Barium	mg/kg	-	-	-	-	125	<21	<21	<15	<16	<17	<21	<17	<15	<21	2.8	1.3	3.5	<19	<18	<29	<15	<14	<29	<18	<14	<29	6.0	2.7	7.4
Beryllium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.173	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	0.065	<0.050	<0.050	0.053	<0.050	<0.050	0.065	0.0067	0.0030	0.0083
Calcium	mg/kg	-	-	-	-	7,648	3,020	2,680	2,270	1,820	2,250	2,408	2,270	1,820	3,020	458	205	568	2,460	2,350	7,120	1,310	1,660	2,980	2,350	1,310	7,120	2,363	1,057	2,934
Chromium	mg/kg	37.3	90	56	110	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Cobalt	mg/kg	-	-	-	-	0.35	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Copper	mg/kg	35.7	197	120	240	0.78	1.48	1.07	2.11	1.58	1.13	1.47	1.48	1.07	2.11	0.418	0.187	0.518	0.98	0.78	0.91	0.57	0.68	0.78	0.78	0.57	0.98	0.17	0.074	0.21
Iron	mg/kg	21,200	43,776	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Lead	mg/kg	35	91	57	110	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	mg/kg	460	1,100	-	-	493	96.8	94.8	104	59.4	103	91.6	96.8	59.4	104	18.4	8.24	22.9	110.0	38.4	94.0	47.4	71.4	72.2	71.4	38.4	110	30.3	13.5	37.6
Molybdenum	mg/kg	-	-	-	-	<0.50	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0	<4.0	<2.0	<2.0	<4.0	<2.0	<2.0	<4.0	0.9	0.4	1
Nickel	mg/kg	16	75	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Phosphorus	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Potassium	mg/kg	-	-	-	-	190	120	<100	100	120	100	108	100	<100	120	11.0	4.90	13.6	<100	130	150	<100	<100	116	<100	<100	150	23.0	10.3	28.6
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Sodium	mg/kg	-	-	-	-	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	0	0	0	<100	<100	260	<100	<100	132	<100	<100	260	71.6	32.0	88.8
Strontium	mg/kg	-	-	-	-	72.5	27.7	23.0	21.8	19.4	21.3	22.6	21.8	19.4	27.7	3.11	1.39	3.86	20.5	22.7	58.5	12.8	16.4	26.2	20.5	12.8	58.5	18.5	8.26	22.9
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0
Uranium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	0.064	<0.050	<0.050	0.053	<0.050	<0.050	0.064	0.0063	0.0028	0.0078
Vanadium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Zinc	mg/kg	123	315	200	380	2.1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0
Carbonate Metals																														
Aluminum	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50	<50	<50	89	76	63	<50	<50	89	18	8.2	23
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	0.150	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	0.186	0.169	0.168	0.125	0.168	<0.050	0.186	0.0685	0.0306	0.0850
Barium	mg/kg	-	-	-	-	36.9	55.1	41.0	61.1	68.8	57.9	56.8	57.9	41.0	68.8	10.2	4.56	12.7	35.1	64.1	55.8	63.3	60.1	55.7	60.1	35.1	64.1	12.0	5.35	14.8
Beryllium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.082	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	0.126	<0.050	<0.050	0.065	<0.050	<0.050	0.126	0.034	0.015	0.042
Calcium	mg/kg	-	-	-	-	898	7,680	7,350	7,910	8,320	7,820	7,816	7,820	7,350	8,320	353	158	438	7,430	8,000	5,160	11,000	11,300	8,578	8,000	5,160	11,300	2,579	1,153	3,202
Chromium	mg/kg	37.3	90	56	110	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Cobalt	mg/kg	-	-	-	-	0.26	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	0.39	0.20	0.22	0.20	0.20	<0.10	0.39	0.12	0.053	0.15
Copper	mg/kg	35.7	197	120	240	2.32	1.11	0.68	1.14	2.24	1.03	1.24	1.11	0.68	2.24	0.588	0.263	0.730	0.71	0.94	10.5	32.3	25.8	14.1	10.5	0.71	32.3	14.4	6.46	17.9
Iron	mg/kg	21,200	43,776	-	-	315	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50	<50	126	301	248	155	126	<50	301	115	51.4	143
Lead	mg/kg	35	91	57	110	0.71	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50	<0.50	0.62	1.02	0.98	0.72	0.62	<0.50	1.02	0.26	0.11	0.32
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	mg/kg	460	1,100	-	-	141	78.6	66.4	76.5	67.8	84.5	74.8	76.5	66.4	84.5	7.60	3.40	9.43	72.6	53.8	135	109	133	101	109	53.8	135	36.3	16.2	45.1
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Nickel	mg/kg	16	75	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Phosphorus	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Strontium	mg/kg	-	-	-	-	9.8	75.5	56.5	98.6	106	89.2	85.2	89.2	56.5	106	19.7	8.79	24.4	52.9	86.0	61.0	82.8	84.4	73.4	82.8	52.9	86.0	15.3	6.86	19.1
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Uranium	mg/kg	-	-	-	-	0.562	0.093	0.087	0.072	<0.050	0.071	0.075	0.072	<0.050	0.093	0.017	0.007	0.021	0.083	0.073	0.305	<0.050	0.063	0.115	0.073	<0.050	0.305	0.107	0.048	0.133
Vanadium	mg/kg	-	-	-	-	0.97	0.22	0.25	<0.20	<0.20	<0.20	0.21	<0.20	<0.20	0.25	0.022	0.010	0.027	0.21	<0.20	1.51	0.54	0.71	0.63	0.54	<0.20	1.51	0.54	0.24	0.67
Zinc	mg/kg	123	315	200	380	3.9	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0	<1.0	<1.0	4.1	1.1	1.2	1.7	1.1	<1.0	4.1	1.4	0.61	1.7

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.

[2] Samples were collected using a sediment corer.

[3] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[4] Contaminated Sites Regulation (Government of British Columbia 1996)

Value is > TEL. Values shown in bold text also exceed Reference 95th percentile value.

Value is > PEL. Values shown in bold text also exceed Reference 95th percentile value.

Table E.35: Raw selectively extracted (Tessier extraction) metals data for sediment from Polley Lake mid-depth sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1,2].

Analyte	Units	BC SQGs [3]		Contaminated Sites Regulation [4]		Bootjack Reference Mid-depth 95th Percentile	POL-1 (Northern Polley Lake)												POL-2 (Southern Polley Lake)											
							POL-1-01	POL-1-02	POL-1-03	POL-1-04	POL-1-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	POL-2-01	POL-2-02	POL-2-O3	POL-2-O4	POL-2-O5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled		TEL	PEL	Sensitive	Typical		21-Oct-14	20-Oct-14	21-Oct-14	21-Oct-14	22-Oct-14								22-Oct-14	22-Oct-14	24-Oct-14	24-Oct-14	24-Oct-14							
Easily Reducible Metals and Iron Oxides																														
Aluminum	mg/kg	-	-	-	-	1,114	2,030	1,690	2,300	2,540	2,090	2,130	2,090	1,690	2,540	317	142	394	1,500	2,250	1,560	2,030	2,060	1,880	2,030	1,500	2,250	331	148	411
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	1.01	1.21	1.07	1.46	1.49	1.17	1.28	1.21	1.07	1.49	0.19	0.083	0.23	1.04	1.43	1.65	1.58	1.67	1.47	1.58	1.04	1.67	0.260	0.116	0.323
Barium	mg/kg	-	-	-	-	48.3	28.9	23.3	30.9	29.5	25.2	27.6	28.9	23.3	30.9	3.18	1.42	3.95	22.6	25.6	37.9	24.5	26.7	27.5	25.6	22.6	37.9	6.03	2.70	7.49
Beryllium	mg/kg	-	-	-	-	0.34	0.24	0.22	0.21	0.23	0.21	0.22	0.22	0.21	0.24	0.013	0.0058	0.016	0.21	0.21	0.29	<0.20	<0.20	0.22	0.21	<0.20	0.29	0.038	0.017	0.048
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.199	0.062	0.058	<0.050	<0.050	<0.050	0.054	<0.050	<0.050	0.062	0.0057	0.0025	0.0070	<0.050	<0.050	0.116	<0.050	<0.050	0.063	<0.050	<0.050	0.116	0.030	0.013	0.037
Calcium	mg/kg	-	-	-	-	727	2,540	4,240	2,350	2,750	3,860	3,148	2,750	2,350	4,240	846	378	1,051	2,850	2,720	1,750	1,610	1,710	2,128	1,750	1,610	2,850	604	270	749
Chromium	mg/kg	37.3	90	56	110	2.37	2.93	2.59	2.59	2.60	2.61	2.66	2.60	2.59	2.93	0.149	0.067	0.185	2.27	2.60	3.15	1.66	1.75	2.29	2.27	1.66	3.15	0.617	0.276	0.766
Cobalt	mg/kg	-	-	-	-	1.43	1.74	1.41	1.50	1.60	1.48	1.55	1.50	1.41	1.74	0.128	0.057	0.159	1.24	1.48	1.86	1.04	1.18	1.36	1.24	1.04	1.86	0.322	0.144	0.399
Copper	mg/kg	35.7	197	120	240	7.50	13.4	14.8	12.4	17.2	12.7	14.1	13.4	12.4	17.2	1.96	0.879	2.44	13.5	27.3	6.4	22.9	18.4	17.7	18.4	6.40	27.3	8.1	3.6	10.1
Iron	mg/kg	21,200	43,776	-	-	5,480	3,200	2,820	2,940	2,680	2,860	2,900	2,860	2,680	3,200	192	86.0	239	2,640	2,730	4,220	1,940	2,040	2,714	2,640	1,940	4,220	912	408	1,132
Lead	mg/kg	35	91	57	110	2.91	2.60	2.12	2.33	2.40	2.20	2.33	2.33	2.12	2.60	0.186	0.083	0.231	1.89	2.03	2.28	1.34	1.40	1.79	1.89	1.34	2.28	0.41	0.18	0.51
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	mg/kg	460	1,100	-	-	193	142	129	119	122	141	131	129	119	142	10.6	4.74	13.2	109	91	124	55	67	89	90.8	55.1	124	29	13	36
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Nickel	mg/kg	16	75	-	-	3.59	2.51	2.08	1.93	1.87	1.84	2.05	1.93	1.84	2.51	0.275	0.123	0.342	1.82	1.86	3.74	1.03	1.29	1.95	1.82	1.03	3.74	1.06	0.47	1.32
Phosphorus	mg/kg	-	-	-	-	100	94	92	84	112	103	97	94	84	112	11	4.8	13	114	87	58	141	116	103	114	58	141	32	14	39
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Strontium	mg/kg	-	-	-	-	8.44	40.2	40.1	40.1	43.3	40.3	40.8	40.2	40.1	43.3	1.40	0.63	1.74	32.4	40.3	25.4	42.6	47.1	37.6	40.3	25.4	47.1	8.64	3.86	10.7
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	<1.0	<1.0	<1.0	1.1	1.3	<1.0	1.1	<1.0	<1.0	1.3	0.13	0.058	0.16	<1.0	1.1	1.1	<1.0	1.1	1.1	1.1	<1.0	1.1	0.055	0.024	0.068
Uranium	mg/kg	-	-	-	-	0.523	0.167	0.145	0.146	0.145	0.145	0.150	0.145	0.145	0.167	0.0097	0.0044	0.0121	0.133	0.150	0.270	0.111	0.101	0.153	0.133	0.101	0.270	0.0681	0.0305	0.0846
Vanadium	mg/kg	-	-	-	-	13.3	8.63	8.12	9.51	7.58	8.24	8.42	8.24	7.58	9.51	0.718	0.321	0.891	7.64	9.06	21.7	6.01	5.95	10.1	7.64	5.95	21.7	6.63	2.96	8.23
Zinc	mg/kg	123	315	200	380	17.2	9.5	8.4	8.5	9.3	8.0	8.7	8.5	8.0	9.5	0.63	0.28	0.79	7.4	8.3	13.8	5.0	5.6	8.0	7.4	5.0	13.8	3.5	1.6	4.3
Organic Bound Metals																														
Aluminum	mg/kg	-	-	-	-	5,098	1,520	1,320	1,190	1,070	1,260	1,272	1,260	1,070	1,520	167	74.7	207	1,200	1,210	4,190	951	1,100	1,730	1,200	951	4,190	1,379	617	1,712
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	2.44	0.493	0.501	0.414	0.330	0.404	0.428	0.414	0.330	0.501	0.0706	0.0316	0.0876	0.444	0.387	1.42	0.273	0.323	0.569	0.387	0.273	1.42	0.480	0.215	0.596
Barium	mg/kg	-	-	-	-	18.7	16.1	14.2	16.9	21.8	18.3	17.5	16.9	14.2	21.8	2.84	1.27	3.53	10.7	22.0	8.80	15.0	14.6	14.2	14.6	8.80	22.0	5.08	2.27	6.30
Beryllium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.099	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Calcium	mg/kg	-	-	-	-	768	1,030	1,010	843	737	923	909	923	737	1,030	121	54.3	151	848	931	1,410	749	788	945	848	749	1,410	269	120	334
Chromium	mg/kg	37.3	90	56	110	18.2	2.66	2.13	1.36	<0.50	1.21	1.57	1.36	<0.50	2.66	0.840	0.376	1.04	2.09	1.46	11.7	<0.50	0.55	3.26	1.46	<0.50	11.7	4.76	2.13	5.92
Cobalt	mg/kg	-	-	-	-	5.80	1.80	1.90	1.64	1.37	1.57	1.66	1.64	1.37	1.90	0.206	0.0921	0.256	1.85	1.76	4.57	1.59	1.57	2.27	1.76	1.57	4.57	1.29	0.578	1.60
Copper	mg/kg	35.7	197	120	240	386	506	469	500	516	506	**499**	**506**	**469**	**516**	17.9	8.02	22.3	464	530	534	472	461	**492**	**472**	**461**	**534**	36.6	16.4	45.4
Iron	mg/kg	21,200	43,776	-	-	5,424	473	522	419	320	425	432	425	320	522	75.1	33.6	93.2	628	399	4,820	295	321	1,293	399	295	4,820	1,976	884	2,453
Lead	mg/kg	35	91	57	110	1.85	0.99	0.84	0.86	0.94	0.90	0.91	0.90	0.84	0.99	0.061	0.027	0.075	0.74	0.80	0.95	0.54	0.55	0.72	0.74	0.54	0.95	0.17	0.078	0.22
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	mg/kg	460	1,100	-	-	62.4	20.4	15.0	14.9	13.1	14.2	15.5	14.9	13.1	20.4	2.83	1.27	3.52	13.8	13.3	50.9	9.80	11.8	19.9	13.3	9.80	50.9	17.4	7.78	21.6
Molybdenum	mg/kg	-	-	-	-	4.25	2.18	1.65	1.32	0.80	0.87	1.36	1.32	0.80	2.18	0.57	0.26	0.71	1.13	1.29	3.47	1.17	1.11	1.63	1.17	1.11	3.47	1.03	0.46	1.28
Nickel	mg/kg	16	75	-	-	13.6	1.66	1.47	1.12	0.73	1.03	1.20	1.12	0.73	1.66	0.37	0.16	0.46	1.36	1.56	7.60	<0.50	0.63	2.33	1.36	<0.50	7.60	2.98	1.33	3.70
Selenium	mg/kg	2	-	-	-	3.08	1.47	1.25	1.17	0.85	1.07	1.16	1.17	0.85	1.47	0.23	0.10	0.28	1.20	1.13	2.95	0.89	0.89	1.41	1.13	0.89	2.95	0.87	0.39	1.08
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Strontium	mg/kg	-	-	-	-	6.79	14.6	20.1	11.9	10.8	18.7	15.2	14.6	10.8	20.1	4.09	1.83	5.08	15.4	14.2	13.0	11.8	11.1	13.1	13.0	11.1	15.4	1.75	0.78	2.17
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	232	46.8	2.5	2.8	1.6	1.5	11.0	2.5	1.5	46.8	20.0	8.9	24.8	01.8	2.4	6.2	1.3	1.4	2.6	1.8	1.3	6.2	2.0	0.92	2.5
Uranium	mg/kg	-	-	-	-	1.33	0.157	0.143	0.150	0.101	0.126	0.135	0.143	0.101	0.157	0.0224	0.0100	0.0278	0.142	0.164	0.532	0.114	0.115	0.213	0.142	0.114	0.532	0.179	0.080	0.223
Vanadium	mg/kg	-	-	-	-	29.6	4.52	2.79	2.31	0.73	0.96	2.26	2.31	0.73	4.52	1.53	0.69	1.91	1.38	1.67	21.5	0.84	1.15	5.31	1.38	0.84	21.5	9.06	4.05	11.2
Zinc	mg/kg	123	315	200	380	23.1	5.1	4.7	4.4	4.0	4.6	4.6	4.6	4.0	5.1	0.40	0.18	0.50	5.2	4.8	16.2	4.1	4.1	6.9	4.8	4.1	16.2	5.2	2.3	6.5

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.

[2] Samples were collected using a sediment corer.

[3] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[4] Contaminated Sites Regulation (Government of British Columbia 1996)

(blue) Value is > TEL. Values shown in bold text also exceed Reference 95th percentile value.

(orange) Value is > PEL. Values shown in bold text also exceed Reference 95th percentile value.

Table E.35: Raw selectively extracted (Tessier extraction) metals data for sediment from Polley Lake mid-depth sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1,2].

Analyte	Units	BC SQGs [3]		Contaminated Sites Regulation [4]		Bootjack Reference Mid-depth 95th Percentile	POL-1 (Northern Polley Lake)												POL-2 (Southern Polley Lake)											
							POL-1-01	POL-1-02	POL-1-03	POL-1-04	POL-1-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	POL-2-01	POL-2-02	POL-2-O3	POL-2-O4	POL-2-O5	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled		TEL	PEL	Sensitive	Typical		21-Oct-14	20-Oct-14	21-Oct-14	21-Oct-14	22-Oct-14								22-Oct-14	22-Oct-14	24-Oct-14	24-Oct-14	24-Oct-14							
Residual Metals																														
Aluminum	mg/kg	-	-	-	-	15,280	19,300	18,800	22,100	21,300	21,000	20,500	21,000	18,800	22,100	1,395	624	1,731	19,200	19,000	21,200	16,500	17,100	18,600	19,000	16,500	21,200	1,867	835	2,318
Antimony	mg/kg	-	-	-	-	0.74	0.37	0.35	0.40	0.47	0.46	0.41	0.40	0.35	0.47	0.053	0.024	0.066	0.33	0.39	0.50	0.38	0.39	0.40	0.39	0.33	0.50	0.062	0.028	0.077
Arsenic	mg/kg	5.9	17	11	20	4.17	9.66	9.61	9.56	10.1	10.7	**9.93**	**9.66**	**9.56**	**10.7**	0.483	0.216	0.600	10.2	9.72	8.66	10.9	10.5	**10.0**	**10.2**	**8.66**	**10.9**	0.86	0.39	1.07
Barium	mg/kg	-	-	-	-	68.9	152	155	157	185	174	165	157	152	185	14.3	6.38	17.7	135	154	124	116	120	130	124	116	154	15.3	6.83	19.0
Beryllium	mg/kg	-	-	-	-	0.20	0.52	0.48	0.53	0.54	0.61	0.54	0.53	0.48	0.61	0.047	0.021	0.059	0.49	0.52	0.40	0.59	0.57	0.51	0.52	0.40	0.59	0.075	0.034	0.093
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Calcium	mg/kg	-	-	-	-	3,738	12,600	12,300	11,900	14,100	15,700	13,320	12,600	11,900	15,700	1,569	702	1,948	13,100	12,700	6,980	15,800	15,000	12,716	13,100	6,980	15,800	3,456	1,546	4,291
Chromium	mg/kg	37.3	90	56	110	22.6	11.0	12.0	14.6	9.8	11.7	11.8	11.7	9.8	14.6	1.77	0.79	2.20	14.6	10.9	20.1	8.80	8.60	12.6	10.9	8.60	20.1	4.84	2.16	6.00
Cobalt	mg/kg	-	-	-	-	5.15	12.4	12.4	15.6	14.1	13.6	13.6	13.6	12.4	15.6	1.33	0.60	1.66	13.4	13.7	13.8	13.3	12.8	13.4	13.4	12.8	13.8	0.39	0.18	0.49
Copper	mg/kg	35.7	197	120	240	79.6	96.2	98.2	127	93.6	108	**105**	**98.2**	**93.6**	**127**	13.7	6.11	17.0	94.7	97.0	118	83.5	84.6	**96**	**94.7**	**83.5**	**118**	13.9	6.21	17.2
Iron	mg/kg	21,200	43,776	-	-	15,360	23,200	22,100	22,900	23,100	26,600	**23,580**	**23,100**	**22,100**	**26,600**	1,743	779	2,163	42,400	35,400	21,500	40,800	28,400	**33,700**	**35,400**	**21,500**	**42,400**	8,745	3,911	10,857
Lead	mg/kg	35	91	57	110	6.70	3.32	3.25	3.99	3.22	3.62	3.48	3.32	3.22	3.99	0.326	0.146	0.405	3.16	3.01	4.14	2.48	2.44	3.05	3.01	2.44	4.14	0.689	0.308	0.855
Lithium	mg/kg	-	-	-	-	10.8	15.7	16.4	20.5	17.0	19.6	17.8	17.0	15.7	20.5	2.09	0.936	2.60	15.6	14.8	19.3	14.5	16.3	16.1	15.6	14.5	19.3	1.92	0.860	2.39
Manganese	mg/kg	460	1,100	-	-	195	464	460	580	532	535	**514**	**532**	460	**580**	51.3	23.0	63.7	452	465	464	468	459	**462**	**464**	452	**468**	6.27	2.80	7.78
Molybdenum	mg/kg	-	-	-	-	0.84	1.44	1.14	0.60	1.86	2.15	1.44	1.44	0.60	2.15	0.61	0.27	0.75	2.05	1.65	1.80	2.22	1.98	1.94	1.98	1.65	2.22	0.22	0.10	0.27
Nickel	mg/kg	16	75	-	-	14	9.2	10.2	12.4	8.9	9.9	10.1	9.9	8.9	12.4	1.38	0.62	1.71	10.2	9.0	15.8	7.3	7.8	10.0	9.0	7.3	15.8	3.4	1.5	4.2
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	mg/kg	0.5	-	-	-	0.45	0.24	0.25	0.25	0.23	0.27	0.25	0.25	0.23	0.27	0.015	0.007	0.018	0.30	0.25	0.36	0.27	0.25	0.29	0.27	0.25	0.36	0.046	0.021	0.057
Strontium	mg/kg	-	-	-	-	57.7	76.5	75.1	79.6	86.1	114	86.3	79.6	75.1	114	16.1	7.2	20.0	83.7	81.4	52.1	89.9	85.3	78.5	83.7	52.1	89.9	15.1	6.74	18.7
Thallium	mg/kg	-	-	-	-	0.071	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	2.0	2.1	2.0	<2.0	<2.0	2.1	0.045	0.020	0.056	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	785	1,720	1,690	2,010	2,030	2,130	1,916	2,010	1,690	2,130	198	88.6	246	1,650	1,720	1,650	1,630	1,690	1,668	1,650	1,630	1,720	36.3	16.2	45.1
Uranium	mg/kg	-	-	-	-	0.480	0.864	0.860	0.859	0.971	0.912	0.893	0.864	0.859	0.971	0.0488	0.0218	0.0606	0.748	0.882	0.559	0.894	0.792	0.775	0.792	0.559	0.894	0.135	0.0605	0.168
Vanadium	mg/kg	-	-	-	-	38.1	91.4	85.6	84.9	94.8	105	92.3	91.4	84.9	105	8.19	3.66	10.2	162	138	67.3	164	115	129	138	67.3	164	40.0	17.9	49.6
Zinc	mg/kg	123	315	200	380	37.0	46.4	46.5	59.4	50.8	50.4	50.7	50.4	46.4	59.4	5.29	2.37	6.57	48.1	47.0	55.2	42.2	43.4	47.2	47.0	42.2	55.2	5.11	2.28	6.34

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.

[2] Samples were collected using a sediment corer.

[3] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[4] Contaminated Sites Regulation (Government of British Columbia 1996)

(blue) Value is > TEL. Values shown in bold text also exceed Reference 95th percentile value.

(orange) Value is > PEL. Values shown in bold text also exceed Reference 95th percentile value.

Table E.36: Raw selectively extracted (Tessier extraction) metals data for sediment from Polley Lake deep sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1,2].

Analyte	BC SQGs [3]		Contaminated Sites Regulation [4]		Reference Bootjack B1 and B2 (Deep) 95th Percentile (Pooled)	P1 (North-Deep Lake)										P2 (South-Deep Lake)									
						POL-P1-01 [5]	POL-P1-02	POL-P1-03	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	POL-P2-O1	POL-P2-O2	POL-P2-O3	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled	TEL	PEL	Sensitive	Typical		9-Oct-14	9-Oct-14	18-Oct-14								24-Oct-14	24-Oct-14	24-Oct-14							
Exchangeable & Adsorbed Metals																									
Aluminum	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50	<50	<50	<50	<50	<50	<50	0	0	0
Antimony	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	5.9	17	11	20	0.086	0.071	0.063	<0.050	0.061	0.063	<0.050	0.071	0.011	0.0061	0.026	<0.050	0.074	0.066	0.063	0.066	<0.050	0.074	0.012	0.0071	0.030
Barium	-	-	-	-	138	<29	20.3	<23	24	23	<23	<29	4.5	2.6	11	<23	<34	<22	<34	<23	<22	<34	6.7	3.8	17
Beryllium	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	0.6	3.5	2.2	4.2	0.197	0.076	0.108	0.072	0.085	0.076	0.072	0.108	0.020	0.011	0.049	0.066	0.065	<0.050	0.060	0.065	<0.050	0.066	0.0090	0.0052	0.022
Calcium	-	-	-	-	6,818	6,710	7,240	5,020	6,323	6,710	5,020	7,240	1,159	669	2,880	5,430	7,480	1,760	4,890	5,430	1,760	7,480	2,898	1,673	7,200
Chromium	37.3	90	56	110	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Cobalt	-	-	-	-	0.65	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Copper	35.7	197	120	240	3.78	0.57	1.47	1.22	1.09	1.22	0.57	1.47	0.46	0.27	1.2	0.98	0.55	1.73	1.09	0.98	0.55	1.73	0.60	0.34	1.48
Iron	21,200	43,776	-	-	190	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50	<50	<50	<50	<50	<50	<50	0	0	0
Lead	35	91	57	110	0.55	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Lithium	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	460	1,100	-	-	1,008	130	55.7	155	114	130	55.7	155	51.6	29.8	128	148	135	15.8	99.6	135	15.8	148	72.9	42.1	181
Molybdenum	-	-	-	-	<0.50	<3.0	1.91	<3.0	2.64	<3.0	1.91	<3.0	0.63	0.36	1.6	<3.0	<4.0	<2.0	<4.0	<3.0	<2.0	<4.0	1.0	0.58	2.5
Nickel	16	75	-	-	0.89	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Phosphorus	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50	<50	<50	<50	<50	<50	<50	0	0	0
Potassium	-	-	-	-	183	130	130	150	137	130	130	150	11.5	6.67	28.7	170	140	150	153	150	140	170	15.3	8.82	37.9
Selenium	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Sodium	-	-	-	-	<100	240	230	190	220	230	190	240	26.5	15.3	65.7	200	230	<100	177	200	<100	230	68.1	39.3	169
Strontium	-	-	-	-	63.2	45.7	50.5	43.8	46.7	45.7	43.8	50.5	3.45	1.99	8.58	49.1	56.1	21.9	42.4	49.1	21.9	56.1	18.1	10.4	44.9
Thallium	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	-	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0
Uranium	-	-	-	-	<0.050	<0.050	<0.050	0.051	0.050	<0.050	<0.050	0.051	0.00058	0.00033	0.0014	0.084	<0.050	<0.050	0.061	<0.050	<0.050	0.084	0.020	0.011	0.049
Vanadium	-	-	-	-	<0.20	0.31	0.26	<0.20	0.26	0.26	<0.20	0.31	0.055	0.032	0.14	<0.20	0.31	0.22	0.24	0.22	<0.20	0.31	0.059	0.034	0.15
Zinc	123	315	200	380	3.3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0
Carbonate Metals																									
Aluminum	-	-	-	-	<50	<50	86	<50	62	<50	<50	86	21	12	52	65	<50	103	73	65	<50	103	27	16	68
Antimony	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	5.9	17	11	20	0.171	0.069	0.391	0.066	0.175	0.069	0.066	0.391	0.19	0.11	0.46	0.169	0.289	0.128	0.195	0.169	0.128	0.289	0.0837	0.0483	0.208
Barium	-	-	-	-	42.3	31.2	63.1	58.3	50.9	58.3	31.2	63.1	17.2	9.93	42.7	74.3	43.1	69.5	62.3	69.5	43.1	74.3	16.8	9.70	41.7
Beryllium	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	0.6	3.5	2.2	4.2	0.075	<0.050	0.141	<0.050	0.080	<0.050	<0.050	0.14	0.053	0.030	0.13	0.109	0.118	<0.050	0.092	0.109	<0.050	0.118	0.0369	0.0213	0.0918
Calcium	-	-	-	-	806	4,620	3,270	6,710	4,867	4,620	3,270	6,710	1,733	1,001	4,306	11,200	4,550	14,500	10,083	11,200	4,550	14,500	5,068	2,926	12,591
Chromium	37.3	90	56	110	<5.0	<5.0	<5.0	13.3	7.8	<5.0	<5.0	13.3	4.8	2.8	11.9	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Cobalt	-	-	-	-	0.29	<0.10	0.56	0.16	0.27	0.16	<0.10	0.56	0.25	0.14	0.62	0.43	0.39	0.24	0.35	0.39	0.24	0.43	0.10	0.058	0.25
Copper	35.7	197	120	240	4.06	<0.50	32.4	0.88	11.3	0.88	<0.50	32.4	18.3	10.6	45.5	18.7	5.53	41.9	22.0	18.7	5.53	**41.9**	18.4	10.6	45.7
Iron	21,200	43,776	-	-	569	<50	198	<50	99.3	<50	<50	198	85.4	49.3	212	218	<50	184	151	184	<50	218	88.8	51.3	221
Lead	35	91	57	110	0.74	<0.50	2.01	<0.50	1.00	<0.50	<0.50	2.01	0.872	0.503	2.17	0.95	0.61	0.90	0.82	0.90	0.61	0.95	0.18	0.11	0.46
Lithium	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	460	1,100	-	-	185	84.0	149	76.5	103	84.0	76.5	149	39.9	23.0	99.0	153	121	95.9	123	121	95.9	153	28.6	16.5	71.1
Molybdenum	-	-	-	-	<0.50	<0.50	<0.50	0.69	0.56	<0.50	<0.50	0.69	0.11	0.063	0.27	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Nickel	16	75	-	-	<2.0	<2.0	<2.0	4.4	2.8	<2.0	<2.0	4.4	1.4	0.80	3.4	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Phosphorus	-	-	-	-	53	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50	<50	<50	<50	<50	<50	<50	0	0	0
Selenium	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Strontium	-	-	-	-	8.9	28.8	70.2	76.2	58.4	70.2	28.8	76.2	25.8	14.9	64.1	79.2	39.0	73.6	63.9	73.6	39.0	79.2	21.8	12.6	54.1
Thallium	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Uranium	-	-	-	-	0.569	0.107	0.396	0.176	0.226	0.176	0.107	0.396	0.151	0.087	0.375	0.218	0.333	0.061	0.204	0.218	0.061	0.333	0.137	0.079	0.339
Vanadium	-	-	-	-	1.16	0.61	3.29	0.40	1.43	0.61	0.40	3.29	1.6	0.93	4.0	1.29	1.65	0.38	1.11	1.29	0.38	1.65	0.65	0.38	1.63
Zinc	123	315	200	380	3.7	<1.0	5.3	<1.0	2.4	<1.0	<1.0	5.3	2.5	1.4	6.2	3.2	3.5	<1.0	2.6	3.2	<1.0	3.5	1.4	0.8	3.4

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.

[2] Samples were collected using a sediment corer.

[3] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[4] Contaminated Sites Regulation (Government of British Columbia 1996)

[5] Samples were collected using a petite ponar.

(blue) Value is > TEL. Values shown in bold text also exceed Reference 95th percentile value.

(orange) Value is > PEL. Values shown in bold text also exceed Reference 95th percentile value.

Table E.36: Raw selectively extracted (Tessier extraction) metals data for sediment from Polley Lake deep sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1,2].

Analyte	BC SQGs [3]		Contaminated Sites Regulation [4]		Reference Bootjack B1 and B2 (Deep) 95th Percentile (Pooled)	P1 (North-Deep Lake)										P2 (South-Deep Lake)									
						POL-P1-01 [5]	POL-P1-02	POL-P1-03	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	POL-P2-O1	POL-P2-O2	POL-P2-O3	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled	TEL	PEL	Sensitive	Typical		9-Oct-14	9-Oct-14	18-Oct-14								24-Oct-14	24-Oct-14	24-Oct-14							
Easily Reducible Metals and Iron Oxides																									
Aluminum	-	-	-	-	1,018	1,010	1,630	2,000	1,547	1,630	1,010	2,000	500	289	1,243	2,040	1,100	1,970	1,703	1,970	1,100	2,040	524	302	1,301
Antimony	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	5.9	17	11	20	1.48	2.04	1.72	1.60	1.79	1.72	1.60	2.04	0.227	0.131	0.565	1.66	1.43	2.03	1.71	1.66	1.43	2.03	0.30	0.17	0.75
Barium	-	-	-	-	65.0	37.3	38.9	46.0	40.7	38.9	37.3	46.0	4.63	2.67	11.5	40.4	25.7	23.9	30.0	25.7	23.9	40.4	9.05	5.23	22.5
Beryllium	-	-	-	-	0.35	0.27	0.28	0.33	0.29	0.28	0.27	0.33	0.032	0.019	0.080	0.32	0.28	<0.20	0.27	0.28	<0.20	0.32	0.061	0.035	0.15
Bismuth	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	0.6	3.5	2.2	4.2	0.157	0.267	0.105	0.131	0.168	0.131	0.105	0.267	0.0870	0.0502	0.216	0.092	0.152	<0.050	0.098	0.092	<0.050	0.152	0.051	0.030	0.13
Calcium	-	-	-	-	664	2,320	1,370	3,020	2,237	2,320	1,370	3,020	828	478	2,057	2,370	1,820	1,910	2,033	1,910	1,820	2,370	295	170	733
Chromium	37.3	90	56	110	2.57	2.74	3.10	3.81	3.22	3.10	2.74	3.81	0.544	0.314	1.35	2.98	2.47	1.69	2.38	2.47	1.69	2.98	0.650	0.375	1.61
Cobalt	-	-	-	-	1.34	2.13	1.92	2.29	2.11	2.13	1.92	2.29	0.186	0.107	0.461	2.15	1.67	1.38	1.73	1.67	1.38	2.15	0.389	0.225	0.966
Copper	35.7	197	120	240	7.13	7.0	10.7	6.6	8.09	6.98	6.58	10.7	2.3	1.3	5.6	8.3	7.5	89.5	35.1	8.31	7.52	**89.5**	47	27	117
Iron	21,200	43,776	-	-	9,138	3,870	3,820	4,580	4,090	3,870	3,820	4,580	425	245	1,056	4,410	3,240	2,540	3,397	3,240	2,540	4,410	945	545	2,347
Lead	35	91	57	110	3.12	2.51	3.38	3.08	2.99	3.08	2.51	3.38	0.442	0.255	1.10	2.40	1.82	1.43	1.88	1.82	1.43	2.40	0.49	0.28	1.21
Lithium	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	460	1,100	-	-	222	214	133	175	174	175	133	214	40.5	23.4	101	120	105	059	94.5	105	58.5	120	32.1	18.5	79.7
Molybdenum	-	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Nickel	16	75	-	-	3.42	4.91	4.32	3.95	4.39	4.32	3.95	4.91	0.484	0.280	1.20	3.18	4.54	1.20	2.97	3.18	1.20	4.54	1.68	0.97	4.17
Phosphorus	-	-	-	-	311	77	64	92	78	77	64	92	14	8.1	35	82	61	159	101	82	61	159	52	30	128
Selenium	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Strontium	-	-	-	-	8.02	21.5	26.6	33.8	27.3	26.6	21.5	33.8	6.18	3.57	15.4	30.0	20.5	46.4	32.3	30.0	20.5	46.4	13.1	7.6	32.6
Thallium	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	-	-	-	-	<1.0	<1.0	1.1	<1.0	1.0	<1.0	<1.0	1.1	0.058	0.033	0.14	1.1	1.1	<1.0	1.1	1.1	<1.0	1.1	0.058	0.033	0.14
Uranium	-	-	-	-	0.578	0.401	0.215	0.304	0.307	0.304	0.215	0.401	0.0930	0.0537	0.231	0.206	0.314	0.123	0.214	0.206	0.123	0.314	0.0958	0.0553	0.238
Vanadium	-	-	-	-	18.4	23.6	19.0	20.1	20.9	20.1	19.0	23.6	2.40	1.39	5.97	18.1	20.0	7.68	15.3	18.1	7.68	20.0	6.63	3.83	16.5
Zinc	123	315	200	380	16.8	20.2	14.8	15.4	16.8	15.4	14.8	20.2	2.96	1.71	7.35	13.3	14.8	6.50	11.5	13.3	6.50	14.8	4.42	2.55	11.0
Organic Bound Metals																									
Aluminum	-	-	-	-	4,613	4,520	4,230	3,200	3,983	4,230	3,200	4,520	694	401	1,723	3,050	5,140	1,110	3,100	3,050	1,110	5,140	2,015	1,164	5,007
Antimony	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	5.9	17	11	20	2.12	2.00	1.14	1.05	1.40	1.14	1.05	2.00	0.52	0.30	1.3	0.823	2.02	0.310	1.05	0.823	0.310	2.02	0.88	0.51	2.18
Barium	-	-	-	-	15.7	7.1	10.0	10.2	9.1	10.0	7.14	10.2	1.7	1.0	4.3	8.7	7.8	16.9	11.1	8.73	7.76	16.9	5.0	2.9	12.5
Beryllium	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	0.6	3.5	2.2	4.2	0.061	0.063	<0.050	<0.050	0.054	<0.050	<0.050	0.063	0.0075	0.0043	0.019	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Calcium	-	-	-	-	839	1,530	1,550	1,400	1,493	1,530	1,400	1,550	81.4	47.0	202	1,340	1,840	644	1,275	1,340	644	1,840	601	347	1,492
Chromium	37.3	90	56	110	17.8	16.0	12.4	7.3	11.9	12.4	7.3	16.0	4.38	2.53	10.9	5.45	17.6	<0.50	7.85	5.45	<0.50	17.6	8.80	5.08	21.9
Cobalt	-	-	-	-	5.57	5.47	4.10	3.62	4.40	4.10	3.62	5.47	0.96	0.55	2.4	3.58	5.68	1.80	3.69	3.58	1.80	5.68	1.94	1.12	4.83
Copper	35.7	197	120	240	361	424	484	658	**522**	**484**	**424**	**658**	122	70.2	302	723	475	472	**557**	**475**	**472**	**723**	144	83.2	358
Iron	21,200	43,776	-	-	4,905	7,420	4,630	2,530	4,860	4,630	2,530	7,420	2,453	1,416	6,094	2,160	7,120	387	3,222	2,160	387	7,120	3,490	2,015	8,670
Lead	35	91	57	110	1.10	1.29	1.28	1.07	1.21	1.28	1.07	1.29	0.124	0.0717	0.309	0.82	1.24	0.57	0.88	0.82	0.57	1.24	0.34	0.20	0.84
Lithium	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	460	1,100	-	-	63.1	70.4	51.8	40.0	54.1	51.8	40.0	70.4	15.3	8.85	38.1	40.2	64.8	12.7	39.2	40.2	12.7	64.8	26.1	15.0	64.8
Molybdenum	-	-	-	-	3.80	2.95	3.24	2.26	2.82	2.95	2.26	3.24	0.503	0.291	1.25	2.36	3.16	1.05	2.19	2.36	1.05	3.16	1.07	0.62	2.65
Nickel	16	75	-	-	13.2	10.7	7.84	5.10	7.88	7.84	5.10	10.70	2.80	1.62	6.96	3.81	11.8	<0.50	5.37	3.81	<0.50	11.80	5.81	3.35	14.4
Selenium	2	-	-	-	3.16	3.27	4.02	2.76	**3.35**	**3.27**	2.76	**4.02**	0.634	0.366	1.57	2.18	3.79	0.91	2.29	2.18	0.91	**3.79**	1.44	0.83	3.59
Silver	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Strontium	-	-	-	-	7.18	13.7	14.9	14.0	14.2	14.0	13.7	14.9	0.624	0.361	1.55	11.8	17.0	10.2	13.0	11.8	10.2	17.0	3.56	2.05	8.83
Thallium	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	-	-	-	-	48	6.7	5.0	3.9	5.2	5.0	3.9	6.7	1.4	0.81	3.5	2.9	8.7	<1.0	4.2	2.9	<1.0	8.7	4.0	2.3	10
Uranium	-	-	-	-	1.10	0.819	0.507	0.369	0.565	0.507	0.369	0.819	0.231	0.133	0.573	0.326	0.895	0.125	0.449	0.326	0.125	0.895	0.399	0.231	0.992
Vanadium	-	-	-	-	26.6	33.6	21.9	10.2	21.9	21.9	10.2	33.6	11.7	6.75	29.1	8.19	33.7	0.92	14.3	8.19	0.92	33.7	17.2	9.94	42.8
Zinc	123	315	200	380	22.7	20.9	13.9	11.1	15.3	13.9	11.1	20.9	5.05	2.91	12.5	10.7	22.0	4.5	12.4	10.7	4.5	22.0	8.87	5.12	22.0

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.

[2] Samples were collected using a sediment corer.

[3] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[4] Contaminated Sites Regulation (Government of British Columbia 1996)

[5] Samples were collected using a petite ponar.

(blue) Value is > TEL. Values shown in bold text also exceed Reference 95th percentile value.

(orange) Value is > PEL. Values shown in bold text also exceed Reference 95th percentile value.

Table E.36: Raw selectively extracted (Tessier extraction) metals data for sediment from Polley Lake deep sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1,2].

Analyte	BC SQGs [3]		Contaminated Sites Regulation [4]		Reference Bootjack B1 and B2 (Deep) 95th Percentile (Pooled)	P1 (North-Deep Lake)										P2 (South-Deep Lake)									
						POL-P1-01 [5]	POL-P1-02	POL-P1-03	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	POL-P2-O1	POL-P2-O2	POL-P2-O3	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled	**TEL**	**PEL**	**Sensitive**	**Typical**		9-Oct-14	9-Oct-14	18-Oct-14								24-Oct-14	24-Oct-14	24-Oct-14							
Residual Metals																									
Aluminum	-	-	-	-	15,900	19,500	20,700	23,800	21,333	20,700	19,500	23,800	2,219	1,281	5,512	27,100	21,800	19,300	22,733	21,800	19,300	27,100	3,983	2,300	9,895
Antimony	-	-	-	-	0.88	0.56	0.60	0.59	0.58	0.59	0.56	0.60	0.021	0.012	0.052	0.61	0.47	0.41	0.50	0.47	0.41	0.61	0.10	0.059	0.25
Arsenic	5.9	17	11	20	4.67	7.53	7.96	9.49	**8.33**	**7.96**	**7.53**	**9.49**	1.03	0.595	2.56	11.9	7.81	11.4	**10.4**	**11.4**	**7.81**	**11.9**	2.23	1.29	5.54
Barium	-	-	-	-	79.5	140	107	161	136	140	107	161	27.2	15.7	67.6	163	120	116	133	120	116	163	26.1	15.0	64.7
Beryllium	-	-	-	-	<0.20	0.33	0.40	0.50	0.41	0.40	0.33	0.50	0.085	0.049	0.21	0.63	0.39	0.63	0.55	0.63	0.39	0.63	0.14	0.080	0.34
Bismuth	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	0.6	3.5	2.2	4.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Calcium	-	-	-	-	2,725	5,910	6,880	8,590	7,127	6,880	5,910	8,590	1,357	783	3,371	11,000	6,160	15,600	10,920	11,000	6,160	15,600	4,721	2,725	11,727
Chromium	37.3	90	56	110	22.1	23.5	21.1	19.3	21.3	21.1	19.3	23.5	2.11	1.22	5.23	17.8	25.8	08.4	17.3	17.8	8.4	25.8	8.71	5.03	21.6
Cobalt	-	-	-	-	5.0	10.8	12.3	15.5	12.9	12.3	10.8	15.5	2.40	1.39	5.96	20.4	11.8	16.9	16.4	16.9	11.8	20.4	4.32	2.50	10.7
Copper	35.7	197	120	240	83.3	94.2	106	141	**114**	**106**	**94.2**	**141**	24.3	14.1	60.5	167	102.0	105	**125**	**105.0**	**102.0**	**167**	36.7	21.18	91.2
Iron	21,200	43,776	-	-	15,825	21,200	19,700	22,700	21,200	21,200	19,700	**22,700**	1,500	866	3,727	26,800	22,000	33,900	**27,567**	**26,800**	**22,000**	**33,900**	5,987	3,457	14,874
Lead	35	91	57	110	6.67	4.37	5.66	5.19	5.07	5.19	4.37	5.66	0.653	0.377	1.62	4.45	3.98	2.41	3.61	3.98	2.41	4.45	1.07	0.617	2.65
Lithium	-	-	-	-	9.3	15.5	18.7	20.5	18.2	18.7	15.5	20.5	2.53	1.46	6.29	28.0	18.7	20.0	22.2	20.0	18.7	28.0	5.04	2.91	12.5
Manganese	460	1,100	-	-	182	357	400	508	422	400	357	**508**	77.8	44.9	193	673	380	598	**550**	**598**	380	**673**	152	87.9	378
Molybdenum	-	-	-	-	0.73	1.95	1.86	1.56	1.79	1.86	1.56	1.95	0.204	0.118	0.507	2.23	1.83	2.50	2.19	2.23	1.83	2.50	0.337	0.195	0.837
Nickel	16	75	-	-	14	16.1	15.9	15.9	16.0	15.9	15.9	**16.1**	0.115	0.067	0.287	16.5	18.1	9.0	14.5	**16.5**	9.0	**18.1**	4.9	2.8	12.1
Selenium	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	0.5	-	-	-	0.38	0.38	0.38	0.35	0.37	0.38	0.35	0.38	0.017	0.010	0.043	0.39	0.41	0.29	0.36	0.39	0.29	0.41	0.064	0.037	0.16
Strontium	-	-	-	-	42.9	46.5	51.2	63.7	53.8	51.2	46.5	63.7	8.89	5.13	22.1	74.0	53.1	87.5	71.5	74.0	53.1	87.5	17.3	10.0	43.1
Thallium	-	-	-	-	0.062	0.063	0.061	0.057	0.060	0.061	0.057	0.063	0.0031	0.0018	0.0076	<0.050	0.064	<0.050	0.055	<0.050	<0.050	0.064	0.0081	0.0047	0.020
Tin	-	-	-	-	<2.0	<2.0	10.4	<2.0	4.8	<2.0	<2.0	10.4	4.8	2.8	12	2.3	<2.0	<2.0	2.1	<2.0	<2.0	2.3	0.17	0.10	0.43
Titanium	-	-	-	-	880	1,510	1,540	1,860	1,637	1,540	1,510	1,860	194	112	482	2,430	1,660	1,940	2,010	1,940	1,660	2,430	390	225	968
Uranium	-	-	-	-	0.404	0.560	0.517	0.712	0.596	0.560	0.517	0.712	0.102	0.059	0.255	0.794	0.562	0.906	0.754	0.794	0.562	0.906	0.175	0.101	0.436
Vanadium	-	-	-	-	36.6	61.6	58.7	78.6	66.3	61.6	58.7	78.6	10.8	6.21	26.7	100	67.0	137	101	100	67.0	137	35.0	20.2	87.0
Zinc	123	315	200	380	37.3	50.0	50.7	61.3	54.0	50.7	50.0	61.3	6.33	3.66	15.7	73.7	51.5	53.8	59.7	53.8	51.5	73.7	12.2	7.05	30.3

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.

[2] Samples were collected using a sediment corer.

[3] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[4] Contaminated Sites Regulation (Government of British Columbia 1996)

[5] Samples were collected using a petite ponar.

(blue) Value is > TEL. Values shown in bold text also exceed Reference 95th percentile value.

(orange) Value is > PEL. Values shown in bold text also exceed Reference 95th percentile value.

Table E.37: Raw selectively extracted (Tessier extraction) metals data for sediment from Boc Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1,2].

Analyte	BC SQGs [3]		Contaminated Sites Regulation [4]		Mid-depth Area (BOL-1)							
Date Sampled	TEL	PEL	Sensitive	Typical	Mean	Median	Minimum	Maximum	95th Percentile	Standard Deviation	Standard Error	t*SE
Exchangeable & Adsorbed Metals												
Aluminum	-	-	-	-	<50	<50	<50	<50	<50	0	0	0
Antimony	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	5.9	17	11	20	0.059	0.059	0.052	0.065	0.065	0.0056	0.0025	0.0069
Barium	-	-	-	-	108	115	85	127	125	16.4	7.32	20.3
Beryllium	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	0.6	3.5	2.2	4.2	0.143	0.133	0.114	0.175	0.173	0.0264	0.0118	0.0327
Calcium	-	-	-	-	6,732	6,700	5,850	7,870	7,648	731	327	908
Chromium	37.3	90	56	110	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Cobalt	-	-	-	-	0.30	0.34	0.22	0.35	0.35	0.065	0.029	0.081
Copper	35.7	197	120	240	0.68	0.70	0.52	0.80	0.78	0.10	0.046	0.13
Iron	21,200	43,776	-	-	<50	<50	<50	<50	<50	0	0	0
Lead	35	91	57	110	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Lithium	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	460	1,100	-	-	359	358	234	521	493	107	47.8	133
Molybdenum	-	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Nickel	16	75	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Phosphorus	-	-	-	-	<50	<50	<50	<50	<50	0	0	0
Potassium	-	-	-	-	176	190	120	190	190	31.3	14.0	38.9
Selenium	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Sodium	-	-	-	-	<100	<100	<100	<100	<100	0	0	0
Strontium	-	-	-	-	63.7	63.8	52.7	74.6	72.5	7.75	3.47	9.6
Thallium	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	-	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0
Uranium	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Vanadium	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Zinc	123	315	200	380	1.6	1.6	1.1	2.2	2.1	0.42	0.19	0.52
Carbonate Metals												
Aluminum	-	-	-	-	<50	<50	<50	<50	<50	0	0	0
Antimony	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	5.9	17	11	20	0.114	0.117	0.078	0.157	0.150	0.0304	0.0136	0.0377
Barium	-	-	-	-	32.7	31.9	27.4	37.0	36.9	4.10	1.83	5.09
Beryllium	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	0.6	3.5	2.2	4.2	0.070	0.076	<0.050	0.083	0.082	0.013	0.0060	0.017
Calcium	-	-	-	-	819	867	645	900	898	106	47	132
Chromium	37.3	90	56	110	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Cobalt	-	-	-	-	0.24	0.24	0.19	0.26	0.26	0.027	0.012	0.034
Copper	35.7	197	120	240	2.04	1.94	1.90	2.39	2.32	0.203	0.0906	0.252
Iron	21,200	43,776	-	-	162	108	53.0	336	315	118	52.9	147
Lead	35	91	57	110	0.60	0.57	<0.50	0.73	0.71	0.089	0.040	0.11
Lithium	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	460	1,100	-	-	130	134	109	141	141	12.9	5.78	16.0
Molybdenum	-	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Nickel	16	75	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Phosphorus	-	-	-	-	<50	<50	<50	<50	<50	0	0	0
Selenium	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Strontium	-	-	-	-	9.0	9.5	7.2	9.8	9.8	1.1	0.48	1.3
Thallium	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Uranium	-	-	-	-	0.507	0.499	0.431	0.567	0.562	0.0518	0.0231	0.0643
Vanadium	-	-	-	-	0.54	0.40	0.31	1.1	0.97	0.31	0.14	0.39
Zinc	123	315	200	380	3.4	3.5	2.7	4.0	3.9	0.50	0.22	0.62
Easily Reducible Metals and Iron Oxides												
Aluminum	-	-	-	-	990	1,050	760	1,120	1,114	147	66	183
Antimony	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	5.9	17	11	20	0.918	0.916	0.833	1.03	1.01	0.0719	0.0322	0.0893
Barium	-	-	-	-	42.7	46.4	32.7	48.8	48.3	6.68	2.99	8.29
Beryllium	-	-	-	-	0.30	0.32	0.23	0.35	0.34	0.046	0.021	0.058
Bismuth	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	0.6	3.5	2.2	4.2	0.168	0.184	0.107	0.201	0.199	0.0374	0.0167	0.0465
Calcium	-	-	-	-	660	688	544	736	727	72.9	32.6	90.5
Chromium	37.3	90	56	110	2.16	2.19	1.80	2.40	2.37	0.220	0.098	0.273
Cobalt	-	-	-	-	1.23	1.19	1.05	1.47	1.43	0.157	0.0704	0.195
Copper	35.7	197	120	240	5.94	5.63	4.72	7.84	7.50	1.18	0.528	1.47
Iron	21,200	43,776	-	-	4,874	5,000	4,200	5,550	5,480	557	249	691
Lead	35	91	57	110	2.32	2.54	1.16	2.97	2.91	0.695	0.311	0.863
Lithium	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	460	1,100	-	-	152	151	107	199	193	34.9	15.6	43.4
Molybdenum	-	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Nickel	16	75	-	-	3.23	3.23	2.67	3.63	3.59	0.356	0.159	0.442
Phosphorus	-	-	-	-	81	73	62	100	100	18	7.8	22
Selenium	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Strontium	-	-	-	-	7.86	7.85	6.89	8.47	8.44	0.617	0.276	0.766
Thallium	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	-	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0
Uranium	-	-	-	-	0.460	0.495	0.315	0.525	0.523	0.0864	0.0386	0.107
Vanadium	-	-	-	-	11.2	10.4	9.5	13.4	13.3	1.72	0.77	2.13
Zinc	123	315	200	380	15.4	16.2	12.8	17.3	17.2	1.90	0.85	2.36

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Summary statistics are reported as < the highest displayed MDL if all

[2] Samples were collected using a sediment corer

[3] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Leve

[4] Contaminated Sites Regulation (Government of British Columbia 1996

(blue)	Value is > TEL.
(orange)	Value is > PEL.

Table E.37: Raw selectively extracted (Tessier extraction) metals data for sediment from Boo Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1,2].

Analyte	BC SQGs [3]		Contaminated Sites Regulation [4]		Mid-depth Area (BOL-1)							
					Mean	Median	Minimum	Maximum	95th Percentile	Standard Deviation	Standard Error	t*SE
Date Sampled	TEL	PEL	Sensitive	Typical								
Organic Bound Metals												
Aluminum	-	-	-	-	4,384	4,300	3,370	5,180	5,098	675	302	839
Antimony	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	5.9	17	11	20	2.21	2.23	1.95	2.46	2.44	0.203	0.0906	0.252
Barium	-	-	-	-	15.3	15.2	12.2	19.2	18.7	2.84	1.27	3.53
Beryllium	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	0.6	3.5	2.2	4.2	0.077	0.074	<0.050	0.100	0.099	0.020	0.0089	0.025
Calcium	-	-	-	-	651	698	452	776	768	131	58.4	162
Chromium	37.3	90	56	110	16.3	16.3	13.7	18.5	18.2	1.76	0.787	2.19
Cobalt	-	-	-	-	5.20	5.06	4.39	5.81	5.80	0.592	0.265	0.735
Copper	35.7	197	120	240	326	328	277	396	386	49.3	22.1	61.2
Iron	21,200	43,776	-	-	4,296	4,170	3,500	5,640	5,424	865	387	1,074
Lead	35	91	57	110	1.44	1.73	0.70	1.88	1.85	0.498	0.223	0.619
Lithium	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	460	1,100	-	-	54.2	53.1	43.7	62.8	62.4	7.71	3.45	9.57
Molybdenum	-	-	-	-	3.52	3.37	3.08	4.44	4.25	0.541	0.242	0.672
Nickel	16	75	-	-	12.1	12.0	10.0	13.9	13.6	1.41	0.630	1.75
Selenium	2	-	-	-	2.75	2.81	2.37	3.12	3.08	0.300	0.134	0.372
Silver	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Strontium	-	-	-	-	6.27	6.27	5.27	6.79	6.79	0.619	0.277	0.769
Thallium	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	-	-	-	-	178	218	9.7	235	232	94.7	42.3	118
Uranium	-	-	-	-	1.04	1.00	0.839	1.39	1.33	0.218	0.097	0.271
Vanadium	-	-	-	-	25.8	26.2	22.2	30.2	29.6	3.13	1.40	3.89
Zinc	123	315	200	380	20.0	19.4	18.1	23.6	23.1	2.31	1.03	2.87
Residual Metals												
Aluminum	-	-	-	-	14,680	15,000	13,200	15,300	15,280	858	384	1,066
Antimony	-	-	-	-	0.69	0.69	0.62	0.75	0.74	0.049	0.022	0.061
Arsenic	5.9	17	11	20	3.80	3.64	3.59	4.23	4.17	0.281	0.126	0.349
Barium	-	-	-	-	60.0	60.5	47.0	69.4	68.9	8.95	4.00	11.1
Beryllium	-	-	-	-	0.2	0.2	0.2	0.2	0.2	0	0	0
Bismuth	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	0.6	3.5	2.2	4.2	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Calcium	-	-	-	-	2,450	1,900	1,660	3,930	3,738	978	437	1,214
Chromium	37.3	90	56	110	21.7	22.2	19.4	22.6	22.6	1.32	0.591	1.64
Cobalt	-	-	-	-	4.79	4.79	4.34	5.21	5.15	0.319	0.143	0.396
Copper	35.7	197	120	240	73.8	74.2	66.2	80.7	79.6	5.19	2.32	6.45
Iron	21,200	43,776	-	-	14,860	15,000	13,800	15,400	15,360	623	279	773
Lead	35	91	57	110	5.90	6.43	3.77	6.76	6.70	1.21	0.542	1.51
Lithium	-	-	-	-	10.1	10.5	9.2	10.8	10.8	0.83	0.37	1.0
Manganese	460	1,100	-	-	168	155	147	196	195	23.3	10.4	29.0
Molybdenum	-	-	-	-	0.58	0.50	0.50	0.92	0.84	0.19	0.084	0.23
Nickel	16	75	-	-	13	14	10	14	14	1.6	0.72	2.0
Selenium	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	0.5	-	-	-	0.38	0.40	0.23	0.45	0.45	0.087	0.039	0.11
Strontium	-	-	-	-	37.5	29.1	24.4	60.3	57.7	15.7	7.02	19.5
Thallium	-	-	-	-	0.065	0.066	0.058	0.072	0.071	0.0058	0.0026	0.0072
Tin	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	-	-	-	-	698	727	569	786	785	95.8	42.8	119
Uranium	-	-	-	-	0.415	0.397	0.380	0.498	0.480	0.0474	0.0212	0.0589
Vanadium	-	-	-	-	33.7	31.7	31.0	38.8	38.1	3.37	1.51	4.19
Zinc	123	315	200	380	35.1	35.7	31.0	37.2	37.0	2.40	1.07	2.98

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Summary statistics are reported as < the highest displayed MDL if all

[2] Samples were collected using a sediment corer

[3] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Leve

[4] Contaminated Sites Regulation (Government of British Columbia 1996

Value is > TEL.

Table E.38: Raw selectively extracted (Tessier extraction) metals data for sediment from Bootjack Lake deep sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment[1,2].

Sample ID	Units	BC SQGs [3]		Contaminated Sites Regulation [4]		BOL-B1 (North)										BOL-B2 (South)										Pooled B1 and B2 95th Percentile
						BOL-B1-01	BOL-B1-02	BOL-B1-03	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	BOL-B2-01	BOL-B2-02	BOL-B2-03	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	
Date Sampled		TEL	PEL	Sensitive	Typical	23-Oct-14	23-Oct-14	23-Oct-14								23-Oct-14	23-Oct-14	23-Oct-14								
Exchangeable & Adsorbed Metals																										
Aluminum	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Arsenic	mg/kg	5.9	17	11	20	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	0.061	0.077	0.089	0.076	0.077	0.061	0.089	0.014	0.0081	0.035	0.086
Barium	mg/kg	-	-	-	-	88.1	88.4	86.2	87.6	88.1	86.2	88.4	1.19	0.689	2.96	132	139	136	136	136	132	139	3.51	2.03	8.72	138
Beryllium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.156	0.162	0.157	0.158	0.157	0.156	0.162	0.00321	0.00186	0.00799	0.185	0.201	0.181	0.189	0.185	0.181	0.201	0.0106	0.00611	0.0263	0.197
Calcium	mg/kg	-	-	-	-	6,210	6,830	6,780	6,607	6,780	6,210	6,830	344	199	856	5,000	5,630	5,410	5,347	5,410	5,000	5,630	320	185	794	6,818
Chromium	mg/kg	37.3	90	56	110	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Cobalt	mg/kg	-	-	-	-	0.36	0.34	0.32	0.34	0.34	0.32	0.36	0.020	0.012	0.050	0.57	0.67	0.56	0.60	0.57	0.56	0.67	0.061	0.035	0.15	0.65
Copper	mg/kg	35.7	197	120	240	1.57	1.55	1.20	1.44	1.55	1.20	1.57	0.208	0.120	0.517	3.68	3.45	3.81	3.65	3.68	3.45	3.81	0.182	0.105	0.453	3.78
Iron	mg/kg	21,200	43,776	-	-	<50	<50	<50	<50	<50	<50	<50	0	0	0	149	113	204	155	149	113	204	45.8	26.5	114	190
Lead	mg/kg	35	91	57	110	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50	0.57	<0.50	0.52	0.50	0.50	0.57	0.040	0.023	0.10	0.55
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Manganese	mg/kg	460	1,100	-	-	522	369	324	405	369	324	522	104	60	258	1,030	690	941	887	941	690	1,030	176	102	438	1,008
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Nickel	mg/kg	16	75	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	0.88	0.86	0.89	0.88	0.88	0.86	0.89	0.015	0.0088	0.038	0.89
Phosphorus	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50
Potassium	mg/kg	-	-	-	-	150	120	130	133	130	120	150	15.3	8.82	37.9	190	150	160	167	160	150	190	20.8	12.0	51.7	183
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Sodium	mg/kg	-	-	-	-	<100	<100	<100	<100	<100	<100	<100	0	0	0	<100	<100	<100	<100	<100	<100	<100	0	0	0	<100
Strontium	mg/kg	-	-	-	-	59.7	63.3	62.7	61.9	62.7	59.7	63.3	1.93	1.11	4.79	50.6	57.7	56.3	54.9	56.3	50.6	57.7	3.76	2.17	9.34	63.2
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0	<1.0
Uranium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Vanadium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Zinc	mg/kg	123	315	200	380	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0	0	0	3.1	3.4	2.8	3.1	3.1	2.8	3.4	0.30	0.17	0.75	3.3
Carbonate Metals																										
Aluminum	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Arsenic	mg/kg	5.9	17	11	20	0.088	0.092	0.086	0.089	0.088	0.086	0.092	0.0031	0.0018	0.0076	0.120	0.140	0.181	0.147	0.140	0.120	0.181	0.0311	0.0180	0.0773	0.171
Barium	mg/kg	-	-	-	-	28.4	29.0	28.4	28.6	28.4	28.4	29.0	0.346	0.200	0.861	42.3	41.3	42.3	42.0	42.3	41.3	42.3	0.577	0.333	1.43	42.3
Beryllium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.063	0.078	0.067	0.069	0.067	0.063	0.078	0.0078	0.0045	0.019	0.057	0.066	0.055	0.059	0.057	0.055	0.066	0.0059	0.0034	0.015	0.075
Calcium	mg/kg	-	-	-	-	714	806	806	775	806	714	806	53.1	30.7	132	648	697	682	676	682	648	697	25.1	14.5	62.4	806
Chromium	mg/kg	37.3	90	56	110	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Cobalt	mg/kg	-	-	-	-	0.25	0.28	0.26	0.26	0.26	0.25	0.28	0.015	0.0088	0.038	0.27	0.29	0.26	0.273	0.270	0.260	0.290	0.0153	0.0088	0.0379	0.29
Copper	mg/kg	35.7	197	120	240	3.53	3.52	4.23	3.76	3.53	3.52	4.23	0.407	0.235	1.01	3.18	3.42	2.42	3.01	3.18	2.42	3.42	0.522	0.301	1.30	4.06
Iron	mg/kg	21,200	43,776	-	-	169	106	95	123	106	95	169	39.9	23.1	99.2	589	354	510	484	510	354	589	120	69.0	297	569
Lead	mg/kg	35	91	57	110	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	0.56	0.78	0.63	0.66	0.63	0.56	0.78	0.11	0.065	0.28	0.74
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Manganese	mg/kg	460	1,100	-	-	155	145	180	160	155	145	180	18.0	10.4	44.8	186	107	178	157	178	107	186	43.5	25.1	108	185
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Nickel	mg/kg	16	75	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Phosphorus	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	0	0	0	54	<50	<50	51	50	50	54	2.3	1.3	5.7	53
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Strontium	mg/kg	-	-	-	-	8.3	8.8	8.9	8.7	8.8	8.3	8.9	0.32	0.19	0.80	8.2	8.7	8.6	8.5	8.6	8.2	8.7	0.26	0.15	0.66	8.9
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Uranium	mg/kg	-	-	-	-	0.485	0.496	0.472	0.484	0.485	0.472	0.496	0.0120	0.0069	0.0298	0.525	0.571	0.563	0.553	0.563	0.525	0.571	0.0246	0.0142	0.0611	0.569
Vanadium	mg/kg	-	-	-	-	0.46	0.47	0.36	0.43	0.46	0.36	0.47	0.061	0.035	0.15	1.07	0.79	1.19	1.02	1.07	0.79	1.19	0.205	0.119	0.510	1.16
Zinc	mg/kg	123	315	200	380	3.2	3.7	3.7	3.5	3.7	3.2	3.7	0.29	0.17	0.72	3.3	3.6	3.2	3.4	3.3	3.2	3.6	0.21	0.12	0.52	3.7

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Summary statistics are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.

[2] Samples were collected using a sediment corer.

[3] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[4] Contaminated Sites Regulation (Government of British Columbia 1996)

(blue)	Value is > TEL.
(orange)	Value is > PEL.

Table E.38: Raw selectively extracted (Tessier extraction) metals data for sediment from Bootjack Lake deep sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment[1,2].

Sample ID	Units	BC SQGs [3]		Contaminated Sites Regulation [4]		BOL-B1 (North)										BOL-B2 (South)										Pooled B1 and B2 95th Percentile
						BOL-B1-01	BOL-B1-02	BOL-B1-03	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	BOL-B2-01	BOL-B2-02	BOL-B2-03	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	
Date Sampled		TEL	PEL	Sensitive	Typical	23-Oct-14	23-Oct-14	23-Oct-14								23-Oct-14	23-Oct-14	23-Oct-14								
Easily Reducible Metals and Iron Oxides																										
Aluminum	mg/kg	-	-	-	-	767	750	762	760	762	750	767	8.74	5.04	21.7	832	1,080	791	901	832	791	1,080	156	90.3	388	1,018
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Arsenic	mg/kg	5.9	17	11	20	0.986	0.829	0.829	0.881	0.829	0.829	0.986	0.0906	0.0523	0.225	1.29	1.40	1.51	1.40	1.40	1.29	1.51	0.110	0.064	0.273	1.48
Barium	mg/kg	-	-	-	-	38.5	36.1	37.2	37.3	37.2	36.1	38.5	1.20	0.69	2.98	65.5	54.7	63.6	61.3	63.6	54.7	65.5	5.77	3.33	14.3	65.0
Beryllium	mg/kg	-	-	-	-	0.26	0.31	0.28	0.28	0.28	0.26	0.31	0.025	0.015	0.063	0.33	0.36	0.29	0.33	0.33	0.29	0.36	0.035	0.020	0.087	0.35
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.127	0.158	0.149	0.145	0.149	0.127	0.158	0.0159	0.0092	0.0396	0.133	0.137	0.153	0.141	0.137	0.133	0.153	0.0106	0.0061	0.0263	0.157
Calcium	mg/kg	-	-	-	-	603	653	667	641	653	603	667	33.6	19.4	83.6	526	535	524	528	526	524	535	5.86	3.38	14.6	664
Chromium	mg/kg	37.3	90	56	110	2.04	1.96	2.00	2.00	2.00	1.96	2.04	0.0400	0.0231	0.0994	2.58	2.50	2.52	2.53	2.52	2.50	2.58	0.0416	0.0240	0.103	2.57
Cobalt	mg/kg	-	-	-	-	1.30	1.28	1.35	1.31	1.3	1.28	1.35	0.0361	0.0208	0.0896	1.22	1.23	1.18	1.21	1.22	1.18	1.23	0.0265	0.0153	0.0657	1.34
Copper	mg/kg	35.7	197	120	240	7.14	6.92	7.08	7.05	7.08	6.92	7.14	0.114	0.066	0.283	5.75	5.76	5.69	5.73	5.75	5.69	5.76	0.0379	0.0219	0.0941	7.13
Iron	mg/kg	21,200	43,776	-	-	5,910	5,010	5,200	5,373	5,200	5,010	5,910	474	274	1,179	9,310	7,120	8,620	8,350	8,620	7,120	9,310	1,120	646	2,782	9,138
Lead	mg/kg	35	91	57	110	1.75	1.93	1.80	1.83	1.80	1.75	1.93	0.093	0.054	0.23	2.57	3.26	2.69	2.84	2.69	2.57	3.26	0.369	0.213	0.916	3.12
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Manganese	mg/kg	460	1,100	-	-	167	143	218	176	167	143	218	38.3	22.1	95.2	217	105	223	182	217	105	223	66.5	38.4	165	222
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Nickel	mg/kg	16	75	-	-	3.25	3.24	3.48	3.32	3.25	3.24	3.48	0.136	0.078	0.337	3.21	3.12	3.22	3.18	3.21	3.12	3.22	0.0551	0.0318	0.137	3.42
Phosphorus	mg/kg	-	-	-	-	118	89	112	106	112	89	118	15.3	8.84	38.0	306	170	312	263	306	170	312	80.3	46.4	200	311
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Strontium	mg/kg	-	-	-	-	7.72	7.91	8.05	7.89	7.91	7.72	8.05	0.166	0.096	0.411	7.41	7.25	7.03	7.23	7.25	7.03	7.41	0.191	0.110	0.474	8.02
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0	<1.0
Uranium	mg/kg	-	-	-	-	0.505	0.552	0.527	0.528	0.527	0.505	0.552	0.0235	0.0136	0.0584	0.568	0.568	0.581	0.572	0.568	0.568	0.581	0.0075	0.0043	0.0186	0.578
Vanadium	mg/kg	-	-	-	-	10.9	10.8	10.6	10.8	10.8	10.6	10.9	0.153	0.088	0.379	18.1	18.2	18.5	18.3	18.2	18.1	18.5	0.208	0.120	0.517	18.4
Zinc	mg/kg	123	315	200	380	15.3	16.9	16.6	16.3	16.6	15.3	16.9	0.850	0.491	2.11	15.6	15.9	16.0	15.8	15.9	15.6	16.0	0.208	0.120	0.517	16.8
Organic Bound Metals																										
Aluminum	mg/kg	-	-	-	-	4,170	4,320	4,430	4,307	4,320	4,170	4,430	131	75.4	324	4,300	4,630	4,560	4,497	4,560	4,300	4,630	174	100	432	4,613
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Arsenic	mg/kg	5.9	17	11	20	1.81	1.94	1.87	1.87	1.87	1.81	1.94	0.0651	0.0376	0.162	1.67	2.18	1.89	1.91	1.89	1.67	2.18	0.256	0.148	0.635	2.12
Barium	mg/kg	-	-	-	-	10.8	10.1	10.4	10.4	10.4	10.1	10.8	0.351	0.203	0.872	15.7	14.1	15.6	15.1	15.6	14.1	15.7	0.896	0.517	2.23	15.7
Beryllium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.052	0.059	0.051	0.054	0.052	0.051	0.059	0.0044	0.0025	0.011	0.054	0.061	0.054	0.056	0.054	0.054	0.061	0.0040	0.0023	0.0100	0.061
Calcium	mg/kg	-	-	-	-	856	789	675	773	789	675	856	91.5	52.8	227	280	383	296	320	296	280	383	55.4	32.0	138	839
Chromium	mg/kg	37.3	90	56	110	16.4	17.8	17.7	17.3	17.7	16.4	17.8	0.781	0.451	1.94	13.3	15.4	14.7	14.5	14.7	13.3	15.4	1.07	0.617	2.66	17.8
Cobalt	mg/kg	-	-	-	-	5.14	5.58	5.53	5.42	5.53	5.14	5.58	0.241	0.139	0.598	4.80	5.20	5.37	5.12	5.20	4.80	5.37	0.293	0.169	0.727	5.57
Copper	mg/kg	35.7	197	120	240	328	349	365	347	349	328	365	18.6	10.7	46.1	276	313	305	298	305	276	313	19.5	11.2	48.4	361
Iron	mg/kg	21,200	43,776	-	-	4,950	4,650	4,770	4,790	4,770	4,650	4,950	151	87.2	375	3,730	3,990	4,060	3,927	3,990	3,730	4,060	174	100	432	4,905
Lead	mg/kg	35	91	57	110	0.57	0.61	0.61	0.60	0.61	0.57	0.61	0.023	0.013	0.057	0.77	1.17	0.88	0.94	0.88	0.77	1.2	0.21	0.12	0.51	1.10
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Manganese	mg/kg	460	1,100	-	-	60.3	57.3	64.0	60.5	60.3	57.3	64.0	3.36	1.94	8.34	54.3	43.2	58.0	51.8	54.3	43.2	58.0	7.70	4.45	19.1	63.1
Molybdenum	mg/kg	-	-	-	-	3.64	3.41	3.61	3.55	3.61	3.41	3.64	0.125	0.0722	0.311	2.87	3.85	3.37	3.36	3.37	2.87	3.85	0.490	0.283	1.22	3.80
Nickel	mg/kg	16	75	-	-	12.2	13.2	13.2	12.9	13.2	12.2	13.2	0.577	0.333	1.43	9.85	11.1	10.6	10.5	10.6	9.85	11.1	0.629	0.363	1.56	13.2
Selenium	mg/kg	2	-	-	-	3.01	2.98	3.21	3.07	3.01	2.98	3.21	0.125	0.0722	0.311	2.71	2.67	2.69	2.69	2.69	2.67	2.71	0.0200	0.0115	0.0497	3.16
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Strontium	mg/kg	-	-	-	-	7.29	6.84	6.51	6.88	6.84	6.51	7.29	0.392	0.226	0.973	4.78	5.30	5.14	5.07	5.14	4.78	5.30	0.266	0.154	0.662	7.18
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	12.9	19.2	8.60	13.6	12.9	8.60	19.2	5.33	3.08	13.2	55.7	19.4	23.5	32.9	23.5	19.4	55.7	19.9	11.5	49.4	47.7
Uranium	mg/kg	-	-	-	-	0.995	1.10	1.10	1.07	1.10	1.00	1.10	0.0606	0.0350	0.151	0.687	0.883	0.760	0.777	0.760	0.687	0.883	0.0991	0.0572	0.246	1.10
Vanadium	mg/kg	-	-	-	-	22.6	25.0	24.3	24.0	24.3	22.6	25.0	1.23	0.713	3.07	23.0	27.0	25.5	25.2	25.5	23.0	27.0	2.02	1.17	5.02	26.6
Zinc	mg/kg	123	315	200	380	22.1	22.2	22.8	22.4	22.2	22.1	22.8	0.379	0.219	0.941	16.9	19.3	18.7	18.3	18.7	16.9	19.3	1.25	0.721	3.10	22.7

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Summary statistics are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.

[2] Samples were collected using a sediment corer.

[3] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[4] Contaminated Sites Regulation (Government of British Columbia 1996)

(blue)	Value is > TEL.
(orange)	Value is > PEL.

Table E.38: Raw selectively extracted (Tessier extraction) metals data for sediment from Bootjack Lake deep sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment[1,2].

Sample ID	Units	BC SQGs [3]		Contaminated Sites Regulation [4]		BOL-B1 (North)										BOL-B2 (South)										Pooled B1 and B2 95th Percentile
						BOL-B1-01	BOL-B1-02	BOL-B1-03	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	BOL-B2-01	BOL-B2-02	BOL-B2-03	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	
Date Sampled		TEL	PEL	Sensitive	Typical	23-Oct-14	23-Oct-14	23-Oct-14								23-Oct-14	23-Oct-14	23-Oct-14								
Residual Metals																										
Aluminum	mg/kg	-	-	-	-	14,700	14,600	15,000	14,767	14,700	14,600	15,000	208	120	517	14,700	15,300	16,100	15,367	15,300	14,700	16,100	702	406	1,745	15,900
Antimony	mg/kg	-	-	-	-	0.70	0.67	0.64	0.67	0.67	0.64	0.70	0.030	0.017	0.075	0.83	0.89	0.84	0.85	0.84	0.83	0.89	0.032	0.019	0.080	0.88
Arsenic	mg/kg	5.9	17	11	20	4.18	4.11	4.24	4.18	4.18	4.11	4.24	0.0651	0.0376	0.162	4.18	4.54	4.71	4.48	4.54	4.18	4.71	0.271	0.156	0.672	4.67
Barium	mg/kg	-	-	-	-	64.1	63.0	62.2	63.1	63.0	62.2	64.1	0.954	0.551	2.37	76.0	67.8	80.6	75	76	68	81	6.48	3.74	16.1	79.5
Beryllium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Cadmium	mg/kg	0.6	3.5	2.2	4.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Calcium	mg/kg	-	-	-	-	2,710	2,730	2,690	2,710	2,710	2,690	2,730	20.0	11.5	49.7	1,770	1,640	1,760	1,723	1,760	1,640	1,770	72.3	41.8	180	2,725
Chromium	mg/kg	37.3	90	56	110	20.4	21.2	20.6	20.7	20.6	20.4	21.2	0.416	0.240	1.03	20.9	21.5	22.3	21.6	21.5	20.9	22.3	0.702	0.406	1.74	22.1
Cobalt	mg/kg	-	-	-	-	4.76	4.90	4.81	4.82	4.81	4.76	4.90	0.0709	0.0410	0.176	4.81	4.90	5.03	4.91	4.90	4.81	5.03	0.111	0.064	0.275	5.00
Copper	mg/kg	35.7	197	120	240	78.8	83.5	82.7	81.7	82.7	78.8	83.5	2.51	1.45	6.25	72.1	77.4	76.8	75.4	76.8	72.1	77.4	2.90	1.68	7.21	83.3
Iron	mg/kg	21,200	43,776	-	-	14,300	14,200	13,800	14,100	14,200	13,800	14,300	265	153	657	15,300	14,500	16,000	15,267	15,300	14,500	16,000	751	433	1,865	15,825
Lead	mg/kg	35	91	57	110	4.41	4.88	4.63	4.64	4.63	4.41	4.88	0.235	0.136	0.584	6.25	5.95	6.81	6.34	6.25	5.95	6.81	0.437	0.252	1.08	6.67
Lithium	mg/kg	-	-	-	-	9.3	8.9	8.8	9.0	8.9	8.8	9.3	0.26	0.15	0.66	8.9	8.8	9.1	8.9	8.9	8.8	9.1	0.15	0.088	0.38	9.3
Manganese	mg/kg	460	1,100	-	-	180	183	177	180	180	177	183	3.00	1.73	7.45	149	150	153	151	150	149	153	2.08	1.20	5.17	182
Molybdenum	mg/kg	-	-	-	-	0.69	0.62	0.73	0.68	0.69	0.62	0.73	0.056	0.032	0.14	0.60	0.71	0.69	0.67	0.69	0.60	0.71	0.059	0.034	0.15	0.73
Nickel	mg/kg	16	75	-	-	11.3	11.6	11.4	11.4	11.4	11.3	11.6	0.153	0.088	0.379	13.1	13.5	13.9	13.5	13.5	13.1	13.9	0.400	0.231	0.994	13.8
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Silver	mg/kg	0.5	-	-	-	0.37	0.34	0.37	0.36	0.37	0.34	0.37	0.017	0.010	0.043	0.35	0.37	0.38	0.37	0.37	0.35	0.38	0.015	0.009	0.038	0.38
Strontium	mg/kg	-	-	-	-	42.9	42.8	40.4	42.0	42.8	40.4	42.9	1.42	0.817	3.52	24.7	24.7	24.2	24.5	24.7	24.2	24.7	0.289	0.167	0.717	42.9
Thallium	mg/kg	-	-	-	-	0.055	0.058	0.058	0.057	0.058	0.055	0.058	0.0017	0.0010	0.0043	0.060	0.059	0.063	0.061	0.060	0.059	0.063	0.0021	0.0012	0.0052	0.062
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	874	882	868	875	874	868	882	7.02	4.06	17.4	625	695	670	663	670	625	695	35.5	20.5	88.1	880
Uranium	mg/kg	-	-	-	-	0.351	0.374	0.385	0.370	0.374	0.351	0.385	0.0173	0.0100	0.0431	0.387	0.318	0.409	0.371	0.387	0.318	0.409	0.0475	0.0274	0.118	0.404
Vanadium	mg/kg	-	-	-	-	36.6	36.5	35.5	36.2	36.5	35.5	36.6	0.608	0.351	1.51	31.6	32.2	32.3	32.0	32.2	31.6	32.3	0.379	0.219	0.941	36.6
Zinc	mg/kg	123	315	200	380	35.1	35.6	35.6	35.4	35.6	35.1	35.6	0.289	0.167	0.717	36.1	36.4	37.6	36.7	36.4	36.1	37.6	0.794	0.458	1.97	37.3

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Summary statistics are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.

[2] Samples were collected using a sediment corer.

[3] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[4] Contaminated Sites Regulation (Government of British Columbia 1996)

(shaded) Value is > TEL.

Table E.39: Raw leachable metals data for sediment from Polley Lake mid-depth sampling areas, Mount Polley Mine, 2014. Data are based on bulk sediment[1].

Sample ID	Units	BCWQG [2]			HWR [3]	Bootjack Reference Mid-depth 95th Percentile	POL-1 (North Polley Lake)											
							POL-1-01 [4]	POL-1-02 [4]	POL-1-03 [4]	POL-1-04 [4]	POL-1-05 [4]	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled		Type	Chronic	Acute			21-Oct-14	20-Oct-14	21-Oct-14	21-Oct-14	22-Oct-14							
Leachable Metals																		
Aluminum	mg/L	-	-	-	-	2.36	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Antimony	mg/L	W	0.009	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Arsenic	mg/L	A	-	0.0050	2.5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Barium	mg/L	W	1.0	-	100	0.154	0.071	0.080	0.105	0.061	0.059	0.075	0.071	0.059	0.105	0.019	0.0083	0.023
Beryllium	mg/L	W	0.00013	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0	0	0
Bismuth	mg/L	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Cadmium	mg/L	A	0.00027	0.00081	0.50	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Calcium	mg/L	-	-	-	-	27.7	94.1	125	182	90.7	78.8	114	94.1	78.8	182	41.6	18.6	51.6
Chromium [5]	mg/L	W	0.001	-	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Cobalt	mg/L	A	0.0040	0.11	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Copper	mg/L	A	0.0055	0.015	100	0.019	<0.010	0.014	<0.010	<0.010	<0.010	0.011	<0.010	<0.010	0.014	0.0018	0.0008	0.0022
Iron	mg/L	A	-	1.0	-	0.571	0.091	<0.030	<0.030	0.091	0.236	0.096	0.091	<0.030	0.236	0.084	0.038	0.10
Lead	mg/L	A	0.008	0.12	5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Magnesium	mg/L	-	-	-	-	3.99	11.8	13.8	19.3	11.5	10.1	13.3	11.8	10.1	19.3	3.60	1.61	4.48
Manganese	mg/L	A	1.21	2.05	-	0.625	2.75	0.317	4.40	3.24	3.71	**2.88**	**3.24**	0.317	**4.40**	1.56	0.70	1.93
Mercury	mg/L	A	0.00002	-	0.1	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0	0	0
Molybdenum	mg/L	A	1	2	-	<0.030	0.044	<0.030	0.075	0.065	0.064	0.056	0.064	<0.030	0.075	0.018	0.0081	0.023
Nickel [6]	mg/L	W	-	0.121	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Phosphorus	mg/L	A	-	0.0050-0.015	-	0.31	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0	0	0
Potassium	mg/L	-	-	-	-	<2.0	5.3	5.6	6.6	5.5	4.9	5.6	5.5	4.9	6.6	0.63	0.28	0.78
Selenium	mg/L	A	0.002	-	1	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Silicon	mg/L	-	-	-	-	42.7	13.1	11.1	8.37	9.41	11.0	10.6	11.0	8.37	13.1	1.81	0.81	2.24
Silver	mg/L	A	0.0015	0.003	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Sodium	mg/L	-	-	-	-	3.8	14.0	14.1	15.6	12.8	12.3	13.8	14.0	12.3	15.6	1.29	0.57	1.60
Strontium	mg/L	-	-	-	-	0.276	0.763	0.951	1.38	0.743	0.649	0.897	0.763	0.649	1.38	0.291	0.130	0.362
Thallium	mg/L	W	0.0008	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Tin	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0
Titanium	mg/L	-	-	-	-	0.028	0.013	0.015	0.019	0.013	0.011	0.014	0.013	0.011	0.019	0.0030	0.0014	0.0038
Uranium	mg/L	W	0.0085	-	10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Vanadium	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0
Zinc	mg/L	A	0.043	0.068	500	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.

[3] Hazardous Waste Regulation (Government of British Columbia 1988)

[4] Samples were collected using a sediment corer.

[5] Samples were collected using a petite ponar.

[6] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.

[6] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)

[orange box] Value is > either guideline (values < MDL excluded). Values shown in bold text also exceed Reference 95th percentile value.

Table E.39: Raw leachable metals data for sediment from Polley Lake mid-depth sampling areas, Mount Polley Mine, 2014. Data are based on bulk sediment[1].

Sample ID	Units	BCWQG [2]			HWR [3]	Bootjack Reference Mid-depth 95th Percentile	POL-2 (South Polley Lake)											
							POL-2-01 [4]	POL-2-02 [4]	POL-2-O3 [5]	POL-2-O4 [5]	POL-2-O5 [5]	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled		**Type**	**Chronic**	**Acute**			22-Oct-14	22-Oct-14	23-Oct-14	23-Oct-14	24-Oct-14							
Leachable Metals																		
Aluminum	mg/L	-	-	-	-	2.36	<0.20	0.20	0.53	<0.20	<0.20	0.27	<0.20	<0.20	0.53	0.15	0.066	0.18
Antimony	mg/L	W	0.009	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Arsenic	mg/L	A	-	0.0050	2.5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Barium	mg/L	W	1.0	-	100	0.154	0.061	0.063	0.044	0.036	0.048	0.050	0.048	0.036	0.063	0.011	0.0051	0.014
Beryllium	mg/L	W	0.00013	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0	0	0
Bismuth	mg/L	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Cadmium	mg/L	A	0.00027	0.00081	0.50	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Calcium	mg/L	-	-	-	-	27.7	76.6	72.2	18.8	40.5	67.3	55	67.3	18.8	77	24.7	11.0	30.6
Chromium [5]	mg/L	W	0.001	-	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Cobalt	mg/L	A	0.0040	0.11	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Copper	mg/L	A	0.0055	0.015	100	0.019	<0.010	<0.010	0.060	0.017	<0.010	**0.021**	<0.010	<0.010	**0.060**	0.022	0.0097	0.027
Iron	mg/L	A	-	1.0	-	0.571	0.486	<0.030	0.054	<0.030	<0.030	0.126	<0.030	<0.030	0.486	0.20	0.090	0.25
Lead	mg/L	A	0.008	0.12	5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Magnesium	mg/L	-	-	-	-	3.99	9.99	9.05	2.80	4.87	7.16	6.77	7.16	2.80	10.0	2.96	1.32	3.68
Manganese	mg/L	A	1.21	2.05	-	0.625	3.31	0.478	0.0148	<0.0050	<0.0050	0.763	0.0148	<0.0050	**3.31**	1.44	0.643	1.79
Mercury	mg/L	A	0.00002	-	0.1	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0	0	0
Molybdenum	mg/L	A	1	2	-	<0.030	0.053	0.110	0.064	0.040	<0.030	0.059	0.053	<0.030	0.110	0.031	0.014	0.039
Nickel [6]	mg/L	W	-	0.121	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Phosphorus	mg/L	A	-	0.0050-0.015	-	0.31	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0	0	0
Potassium	mg/L	-	-	-	-	<2.0	4.3	5.6	3.8	3.1	3.6	4.1	3.8	3.1	5.6	0.95	0.43	1.2
Selenium	mg/L	A	0.002	-	1	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Silicon	mg/L	-	-	-	-	42.7	11.8	8.72	7.36	6.14	7.71	8.35	7.71	6.14	11.8	2.14	0.96	2.66
Silver	mg/L	A	0.0015	0.003	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Sodium	mg/L	-	-	-	-	3.8	10.0	15.5	13.2	8.0	8.4	11.0	10.0	8.0	15.5	3.2	1.4	4.0
Strontium	mg/L	-	-	-	-	0.276	0.625	0.589	0.221	0.342	0.533	0.462	0.533	0.221	0.625	0.173	0.0775	0.215
Thallium	mg/L	W	0.0008	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Tin	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0
Titanium	mg/L	-	-	-	-	0.028	0.011	0.011	<0.010	<0.010	<0.010	0.010	<0.010	<0.010	0.011	0.00055	0.00024	0.00068
Uranium	mg/L	W	0.0085	-	10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Vanadium	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0
Zinc	mg/L	A	0.043	0.068	500	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.

[3] Hazardous Waste Regulation (Government of British Columbia 1988)

[4] Samples were collected using a sediment corer.

[5] Samples were collected using a petite ponar.

[6] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.

[6] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)

(orange box) Value is > either guideline (values < MDL excluded). Values shown in bold text also exceed Reference 95th percentile value.

Table E.40: Raw leachable metals data for sediment from Polley Lake deep sampling areas, Mount Polley Mine, 2014. Data are based on bulk sediment[1].

Sample ID	Units	BCWQG [2]			HWR [3]	Bootjack Deep Reference 95th Percentile (Pooled B1 and B2)	POL-P1 (Polley North-Deep)									
							POL-P1-01 [5]	POL-P1-02 [4]	POL-P1-03 [4]	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled		Type	Chronic	Acute			9-Oct-14	9-Oct-14	18-Oct-14							
Leachable Metals																
Aluminum	mg/L	-	-	-	-	2.78	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Antimony	mg/L	W	0.009	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Arsenic	mg/L	A	-	0.0050	2.5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Barium	mg/L	W	1.0	-	100	0.163	0.056	0.089	0.090	0.078	0.089	0.056	0.090	0.019	0.011	0.048
Beryllium	mg/L	W	0.00013	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0	0	0
Bismuth	mg/L	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Cadmium	mg/L	A	0.000267	0.00081	0.50	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Calcium	mg/L	-	-	-	-	36.1	141	151	147	146	147	141	151	5.03	2.91	12.5
Chromium [6]	mg/L	W	0.001	-	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Cobalt	mg/L	A	0.0040	0.11	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Copper	mg/L	A	0.0055	0.015	100	0.049	<0.010	0.012	0.011	0.011	0.011	<0.010	0.012	0.0010	0.00058	0.0025
Iron	mg/L	A	-	1.0	-	1.07	<0.030	0.033	<0.030	0.031	<0.030	<0.030	0.033	0.0017	0.0010	0.0043
Lead	mg/L	A	0.008	0.12	5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Magnesium	mg/L	-	-	-	-	5.83	14.7	23.4	17.9	18.7	17.9	14.7	23.4	4.40	2.54	10.9
Manganese	mg/L	A	1.21	2.05	-	2.08	0.0222	0.0792	1.37	0.490	0.0792	0.0222	1.37	0.762	0.440	1.89
Mercury	mg/L	A	0.00002	-	0.1	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0	0	0
Molybdenum	mg/L	A	1	2	-	0.056	<0.030	0.108	0.103	0.080	0.103	<0.030	0.108	0.044	0.025	0.11
Nickel [7]	mg/L	W	-	0.121	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Phosphorus	mg/L	A	-	0.0050-0.015	-	0.46	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0	0	0
Potassium	mg/L	-	-	-	-	3.4	4.5	3.0	5.7	4.4	4.5	3.0	5.7	1.4	0.78	3.4
Selenium	mg/L	A	0.002	-	1	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Silicon	mg/L	-	-	-	-	52.2	12.9	11.6	9.86	11.5	11.6	9.86	12.9	1.53	0.88	3.79
Silver	mg/L	A	0.0015	0.003	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Sodium	mg/L	-	-	-	-	10.8	20.6	21.9	22.0	21.5	21.9	20.6	22.0	0.781	0.451	1.94
Strontium	mg/L	-	-	-	-	0.352	0.988	0.993	1.05	1.01	0.993	0.988	1.05	0.034	0.020	0.086
Thallium	mg/L	W	0.0008	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Tin	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0
Titanium	mg/L	-	-	-	-	0.030	0.017	0.015	0.018	0.017	0.017	0.015	0.018	0.0015	0.0009	0.0038
Uranium	mg/L	W	0.0085	-	10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Vanadium	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0
Zinc	mg/L	A	0.043	0.068	500	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.

[3] Hazardous Waste Regulation (Government of British Columbia 1988)

[4] Samples were collected using a sediment corer.

[5] Samples were collected using a petite ponar.

[6] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.

[7] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)

(orange shading) Value is > either guideline (values < MDL excluded). Values shown in bold text also exceed Reference 95th percentile value.

Table E.40: Raw leachable metals data for sediment from Polley Lake deep sampling areas, Mount Polley Mine, 2014. Data are based on bulk sediment[1].

Sample ID	Units	BCWQG [2]			HWR [3]	Bootjack Deep Reference 95th Percentile (Pooled B1 and B2)	POL-P2 (Polley South-Deep)									
							POL-P2-O1 [5]	POL-P2-O2 [5]	POL-P2-O3 [5]	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled		Type	Chronic	Acute			24-Oct-14	24-Oct-14	24-Oct-14							
Leachable Metals																
Aluminum	mg/L	-	-	-	-	2.78	0.60	0.90	0.52	0.67	0.60	0.52	0.90	0.20	0.12	0.50
Antimony	mg/L	W	0.009	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Arsenic	mg/L	A	-	0.0050	2.5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Barium	mg/L	W	1.0	-	100	0.163	0.115	0.104	0.075	0.098	0.104	0.075	0.115	0.021	0.012	0.051
Beryllium	mg/L	W	0.00013	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0	0	0
Bismuth	mg/L	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Cadmium	mg/L	A	0.000267	0.00081	0.50	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Calcium	mg/L	-	-	-	-	36.1	110	106	107	108	107	106	110	2.08	1.20	5.17
Chromium [6]	mg/L	W	0.001	-	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Cobalt	mg/L	A	0.0040	0.11	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Copper	mg/L	A	0.0055	0.015	100	0.049	0.020	0.039	0.037	0.032	0.037	0.020	0.039	0.010	0.0060	0.026
Iron	mg/L	A	-	1.0	-	1.07	0.176	0.129	0.094	0.133	0.129	0.094	0.176	0.0411	0.0238	0.102
Lead	mg/L	A	0.008	0.12	5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Magnesium	mg/L	-	-	-	-	5.83	15.3	14.3	15.0	14.9	15.0	14.3	15.3	0.513	0.296	1.27
Manganese	mg/L	A	1.21	2.05	-	2.08	2.73	0.325	0.126	1.06	0.33	0.126	**2.73**	1.45	0.837	3.60
Mercury	mg/L	A	0.00002	-	0.1	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0	0	0
Molybdenum	mg/L	A	1	2	-	0.056	0.198	0.173	0.168	0.180	0.173	0.168	0.198	0.0161	0.0093	0.0399
Nickel [7]	mg/L	W	-	0.121	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Phosphorus	mg/L	A	-	0.0050-0.015	-	0.46	0.37	0.41	<0.30	0.36	0.37	<0.30	0.41	0.056	0.032	0.14
Potassium	mg/L	-	-	-	-	3.4	4.6	5.9	7.4	6.0	5.9	4.6	7.4	1.4	0.81	3.5
Selenium	mg/L	A	0.002	-	1	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Silicon	mg/L	-	-	-	-	52.2	18.7	19.0	15.4	17.7	18.7	15.4	19.0	2.00	1.15	4.96
Silver	mg/L	A	0.0015	0.003	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Sodium	mg/L	-	-	-	-	10.8	24.5	23.8	32.0	26.8	24.5	23.8	32.0	4.55	2.62	11.3
Strontium	mg/L	-	-	-	-	0.352	0.786	0.836	0.938	0.853	0.836	0.786	0.938	0.0775	0.0447	0.192
Thallium	mg/L	W	0.0008	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Tin	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0
Titanium	mg/L	-	-	-	-	0.030	0.017	0.022	0.018	0.019	0.018	0.017	0.022	0.0026	0.0015	0.0066
Uranium	mg/L	W	0.0085	-	10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Vanadium	mg/L	-	-	-	-	<0.030	<0.030	0.033	<0.030	0.031	<0.030	<0.030	0.033	0.0017	0.0010	0.0043
Zinc	mg/L	A	0.043	0.068	500	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.

[3] Hazardous Waste Regulation (Government of British Columbia 1988)

[4] Samples were collected using a sediment corer.

[5] Samples were collected using a petite ponar.

[6] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.

[7] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)

[orange box] Value is > either guideline (values < MDL excluded). Values shown in bold text also exceed Reference 95th percentile value.

Table E.41: Raw leachable metals data for sediment from Bootjack Lake mid-depth sampling areas, Mount Polley Mine, 2014. Data are based on bulk sediment [1].

Sample ID	Units	BCWQG [2]			HWR [3]	Mid-depth Area (BOL-1)												
						BOL-1-01	BOL-1-02	BOL-1-03	BOL-1-04	BOL-1-05	Mean	Median	Minimum	Maximum	95th Percentile	Standard Deviation	Standard Error	t*SE
Date Sampled		Type	Chronic	Acute		23-Oct-14	23-Oct-14	23-Oct-14	23-Oct-14	23-Oct-14								
Leachable Metals [4]																		
Aluminum	mg/L	-	-	-	-	1.87	2.48	1.20	1.13	0.79	1.49	1.20	0.79	2.48	2.36	0.676	0.302	0.839
Antimony	mg/L	W	0.009	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Arsenic	mg/L	A	-	0.0050	2.5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Barium	mg/L	W	1.0	-	100	0.160	0.130	0.114	0.127	0.106	0.127	0.127	0.106	0.160	0.154	0.021	0.0092	0.026
Beryllium	mg/L	W	0.00013	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0	0	0
Bismuth	mg/L	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Cadmium	mg/L	A	0.00027	0.00081	0.5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Calcium	mg/L	-	-	-	-	20.7	21.2	26.6	26.8	27.9	24.6	26.6	20.7	27.9	27.7	3.41	1.52	4.23
Chromium [5]	mg/L	W	0.001	-	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Cobalt	mg/L	A	0.0040	0.11	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Copper	mg/L	A	0.0055	0.015	100	0.012	0.015	0.019	<0.010	0.018	0.015	0.015	<0.010	0.019	0.019	0.0038	0.0017	0.0048
Iron	mg/L	A	-	1.0	-	0.470	0.596	0.331	0.225	0.249	0.374	0.331	0.225	0.596	0.571	0.157	0.0701	0.194
Lead	mg/L	A	0.008	0.12	5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Magnesium	mg/L	-	-	-	-	3.12	3.10	3.77	3.97	3.99	3.59	3.77	3.10	3.99	3.99	0.45	0.20	0.55
Manganese	mg/L	A	1.21	2.05	-	0.719	0.248	0.070	0.184	0.034	0.251	0.184	0.034	0.719	0.625	0.28	0.12	0.34
Mercury	mg/L	A	0.00002	-	0.1	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0	0	0
Molybdenum	mg/L	A	1	2	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0.000	0.000	0.000
Nickel [6]	mg/L	W	-	0.121	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Phosphorus	mg/L	A	-	0.0050-0.015	-	<0.30	0.31	<0.30	<0.30	<0.30	0.30	<0.30	<0.30	0.31	0.31	0.0045	0.0020	0.0056
Potassium	mg/L	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Selenium	mg/L	A	0.002	-	1	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Silicon	mg/L	-	-	-	-	37.2	44.1	26.4	28.7	19.3	31.1	28.7	19.3	44.1	42.7	9.66	4.32	12.0
Silver	mg/L	A	0.0015	0.003	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Sodium	mg/L	-	-	-	-	3.6	3.8	3.4	3.7	3.4	3.6	3.6	3.4	3.8	3.8	0.18	0.080	0.22
Strontium	mg/L	-	-	-	-	0.225	0.226	0.274	0.271	0.276	0.254	0.271	0.225	0.276	0.276	0.0264	0.0118	0.0328
Thallium	mg/L	W	0.0008	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Tin	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0
Titanium	mg/L	-	-	-	-	0.02	0.029	0.023	0.012	0.016	0.020	0.020	0.012	0.029	0.028	0.0065	0.0029	0.0081
Uranium	mg/L	W	0.0085	-	10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Vanadium	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0
Zinc	mg/L	A	0.043	0.068	500	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0

[1] Data < method detection limit (MDL) were used at the MDL for calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.

[3] Hazardous Waste Regulation (Government of British Columbia 1988)

[4] Samples were collected using a petite ponar.

[5] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.

[6] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)

(orange box) Value is > one or all guidelines (values < MDL excluded).

Table E.42: Raw leachable metals data for sediment from Bootjack Lake deep sampling areas, Mount Polley Mine, 2014. Data are based on bulk sediment[1].

Sample ID	Units	BCWQG [2]			HWR [3]	BOL-B1 (North)										BOL-B2 (South)										Pooled B1 and B2 95th Percentile
						BOL-B1-01	BOL-B1-02	BOL-B1-03	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	BOL-B2-01	BOL-B2-02	BOL-B2-03	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	
Date Sampled		Type	Chronic	Acute		23-Oct-14	24-Oct-14	24-Oct-14								22-Oct-14	22-Oct-14	24-Oct-14								
Leachable Metals [4]																										
Aluminum	mg/L	-	-	-	-	0.74	0.51	0.64	0.63	0.64	0.51	0.74	0.12	0.067	0.29	2.79	2.73	0.54	2.02	2.73	0.54	2.79	1.3	0.74	3.2	2.78
Antimony	mg/L	W	0.009	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Arsenic	mg/L	A	-	0.0050	2.5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Barium	mg/L	W	1.0	-	100	0.129	0.127	0.139	0.132	0.129	0.127	0.139	0.0064	0.0037	0.016	0.161	0.164	0.044	0.12	0.16	0.04	0.16	0.068	0.040	0.17	0.163
Beryllium	mg/L	W	0.00013	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0	0	0	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0	0	0	<0.0050
Bismuth	mg/L	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Cadmium	mg/L	A	0.00027	0.00081	0.5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010
Calcium	mg/L	-	-	-	-	37.3	30.6	32.4	33.4	32.4	30.6	37.3	3.47	2.00	8.61	17.0	15.6	18.6	17.1	17.0	15.6	18.6	1.50	0.87	3.73	36.1
Chromium [5]	mg/L	W	0.001	-	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010
Cobalt	mg/L	A	0.0040	0.11	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010
Copper	mg/L	A	0.0055	0.015	100	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	0.018	0.019	0.059	0.032	0.019	0.018	0.059	0.023	0.014	0.058	0.049
Iron	mg/L	A	-	1.0	-	0.114	0.129	0.146	0.130	0.129	0.114	0.146	0.0160	0.0092	0.0398	1.07	1.06	0.071	0.73	1.06	0.071	1.07	0.57	0.33	1.4	1.07
Lead	mg/L	A	0.008	0.12	5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Magnesium	mg/L	-	-	-	-	6.27	4.30	4.49	5.02	4.49	4.30	6.27	1.09	0.627	2.70	2.52	2.28	2.80	2.53	2.52	2.28	2.80	0.260	0.150	0.647	5.83
Manganese	mg/L	A	1.21	2.05	-	0.132	0.301	0.443	0.292	0.301	0.132	0.443	0.156	0.090	0.387	1.97	2.11	0.015	1.37	1.97	0.015	2.11	1.2	0.7	2.9	2.08
Mercury	mg/L	A	0.00002	-	0.1	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0	0	0	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0	0	0	<0.000050
Molybdenum	mg/L	A	1	2	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0	<0.030	<0.030	0.064	0.041	<0.030	<0.030	0.064	0.020	0.011	0.049	0.056
Nickel [6]	mg/L	W	-	0.121	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Phosphorus	mg/L	A	-	.0050-0.01	-	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0	0	0	0.47	0.43	<0.30	0.40	0.43	<0.30	0.47	0.089	0.051	0.22	0.46
Potassium	mg/L	-	-	-	-	<2.0	2.2	2.3	2.2	2.2	<2.0	2.3	0.15	0.088	0.38	2.0	2.2	3.7	2.6	2.2	2.0	3.7	0.93	0.54	2.3	3.4
Selenium	mg/L	A	0.002	-	1	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Silicon	mg/L	-	-	-	-	20.2	20.1	22.0	20.8	20.2	20.1	22.0	1.07	0.62	2.66	52.4	51.6	7.31	37.1	51.6	7.3	52.4	25.8	14.9	64.1	52.2
Silver	mg/L	A	0.0015	0.003	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010
Sodium	mg/L	-	-	-	-	3.8	3.4	3.4	3.5	3.4	3.4	3.8	0.23	0.13	0.57	3.4	3.2	13.1	6.6	3.4	3.2	13.1	5.7	3.3	14	10.8
Strontium	mg/L	-	-	-	-	0.365	0.296	0.311	0.324	0.311	0.296	0.365	0.0363	0.0210	0.0902	0.181	0.168	0.219	0.189	0.181	0.168	0.219	0.0265	0.0153	0.0658	0.352
Thallium	mg/L	W	0.0008	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Tin	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0	<0.030
Titanium	mg/L	-	-	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	0.030	0.029	<0.010	0.023	0.029	<0.010	0.030	0.011	0.0065	0.028	0.030
Uranium	mg/L	W	0.0085	-	10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Vanadium	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0	<0.030
Zinc	mg/L	A	0.043	0.068	500	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0	<0.020

[1] Data < method detection limit (MDL) were used at the MDL for calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.

[3] Hazardous Waste Regulation (Government of British Columbia 1988)

[4] Samples were collected using a petite ponar.

[5] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.

[6] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)

(orange box) Value is > one or all guidelines (values < MDL excluded).

Table E.43: Raw acid base accounting, sulphur, and carbon content data for sediment from mid-depth and deep lake sampling areas in Polley Lake, Mount Polley Mine, 2014 [1,2].

Parameter	Units	POL-P1 (North-Deep)									
		POL-P1-01	POL-P1-02	POL-P1-03	Mean	Median	Minimum	Maximum	Standard	Standard	t*SE
Sampling Date		9-Oct-14	17-Oct-14	17-Oct-14							
Maximum Potential Acidity (MPA)	tCaCO3/1Kt	17.8	NSS	NSS	17.8				-		
Fizz Rating	Unity	2	NSS	NSS	2				-		
Net Neutralization Potential (NNP)	tCaCO3/1Kt	22	NSS	NSS	22				-		
pH	Unity	7.3	NSS	NSS	7.3				-		
Neutralization Potential (NP)	tCaCO3/1Kt	40	NSS	NSS	40				-		
Neutralization Potential Ratio (NP/MPA)	Unity	2.25	NSS	NSS	2.25				-		
Total Sulphur (S) - Leco	%	0.57	NSS	NSS	0.57				-		
Sulphide Sulphur (S) - Calculated Leco	%	0.55	NSS	NSS	0.55				-		
Sulphate Sulphur (S) - Carbonate Leach	%	0.02	NSS	NSS	0.02				-		
Inorganic Carbon (C)	%	0.27	NSS	NSS	0.27				-		
Carbon Dioxide (CO2)	%	1	NSS	NSS	1				-		
Sulphate Sulphur (S) - HCl leachable	%	0.05	NSS	NSS	0.05				-		

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Summary statistics are reported as < MDL if all the data used in their calculation were < MDL.

[2] Samples were collected using a petite ponar, except samples for station POL-P1-01 which were collected using a sediment corer.

NSS = Non-sufficient sample.

(grey box) Indicates Neutralization Potential Ratio > 4; no potential for Acid Rock Drainage (Price 1997)

Table E.43: Raw acid base accounting, sulphur, and carbon content data for sediment from mid-depth and deep lake sampling areas in Polley Lake, Mount Polley Mine, 2014 [1,2].

Parameter	Units	POL-P2 (South-Deep)									
		POL-P2-O1	POL-P2-O2	POL-P2-O3	Mean	Median	Minimum	Maximum	Standard	Standard	t*SE
Sampling Date		24-Oct-14	24-Oct-14	24-Oct-14							
Maximum Potential Acidity (MPA)	tCaCO3/1Kt	30.3	28.1	18.1	25.5	28.1	18.1	30.3	6.50	3.75	16.2
Fizz Rating	Unity	1	2	2	2	2	1	2	0.6	0.3	1
Net Neutralization Potential (NNP)	tCaCO3/1Kt	-6	8	25	9	8	-6	25	16	9	39
pH	Unity	NSS	NSS	NSS	-	-	-	-	-	-	-
Neutralization Potential (NP)	tCaCO3/1Kt	24	36	43	34	36	24	43	10	5.5	24
Neutralization Potential Ratio (NP/MPA)	Unity	0.79	1.28	2.37	1.48	1.28	0.79	2.37	0.81	0.47	2.01
Total Sulphur (S) - Leco	%	0.97	0.90	0.58	0.82	0.90	0.58	0.97	0.21	0.12	0.52
Sulphide Sulphur (S) - Calculated Leco	%	0.95	0.89	0.57	0.80	0.89	0.57	0.95	0.20	0.12	0.51
Sulphate Sulphur (S) - Carbonate Leach	%	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.003	0.01
Inorganic Carbon (C)	%	0.14	0.16	0.30	0.20	0.16	0.14	0.30	0.09	0.05	0.22
Carbon Dioxide (CO2)	%	0.5	0.6	1.1	0.7	0.6	0.5	1.1	0.3	0.2	0.8
Sulphate Sulphur (S) - HCl leachable	%	NSS	NSS	NSS	-	-	-	-	-	-	-

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Summary statistics are reported as < MDL if all the data used in their calculation were < MDL.

[2] Samples were collected using a petite ponar, except samples for station POL-P1-01 which were collected using a sediment corer.

NSS = Non-sufficient sample.

(grey box) Indicates Neutralization Potential Ratio > 4; no potential for Acid Rock Drainage (Price 1997)

Table E.43: Raw acid base accounting, sulphur, and carbon content data for sediment from mid-depth and deep lake sampling areas in Polley Lake, Mount Polley Mine, 2014[1,2].

Parameter	Units	POL-1 (Mid-depth North)											
		POL-1-01	POL-1-02	POL-1-03	POL-1-04	POL-1-O5	Mean	Median	Minimum	Maximum	Standard	Standard	t*SE
Sampling Date		21-Oct-14	20-Oct-14	20-Oct-14	22-Oct-14	23-Oct-14							
Maximum Potential Acidity (MPA)	tCaCO3/1Kt	12.8	7.2	4.7	7.2	9.1	8.2	7.2	4.7	12.8	3.0	1.3	3.7
Fizz Rating	Unity	2	2	2	2	2	2	2	2	2	0	0	0
Net Neutralization Potential (NNP)	tCaCO3/1Kt	22	41	39	41	36	36	39	22	41	8.0	3.6	10
pH	Unity	7.5	7.5	7.8	7.8	7.3	7.6	7.5	7.3	7.8	0.22	0.10	0.27
Neutralization Potential (NP)	tCaCO3/1Kt	35	48	44	48	45	44	45	35	48	5.3	2.4	6.6
Neutralization Potential Ratio (NP/MPA)	Unity	2.73	6.68	9.39	6.68	4.97	6.09	6.68	2.73	9.39	2.46	1.10	3.05
Total Sulphur (S) - Leco	%	0.41	0.23	0.15	0.23	0.29	0.26	0.23	0.15	0.41	0.10	0.04	0.12
Sulphide Sulphur (S) - Calculated Leco	%	0.41	0.23	0.15	0.23	0.27	0.26	0.23	0.15	0.41	0.10	0.04	0.12
Sulphate Sulphur (S) - Carbonate Leach	%	<0.01	<0.01	<0.01	<0.01	0.02	0.01	<0.01	<0.01	0.02	0.004	0.002	0.006
Inorganic Carbon (C)	%	0.2	0.39	0.35	0.40	0.37	0.34	0.37	0.20	0.40	0.082	0.037	0.10
Carbon Dioxide (CO2)	%	0.7	1.4	1.3	1.5	1.4	1.3	1.4	0.7	1.5	0.32	0.14	0.40
Sulphate Sulphur (S) - HCl leachable	%	0.06	0.01	0.02	0.01	0.06	0.03	0.02	0.01	0.06	0.03	0.01	0.03

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Summary statistics are reported as < MDL if all the data used in their calculation were < MDL.

[2] Samples were collected using a petite ponar, except samples for station POL-P1-01 which were collected using a sediment corer.

NSS = Non-sufficient sample.

[shaded cell] Indicates Neutralization Potential Ratio > 4; no potential for Acid Rock Drainage (Price 1997)

Table E.43: Raw acid base accounting, sulphur, and carbon content data for sediment from mid-depth and deep lake sampling areas in Polley Lake, Mount Polley Mine, 2014 [1,2].

Parameter	Units	POL-2 (Mid-depth South)											
		POL-2-O1	POL-2-O2	POL-2-O3	POL-2-O4	POL-2-O5	Mean	Median	Minimum	Maximum	Standard	Standard	t*SE
Sampling Date		23-Oct-14	23-Oct-14	23-Oct-14	23-Oct-14	24-Oct-14							
Maximum Potential Acidity (MPA)	tCaCO3/1Kt	6.6	4.1	3.4	4.4	5.0	4.7	4.4	3.4	6.6	1.2	0.54	1.5
Fizz Rating	Unity	2	2	2	2	2	2	2	2	2	0	0	0
Net Neutralization Potential (NNP)	tCaCO3/1Kt	32	37	45	40	42	39.2	40	32	45	5.0	2.2	6.2
pH	Unity	7.8	8.2	8.1	8.1	8	8.0	8.1	7.8	8.2	0.15	0.07	0.19
Neutralization Potential (NP)	tCaCO3/1Kt	39	41	48	44	47	44	44	39	48	3.8	1.7	4.8
Neutralization Potential Ratio (NP/MPA)	Unity	5.94	10.1	14.0	10.1	9.4	9.9	10.1	5.9	14.0	2.8	1.3	3.5
Total Sulphur (S) - Leco	%	0.21	0.13	0.11	0.14	0.16	0.15	0.14	0.11	0.21	0.038	0.017	0.047
Sulphide Sulphur (S) - Calculated Leco	%	0.21	0.13	0.11	0.14	0.14	0.15	0.14	0.11	0.21	0.038	0.017	0.047
Sulphate Sulphur (S) - Carbonate Leach	%	<0.01	<0.01	<0.01	<0.01	0.02	0.01	<0.01	<0.01	0.02	0	0	0
Inorganic Carbon (C)	%	0.29	0.33	0.37	0.33	0.38	0.34	0.33	0.29	0.38	0.036	0.016	0.045
Carbon Dioxide (CO2)	%	1.1	1.2	1.4	1.2	1.4	1.3	1.2	1.1	1.4	0.13	0.060	0.17
Sulphate Sulphur (S) - HCl leachable	%	0.02	0.01	NSS	NSS	NSS	0.02	0.02	0.01	0.02	0.01	0.01	0.1

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Summary statistics are reported as < MDL if all the data used in their calculation were < MDL.

[2] Samples were collected using a petite ponar, except samples for station POL-P1-01 which were collected using a sediment corer.

NSS = Non-sufficient sample.

(shaded) Indicates Neutralization Potential Ratio > 4; no potential for Acid Rock Drainage (Price 1997)

Table E.44: Raw acid base accounting, sulphur, and carbon content data for sediment from mid-depth and deep sampling areas in Bootjack Lake, Mount Polley, 2014 [1].

Parameter	Units	Mid-depth (BOL-1)											
		BOL-1-01	BOL-1-02	BOL-1-03	BOL-1-04	BOL-1-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Sampling Date		**22-Oct-14**	**22-Oct-14**	**22-Oct-14**	**22-Oct-14**	**22-Oct-14**							
Maximum Potential Acidity (MPA)	tCaCO3/1Kt	22.2	17.8	27.2	19.1	13.1	19.9	19.1	13.1	27.2	5.24	2.34	6.51
Fizz Rating	Unity	1	1	1	1	1	1	1	1	1	0	0	0
Net Neutralization Potential (NNP)	tCaCO3/1Kt	-14	-10	-19	-10	-5	-12	-10	-19	-5	5	2	6
pH	Unity	NSS	NSS	NSS	NSS	NSS	-	-	-	-	-	-	-
Neutralization Potential (NP)	tCaCO3/1Kt	8	8	8	9	8	8	8	8	9	0.4	0.2	0.6
Neutralization Potential Ratio (NP/MPA)	Unity	0.36	0.45	0.29	0.47	0.61	0.44	0.45	0.29	0.61	0.12	0.054	0.15
Total Sulphur (S) - Leco	%	0.71	0.57	0.87	0.61	0.42	0.64	0.61	0.42	0.87	0.17	0.075	0.21
Sulphide Sulphur (S) - Calculated Leco	%	0.66	0.53	0.84	0.59	0.40	0.60	0.59	0.40	0.84	0.16	0.073	0.20
Sulphate Sulphur (S) - Carbonate Leach	%	0.05	0.04	0.03	0.02	0.02	0.03	0.03	0.02	0.05	0.01	0.01	0.02
Inorganic Carbon (C)	%	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0	0
Carbon Dioxide (CO2)	%	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0
Sulphate Sulphur (S) - HCl leachable	%	NSS	NSS	NSS	NSS	NSS	-	-	-	-	-	-	-

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Summary statistics are reported as < MDL if all the data used in their calculation were < MDL.

NSS = Non-sufficient sample.

Indicates Neutralization Potential Ratio > 4; no potential for Acid Rock Drainage (Price 1997)

Table E.44: Raw acid base accounting, sulphur, and carbon content data for sediment from mid-depth and deep sampling areas in Bootjack Lake, Mount Polley, 2014 [1].

Parameter	Units	North-Deep Lake (BOL-B1)									
		BOL-B1-01	BOL-B1-02	BOL-B1-03	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Sampling Date		**23-Oct-14**	**24-Oct-14**	**24-Oct-14**							
Maximum Potential Acidity (MPA)	tCaCO3/1Kt	23.8	19.7	18.4	20.6	19.7	18.4	23.8	2.82	1.63	7.00
Fizz Rating	Unity	1	1	1	1	1	1	1	0	0	0
Net Neutralization Potential (NNP)	tCaCO3/1Kt	-16	-12	-11	-13	-12	-16	-11	2.6	1.5	6.6
pH	Unity	5.5	6.0	NSS	5.8	5.8	5.5	6.0	0.35	0.25	3.2
Neutralization Potential (NP)	tCaCO3/1Kt	8	8	7	8	8	7	8	0.6	0.3	1
Neutralization Potential Ratio (NP/MPA)	Unity	0.34	0.41	0.38	0.38	0.38	0.34	0.41	0.035	0.020	0.087
Total Sulphur (S) - Leco	%	0.76	0.63	0.59	0.66	0.63	0.59	0.76	0.089	0.051	0.22
Sulphide Sulphur (S) - Calculated Leco	%	0.76	0.61	0.57	0.65	0.61	0.57	0.76	0.10	0.058	0.25
Sulphate Sulphur (S) - Carbonate Leach	%	<0.01	0.02	0.02	0.02	0.02	<0.01	0.02	0.01	0.003	0.01
Inorganic Carbon (C)	%	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0	0
Carbon Dioxide (CO2)	%	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0
Sulphate Sulphur (S) - HCl leachable	%	0.16	0.11	0.15	0.14	0.15	0.11	0.16	0.026	0.015	0.066

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Summary statistics are reported as < MDL if all the data used in their calculation were < MDL.

NSS = Non-sufficient sample.

(shaded) Indicates Neutralization Potential Ratio > 4; no potential for Acid Rock Drainage (Price 1997)

Table E.44: Raw acid base accounting, sulphur, and carbon content data for sediment from mid-depth and deep sampling areas in Bootjack Lake, Mount Polley, 2014 [1].

Parameter	Units	South-Deep Lake (BOL-B2)									
		BOL-B2-01	BOL-B2-02	BOL-B2-03	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Sampling Date		**22-Oct-14**	**22-Oct-14**	**24-Oct-14**							
Maximum Potential Acidity (MPA)	tCaCO3/1Kt	18.1	17.8	19.1	18.3	18.1	17.8	19.1	0.681	0.393	1.69
Fizz Rating	Unity	1	1	1	1	1	1	1	0	0	0
Net Neutralization Potential (NNP)	tCaCO3/1Kt	-14	-14	-14	-14	-14	-14	-14	0	0	0
pH	Unity	NSS	NSS	5.7	5.7				-	-	-
Neutralization Potential (NP)	tCaCO3/1Kt	4	4	5	4	4	4	5	0.6	0.3	1
Neutralization Potential Ratio (NP/MPA)	Unity	0.22	0.22	0.26	0.23	0.22	0.22	0.26	0.023	0.013	0.057
Total Sulphur (S) - Leco	%	0.58	0.57	0.61	0.59	0.58	0.57	0.61	0.021	0.012	0.052
Sulphide Sulphur (S) - Calculated Leco	%	0.57	0.54	0.58	0.56	0.57	0.54	0.58	0.021	0.012	0.052
Sulphate Sulphur (S) - Carbonate Leach	%	0.01	0.03	0.03	0.02	0.03	0.01	0.03	0.01	0.01	0.03
Inorganic Carbon (C)	%	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0	0
Carbon Dioxide (CO2)	%	<0.2	0.2	<0.2	0.2	0.2	<0.2	0.2	0	0	0
Sulphate Sulphur (S) - HCl leachable	%	NSS	NSS	0.11	0.11				-	-	-

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Summary statistics are reported as < MDL if all the data used in their calculation were < MDL.

NSS = Non-sufficient sample.

[shaded cell] Indicates Neutralization Potential Ratio > 4; no potential for Acid Rock Drainage (Price 1997)

Table E.45: Raw sediment quality data for Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Metals data are based on the < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference 95th Percentile [4]		Reference LRef1 (QUL-51)												
		TEL	PEL	Sensitive	Typical	LRef1	LRef2 [5]	QUL-51-01	QUL-51-02	QUL-51-03	QUL-51-04	QUL-51-05	Mean	Median	Minimum	Maximum	95th Percentile	Standard Deviation	Standard Error	t*SE
Date Sampled	-	-	-	-	-	-	-	26-Aug-14	24-Aug-14	25-Aug-14	25-Aug-14	26-Aug-14								
Physical Tests																				
Moisture	%	-	-	-	-	43.7	53.4	44.1	36.9	39.6	42.3	40.4	40.7	40.4	36.9	44.1	43.7	2.7	1.2	3.39
pH (1:2 soil:water)	pH	-	-	-	-	6.37	-	6.73	6.36	6.60	6.68	6.43	6.56	6.60	6.36	6.73	6.37	0.16	0.07	0.20
Particle Size																				
% Gravel (>2mm)	%	-	-	-	-	1.8	0.1	2.0	0.2	1.1	0.7	1.0	1.0	1.0	0.2	2.0	1.8	0.65	0.29	0.80
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	66	59.0	61	54	52	66	65	60	61	52	66	66	6.4	2.8	7.9
% Silt (0.063mm - 4um)	%	-	-	-	-	42	76.4	32	42	42	29	30	35	32	29	42	42	6.5	2.9	8.0
% Clay (<4um)	%	-	-	-	-	4.9	6.3	5.0	4.0	4.3	4.2	3.3	4.2	4.2	3.3	5.0	4.9	0.59	0.26	0.73
Texture	-	-	-	-	-	-	-	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	-	-	-	-	-	-	-	-
Leachable Anions & Nutrients																				
pH	pH	-	-	-	-	6.06	-	6.08	6.06	6.08	6.06	6.10	6.08	6.08	6.06	6.10	6.06	0.017	0.0075	0.021
Anions and Nutrients																				
Total Nitrogen by LECO (TN)	%	-	-	-	-	0.071	0.138	0.071	0.061	0.068	0.069	0.060	0.066	0.068	0.060	0.071	0.071	0.0050	0.0022	0.0062
Organic / Inorganic Carbon																				
Total Organic Carbon (TOC)	%	-	-	-	-	0.83	2.53	0.81	0.69	0.83	0.77	0.64	0.75	0.77	0.64	0.83	0.83	0.081	0.036	0.10
Metals																				
Aluminum	mg/kg	-	-	-	-	10,340	22,520	10,400	9,770	10,100	9,260	9,410	9,788	9,770	9,260	10,400	10,340	473	211	587
Antimony	mg/kg	-	-	-	-	0.22	<0.10	0.22	0.20	0.18	0.17	0.20	0.19	0.20	0.17	0.22	0.22	0.019	0.009	0.02
Arsenic	mg/kg	5.9	17	11	20	3.91	2.29	4.03	3.14	3.41	3.41	3.40	3.48	3.41	3.14	4.0	3.91	0.329	0.147	0.409
Barium	mg/kg	-	-	-	-	94.6	71.5	72.1	97.5	72.0	64.3	82.9	77.8	72.1	64.3	97.5	94.6	12.9	5.76	16.0
Beryllium	mg/kg	-	-	-	-	0.26	0.62	0.26	0.23	0.24	0.22	0.23	0.24	0.23	0.22	0.26	0.26	0.015	0.0068	0.019
Bismuth	mg/kg	-	-	-	-	<0.20	0.38	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Boron	mg/kg	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.220	0.091	0.196	0.221	0.215	0.198	0.206	0.207	0.206	0.196	0.221	0.220	0.0108	0.0048	0.0134
Calcium	mg/kg	-	-	-	-	5,960	11,035	6,080	5,110	5,370	5,480	5,280	5,464	5,370	5,110	6,080	5,960	370	165	459
Chromium	mg/kg	37.3	90	56	110	35.9	48.4	35.4	35.5	36.0	35.3	34.6	35.4	35.4	34.6	36.0	35.9	0.503	0.225	0.624
Cobalt	mg/kg	-	-	-	-	9.4	21.7	8.80	8.36	9.54	8.00	7.84	8.51	8.36	7.84	9.5	9.39	0.685	0.306	0.850
Copper	mg/kg	35.7	197	120	240	20.4	39.1	19.5	20.4	20.2	17.4	19.2	19.3	19.5	17.4	20.4	20.4	1.19	0.53	1.48
Iron	mg/kg	21,200	43,776	-	-	18,700	44,220	18,800	17,700	18,300	17,200	17,700	17,940	17,700	17,200	18,800	18,700	619	277	768
Lead	mg/kg	35	91	57	110	3.2	12.4	3.16	3.22	3.18	2.99	2.99	3.11	3.16	2.99	3.22	3.21	0.110	0.049	0.136
Lithium	mg/kg	-	-	-	-	8.7	44.2	8.7	8.5	8.7	8.2	7.8	8.4	8.5	7.8	8.7	8.7	0.38	0.17	0.48
Magnesium	mg/kg	-	-	-	-	5,658	11,200	5,330	5,300	5,740	4,970	4,950	5,258	5,300	4,950	5,740	5,658	323	144	401
Manganese	mg/kg	460	1,100	-	-	299	507	306	212	273	261	210	252	261	210	306	299	41.2	18.4	51.2
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0258	-	0.0259	0.0244	0.0232	0.0238	0.0256	0.0246	0.0244	0.0232	0.0259	0.0258	0.00115	0.00052	0.00143
Molybdenum	mg/kg	-	-	-	-	0.52	<0.50	0.53	0.50	<0.50	<0.50	<0.50	0.51	<0.50	<0.50	0.53	0.52	0.013	0.006	0.017
Nickel	mg/kg	16	75	-	-	24.0	58.0	21.6	21.8	24.5	20.7	19.7	21.7	21.6	19.7	24.5	24.0	1.79	0.80	2.23
Phosphorus	mg/kg	-	-	-	-	876	725	857	881	779	783	806	821	806	779	881	876	45.6	20.4	56.6
Potassium	mg/kg	-	-	-	-	736	3,598	740	710	720	640	700	702	710	640	740	736	37.7	16.9	46.8
Selenium	mg/kg	2	-	-	-	0.42	0.29	0.43	0.33	0.36	0.35	0.31	0.36	0.35	0.31	0.43	0.42	0.046	0.020	0.057
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Sodium	mg/kg	-	-	-	-	268	358	270	260	220	200	240	238	240	200	270	268	28.6	12.8	35.6
Strontium	mg/kg	-	-	-	-	39.9	91.6	40.1	39.2	38.1	36.8	37.2	38.3	38.1	36.8	40.1	39.9	1.37	0.61	1.71
Thallium	mg/kg	-	-	-	-	0.098	0.278	0.078	0.10	0.086	0.067	0.088	0.084	0.086	0.067	0.100	0.098	0.012	0.005	0.015
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	936	994	952	847	871	810	818	860	847	810	952	936	57.0	25.5	70.8
Uranium	mg/kg	-	-	-	-	0.673	1.63	0.686	0.596	0.609	0.620	0.592	0.621	0.609	0.592	0.686	0.673	0.0382	0.0171	0.0474
Vanadium	mg/kg	-	-	-	-	49.2	37.0	49.5	43.7	48.1	43.1	45.4	46.0	45.4	43.1	49.5	49.2	2.77	1.24	3.44
Zinc	mg/kg	123	315	200	380	47.6	81.3	44.7	46.1	48.0	42.4	42.2	44.7	44.7	42.2	48.0	47.6	2.47	1.10	3.07

[1] Reported TOC, TN, pH, and moisture data are based on bulk sediment. Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Reference 95th percentile was calculated using displayed metals data for the < 2mm sediment fraction, and using displayed TOC, pH, TN, particle size and moisture data. The 5th percentile is reported for pH.

[5] Summary statistics (95th percentile, mean, t*SE, and maximum) for reference area LRef2 are based only on data from replicates QUL-52-01 to QUL-52-03 due to high sand content in replicates QUL-52-04 and QUL-52-05 (> 90%).

(blue)	Value is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.
(orange)	Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Table E.45: Raw sediment quality data for Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Metals data are based on the < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference 95th Percentile [4]		Reference LRef2 (QUL-52)													
		TEL	PEL	Sensitive	Typical	LRef1	LRef2 [5]	QUL-52-01	QUL-52-02	QUL-52-03	QUL-52-04	QUL-52-05	Mean [5]	Median[5]	Minimum [5]	Maximum [5]	95th Percentile [5]	Standard Deviation [5]	Standard Error [5]	t*SE [5]
Date Sampled	-	-	-	-	-	-	-	16-Oct-14	16-Oct-14	16-Oct-14	17-Oct-14	17-Oct-14								
Physical Tests																				
Moisture	%	-	-	-	-	43.7	53.4	44.3	48.4	54.0	34.6	34.2	48.9	48.4	44.3	54.0	53.4	4.87	2.81	12.1
pH (1:2 soil:water)	pH	-	-	-	-	6.37	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Particle Size																				
% Gravel (>2mm)	%	-	-	-	-	1.8	0.1	<0.10	0.13	<0.10	<0.10	<0.10	0.11	<0.10	<0.10	0.13	0.13	0.017	0.010	0.043
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	66	59.0	62	32	19	93	90	38	32	19	62	59	22	13	55
% Silt (0.063mm - 4um)	%	-	-	-	-	42	76.4	36	61	78	6.9	9.2	59	61	36	78	76	21	12	52
% Clay (<4um)	%	-	-	-	-	4.9	6.3	1.7	6.7	3.4	0.52	0.50	3.9	3.4	1.7	6.7	6.3	2.5	1.5	6.3
Texture	-	-	-	-	-	-	-	Sandy loam	Silt loam	Silt loam	Sand	Sand	-	-	-	-	-	-	-	-
Leachable Anions & Nutrients																				
pH	pH	-	-	-	-	6.06	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anions and Nutrients																				
Total Nitrogen by LECO (TN)	%	-	-	-	-	0.071	0.138	0.085	0.112	0.141	0.034	0.043	0.113	0.112	0.085	0.141	0.138	0.028	0.016	0.070
Organic / Inorganic Carbon																				
Total Organic Carbon (TOC)	%	-	-	-	-	0.83	2.53	1.45	1.84	2.61	0.38	0.56	1.97	1.84	1.45	2.61	2.53	0.59	0.34	1.47
Metals																				
Aluminum	mg/kg	-	-	-	-	10,340	22,520	17,100	22,700	20,900	10,300	9,380	20,233	20,900	17,100	22,700	22,520	2,859	1,651	7,102
Antimony	mg/kg	-	-	-	-	0.22	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	3.91	2.29	1.91	2.06	2.31	1.20	1.42	2.09	2.06	1.91	2.31	2.29	0.202	0.117	0.502
Barium	mg/kg	-	-	-	-	94.6	71.5	33.9	73.1	57.4	16.5	14.2	54.8	57.4	33.9	73.1	71.5	19.7	11.4	49.0
Beryllium	mg/kg	-	-	-	-	0.26	0.62	0.42	0.64	0.47	0.27	0.27	0.51	0.47	0.42	0.64	0.62	0.12	0.067	0.29
Bismuth	mg/kg	-	-	-	-	<0.20	0.38	<0.20	0.39	0.27	<0.20	<0.20	0.29	0.27	<0.20	0.39	0.38	0.10	0.055	0.24
Boron	mg/kg	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.220	0.091	0.055	0.091	0.090	<0.050	<0.050	0.079	0.090	0.055	0.091	0.091	0.021	0.012	0.051
Calcium	mg/kg	-	-	-	-	5,960	11,035	4,450	11,300	8,650	3,410	3,080	8,133	8,650	4,450	11,300	11,035	3,454	1,994	8,581
Chromium	mg/kg	37.3	90	56	110	35.9	48.4	36.1	48.8	44.9	20.1	18.5	43.3	44.9	36.1	48.8	48.4	6.51	3.76	16.2
Cobalt	mg/kg	-	-	-	-	9.4	21.7	15.0	22.1	17.7	7.76	7.58	18.3	17.7	15.0	22.1	21.7	3.58	2.07	8.90
Copper	mg/kg	35.7	197	120	240	20.4	39.1	18.0	39.9	31.5	7.99	6.54	29.8	31.5	18.0	39.9	39.1	11.0	6.38	27.4
Iron	mg/kg	21,200	43,776	-	-	18,700	44,220	35,700	44,900	38,100	20,100	20,000	39,567	38,100	35,700	44,900	44,220	4,772	2,755	11,856
Lead	mg/kg	35	91	57	110	3.2	12.4	7.65	12.5	11.4	4.12	3.80	10.5	11.4	7.7	12.5	12.4	2.54	1.47	6.32
Lithium	mg/kg	-	-	-	-	8.7	44.2	29.4	44.7	40.0	18.5	17.2	38.0	40.0	29.4	44.7	44.2	7.84	4.52	19.5
Magnesium	mg/kg	-	-	-	-	5,658	11,200	8,290	11,300	10,300	4,720	4,430	9,963	10,300	8,290	11,300	11,200	1,533	885	3,808
Manganese	mg/kg	460	1,100	-	-	299	507	274	519	401	175	170	398	401	274	519	507	123	70.7	304
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0258	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum	mg/kg	-	-	-	-	0.52	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Nickel	mg/kg	16	75	-	-	24.0	58.0	39.2	59.0	49.1	21.2	20.5	49.1	49.1	39.2	59.0	58.0	9.90	5.72	24.6
Phosphorus	mg/kg	-	-	-	-	876	725	571	633	735	450	366	646	633	571	735	725	82.8	47.8	206
Potassium	mg/kg	-	-	-	-	736	3,598	1,650	3,680	2,860	830	650	2,730	2,860	1,650	3,680	3,598	1,021	590	2,537
Selenium	mg/kg	2	-	-	-	0.42	0.29	<0.20	0.27	0.29	<0.20	<0.20	0.25	0.27	<0.20	0.29	0.29	0.047	0.027	0.12
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Sodium	mg/kg	-	-	-	-	268	358	330	360	340	270	220	343	340	330	360	358	15.3	8.82	37.9
Strontium	mg/kg	-	-	-	-	39.9	91.6	61.9	92.3	85.4	48.9	37.0	79.9	85.4	61.9	92.3	91.6	15.9	9.20	39.6
Thallium	mg/kg	-	-	-	-	0.098	0.278	0.13	0.29	0.20	0.066	0.058	0.21	0.20	0.13	0.29	0.28	0.077	0.044	0.19
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	936	994	771	1,010	847	433	341	876	847	771	1,010	994	122	70.5	303
Uranium	mg/kg	-	-	-	-	0.673	1.63	0.933	1.58	1.64	0.658	0.572	1.38	1.58	0.93	1.64	1.63	0.392	0.226	0.974
Vanadium	mg/kg	-	-	-	-	49.2	37.0	27.6	37.5	32.8	14.8	13.0	32.6	32.8	27.6	37.5	37.0	4.95	2.86	12.3
Zinc	mg/kg	123	315	200	380	47.6	81.3	64.3	82.0	75.1	34.7	33.2	73.8	75.1	64.3	82.0	81.3	8.92	5.15	22.2

[1] Reported TOC, TN, pH, and moisture data are based on bulk sediment. Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Reference 95th percentile was calculated using displayed metals data for the < 2mm sediment fraction, and using displayed TOC, pH, TN, particle size and moisture data. The 5th percentile is reported for pH.

[5] Summary statistics (95th percentile, mean, t*SE, and maximum) for reference area LRef2 are based only on data from replicates QUL-52-01 to QUL-52-03 due to high sand content in replicates QUL-52-04 and QUL-52-05 (> 90%).

(blue) Value is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Table E.45: Raw sediment quality data for Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Metals data are based on the < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference 95th Percentile [4]		Exposed LNF1 (QUL-45)												
		TEL	PEL	Sensitive	Typical	LRef1	LRef2 [5]	QUL-45-01	QUL-45-02	QUL-45-03	QUL-45-04	QUL-45-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled	-	-	-	-	-	-	-	13-Aug-14	13-Aug-14	15-Aug-14	16-Aug-14	16-Aug-14							
Physical Tests																			
Moisture	%	-	-	-	-	43.7	53.4	30.5	31.1	41.0	28.8	31.4	32.6	31.1	28.8	41.0	4.82	2.16	5.99
pH (1:2 soil:water)	pH	-	-	-	-	6.37	-	8.72	8.65	8.25	8.47	8.30	8.48	8.47	8.25	8.72	0.21	0.093	0.26
Particle Size																			
% Gravel (>2mm)	%	-	-	-	-	1.8	0.1	<0.10	5.3	<0.10	<0.10	<0.10	1.1	<0.10	<0.10	5.3	2.3	1.0	2.9
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	66	59.0	50	46	49	50	51	49	50	46	51	2.1	1.0	2.7
% Silt (0.063mm - 4um)	%	-	-	-	-	42	76.4	42	38	43	43	43	42	43	38	43	2.0	0.9	2.5
% Clay (<4um)	%	-	-	-	-	4.9	6.3	8.1	11	8.3	7.5	5.7	8.1	8.1	5.7	11	1.8	0.8	2.3
Texture	-	-	-	-	-	-	-	Sandy loam	Loam	Sandy loam	Sandy loam	Sandy loam	-	-	-	-	-	-	-
Leachable Anions & Nutrients																			
pH	pH	-	-	-	-	6.06	-	8.47	8.46	8.27	8.93	8.50	8.53	8.47	8.27	8.93	0.24	0.11	0.30
Anions and Nutrients																			
Total Nitrogen by LECO (TN)	%	-	-	-	-	0.071	0.138	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0
Organic / Inorganic Carbon																			
Total Organic Carbon (TOC)	%	-	-	-	-	0.83	2.53	0.25	0.30	0.24	0.12	0.21	0.22	0.24	0.12	0.30	0.067	0.030	0.083
Metals																			
Aluminum	mg/kg	-	-	-	-	10,340	22,520	15,100	15,800	15,600	14,800	13,800	15,020	15,100	13,800	15,800	789	353	979
Antimony	mg/kg	-	-	-	-	0.22	<0.10	0.38	0.41	0.44	0.35	0.34	0.38	0.38	0.34	0.44	0.042	0.019	0.052
Arsenic	mg/kg	5.9	17	11	20	3.91	2.29	10.9	12.0	11.1	10.6	9.9	**10.9**	**10.9**	**9.9**	**12.0**	0.78	0.35	0.97
Barium	mg/kg	-	-	-	-	94.6	71.5	144	147	163	155	136	149	147	136	163	10	5	12.9
Beryllium	mg/kg	-	-	-	-	0.26	0.62	0.64	0.64	0.62	0.57	0.50	0.59	0.62	0.50	0.64	0.060	0.027	0.074
Bismuth	mg/kg	-	-	-	-	<0.20	0.38	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Boron	mg/kg	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.220	0.091	0.128	0.145	0.143	0.205	0.118	0.148	0.143	0.118	0.205	0.0338	0.0151	0.0420
Calcium	mg/kg	-	-	-	-	5,960	11,035	23,300	23,400	22,900	23,200	20,800	22,720	23,200	20,800	23,400	1,089	487	1,353
Chromium	mg/kg	37.3	90	56	110	35.9	48.4	15.7	20.6	14.4	11.5	12.6	15.0	14.4	11.5	20.6	3.54	1.58	4.40
Cobalt	mg/kg	-	-	-	-	9.4	21.7	15.3	16.4	17.3	15.6	13.9	15.7	15.6	13.9	17.3	1.27	0.57	1.58
Copper	mg/kg	35.7	197	120	240	20.4	39.1	677	719	734	829	681	**728**	**719**	**677**	**829**	61.5	27.5	76.3
Iron	mg/kg	21,200	43,776	-	-	18,700	44,220	44,500	43,000	45,600	47,700	43,800	**44,920**	**44,500**	43,000	**47,700**	1,824	816	2,264
Lead	mg/kg	35	91	57	110	3.2	12.4	4.71	4.98	5.00	5.23	4.63	4.91	4.98	4.63	5.23	0.24	0.11	0.30
Lithium	mg/kg	-	-	-	-	8.7	44.2	15.3	16.0	14.9	15.2	13.3	14.9	15.2	13.3	16.0	1.00	0.45	1.24
Magnesium	mg/kg	-	-	-	-	5,658	11,200	9,190	9,790	9,330	9,350	8,240	9,180	9,330	8,240	9,790	572	256	710
Manganese	mg/kg	460	1,100	-	-	299	507	574	633	662	601	531	**600**	**601**	**531**	**662**	51	23	63.2
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0258	-	0.0844	0.0851	-	-	-	0.0848	0.0848	0.0844	0.0851	0.0005	0.0003	0.0044
Molybdenum	mg/kg	-	-	-	-	0.52	<0.50	4.01	3.53	3.49	3.84	3.16	3.61	3.53	3.16	4.01	0.330	0.148	0.410
Nickel	mg/kg	16	75	-	-	24.0	58.0	10.7	10.3	11.1	9.3	9.7	10.2	10.3	9.3	11.1	0.73	0.33	0.91
Phosphorus	mg/kg	-	-	-	-	876	725	1,180	1,240	1,230	1,270	1,140	1,212	1,230	1,140	1,270	51.7	23.1	64.1
Potassium	mg/kg	-	-	-	-	736	3,598	1,340	1,370	1,550	1,340	1,300	1,380	1,340	1,300	1,550	98.2	43.9	122
Selenium	mg/kg	2	-	-	-	0.42	0.29	0.84	1.03	1.01	1.00	0.89	0.95	1.00	0.84	1.03	0.084	0.037	0.10
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	0.32	0.34	0.33	0.37	0.31	0.33	0.33	0.31	0.37	0.023	0.010	0.029
Sodium	mg/kg	-	-	-	-	268	358	920	920	1,010	930	940	944	930	920	1,010	37.8	16.9	46.9
Strontium	mg/kg	-	-	-	-	39.9	91.6	157	160	171	143	142	155	157	142	171	12.2	5.46	15.2
Thallium	mg/kg	-	-	-	-	0.098	0.278	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	936	994	1,270	1,280	1,310	1,120	1,130	1,222	1,270	1,120	1,310	89.8	40.2	112
Uranium	mg/kg	-	-	-	-	0.673	1.63	0.924	0.934	0.874	0.863	0.783	0.876	0.874	0.783	0.934	0.0602	0.0269	0.0747
Vanadium	mg/kg	-	-	-	-	49.2	37.0	169	160	171	175	163	168	169	160	175	6.07	2.71	7.53
Zinc	mg/kg	123	315	200	380	47.6	81.3	52.8	56.4	50.6	62.1	47.3	53.8	52.8	47.3	62.1	5.68	2.54	7.05

[1] Reported TOC, TN, pH, and moisture data are based on bulk sediment. Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Reference 95th percentile was calculated using displayed metals data for the < 2mm sediment fraction, and using displayed TOC, pH, TN, particle size and moisture data. The 5th percentile is reported for pH.

[5] Summary statistics (95th percentile, mean, t*SE, and maximum) for reference area LRef2 are based only on data from replicates QUL-52-01 to QUL-52-03 due to high sand content in replicates QUL-52-04 and QUL-52-05 (> 90%).

(blue) Value is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Table E.45: Raw sediment quality data for Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Metals data are based on the < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference 95th Percentile [4]		Exposed LNF2 (QUL-49)											
		TEL	PEL	Sensitive	Typical	LRef1	LRef2 [5]	QUL-49-01	QUL-49-02	QUL-49-03	QUL-49-04	QUL-49-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled	-	-	-	-	-	-	-	18-Aug-14	20-Aug-14	20-Aug-14	23-Aug-14	23-Aug-14							
Physical Tests																			
Moisture	%	-	-	-	-	43.7	53.4	52.1	47.3	51.6	40.9	40.2	46.4	47.3	40.2	52.1	5.7	2.5	7.05
pH (1:2 soil:water)	pH	-	-	-	-	6.37	-	-	-	-	8.41	8.54	8.48	8.48	8.41	8.54	0.09	0.06	0.83
Particle Size																			
% Gravel (>2mm)	%	-	-	-	-	1.8	0.1	<0.10	<0.10	<0.10	0.17	<0.10	0.11	<0.10	<0.10	0.17	0.031	0.014	0.039
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	66	59.0	6.7	9.6	5.5	5.5	15	8.4	6.7	5.5	15	4.0	1.8	4.9
% Silt (0.063mm - 4um)	%	-	-	-	-	42	76.4	87	84	85	89	80	85	85	80	89	3.4	1.5	4.2
% Clay (<4um)	%	-	-	-	-	4.9	6.3	6.6	6.8	9.9	5.7	5.3	6.8	6.6	5.3	9.9	1.8	0.81	2.2
Texture	-	-	-	-	-	-	-	Silt	Silt	Silt	Silt	Silt loam / Silt	-	-	-	-	-	-	-
Leachable Anions & Nutrients																			
pH	pH	-	-	-	-	6.06	-	6.78	6.82	6.86	7.27	7.44	7.03	6.86	6.78	7.44	0.30	0.13	0.37
Anions and Nutrients																			
Total Nitrogen by LECO (TN)	%	-	-	-	-	0.071	0.138	0.191	0.132	0.111	0.037	0.029	0.100	0.111	0.029	0.191	0.068	0.030	0.084
Organic / Inorganic Carbon																			
Total Organic Carbon (TOC)	%	-	-	-	-	0.83	2.53	5.08	3.38	3.30	0.93	0.77	2.69	3.30	0.77	5.08	1.83	0.82	2.27
Metals																			
Aluminum	mg/kg	-	-	-	-	10,340	22,520	15,100	15,200	16,400	15,600	14,700	15,400	15,200	14,700	16,400	644	288	800
Antimony	mg/kg	-	-	-	-	0.22	<0.10	0.39	0.38	0.39	0.39	0.35	0.38	0.39	0.35	0.39	0.017	0.008	0.022
Arsenic	mg/kg	5.9	17	11	20	3.91	2.29	9.86	9.56	10.4	11.0	10.5	**10.3**	**10.4**	**9.6**	**11.0**	0.56	0.25	0.70
Barium	mg/kg	-	-	-	-	94.6	71.5	172	172	183	179	170	175	172	170	183	5.54	2.48	6.88
Beryllium	mg/kg	-	-	-	-	0.26	0.62	0.54	0.53	0.57	0.53	0.52	0.54	0.53	0.52	0.57	0.019	0.0086	0.024
Bismuth	mg/kg	-	-	-	-	<0.20	0.38	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Boron	mg/kg	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.220	0.091	0.224	0.186	0.189	0.132	0.143	0.175	0.186	0.132	0.224	0.0374	0.0167	0.0464
Calcium	mg/kg	-	-	-	-	5,960	11,035	22,700	22,200	24,000	24,600	23,200	23,340	23,200	22,200	24,600	969	433	1,202
Chromium	mg/kg	37.3	90	56	110	35.9	48.4	17.4	17.8	16.7	16.1	16.8	17.0	16.8	16.1	17.8	0.66	0.29	0.82
Cobalt	mg/kg	-	-	-	-	9.4	21.7	13.8	14.4	14.9	14.4	15.2	14.5	14.4	13.8	15.2	0.54	0.24	0.67
Copper	mg/kg	35.7	197	120	240	20.4	39.1	419	438	487	472	495	**462**	**472**	**419**	**495**	32.6	14.6	40.4
Iron	mg/kg	21,200	43,776	-	-	18,700	44,220	43,400	46,100	39,300	46,600	55,100	**46,100**	**46,100**	39,300	**55,100**	5,805	2,596	7,206
Lead	mg/kg	35	91	57	110	3.2	12.4	5.63	5.51	5.82	5.10	5.02	5.42	5.51	5.02	5.82	0.344	0.154	0.428
Lithium	mg/kg	-	-	-	-	8.7	44.2	14.1	14.1	16.0	14.4	13.6	14.4	14.1	13.6	16.0	0.918	0.411	1.14
Magnesium	mg/kg	-	-	-	-	5,658	11,200	8,180	8,530	9,660	9,010	8,550	8,786	8,550	8,180	9,660	571	255	708
Manganese	mg/kg	460	1,100	-	-	299	507	650	637	647	582	563	**616**	**637**	**563**	**650**	40.4	18.1	50.1
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0258	-	-	-	-	0.0629	0.0674	0.0652	0.0652	0.0629	0.0674	0.0032	0.0023	0.029
Molybdenum	mg/kg	-	-	-	-	0.52	<0.50	3.16	2.98	3.25	2.83	2.94	3.03	2.98	2.83	3.25	0.170	0.076	0.211
Nickel	mg/kg	16	75	-	-	24.0	58.0	14.3	14.6	14.3	12.5	12.2	13.6	14.3	12.2	14.6	1.13	0.51	1.41
Phosphorus	mg/kg	-	-	-	-	876	725	1,150	1,080	1,130	1,280	1,330	1,194	1,150	1,080	1,330	106	47.4	132
Potassium	mg/kg	-	-	-	-	736	3,598	1,440	1,410	1,570	1,460	1,380	1,452	1,440	1,380	1,570	72.6	32.5	90.1
Selenium	mg/kg	2	-	-	-	0.42	0.29	0.81	0.76	0.89	0.73	0.75	0.79	0.76	0.73	0.89	0.064	0.029	0.080
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	0.25	0.25	0.25	0.23	0.23	0.24	0.25	0.23	0.25	0.011	0.0049	0.014
Sodium	mg/kg	-	-	-	-	268	358	760	790	810	820	850	806	810	760	850	33.6	15.0	41.7
Strontium	mg/kg	-	-	-	-	39.9	91.6	165	159	168	155	147	159	159	147	168	8.32	3.72	10.3
Thallium	mg/kg	-	-	-	-	0.098	0.278	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	936	994	1,230	1,200	1,290	1,500	1,350	1,314	1,290	1,200	1,500	119	53.2	148
Uranium	mg/kg	-	-	-	-	0.673	1.63	1.15	1.09	1.20	1.06	0.916	1.08	1.09	0.92	1.20	0.108	0.048	0.134
Vanadium	mg/kg	-	-	-	-	49.2	37.0	153	161	136	171	207	166	161	136	207	26.5	11.8	32.8
Zinc	mg/kg	123	315	200	380	47.6	81.3	54.8	54.0	56.8	52.1	52.2	54.0	54.0	52.1	56.8	1.96	0.88	2.43

[1] Reported TOC, TN, pH, and moisture data are based on bulk sediment. Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Reference 95th percentile was calculated using displayed metals data for the < 2mm sediment fraction, and using displayed TOC, pH, TN, particle size and moisture data. The 5th percentile is reported for pH.

[5] Summary statistics (95th percentile, mean, t*SE, and maximum) for reference area LRef2 are based only on data from replicates QUL-52-01 to QUL-52-03 due to high sand content in replicates QUL-52-04 and QUL-52-05 (> 90%).

(Blue) Values is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.

(Orange) Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Table E.45: Raw sediment quality data for Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Metals data are based on the < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference 95th Percentile [4]		Exposed LFF (QUL-47)											
		TEL	PEL	Sensitive	Typical	LRef1	LRef2 [5]	QUL-47-01	QUL-47-02	QUL-47-03	QUL-47-04	QUL-47-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled	-	-	-	-	-	-	-	27-Aug-14	27-Aug-14	4-Sep-14	4-Sep-14	4-Sep-14							
Physical Tests																			
Moisture	%	-	-	-	-	43.7	53.4	62.3	40.0	43.3	42.5	52.0	48.0	43.3	40.0	62.3	9.2	4.1	11.4
pH (1:2 soil:water)	pH	-	-	-	-	6.37	-	6.86	6.93	6.53	6.76	7.14	6.84	6.86	6.53	7.14	0.22	0.10	0.28
Particle Size																			
% Gravel (>2mm)	%	-	-	-	-	1.8	0.1	1.70	1.45	3.62	<0.10	0.49	1.47	1.45	<0.10	3.6	1.37	0.61	1.70
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	66	59.0	62	80	63	59	65	66	63	59	80	8.3	3.7	10
% Silt (0.063mm - 4um)	%	-	-	-	-	42	76.4	33	17	31	39	30	30	31	17	39	8.0	3.6	10
% Clay (<4um)	%	-	-	-	-	4.9	6.3	3.7	1.5	2.4	2.1	4.5	2.9	2.4	1.5	4.5	1.2	0.5	1.5
Texture	-	-	-	-	-	-	-	Sandy loam	Sand	Loamy sand	Sandy loam	Sandy loam / Loamy sand	-	-	-	-	-	-	-
Leachable Anions & Nutrients																			
pH	pH	-	-	-	-	6.06	-	-	-	-	-	-	-	-	-	-	-	-	-
Anions and Nutrients																			
Total Nitrogen by LECO (TN)	%	-	-	-	-	0.071	0.138	0.222	0.057	0.061	0.057	0.113	0.102	0.061	0.057	0.222	0.071	0.032	0.088
Organic / Inorganic Carbon																			
Total Organic Carbon (TOC)	%	-	-	-	-	0.83	2.53	6.73	1.19	0.90	0.76	2.09	2.33	1.19	0.76	6.73	2.51	1.12	3.12
Metals																			
Aluminum	mg/kg	-	-	-	-	10,340	22,520	9,890	14,800	15,200	13,000	10,800	12,738	13,000	9,890	15,200	2,358	1,055	2,928
Antimony	mg/kg	-	-	-	-	0.22	<0.10	0.41	0.15	0.20	0.19	0.19	0.23	0.19	0.15	0.41	0.10	0.046	0.13
Arsenic	mg/kg	5.9	17	11	20	3.91	2.29	3.11	2.13	4.88	4.39	2.36	3.37	3.11	2.13	4.88	1.22	0.545	1.51
Barium	mg/kg	-	-	-	-	94.6	71.5	50.0	32.8	88.3	78.6	42.2	58.4	50.0	32.8	88.3	23.9	10.7	29.7
Beryllium	mg/kg	-	-	-	-	0.26	0.62	0.34	0.32	0.37	0.31	0.28	0.32	0.32	0.28	0.37	0.034	0.015	0.042
Bismuth	mg/kg	-	-	-	-	<0.20	0.38	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Boron	mg/kg	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.220	0.091	0.299	0.118	0.107	0.088	0.134	0.149	0.118	0.088	0.299	0.085	0.038	0.106
Calcium	mg/kg	-	-	-	-	5,960	11,035	11,700	11,300	9,580	8,540	8,030	9,830	9,580	8,030	11,700	1,630	729	2,023
Chromium	mg/kg	37.3	90	56	110	35.9	48.4	26.0	28.6	43.9	42.4	24.3	33.0	28.6	24.3	43.9	9.37	4.19	11.6
Cobalt	mg/kg	-	-	-	-	9.4	21.7	8.60	12.1	10.8	9.88	8.78	10.0	9.88	8.60	12.1	1.46	0.65	1.81
Copper	mg/kg	35.7	197	120	240	20.4	39.1	28.0	24.0	27.7	26.0	20.8	25.3	26.0	20.8	28.0	2.98	1.33	3.70
Iron	mg/kg	21,200	43,776	-	-	18,700	44,220	17,300	23,900	26,200	25,300	19,100	22,360	23,900	17,300	26,200	3,937	1,761	4,887
Lead	mg/kg	35	91	57	110	3.2	12.4	4.77	3.81	5.96	3.76	4.24	4.51	4.24	3.76	5.96	0.908	0.406	1.13
Lithium	mg/kg	-	-	-	-	8.7	44.2	11.1	10.1	11.7	11.3	11.3	11.1	11.3	10.1	11.7	0.60	0.27	0.74
Magnesium	mg/kg	-	-	-	-	5,658	11,200	4,960	8,180	6,840	6,360	5,540	6,376	6,360	4,960	8,180	1,242	556	1,542
Manganese	mg/kg	460	1,100	-	-	299	507	251	312	321	334	271	298	312	251	334	35.2	15.7	43.7
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0258	-	0.0694	0.0414	0.0746	0.0360	0.0336	0.0510	0.0414	0.0336	0.075	0.0195	0.0087	0.0242
Molybdenum	mg/kg	-	-	-	-	0.52	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Nickel	mg/kg	16	75	-	-	24.0	58.0	24.1	23.4	25.5	23.2	21.3	23.5	23.4	21.3	25.5	1.52	0.68	1.89
Phosphorus	mg/kg	-	-	-	-	876	725	392	508	767	823	500	598	508	392	823	187	83.5	232
Potassium	mg/kg	-	-	-	-	736	3,598	630	480	1,070	940	660	756	660	480	1,070	242	108	300
Selenium	mg/kg	2	-	-	-	0.42	0.29	1.36	0.25	0.21	<0.20	0.37	0.48	0.25	0.20	1.4	0.50	0.22	0.62
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	0.10	<0.10	<0.10	<0.10	<0.10	0.10	<0.10	<0.10	0.10	0	0	0
Sodium	mg/kg	-	-	-	-	268	358	130	220	520	430	150	290	220	130	520	175	78.3	217
Strontium	mg/kg	-	-	-	-	39.9	91.6	55.8	53.2	110	97.9	37.7	70.9	55.8	37.7	110	31.2	14.0	38.8
Thallium	mg/kg	-	-	-	-	0.098	0.278	0.054	<0.050	<0.050	<0.050	<0.050	0.051	<0.050	<0.050	0.054	0.0018	0.0008	0.0022
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	936	994	802	1,400	1,090	1,040	902	1,047	1,040	802	1,400	228	102	283
Uranium	mg/kg	-	-	-	-	0.673	1.63	1.29	0.639	0.676	0.602	0.627	0.767	0.639	0.602	1.29	0.294	0.131	0.365
Vanadium	mg/kg	-	-	-	-	49.2	37.0	46.1	90.9	88.4	80.5	52.7	71.7	80.5	46.1	90.9	20.9	9.3	25.9
Zinc	mg/kg	123	315	200	380	47.6	81.3	36.8	39.8	44.8	40.9	35.3	39.5	39.8	35.3	44.8	3.71	1.66	4.61

[1] Reported TOC, TN, pH, and moisture data are based on bulk sediment. Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Reference 95th percentile was calculated using displayed metals data for the < 2mm sediment fraction, and using displayed TOC, pH, TN, particle size and moisture data. The 5th percentile is reported for pH.

[5] Summary statistics (95th percentile, mean, t*SE, and maximum) for reference area LRef2 are based only on data from replicates QUL-52-01 to QUL-52-03 due to high sand content in replicates QUL-52-04 and QUL-52-05 (> 90%).

Values is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Table E.45: Raw sediment quality data for Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Metals data are based on the < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference 95th Percentile [4]		Exposed LFFF (QUL-48)											
		TEL	PEL	Sensitive	Typical	LRef1	LRef2 [5]	QUL-48-01	QUL-48-02	QUL-48-03	QUL-48-04	QUL-48-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled	-	-	-	-	-	-	-	6-Sep-14	7-Sep-14	7-Sep-14	7-Sep-14	7-Sep-14							
Physical Tests																			
Moisture	%	-	-	-	-	43.7	53.4	66.1	85.9	70.5	75.4	70.1	73.6	70.5	66.1	85.9	7.63	3.41	9.47
pH (1:2 soil:water)	pH	-	-	-	-	6.37	-	6.16	6.57	6.37	6.65	6.13	6.38	6.37	6.13	6.65	0.23	0.10	0.29
Particle Size																			
% Gravel (>2mm)	%	-	-	-	-	1.8	0.1	12.80	0.13	4.16	4.76	4.37	5.2	4.4	0.13	13	4.62	2.07	5.74
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	66	59.0	40.0	12.2	38.2	33.5	51.9	35	38	12	52	14.5	6.49	18.0
% Silt (0.063mm - 4um)	%	-	-	-	-	42	76.4	43.4	74.9	55.0	56.7	41.0	54	55	41	75	13.5	6.03	16.7
% Clay (<4um)	%	-	-	-	-	4.9	6.3	3.87	12.80	2.69	4.99	2.76	5.4	3.9	2.7	13	4.23	1.89	5.25
Texture	-	-	-	-	-	-	-	Silt loam / Sandy loam	Silt loam	Silt loam	Silt loam	Sandy loam	-	-	-	-	-	-	-
Leachable Anions & Nutrients																			
pH	pH	-	-	-	-	6.06	-	-	-	-	-	-	-	-	-	-	-	-	-
Anions and Nutrients																			
Total Nitrogen by LECO (TN)	%	-	-	-	-	0.071	0.138	0.245	0.935	0.294	0.614	0.323	0.482	0.323	0.245	0.935	0.291	0.130	0.362
Organic / Inorganic Carbon																			
Total Organic Carbon (TOC)	%	-	-	-	-	0.83	2.53	3.29	11.1	5.90	10.7	5.79	7.36	5.90	3.29	11.1	3.40	1.52	4.22
Metals																			
Aluminum	mg/kg	-	-	-	-	10,340	22,520	20,000	23,000	18,400	15,800	14,900	18,420	18,400	14,900	23,000	3,268	1,462	4,058
Antimony	mg/kg	-	-	-	-	0.22	<0.10	1.29	1.34	0.47	0.54	0.51	0.83	0.54	0.47	1.3	0.44	0.20	0.55
Arsenic	mg/kg	5.9	17	11	20	3.91	2.29	18.5	7.42	5.72	7.45	6.19	**9.06**	**7.42**	5.72	**18.5**	5.33	2.39	6.62
Barium	mg/kg	-	-	-	-	94.6	71.5	58.7	270	89.9	80.1	54.1	111	80.1	54.1	270	90.4	40.4	112
Beryllium	mg/kg	-	-	-	-	0.26	0.62	0.41	0.62	0.46	0.37	0.34	0.44	0.41	0.34	0.62	0.11	0.049	0.14
Bismuth	mg/kg	-	-	-	-	<0.20	0.38	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Boron	mg/kg	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.220	0.091	0.456	0.882	0.483	0.312	0.280	0.483	0.456	0.280	**0.882**	0.240	0.107	0.298
Calcium	mg/kg	-	-	-	-	5,960	11,035	9,510	7,560	10,400	9,810	10,600	9,576	9,810	7,560	10,600	1,209	541	1,501
Chromium	mg/kg	37.3	90	56	110	35.9	48.4	63.0	28.4	53.7	45.8	44.2	47.0	45.8	28.4	**63.0**	12.8	5.7	15.9
Cobalt	mg/kg	-	-	-	-	9.4	21.7	20.6	10.3	13.8	13.9	12.5	14.2	13.8	10.3	20.6	3.85	1.72	4.78
Copper	mg/kg	35.7	197	120	240	20.4	39.1	79.7	136	58.1	44.4	34.5	**70.5**	**58.1**	34.5	**136**	40.3	18.0	50.1
Iron	mg/kg	21,200	43,776	-	-	18,700	44,220	37,400	24,900	27,600	26,300	27,500	28,740	27,500	24,900	37,400	4,963	2,220	6,162
Lead	mg/kg	35	91	57	110	3.2	12.4	7.84	10.2	10.3	7.74	6.60	8.54	7.84	6.60	10.3	1.64	0.73	2.03
Lithium	mg/kg	-	-	-	-	8.7	44.2	17.5	17.2	19.4	15.3	14.8	16.8	17.2	14.8	19.4	1.85	0.83	2.29
Magnesium	mg/kg	-	-	-	-	5,658	11,200	14,100	4,750	9,580	8,870	9,660	9,392	9,580	4,750	14,100	3,320	1,485	4,122
Manganese	mg/kg	460	1,100	-	-	299	507	469	291	294	361	376	358	361	291	469	72.9	32.6	90.5
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0258	-	0.0608	0.113	0.0836	0.106	0.0510	0.0829	0.0836	0.0510	0.113	0.0271	0.0121	0.0337
Molybdenum	mg/kg	-	-	-	-	0.52	<0.50	0.79	1.23	1.35	0.77	0.68	0.96	0.79	0.68	1.35	0.30	0.14	0.38
Nickel	mg/kg	16	75	-	-	24.0	58.0	39.2	37.5	51.7	42.6	40.3	42.3	40.3	37.5	51.7	5.59	2.50	6.94
Phosphorus	mg/kg	-	-	-	-	876	725	774	879	722	713	737	765	737	713	879	67.8	30.3	84.2
Potassium	mg/kg	-	-	-	-	736	3,598	900	1,580	1,310	830	860	1,096	900	830	1,580	334	149	414
Selenium	mg/kg	2	-	-	-	0.42	0.29	0.85	0.58	3.20	0.92	1.26	1.4	0.92	0.58	**3.2**	1.06	0.47	1.31
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	0.27	0.81	0.16	0.13	0.11	0.30	0.16	0.11	**0.81**	0.29	0.13	0.36
Sodium	mg/kg	-	-	-	-	268	358	200	180	210	250	170	202	200	170	250	31.1	13.9	38.7
Strontium	mg/kg	-	-	-	-	39.9	91.6	49.7	67.5	82.0	74.2	57.0	66.1	67.5	49.7	82.0	13.0	5.8	16.1
Thallium	mg/kg	-	-	-	-	0.098	0.278	0.087	0.149	0.129	0.099	0.078	0.11	0.099	0.078	0.15	0.0298	0.0133	0.0369
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	936	994	1,330	79	834	888	1,130	852	888	78.8	1,330	476	213	591
Uranium	mg/kg	-	-	-	-	0.673	1.63	0.821	1.27	1.53	1.00	1.41	1.21	1.27	0.82	1.53	0.29	0.13	0.36
Vanadium	mg/kg	-	-	-	-	49.2	37.0	102	50.1	60.7	70.8	70.2	70.8	70.2	50.1	102	19.4	8.67	24.1
Zinc	mg/kg	123	315	200	380	47.6	81.3	86.3	152	75.2	66.5	59.6	87.9	75.2	59.6	**152**	37.2	16.6	46.2

[1] Reported TOC, TN, pH, and moisture data are based on bulk sediment. Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Reference 95th percentile was calculated using displayed metals data for the < 2mm sediment fraction, and using displayed TOC, pH, TN, particle size and moisture data. The 5th percentile is reported for pH.

[5] Summary statistics (95th percentile, mean, t*SE, and maximum) for reference area LRef2 are based only on data from replicates QUL-52-01 to QUL-52-03 due to high sand content in replicates QUL-52-04 and QUL-52-05 (> 90%).

(Blue) Values is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.

(Orange) Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Table E.46: Raw sediment quality data for Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Data are based on the < 63µm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference 95th Percentile [4]		Reference LRef1 (QUL-51)												
		TEL	PEL	Sensitive	Typical	LRef1	LRef2	QUL-51-01	QUL-51-02	QUL-51-03	QUL-51-04	QUL-51-05	Mean	Median	Minimum	Maximum	95th Percentile	Standard Deviation	Standard Error	t*SE
Date Sampled		-	-	-	-			26-Aug-14	24-Aug-14	25-Aug-14	25-Aug-14	26-Aug-14								
Physical Tests																				
pH (1:2 soil:water)	pH	-	-	-	-	6.32	6.40	6.60	6.32	6.63	6.81	6.32	6.54	6.60	6.32	6.81	6.32	0.213	0.095	0.264
Organic / Inorganic Carbon																				
Total Organic Carbon	%	-	-	-	-	1.35	1.92	1.23	0.91	1.04	1.38	1.03	1.12	1.04	0.91	1.38	1.35	0.186	0.083	0.231
Metals																				
Aluminum	mg/kg	-	-	-	-	14,760	25,540	14,600	12,300	12,900	14,800	11,700	13,260	12,900	11,700	14,800	14,760	1,383	619	1,717
Antimony	mg/kg	-	-	-	-	0.36	<0.10	0.37	0.26	0.26	0.33	0.26	0.30	0.26	0.26	0.37	0.36	0.051	0.023	0.064
Arsenic	mg/kg	5.9	17	11	20	4.92	2.54	4.90	3.30	3.56	4.92	3.71	4.08	3.71	3.30	4.92	4.92	0.77	0.35	0.96
Barium	mg/kg	-	-	-	-	133	77	126	135	114	124	120	124	124	114	135	133	7.76	3.47	9.63
Beryllium	mg/kg	-	-	-	-	0.39	0.69	0.37	0.34	0.33	0.40	0.31	0.35	0.34	0.31	0.40	0.39	0.035	0.016	0.044
Bismuth	mg/kg	-	-	-	-	0.14	0.47	0.14	<0.10	<0.10	0.12	<0.10	0.11	<0.10	<0.10	0.14	0.14	0.018	0.008	0.022
Boron	mg/kg	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.351	0.114	0.341	0.286	0.311	0.354	0.275	0.313	0.311	0.275	0.354	0.351	0.0341	0.0152	0.0423
Calcium	mg/kg	-	-	-	-	7,736	14,400	7,760	6,690	6,970	7,640	6,620	7,136	6,970	6,620	7,760	7,736	533	238	662
Chromium	mg/kg	37.3	90	56	110	54.2	58.1	53.6	46.3	46.1	54.4	47.3	49.5	47.3	46.1	54.4	54.2	4.11	1.84	5.10
Cobalt	mg/kg	-	-	-	-	11.9	24.2	11.5	8.99	9.90	12.0	8.99	10.3	9.9	9.0	12.0	11.9	1.41	0.63	1.75
Copper	mg/kg	35.7	197	120	240	34.8	49.4	33.1	26.9	28.7	35.2	27.4	30.3	28.7	26.9	35.2	34.8	3.69	1.65	4.58
Iron	mg/kg	21,200	43,776	-	-	26,180	48,160	25,700	21,500	22,000	26,300	22,900	23,680	22,900	21,500	26,300	26,180	2,187	978	2,715
Lead	mg/kg	35	91	57	110	6.01	14.6	5.78	4.72	4.99	6.07	4.80	5.27	4.99	4.72	6.07	6.01	0.613	0.274	0.761
Lithium	mg/kg	-	-	-	-	13.2	45.8	12.4	10.5	11.1	13.4	9.90	11.5	11.1	9.9	13.4	13.2	1.43	0.64	1.77
Magnesium	mg/kg	-	-	-	-	6,950	12,320	6,790	5,980	6,170	6,990	5,870	6,360	6,170	5,870	6,990	6,950	501	224	621
Manganese	mg/kg	460	1,100	-	-	365	529	364	254	298	365	264	309	298	254	365	365	53.2	23.8	66.1
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0457	0.0171	0.0403	0.0316	0.0354	0.0470	0.0340	0.0377	0.0354	0.0316	0.0470	0.0457	0.0061	0.0027	0.0076
Molybdenum	mg/kg	-	-	-	-	0.86	0.44	0.87	0.82	0.69	0.83	0.70	0.78	0.82	0.69	0.87	0.86	0.082	0.037	0.10
Nickel	mg/kg	16	75	-	-	33.1	69.1	32.6	26.3	28.1	33.2	26.2	29.3	28.1	26.2	33.2	33.1	3.40	1.52	4.22
Phosphorus	mg/kg	-	-	-	-	1,230	1,114	1,230	1,040	1,080	1,100	1,230	1,136	1,100	1,040	1,230	1,230	88.5	39.6	110
Potassium	mg/kg	-	-	-	-	1,312	4,328	1,280	950	1,060	1,320	990	1,120	1,060	950	1,320	1,312	170	75.8	211
Selenium	mg/kg	2	-	-	-	0.70	0.32	0.70	0.48	0.52	0.70	0.52	0.58	0.52	0.48	0.70	0.70	0.11	0.05	0.13
Silver	mg/kg	0.5	-	-	-	0.166	0.124	0.152	0.130	0.151	0.169	0.120	0.144	0.151	0.120	0.169	0.166	0.0194	0.0087	0.0241
Sodium	mg/kg	-	-	-	-	406	424	410	390	370	390	370	386	390	370	410	406	16.7	7.5	20.8
Strontium	mg/kg	-	-	-	-	70.4	114	70.6	58.4	62.2	69.5	55.8	63.3	62.2	55.8	70.6	70.4	6.58	2.94	8.17
Thallium	mg/kg	-	-	-	-	0.148	0.310	0.153	0.119	0.110	0.130	0.102	0.123	0.119	0.102	0.153	0.148	0.0198	0.0089	0.025
Tin	mg/kg	-	-	-	-	0.40	0.56	0.40	0.37	0.34	0.38	0.28	0.35	0.37	0.28	0.40	0.40	0.047	0.021	0.058
Titanium	mg/kg	-	-	-	-	1,084	1,071	1,090	962	961	1,060	876	990	962	876	1,090	1,084	85.9	38.4	107
Uranium	mg/kg	-	-	-	-	1.15	1.95	1.13	0.855	0.935	1.15	0.869	0.988	0.935	0.855	1.15	1.15	0.142	0.064	0.177
Vanadium	mg/kg	-	-	-	-	61.5	39.9	61.6	53.8	53.3	61.1	54.8	56.9	54.8	53.3	61.6	61.5	4.08	1.83	5.07
Zinc	mg/kg	123	315	200	380	68.2	87.6	66.8	55.5	58.7	68.5	54.6	60.8	58.7	54.6	68.5	68.2	6.45	2.88	8.00

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996)
[4] Reference 95th percentile was calculated using displayed data for the <63µm sediment fraction. The 5th percentile is reported for pH.

Values is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.
Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Table E.46: Raw sediment quality data for Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Data are based on the < 63µm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference 95th Percentile [4]		Reference LRef2 (QUL-52)													
		TEL	PEL	Sensitive	Typical	LRef1	LRef2	QUL-52-01	QUL-52-02	QUL-52-03	QUL-52-04	QUL-52-05	Mean	Median	Minimum	Maximum	95th Percentile	Standard Deviation	Standard Error	t*SE
Date Sampled		-	-	-	-			16-Oct-14	16-Oct-14	16-Oct-14	17-Oct-14	17-Oct-14								
Physical Tests																				
pH (1:2 soil:water)	pH	-	-	-	-	6.32	6.40	6.86	7.88	7.73	6.45	6.39	7.06	6.86	6.39	7.88	6.40	0.704	0.315	0.874
Organic / Inorganic Carbon																				
Total Organic Carbon	%	-	-	-	-	1.35	1.92	1.81	1.71	1.09	1.58	1.95	1.63	1.71	1.09	1.95	1.92	0.330	0.148	0.410
Metals																				
Aluminum	mg/kg	-	-	-	-	14,760	25,540	20,000	26,600	20,100	21,300	17,700	21,140	20,100	17,700	26,600	25,540	3,319	1,484	4,120
Antimony	mg/kg	-	-	-	-	0.36	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	4.92	2.54	2.31	2.16	2.07	2.21	2.60	2.27	2.21	2.07	2.60	2.54	0.204	0.091	0.253
Barium	mg/kg	-	-	-	-	133	77	46.6	85.2	45.8	44.8	36.2	51.7	45.8	36.2	85.2	77.5	19.2	8.58	23.8
Beryllium	mg/kg	-	-	-	-	0.39	0.69	0.44	0.73	0.49	0.53	0.44	0.53	0.49	0.44	0.73	0.69	0.12	0.054	0.15
Bismuth	mg/kg	-	-	-	-	0.14	0.47	0.26	0.51	0.30	0.24	0.20	0.30	0.26	0.20	0.51	0.47	0.12	0.054	0.15
Boron	mg/kg	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.351	0.114	0.0920	0.119	0.0690	0.0850	0.0930	0.0916	0.0920	0.0690	0.119	0.114	0.0181	0.0081	0.022
Calcium	mg/kg	-	-	-	-	7,736	14,400	5,520	15,500	10,000	6,600	5,870	8,698	6,600	5,520	15,500	14,400	4,197	1,877	5,211
Chromium	mg/kg	37.3	90	56	110	54.2	58.1	43.5	60.5	42.5	48.3	37.6	46.5	43.5	37.6	60.5	58.1	8.71	3.90	10.8
Cobalt	mg/kg	-	-	-	-	11.9	24.2	15.2	26.1	16.4	15.9	13.8	17.5	15.9	13.8	26.1	24.2	4.92	2.20	6.10
Copper	mg/kg	35.7	197	120	240	34.8	49.4	29.2	53.6	32.4	27.3	23.2	33.1	29.2	23.2	53.6	49.4	11.9	5.33	14.8
Iron	mg/kg	21,200	43,776	-	-	26,180	48,160	36,600	50,100	36,200	40,400	36,000	39,860	36,600	36,000	50,100	48,160	6,001	2,684	7,451
Lead	mg/kg	35	91	57	110	6.01	14.6	12.0	15.3	11.8	10.4	10.1	11.9	11.8	10.1	15.3	14.6	2.07	0.92	2.56
Lithium	mg/kg	-	-	-	-	13.2	45.8	36.1	47.5	36.8	39.1	31.5	38.2	36.8	31.5	47.5	45.8	5.89	2.63	7.31
Magnesium	mg/kg	-	-	-	-	6,950	12,320	9,840	12,800	9,710	10,400	8,780	10,306	9,840	8,780	12,800	12,320	1,511	676	1,876
Manganese	mg/kg	460	1,100	-	-	365	529	299	573	352	322	286	366	322	286	573	529	118	52.9	147
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0457	0.0171	0.0171	0.0169	0.0136	0.0133	0.0139	0.0150	0.0139	0.0133	0.0171	0.0171	0.0019	0.0008	0.0023
Molybdenum	mg/kg	-	-	-	-	0.86	0.44	0.34	0.44	0.31	0.38	0.43	0.38	0.38	0.31	0.44	0.44	0.056	0.025	0.070
Nickel	mg/kg	16	75	-	-	33.1	69.1	47.3	74.1	47.8	49.3	42.1	52.1	47.8	42.1	74.1	69.1	12.6	5.63	15.6
Phosphorus	mg/kg	-	-	-	-	1,230	1,114	1,010	825	984	1,090	1,120	1,006	1,010	825	1,120	1,114	115	51.6	143
Potassium	mg/kg	-	-	-	-	1,312	4,328	2,010	4,780	2,520	2,190	1,450	2,590	2,190	1,450	4,780	4,328	1,284	574	1,594
Selenium	mg/kg	2	-	-	-	0.70	0.32	0.30	0.32	0.25	0.25	0.24	0.27	0.25	0.24	0.32	0.32	0.036	0.016	0.044
Silver	mg/kg	0.5	-	-	-	0.166	0.124	0.076	0.136	0.077	0.066	0.053	0.082	0.076	0.053	0.136	0.124	0.032	0.014	0.040
Sodium	mg/kg	-	-	-	-	406	424	290	430	370	400	320	362	370	290	430	424	57.2	25.6	71.0
Strontium	mg/kg	-	-	-	-	70.4	114	59.6	120	87.5	76.6	62.1	81.2	76.6	59.6	120	114	24.5	10.9	30.4
Thallium	mg/kg	-	-	-	-	0.148	0.310	0.139	0.343	0.180	0.138	0.100	0.180	0.139	0.100	0.343	0.310	0.0954	0.0427	0.118
Tin	mg/kg	-	-	-	-	0.40	0.56	0.33	0.59	0.35	0.41	0.42	0.42	0.41	0.33	0.59	0.56	0.10	0.046	0.13
Titanium	mg/kg	-	-	-	-	1,084	1,071	581	1,160	641	717	505	721	641	505	1,160	1,071	258	115	320
Uranium	mg/kg	-	-	-	-	1.15	1.95	1.54	1.98	1.81	1.40	1.47	1.64	1.54	1.40	1.98	1.95	0.245	0.110	0.305
Vanadium	mg/kg	-	-	-	-	61.5	39.9	27.8	42.5	28.5	29.7	24.3	30.6	28.5	24.3	42.5	39.9	6.97	3.12	8.65
Zinc	mg/kg	123	315	200	380	68.2	87.6	71.9	90.5	67.5	75.8	66.7	74.5	71.9	66.7	90.5	87.6	9.67	4.33	12.0

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996)
[4] Reference 95th percentile was calculated using displayed data for the <63µm sediment fraction. The 5th percentile is reported for pH.

(blue) Values is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.
(orange) Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Table E.46: Raw sediment quality data for Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Data are based on the < 63µm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference 95th Percentile [4]		Exposed LNF1 (QUL-45)											
		TEL	PEL	Sensitive	Typical	LRef1	LRef2	QUL-45-01	QUL-45-02	QUL-45-03	QUL-45-04	QUL-45-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled		-	-	-	-			13-Aug-14	13-Aug-14	15-Aug-14	16-Aug-14	16-Aug-14							
Physical Tests																			
pH (1:2 soil:water)	pH	-	-	-	-	6.32	6.40	-	-	8.46	8.74	8.52	8.57	8.52	8.46	8.74	0.15	0.09	0.37
Organic / Inorganic Carbon																			
Total Organic Carbon	%	-	-	-	-	1.35	1.92	0.23	0.26	0.28	<0.10	0.20	0.21	0.23	<0.10	0.28	0.071	0.032	0.088
Metals																			
Aluminum	mg/kg	-	-	-	-	14,760	25,540	17,600	18,600	18,500	18,400	16,500	17,920	18,400	16,500	18,600	887	397	1,101
Antimony	mg/kg	-	-	-	-	0.36	<0.10	0.40	0.41	0.43	0.46	0.43	0.43	0.43	0.40	0.46	0.023	0.010	0.029
Arsenic	mg/kg	5.9	17	11	20	4.92	2.54	13.3	12.4	12.9	13.6	12.6	**13.0**	**12.9**	**12.4**	**13.6**	0.49	0.22	0.61
Barium	mg/kg	-	-	-	-	133	77	186	199	197	212	179	195	197	179	212	12.7	5.68	15.8
Beryllium	mg/kg	-	-	-	-	0.39	0.69	0.65	0.68	0.73	0.71	0.61	0.68	0.68	0.61	0.73	0.048	0.021	0.059
Bismuth	mg/kg	-	-	-	-	0.14	0.47	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Boron	mg/kg	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.351	0.114	0.135	0.119	0.128	0.155	0.129	0.133	0.129	0.119	0.155	0.0135	0.0060	0.0167
Calcium	mg/kg	-	-	-	-	7,736	14,400	27,100	26,800	29,300	30,800	27,500	28,300	27,500	26,800	30,800	1,701	761	2,112
Chromium	mg/kg	37.3	90	56	110	54.2	58.1	16.7	13.0	16.2	14.9	16.7	15.5	16.2	13.0	16.7	1.58	0.71	1.96
Cobalt	mg/kg	-	-	-	-	11.9	24.2	20.9	20.3	20.6	21.0	18.9	20.3	20.6	18.9	21.0	0.85	0.38	1.06
Copper	mg/kg	35.7	197	120	240	34.8	49.4	630	707	629	706	588	**652**	**630**	**588**	**707**	52.6	23.5	65.3
Iron	mg/kg	21,200	43,776	-	-	26,180	48,160	66,600	51,000	61,300	70,200	64,600	**62,740**	**64,600**	**51,000**	**70,200**	7,313	3,270	9,079
Lead	mg/kg	35	91	57	110	6.01	14.6	6.09	5.68	5.69	5.77	5.55	5.76	5.69	5.55	6.09	0.203	0.091	0.252
Lithium	mg/kg	-	-	-	-	13.2	45.8	16.8	18.5	18.9	19.6	17.0	18.2	18.5	16.8	19.6	1.22	0.54	1.51
Magnesium	mg/kg	-	-	-	-	6,950	12,320	10,900	11,900	11,700	11,800	10,300	11,320	11,700	10,300	11,900	694	310	862
Manganese	mg/kg	460	1,100	-	-	365	529	676	691	705	754	651	**695**	**691**	**651**	**754**	38.4	17.2	47.7
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0457	0.0171	0.0747	0.0745	0.0764	0.0836	0.0771	0.0773	0.0764	0.0745	0.0836	0.0037	0.0017	0.0046
Molybdenum	mg/kg	-	-	-	-	0.86	0.44	4.00	3.60	3.76	3.89	3.51	3.75	3.76	3.51	4.00	0.201	0.090	0.250
Nickel	mg/kg	16	75	-	-	33.1	69.1	12.7	11.7	12.7	11.9	12.2	12.2	12.2	11.7	12.7	0.456	0.204	0.566
Phosphorus	mg/kg	-	-	-	-	1,230	1,114	1,740	1,430	1,640	1,800	1,690	1,660	1,690	1,430	1,800	142	63.3	176
Potassium	mg/kg	-	-	-	-	1,312	4,328	1,720	1,860	1,870	1,810	1,670	1,786	1,810	1,670	1,870	87.9	39.3	109
Selenium	mg/kg	2	-	-	-	0.70	0.32	0.99	1.00	1.06	1.05	1.00	1.02	1.00	0.99	1.06	0.032	0.014	0.040
Silver	mg/kg	0.5	-	-	-	0.166	0.124	0.312	0.321	0.317	0.367	0.307	0.325	0.317	0.307	0.367	0.0242	0.0108	0.0300
Sodium	mg/kg	-	-	-	-	406	424	1,150	1,220	1,140	1,190	1,100	1,160	1,150	1,100	1,220	46.4	20.7	57.6
Strontium	mg/kg	-	-	-	-	70.4	114	190	206	205	185	181	193	190	181	206	11.5	5.14	14.3
Thallium	mg/kg	-	-	-	-	0.148	0.310	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	0.40	0.56	1.55	1.52	1.71	1.75	1.62	1.63	1.62	1.52	1.75	0.099	0.044	0.123
Titanium	mg/kg	-	-	-	-	1,084	1,071	1,610	1,640	1,730	1,800	1,670	1,690	1,670	1,610	1,800	75.8	33.9	94.1
Uranium	mg/kg	-	-	-	-	1.15	1.95	1.13	1.14	1.34	1.30	1.12	1.21	1.14	1.12	1.34	0.105	0.047	0.131
Vanadium	mg/kg	-	-	-	-	61.5	39.9	253	193	229	257	241	235	241	193	257	25.7	11.5	31.9
Zinc	mg/kg	123	315	200	380	68.2	87.6	60.2	60.3	64.8	70.0	60.1	63.1	60.3	60.1	70.0	4.35	1.95	5.40

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996)
[4] Reference 95th percentile was calculated using displayed data for the <63µm sediment fraction. The 5th percentile is reported for pH.

(blue) Values is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.
(orange) Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Table E.46: Raw sediment quality data for Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Data are based on the < 63µm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference 95th Percentile [4]		Exposed LNF2 (QUL-49)											
		TEL	PEL	Sensitive	Typical	LRef1	LRef2	QUL-49-01	QUL-49-02	QUL-49-03	QUL-49-04	QUL-49-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled		-	-	-	-			18-Aug-14	20-Aug-14	20-Aug-14	23-Aug-14	23-Aug-14							
Physical Tests																			
pH (1:2 soil:water)	pH	-	-	-	-	6.32	6.40	7.67	7.75	7.87	8.25	8.47	8.00	7.87	7.67	8.47	0.34	0.15	0.43
Organic / Inorganic Carbon																			
Total Organic Carbon	%	-	-	-	-	1.35	1.92	0.68	0.72	0.65	0.29	0.28	0.52	0.65	0.28	0.72	0.22	0.098	0.27
Metals																			
Aluminum	mg/kg	-	-	-	-	14,760	25,540	14,200	14,100	16,100	16,100	15,400	15,180	15,400	14,100	16,100	983	440	1,221
Antimony	mg/kg	-	-	-	-	0.36	<0.10	0.32	0.33	0.36	0.43	0.42	0.37	0.36	0.32	0.43	0.051	0.023	0.063
Arsenic	mg/kg	5.9	17	11	20	4.92	2.54	9.48	9.59	10.3	11.7	12.0	**10.6**	**10.3**	**9.5**	**12.0**	1.18	0.53	1.46
Barium	mg/kg	-	-	-	-	133	77	160	161	184	171	164	168	164	160	184	9.92	4.44	12.3
Beryllium	mg/kg	-	-	-	-	0.39	0.69	0.48	0.48	0.54	0.59	0.59	0.54	0.54	0.48	0.59	0.055	0.025	0.068
Bismuth	mg/kg	-	-	-	-	0.14	0.47	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Boron	mg/kg	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.351	0.114	0.148	0.137	0.148	0.126	0.131	0.138	0.137	0.126	0.148	0.00992	0.00444	0.0123
Calcium	mg/kg	-	-	-	-	7,736	14,400	21,100	21,500	23,200	27,100	26,400	23,860	23,200	21,100	27,100	2,765	1,236	3,432
Chromium	mg/kg	37.3	90	56	110	54.2	58.1	16.7	16.8	15.1	16.3	19.1	16.8	16.7	15.1	19.1	1.45	0.65	1.80
Cobalt	mg/kg	-	-	-	-	11.9	24.2	13.5	14.2	15.0	15.2	16.8	14.9	15.0	13.5	16.8	1.24	0.55	1.54
Copper	mg/kg	35.7	197	120	240	34.8	49.4	421	439	497	469	485	**462**	**469**	**421**	**497**	31.7	14.2	39.3
Iron	mg/kg	21,200	43,776	-	-	26,180	48,160	46,100	48,600	40,800	49,900	67,800	**50,640**	**48,600**	40,800	**67,800**	10,206	4,564	12,670
Lead	mg/kg	35	91	57	110	6.01	14.6	4.99	5.17	5.71	5.04	5.42	5.27	5.17	4.99	5.71	0.299	0.134	0.371
Lithium	mg/kg	-	-	-	-	13.2	45.8	13.3	14.1	16.2	15.7	14.4	14.7	14.4	13.3	16.2	1.19	0.53	1.48
Magnesium	mg/kg	-	-	-	-	6,950	12,320	7,930	8,070	9,540	8,480	8,150	8,434	8,150	7,930	9,540	650	291	808
Manganese	mg/kg	460	1,100	-	-	365	529	519	543	581	612	617	**574**	**581**	519	**617**	42.8	19.1	53.1
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0457	0.0171	0.0743	0.0769	0.0820	0.0695	0.0652	0.0736	0.0743	0.0652	0.0820	0.00651	0.00291	0.00808
Molybdenum	mg/kg	-	-	-	-	0.86	0.44	2.59	2.72	2.92	2.98	2.99	2.84	2.92	2.59	2.99	0.177	0.079	0.220
Nickel	mg/kg	16	75	-	-	33.1	69.1	12.6	12.7	13.3	11.9	13.0	12.7	12.7	11.9	13.3	0.524	0.235	0.651
Phosphorus	mg/kg	-	-	-	-	1,230	1,114	1,250	1,250	1,200	1,620	1,620	1,388	1,250	1,200	1,620	213	95.2	264
Potassium	mg/kg	-	-	-	-	1,312	4,328	1,300	1,290	1,610	1,540	1,450	1,438	1,450	1,290	1,610	142	63.7	177
Selenium	mg/kg	2	-	-	-	0.70	0.32	0.68	0.71	0.77	0.75	0.83	0.75	0.75	0.68	0.83	0.058	0.026	0.072
Silver	mg/kg	0.5	-	-	-	0.166	0.124	0.209	0.227	0.237	0.256	0.256	0.237	0.237	0.209	0.256	0.0200	0.0090	0.0249
Sodium	mg/kg	-	-	-	-	406	424	740	750	840	780	810	784	780	740	840	41.6	18.6	51.6
Strontium	mg/kg	-	-	-	-	70.4	114	139	143	155	165	152	151	152	139	165	10.3	4.59	12.7
Thallium	mg/kg	-	-	-	-	0.148	0.310	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	0.40	0.56	0.98	0.95	1.10	1.56	1.42	1.20	1.10	0.95	1.56	0.273	0.122	0.339
Titanium	mg/kg	-	-	-	-	1,084	1,071	1,070	1,050	1,190	1,660	1,550	1,304	1,190	1,050	1,660	283	126	351
Uranium	mg/kg	-	-	-	-	1.15	1.95	0.854	0.844	0.953	1.10	1.04	0.958	0.953	0.844	1.10	0.113	0.050	0.140
Vanadium	mg/kg	-	-	-	-	61.5	39.9	161	169	139	187	256	182	169	139	256	44.6	19.9	55.4
Zinc	mg/kg	123	315	200	380	68.2	87.6	52.7	53.2	56.7	53.7	55.3	54.3	53.7	52.7	56.7	1.65	0.74	2.05

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996)
[4] Reference 95th percentile was calculated using displayed data for the <63µm sediment fraction. The 5th percentile is reported for pH.

(blue) Values is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.
(orange) Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Table E.46: Raw sediment quality data for Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Data are based on the < 63µm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference 95th Percentile [4]		Exposed LFF (QUL-47)												
		TEL	PEL	Sensitive	Typical	LRef1	LRef2	QUL-47-01	QUL-47-02	QUL-47-03	QUL-47-04	QUL-47-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled		-	-	-	-			27-Aug-14	27-Aug-14	4-Sep-14	4-Sep-14	4-Sep-14							
Physical Tests																			
pH (1:2 soil:water)	pH	-	-	-	-	6.32	6.40	6.67	6.54	6.03	6.72	6.80	6.55	6.67	6.03	6.80	0.31	0.14	0.38
Organic / Inorganic Carbon																			
Total Organic Carbon	%	-	-	-	-	1.35	1.92	3.73	1.61	1.02	0.59	1.96	1.78	1.61	0.59	3.73	1.21	0.54	1.50
Metals																			
Aluminum	mg/kg	-	-	-	-	14,760	25,540	10,700	14,600	11,700	12,200	13,000	12,440	12,200	10,700	14,600	1,467	656	1,822
Antimony	mg/kg	-	-	-	-	0.36	<0.10	0.30	0.18	0.20	0.21	0.25	0.23	0.21	0.18	0.30	0.048	0.021	0.059
Arsenic	mg/kg	5.9	17	11	20	4.92	2.54	2.94	1.80	3.99	4.11	2.60	3.09	2.94	1.80	4.11	0.972	0.435	1.21
Barium	mg/kg	-	-	-	-	133	77	53.6	42.2	60.0	64.1	57.3	55.4	57.3	42.2	64.1	8.34	3.73	10.3
Beryllium	mg/kg	-	-	-	-	0.39	0.69	0.28	0.33	0.29	0.30	0.32	0.30	0.30	0.28	0.33	0.021	0.0093	0.026
Bismuth	mg/kg	-	-	-	-	0.14	0.47	<0.10	<0.10	<0.10	<0.10	0.11	0.10	<0.10	<0.10	0.11	0.0045	0.0020	0.0056
Boron	mg/kg	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.351	0.114	0.309	0.172	0.112	0.083	0.188	0.173	0.172	0.083	0.309	0.0874	0.0391	0.108
Calcium	mg/kg	-	-	-	-	7,736	14,400	9,620	9,800	7,040	8,550	8,550	8,712	8,550	7,040	9,800	1,102	493	1,368
Chromium	mg/kg	37.3	90	56	110	54.2	58.1	32.8	38.9	45.9	57.5	44.1	43.8	44.1	32.8	57.5	9.18	4.11	11.4
Cobalt	mg/kg	-	-	-	-	11.9	24.2	7.51	11.2	8.61	8.98	10.3	9.32	8.98	7.51	11.2	1.45	0.65	1.80
Copper	mg/kg	35.7	197	120	240	34.8	49.4	31.4	33.8	25.6	27.8	32.1	30.1	31.4	25.6	33.8	3.35	1.50	4.16
Iron	mg/kg	21,200	43,776	-	-	26,180	48,160	17,200	24,000	23,400	29,200	22,400	23,240	23,400	17,200	29,200	4,281	1,915	5,315
Lead	mg/kg	35	91	57	110	6.01	14.6	5.15	4.90	6.07	3.88	6.53	5.31	5.15	3.88	6.53	1.04	0.464	1.29
Lithium	mg/kg	-	-	-	-	13.2	45.8	11.9	11.4	10.4	10.1	15.1	11.8	11.4	10.1	15.1	1.99	0.89	2.48
Magnesium	mg/kg	-	-	-	-	6,950	12,320	5,130	8,490	5,640	6,090	6,430	6,356	6,090	5,130	8,490	1,289	576	1,600
Manganese	mg/kg	460	1,100	-	-	365	529	205	289	260	339	279	274	279	205	339	48.6	21.7	60.3
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0457	0.0171	0.0699	0.0440	0.0405	0.0286	0.0485	0.0463	0.0440	0.0286	0.0699	0.0151	0.0068	0.0188
Molybdenum	mg/kg	-	-	-	-	0.86	0.44	0.67	0.61	0.52	0.30	1.56	0.73	0.61	0.30	1.56	0.48	0.22	0.60
Nickel	mg/kg	16	75	-	-	33.1	69.1	24.9	26.8	22.1	23.3	33.5	26.1	24.9	22.1	33.5	4.49	2.01	5.57
Phosphorus	mg/kg	-	-	-	-	1,230	1,114	616	727	987	1,240	747	863	747	616	1,240	250	112	311
Potassium	mg/kg	-	-	-	-	1,312	4,328	720	580	790	770	950	762	770	580	950	133	59.6	165
Selenium	mg/kg	2	-	-	-	0.70	0.32	1.15	0.44	0.29	0.15	0.64	0.53	0.44	0.15	1.15	0.39	0.17	0.48
Silver	mg/kg	0.5	-	-	-	0.166	0.124	0.151	0.074	0.053	<0.050	0.088	0.083	0.074	<0.050	0.151	0.041	0.018	0.051
Sodium	mg/kg	-	-	-	-	406	424	170	320	300	400	180	274	300	170	400	97.9	43.8	122
Strontium	mg/kg	-	-	-	-	70.4	114	51.2	56.8	66.2	77.0	50.2	60.3	56.8	50.2	77.0	11.3	5.05	14.0
Thallium	mg/kg	-	-	-	-	0.148	0.310	0.057	<0.050	<0.050	<0.050	0.072	0.056	<0.050	<0.050	0.072	0.0095	0.0043	0.012
Tin	mg/kg	-	-	-	-	0.40	0.56	0.45	<0.41	0.25	0.28	0.28	0.33	0.28	0.25	0.45	0.090	0.040	0.11
Titanium	mg/kg	-	-	-	-	1,084	1,071	690	1,310	887	1,080	812	956	887	690	1,310	243	109	302
Uranium	mg/kg	-	-	-	-	1.15	1.95	1.27	0.862	0.835	0.738	0.959	0.933	0.862	0.738	1.27	0.204	0.091	0.254
Vanadium	mg/kg	-	-	-	-	61.5	39.9	40.3	80.3	74.9	96.3	47.6	67.9	74.9	40.3	96.3	23.4	10.4	29.0
Zinc	mg/kg	123	315	200	380	68.2	87.6	40.1	49.1	43.8	45.5	47.2	45.1	45.5	40.1	49.1	3.44	1.54	4.27

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996)
[4] Reference 95th percentile was calculated using displayed data for the <63µm sediment fraction. The 5th percentile is reported for pH.

(blue) Values is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.
(orange) Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Table E.46: Raw sediment quality data for Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Data are based on the < 63µm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference 95th Percentile [4]		Exposed LFFF (QUL-48)												
		TEL	PEL	Sensitive	Typical	LRef1	LRef2	QUL-48-01	QUL-48-02	QUL-48-03	QUL-48-04	QUL-48-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled		-	-	-	-			6-Sep-14	7-Sep-14	7-Sep-14	7-Sep-14	7-Sep-14							
Physical Tests																			
pH (1:2 soil:water)	pH	-	-	-	-	6.32	6.40	5.27	6.34	6.16	6.46	6.05	6.06	6.16	5.27	6.46	0.47	0.21	0.58
Organic / Inorganic Carbon																			
Total Organic Carbon	%	-	-	-	-	1.35	1.92	5.98	8.75	4.33	6.17	3.90	5.83	5.98	3.90	8.75	1.91	0.86	2.38
Metals																			
Aluminum	mg/kg	-	-	-	-	14,760	25,540	18,200	17,700	18,200	17,500	15,200	17,360	17,700	15,200	18,200	1,246	557	1,547
Antimony	mg/kg	-	-	-	-	0.36	<0.10	1.46	0.50	0.48	0.69	0.46	0.72	0.50	0.46	1.46	0.42	0.19	0.53
Arsenic	mg/kg	5.9	17	11	20	4.92	2.54	19.1	6.42	6.31	9.85	5.92	**9.52**	**6.42**	**5.92**	**19.1**	5.58	2.50	6.93
Barium	mg/kg	-	-	-	-	133	77	59.4	91.2	93.2	87.4	61.3	78.5	87.4	59.4	93.2	16.7	7.5	20.7
Beryllium	mg/kg	-	-	-	-	0.39	0.69	0.35	0.46	0.39	0.44	0.34	0.40	0.39	0.34	0.46	0.053	0.024	0.066
Bismuth	mg/kg	-	-	-	-	0.14	0.47	0.13	0.15	<0.10	0.13	<0.10	0.12	0.13	<0.10	0.15	0.022	0.010	0.027
Boron	mg/kg	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.351	0.114	0.489	0.462	0.287	0.425	0.284	0.389	0.425	0.284	0.489	0.0975	0.0436	0.121
Calcium	mg/kg	-	-	-	-	7,736	14,400	8,630	10,800	9,890	10,900	9,210	9,886	9,890	8,630	10,900	987	441	1,226
Chromium	mg/kg	37.3	90	56	110	54.2	58.1	62.4	56.3	55.5	72.1	54.7	**60.2**	56.3	54.7	**72.1**	7.31	3.27	9.08
Cobalt	mg/kg	-	-	-	-	11.9	24.2	18.2	12.9	12.8	13.7	11.8	13.9	12.9	11.8	18.2	2.51	1.12	3.11
Copper	mg/kg	35.7	197	120	240	34.8	49.4	85.6	54.6	45.1	54.8	39.1	**55.8**	**54.6**	39.1	**85.6**	17.9	8.01	22.2
Iron	mg/kg	21,200	43,776	-	-	26,180	48,160	34,600	27,400	26,900	31,100	26,800	29,360	27,400	26,800	34,600	3,425	1,532	4,252
Lead	mg/kg	35	91	57	110	6.01	14.6	9.09	10.0	7.72	11.9	7.09	9.16	9.09	7.09	11.9	1.91	0.85	2.37
Lithium	mg/kg	-	-	-	-	13.2	45.8	15.4	17.6	16.6	16.2	14.9	16.1	16.2	14.9	17.6	1.05	0.47	1.31
Magnesium	mg/kg	-	-	-	-	6,950	12,320	12,200	8,910	9,400	9,310	10,100	9,984	9,400	8,910	12,200	1,311	586	1,627
Manganese	mg/kg	460	1,100	-	-	365	529	393	276	344	300	341	331	341	276	393	45.0	20.1	55.9
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0457	0.0171	0.0640	0.0961	0.0707	0.0892	0.0423	0.0725	0.0707	0.0423	0.0961	0.0214	0.0095	0.0265
Molybdenum	mg/kg	-	-	-	-	0.86	0.44	0.85	1.46	0.76	1.62	0.80	1.10	0.85	0.76	1.62	0.41	0.18	0.51
Nickel	mg/kg	16	75	-	-	33.1	69.1	38.8	51.2	43.2	54.2	44.2	46.3	44.2	38.8	54.2	6.26	2.80	7.77
Phosphorus	mg/kg	-	-	-	-	1,230	1,114	719	687	738	720	806	734	720	687	806	44.2	19.8	54.9
Potassium	mg/kg	-	-	-	-	1,312	4,328	960	1,350	1,140	1,300	1,030	1,156	1,140	960	1,350	168	75.1	209
Selenium	mg/kg	2	-	-	-	0.70	0.32	1.01	3.48	0.71	4.14	1.17	**2.10**	1.17	0.71	**4.14**	1.59	0.71	1.97
Silver	mg/kg	0.5	-	-	-	0.166	0.124	0.345	0.176	0.135	0.199	0.117	0.194	0.176	0.117	0.345	0.090	0.040	0.112
Sodium	mg/kg	-	-	-	-	406	424	210	230	280	290	230	248	230	210	290	34.9	15.6	43.4
Strontium	mg/kg	-	-	-	-	70.4	114	52.9	87.3	84.0	73.5	58.3	71.2	73.5	52.9	87.3	15.2	6.82	18.9
Thallium	mg/kg	-	-	-	-	0.148	0.310	0.067	0.132	0.095	0.113	0.069	0.095	0.095	0.067	0.13	0.028	0.013	0.035
Tin	mg/kg	-	-	-	-	0.40	0.56	0.48	0.57	0.95	2.83	1.09	1.18	0.95	0.48	2.83	0.95	0.43	1.19
Titanium	mg/kg	-	-	-	-	1,084	1,071	1,300	887	1,110	938	1,100	1,067	1,100	887	1,300	163	72.9	202
Uranium	mg/kg	-	-	-	-	1.15	1.95	0.847	1.47	0.983	1.25	1.39	1.19	1.25	0.85	1.47	0.266	0.119	0.330
Vanadium	mg/kg	-	-	-	-	61.5	39.9	91.6	60.1	79.1	67.5	64.8	72.6	67.5	60.1	91.6	12.7	5.7	15.8
Zinc	mg/kg	123	315	200	380	68.2	87.6	84.0	69.2	72.1	79.9	64.0	73.8	72.1	64.0	84.0	8.08	3.61	10.0

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996)
[4] Reference 95th percentile was calculated using displayed data for the <63µm sediment fraction. The 5th percentile is reported for pH.

(blue) Values is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.
(orange) Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Table E.47: PCA results displaying; eigen value, percent variance explained, Monte Carlo randomization p-values of axis significance, and station scores for < 2mm sediment from Quesnel Lake littoral sampling stations, Mount Polley Mine, 2014. Data were Log (X+1) transformed prior to analysis [a].

		Axis 1	Axis 2	Axis 3
Eigenvalue		13.6	6.8	3.6
% Variance explained		47.1	23.5	12.5
Monte Carlo p		0.0001	0.0001	0.0001
LRef1 (QUL-51)	LRef1-1	3.5	1.4	0.42
	LRef1-2	4.1	1.3	0.64
	LRef1-3	3.9	1.1	0.46
	LRef1-4	4.5	1.7	0.57
	LRef1-5	4.4	1.7	0.64
LRef2 (QUL-52)	LRef2-1	1.8	-3.1	-2.1
	LRef2-2	-1.8	-7.7	-4.3
	LRef2-3	-0.6	-5.7	-2.9
	LRef2-4	5.7	0.4	-1.2
	LRef2-5	6.5	0.7	-0.9
LNF1 (QUL-45)	LNF1-1	-4.4	2.0	-0.51
	LNF1-2	-4.7	1.6	-0.27
	LNF1-3	-4.8	2.0	-0.46
	LNF1-4	-4.7	2.1	-0.01
	LNF1-5	-3.5	2.6	-0.50
LNF2 (QUL-49)	LNF2-1	-3.9	1.4	-0.08
	LNF2-2	-3.8	1.4	-0.30
	LNF2-3	-4.3	1.0	-0.32
	LNF2-4	-4.1	1.8	-0.67
	LNF2-5	-4.0	2.0	-0.66
LFF (QUL-47)	LFF-1	3.4	0.38	1.4
	LFF-2	2.9	1.1	-1.0
	LFF-3	1.2	0.49	-0.89
	LFF-4	2.0	1.3	-0.89
	LFF-5	4.2	1.3	-0.23
LFFF (QUL-48)	LFFF-1	-1.8	-2.6	2.6
	LFFF-2	-1.7	-4.3	7.1
	LFFF-3	-1.0	-3.7	2.2
	LFFF-4	0.26	-1.8	1.3
	LFFF-5	0.58	-1.7	1.0

[a] Boron, mercury and tin were omitted from PCA calculations due to an incomplete data set, or a lack of variability in the data set (all values for each analyte were the same).

Table E.48: PCA axis scores Spearman correlation with sediment metal concentrations (A) and sediment physical characteristics (B) for Quesnel Lake Littoral sediment (< 2mm fraction), Mount Polley Mine, 2014. Data were Log_{10} (X+1) transformed prior to analysis.

A)

Metal	Spearman Correlation Coefficient [a]			P-Value [b]		
	PCA Axis-1 (47.1%)	PCA Axis-2 (23.5%)	PCA Axis-3 (12.5%)	PCA Axis-1 (47.1%)	PCA Axis-2 (23.5%)	PCA Axis-3 (12.5%)
Aluminum	-0.638	-0.465	-0.083	0.000	0.010	0.663
Antimony	-0.549	0.052	0.697	0.002	0.783	0.000
Arsenic	-0.816	0.486	0.319	0.000	0.006	0.086
Barium	-0.745	0.428	0.191	0.000	0.018	0.311
Beryllium	-0.918	0.071	-0.179	0.000	0.708	0.343
Bismuth	-0.079	-0.433	-0.433	0.677	0.017	0.017
Cadmium	-0.106	-0.090	0.952	0.578	0.637	0.000
Calcium	-0.878	0.418	-0.058	0.000	0.022	0.760
Chromium	0.420	-0.746	0.180	0.021	0.000	0.341
Cobalt	-0.844	0.003	-0.229	0.000	0.989	0.223
Copper	-0.957	0.378	0.088	0.000	0.039	0.644
Iron	-0.892	0.274	-0.336	0.000	0.142	0.070
Lead	-0.517	-0.584	-0.004	0.003	0.001	0.985
Lithium	-0.379	-0.544	-0.268	0.039	0.002	0.153
Magnesium	-0.735	-0.097	-0.105	0.000	0.608	0.582
Manganese	-0.932	0.349	-0.152	0.000	0.059	0.421
Molybdenum	-0.875	0.486	0.185	0.000	0.006	0.327
Nickel	0.411	-0.898	0.126	0.024	0.000	0.506
Phosphorus	-0.723	0.719	0.082	0.000	0.000	0.666
Potassium	-0.733	-0.120	-0.327	0.000	0.528	0.077
Selenium	-0.594	0.202	0.606	0.001	0.284	0.000
Silver	-0.841	0.342	0.283	0.000	0.065	0.129
Sodium	-0.717	0.587	-0.489	0.000	0.001	0.006
Strontium	-0.914	0.291	-0.253	0.000	0.118	0.177
Thallium	0.391	-0.710	0.243	0.033	0.000	0.196
Titanium	-0.694	0.466	-0.166	0.000	0.010	0.382
Uranium	-0.569	-0.402	0.067	0.001	0.028	0.727
Vanadium	-0.804	0.628	0.059	0.000	0.000	0.759
Zinc	-0.608	-0.381	0.214	0.000	0.038	0.256

[a] Highlighted cells indicate Spearman correlation coefficient > 0.7 or < -0.7.
[b] Highlighted cells indicate Spearman correlation with p value < 0.1.

B)

Physical Characteristic	Spearman Correlation Coefficient			P-Value		
	PCA Axis-1	PCA Axis-2	PCA Axis-3	PCA Axis-1	PCA Axis-2	PCA Axis-3
% Sand	0.779	0.019	-0.122	0.000	0.921	0.522
% Silt	-0.710	-0.019	0.100	0.000	0.922	0.599
% Clay	-0.748	0.383	0.205	0.000	0.037	0.276
Total Organic Carbon	0.045	-0.683	0.375	0.814	0.000	0.041

Table E.49: PCA results displaying; eigen value, percent variance explained, Monte Carlo randomization p-values of axis significance, and station scores for < 63µm sediment from Quesnel Lake littoral sampling stations, Mount Polley Mine, 2014. Data were Log (X+1) transformed prior to analysis [a].

		Axis 1	Axis 2	Axis 3
Eigenvalue		15.1	8.3	3.9
% Variance explained		48.6	26.7	12.5
Monte Carlo p		0.0001	0.0001	0.0001
LRef1 (QUL-51)	LRef1-1	-1.9	-0.66	-0.46
	LRef1-2	-3.1	-2.7	0.63
	LRef1-3	-2.9	-2.2	0.34
	LRef1-4	-1.9	-0.5	-0.69
	LRef1-5	-3.2	-2.8	0.81
LRef2 (QUL-52)	LRef2-1	-3.9	4.3	1.3
	LRef2-2	-1.0	9.3	0.56
	LRef2-3	-3.2	5.1	1.8
	LRef2-4	-3.0	4.6	1.6
	LRef2-5	-4.0	2.9	1.8
LNF1 (QUL-45)	LNF1-1	6.1	0.26	0.43
	LNF1-2	6.1	0.47	0.42
	LNF1-3	6.4	0.87	0.19
	LNF1-4	6.9	0.85	-0.10
	LNF1-5	5.8	-0.15	0.43
LNF2 (QUL-49)	LNF2-1	3.1	-1.9	1.1
	LNF2-2	3.3	-1.8	1.1
	LNF2-3	3.9	-0.83	0.57
	LNF2-4	4.8	-0.94	0.89
	LNF2-5	4.8	-0.93	0.84
LFF (QUL-47)	LFF-1	-4.3	-3.7	-0.54
	LFF-2	-3.0	-2.4	0.91
	LFF-3	-3.6	-3.3	1.9
	LFF-4	-2.7	-3.3	2.6
	LFF-5	-3.8	-1.9	0.38
LFFF (QUL-48)	LFFF-1	-0.3	-0.08	-5.3
	LFFF-2	-1.5	0.88	-4.2
	LFFF-3	-1.4	0.006	-2.0
	LFFF-4	-0.4	0.87	-5.4
	LFFF-5	-2.2	-0.27	-1.9

[a] Boron was omitted from PCA calculations due to a lack of variability in the data set (all values were the same).

Table E.50: PCA axis scores Spearman correlation with sediment metal concentrations (A) and sediment physical characteristics (B) for Quesnel Lake Littoral sediment (< 63µm fraction), Mount Polley Mine, 2014. Data were Log_{10} (X+1) transformed prior to analysis.

A)

Metal	Spearman Correlation Coefficient [a]			P-Value [b]		
	PCA Axis-1 (48.6%)	PCA Axis-2 (26.7%)	PCA Axis-3 (12.5%)	PCA Axis-1 (48.6%)	PCA Axis-2 (26.7%)	PCA Axis-3 (12.5%)
Aluminum	0.352	0.948	-0.097	0.057	0.000	0.608
Antimony	0.671	0.076	-0.751	0.000	0.690	0.000
Arsenic	0.855	0.057	-0.419	0.000	0.766	0.021
Barium	0.835	-0.052	-0.230	0.000	0.786	0.221
Beryllium	0.757	0.674	-0.004	0.000	0.000	0.984
Bismuth	-0.359	0.670	-0.002	0.051	0.000	0.991
Cadmium	0.034	-0.252	-0.818	0.859	0.179	0.000
Calcium	0.870	0.177	-0.226	0.000	0.350	0.230
Chromium	-0.420	0.057	-0.286	0.021	0.766	0.126
Cobalt	0.695	0.747	-0.056	0.000	0.000	0.770
Copper	0.934	0.270	-0.373	0.000	0.149	0.042
Iron	0.779	0.541	0.143	0.000	0.002	0.449
Lead	-0.113	0.811	-0.208	0.553	0.000	0.271
Lithium	0.270	0.937	-0.042	0.149	0.000	0.827
Magnesium	0.558	0.809	-0.223	0.001	0.000	0.237
Manganese	0.900	0.374	-0.104	0.000	0.042	0.585
Mercury	0.696	-0.010	-0.526	0.000	0.960	0.003
Molybdenum	0.834	0.026	-0.406	0.000	0.893	0.026
Nickel	-0.553	0.428	-0.188	0.002	0.018	0.320
Phosphorus	0.614	0.004	0.312	0.000	0.984	0.093
Potassium	0.435	0.827	0.113	0.016	0.000	0.552
Selenium	0.582	0.093	-0.788	0.001	0.624	0.000
Silver	0.867	0.159	-0.503	0.000	0.402	0.005
Sodium	0.742	0.140	0.240	0.000	0.461	0.202
Strontium	0.833	0.374	0.077	0.000	0.042	0.687
Thallium	-0.527	0.426	-0.166	0.003	0.019	0.380
Tin	0.835	0.365	-0.389	0.000	0.048	0.034
Titanium	0.869	0.022	-0.268	0.000	0.910	0.152
Uranium	-0.048	0.801	-0.186	0.802	0.000	0.324
Vanadium	0.872	-0.151	-0.124	0.000	0.427	0.514
Zinc	0.197	0.855	-0.418	0.297	0.000	0.022

[a] Highlighted cells indicate Spearman correlation coefficient > 0.7 or < -0.7.

[b] Highlighted cells indicate Spearman correlation with p value < 0.1.

B)

Physical Characteristic	Spearman Correlation Coefficient			P-Value		
	PCA Axis-1	PCA Axis-2	PCA Axis-3	PCA Axis-1	PCA Axis-2	PCA Axis-3
% Silt	0.592	0.135	-0.115	0.001	0.477	0.546
% Clay	0.772	0.166	-0.367	0.000	0.382	0.046
Total Organic Carbon	-0.584	0.166	-0.372	0.001	0.380	0.043

Table E.51: Raw selectively extracted (Tessier extraction) metals data for sediment from Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		Reference LRef1 (QUL-51) QUL-51-01	QUL-51-02	QUL-51-03	QUL-51-04	QUL-51-05	Mean	Median	Minimum	Maximum	95th Percentile	Standard Deviation	Standard Error	t*SE	LRef2 (QUL-52) Composite
Date Sampled		TEL	PEL	Sensitive	Typical	LRef1	LRef2	26-Aug-14	24-Aug-14	25-Aug-14	25-Aug-14	26-Aug-14									17-Oct-14
Exchangeable & Adsorbed Metals																					
Aluminum	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Arsenic	mg/kg	5.9	17	11	20	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Barium	mg/kg	-	-	-	-	28.3	<14	<20	29.1	<20	<20	<25	22.8	<20	<20	29.1	28.3	4.12	1.84	5.12	<14
Beryllium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.069	<0.050	0.051	0.069	0.057	0.052	0.067	0.059	0.057	0.051	0.069	0.069	0.0084	0.0037	0.010	<0.050
Calcium	mg/kg	-	-	-	-	1,037	1,350	907	848	1,070	899	835	912	899	835	1,070	1,037	93.8	41.9	116	1,350
Chromium	mg/kg	37.3	90	56	110	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Cobalt	mg/kg	-	-	-	-	0.35	<0.10	0.28	0.35	0.33	0.25	0.31	0.30	0.31	0.25	0.35	0.35	0.040	0.018	0.049	<0.10
Copper	mg/kg	35.7	197	120	240	0.52	<0.50	<0.50	0.52	<0.50	<0.50	<0.50	0.50	<0.50	<0.50	0.52	0.52	0.0089	0.0040	0.011	<0.50
Iron	mg/kg	21,200	43,776	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50
Lead	mg/kg	35	91	57	110	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Manganese	mg/kg	460	1,100	-	-	35.0	23.9	34.8	21.2	33.5	35.0	21.5	29.2	33.5	21.2	35.0	35.0	7.19	3.22	8.93	23.9
Molybdenum	mg/kg	-	-	-	-	<0.50	<1.0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<1.0
Nickel	mg/kg	16	75	-	-	0.93	<0.50	0.77	0.95	0.87	0.73	0.80	0.82	0.80	0.73	0.95	0.93	0.087	0.039	0.11	<0.50
Phosphorus	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50
Potassium	mg/kg	-	-	-	-	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	0	0	0	<100
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Sodium	mg/kg	-	-	-	-	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	0	0	0	<100
Strontium	mg/kg	-	-	-	-	7.39	8.24	6.22	5.53	7.64	6.37	5.55	6.26	6.22	5.53	7.64	7.39	0.860	0.384	1.07	8.24
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0	<1.0
Uranium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Vanadium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Zinc	mg/kg	123	315	200	380	1.1	<1.0	<1.0	1.1	<1.0	<1.0	<1.0	1.0	<1.0	<1.0	1.1	1.1	0.045	0.020	0.056	<1.0
Carbonate Metals																					
Aluminum	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Arsenic	mg/kg	5.9	17	11	20	0.084	<0.050	<0.050	0.064	0.086	0.061	0.077	0.068	0.064	<0.050	0.086	0.084	0.014	0.0063	0.017	<0.050
Barium	mg/kg	-	-	-	-	10.6	8.60	7.4	10.9	8.7	7.6	9.2	8.8	8.7	7.4	10.9	10.6	1.4	0.63	1.8	8.60
Beryllium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Cadmium	mg/kg	0.6	3.5	2.2	4.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Calcium	mg/kg	-	-	-	-	86	1,300	80	76	86	84	71	79	80	71	86	86	6.1	2.7	7.5	1,300
Chromium	mg/kg	37.3	90	56	110	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Cobalt	mg/kg	-	-	-	-	0.44	0.25	0.43	0.32	0.44	0.38	0.28	0.37	0.38	0.28	0.44	0.44	0.069	0.030983867	0.086	0.25
Copper	mg/kg	35.7	197	120	240	1.25	<0.50	0.98	1.28	1.15	0.99	1.06	1.09	1.06	0.98	1.28	1.25	0.125	0.056	0.155	<0.50
Iron	mg/kg	21,200	43,776	-	-	233	<50	112	239	178	189	211	186	189	112	239	233	47.4	21.2	58.8	<50
Lead	mg/kg	35	91	57	110	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Manganese	mg/kg	460	1,100	-	-	26.2	38.1	27.7	<5.0	19.9	20.1	<5.0	15.5	19.9	<5.0	27.7	26.2	10.1	4.5	12.6	38.1
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Nickel	mg/kg	16	75	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Phosphorus	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Strontium	mg/kg	-	-	-	-	<5.0	6.80	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	6.80
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Uranium	mg/kg	-	-	-	-	0.11	0.12	0.106	0.088	0.115	0.112	0.093	0.103	0.106	0.088	0.115	0.114	0.012	0.005	0.015	0.12
Vanadium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Zinc	mg/kg	123	315	200	380	1.2	<1.0	<1.0	1.1	1.2	<1.0	<1.0	1.1	<1.0	<1.0	1.2	1.2	0.09	0.040	0.11	<1.0

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
Summary statistics were only calculated for sampling areas with replicate samples (LRef1, LNF1,and LNF2) but not for single composite samples (LRef2, LFF, and LFFF).

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Displayed reference values are the 95th percentiles of data from reference area LRef1 and are the single values available for reference area LRef2.

(Blue) Value is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.

(Orange) Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Table E.51: Raw selectively extracted (Tessier extraction) metals data for sediment from Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		Reference LRef1 (QUL-51) QUL-51-01	QUL-51-02	QUL-51-03	QUL-51-04	QUL-51-05	Mean	Median	Minimum	Maximum	95th Percentile	Standard Deviation	Standard Error	t*SE	LRef2 (QUL-52) Composite
Date Sampled		TEL	PEL	Sensitive	Typical	LRef1	LRef2	26-Aug-14	24-Aug-14	25-Aug-14	25-Aug-14	26-Aug-14									17-Oct-14
Easily Reducible Metals and Iron Oxides																					
Aluminum	mg/kg	-	-	-	-	828	1,010	796	763	836	786	787	794	787	763	836	828	26.7	11.9	33.1	1,010
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Arsenic	mg/kg	5.9	17	11	20	0.789	0.167	0.80	0.62	0.75	0.73	0.76	0.73	0.75	0.62	0.80	0.79	0.068	0.031	0.085	0.167
Barium	mg/kg	-	-	-	-	13.5	8.33	9.69	13.7	11.9	9.56	12.9	11.6	11.9	9.56	13.7	13.5	1.87	0.84	2.32	8.33
Beryllium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.093	<0.050	0.083	0.085	0.091	0.092	0.093	0.089	0.091	0.083	0.093	0.093	0.0045	0.0020	0.0056	<0.050
Calcium	mg/kg	-	-	-	-	496	710	458	412	506	452	432	452	452	412	506	496	35.2	15.7	43.7	710
Chromium	mg/kg	37.3	90	56	110	2.88	1.70	2.61	2.74	2.90	2.75	2.82	2.76	2.75	2.61	2.90	2.88	0.107	0.048	0.133	1.70
Cobalt	mg/kg	-	-	-	-	2.69	4.46	2.65	2.06	2.70	2.64	2.06	2.42	2.64	2.06	2.70	2.69	0.331	0.148	0.411	4.46
Copper	mg/kg	35.7	197	120	240	3.25	3.90	2.71	3.28	3.13	2.69	2.92	2.95	2.92	2.69	3.28	3.25	0.259	0.116	0.321	3.90
Iron	mg/kg	21,200	43,776	-	-	3,992	5,230	3,470	3,840	3,720	3,400	4,030	3,692	3,720	3,400	4,030	3,992	261	117	323	5,230
Lead	mg/kg	35	91	57	110	1.22	4.75	1.14	1.09	1.24	1.11	1.13	1.14	1.13	1.09	1.24	1.22	0.058	0.026	0.072	4.75
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Manganese	mg/kg	460	1,100	-	-	46.2	74.4	46.1	33.0	46.2	39.3	33.6	39.6	39.3	33.0	46.2	46.2	6.43	2.88	7.98	74.4
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Nickel	mg/kg	16	75	-	-	5.84	9.65	5.31	4.87	5.94	5.45	4.72	5.26	5.31	4.72	5.94	5.84	0.486	0.217	0.603	9.65
Phosphorus	mg/kg	-	-	-	-	104	<50	101	105	83	77	71	87.4	83.0	71.0	105	104	14.9	6.68	18.5	<50
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Strontium	mg/kg	-	-	-	-	5.44	6.22	4.46	5.09	5.53	4.44	4.92	4.89	4.92	4.44	5.53	5.44	0.458	0.205	0.568	6.22
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	1.0	2.0	1.0	<1.0	1.0	1.0	<1.0	1.0	1.0	<1.0	1.0	1.0	0	0	0	2.0
Uranium	mg/kg	-	-	-	-	0.109	0.282	0.101	0.089	0.111	0.100	0.091	0.098	0.100	0.089	0.111	0.109	0.0088	0.0039	0.011	0.282
Vanadium	mg/kg	-	-	-	-	5.27	1.94	4.81	5.06	5.28	4.90	5.24	5.06	5.06	4.81	5.28	5.27	0.205	0.092	0.255	1.94
Zinc	mg/kg	123	315	200	380	12.0	10.0	10.7	10.8	12.3	10.9	10.7	11.1	10.8	10.7	12.3	12.0	0.69	0.31	0.85	10.0
Organic Bound Metals																					
Aluminum	mg/kg	-	-	-	-	743	783	620	734	745	608	686	679	686	608	745	743	63.1	28.2	78.4	783
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Arsenic	mg/kg	5.9	17	11	20	0.246	0.085	0.203	0.240	0.203	0.174	0.247	0.213	0.203	0.174	0.247	0.246	0.0300	0.0134	0.0373	0.085
Barium	mg/kg	-	-	-	-	6.23	1.40	3.93	6.39	5.39	4.51	5.61	5.17	5.39	3.93	6.39	6.23	0.962	0.430	1.19	1.40
Beryllium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Cadmium	mg/kg	0.6	3.5	2.2	4.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Calcium	mg/kg	-	-	-	-	522	367	481	531	475	392	487	473	481	392	531	522	50.5	22.6	62.7	367
Chromium	mg/kg	37.3	90	56	110	2.70	1.80	2.44	2.45	2.72	2.45	2.63	2.54	2.45	2.44	2.72	2.70	0.129	0.058	0.160	1.80
Cobalt	mg/kg	-	-	-	-	1.52	0.96	0.82	1.53	1.13	0.79	1.49	1.15	1.13	0.79	1.53	1.52	0.353	0.158	0.438	0.96
Copper	mg/kg	35.7	197	120	240	3.73	4.00	3.11	3.72	3.64	3.00	3.73	3.44	3.64	3.00	3.73	3.73	0.355	0.159	0.441	4.00
Iron	mg/kg	21,200	43,776	-	-	301	310	237	287	267	217	304	262	267	217	304	301	35.6	15.9	44.2	310
Lead	mg/kg	35	91	57	110	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Manganese	mg/kg	460	1,100	-	-	8.2	6.5	8.2	7.8	8.2	7.4	7.4	7.8	7.8	7.4	8.2	8.2	0.40	0.18	0.50	6.50
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Nickel	mg/kg	16	75	-	-	2.10	2.40	1.58	2.09	1.84	1.56	2.10	1.83	1.84	1.56	2.10	2.10	0.263	0.117	0.326	2.40
Selenium	mg/kg	2	-	-	-	0.28	<0.20	0.24	0.26	0.28	0.24	0.27	0.26	0.26	0.24	0.28	0.28	0.018	0.008	0.022	<0.20
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Strontium	mg/kg	-	-	-	-	2.71	2.82	2.23	2.73	2.64	2.03	2.50	2.43	2.50	2.03	2.73	2.71	0.291	0.130	0.361	2.82
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	57.3	28.8	57.3	26.4	49.2	57.1	41.7	46.3	49.2	26.4	57.3	57.3	12.9	5.76	16.0	28.8
Uranium	mg/kg	-	-	-	-	0.062	0.066	0.054	0.056	0.064	0.056	0.052	0.056	0.056	0.052	0.064	0.062	0.0046	0.0020	0.0057	0.066
Vanadium	mg/kg	-	-	-	-	2.97	2.29	3.00	2.41	2.86	2.77	2.61	2.73	2.77	2.41	3.00	2.97	0.228	0.102	0.283	2.29
Zinc	mg/kg	123	315	200	380	4.2	3.1	3.4	4.2	4.0	3.6	3.7	3.8	3.7	3.4	4.2	4.2	0.32	0.14	0.40	3.1

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
Summary statistics were only calculated for sampling areas with replicate samples (LRef1, LNF1,and LNF2) but not for single composite samples (LRef2, LFF, and LFFF).

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Displayed reference values are the 95th percentiles of data from reference area LRef1 and are the single values available for reference area LRef2.

(blue)	Value is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.
(orange)	Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Table E.51: Raw selectively extracted (Tessier extraction) metals data for sediment from Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		Reference													
								LRef1 (QUL-51)													LRef2 (QUL-52) Composite
								QUL-51-01	QUL-51-02	QUL-51-03	QUL-51-04	QUL-51-05	Mean	Median	Minimum	Maximum	95th Percentile	Standard Deviation	Standard Error	t*SE	
Date Sampled		TEL	PEL	Sensitive	Typical	LRef1	LRef2	26-Aug-14	24-Aug-14	25-Aug-14	25-Aug-14	26-Aug-14									17-Oct-14
Residual Metals																					
Aluminum	mg/kg	-	-	-	-	9,092	14,200	8,660	7,960	9,200	8,550	7,610	8,396	8,550	7,610	9,200	9,092	622	278	772	14,200
Antimony	mg/kg	-	-	-	-	0.20	<0.10	0.17	0.18	0.19	0.18	0.20	0.18	0.18	0.17	0.20	0.20	0.011	0.005	0.014	<0.10
Arsenic	mg/kg	5.9	17	11	20	2.85	1.44	2.97	1.98	2.32	2.36	2.18	2.36	2.32	1.98	2.97	2.85	0.371	0.166	0.461	1.44
Barium	mg/kg	-	-	-	-	41.0	25.1	32.4	39.5	40.0	41.2	35.4	37.7	39.5	32.4	41.2	41.0	3.68	1.65	4.57	25.1
Beryllium	mg/kg	-	-	-	-	<0.20	0.25	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	0.25
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Cadmium	mg/kg	0.6	3.5	2.2	4.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Calcium	mg/kg	-	-	-	-	4,092	2,280	3,820	3,280	3,900	4,140	3,320	3,692	3,820	3,280	4,140	4,092	377	169	468	2,280
Chromium	mg/kg	37.3	90	56	110	30.8	32.9	27.5	27.6	31.1	29.4	26.5	28.4	27.6	26.5	31.1	30.8	1.83	0.82	2.27	32.9
Cobalt	mg/kg	-	-	-	-	4.20	7.82	4.16	3.68	4.21	3.89	3.51	3.89	3.89	3.51	4.21	4.20	0.302	0.135	0.374	7.82
Copper	mg/kg	35.7	197	120	240	12.7	13.8	11.7	11.6	12.9	10.9	11.1	11.6	11.6	10.9	12.9	12.7	0.78	0.35	0.97	13.8
Iron	mg/kg	21,200	43,776	-	-	14,920	24,800	15,000	12,800	14,600	13,900	12,400	13,740	13,900	12,400	15,000	14,920	1,122	502	1,392	24,800
Lead	mg/kg	35	91	57	110	1.80	2.60	1.56	1.65	1.84	1.59	1.55	1.64	1.59	1.55	1.84	1.80	0.119	0.053	0.148	2.60
Lithium	mg/kg	-	-	-	-	6.86	24.1	6.7	6.4	6.9	6.4	5.9	6.46	6.40	5.90	6.9	6.9	0.378	0.169	0.469	24.1
Manganese	mg/kg	460	1,100	-	-	169	150	170	137	162	166	135	154	162	135	170	169	16.7	7.46	20.7	150
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Nickel	mg/kg	16	75	-	-	13.7	24.0	13.1	12.3	13.8	12.4	11.5	12.6	12.4	11.5	13.8	13.7	0.870	0.389	1.08	24.0
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Silver	mg/kg	0.5	-	-	-	0.16	<0.10	<0.10	<0.10	<0.10	0.17	<0.10	0.11	<0.10	<0.10	0.17	0.16	0.031	0.014	0.039	<0.10
Strontium	mg/kg	-	-	-	-	30.2	37.2	25.1	27.0	30.4	29.2	26.8	27.7	27	25.1	30.4	30.2	2.10	0.938	2.60	37.2
Thallium	mg/kg	-	-	-	-	0.063	0.11	0.057	0.063	0.061	0.050	0.053	0.057	0.057	0.050	0.063	0.063	0.0054	0.0024	0.0067	0.11
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	868	698	816	796	876	836	750	815	816	750	876	868	46.8	20.9	58.1	698
Uranium	mg/kg	-	-	-	-	0.414	0.613	0.380	0.397	0.413	0.414	0.353	0.391	0.397	0.353	0.414	0.414	0.0256	0.0114	0.0317	0.613
Vanadium	mg/kg	-	-	-	-	40.3	21.0	40.4	34.3	39.7	38.7	33.5	37.3	38.7	33.5	40.4	40.3	3.19	1.43	3.96	21.0
Zinc	mg/kg	123	315	200	380	29.3	42.6	27.6	26.8	29.7	26.4	24.8	27.1	26.8	24.8	29.7	29.3	1.79	0.80	2.23	42.6

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
Summary statistics were only calculated for sampling areas with replicate samples (LRef1, LNF1,and LNF2) but not for single composite samples (LRef2, LFF, and LFFF).

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Displayed reference values are the 95th percentiles of data from reference area LRef1 and are the single values available for reference area LRef2.

(blue) Value is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Table E.51: Raw selectively extracted (Tessier extraction) metals data for sediment from Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		Exposed LNF1 (QUL-45)										
								QUL-45-01	QUL-45-02	QUL-45-03	QUL-45-04	QUL-45-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled		TEL	PEL	Sensitive	Typical	LRef1	LRef2	13-Aug-14	13-Aug-14	15-Aug-14	16-Aug-14	16-Aug-14							
Exchangeable & Adsorbed Metals																			
Aluminum	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Barium	mg/kg	-	-	-	-	28.3	<14	14.1	17.0	<20	<25	<15	18.2	17.0	14.1	<25	4.41	1.97	5.48
Beryllium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.069	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Calcium	mg/kg	-	-	-	-	1,037	1,350	1,330	1,500	1,290	1,180	1,140	1,288	1,290	1,140	1,500	142	63.4	176
Chromium	mg/kg	37.3	90	56	110	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Cobalt	mg/kg	-	-	-	-	0.35	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Copper	mg/kg	35.7	197	120	240	0.52	<0.50	2.01	1.92	2.19	2.80	2.12	2.21	2.12	1.92	2.80	0.347	0.155	0.430
Iron	mg/kg	21,200	43,776	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Lead	mg/kg	35	91	57	110	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	mg/kg	460	1,100	-	-	35.0	23.9	9.80	10.0	9.70	7.50	8.40	9.08	9.70	7.50	10.0	1.08	0.485	1.35
Molybdenum	mg/kg	-	-	-	-	<0.50	<1.0	<0.60	<0.60	0.61	0.60	0.58	0.60	0.60	0.58	0.61	0.011	0.0049	0.014
Nickel	mg/kg	16	75	-	-	0.93	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Phosphorus	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Potassium	mg/kg	-	-	-	-	<100	<100	<100	110	110	110	<100	106	110	<100	110	5.48	2.45	6.80
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Sodium	mg/kg	-	-	-	-	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	0	0	0
Strontium	mg/kg	-	-	-	-	7.39	8.24	11.8	15.2	14.6	13.8	12.3	13.5	13.8	11.8	15.2	1.46	0.65	1.81
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0
Uranium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Vanadium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Zinc	mg/kg	123	315	200	380	1.1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0
Carbonate Metals																			
Aluminum	mg/kg	-	-	-	-	<50	<50	62	70	56	60	53	60	60	53	70	6.5	2.9	8.1
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	0.084	<0.050	0.054	0.060	0.065	0.070	<0.050	0.060	0.060	<0.050	0.070	0.0081	0.0036	0.010
Barium	mg/kg	-	-	-	-	10.6	8.60	30.8	32.0	27.6	28.3	24.2	28.6	28.3	24.2	32.0	3.04	1.36	3.77
Beryllium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Calcium	mg/kg	-	-	-	-	86	1,300	8,690	8,900	8,460	8,890	7,970	8,582	8,690	7,970	8,900	386	173	480
Chromium	mg/kg	37.3	90	56	110	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Cobalt	mg/kg	-	-	-	-	0.44	0.25	0.30	0.30	0.24	0.22	0.23	0.26	0.24	0.22	0.3	0.039	0.017	0.048
Copper	mg/kg	35.7	197	120	240	1.25	<0.50	36.1	34.6	34.6	48.3	34.8	**37.7**	34.8	34.6	**48.3**	5.97	2.67	7.41
Iron	mg/kg	21,200	43,776	-	-	233	<50	89	96	72	81	70	82	81	70	96	11	4.9	14
Lead	mg/kg	35	91	57	110	<0.50	<0.50	0.56	0.53	0.57	0.65	<0.50	0.56	0.56	<0.50	0.65	0.056	0.025	0.070
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	mg/kg	460	1,100	-	-	26.2	38.1	79.2	80.6	73.9	75.9	72.9	76.5	75.9	72.9	80.6	3.32	1.49	4.13
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Nickel	mg/kg	16	75	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Phosphorus	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Strontium	mg/kg	-	-	-	-	<5.0	6.80	42.3	46.0	38.3	32.1	32.0	38.1	38.3	32.0	46.0	6.19	2.77	7.69
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Uranium	mg/kg	-	-	-	-	0.11	0.12	0.058	0.055	<0.050	<0.050	<0.050	0.053	<0.050	<0.050	0.058	0.0037	0.0017	0.0046
Vanadium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Zinc	mg/kg	123	315	200	380	1.2	<1.0	1.2	1.0	<1.0	<1.0	<1.0	1.0	<1.0	<1.0	1.2	0.089	0.040	0.11

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
Summary statistics were only calculated for sampling areas with replicate samples (LRef1, LNF1,and LNF2) but not for single composite samples (LRef2, LFF, and LFFF).
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996)
[4] Displayed reference values are the 95th percentiles of data from reference area LRef1 and are the single values available for reference area LRef2.

Value is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.
Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Table E.51: Raw selectively extracted (Tessier extraction) metals data for sediment from Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		Exposed LNF1 (QUL-45)											
								QUL-45-01	QUL-45-02	QUL-45-03	QUL-45-04	QUL-45-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled		TEL	PEL	Sensitive	Typical	LRef1	LRef2	13-Aug-14	13-Aug-14	15-Aug-14	16-Aug-14	16-Aug-14							
Easily Reducible Metals and Iron Oxides																			
Aluminum	mg/kg	-	-	-	-	828	1,010	1,570	1,720	1,230	1,130	1,180	1,366	1,230	1,130	1,720	263	117	326
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	0.789	0.167	1.52	1.63	1.38	1.55	1.43	1.50	1.52	1.38	1.63	0.099	0.044	0.123
Barium	mg/kg	-	-	-	-	13.5	8.33	17.3	19.1	15.5	14.2	14.5	16.1	15.5	14.2	19.1	2.06	0.921	2.56
Beryllium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.093	<0.050	<0.050	0.063	<0.050	<0.050	0.051	0.053	<0.050	<0.050	0.063	0.0057	0.0026	0.0071
Calcium	mg/kg	-	-	-	-	496	710	1,510	1,710	1,430	1,390	1,320	1,472	1,430	1,320	1,710	150	67.0	186
Chromium	mg/kg	37.3	90	56	110	2.88	1.70	1.80	1.90	1.47	1.51	1.65	1.67	1.65	1.47	1.90	0.184	0.082	0.229
Cobalt	mg/kg	-	-	-	-	2.69	4.46	1.56	1.76	1.30	1.12	1.22	1.39	1.30	1.12	1.76	0.263	0.117	0.326
Copper	mg/kg	35.7	197	120	240	3.25	3.90	73.7	78.7	70.1	92.7	74.2	**77.9**	**74.2**	**70.1**	**92.7**	8.83	3.95	11.0
Iron	mg/kg	21,200	43,776	-	-	3,992	5,230	2,950	3,170	2,180	2,070	2,240	2,522	2,240	2,070	3,170	501	224	622
Lead	mg/kg	35	91	57	110	1.22	4.75	1.54	1.73	1.47	1.33	1.29	1.47	1.47	1.29	1.73	0.176	0.079	0.219
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	mg/kg	460	1,100	-	-	46.2	74.4	73.8	85.8	70.0	54.2	64.5	69.7	70.0	54.2	85.8	11.7	5.21	14.5
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Nickel	mg/kg	16	75	-	-	5.84	9.65	1.97	2.27	1.48	1.24	1.59	1.71	1.59	1.24	2.27	0.409	0.183	0.508
Phosphorus	mg/kg	-	-	-	-	104	<50	212	196	174	164	155	180	174	155	212	23.4	10.5	29.1
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Strontium	mg/kg	-	-	-	-	5.44	6.22	26.1	28.8	25.4	23.9	23.7	25.6	25.4	23.7	28.8	2.06	0.92	2.56
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	1.0	2.0	1.0	1.2	<1.0	1.2	<1.0	1.1	1.0	<1.0	1.2	0.11	0.049	0.14
Uranium	mg/kg	-	-	-	-	0.109	0.282	0.104	0.115	0.086	0.092	0.080	0.0954	0.0920	0.0800	0.115	0.0141	0.0063	0.0175
Vanadium	mg/kg	-	-	-	-	5.27	1.94	8.38	8.80	5.96	6.02	6.10	7.05	6.10	5.96	8.80	1.41	0.63	1.75
Zinc	mg/kg	123	315	200	380	12.0	10.0	6.50	7.60	4.70	5.30	4.90	5.80	5.30	4.70	7.60	1.22	0.55	1.52
Organic Bound Metals																			
Aluminum	mg/kg	-	-	-	-	743	783	815	886	725	659	640	745	725	640	886	104	46.7	130
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Arsenic	mg/kg	5.9	17	11	20	0.246	0.085	0.273	0.278	0.620	0.505	0.553	0.446	0.505	0.273	0.620	0.161	0.072	0.200
Barium	mg/kg	-	-	-	-	6.23	1.40	9.96	10.5	8.84	8.60	7.92	9.16	8.84	7.92	10.5	1.05	0.47	1.30
Beryllium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	<0.050	<0.050	<0.050	0.052	<0.050	<0.050	<0.050	0.050	<0.050	<0.050	0.052	0.00089	0.00040	0.0011
Calcium	mg/kg	-	-	-	-	522	367	605	630	787	660	669	670	660	605	787	70.0	31.3	86.9
Chromium	mg/kg	37.3	90	56	110	2.70	1.80	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Cobalt	mg/kg	-	-	-	-	1.52	0.96	1.34	1.43	1.28	1.31	1.11	1.29	1.31	1.11	1.43	0.117	0.052	0.145
Copper	mg/kg	35.7	197	120	240	3.73	4.00	549	561	500	550	487	**529**	**549**	**487**	**561**	33.4	14.9	41.5
Iron	mg/kg	21,200	43,776	-	-	301	310	350	365	356	354	342	353	354	342	365	8.41	3.76	10.4
Lead	mg/kg	35	91	57	110	<0.50	<0.50	0.63	0.67	0.68	0.57	0.57	0.62	0.63	0.57	0.68	0.053	0.024	0.065
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0
Manganese	mg/kg	460	1,100	-	-	8.2	6.5	10.7	12.5	10.0	9.3	8.3	10.2	10.0	8.3	12.5	1.58	0.71	1.96
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	0.79	0.76	1.04	1.09	1.08	0.95	1.04	0.76	1.09	0.16	0.073	0.20
Nickel	mg/kg	16	75	-	-	2.10	2.40	<0.50	0.51	<0.50	<0.50	<0.50	0.50	<0.50	<0.50	0.51	0.0045	0.0020	0.0056
Selenium	mg/kg	2	-	-	-	0.28	<0.20	0.74	0.78	0.65	0.68	0.62	0.69	0.68	0.62	0.78	0.065	0.029	0.081
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Strontium	mg/kg	-	-	-	-	2.71	2.82	9.73	9.32	8.98	8.81	8.97	9.16	8.98	8.81	9.73	0.368	0.165	0.457
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	57.3	28.8	<1.0	1.40	2.20	1.40	1.70	1.54	1.40	<1.0	2.20	0.44	0.20	0.55
Uranium	mg/kg	-	-	-	-	0.062	0.066	0.076	0.080	0.074	0.071	0.064	0.073	0.074	0.064	0.080	0.0060	0.0027	0.0074
Vanadium	mg/kg	-	-	-	-	2.97	2.29	0.56	0.59	0.82	0.68	0.70	0.67	0.68	0.56	0.82	0.10	0.05	0.13
Zinc	mg/kg	123	315	200	380	4.2	3.1	3.3	4.0	3.7	5.4	3.9	4.1	3.9	3.3	5.4	0.80	0.36	0.99

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
Summary statistics were only calculated for sampling areas with replicate samples (LRef1, LNF1,and LNF2) but not for single composite samples (LRef2, LFF, and LFFF).

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Displayed reference values are the 95th percentiles of data from reference area LRef1 and are the single values available for reference area LRef2.

(blue) Value is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Table E.51: Raw selectively extracted (Tessier extraction) metals data for sediment from Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		Exposed LNF1 (QUL-45)											
								QUL-45-01	QUL-45-02	QUL-45-03	QUL-45-04	QUL-45-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled		TEL	PEL	Sensitive	Typical	LRef1	LRef2	13-Aug-14	13-Aug-14	15-Aug-14	16-Aug-14	16-Aug-14							
Residual Metals																			
Aluminum	mg/kg	-	-	-	-	9,092	14,200	11,700	12,900	13,300	13,800	12,500	12,840	12,900	11,700	13,800	799	357	992
Antimony	mg/kg	-	-	-	-	0.20	<0.10	0.24	0.25	0.33	0.33	0.30	0.29	0.3	0.24	0.33	0.043	0.019	0.053
Arsenic	mg/kg	5.9	17	11	20	2.85	1.44	7.88	8.85	8.53	9.48	8.56	**8.66**	**8.56**	**7.88**	**9.48**	0.580	0.259	0.720
Barium	mg/kg	-	-	-	-	41.0	25.1	80.9	78.3	89.1	87.0	86.1	84.3	86.1	78.3	89.1	4.50	2.01	5.59
Beryllium	mg/kg	-	-	-	-	<0.20	0.25	0.38	0.38	0.44	0.44	0.41	0.41	0.41	0.38	0.44	0.030	0.013	0.037
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Cadmium	mg/kg	0.6	3.5	2.2	4.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Calcium	mg/kg	-	-	-	-	4,092	2,280	8,460	8,700	10,100	11,700	9,740	9,740	9,740	8,460	11,700	1,293	578	1,606
Chromium	mg/kg	37.3	90	56	110	30.8	32.9	9.7	9.4	10.4	9.8	10.5	10.0	9.8	9.4	10.5	0.47	0.21	0.59
Cobalt	mg/kg	-	-	-	-	4.20	7.82	11.7	12.6	12.3	13.4	11.6	12.3	12.3	11.6	13.4	0.73	0.33	0.91
Copper	mg/kg	35.7	197	120	240	12.7	13.8	150	141	130	160	119	**140**	**141**	**119**	**160**	16.1	7.22	20.0
Iron	mg/kg	21,200	43,776	-	-	14,920	24,800	37,900	35,400	40,700	45,100	40,600	**39,940**	**40,600**	**35,400**	**45,100**	3,620	1,619	4,494
Lead	mg/kg	35	91	57	110	1.80	2.60	2.10	2.31	2.36	2.25	2.17	2.24	2.25	2.10	2.36	0.10	0.05	0.13
Lithium	mg/kg	-	-	-	-	6.86	24.1	12.4	13.5	13.4	14.0	12.6	13.2	13.4	12.4	14.0	0.66	0.30	0.83
Manganese	mg/kg	460	1,100	-	-	169	150	363	397	414	457	377	402	397	363	457	36.5	16.3	45.4
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	2.50	2.54	2.31	2.88	2.43	2.53	2.50	2.31	2.88	0.213	0.095	0.265
Nickel	mg/kg	16	75	-	-	13.7	24.0	6.9	8.1	8.0	7.8	7.7	7.7	7.8	6.9	8.1	0.47	0.21	0.59
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	0.22	0.21	0.21	0.30	0.20	0.23	0.21	0.20	0.30	0.041	0.018	0.051
Silver	mg/kg	0.5	-	-	-	0.16	<0.10	0.29	0.28	0.30	0.31	0.28	0.29	0.29	0.28	0.31	0.013	0.0058	0.016
Strontium	mg/kg	-	-	-	-	30.2	37.2	59.3	57.6	68.2	70.6	67.4	64.6	67.4	57.6	70.6	5.79	2.59	7.18
Thallium	mg/kg	-	-	-	-	0.063	0.11	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.7	2.1	<2.0	<2.0	2.7	0.31	0.14	0.39
Titanium	mg/kg	-	-	-	-	868	698	988	1,000	1,390	1,410	1,230	1,204	1,230	988	1,410	204	91.1	253
Uranium	mg/kg	-	-	-	-	0.414	0.613	0.553	0.571	0.692	0.758	0.634	0.642	0.634	0.553	0.758	0.0851	0.0381	0.106
Vanadium	mg/kg	-	-	-	-	40.3	21.0	144	133	157	167	156	151	156	133	167	13.1	5.87	16.3
Zinc	mg/kg	123	315	200	380	29.3	42.6	39.8	44.4	42.7	47.6	39.9	42.9	42.7	39.8	47.6	3.28	1.47	4.07

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
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[4] Displayed reference values are the 95th percentiles of data from reference area LRef1 and are the single values available for reference area LRef2.

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Table E.51: Raw selectively extracted (Tessier extraction) metals data for sediment from Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		Exposed													
								LNF2 (QUL-49)												LFF (QUL-47) Composite	LFFF (QUL-48) Composite
								QUL-49-01	QUL-49-02	QUL-49-03	QUL-49-04	QUL-49-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE		
Date Sampled		TEL	PEL	Sensitive	Typical	LRef1	LRef2	18-Aug-14	20-Aug-14	20-Aug-14	23-Aug-14	23-Aug-14								6-Sep-14	7-Sep-14
Exchangeable & Adsorbed Metals																					
Aluminum	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50	<50
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10
Arsenic	mg/kg	5.9	17	11	20	<0.050	<0.050	<0.050	<0.050	0.059	<0.050	<0.050	0.052	<0.050	<0.050	0.059	0.0040	0.0018	0.0050	<0.050	0.061
Barium	mg/kg	-	-	-	-	28.3	<14	<25	<20	<25	<20	<20	<25	<20	<20	<25	2.7	1.2	3.4	<15	<15
Beryllium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.069	<0.050	0.070	0.059	0.052	<0.050	<0.050	0.056	0.052	<0.050	0.070	0.0086	0.0038	0.011	<0.050	0.11
Calcium	mg/kg	-	-	-	-	1,037	1,350	3,740	3,160	3,070	1,500	1,270	2,548	3,070	1,270	3,740	1,095	490	1,360	2,010	3,700
Chromium	mg/kg	37.3	90	56	110	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50	<0.50
Cobalt	mg/kg	-	-	-	-	0.35	<0.10	0.16	0.13	0.11	<0.10	<0.10	0.12	0.11	<0.10	0.16	0.025	0.011	0.032	0.21	0.47
Copper	mg/kg	35.7	197	120	240	0.52	<0.50	0.66	0.84	0.85	1.08	1.32	0.95	0.85	0.66	1.32	0.25	0.11	0.32	<0.50	<0.50
Iron	mg/kg	21,200	43,776	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50	<50
Lead	mg/kg	35	91	57	110	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50	<0.50
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0
Manganese	mg/kg	460	1,100	-	-	35.0	23.9	137	127	95.7	36.7	31.4	85.6	95.7	31.4	137	49.5	22.1	61.4	22.5	31.3
Molybdenum	mg/kg	-	-	-	-	<0.50	<1.0	0.69	0.69	0.75	0.66	0.61	0.68	0.69	0.61	0.75	0.051	0.023	0.063	<0.50	<0.50
Nickel	mg/kg	16	75	-	-	0.93	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	0.51	0.98
Phosphorus	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50	<50
Potassium	mg/kg	-	-	-	-	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	0	0	0	<100	<100
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10
Sodium	mg/kg	-	-	-	-	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	0	0	0	<100	<100
Strontium	mg/kg	-	-	-	-	7.39	8.24	27.5	24.0	25.8	13.0	10.9	20.2	24.0	10.9	27.5	7.70	3.45	9.56	11.7	21.9
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0
Titanium	mg/kg	-	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0	<1.0	<1.0
Uranium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050
Vanadium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20
Zinc	mg/kg	123	315	200	380	1.1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0	<1.0	<1.0
Carbonate Metals																					
Aluminum	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50	<50
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10
Arsenic	mg/kg	5.9	17	11	20	0.084	<0.050	0.199	0.175	0.177	0.123	0.099	0.155	0.175	0.099	0.199	0.0418	0.0187	0.0519	<0.050	0.12
Barium	mg/kg	-	-	-	-	10.6	8.60	27.1	29.2	34.8	32.9	28.8	30.6	29.2	27.1	34.8	3.18	1.42	3.94	4.80	7.70
Beryllium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20
Cadmium	mg/kg	0.6	3.5	2.2	4.2	<0.050	<0.050	0.057	0.054	<0.050	<0.050	<0.050	0.052	<0.050	<0.050	0.057	0.0032	0.0014	0.0040	<0.050	<0.050
Calcium	mg/kg	-	-	-	-	86	1,300	6,590	7,040	8,420	9,170	8,550	7,954	8,420	6,590	9,170	1,089	487	1,352	178	454
Chromium	mg/kg	37.3	90	56	110	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0
Cobalt	mg/kg	-	-	-	-	0.44	0.25	0.57	0.56	0.53	0.35	0.34	0.47	0.53	0.34	0.57	0.12	0.05	0.14	0.23	0.37
Copper	mg/kg	35.7	197	120	240	1.25	<0.50	5.91	7.43	9.33	19.4	20.9	12.6	9.3	5.9	20.9	7.02	3.14	8.72	<0.50	<0.50
Iron	mg/kg	21,200	43,776	-	-	233	<50	<50	69	73	149	143	97	73	<50	149	46	20	57	<50	<50
Lead	mg/kg	35	91	57	110	<0.50	<0.50	0.58	0.67	0.78	0.81	0.73	0.71	0.73	0.58	0.81	0.092	0.041	0.11	<0.50	<0.50
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0
Manganese	mg/kg	460	1,100	-	-	26.2	38.1	102	106	104	85.2	78.6	95.2	102.0	78.6	106	12.4	5.55	15.4	11.5	10.8
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50	<0.50
Nickel	mg/kg	16	75	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0
Phosphorus	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50	<50
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10
Strontium	mg/kg	-	-	-	-	<5.0	6.80	29.4	30.6	36.8	36.5	32.7	33.2	32.7	29.4	36.8	3.37	1.50	4.18	<5.0	<5.0
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0
Titanium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0
Uranium	mg/kg	-	-	-	-	0.11	0.12	0.21	0.21	0.20	0.10	0.07	0.16	0.20	0.07	0.21	0.069	0.031	0.085	0.12	0.26
Vanadium	mg/kg	-	-	-	-	<0.20	<0.20	0.30	0.34	0.37	0.31	0.26	0.32	0.31	0.26	0.37	0.042	0.019	0.052	<0.20	<0.20
Zinc	mg/kg	123	315	200	380	1.2	<1.0	2.3	1.8	1.7	1.1	<1.0	1.6	1.7	<1.0	2.3	0.54	0.24	0.67	<1.0	1.5

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
Summary statistics were only calculated for sampling areas with replicate samples (LRef1, LNF1,and LNF2) but not for single composite samples (LRef2, LFF, and LFFF).

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Displayed reference values are the 95th percentiles of data from reference area LRef1 and are the single values available for reference area LRef2.

Value is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Table E.51: Raw selectively extracted (Tessier extraction) metals data for sediment from Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		Exposed LNF2 (QUL-49)												LFF (QUL-47) Composite	LFFF (QUL-48) Composite
								QUL-49-01	QUL-49-02	QUL-49-03	QUL-49-04	QUL-49-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE		
Date Sampled		TEL	PEL	Sensitive	Typical	LRef1	LRef2	18-Aug-14	20-Aug-14	20-Aug-14	23-Aug-14	23-Aug-14								6-Sep-14	7-Sep-14
Easily Reducible Metals and Iron Oxides																					
Aluminum	mg/kg	-	-	-	-	828	1,010	1,200	1,220	1,370	1,250	1,250	1,258	1,250	1,200	1,370	66.1	29.6	82.1	826	1,170
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10
Arsenic	mg/kg	5.9	17	11	20	0.789	0.167	1.42	1.44	1.59	1.66	1.61	1.54	1.59	1.42	1.66	0.107	0.048	0.133	0.448	2.03
Barium	mg/kg	-	-	-	-	13.5	8.33	23.2	21.4	23.8	20.5	18.5	21.5	21.4	18.5	23.8	2.13	0.95	2.65	5.98	13.1
Beryllium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20
Cadmium	mg/kg	0.6	3.5	2.2	4.2	0.093	<0.050	0.080	0.062	0.068	<0.050	<0.050	0.062	0.062	<0.050	0.080	0.013	0.0057	0.016	<0.050	0.18
Calcium	mg/kg	-	-	-	-	496	710	2,050	1,880	2,010	1,550	1,460	1,790	1,880	1,460	2,050	270	121	335	627	719
Chromium	mg/kg	37.3	90	56	110	2.88	1.70	1.29	1.39	1.69	1.68	1.75	1.56	1.68	1.29	1.75	0.206	0.092	0.255	2.29	2.86
Cobalt	mg/kg	-	-	-	-	2.69	4.46	1.76	1.72	1.80	1.19	1.16	1.53	1.72	1.16	1.80	0.322	0.144	0.400	2.36	3.37
Copper	mg/kg	35.7	197	120	240	3.25	3.90	36.9	43.1	52.6	71.5	70.0	**54.8**	**52.6**	**36.9**	**71.5**	15.6	6.97	19.4	1.99	1.96
Iron	mg/kg	21,200	43,776	-	-	3,992	5,230	3,090	3,130	3,180	2,270	2,280	2,790	3,090	2,270	3,180	471	211	585	3,090	5,340
Lead	mg/kg	35	91	57	110	1.22	4.75	1.64	1.66	1.80	1.42	1.37	1.58	1.64	1.37	1.80	0.179	0.080	0.222	1.64	3.43
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0
Manganese	mg/kg	460	1,100	-	-	46.2	74.4	73.5	70.5	73.0	51.4	50.8	63.8	70.5	50.8	73.5	11.7	5.23	14.5	35.7	41.3
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50	<0.50
Nickel	mg/kg	16	75	-	-	5.84	9.65	2.88	2.79	2.99	1.90	1.83	2.48	2.79	1.83	2.99	0.56	0.25	0.70	4.88	7.91
Phosphorus	mg/kg	-	-	-	-	104	<50	129	98	119	155	174	135	129	98	174	29.9	13.4	37.2	54.0	<50
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10
Strontium	mg/kg	-	-	-	-	5.44	6.22	35.3	34.1	35.1	32.7	30.6	33.6	34.1	30.6	35.3	1.95	0.87	2.42	4.15	5.38
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0
Titanium	mg/kg	-	-	-	-	1.0	2.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0	<1.0	<1.0
Uranium	mg/kg	-	-	-	-	0.109	0.282	0.179	0.158	0.185	0.106	0.093	0.144	0.158	0.093	0.185	0.042	0.019	0.052	0.120	0.343
Vanadium	mg/kg	-	-	-	-	5.27	1.94	6.20	6.00	6.47	5.49	5.80	5.99	6.00	5.49	6.47	0.374	0.167	0.465	4.75	6.96
Zinc	mg/kg	123	315	200	380	12.0	10.0	8.80	8.20	8.30	5.50	5.20	7.20	8.20	5.20	8.80	1.71	0.76	2.12	8.00	18.2
Organic Bound Metals																					
Aluminum	mg/kg	-	-	-	-	743	783	1,640	1,350	1,450	806	707	1,191	1,350	707	1,640	411	184	511	1,110	3,110
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10
Arsenic	mg/kg	5.9	17	11	20	0.246	0.085	1.60	1.23	1.47	0.926	0.867	1.22	1.23	0.87	1.60	0.323	0.145	0.401	0.195	1.56
Barium	mg/kg	-	-	-	-	6.23	1.40	17.7	14.8	16.1	10.3	9.26	13.6	14.8	9.26	17.7	3.68	1.65	4.57	2.52	7.38
Beryllium	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20
Cadmium	mg/kg	0.6	3.5	2.2	4.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050
Calcium	mg/kg	-	-	-	-	522	367	1,430	1,180	1,410	1,070	1,070	1,232	1,180	1,070	1,430	178	79.4	220	665	916
Chromium	mg/kg	37.3	90	56	110	2.70	1.80	3.26	2.68	2.47	0.83	0.65	1.98	2.47	0.65	3.26	1.17	0.52	1.45	3.30	11.6
Cobalt	mg/kg	-	-	-	-	1.52	0.96	1.56	1.42	1.59	1.39	1.27	1.45	1.42	1.27	1.59	0.131	0.059	0.162	1.26	4.10
Copper	mg/kg	35.7	197	120	240	3.73	4.00	327	324	387	322	346	**341**	**327**	**322**	**387**	27.3	12.2	33.9	6.57	29.0
Iron	mg/kg	21,200	43,776	-	-	301	310	994	742	766	415	365	656	742	365	994	263	118	326	531	4,000
Lead	mg/kg	35	91	57	110	<0.50	<0.50	1.10	0.88	0.97	0.60	0.58	0.83	0.88	0.58	1.10	0.23	0.10	0.28	<0.50	2.2
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0	<5.0
Manganese	mg/kg	460	1,100	-	-	8.2	6.5	17.6	13.8	16.9	10.0	9.1	13.5	13.8	9.1	17.6	3.88	1.73	4.81	10.0	33.5
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	2.08	1.60	1.51	1.14	1.10	1.49	1.51	1.10	2.08	0.40	0.18	0.49	<0.50	0.67
Nickel	mg/kg	16	75	-	-	2.10	2.40	1.88	1.41	1.39	0.71	0.56	1.19	1.39	0.56	1.88	0.546	0.244	0.678	2.35	9.54
Selenium	mg/kg	2	-	-	-	0.28	<0.20	0.73	0.72	0.82	0.61	0.63	0.70	0.72	0.61	0.82	0.085	0.038	0.11	0.27	1.75
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.10
Strontium	mg/kg	-	-	-	-	2.71	2.82	14.7	13.9	14.3	9.47	9.41	12.4	13.9	9.4	14.7	2.68	1.20	3.32	3.15	4.97
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0
Titanium	mg/kg	-	-	-	-	57.3	28.8	14.0	8.0	6.7	3.7	2.6	7.0	6.7	2.6	14	4.5	2.0	5.6	11.9	21.9
Uranium	mg/kg	-	-	-	-	0.062	0.066	0.226	0.177	0.197	0.118	0.126	0.169	0.177	0.118	0.226	0.046	0.021	0.057	0.070	0.25
Vanadium	mg/kg	-	-	-	-	2.97	2.29	6.56	3.56	4.06	1.40	1.21	3.36	3.56	1.21	6.56	2.19	0.981	2.72	2.69	10.4
Zinc	mg/kg	123	315	200	380	4.2	3.1	5.9	5.0	5.5	3.9	3.8	4.8	5.0	3.8	5.9	0.94	0.42	1.2	2.9	14

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
Summary statistics were only calculated for sampling areas with replicate samples (LRef1, LNF1,and LNF2) but not for single composite samples (LRef2, LFF, and LFFF).

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Displayed reference values are the 95th percentiles of data from reference area LRef1 and are the single values available for reference area LRef2.

(blue) Value is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Table E.51: Raw selectively extracted (Tessier extraction) metals data for sediment from Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		Exposed														
								LNF2 (QUL-49)													LFF (QUL-47) Composite	LFFF (QUL-48) Composite
								QUL-49-01	QUL-49-02	QUL-49-03	QUL-49-04	QUL-49-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE			
Date Sampled		TEL	PEL	Sensitive	Typical	LRef1	LRef2	18-Aug-14	20-Aug-14	20-Aug-14	23-Aug-14	23-Aug-14								6-Sep-14	7-Sep-14	
Residual Metals																						
Aluminum	mg/kg	-	-	-	-	9,092	14,200	12,300	12,700	15,000	12,900	12,200	13,020	12,700	12,200	15,000	1,143	511	1,419	9,930	13,000	
Antimony	mg/kg	-	-	-	-	0.20	<0.10	0.28	0.27	0.34	0.29	0.29	0.29	0.29	0.27	0.34	0.027	0.012	0.034	0.13	0.42	
Arsenic	mg/kg	5.9	17	11	20	2.85	1.44	6.47	6.94	7.93	7.74	7.55	**7.33**	**7.55**	**6.47**	**7.93**	0.606	0.271	0.752	2.48	4.91	
Barium	mg/kg	-	-	-	-	41.0	25.1	90.3	97.5	105	94.7	92.7	96.0	94.7	90.3	105	5.66	2.53	7.03	31.1	32.3	
Beryllium	mg/kg	-	-	-	-	<0.20	0.25	0.34	0.36	0.42	0.38	0.38	0.38	0.38	0.34	0.42	0.030	0.013	0.037	<0.20	<0.20	
Bismuth	mg/kg	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	
Cadmium	mg/kg	0.6	3.5	2.2	4.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.050	
Calcium	mg/kg	-	-	-	-	4,092	2,280	7,980	8,440	9,900	10,300	10,300	9,384	9,900	7,980	10,300	1,096	490	1,361	5,210	4,360	
Chromium	mg/kg	37.3	90	56	110	30.8	32.9	13.8	14.3	14.0	12.3	12.9	13.5	13.8	12.3	14.3	0.832	0.372	1.03	26.3	35.8	
Cobalt	mg/kg	-	-	-	-	4.20	7.82	10.2	11.1	12.4	11.2	11.6	11.3	11.2	10.2	12.4	0.800	0.358	0.993	5.69	6.84	
Copper	mg/kg	35.7	197	120	240	12.7	13.8	70.7	74.5	85.7	68.5	71.6	**74.2**	**71.6**	**68.5**	**85.7**	6.78	3.03	8.42	14.2	18.8	
Iron	mg/kg	21,200	43,776	-	-	14,920	24,800	38,800	42,100	37,900	41,800	50,900	42,300	41,800	37,900	50,900	5,144	2,301	6,387	17,700	19,900	
Lead	mg/kg	35	91	57	110	1.80	2.60	2.31	2.43	2.69	2.18	2.11	2.34	2.31	2.11	2.69	0.229	0.102	0.284	2.09	1.98	
Lithium	mg/kg	-	-	-	-	6.86	24.1	12.6	13.3	15.6	13.2	12.6	13.5	13.2	12.6	15.6	1.24	0.55	1.54	8.00	12.0	
Manganese	mg/kg	460	1,100	-	-	169	150	324	337	403	368	363	359	363	324	403	30.6	13.7	38.0	194	246	
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	0.77	1.15	1.42	1.61	1.75	1.34	1.42	0.77	1.75	0.390	0.174	0.484	<0.50	<0.50	
Nickel	mg/kg	16	75	-	-	13.7	24.0	9.5	9.8	10.5	8.9	8.8	9.5	9.5	8.8	10.5	0.70	0.31	0.86	14.7	22.6	
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.20	
Silver	mg/kg	0.5	-	-	-	0.16	<0.10	0.24	0.23	0.25	0.23	0.23	0.24	0.23	0.23	0.25	0.0089	0.0040	0.011	<0.10	<0.10	
Strontium	mg/kg	-	-	-	-	30.2	37.2	51.1	54.0	61.9	59.2	62.8	57.8	59.2	51.1	62.8	5.08	2.27	6.30	41.3	28.5	
Thallium	mg/kg	-	-	-	-	0.063	0.11	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	0.055	
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0	<2.0	
Titanium	mg/kg	-	-	-	-	868	698	1,040	1,050	1,320	1,330	1,340	1,216	1,320	1,040	1,340	156	69.9	194	866	1,090	
Uranium	mg/kg	-	-	-	-	0.414	0.613	0.522	0.531	0.660	0.646	0.636	0.599	0.636	0.522	0.66	0.0668	0.0299	0.0829	0.302	0.292	
Vanadium	mg/kg	-	-	-	-	40.3	21.0	139	152	138	156	188	155	152	138	188	20.3	9.06	25.2	59.7	60.0	
Zinc	mg/kg	123	315	200	380	29.3	42.6	39.0	40.6	45.6	39.9	39.3	40.9	39.9	39.0	45.6	2.71	1.21	3.36	28.7	35.0	

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
Summary statistics were only calculated for sampling areas with replicate samples (LRef1, LNF1,and LNF2) but not for single composite samples (LRef2, LFF, and LFFF).
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996)
[4] Displayed reference values are the 95th percentiles of data from reference area LRef1 and are the single values available for reference area LRef2.

(blue) Value is > TEL. Values shown in bold text also exceed both Reference 95th Percentile values.
(orange) Value is > PEL. Values shown in bold text also exceed both Reference 95th Percentile values.

Table E.52: Raw leachable metals data for sediment from Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Data are based on bulk sediment [1].

Sample ID	Units	BCWQG [2]			HWR [3]	Reference Value [4]		Reference												
								LRef1 (QUL-51)												LRef2 (QUL-52) Composite
								QUL-51-01	QUL-51-02	QUL-51-03	QUL-51-04	QUL-51-05	Mean	Median	Minimum	Maximum	95th Percentile	Standard Deviation	Standard Error	t*SE	
Date Sampled		**Type**	**Chronic**	**Acute**		**LRef1**	**LRef2**	26-Aug-14	24-Aug-14	25-Aug-14	25-Aug-14	26-Aug-14									17-Oct-14
Aluminum	mg/L	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Antimony	mg/L	W	0.009	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Arsenic	mg/L	A	-	0.0050	2.5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Barium	mg/L	W	1.0	-	100	0.045	0.043	0.034	0.043	0.024	0.031	0.045	0.035	0.034	0.024	0.045	0.045	0.0087	0.0039	0.011	0.043
Beryllium	mg/L	W	0.00013	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0	0	0	<0.0050
Bismuth	mg/L	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Cadmium	mg/L	A	0.00027	0.00081	0.5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010
Calcium	mg/L	-	-	-	-	14.0	93.2	14.1	6.81	11.1	13.8	9.75	11.1	11.1	6.81	14.1	14.0	3.02	1.35	3.75	93.2
Chromium [5]	mg/L	W	0.001	-	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010
Cobalt	mg/L	A	0.0040	0.11	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010
Copper	mg/L	A	0.0055	0.015	100	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010
Iron	mg/L	A	-	1.0	-	0.345	0.579	0.362	0.279	0.229	0.125	0.224	0.244	0.229	0.125	0.362	0.345	0.0865	0.0387	0.107	0.579
Lead	mg/L	A	0.008	0.12	5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Magnesium	mg/L	-	-	-	-	2.16	4.53	2.09	1.69	1.72	1.91	2.18	1.92	1.91	1.69	2.18	2.16	0.218	0.097	0.270	4.53
Manganese	mg/L	A	1.21	2.05	-	0.254	2.02	0.0433	0.178	0.0160	0.0395	0.273	0.110	0.0433	0.016	0.273	0.254	0.111	0.050	0.138	2.02
Mercury	mg/L	A	0.00002	-	0.1	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0	0	0	<0.000050
Molybdenum	mg/L	A	1	2	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0	<0.030
Nickel [6]	mg/L	W	-	0.121	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Phosphorus	mg/L	A	-	0.0050-0.015	-	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0	0	0	<0.30
Potassium	mg/L	-	-	-	-	3.6	2.4	3.8	<2.0	2.2	2.8	2.2	2.6	2.2	<2.0	3.8	3.6	0.73	0.33	0.91	2.4
Selenium	mg/L	A	0.002	-	1	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Silicon	mg/L	-	-	-	-	5.38	4.72	5.24	5.20	4.60	4.20	5.42	4.93	5.2	4.2	5.42	5.38	0.513	0.229	0.636	4.72
Silver	mg/L	A	0.0015	0.003	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010
Sodium	mg/L	-	-	-	-	2.6	<2.0	<2.0	2.2	<2.0	<2.0	2.7	2.2	<2.0	<2.0	2.7	2.6	0.30	0.14	0.38	<2.0
Strontium	mg/L	-	-	-	-	0.0975	0.638	0.0985	0.0442	0.0770	0.0936	0.0635	0.0754	0.077	0.0442	0.0985	0.0975	0.0223	0.0100	0.0276	0.638
Thallium	mg/L	W	0.0008	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Tin	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0	<0.030
Titanium	mg/L	-	-	-	-	0.013	0.013	0.013	0.013	0.011	<0.010	<0.010	0.011	0.011	<0.010	0.011	0.013	0.0015	0.0007	0.0019	0.013
Uranium	mg/L	W	0.0085	-	10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Vanadium	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0	<0.030
Zinc	mg/L	A	0.043	0.068	500	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0	<0.020

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL. Summary statistics were only calculated for sampling areas with replicate samples (LRef1, LNF1,and LNF2) but not for single composite samples (LRef2, LFF, and LFFF).

[2] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.

[3] Hazardous Waste Regulation (Government of British Columbia 1988)

[4] Displayed reference values are the 95th percentiles of data from reference area LRef1, and are the single values available for reference area LRef2.

[5] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.

[6] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)

(orange) Value is > either guideline (values < MDL excluded). Values shown in bold text also exceed both Reference Values.

Table E.52: Raw leachable metals data for sediment from Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Data are based on bulk sediment [1].

Sample ID	Units	BCWQG [2]			HWR [3]	Reference Value [4]		Exposed LNF1 (QUL-45)											
								QUL-45-01	QUL-45-02	QUL45-03	QUL45-04	QUL45-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled		**Type**	**Chronic**	**Acute**		**LRef1**	**LRef2**	13-Aug-14	13-Aug-14	15-Aug-14	16-Aug-14	16-Aug-14							
Aluminum	mg/L	-	-	-	-	<0.20	<0.20	0.27	0.27	<0.20	0.58	<0.20	0.30	0.27	<0.20	0.58	0.16	0.071	0.20
Antimony	mg/L	W	0.009	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Arsenic	mg/L	A	-	0.0050	2.5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Barium	mg/L	W	1.0	-	100	0.045	0.043	0.027	0.031	0.027	0.039	0.022	0.029	0.027	0.022	0.039	0.0063	0.0028	0.0079
Beryllium	mg/L	W	0.00013	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0	0	0
Bismuth	mg/L	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
Cadmium	mg/L	A	0.00027	0.00081	0.5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Calcium	mg/L	-	-	-	-	14.0	93.2	20.1	23.9	22.7	12.6	18.5	19.6	20.1	12.6	23.9	4.43	1.98	5.50
Chromium [5]	mg/L	W	0.001	-	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Cobalt	mg/L	A	0.0040	0.11	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Copper	mg/L	A	0.0055	0.015	100	<0.010	<0.010	0.025	0.014	0.021	0.025	0.028	**0.023**	**0.025**	**0.014**	**0.028**	0.0054	0.0024	0.0067
Iron	mg/L	A	-	1.0	-	0.345	0.579	0.167	0.189	0.108	0.394	0.208	0.213	0.189	0.108	0.394	0.108	0.048	0.134
Lead	mg/L	A	0.008	0.12	5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Magnesium	mg/L	-	-	-	-	2.16	4.53	2.86	3.47	3.24	1.47	2.58	2.72	2.86	1.47	3.47	0.780	0.349	0.969
Manganese	mg/L	A	1.21	2.05	-	0.254	2.02	0.0380	0.0377	0.0503	0.0174	0.0341	0.0355	0.0377	0.0174	0.0503	0.0118	0.0053	0.0147
Mercury	mg/L	A	0.00002	-	0.1	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0	0	0
Molybdenum	mg/L	A	1	2	-	<0.030	<0.030	0.044	0.051	0.045	0.034	0.033	0.041	0.044	0.033	0.051	0.0077	0.0034	0.0096
Nickel [6]	mg/L	W	-	0.121	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Phosphorus	mg/L	A	-	0.0050-0.015	-	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0	0	0
Potassium	mg/L	-	-	-	-	3.6	2.4	3.5	4.5	3.6	3.4	2.9	3.6	3.5	2.9	4.5	0.58	0.26	0.72
Selenium	mg/L	A	0.002	-	1	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Silicon	mg/L	-	-	-	-	5.38	4.72	4.92	5.67	5.12	5.62	4.20	5.11	5.12	4.20	5.67	0.60	0.27	0.74
Silver	mg/L	A	0.0015	0.003	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0
Sodium	mg/L	-	-	-	-	2.6	<2.0	14.4	20.8	16.4	12.0	12.3	15.2	14.4	12.0	20.8	3.61	1.61	4.48
Strontium	mg/L	-	-	-	-	0.0975	0.638	0.225	0.269	0.252	0.159	0.197	0.220	0.225	0.159	0.269	0.0439	0.0196	0.0545
Thallium	mg/L	W	0.0008	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Tin	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0
Titanium	mg/L	-	-	-	-	0.013	0.013	0.011	0.011	<0.010	0.015	<0.010	0.011	0.011	<0.010	0.015	0.0021	0.00093	0.0026
Uranium	mg/L	W	0.0085	-	10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0
Vanadium	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0
Zinc	mg/L	A	0.043	0.068	500	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were
statistics were only calculated for sampling areas with replicate samples (LRef1, LNF1,and LNF2) but not for single composite samples (LRef2, LFF, and LFFF).
[2] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based gu
[3] Hazardous Waste Regulation (Government of British Columbia 1988)
[4] Displayed reference values are the 95th percentiles of data from reference area LRef1, and are the single values available for reference area LRef2.
[5] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.
[6] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)
(orange box) Value is > either guideline (values < MDL excluded). Values shown in bold text also exceed both Reference Values.

Table E.52: Raw leachable metals data for sediment from Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014. Data are based on bulk sediment [1].

Sample ID	Units	BCWQG [2]			HWR [3]	Reference Value [4]		Exposed													
								LNF2 (QUL-49)												LFF (QUL-47) Composite	LFFF (QUL-48) Composite
								QUL49-01	QUL49-02	QUL49-03	QUL49-04	QUL49-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE		
Date Sampled		**Type**	**Chronic**	**Acute**		**LRef1**	**LRef2**	18-Aug-14	20-Aug-14	20-Aug-14	23-Aug-14	23-Aug-14								6-Sep-14	7-Sep-14
Aluminum	mg/L	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.40
Antimony	mg/L	W	0.009	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.10
Arsenic	mg/L	A	-	0.0050	2.5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.10
Barium	mg/L	W	1.0	-	100	0.045	0.043	0.173	0.153	0.145	0.095	0.083	0.130	0.145	0.083	0.173	0.0388	0.0174	0.0482	0.019	0.097
Beryllium	mg/L	W	0.00013	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0	0	0	<0.0050	<0.010
Bismuth	mg/L	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10	<0.20
Cadmium	mg/L	A	0.00027	0.00081	0.5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010	<0.020
Calcium	mg/L	-	-	-	-	14.0	93.2	111	94.6	85.3	45.3	41.7	75.6	85.3	41.7	111	30.7	13.7	38.1	23.7	111
Chromium [5]	mg/L	W	0.001	-	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010	<0.020
Cobalt	mg/L	A	0.0040	0.11	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010	<0.020
Copper	mg/L	A	0.0055	0.015	100	<0.010	<0.010	<0.010	<0.010	<0.010	0.019	0.028	**0.015**	<0.010	<0.010	**0.028**	0.0080	0.0036	0.010	<0.010	<0.020
Iron	mg/L	A	-	1.0	-	0.345	0.579	1.26	1.18	0.748	0.123	0.138	0.690	0.748	0.123	**1.26**	0.546	0.244	0.678	0.0550	0.101
Lead	mg/L	A	0.008	0.12	5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.10
Magnesium	mg/L	-	-	-	-	2.16	4.53	14.8	13.0	11.6	5.12	4.73	9.85	11.6	4.73	14.8	4.64	2.07	5.76	2.48	10.7
Manganese	mg/L	A	1.21	2.05	-	0.254	2.02	3.85	3.80	2.60	0.477	0.245	**2.19**	**2.60**	0.25	**3.85**	1.75	0.78	2.17	0.234	0.156
Mercury	mg/L	A	0.00002	-	0.1	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0	0	0	<0.000050	<0.000050
Molybdenum	mg/L	A	1	2	-	<0.030	<0.030	0.070	0.063	0.096	0.049	0.045	0.065	0.063	0.045	0.096	0.020	0.0091	0.025	<0.030	<0.060
Nickel [6]	mg/L	W	-	0.121	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.10
Phosphorus	mg/L	A	-	0.0050-0.015	-	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0	0	0	<0.30	<0.60
Potassium	mg/L	-	-	-	-	3.6	2.4	4.9	4.2	5.1	3.2	3.3	4.1	4.2	3.2	5.1	0.88	0.39	1.1	<2.0	4.6
Selenium	mg/L	A	0.002	-	1	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050	<0.10
Silicon	mg/L	-	-	-	-	5.38	4.72	11.6	10.3	10.9	5.96	6.15	8.98	10.3	5.96	11.6	2.71	1.21	3.37	4.95	10.7
Silver	mg/L	A	0.0015	0.003	5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010	<0.020
Sodium	mg/L	-	-	-	-	2.6	<2.0	9.1	10.0	14.0	5.9	6.8	9.2	9.10	5.90	14.0	3.18	1.42	3.94	<2.0	4.0
Strontium	mg/L	-	-	-	-	0.0975	0.638	0.918	0.812	0.827	0.403	0.370	0.666	0.812	0.370	0.918	0.259	0.116	0.321	0.144	0.610
Thallium	mg/L	W	0.0008	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20	<0.40
Tin	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0	<0.030	<0.060
Titanium	mg/L	-	-	-	-	0.013	0.013	0.018	0.016	0.015	0.010	0.011	0.014	0.015	0.010	0.018	0.0034	0.0015	0.0042	<0.010	<0.020
Uranium	mg/L	W	0.0085	-	10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50	<1.0
Vanadium	mg/L	-	-	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	0	<0.030	<0.060
Zinc	mg/L	A	0.043	0.068	500	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0	<0.020	<0.040

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL. Summary statistics were only calculated for sampling areas with replicate samples (LRef1, LNF1,and LNF2) but not for single composite samples (LRef2, LFF, and LFFF).

[2] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.

[3] Hazardous Waste Regulation (Government of British Columbia 1988)

[4] Displayed reference values are the 95th percentiles of data from reference area LRef1, and are the single values available for reference area LRef2.

[5] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.

[6] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)

(orange box) Value is > either guideline (values < MDL excluded). Values shown in bold text also exceed both Reference Values.

Table E.53: Raw acid base accounting, sulphur, and carbon content data for sediment from littoral sampling areas in Quesnel Lake, Mount Polley, 2014 [1].

Parameter	Units	Reference												
		LRef1 (QUL-51)												LRef2 (QUL-52) Composite
		QUL-51-01	QUL-51-02	QUL-51-03	QUL-51-04	QUL-51-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	
Maximum Potential Acidity (MPA)	tCaCO3/1Kt	1.3	1.3	1.3	0.9	1.3	1.2	1.3	0.9	1.3	0.18	0.08	0.22	1.9
Fizz Rating	Unity	1	1	1	1	1	1	1	1	1	0	0	0	2
Net Neutralization Potential (NNP)	tCaCO3/1Kt	6	6	6	5	5	6	6	5	6	0.5	0.2	0.7	13
pH	Unity	5.8	5.5	5.8	5.8	5.5	5.7	5.8	5.5	5.8	0.2	0.1	0.2	7.4
Neutralization Potential (NP)	tCaCO3/1Kt	7	7	7	6	6	7	7	6	7	0.5	0.2	0.7	15
Neutralization Potential Ratio (NP/MPA)	Unity	5.6	5.6	5.6	6.4	4.8	5.6	5.6	4.8	6.4	0.6	0.3	0.7	8
Total Sulphur (S) - Leco	%	0.04	0.04	0.04	0.03	0.04	0.04	0.04	0.03	0.04	0.004	0.002	0.006	0.06
Sulphide Sulphur (S) - Calculated Leco	%	0.03	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.04	0.004	0.002	0.006	0.06
Sulphate Sulphur (S) - Carbonate Leach	%	0.01	0.01	0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	0	0	0	<0.01
Inorganic Carbon (C)	%	<0.05	0.05	<0.05	<0.05	0.05	0.05	0.05	<0.05	0.05	0	0	0	0.08
Carbon Dioxide (CO2)	%	<0.2	0.2	<0.2	<0.2	0.2	0.2	0.2	<0.2	0.2	0	0	0	0.3
Sulphate Sulphur (S) - HCl leachable	%	0.01	0.01	0.01	<0.01	<0.01	0.01	0.01	<0.01	0.01	0	0	0	<0.01

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics.
Summary statistics are reported as < MDL if all the data used in their calculation were < MDL.

(shaded box) Indicates Neutralization Potential Ratio > 4; no potential for Acid Rock Drainage (Price 1997)

Table E.53: Raw acid base accounting, sulphur, and carbon content data for sediment from littoral sampling areas in Quesnel Lake, Mount Polley, 2014 [1].

Parameter	Units	Exposed LNF1 (QUL-45)											
		QUL-45-01	QUL-45-02	QUL-45-03	QUL-45-04	QUL-45-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Maximum Potential Acidity (MPA)	tCaCO3/1Kt	4.1	4.4	4.4	4.1	3.8	4.2	4.1	3.8	4.4	0.3	0.1	0.3
Fizz Rating	Unity	2	2	2	2	2	2	2	2	2	0	0	0
Net Neutralization Potential (NNP)	tCaCO3/1Kt	38	41	38	34	35	37	38	34	41	3	1	2
pH	Unity	8.2	8.2	8.1	8.2	8.3	8.2	8.2	8.1	8.3	0.1	0.0	0.5
Neutralization Potential (NP)	tCaCO3/1Kt	42	45	42	38	39	41	42	38	45	3	1	3
Neutralization Potential Ratio (NP/MPA)	Unity	10.34	10.29	9.6	9.35	10.4	10.0	10.3	9.4	10.4	0.5	0.2	2.3
Total Sulphur (S) - Leco	%	0.13	0.14	0.14	0.13	0.12	0.13	0.13	0.12	0.14	0.008	0.004	0.027
Sulphide Sulphur (S) - Calculated Leco	%	0.13	0.11	0.14	0.13	0.12	0.13	0.13	0.11	0.14	0.011	0.005	0.035
Sulphate Sulphur (S) - Carbonate Leach	%	<0.01	0.03	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	0.03	0.009	0.004	0.006
Inorganic Carbon (C)	%	0.33	0.35	0.32	0.32	0.30	0.32	0.32	0.30	0.35	0.018	0.008	0.029
Carbon Dioxide (CO2)	%	1.2	1.3	1.2	1.2	1.1	1.2	1.2	1.1	1.3	0.1	0.0	0.1
Sulphate Sulphur (S) - HCl leachable	%	0.01	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.005	0.002	0.006

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics.
Summary statistics are reported as < MDL if all the data used in their calculation were < MDL.

(shaded) Indicates Neutralization Potential Ratio > 4; no potential for Acid Rock Drainage (Price 1997)

Table E.53: Raw acid base accounting, sulphur, and carbon content data for sediment from littoral sampling areas in Quesnel Lake, Mount Polley, 2014 [1].

Parameter	Units	Exposed												LFF (QUL-47) Composite	LFFF (QUL-48) Composite
		LNF2 (QUL-49)													
		QUL-49-01	QUL-49-02	QUL-49-03	QUL-49-04	QUL-49-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE		
Maximum Potential Acidity (MPA)	tCaCO3/1Kt	2.8	2.5	2.8	3.1	3.1	2.9	2.8	2.5	3.1	0.25	0.11	0.31	3.1	11.3
Fizz Rating	Unity	2	2	2	2	2	2	2	2	2	0	0	0	1	1
Net Neutralization Potential (NNP)	tCaCO3/1Kt	34	32	32	35	33	33	33	32	35	1.3	0.6	1.6	9	1
pH	Unity	7.6	7.4	7.6	7.5	7.6	7.5	7.6	7.4	7.6	0.09	0.04	0.11	6.9	6.4
Neutralization Potential (NP)	tCaCO3/1Kt	37	34	35	38	36	36	36	34	38	2	1	2	12	12
Neutralization Potential Ratio (NP/MPA)	Unity	13.16	13.6	12.4	12.2	11.5	12.6	12.4	11.5	13.6	0.8	0.4	1.0	3.84	1.07
Total Sulphur (S) - Leco	%	0.09	0.08	0.09	0.1	0.1	0.09	0.09	0.08	0.10	0.01	0.00	0.01	0.1	0.36
Sulphide Sulphur (S) - Calculated Leco	%	0.07	0.07	0.09	0.1	0.09	0.08	0.09	0.07	0.10	0.01	0.01	0.02	0.1	0.36
Sulphate Sulphur (S) - Carbonate Leach	%	0.02	0.01	<0.01	<0.01	0.01	0.01	0.01	<0.01	0.02	0.004	0.002	0.006	<0.01	<0.01
Inorganic Carbon (C)	%	0.33	0.27	0.30	0.33	0.34	0.31	0.33	0.27	0.34	0.029	0.013	0.036	<0.05	<0.05
Carbon Dioxide (CO2)	%	1.2	1.0	1.1	1.2	1.2	1.1	1.2	1.0	1.2	0.1	0.0	0.1	<0.2	<0.2
Sulphate Sulphur (S) - HCl leachable	%	<0.01	<0.01	<0.01	0.01	0.01	0.01	<0.01	<0.01	0.01	0	0	0	0.02	0.03

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics.
Summary statistics are reported as < MDL if all the data used in their calculation were < MDL.

(Shaded) Indicates Neutralization Potential Ratio > 4; no potential for Acid Rock Drainage (Price 1997)

Table E.54: Raw sediment quality data for Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Metals data are based on the < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		Contaminated Sites Regulation [3]		Reference 95th Percentile [4]		Reference PRef1 (QULP-5)											
		TEL	PEL	Sensitive	Typical	PRef1	PRef2	QULP-5-01	QULP-5-02	QULP-5-03	QULP-5-04	QULP-5-05	Mean	Median	Minimum	Maximum	95th Percentile	Standard Deviation	Standard Error	t*SE
Date Sampled								13-Sep-14	14-Sep-14	17-Sep-14	18-Sep-14	18-Sep-14								
Physical Tests																				
Moisture	%	-	-	-	-	54.1	70.5	51.8	47.6	53.3	54.3	52.0	51.8	52.0	47.6	54.3	54	2.56	1.14	3.18
pH (1:2 soil:water)	pH	-	-	-	-	6.84	7.26	6.89	6.86	7.03	6.84	6.90	6.90	6.89	6.84	7.03	6.84	0.074	0.033	0.092
Particle Size																				
% Gravel (>2mm)	%	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	31	13	31	32	21	17	17	24	21	17	32	31	7.2	3.2	9.0
% Silt (0.063mm - 4µm)	%	-	-	-		74	74	59	61	69	74	74	67	69	59	74	74	7.2	3.2	9.0
% Clay (<4µm)	%	-	-	-	-	10	27	11	7.4	9.3	9.2	8.8	9.1	9.2	7.4	11	10	1.2	0.52	1.5
Texture	-	-	-	-	-	-	-	Silt loam	Silt loam	Silt loam	Silt loam	Silt loam	-	-	-	-	-	-	-	-
Leachable Anions & Nutrients																				
pH	pH	-	-	-	-	6.82	-	6.83	6.71	6.79	6.78	6.79	6.78	6.79	6.71	6.83	6.82	0.0436	0.0195	0.0541
Anions and Nutrients																				
Total Nitrogen by LECO	%	-	-	-	-	0.148	0.176	0.140	0.127	0.141	0.149	0.145	0.140	0.141	0.127	0.149	0.148	0.0083	0.0037	0.0103
Organic / Inorganic Carbon																				
Total Organic Carbon	%	-	-	-	-	2.10	2.06	1.90	2.07	1.98	2.10	2.09	2.03	2.07	1.90	2.10	2.10	0.0858	0.0384	0.107
Metals																				
Aluminum	mg/kg	-	-	-	-	16,160	26,520	14,100	14,400	15,600	16,200	16,000	15,260	15,600	14,100	16,200	16,160	953	426	1,183
Antimony	mg/kg	-	-	-	-	0.45	0.44	0.38	0.38	0.41	0.43	0.45	0.41	0.41	0.38	0.45	0.45	0.031	0.014	0.038
Arsenic	mg/kg	5.9	17	11	20	9.29	22.2	6.51	7.23	9.02	9.15	9.32	8.25	9.02	6.51	9.32	9.29	1.29	0.575	1.60
Barium	mg/kg	-	-	-	-	153	246	129	132	151	154	146	142	146	129	154	153	11.3	5.05	14.0
Beryllium	mg/kg	-	-	-	-	0.47	0.94	0.40	0.43	0.47	0.45	0.43	0.44	0.43	0.40	0.47	0.47	0.026	0.012	0.032
Bismuth	mg/kg	-	-	-	-	<0.20	0.52	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Boron	mg/kg	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.419	0.329	0.389	0.381	0.415	0.420	0.417	0.404	0.415	0.381	0.420	0.419	0.0180	0.0081	0.0224
Calcium	mg/kg	-	-	-	-	8,248	6,940	7,390	7,750	8,260	7,910	8,200	7,902	7,910	7,390	8,260	8,248	354	158	440
Chromium	mg/kg	37	90	56	110	55.9	53.4	50.3	53.3	56.2	54.6	54.1	53.7	54.1	50.3	56.2	55.9	2.18	0.97	2.70
Cobalt	mg/kg	-	-	-	-	14.4	25.6	13.3	13.9	14.4	14.4	14.4	14.1	14.4	13.3	14.4	14.4	0.487	0.218	0.604
Copper	mg/kg	36	197	120	240	45.9	50.0	41.3	41.2	44.8	46.1	45.3	43.7	44.8	41.2	46.1	45.9	2.32	1.04	2.88
Iron	mg/kg	21,200	43,776	-	-	30,900	111,840	27,600	28,100	30,500	31,000	30,200	29,480	30,200	27,600	31,000	30,900	1,525	682.2	1,894
Lead	mg/kg	35	91	57	110	7.12	21.9	6.17	6.12	6.89	6.92	7.17	6.65	6.89	6.12	7.17	7.12	0.478	0.214	0.593
Lithium	mg/kg	-	-	-	-	14.5	38.8	12.7	13.6	14.6	14.3	14.2	13.9	14.2	12.7	14.6	14.5	0.753	0.337	0.935
Magnesium	mg/kg	-	-	-	-	8,024	9,692	7,210	7,520	7,920	8,050	7,800	7,700	7,800	7,210	8,050	8,024	337	151	418
Manganese	mg/kg	460	1,100	-	-	571	6,960	414	456	514	538	579	500	514	414	579	571	65.6	29.3	81.4
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0521	0.0644	0.0477	0.0450	0.0507	0.0524	0.0490	0.0490	0.0490	0.0450	0.0524	0.0521	0.00283	0.00127	0.00352
Molybdenum	mg/kg	-	-	-	-	1.02	2.63	0.88	0.82	0.95	0.95	1.04	0.93	0.95	0.82	1.04	1.02	0.083	0.037	0.10
Nickel	mg/kg	16	75	-	-	38.7	61.2	36.1	35.9	37.6	39.0	37.7	37.3	37.6	35.9	39.0	38.7	1.28	0.571	1.59
Phosphorus	mg/kg	-	-	-	-	1,138	2,152	988	964	1,090	1,130	1,140	1,062	1,090	964	1,140	1,138	81.5	36.4	101
Potassium	mg/kg	-	-	-	-	1,430	3,526	1,170	1,280	1,420	1,430	1,430	1,346	1,420	1,170	1,430	1,430	117	52.4	145
Selenium	mg/kg	2.0	-	-	-	0.988	1.012	0.880	0.900	0.940	0.990	0.980	0.938	0.940	0.880	0.990	0.988	0.0482	0.0215	0.0598
Silver	mg/kg	0.50	-	-	-	0.21	0.20	0.19	0.16	0.19	0.20	0.21	0.19	0.19	0.16	0.21	0.21	0.019	0.0084	0.023
Sodium	mg/kg	-	-	-	-	460	378	350	380	470	420	400	404	400	350	470	460	45.1	20.1	55.9
Strontium	mg/kg	-	-	-	-	80.5	97.2	67.5	69.0	80.5	78.5	80.3	75.2	78.5	67.5	80.5	80.5	6.38	2.85	7.92
Thallium	mg/kg	-	-	-	-	0.183	0.289	0.147	0.166	0.155	0.181	0.184	0.167	0.166	0.147	0.184	0.183	0.0160	0.0072	0.0199
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	1,162	947	960	1,050	1,030	1,030	1,190	1,052	1,030	960	1,190	1,162	84.4	37.7	105
Uranium	mg/kg	-	-	-	-	1.34	3.06	1.19	1.18	1.34	1.29	1.33	1.27	1.29	1.18	1.34	1.34	0.0764	0.0341	0.0948
Vanadium	mg/kg	-	-	-	-	65.6	48.2	59.0	62.7	64.6	65.9	62.8	63.0	62.8	59.0	65.9	65.6	2.60	1.16	3.23
Zinc	mg/kg	123	315	200	380	79.3	104	71.1	70.9	76.6	80.0	74.7	74.7	74.7	70.9	80.0	79.3	3.84	1.72	4.77

[1] Reported TOC, TN, pH, and moisture data are based on bulk sediment. Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Reference 95th percentile was calculated using displayed metals data for the < 2mm sediment fraction, and using displayed TOC, pH, TN, particle size and moisture data. The 5th percentile is reported for pH

Value is > TEL. Values shown in bold text also exceed Reference 95th Percentile values.

Value is > PEL. Values shown in bold text also exceed Reference 95th Percentile values.

Table E.54: Raw sediment quality data for Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Metals data are based on the < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		Contaminated Sites Regulation [3]		Reference 95th Percentile [4]		Reference PRef2 (QULP-6)												
		TEL	PEL	Sensitive	Typical	PRef1	PRef2	QULP-6-01	QULP-6-02	QULP-6-03	QULP-6-04	QULP-6-05	Mean	Median	Minimum	Maximum	95th Percentile	Standard Deviation	Standard Error	t*SE
Date Sampled								17-Oct-14	18-Oct-14	18-Oct-14	18-Oct-14	20-Oct-14								
Physical Tests																				
Moisture	%	-	-	-	-	54.1	70.5	68.9	69.5	68.3	60.4	70.8	67.6	68.9	60.4	70.8	70.5	4.12	1.84	5.11
pH (1:2 soil:water)	pH	-	-	-	-	6.84	7.26	-	-	-	-	7.26			7.26				0	
Particle Size																				
% Gravel (>2mm)	%	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	31	13	10	3.3	0.74	14	7.3	7.0	7.3	0.74	14	13	5.2	2.3	6.5
% Silt (0.063mm - 4µm)	%	-	-	-		74	74	71	73	71	73	75	73	73	71	75	74	1.5	0.68	1.9
% Clay (<4µm)	%	-	-	-	-	10	27	20	24	28	13	18	20	20	13	28	27	5.7	2.5	7.1
Texture	-	-	-	-	-	-	-	Silt loam	Silt loam	Silt loam	Silt loam	Silt loam / Silt	-	-	-	-	-	-	-	-
Leachable Anions & Nutrients																				
pH	pH	-	-	-	-	6.82	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anions and Nutrients																				
Total Nitrogen by LECO	%	-	-	-	-	0.148	0.176	0.148	0.145	0.165	0.111	0.179	0.150	0.148	0.111	0.179	0.176	0.0256	0.0114	0.0317
Organic / Inorganic Carbon																				
Total Organic Carbon	%	-	-	-	-	2.10	2.06	2.06	1.75	1.78	1.25	2.04	1.78	1.78	1.25	2.06	2.06	0.327	0.146	0.406
Metals																				
Aluminum	mg/kg	-	-	-	-	16,160	26,520	22,400	21,800	26,900	19,300	25,000	23,080	22,400	19,300	26,900	26,520	2,944	1,317	3,655
Antimony	mg/kg	-	-	-	-	0.45	0.44	0.40	0.40	0.45	0.35	0.39	0.40	0.40	0.35	0.45	0.44	0.036	0.016	0.044
Arsenic	mg/kg	5.9	17	11	20	9.29	22.2	17.7	23.3	15.8	14.6	16.9	17.7	16.9	14.6	23.3	22.2	3.36	1.50	4.17
Barium	mg/kg	-	-	-	-	153	246	250	229	193	191	218	216	218	191	250	246	24.9	11.1	30.9
Beryllium	mg/kg	-	-	-	-	0.47	0.94	0.81	0.88	0.95	0.80	0.90	0.87	0.88	0.80	0.95	0.94	0.063	0.028	0.078
Bismuth	mg/kg	-	-	-	-	<0.20	0.52	0.44	0.46	0.53	0.35	0.50	0.46	0.46	0.35	0.53	0.52	0.069	0.031	0.09
Boron	mg/kg	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.419	0.329	0.312	0.309	0.314	0.318	0.332	0.317	0.314	0.309	0.332	0.329	0.0090	0.0040	0.0112
Calcium	mg/kg	-	-	-	-	8,248	6,940	6,970	6,820	5,390	5,510	5,990	6,136	5,990	5,390	6,970	6,940	730	327	907
Chromium	mg/kg	37	90	56	110	55.9	53.4	48.2	47.7	53.8	43.6	51.9	49.0	48.2	43.6	53.8	53.4	3.97	1.77	4.92
Cobalt	mg/kg	-	-	-	-	14.4	25.6	25.9	24.1	24.6	20.7	22.8	23.6	24.1	20.7	25.9	25.6	1.97	0.883	2.45
Copper	mg/kg	36	197	120	240	45.9	50.0	41.9	44.2	50.2	38.0	49.1	44.7	44.2	38.0	50.2	50.0	5.06	2.26	6.29
Iron	mg/kg	21,200	43,776	-	-	30,900	111,840	99,200	115,000	55,800	82,800	67,000	83,960	82,800	55,800	115,000	111,840	23,863	10,672	29,625
Lead	mg/kg	35	91	57	110	7.12	21.9	18.0	18.6	22.3	15.0	20.3	18.8	18.6	15.0	22.3	21.9	2.72	1.22	3.38
Lithium	mg/kg	-	-	-	-	14.5	38.8	30.0	33.3	39.0	32.7	37.8	34.6	33.3	30.0	39.0	38.8	3.74	1.67	4.65
Magnesium	mg/kg	-	-	-	-	8,024	9,692	8,840	8,440	9,720	8,180	9,580	8,952	8,840	8,180	9,720	9,692	681	305	845
Manganese	mg/kg	460	1,100	-	-	571	6,960	2,480	6,800	7,000	2,010	4,630	4,584	4,630	2,010	7,000	6,960	2,335	1,044	2,898
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0521	0.0644	-	-	-	-	0.0644			0.0644				0	
Molybdenum	mg/kg	-	-	-	-	1.02	2.63	2.28	2.68	2.42	1.54	2.26	2.24	2.28	1.54	2.68	2.63	0.424	0.189	0.526
Nickel	mg/kg	16	75	-	-	38.7	61.2	56.7	56.9	61.0	55.3	61.2	58.2	56.9	55.3	61.2	61.2	2.70	1.21	3.35
Phosphorus	mg/kg	-	-	-	-	1,138	2,152	2,180	2,040	1,160	1,980	1,380	1,748	1,980	1,160	2,180	2,152	449	201	558
Potassium	mg/kg	-	-	-	-	1,430	3,526	3,230	3,070	3,600	2,470	3,220	3,118	3,220	2,470	3,600	3,526	412	184	511
Selenium	mg/kg	2.0	-	-	-	0.988	1.012	1.02	0.76	0.85	0.60	0.98	0.84	0.85	0.60	1.02	1.01	0.17	0.08	0.21
Silver	mg/kg	0.50	-	-	-	0.21	0.20	0.15	0.18	0.20	0.14	0.19	0.17	0.18	0.14	0.20	0.20	0.026	0.012	0.032
Sodium	mg/kg	-	-	-	-	460	378	380	310	370	260	350	334	350	260	380	378	49.3	22.0	61.2
Strontium	mg/kg	-	-	-	-	80.5	97.2	91.0	98.7	77.0	87.6	78.5	86.6	87.6	77.0	98.7	97.2	9.01	4.03	11.2
Thallium	mg/kg	-	-	-	-	0.183	0.289	0.271	0.273	0.289	0.260	0.288	0.276	0.273	0.260	0.289	0.289	0.0123	0.0055	0.0152
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	1,162	947	965	750	821	855	873	853	855	750	965	947	78.4	35.1	97.3
Uranium	mg/kg	-	-	-	-	1.34	3.06	2.41	2.66	2.90	3.03	3.07	2.81	2.90	2.41	3.07	3.06	0.277	0.124	0.344
Vanadium	mg/kg	-	-	-	-	65.6	48.2	48.2	44.0	48.0	43.3	48.2	46.3	48.0	43.3	48.2	48.2	2.47	1.10	3.07
Zinc	mg/kg	123	315	200	380	79.3	104	89.2	92.2	104	85.6	102	94.6	92.2	85.6	104	104	8.05	3.60	9.99

[1] Reported TOC, TN, pH, and moisture data are based on bulk sediment. Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Reference 95th percentile was calculated using displayed metals data for the < 2mm sediment fraction, and using displayed TOC, pH, TN, particle size and moisture data. The 5th percentile is reported for pH

(blue) Value is > TEL. Values shown in bold text also exceed Reference 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed Reference 95th Percentile values.

Table E.54: Raw sediment quality data for Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Metals data are based on the < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		Contaminated Sites Regulation [3]		Reference 95th Percentile [4]		Exposed PNF (QULP-1)												
		TEL	PEL	Sensitive	Typical	PRef1	PRef2	QULP-1-01	QULP-1-02	QULP-1-03	QULP-1-04	QULP-1-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								9-Sep-14	10-Sep-14	11-Sep-14	12-Sep-14	13-Sep-14							
Physical Tests																			
Moisture	%	-	-	-	-	54.1	70.5	40.9	48.2	37.8	32.2	29.5	37.7	37.8	29.5	48.2	7.38	3.30	9.16
pH (1:2 soil:water)	pH	-	-	-	-	6.84	7.26	8.56	8.60	8.44	8.39	8.56	8.51	8.56	8.39	8.60	0.090	0.040	0.112
Particle Size																			
% Gravel (>2mm)	%	-	-	-	-	<0.10	<0.10	0.11	<0.10	<0.10	<0.10	<0.10	0.10	<0.10	<0.10	0.11	0.0045	0.0020	0.0056
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	31	13	4.1	0.34	0.22	4.0	30	7.8	4.0	0.22	30	12.6	5.7	16
% Silt (0.063mm - 4µm)	%	-	-	-		74	74	70	60	75	84	59	70	70	59	84	10.8	4.8	13
% Clay (<4µm)	%	-	-	-	-	10	27	26	40	25	12	11	23	25	11	40	11.9	5.3	15
Texture	-	-	-	-	-	-	-	Silt loam	Silty clay	Silt loam	Silt	Silt loam	-	-	-	-	-	-	-
Leachable Anions & Nutrients																			
pH	pH	-	-	-	-	6.82	-	7.43	8.18	8.36	8.50	8.38	8.17	8.36	7.43	8.50	0.429	0.192	0.533
Anions and Nutrients																			
Total Nitrogen by LECO	%	-	-	-	-	0.148	0.176	0.022	0.032	<0.020	<0.020	<0.020	0.023	<0.020	<0.020	0.032	0.0052	0.0023	0.0065
Organic / Inorganic Carbon																			
Total Organic Carbon	%	-	-	-	-	2.10	2.06	0.20	0.31	0.15	<0.10	<0.10	0.17	0.15	<0.10	0.31	0.088	0.039	0.11
Metals																			
Aluminum	mg/kg	-	-	-	-	16,160	26,520	24,100	26,000	22,100	17,200	15,300	20,940	22,100	15,300	26,000	4,548	2,034	5,646
Antimony	mg/kg	-	-	-	-	0.45	0.44	0.55	0.64	0.50	0.42	0.34	0.49	0.50	0.34	0.64	0.12	0.052	0.14
Arsenic	mg/kg	5.9	17	11	20	9.29	22.2	15.6	19.0	15.2	14.0	11.7	15.1	15.2	11.7	19.0	2.66	1.19	3.30
Barium	mg/kg	-	-	-	-	153	246	234	269	232	191	171	219	232	171	269	38.7	17.3	48.0
Beryllium	mg/kg	-	-	-	-	0.47	0.94	0.91	1.06	0.89	0.64	0.58	0.82	0.89	0.58	1.06	0.20	0.090	0.25
Bismuth	mg/kg	-	-	-	-	<0.20	0.52	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Boron	mg/kg	-	-	-	-	<10	<10	12	13	11	10	<10	11	11	<10	13	1.3	0.58	1.6
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.419	0.329	0.165	0.187	0.151	0.119	0.138	0.152	0.151	0.119	0.187	0.0259	0.0116	0.0321
Calcium	mg/kg	-	-	-	-	8,248	6,940	35,600	38,800	35,600	32,700	25,300	33,600	35,600	25,300	38,800	5,117	2,288	6,353
Chromium	mg/kg	37	90	56	110	55.9	53.4	12.6	14.3	10.9	10.2	14.8	12.6	12.6	10.2	14.8	2.02	0.905	2.51
Cobalt	mg/kg	-	-	-	-	14.4	25.6	20.5	23.1	18.5	14.7	16.7	18.7	18.5	14.7	23.1	3.26	1.46	4.05
Copper	mg/kg	36	197	120	240	45.9	50.0	749	849	675	551	668	**698**	**675**	**551**	**849**	110	49.2	137
Iron	mg/kg	21,200	43,776	-	-	30,900	111,840	28,900	31,500	25,900	33,800	55,900	35,200	31,500	25,900	55,900	11,941	5,340	14,824
Lead	mg/kg	35	91	57	110	7.12	21.9	7.40	8.97	6.58	5.05	5.97	6.79	6.58	5.05	8.97	1.49	0.666	1.85
Lithium	mg/kg	-	-	-	-	14.5	38.8	25.0	25.5	22.7	16.1	16.2	21.1	22.7	16.1	25.5	4.64	2.08	5.76
Magnesium	mg/kg	-	-	-	-	8,024	9,692	14,900	15,700	13,400	9,640	9,580	12,644	13,400	9,580	15,700	2,890	1,293	3,588
Manganese	mg/kg	460	1,100	-	-	571	6,960	860	966	776	621	609	766	776	609	966	154	68.8	191
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0521	0.0644	0.0803	0.0817	0.0694	0.0645	0.0835	0.0759	0.0803	0.0645	0.0835	0.00841	0.00376	0.0104
Molybdenum	mg/kg	-	-	-	-	1.02	2.63	3.91	4.22	3.83	3.56	3.60	3.82	3.83	3.56	4.22	0.267	0.119	0.331
Nickel	mg/kg	16	75	-	-	38.7	61.2	13.3	15.3	11.6	9.04	11.2	12.1	11.6	9.04	15.3	2.35	1.05	2.92
Phosphorus	mg/kg	-	-	-	-	1,138	2,152	1,610	1,850	1,660	2,000	1,410	1,706	1,660	1,410	2,000	227	102	282
Potassium	mg/kg	-	-	-	-	1,430	3,526	2,070	2,150	1,970	1,550	1,540	1,856	1,970	1,540	2,150	291	130	361
Selenium	mg/kg	2.0	-	-	-	0.988	1.012	1.18	1.36	0.92	0.86	0.89	1.04	0.92	0.86	1.36	0.22	0.10	0.27
Silver	mg/kg	0.50	-	-	-	0.21	0.20	0.34	0.39	0.31	0.29	0.31	0.33	0.31	0.29	0.39	0.04	0.02	0.048
Sodium	mg/kg	-	-	-	-	460	378	1,150	1,250	1,170	930	910	1,082	1,150	910	1,250	153	68.3	190
Strontium	mg/kg	-	-	-	-	80.5	97.2	208	215	202	173	133	186	202	133	215	33.8	15.1	41.9
Thallium	mg/kg	-	-	-	-	0.183	0.289	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	<2.0	<2.0	2.2	2.6	2.1	<2.0	<2.0	2.2	2.1	<2.0	2.6	0.25	0.11	0.31
Titanium	mg/kg	-	-	-	-	1,162	947	2,100	2,420	1,850	1,600	1,290	1,852	1,850	1,290	2,420	437	195	542
Uranium	mg/kg	-	-	-	-	1.34	3.06	1.49	1.83	1.37	1.23	0.90	1.36	1.37	0.90	1.83	0.34	0.15	0.42
Vanadium	mg/kg	-	-	-	-	65.6	48.2	106	118	98	127	210	132	118	98	210	45.2	20.2	56.1
Zinc	mg/kg	123	315	200	380	79.3	104	75.3	82.7	67.1	51.1	59.2	67.1	67.1	51.1	82.7	12.5	5.61	15.6

[1] Reported TOC, TN, pH, and moisture data are based on bulk sediment. Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Reference 95th percentile was calculated using displayed metals data for the < 2mm sediment fraction, and using displayed TOC, pH, TN, particle size and moisture data. The 5th percentile is reported for pH

(blue) Value is > TEL. Values shown in bold text also exceed Reference 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed Reference 95th Percentile values.

Table E.54: Raw sediment quality data for Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Metals data are based on the < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		Contaminated Sites Regulation [3]		Reference 95th Percentile [4]		Exposed PFF2 (QULP-4)											
		TEL	PEL	Sensitive	Typical	PRef1	PRef2	QULP-4-01	QULP-4-02	QULP-4-03	QULP-4-04	QULP-4-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								8-Oct-14	8-Oct-14	10-Oct-14	20-Oct-14	20-Oct-14							
Physical Tests																			
Moisture	%	-	-	-	-	54.1	70.5	38.0	44.1	37.2	42.1	40.2	40.3	40.2	37.2	44.1	2.85	1.28	3.54
pH (1:2 soil:water)	pH	-	-	-	-	6.84	7.26	7.99	8.20	-	8.23	8.30	8.18	8.22	7.99	8.30	0.133	0.067	0.212
Particle Size																			
% Gravel (>2mm)	%	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	31	13	0.20	0.10	0.52	0.30	0.19	0.26	0.20	0.10	0.52	0.16	0.072	0.20
% Silt (0.063mm - 4µm)	%	-	-	-		74	74	82	79	87	87	86	84	86	79	87	3.5	1.6	4.4
% Clay (<4µm)	%	-	-	-	-	10	27	18	21	12	13	14	16	14	12	21	3.6	1.6	4.5
Texture	-	-	-	-	-	-	-	Silt	Silt	Silt	Silt	Silt	-	-	-	-	-	-	-
Leachable Anions & Nutrients																			
pH	pH	-	-	-	-	6.82	-	-	-	-	-	-	-	-	-	-	-	-	-
Anions and Nutrients																			
Total Nitrogen by LECO	%	-	-	-	-	0.148	0.176	0.031	0.038	<0.020	<0.020	<0.020	0.026	<0.020	<0.020	0.038	0.0083	0.0037	0.010
Organic / Inorganic Carbon																			
Total Organic Carbon	%	-	-	-	-	2.10	2.06	0.43	0.40	0.19	0.37	0.22	0.32	0.37	0.19	0.43	0.11	0.049	0.14
Metals																			
Aluminum	mg/kg	-	-	-	-	16,160	26,520	21,000	22,600	17,200	19,900	20,000	20,140	20,000	17,200	22,600	1,969	881	2,445
Antimony	mg/kg	-	-	-	-	0.45	0.44	0.51	0.53	0.36	0.51	0.50	0.48	0.51	0.36	0.53	0.069	0.031	0.086
Arsenic	mg/kg	5.9	17	11	20	9.29	22.2	13.9	13.7	12.9	14.3	14.0	13.8	13.9	12.9	14.3	0.527	0.236	0.655
Barium	mg/kg	-	-	-	-	153	246	226	238	188	210	211	215	211	188	238	18.8	8.42	23.4
Beryllium	mg/kg	-	-	-	-	0.47	0.94	0.78	0.86	0.63	0.71	0.74	0.74	0.74	0.63	0.86	0.085	0.038	0.11
Bismuth	mg/kg	-	-	-	-	<0.20	0.52	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Boron	mg/kg	-	-	-	-	<10	<10	10	10	10	10	11	10	10	10	11	0.45	0.20	0.56
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.419	0.329	0.181	0.187	0.121	0.151	0.155	0.159	0.155	0.121	0.187	0.0264	0.0118	0.0328
Calcium	mg/kg	-	-	-	-	8,248	6,940	30,500	30,800	30,800	31,900	31,100	31,020	30,800	30,500	31,900	536	240	665
Chromium	mg/kg	37	90	56	110	55.9	53.4	15.4	16.6	10.2	13.5	12.3	13.6	13.5	10.2	16.6	2.52	1.13	3.13
Cobalt	mg/kg	-	-	-	-	14.4	25.6	16.7	18.4	13.8	15.8	15.0	15.9	15.8	13.8	18.4	1.74	0.778	2.16
Copper	mg/kg	36	197	120	240	45.9	50.0	569	596	490	558	529	**548**	**558**	**490**	**596**	40.5	18.1	50.3
Iron	mg/kg	21,200	43,776	-	-	30,900	111,840	26,200	26,700	22,100	25,700	23,700	24,880	25,700	22,100	26,700	1,927	862	2,392
Lead	mg/kg	35	91	57	110	7.12	21.9	6.80	7.55	5.01	5.93	5.63	6.18	5.93	5.01	7.55	1.00	0.447	1.24
Lithium	mg/kg	-	-	-	-	14.5	38.8	20.3	25.2	16.7	18.9	18.5	19.9	18.9	16.7	25.2	3.22	1.44	4.00
Magnesium	mg/kg	-	-	-	-	8,024	9,692	12,800	13,900	10,100	11,600	11,000	11,880	11,600	10,100	13,900	1,496	669	1,857
Manganese	mg/kg	460	1,100	-	-	571	6,960	774	835	637	704	685	727	704	637	835	77.9	34.8	96.7
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0521	0.0644	-	-	-	0.064	0.062	0.063	0.063	0.062	0.064	0.0015	0.0011	0.013
Molybdenum	mg/kg	-	-	-	-	1.02	2.63	3.20	3.31	3.18	3.37	3.31	3.27	3.31	3.18	3.37	0.0808	0.0361	0.100
Nickel	mg/kg	16	75	-	-	38.7	61.2	14.7	16.5	9.9	12.8	11.9	13.2	12.8	9.9	16.5	2.53	1.13	3.15
Phosphorus	mg/kg	-	-	-	-	1,138	2,152	1,630	1,450	1,670	1,560	1,530	1,568	1,560	1,450	1,670	86.1	38.5	107
Potassium	mg/kg	-	-	-	-	1,430	3,526	2,020	2,050	1,480	1,710	1,760	1,804	1,760	1,480	2,050	236	106	293
Selenium	mg/kg	2.0	-	-	-	0.988	1.012	1.00	0.97	0.77	0.92	0.87	0.91	0.92	0.77	1.00	0.091	0.041	0.11
Silver	mg/kg	0.50	-	-	-	0.21	0.20	0.27	0.28	0.22	0.28	0.26	0.26	0.27	0.22	0.28	0.025	0.011	0.031
Sodium	mg/kg	-	-	-	-	460	378	970	1,010	950	1,000	1,070	1,000	1,000	950	1,070	45.8	20.5	56.9
Strontium	mg/kg	-	-	-	-	80.5	97.2	188	212	193	194	204	198	194	188	212	9.65	4.32	12.0
Thallium	mg/kg	-	-	-	-	0.183	0.289	0.052	0.053	<0.050	<0.050	<0.050	0.051	<0.050	<0.050	0.053	0.0014	0.00063	0.0018
Tin	mg/kg	-	-	-	-	<2.0	<2.0	2.1	<2.0	<2.0	2.1	2.2	2.1	2.1	<2.0	2.2	0.084	0.037	0.10
Titanium	mg/kg	-	-	-	-	1,162	947	1,840	1,760	1,690	1,850	1,870	1,802	1,840	1,690	1,870	75.3	33.7	93.5
Uranium	mg/kg	-	-	-	-	1.34	3.06	1.49	1.45	1.25	1.44	1.38	1.40	1.44	1.25	1.49	0.0936	0.0419	0.116
Vanadium	mg/kg	-	-	-	-	65.6	48.2	94.5	92.4	83.6	95.3	91.1	91.4	92.4	83.6	95.3	4.66	2.08	5.78
Zinc	mg/kg	123	315	200	380	79.3	104	64.4	70.1	49.1	61.7	58.2	60.7	61.7	49.1	70.1	7.81	3.49	9.69

[1] Reported TOC, TN, pH, and moisture data are based on bulk sediment. Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Reference 95th percentile was calculated using displayed metals data for the < 2mm sediment fraction, and using displayed TOC, pH, TN, particle size and moisture data. The 5th percentile is reported for pH

(blue) Value is > TEL. Values shown in bold text also exceed Reference 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed Reference 95th Percentile values.

Table E.54: Raw sediment quality data for Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Metals data are based on the < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		Contaminated Sites Regulation [3]		Reference 95th Percentile [4]		Exposed PFF1 (QULP-2)											
		TEL	PEL	Sensitive	Typical	PRef1	PRef2	QULP-2-01	QULP-2-02	QULP-2-03	QULP-2-04	QULP-2-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								19-Sep-14	19-Sep-14	19-Sep-14	20-Sep-14	20-Sep-14							
Physical Tests																			
Moisture	%	-	-	-	-	54.1	70.5	60.1	36.7	43.6	33.9	35.3	41.9	36.7	33.9	60.1	10.8	4.84	13.4
pH (1:2 soil:water)	pH	-	-	-	-	6.84	7.26	8.01	8.29	8.33	8.46	8.52	8.32	8.33	8.01	8.52	0.198	0.089	0.246
Particle Size																			
% Gravel (>2mm)	%	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	31	13	0.16	<0.10	0.94	0.48	0.19	0.37	0.19	<0.10	0.94	0.35	0.16	0.43
% Silt (0.063mm - 4µm)	%	-	-	-		74	74	67	89	88	90	87	84	88	67	90	10	4.4	12
% Clay (<4µm)	%	-	-	-	-	10	27	33	11	11	9.2	13	16	11	9.2	33	10	4.5	12
Texture	-	-	-	-	-	-	-	Silt loam	Silt	Silt	Silt	Silt	-	-	-	-	-	-	-
Leachable Anions & Nutrients																			
pH	pH	-	-	-	-	6.82	-	7.35	7.86	7.86	8.20	8.23	7.90	7.86	7.35	8.23	0.355	0.159	0.441
Anions and Nutrients																			
Total Nitrogen by LECO	%	-	-	-	-	0.148	0.176	0.117	0.028	0.029	<0.020	<0.020	0.043	0.028	<0.020	0.117	0.042	0.019	0.052
Organic / Inorganic Carbon																			
Total Organic Carbon	%	-	-	-	-	2.10	2.06	1.73	0.35	0.37	0.14	0.11	0.54	0.35	0.11	1.73	0.68	0.30	0.84
Metals																			
Aluminum	mg/kg	-	-	-	-	16,160	26,520	26,700	17,300	18,500	17,000	18,700	19,640	18,500	17,000	26,700	4,015	1,795	4,984
Antimony	mg/kg	-	-	-	-	0.45	0.44	0.67	0.43	0.46	0.46	0.45	0.49	0.46	0.43	0.67	0.10	0.044	0.12
Arsenic	mg/kg	5.9	17	11	20	9.29	22.2	16.3	11.8	12.8	12.5	11.6	13.0	12.5	11.6	16.3	1.91	0.854	2.37
Barium	mg/kg	-	-	-	-	153	246	252	182	189	178	190	198	189	178	252	30.5	13.6	37.8
Beryllium	mg/kg	-	-	-	-	0.47	0.94	0.91	0.64	0.66	0.64	0.65	0.70	0.65	0.64	0.91	0.12	0.053	0.15
Bismuth	mg/kg	-	-	-	-	<0.20	0.52	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0
Boron	mg/kg	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.419	0.329	0.382	0.170	0.188	0.129	0.116	0.197	0.170	0.116	0.382	0.107	0.0481	0.133
Calcium	mg/kg	-	-	-	-	8,248	6,940	28,900	26,800	28,600	29,500	27,900	28,340	28,600	26,800	29,500	1,036	463	1,286
Chromium	mg/kg	37	90	56	110	55.9	53.4	32.5	16.4	17.4	13.9	12.6	18.6	16.4	12.6	32.5	8.02	3.59	9.96
Cobalt	mg/kg	-	-	-	-	14.4	25.6	24.3	13.9	15.8	13.2	13.7	16.2	13.9	13.2	24.3	4.65	2.08	5.77
Copper	mg/kg	36	197	120	240	45.9	50.0	653	420	499	417	427	**483**	**427**	**417**	**653**	101	45.1	125
Iron	mg/kg	21,200	43,776	-	-	30,900	111,840	36,800	24,600	29,800	24,400	22,300	27,580	24,600	22,300	36,800	5,848	2,615	7,260
Lead	mg/kg	35	91	57	110	7.12	21.9	12.6	6.44	6.96	5.49	5.15	7.33	6.44	5.15	12.6	3.03	1.36	3.77
Lithium	mg/kg	-	-	-	-	14.5	38.8	29.4	17.8	18.0	16.5	17.4	19.8	17.8	16.5	29.4	5.39	2.41	6.69
Magnesium	mg/kg	-	-	-	-	8,024	9,692	15,600	9,620	10,500	9,060	9,880	10,932	9,880	9,060	15,600	2,660	1,190	3,303
Manganese	mg/kg	460	1,100	-	-	571	6,960	1,210	618	695	600	613	747	618	600	1,210	261	117	324
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0521	0.0644	0.108	0.0685	0.0729	0.0623	0.0595	0.0742	0.0685	0.0595	0.108	0.0196	0.0088	0.0243
Molybdenum	mg/kg	-	-	-	-	1.02	2.63	3.50	2.63	2.99	2.81	2.87	2.96	2.87	2.63	3.50	0.329	0.147	0.408
Nickel	mg/kg	16	75	-	-	38.7	61.2	31.2	14.9	15.8	12.1	11.8	17.2	14.9	11.8	31.2	8.04	3.59	10.0
Phosphorus	mg/kg	-	-	-	-	1,138	2,152	1,290	1,500	1,580	1,640	1,400	1,482	1,500	1,290	1,640	140	62.6	174
Potassium	mg/kg	-	-	-	-	1,430	3,526	2,530	1,500	1,690	1,490	1,810	1,804	1,690	1,490	2,530	428	191	531
Selenium	mg/kg	2.0	-	-	-	0.988	1.012	1.60	0.82	0.92	0.65	0.62	0.92	0.82	0.62	1.60	0.40	0.18	0.49
Silver	mg/kg	0.50	-	-	-	0.21	0.20	0.40	0.24	0.29	0.24	0.22	0.28	0.24	0.22	0.40	0.073	0.033	0.091
Sodium	mg/kg	-	-	-	-	460	378	950	820	850	830	990	888	850	820	990	76.9	34.4	95.5
Strontium	mg/kg	-	-	-	-	80.5	97.2	199	173	176	182	202	186	182	173	202	13.3	5.95	16.5
Thallium	mg/kg	-	-	-	-	0.183	0.289	0.118	0.053	0.051	<0.050	<0.050	0.064	0.051	<0.050	0.118	0.030	0.013	0.037
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	1,162	947	1,960	1,420	1,670	1,700	1,800	1,710	1,700	1,420	1,960	198	88.4	245
Uranium	mg/kg	-	-	-	-	1.34	3.06	1.91	1.17	1.26	1.24	1.19	1.35	1.24	1.17	1.91	0.313	0.140	0.389
Vanadium	mg/kg	-	-	-	-	65.6	48.2	102	78.5	98.0	85.1	80.1	88.7	85.1	78.5	102	10.7	4.77	13.2
Zinc	mg/kg	123	315	200	380	79.3	104	94.5	54.2	57.9	49.2	50.9	61.3	54.2	49.2	94.5	18.8	8.42	23.4

[1] Reported TOC, TN, pH, and moisture data are based on bulk sediment. Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Reference 95th percentile was calculated using displayed metals data for the < 2mm sediment fraction, and using displayed TOC, pH, TN, particle size and moisture data. The 5th percentile is reported for pH

(blue) Value is > TEL. Values shown in bold text also exceed Reference 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed Reference 95th Percentile values.

Table E.54: Raw sediment quality data for Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Metals data are based on the < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		Contaminated Sites Regulation [3]		Reference 95th Percentile [4]		Exposed PFFF (QULP-3)												
		TEL	PEL	Sensitive	Typical	PRef1	PRef2	QULP-3-01	QULP-3-02	QULP-3-03	QULP-3-04	QULP-3-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								15-Oct-14	15-Oct-14	15-Oct-14	16-Oct-14	18-Oct-14							
Physical Tests																			
Moisture	%	-	-	-	-	54.1	70.5	80.3	80.6	80.3	79.6	79.6	80.1	80.3	79.6	80.6	0.455	0.203	0.565
pH (1:2 soil:water)	pH	-	-	-	-	6.84	7.26	-	-	-	-	-	-	-	-	-	-	-	-
Particle Size																			
% Gravel (>2mm)	%	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0
% Sand (2.0mm - 0.063mm)	%	-	-	-	-	31	13	0.61	0.62	0.54	0.61	0.43	0.56	0.61	0.43	0.62	0.080	0.036	0.10
% Silt (0.063mm - 4µm)	%	-	-	-		74	74	63	67	72	68	70	68	68	63	72	3.5	1.6	4.4
% Clay (<4µm)	%	-	-	-	-	10	27	37	33	28	31	29	32	31	28	37	3.5	1.5	4.3
Texture	-	-	-	-	-	-	-	Silt loam /	Silt loam	Silt loam	Silt loam	Silt loam	-	-	-	-	-	-	-
Leachable Anions & Nutrients																			
pH	pH	-	-	-	-	6.82	-	-	-	-	-	-	-	-	-	-	-	-	-
Anions and Nutrients																			
Total Nitrogen by LECO	%	-	-	-	-	0.148	0.176	0.272	0.304	0.303	0.310	0.321	0.302	0.304	0.272	0.321	0.0182	0.0082	0.0226
Organic / Inorganic Carbon																			
Total Organic Carbon	%	-	-	-	-	2.10	2.06	2.53	3.14	3.20	3.07	3.36	3.06	3.14	2.53	3.36	0.315	0.141	0.391
Metals																			
Aluminum	mg/kg	-	-	-	-	16,160	26,520	29,500	28,100	29,200	27,100	28,100	28,400	28,100	27,100	29,500	964	431	1,197
Antimony	mg/kg	-	-	-	-	0.45	0.44	0.67	0.74	0.74	0.82	0.81	0.76	0.74	0.67	0.82	0.061	0.027	0.076
Arsenic	mg/kg	5.9	17	11	20	9.29	22.2	43.4	38.8	62.3	78.1	48.4	**54.2**	**48.4**	**38.8**	**78.1**	16.0	7.16	19.9
Barium	mg/kg	-	-	-	-	153	246	262	224	220	244	231	236	231	220	262	17.1	7.63	21.2
Beryllium	mg/kg	-	-	-	-	0.47	0.94	0.930	0.930	0.850	0.820	0.880	0.882	0.880	0.820	0.930	0.0487	0.0218	0.0604
Bismuth	mg/kg	-	-	-	-	<0.20	0.52	0.34	0.34	0.34	0.31	0.34	0.33	0.34	0.31	0.34	0.013	0.0060	0.017
Boron	mg/kg	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.419	0.329	0.772	0.705	0.701	0.650	0.695	**0.705**	**0.701**	**0.650**	**0.772**	0.0437	0.0195	0.0542
Calcium	mg/kg	-	-	-	-	8,248	6,940	10,000	11,200	9,600	10,800	9,800	10,280	10,000	9,600	11,200	687	307	853
Chromium	mg/kg	37	90	56	110	55.9	53.4	72.0	68.7	72.1	59.7	68.8	**68.3**	**68.8**	**59.7**	**72.1**	5.06	2.26	6.28
Cobalt	mg/kg	-	-	-	-	14.4	25.6	29.0	27.6	27.7	25.6	26.7	27.3	27.6	25.6	29.0	1.26	0.565	1.57
Copper	mg/kg	36	197	120	240	45.9	50.0	91.2	120	91.6	98.8	123	**105**	**98.8**	**91.2**	**123**	15.5	6.92	19.2
Iron	mg/kg	21,200	43,776	-	-	30,900	111,840	71,700	58,300	61,000	59,000	61,600	62,320	61,000	58,300	71,700	5,418	2,423	6,727
Lead	mg/kg	35	91	57	110	7.12	21.9	16.9	20.1	20.9	19.4	19.8	19.4	19.8	16.9	20.9	1.51	0.676	1.88
Lithium	mg/kg	-	-	-	-	14.5	38.8	27.8	28.9	27.4	26.7	29.8	28.1	27.8	26.7	29.8	1.23	0.551	1.53
Magnesium	mg/kg	-	-	-	-	8,024	9,692	12,400	13,000	12,900	11,900	12,800	12,600	12,800	11,900	13,000	453	202	562
Manganese	mg/kg	460	1,100	-	-	571	6,960	8,700	17,100	16,900	20,800	11,300	**14,960**	**16,900**	**8,700**	**20,800**	4,874	2,180	6,051
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0521	0.0644	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum	mg/kg	-	-	-	-	1.02	2.63	6.35	27.4	5.49	6.03	5.00	10.05	6.03	5.00	27.4	9.71	4.34	12.1
Nickel	mg/kg	16	75	-	-	38.7	61.2	74.0	67.6	69.5	62.1	69.3	**68.5**	**69.3**	**62.1**	**74.0**	4.29	1.92	5.33
Phosphorus	mg/kg	-	-	-	-	1,138	2,152	2,750	1,780	1,700	1,720	1,690	1,928	1,720	1,690	2,750	461	206	572
Potassium	mg/kg	-	-	-	-	1,430	3,526	3,020	2,780	2,840	2,760	2,790	2,838	2,790	2,760	3,020	106	47.4	132
Selenium	mg/kg	2.0	-	-	-	0.988	1.012	1.27	1.63	1.87	1.71	1.88	1.67	1.71	1.27	1.88	0.249	0.111	0.309
Silver	mg/kg	0.50	-	-	-	0.21	0.20	0.34	0.35	0.34	0.33	0.37	0.35	0.34	0.33	0.37	0.015	0.0068	0.019
Sodium	mg/kg	-	-	-	-	460	378	430	530	440	440	460	460	440	430	530	40.6	18.2	50.4
Strontium	mg/kg	-	-	-	-	80.5	97.2	126	143	113	131	116	126	126	113	143	12.1	5.40	15.0
Thallium	mg/kg	-	-	-	-	0.183	0.289	0.344	0.333	0.296	0.300	0.331	0.321	0.331	0.296	0.344	0.0214	0.0096	0.0266
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0
Titanium	mg/kg	-	-	-	-	1,162	947	966	1,010	1,020	844	861	940	966	844	1,020	82.8	37.0	103
Uranium	mg/kg	-	-	-	-	1.34	3.06	3.81	3.43	3.43	3.13	3.47	3.45	3.43	3.13	3.81	0.241	0.108	0.300
Vanadium	mg/kg	-	-	-	-	65.6	48.2	91.6	92.1	93.1	85.3	88.9	90.2	91.6	85.3	93.1	3.15	1.41	3.91
Zinc	mg/kg	123	315	200	380	79.3	104	126	118	120	113	123	120	120	113	**126**	4.95	2.21	6.14

[1] Reported TOC, TN, pH, and moisture data are based on bulk sediment. Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Reference 95th percentile was calculated using displayed metals data for the < 2mm sediment fraction, and using displayed TOC, pH, TN, particle size and moisture data. The 5th percentile is reported for pH

(blue) Value is > TEL. Values shown in bold text also exceed Reference 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed Reference 95th Percentile values.

Table E.55: Raw sediment quality data for Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Metals data are based on the < 63µm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		Contaminated Sites Regulation [3]		Reference 95th Percentile [4]		Reference PRef1 (QULP-5)												
		TEL	PEL	Sensitive	Typical	PRef1	PRef2	QULP-5-01	QULP-5-02	QULP-5-03	QULP-5-04	QULP-5-05	Mean	Median	Minimum	Maximum	95th Percentile	Standard Deviation	Standard Error	t*SE
Date Sampled								13-Sep-14	14-Sep-14	17-Sep-14	18-Sep-14	18-Sep-14								
Physical Tests																				
pH (1:2 soil:water)	pH	-	-	-	-	6.83	7.21	7.03	6.82	6.97	7.00	6.87	6.94	6.97	6.82	7.03	6.83	0.089	0.040	0.111
Organic / Inorganic Carbon																				
Total Organic Carbon	%	-	-	-	-	1.72	1.93	1.62	1.70	1.72	1.64	1.71	1.68	1.70	1.62	1.72	1.72	0.045	0.020	0.056
Metals																				
Aluminum	mg/kg	-	-	-	-	15,380	25,380	15,300	14,000	15,400	15,300	13,900	14,780	15,300	13,900	15,400	15,380	760	340	943
Antimony	mg/kg	-	-	-	-	0.44	0.40	0.43	0.40	0.40	0.44	0.41	0.42	0.41	0.40	0.44	0.44	0.018	0.0081	0.023
Arsenic	mg/kg	5.9	17	11	20	8.51	20.9	7.15	6.95	8.60	8.15	7.89	7.75	7.89	6.95	8.60	8.51	0.690	0.308	0.856
Barium	mg/kg	-	-	-	-	151	220	147	140	152	144	135	144	144	135	152	151	6.50	2.91	8.07
Beryllium	mg/kg	-	-	-	-	0.44	0.90	0.45	0.41	0.39	0.41	0.40	0.41	0.41	0.39	0.45	0.44	0.023	0.010	0.028
Bismuth	mg/kg	-	-	-	-	0.15	0.51	0.15	0.14	0.14	0.14	0.13	0.14	0.14	0.13	0.15	0.15	0.0071	0.003	0.0088
Boron	mg/kg	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.414	0.315	0.416	0.346	0.404	0.390	0.363	0.384	0.390	0.346	0.416	0.414	0.0289	0.0129	0.0359
Calcium	mg/kg	-	-	-	-	8,034	7,392	8,050	7,650	7,970	7,740	7,300	7,742	7,740	7,300	8,050	8,034	296	132	368
Chromium	mg/kg	37	90	56	110	55.8	52.2	56.3	50.2	53.6	52.1	47.9	52.0	52.1	47.9	56.3	55.8	3.21	1.43	3.98
Cobalt	mg/kg	-	-	-	-	14.0	25.7	14.0	12.7	13.8	13.3	12.5	13.3	13.3	12.5	14.0	14.0	0.658	0.294	0.817
Copper	mg/kg	36	197	120	240	46.2	48.3	46.7	39.1	44.0	42.2	38.8	42.2	42.2	38.8	46.7	46.2	3.34	1.49	4.15
Iron	mg/kg	21,200	43,776	-	-	29,820	102,460	29,200	26,900	29,900	29,500	27,400	28,580	29,200	26,900	29,900	29,820	1,341	599	1,664
Lead	mg/kg	35	91	57	110	7.24	22.1	7.09	6.84	7.27	7.11	6.68	7.00	7.09	6.68	7.27	7.24	0.235	0.105	0.292
Lithium	mg/kg	-	-	-	-	13.8	37.4	12.8	13.0	13.9	13.4	12.6	13.1	13.0	12.6	13.9	13.8	0.518	0.232	0.643
Magnesium	mg/kg	-	-	-	-	8,036	9,344	8,040	7,350	8,020	7,720	7,200	7,666	7,720	7,200	8,040	8,036	382	171	475
Manganese	mg/kg	460	1,100	-	-	496	7,814	456	421	484	494	496	470	484	421	496	496	31.8	14.2	39.5
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0515	0.0593	0.0461	0.0474	0.0517	0.0506	0.0473	0.0486	0.0474	0.0461	0.0517	0.0515	0.0024	0.0011	0.0030
Molybdenum	mg/kg	-	-	-	-	0.96	2.72	0.96	0.84	0.94	0.91	0.90	0.91	0.91	0.84	0.96	0.96	0.046	0.020	0.057
Nickel	mg/kg	16	75	-	-	37.9	60.7	38.1	33.8	36.9	36.0	33.2	35.6	36.0	33.2	38.1	37.9	2.07	0.92	2.57
Phosphorus	mg/kg	-	-	-	-	1,126	1,776	1,110	1,070	1,110	1,130	1,050	1,094	1,110	1,050	1,130	1,126	33	15	41
Potassium	mg/kg	-	-	-	-	1,370	3,704	1,370	1,230	1,370	1,350	1,240	1,312	1,350	1,230	1,370	1,370	71	32	88
Selenium	mg/kg	2.0	-	-	-	0.94	0.91	0.95	0.82	0.90	0.87	0.76	0.86	0.87	0.76	0.95	0.94	0.073	0.033	0.091
Silver	mg/kg	0.50	-	-	-	0.203	0.189	0.205	0.172	0.196	0.191	0.177	0.188	0.191	0.172	0.205	0.203	0.0136	0.0061	0.0169
Sodium	mg/kg	-	-	-	-	420	374	420	370	420	390	380	396	390	370	420	420	23	10	29
Strontium	mg/kg	-	-	-	-	78.1	94.3	75.6	71.3	78.6	76.0	71.4	74.6	75.6	71.3	78.6	78.1	3.17	1.42	3.93
Thallium	mg/kg	-	-	-	-	0.166	0.293	0.147	0.161	0.161	0.167	0.149	0.157	0.161	0.147	0.167	0.166	0.0086	0.0038	0.011
Tin	mg/kg	-	-	-	-	0.47	0.61	0.47	0.35	0.38	0.46	0.38	0.41	0.38	0.35	0.47	0.47	0.054	0.024	0.067
Titanium	mg/kg	-	-	-	-	1,084	923	1,090	1,010	1,060	1,050	969	1,036	1,050	969	1,090	1,084	47	21	58
Uranium	mg/kg	-	-	-	-	1.35	3.16	1.32	1.30	1.36	1.30	1.22	1.30	1.30	1.22	1.36	1.35	0.0510	0.0228	0.0633
Vanadium	mg/kg	-	-	-	-	66.3	46.6	66.8	60.5	64.1	62.1	57.4	62.2	62.1	57.4	66.8	66.3	3.56	1.59	4.42
Zinc	mg/kg	123	315	200	380	77.1	95.3	74.1	71.4	77.6	75.3	70.3	73.7	74.1	70.3	77.6	77.1	2.95	1.32	3.66

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996)
[4] Reference 95th percentile was calculated using displayed data for the <63µm sediment fraction. The 5th percentile is reported for pH.

(blue) Value is > TEL. Values shown in bold text also exceed Reference 95th Percentile values.
(orange) Value is > PEL. Values shown in bold text also exceed Reference 95th Percentile values.

Table E.55: Raw sediment quality data for Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Metals data are based on the < 63µm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		Contaminated Sites Regulation [3]		Reference 95th Percentile [4]		Reference PRef2 (QULP-6)												
		TEL	PEL	Sensitive	Typical	PRef1	PRef2	QULP-6-01	QULP-6-02	QULP-6-03	QULP-6-04	QULP-6-05	Mean	Median	Minimum	Maximum	95th Percentile	Standard Deviation	Standard Error	t*SE
Date Sampled								17-Oct-14	18-Oct-14	18-Oct-14	18-Oct-14	20-Oct-14								
Physical Tests																				
pH (1:2 soil:water)	pH	-	-	-	-	6.83	7.21	7.21	7.45	7.21	7.34	7.46	7.33	7.34	7.21	7.46	7.21	0.123	0.055	0.152
Organic / Inorganic Carbon																				
Total Organic Carbon	%	-	-	-	-	1.72	1.93	1.88	1.58	1.73	1.34	1.94	1.69	1.73	1.34	1.94	1.93	0.242	0.108	0.301
Metals																				
Aluminum	mg/kg	-	-	-	-	15,380	25,380	23,100	23,700	25,800	19,900	22,600	23,020	23,100	19,900	25,800	25,380	2,128	952	2,641
Antimony	mg/kg	-	-	-	-	0.44	0.40	0.34	0.37	0.40	0.33	0.39	0.37	0.37	0.33	0.40	0.40	0.030	0.014	0.038
Arsenic	mg/kg	5.9	17	11	20	8.51	20.9	16.1	15.8	19.0	12.0	21.4	16.9	16.1	12.0	21.4	20.9	3.55	1.59	4.41
Barium	mg/kg	-	-	-	-	151	220	219	219	168	148	220	195	219	148	220	220	34.3	15.4	42.6
Beryllium	mg/kg	-	-	-	-	0.44	0.90	0.83	0.84	0.91	0.74	0.82	0.83	0.83	0.74	0.91	0.90	0.061	0.027	0.075
Bismuth	mg/kg	-	-	-	-	0.15	0.51	0.46	0.47	0.52	0.43	0.43	0.46	0.46	0.43	0.52	0.51	0.037	0.017	0.046
Boron	mg/kg	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.414	0.315	0.316	0.301	0.307	0.252	0.310	0.297	0.307	0.252	0.316	0.315	0.0258	0.0116	0.0321
Calcium	mg/kg	-	-	-	-	8,034	7,392	7,540	6,800	5,720	5,140	6,680	6,376	6,680	5,140	7,540	7,392	947	423	1,175
Chromium	mg/kg	37	90	56	110	55.8	52.2	48.9	49.7	52.8	43.4	47.1	48.4	48.9	43.4	52.8	52.2	3.46	1.55	4.30
Cobalt	mg/kg	-	-	-	-	14.0	25.7	25.9	23.8	24.7	19.7	23.0	23.4	23.8	19.7	25.9	25.7	2.34	1.05	2.91
Copper	mg/kg	36	197	120	240	46.2	48.3	43.5	44.9	48.7	37.4	46.6	44.2	44.9	37.4	48.7	48.3	4.28	1.91	5.31
Iron	mg/kg	21,200	43,776	-	-	29,820	102,460	96,300	104,000	60,200	71,800	77,200	81,900	77,200	60,200	104,000	102,460	17,964	8,034	22,301
Lead	mg/kg	35	91	57	110	7.24	22.1	19.4	19.8	22.7	16.7	18.8	19.5	19.4	16.7	22.7	22.1	2.16	0.97	2.68
Lithium	mg/kg	-	-	-	-	13.8	37.4	32.5	32.6	38.2	31.4	34.0	33.7	32.6	31.4	38.2	37.4	2.66	1.19	3.30
Magnesium	mg/kg	-	-	-	-	8,036	9,344	8,610	8,640	9,520	7,770	8,190	8,546	8,610	7,770	9,520	9,344	650	291	807
Manganese	mg/kg	460	1,100	-	-	496	7,814	2,680	7,350	7,930	1,590	6,560	5,222	6,560	1,590	7,930	7,814	2,886	1,290	3,582
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0515	0.0593	0.0491	0.0533	0.0594	0.0368	0.0590	0.0515	0.0533	0.0368	0.0594	0.0593	0.0093	0.0041	0.0115
Molybdenum	mg/kg	-	-	-	-	0.96	2.72	2.23	2.48	2.56	1.43	2.76	2.29	2.48	1.43	2.76	2.72	0.518	0.232	0.643
Nickel	mg/kg	16	75	-	-	37.9	60.7	57.1	58.6	61.2	51.5	56.3	56.9	57.1	51.5	61.2	60.7	3.57	1.60	4.43
Phosphorus	mg/kg	-	-	-	-	1,126	1,776	1,760	1,700	1,440	1,610	1,780	1,658	1,700	1,440	1,780	1,776	139	62.0	172
Potassium	mg/kg	-	-	-	-	1,370	3,704	3,170	3,400	3,780	2,630	2,900	3,176	3,170	2,630	3,780	3,704	444	199	551
Selenium	mg/kg	2.0	-	-	-	0.94	0.91	0.90	0.70	0.76	0.55	0.91	0.76	0.76	0.55	0.91	0.91	0.15	0.067	0.19
Silver	mg/kg	0.50	-	-	-	0.203	0.189	0.169	0.180	0.191	0.144	0.176	0.172	0.176	0.144	0.191	0.189	0.0176	0.0079	0.0218
Sodium	mg/kg	-	-	-	-	420	374	350	310	380	260	300	320	310	260	380	374	46.4	20.7	57.6
Strontium	mg/kg	-	-	-	-	78.1	94.3	95.0	90.6	85.4	71.1	91.6	86.7	90.6	71.1	95.0	94.3	9.40	4.20	11.7
Thallium	mg/kg	-	-	-	-	0.166	0.293	0.257	0.256	0.296	0.239	0.280	0.266	0.257	0.239	0.296	0.293	0.0224	0.0100	0.0278
Tin	mg/kg	-	-	-	-	0.47	0.61	0.50	0.61	0.61	0.45	0.46	0.53	0.50	0.45	0.61	0.61	0.08	0.035	0.10
Titanium	mg/kg	-	-	-	-	1,084	923	942	813	824	815	846	848	824	813	942	923	54	24	67
Uranium	mg/kg	-	-	-	-	1.35	3.16	2.61	2.70	3.09	2.91	3.18	2.90	2.91	2.61	3.18	3.16	0.244	0.109	0.303
Vanadium	mg/kg	-	-	-	-	66.3	46.6	46.4	44.7	46.7	40.9	44.9	44.7	44.9	40.9	46.7	46.6	2.31	1.03	2.87
Zinc	mg/kg	123	315	200	380	77.1	95.3	85.6	88.9	96.9	76.8	86.0	86.8	86.0	76.8	96.9	95.3	7.22	3.23	8.96

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Reference 95th percentile was calculated using displayed data for the <63µm sediment fraction. The 5th percentile is reported for pH.

(blue) Value is > TEL. Values shown in bold text also exceed Reference 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed Reference 95th Percentile values.

Table E.55: Raw sediment quality data for Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Metals data are based on the < 63µm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		Contaminated Sites Regulation [3]		Reference 95th Percentile [4]		Exposed PNF (QULP-1)											
		TEL	PEL	Sensitive	Typical	PRef1	PRef2	QULP-1-01	QULP-1-02	QULP-1-03	QULP-1-04	QULP-1-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								9-Sep-14	10-Sep-14	11-Sep-14	12-Sep-14	13-Sep-14							
Physical Tests																			
pH (1:2 soil:water)	pH	-	-	-	-	6.83	7.21	8.67	8.58	8.72	8.73	8.71	8.68	8.71	8.58	8.73	0.0614	0.0275	0.0762
Organic / Inorganic Carbon																			
Total Organic Carbon	%	-	-	-	-	1.72	1.93	0.12	0.12	0.27	0.17	0.15	0.17	0.15	0.12	0.27	0.062	0.028	0.077
Metals																			
Aluminum	mg/kg	-	-	-	-	15,380	25,380	24,300	24,600	21,800	17,000	16,300	20,800	21,800	16,300	24,600	3,949	1,766	4,903
Antimony	mg/kg	-	-	-	-	0.44	0.40	0.50	0.59	0.56	0.52	0.41	0.52	0.52	0.41	0.59	0.069	0.031	0.085
Arsenic	mg/kg	5.9	17	11	20	8.51	20.9	15.5	18.6	15.4	14.4	13.2	15.4	15.4	13.2	18.6	2.01	0.897	2.49
Barium	mg/kg	-	-	-	-	151	220	233	277	233	196	187	225	233	187	277	35.8	16.0	44.4
Beryllium	mg/kg	-	-	-	-	0.44	0.90	0.88	0.99	0.83	0.63	0.62	0.79	0.83	0.62	0.99	0.16	0.072	0.20
Bismuth	mg/kg	-	-	-	-	0.15	0.51	<0.10	0.12	<0.10	<0.10	<0.10	0.10	<0.10	<0.10	0.12	0.0089	0.0040	0.011
Boron	mg/kg	-	-	-	-	<10	<10	11	11	11	10	<10	11	11	<10	11	0.55	0.24	0.68
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.414	0.315	0.166	0.203	0.154	0.128	0.167	0.164	0.166	0.128	0.203	0.0271	0.0121	0.0336
Calcium	mg/kg	-	-	-	-	8,034	7,392	35,900	37,400	34,300	32,100	27,000	33,340	34,300	27,000	37,400	4,053	1,812	5,031
Chromium	mg/kg	37	90	56	110	55.8	52.2	13.8	15.4	12.5	10.9	18.8	14.3	13.8	10.9	18.8	3.02	1.35	3.75
Cobalt	mg/kg	-	-	-	-	14.0	25.7	20.5	23.0	18.5	15.1	19.8	19.4	19.8	15.1	23.0	2.90	1.30	3.60
Copper	mg/kg	36	197	120	240	46.2	48.3	766	865	690	566	681	**714**	**690**	**566**	**865**	111	49.5	138
Iron	mg/kg	21,200	43,776	-	-	29,820	102,460	27,900	31,100	25,500	33,700	68,000	37,240	31,100	25,500	68,000	17,475	7,815	21,694
Lead	mg/kg	35	91	57	110	7.24	22.1	7.39	9.28	6.69	5.23	6.87	7.09	6.87	5.23	9.28	1.46	0.654	1.82
Lithium	mg/kg	-	-	-	-	13.8	37.4	24.5	24.2	21.5	15.5	16.6	20.5	21.5	15.5	24.5	4.21	1.88	5.23
Magnesium	mg/kg	-	-	-	-	8,036	9,344	14,900	15,700	13,600	9,890	10,700	12,958	13,600	9,890	15,700	2,560	1,145	3,178
Manganese	mg/kg	460	1,100	-	-	496	7,814	863	948	811	650	711	797	811	650	948	119	53.1	147
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0515	0.0593	0.0729	0.0779	0.0690	0.0577	0.0708	0.0697	0.0708	0.0577	0.0779	0.0075	0.0033	0.0093
Molybdenum	mg/kg	-	-	-	-	0.96	2.72	3.90	4.06	3.66	3.35	3.83	3.76	3.83	3.35	4.06	0.270	0.121	0.336
Nickel	mg/kg	16	75	-	-	37.9	60.7	13.8	15.5	12.5	9.4	13.4	12.9	13.4	9.37	15.5	2.26	1.01	2.81
Phosphorus	mg/kg	-	-	-	-	1,126	1,776	1,600	1,910	1,620	1,730	1,670	1,706	1,670	1,600	1,910	125	56	155
Potassium	mg/kg	-	-	-	-	1,370	3,704	1,880	2,440	2,130	1,540	1,720	1,942	1,880	1,540	2,440	353	158	438
Selenium	mg/kg	2.0	-	-	-	0.94	0.91	1.06	1.38	1.00	0.93	1.00	1.07	1.00	0.93	1.38	0.177	0.079	0.220
Silver	mg/kg	0.50	-	-	-	0.203	0.189	0.320	0.400	0.326	0.294	0.321	0.332	0.321	0.294	0.400	0.0399	0.0178	0.0495
Sodium	mg/kg	-	-	-	-	420	374	1,070	1,390	1,270	940	920	1,118	1,070	920	1,390	206	92.3	256
Strontium	mg/kg	-	-	-	-	78.1	94.3	206	209	207	177	141	188	206	141	209	29.4	13.1	36.5
Thallium	mg/kg	-	-	-	-	0.166	0.293	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0
Tin	mg/kg	-	-	-	-	0.47	0.61	2.27	2.38	2.28	1.89	1.44	2.05	2.27	1.44	2.38	0.390	0.174	0.484
Titanium	mg/kg	-	-	-	-	1,084	923	2,140	2,160	2,100	1,810	1,520	1,946	2,100	1,520	2,160	277	124	344
Uranium	mg/kg	-	-	-	-	1.35	3.16	1.45	1.83	1.50	1.34	1.04	1.43	1.45	1.04	1.83	0.285	0.128	0.354
Vanadium	mg/kg	-	-	-	-	66.3	46.6	107	117	102	135	265	145	117	102	265	68.1	30.5	84.6
Zinc	mg/kg	123	315	200	380	77.1	95.3	75.2	81.7	68.1	51.8	68.1	69.0	68.1	51.8	81.7	11.1	4.99	13.8

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996)
[4] Reference 95th percentile was calculated using displayed data for the <63µm sediment fraction. The 5th percentile is reported for pH.

(blue) Value is > TEL. Values shown in bold text also exceed Reference 95th Percentile values.
(orange) Value is > PEL. Values shown in bold text also exceed Reference 95th Percentile values.

Table E.55: Raw sediment quality data for Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Metals data are based on the < 63µm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		Contaminated Sites Regulation [3]		Reference 95th Percentile [4]		Exposed PFF2 (QULP-4)											
		TEL	PEL	Sensitive	Typical	PRef1	PRef2	QULP-4-01	QULP-4-02	QULP-4-03	QULP-4-04	QULP-4-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								8-Oct-14	8-Oct-14	15-Oct-14	20-Oct-14	20-Oct-14							
Physical Tests																			
pH (1:2 soil:water)	pH	-	-	-	-	6.83	7.21	8.67	8.59	8.49	8.25	8.48	8.50	8.49	8.25	8.67	0.158	0.071	0.196
Organic / Inorganic Carbon																			
Total Organic Carbon	%	-	-	-	-	1.72	1.93	0.35	0.46	0.17	0.24	0.21	0.29	0.24	0.17	0.46	0.12	0.053	0.15
Metals																			
Aluminum	mg/kg	-	-	-	-	15,380	25,380	22,900	22,900	19,900	19,800	18,600	20,820	19,900	18,600	22,900	1,966	879	2,441
Antimony	mg/kg	-	-	-	-	0.44	0.40	0.47	0.46	0.45	0.47	0.39	0.45	0.46	0.39	0.47	0.033	0.015	0.042
Arsenic	mg/kg	5.9	17	11	20	8.51	20.9	14.4	13.6	13.6	14.0	12.9	13.7	13.6	12.9	14.4	0.56	0.25	0.69
Barium	mg/kg	-	-	-	-	151	220	236	229	202	213	218	220	218	202	236	13.4	5.97	16.6
Beryllium	mg/kg	-	-	-	-	0.44	0.90	0.75	0.78	0.67	0.74	0.65	0.72	0.74	0.65	0.78	0.055	0.025	0.069
Bismuth	mg/kg	-	-	-	-	0.15	0.51	<0.10	0.11	<0.10	<0.10	<0.10	0.10	<0.10	<0.10	0.11	0.0045	0.0020	0.0056
Boron	mg/kg	-	-	-	-	<10	<10	11	11	11	10	<10	11	11	10	11	0.55	0.24	0.68
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.414	0.315	0.176	0.174	0.128	0.138	0.128	0.149	0.138	0.128	0.176	0.0243	0.0109	0.0301
Calcium	mg/kg	-	-	-	-	8,034	7,392	33,700	31,700	32,700	32,600	30,700	32,280	32,600	30,700	33,700	1,132	506	1,406
Chromium	mg/kg	37	90	56	110	55.8	52.2	17.4	17.9	11.0	13.3	11.1	14.1	13.3	11.0	17.9	3.34	1.49	4.14
Cobalt	mg/kg	-	-	-	-	14.0	25.7	17.7	18.4	14.0	15.6	14.3	16.0	15.6	14.0	18.4	1.98	0.89	2.46
Copper	mg/kg	36	197	120	240	46.2	48.3	611	589	503	534	513	**550**	**534**	**503**	**611**	47.6	21.3	59.1
Iron	mg/kg	21,200	43,776	-	-	29,820	102,460	26,600	27,000	23,400	25,000	22,900	24,980	25,000	22,900	27,000	1,839	822	2,283
Lead	mg/kg	35	91	57	110	7.24	22.1	6.98	7.35	5.38	5.92	5.30	6.19	5.92	5.30	7.35	0.934	0.418	1.16
Lithium	mg/kg	-	-	-	-	13.8	37.4	21.5	23.1	16.9	19.8	18.2	19.9	19.8	16.9	23.1	2.48	1.11	3.08
Magnesium	mg/kg	-	-	-	-	8,036	9,344	13,500	14,400	10,600	11,200	10,200	11,980	11,200	10,200	14,400	1,861	832	2,310
Manganese	mg/kg	460	1,100	-	-	496	7,814	824	826	661	711	628	730	711	628	826	91.6	41.0	114
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0515	0.0593	0.0770	0.0740	0.0631	0.0699	0.0666	0.0701	0.0699	0.0631	0.0770	0.00557	0.00249	0.00692
Molybdenum	mg/kg	-	-	-	-	0.96	2.72	3.44	3.32	3.22	3.36	3.21	3.31	3.32	3.21	3.44	0.097	0.043	0.120
Nickel	mg/kg	16	75	-	-	37.9	60.7	16.2	17.1	10.1	12.2	11.1	13.3	12.2	10.1	17.1	3.13	1.40	3.88
Phosphorus	mg/kg	-	-	-	-	1,126	1,776	1,710	1,350	1,720	1,790	1,690	1,652	1,710	1,350	1,790	173	77.4	215
Potassium	mg/kg	-	-	-	-	1,370	3,704	2,080	2,240	1,860	1,740	1,600	1,904	1,860	1,600	2,240	257	115	320
Selenium	mg/kg	2.0	-	-	-	0.94	0.91	1.0	0.94	0.78	0.93	0.80	0.89	0.93	0.78	1.0	0.095	0.043	0.12
Silver	mg/kg	0.50	-	-	-	0.203	0.189	0.302	0.271	0.266	0.267	0.247	0.271	0.267	0.247	0.302	0.0199	0.0089	0.0247
Sodium	mg/kg	-	-	-	-	420	374	1,060	1,130	1,030	900	900	1,004	1,030	900	1,130	102	45.5	126
Strontium	mg/kg	-	-	-	-	78.1	94.3	197	213	197	195	187	198	197	187	213	9.44	4.22	11.7
Thallium	mg/kg	-	-	-	-	0.166	0.293	0.053	0.054	<0.050	<0.050	<0.050	0.051	<0.050	<0.050	0.054	0.0019	0.00087	0.0024
Tin	mg/kg	-	-	-	-	0.47	0.61	2.0	2.0	2.2	1.8	1.5	1.9	2.0	1.5	2.2	0.27	0.12	0.33
Titanium	mg/kg	-	-	-	-	1,084	923	2,030	2,040	1,940	1,760	1,440	1,842	1,940	1,440	2,040	251	112	312
Uranium	mg/kg	-	-	-	-	1.35	3.16	1.49	1.40	1.39	1.38	1.16	1.36	1.39	1.16	1.49	0.122	0.055	0.152
Vanadium	mg/kg	-	-	-	-	66.3	46.6	97.9	92.0	86.8	92.9	81.3	90.2	92.0	81.3	97.9	6.34	2.83	7.87
Zinc	mg/kg	123	315	200	380	77.1	95.3	70.2	69.2	53.3	57.7	53.0	60.7	57.7	53.0	70.2	8.45	3.78	10.5

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996)
[4] Reference 95th percentile was calculated using displayed data for the <63µm sediment fraction. The 5th percentile is reported for pH.

(blue) Value is > TEL. Values shown in bold text also exceed Reference 95th Percentile values.
(orange) Value is > PEL. Values shown in bold text also exceed Reference 95th Percentile values.

Table E.55: Raw sediment quality data for Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Metals data are based on the < 63µm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		Contaminated Sites Regulation [3]		Reference 95th Percentile [4]		Exposed PFF1 (QULP-2)												
		TEL	PEL	Sensitive	Typical	PRef1	PRef2	QULP-2-01	QULP-2-02	QULP-2-03	QULP-2-04	QULP-2-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								19-Sep-14	19-Sep-14	19-Sep-14	20-Sep-14	20-Sep-14							
Physical Tests																			
pH (1:2 soil:water)	pH	-	-	-	-	6.83	7.21	8.01	8.32	8.35	8.43	8.46	8.31	8.35	8.01	8.46	0.179	0.080	0.223
Organic / Inorganic Carbon																			
Total Organic Carbon	%	-	-	-	-	1.72	1.93	1.24	0.32	0.36	0.15	0.12	0.44	0.32	0.12	1.24	0.46	0.21	0.57
Metals																			
Aluminum	mg/kg	-	-	-	-	15,380	25,380	26,500	18,800	17,900	16,700	17,800	19,540	17,900	16,700	26,500	3,961	1,772	4,918
Antimony	mg/kg	-	-	-	-	0.44	0.40	0.64	0.48	0.43	0.38	0.38	0.46	0.43	0.38	0.64	0.11	0.048	0.13
Arsenic	mg/kg	5.9	17	11	20	8.51	20.9	16.0	13.1	12.9	12.4	11.7	13.2	12.9	11.7	16.0	1.65	0.74	2.04
Barium	mg/kg	-	-	-	-	151	220	261	192	194	181	193	204	193	181	261	32.2	14.4	40.0
Beryllium	mg/kg	-	-	-	-	0.44	0.90	0.92	0.64	0.62	0.63	0.62	0.69	0.63	0.62	0.92	0.13	0.059	0.16
Bismuth	mg/kg	-	-	-	-	0.15	0.51	0.19	0.10	0.10	<0.10	<0.10	0.12	0.10	<0.10	0.19	0.040	0.018	0.050
Boron	mg/kg	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.414	0.315	0.317	0.173	0.174	0.129	0.113	0.181	0.173	0.113	0.317	0.081	0.036	0.100
Calcium	mg/kg	-	-	-	-	8,034	7,392	28,700	28,300	27,600	28,400	26,500	27,900	28,300	26,500	28,700	880	394	1,093
Chromium	mg/kg	37	90	56	110	55.8	52.2	32.3	18.1	17.7	13.8	12.3	18.8	17.7	12.3	32.3	7.92	3.54	9.84
Cobalt	mg/kg	-	-	-	-	14.0	25.7	23.6	14.5	15.9	13.3	13.4	16.1	14.5	13.3	23.6	4.30	1.92	5.34
Copper	mg/kg	36	197	120	240	46.2	48.3	643	431	501	413	419	**481**	**431**	**413**	**643**	97.0	43.4	120
Iron	mg/kg	21,200	43,776	-	-	29,820	102,460	36,300	26,200	29,400	24,600	21,900	27,680	26,200	21,900	36,300	5,531	2,473	6,866
Lead	mg/kg	35	91	57	110	7.24	22.1	11.5	6.52	6.56	5.36	4.89	6.97	6.52	4.89	11.5	2.64	1.18	3.27
Lithium	mg/kg	-	-	-	-	13.8	37.4	29.5	19.1	19.0	16.7	17.3	20.3	19.0	16.7	29.5	5.24	2.34	6.50
Magnesium	mg/kg	-	-	-	-	8,036	9,344	15,400	9,960	10,500	9,160	9,670	10,938	9,960	9,160	15,400	2,541	1,136	3,155
Manganese	mg/kg	460	1,100	-	-	496	7,814	1,150	654	661	578	580	725	654	578	1,150	241	108	299
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0515	0.0593	0.106	0.0716	0.0767	0.0651	0.0623	0.0763	0.0716	0.0623	0.106	0.0175	0.0078	0.0217
Molybdenum	mg/kg	-	-	-	-	0.96	2.72	3.35	2.71	2.93	2.86	2.62	2.89	2.86	2.62	3.35	0.283	0.126	0.351
Nickel	mg/kg	16	75	-	-	37.9	60.7	29.7	15.9	15.5	12.0	11.3	16.9	15.5	11.3	29.7	7.45	3.33	9.25
Phosphorus	mg/kg	-	-	-	-	1,126	1,776	1,260	1,610	1,590	1,700	1,370	1,506	1,590	1,260	1,700	183	82.0	228
Potassium	mg/kg	-	-	-	-	1,370	3,704	2,590	1,800	1,700	1,460	1,660	1,842	1,700	1,460	2,590	436	195	541
Selenium	mg/kg	2.0	-	-	-	0.94	0.91	1.52	0.83	0.99	0.72	0.65	0.94	0.83	0.65	1.52	0.35	0.16	0.43
Silver	mg/kg	0.50	-	-	-	0.203	0.189	0.370	0.239	0.276	0.223	0.196	0.261	0.239	0.196	0.370	0.0676	0.0302	0.0839
Sodium	mg/kg	-	-	-	-	420	374	1,030	920	870	840	1,020	936	920	840	1,030	86.2	38.5	107
Strontium	mg/kg	-	-	-	-	78.1	94.3	199	185	169	174	190	183	185	169	199	12.1	5.41	15.0
Thallium	mg/kg	-	-	-	-	0.166	0.293	0.122	0.0590	0.0510	<0.050	<0.050	0.0664	0.0510	<0.050	0.122	0.0313	0.0140	0.0389
Tin	mg/kg	-	-	-	-	0.47	0.61	1.8	1.6	1.3	1.5	1.4	1.5	1.5	1.3	1.8	0.20	0.090	0.25
Titanium	mg/kg	-	-	-	-	1,084	923	1,810	1,570	1,250	1,300	1,390	1,464	1,390	1,250	1,810	229	102	284
Uranium	mg/kg	-	-	-	-	1.35	3.16	1.82	1.36	1.19	1.23	1.11	1.34	1.23	1.11	1.82	0.282	0.126	0.350
Vanadium	mg/kg	-	-	-	-	66.3	46.6	104	88.1	97.8	85.8	78.4	90.8	88.1	78.4	104	10.1	4.52	12.6
Zinc	mg/kg	123	315	200	380	77.1	95.3	95.3	59.0	60.1	50.2	51.3	63.2	59.0	50.2	95.3	18.5	8.27	23.0

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Summary statistics are reported as < MDL if all the data used in their calculation were < MDL.
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996)
[4] Reference 95th percentile was calculated using displayed data for the <63µm sediment fraction. The 5th percentile is reported for pH.

(blue) Value is > TEL. Values shown in bold text also exceed Reference 95th Percentile values.
(orange) Value is > PEL. Values shown in bold text also exceed Reference 95th Percentile values.

Table E.55: Raw sediment quality data for Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Metals data are based on the < 63µm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		Contaminated Sites Regulation [3]		Reference 95th Percentile [4]		Exposed PFFF (QULP-3)												
		TEL	PEL	Sensitive	Typical	PRef1	PRef2	QULP-3-01	QULP-3-02	QULP-3-03	QULP-3-04	QULP-3-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE
Date Sampled								15-Oct-14	15-Oct-14	15-Oct-14	16-Oct-14	18-Oct-14							
Physical Tests																			
pH (1:2 soil:water)	pH	-	-	-	-	6.83	7.21	7.37	7.31	7.26	7.23	7.38	7.31	7.31	7.23	7.38	0.0660	0.0295	0.0819
Organic / Inorganic Carbon																			
Total Organic Carbon	%	-	-	-	-	1.72	1.93	2.58	3.14	3.29	2.98	3.18	3.03	3.14	2.58	3.29	0.277	0.124	0.344
Metals																			
Aluminum	mg/kg	-	-	-	-	15,380	25,380	29,100	29,400	27,900	27,500	29,200	28,620	29,100	27,500	29,400	858	384	1,066
Antimony	mg/kg	-	-	-	-	0.44	0.40	0.69	0.84	0.82	0.79	0.82	0.79	0.82	0.69	0.84	0.060	0.027	0.074
Arsenic	mg/kg	5.9	17	11	20	8.51	20.9	55.9	54.0	115	165	56.2	**89.2**	**56.2**	**54.0**	**165**	49.6	22.2	61.6
Barium	mg/kg	-	-	-	-	151	220	278	266	239	280	263	265	266	239	280	16.4	7.33	20.4
Beryllium	mg/kg	-	-	-	-	0.44	0.90	0.89	0.84	0.85	0.76	0.84	0.84	0.84	0.76	0.89	0.047	0.021	0.059
Bismuth	mg/kg	-	-	-	-	0.15	0.51	0.33	0.33	0.32	0.31	0.33	0.32	0.33	0.31	0.33	0.0089	0.0040	0.011
Boron	mg/kg	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0	0
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.414	0.315	0.811	0.757	0.690	0.626	0.684	**0.714**	**0.690**	**0.626**	**0.811**	0.0715	0.0320	0.0888
Calcium	mg/kg	-	-	-	-	8,034	7,392	10,000	11,200	10,600	10,900	10,400	10,620	10,600	10,000	11,200	460	206	572
Chromium	mg/kg	37	90	56	110	55.8	52.2	68.2	70.4	67.4	64.7	69.8	**68.1**	**68.2**	**64.7**	**70.4**	2.25	1.01	2.79
Cobalt	mg/kg	-	-	-	-	14.0	25.7	26.7	27.6	26.4	27.7	26.6	27.0	26.7	26.4	27.7	0.604	0.270	0.750
Copper	mg/kg	36	197	120	240	46.2	48.3	87.2	115	84.8	93.4	117	**99.5**	**93.4**	**84.8**	**117**	15.4	6.90	19.1
Iron	mg/kg	21,200	43,776	-	-	29,820	102,460	75,100	63,000	70,000	74,700	64,500	69,460	70,000	63,000	75,100	5,610	2,509	6,965
Lead	mg/kg	35	91	57	110	7.24	22.1	16.1	20.0	19.4	19.1	19.6	18.8	19.4	16.1	20.0	1.57	0.700	1.94
Lithium	mg/kg	-	-	-	-	13.8	37.4	27.2	28.0	27.6	24.1	26.5	26.7	27.2	24.1	28.0	1.54	0.691	1.92
Magnesium	mg/kg	-	-	-	-	8,036	9,344	11,300	12,300	11,700	11,200	12,800	11,860	11,700	11,200	12,800	680	304	845
Manganese	mg/kg	460	1,100	-	-	496	7,814	9,160	21,100	22,400	27,700	14,900	**19,052**	**21,100**	**9,160**	**27,700**	7,164	3,204	8,894
Mercury	mg/kg	0.17	0.49	0.30	0.58	0.0515	0.0593	0.121	0.149	0.143	0.138	0.147	0.140	0.143	0.121	0.149	0.0112	0.0050	0.0139
Molybdenum	mg/kg	-	-	-	-	0.96	2.72	6.80	30.7	7.05	7.39	5.72	11.5	7.05	5.72	30.7	10.7	4.80	13.3
Nickel	mg/kg	16	75	-	-	37.9	60.7	70.9	67.8	66.3	64.2	68.0	**67.4**	**67.8**	**64.2**	**70.9**	2.46	1.10	3.05
Phosphorus	mg/kg	-	-	-	-	1,126	1,776	3,060	2,030	2,210	2,760	1,790	2,370	2,210	1,790	3,060	526	235	653
Potassium	mg/kg	-	-	-	-	1,370	3,704	3,180	3,110	2,920	3,000	3,220	3,086	3,110	2,920	3,220	125	55.8	155
Selenium	mg/kg	2.0	-	-	-	0.94	0.91	1.28	1.71	1.74	1.78	1.84	1.67	1.74	1.28	1.84	0.223	0.100	0.277
Silver	mg/kg	0.50	-	-	-	0.203	0.189	0.345	0.357	0.321	0.309	0.359	0.338	0.345	0.309	0.359	0.0223	0.0100	0.0276
Sodium	mg/kg	-	-	-	-	420	374	440	540	430	470	500	476	470	430	540	45.1	20.1	55.9
Strontium	mg/kg	-	-	-	-	78.1	94.3	127	146	130	140	124	133	130	124	146	9.26	4.14	11.5
Thallium	mg/kg	-	-	-	-	0.166	0.293	0.391	0.368	0.341	0.340	0.329	0.354	0.341	0.329	0.391	0.0253	0.0113	0.0314
Tin	mg/kg	-	-	-	-	0.47	0.61	0.72	0.78	0.69	1.09	0.68	0.79	0.72	0.68	1.09	0.17	0.077	0.21
Titanium	mg/kg	-	-	-	-	1,084	923	881	943	927	864	980	919	927	864	980	47.0	21.0	58.3
Uranium	mg/kg	-	-	-	-	1.35	3.16	3.64	3.52	3.13	3.11	3.38	3.36	3.38	3.11	3.64	0.234	0.105	0.291
Vanadium	mg/kg	-	-	-	-	66.3	46.6	84.5	88.0	89.4	84.1	91.0	87.4	88.0	84.1	91.0	3.03	1.35	3.76
Zinc	mg/kg	123	315	200	380	77.1	95.3	119	119	112	105	115	114	115	105	119	5.83	2.61	7.24

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Reference 95th percentile was calculated using displayed data for the <63µm sediment fraction. The 5th percentile is reported for pH.

(blue) Value is > TEL. Values shown in bold text also exceed Reference 95th Percentile values.

(orange) Value is > PEL. Values shown in bold text also exceed Reference 95th Percentile values.

Table E.56: PCA results displaying; eigen value, percent variance explained, Monte Carlo randomization p-values of axis significance, and station scores for < 2mm sediment from Quesnel Lake profundal sampling stations, Mount Polley Mine, 2014. Data were Log (X+1) transformed prior to analysis [a].

		Axis 1	Axis 2
Eigenvalue		15.1	9.6
% Variance explained		48.8	31.0
Monte Carlo p		0.0001	0.0001
PRef1 (QULP-5)	PRef1-1	-2.5	-5.8
	PRef1-2	-2.3	-5.5
	PRef1-3	-1.6	-4.5
	PRef1-4	-1.4	-4.4
	PRef1-5	-1.5	-4.4
PRef2 (QULP-6)	PRef2-1	4.1	-2.0
	PRef2-2	4.6	-2.3
	PRef2-3	4.8	-2.3
	PRef2-4	3.0	-3.6
	PRef2-5	4.6	-2.3
PNF (QULP-1)	PNF-1	-1.9	4.4
	PNF-2	-1.1	6.6
	PNF-3	-2.5	3.3
	PNF-4	-3.9	1.0
	PNF-5	-3.7	0.18
PFF2 (QULP-4)	PFF2-1	-2.4	2.1
	PFF2-2	-1.8	2.4
	PFF2-3	-4.4	0.24
	PFF2-4	-3.1	1.7
	PFF2-5	-3.5	2.1
PFF1 (QULP-2)	PFF1-1	0.9	3.6
	PFF1-2	-3.5	-0.32
	PFF1-3	-3.0	0.70
	PFF1-4	-4.1	-0.125
	PFF1-5	-4.1	0.20
PFFF (QULP-3)	PFFF-1	6.3	1.7
	PFFF-2	6.0	2.4
	PFFF-3	6.1	1.5
	PFFF-4	5.8	1.6
	PFFF-5	6.1	1.6

[a] Mercury data was omitted from PCA calculations due to an incomplete data set.

Table E.57: PCA axis scores Spearman correlation with sediment metal concentrations (A) and sediment physical characteristics (B) for Quesnel Lake Profundal sediment (< 2mm fraction), Mount Polley Mine, 2014. Data were Log_{10} (X+1) transformed prior to analysis.

A)

Metal [a]	Spearman Correlation Coefficient [b]		P-Value [c]	
	PCA Axis-1 (50.3%)	PCA Axis-2 (31.0%)	PCA Axis-1 (50.3%)	PCA Axis-2 (31.0%)
Aluminum	0.719	0.618	0.000	0.000
Antimony	0.421	0.746	0.021	0.000
Arsenic	0.704	0.533	0.000	0.002
Barium	0.512	0.750	0.004	0.000
Beryllium	0.607	0.640	0.000	0.000
Bismuth	0.771	-0.170	0.000	0.370
Boron	-0.122	0.538	0.522	0.002
Cadmium	0.851	-0.184	0.000	0.330
Calcium	-0.536	0.778	0.002	0.000
Chromium	0.825	-0.328	0.000	0.077
Cobalt	0.845	0.427	0.000	0.019
Copper	-0.402	0.826	0.028	0.000
Iron	0.814	-0.127	0.000	0.502
Lead	0.941	0.075	0.000	0.694
Lithium	0.692	0.329	0.000	0.076
Magnesium	0.184	0.959	0.332	0.000
Manganese	0.754	0.468	0.000	0.009
Molybdenum	0.234	0.846	0.214	0.000
Nickel	0.936	-0.212	0.000	0.261
Phosphorus	0.277	0.424	0.138	0.019
Potassium	0.719	0.358	0.000	0.052
Selenium	0.654	0.470	0.000	0.009
Silver	0.156	0.840	0.411	0.000
Sodium	-0.509	0.779	0.004	0.000
Strontium	-0.417	0.838	0.022	0.000
Thallium	0.891	-0.273	0.000	0.145
Tin	-0.205	0.604	0.277	0.000
Titanium	-0.606	0.612	0.000	0.000
Uranium	0.880	0.344	0.000	0.063
Vanadium	-0.256	0.784	0.172	0.000
Zinc	0.986	0.051	0.000	0.787

[a] Highlighted cells indicate Spearman correlation coefficient > 0.7 or < -0.7.

[b] Highlighted cells indicate Spearman correlation with p value < 0.1.

B)

Physical Characteristic	Spearman Correlation		P-Value	
	PCA Axis-1 (50.3%)	PCA Axis-2 (31.0%)	PCA Axis-1 (50.3%)	PCA Axis-2 (31.0%)
% Sand	0.154	-0.685	0.415	0.000
% Silt	-0.556	0.022	0.001	0.909
% Clay	0.634	0.694	0.000	0.000
Total Organic Carbon	0.842	-0.231	0.000	0.219

Table E.58: PCA results displaying; eigen value, percent variance explained, Monte Carlo randomization p-values of axis significance, and station scores for < 63µm sediment from Quesnel Lake profundal sampling stations, Mount Polley Mine, 2014. Data were Log (X+1) transformed prior to analysis.

		Axis 1	Axis 2
Eigenvalue		15.6	10.8
% Variance explained		48.7	33.7
Monte Carlo p		0.0001	0.0001
PRef1 (QULP-5)	PRef1-1	-1.8	-4.6
	PRef1-2	-2.2	-5.6
	PRef1-3	-1.6	-4.8
	PRef1-4	-1.7	-4.9
	PRef1-5	-2.3	-5.7
PRef2 (QULP-6)	PRef2-1	3.7	-2.7
	PRef2-2	4.1	-2.9
	PRef2-3	4.5	-2.7
	PRef2-4	2.3	-4.9
	PRef2-5	4.1	-2.8
PNF (QULP-1)	PNF-1	-2.3	3.9
	PNF-2	-1.0	5.4
	PNF-3	-2.7	3.7
	PNF-4	-3.9	1.5
	PNF-5	-2.7	1.4
PFF2 (QULP-4)	PFF2-1	-2.4	3.1
	PFF2-2	-2.5	2.9
	PFF2-3	-4.1	1.9
	PFF2-4	-3.1	1.7
	PFF2-5	-3.8	0.77
PFF1 (QULP-2)	PFF1-1	0.8	3.8
	PFF1-2	-3.0	0.59
	PFF1-3	-2.8	0.61
	PFF1-4	-4.0	-0.22
	PFF1-5	-4.3	-0.19
PFFF (QULP-3)	PFFF-1	6.6	1.6
	PFFF-2	6.9	2.9
	PFFF-3	6.6	1.8
	PFFF-4	6.6	2.2
	PFFF-5	6.3	2.1

Table E.59: PCA axis scores Spearman correlation with sediment metal concentrations (A) and sediment physical characteristics (B) for Quesnel Lake Profundal sediment (< 63µm fraction), Mount Polley Mine, 2014. Data were Log_{10} (X+1) transformed prior to analysis.

A)

Metal	Spearman Correlation Coefficient [a]		P-Value [b]	
	PCA Axis-1 (48.7%)	PCA Axis-2 (33.7%)	PCA Axis-1 (48.7%)	PCA Axis-2 (33.7%)
Aluminum	0.656	0.640	0.000	0.000
Antimony	0.298	0.735	0.110	0.000
Arsenic	0.628	0.599	0.000	0.000
Barium	0.430	0.817	0.018	0.000
Beryllium	0.557	0.634	0.001	0.000
Bismuth	0.886	-0.300	0.000	0.108
Boron	-0.241	0.626	0.200	0.000
Cadmium	0.873	-0.156	0.000	0.411
Calcium	-0.544	0.794	0.002	0.000
Chromium	0.862	-0.252	0.000	0.179
Cobalt	0.752	0.485	0.000	0.007
Copper	-0.432	0.842	0.017	0.000
Iron	0.819	-0.099	0.000	0.601
Lead	0.940	0.083	0.000	0.662
Lithium	0.640	0.305	0.000	0.101
Magnesium	0.069	0.980	0.717	0.000
Manganese	0.725	0.461	0.000	0.010
Mercury	0.253	0.821	0.177	0.000
Molybdenum	0.234	0.864	0.214	0.000
Nickel	0.944	-0.175	0.000	0.355
Phosphorus	0.346	0.476	0.061	0.008
Potassium	0.687	0.382	0.000	0.037
Selenium	0.441	0.716	0.015	0.000
Silver	0.124	0.875	0.512	0.000
Sodium	-0.515	0.810	0.004	0.000
Strontium	-0.446	0.846	0.014	0.000
Thallium	0.897	-0.251	0.000	0.181
Tin	-0.466	0.841	0.009	0.000
Titanium	-0.659	0.605	0.000	0.000
Uranium	0.825	0.327	0.000	0.077
Vanadium	-0.321	0.797	0.084	0.000
Zinc	0.986	0.093	0.000	0.625

[a] Highlighted cells indicate Spearman correlation coefficient > 0.7 or < -0.7.

[b] Highlighted cells indicate Spearman correlation with p value < 0.1.

B)

Physical Characteristic	Spearman Correlation		P-Value	
	PCA Axis-1 (48.7%)	PCA Axis-2 (33.7%)	PCA Axis-1 (48.7%)	PCA Axis-2 (33.7%)
% Silt	-0.661	-0.058	0.000	0.761
% Clay	0.600	0.695	0.000	0.000
Total Organic Carbon	0.825	-0.250	0.000	0.182

Table E.60: Raw selectively extracted (Tessier extraction) metals data for sediment from Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		Reference													
								PRef1 (QULP-5)													PRef2 (QULP-6) Composite
								QULP-5-01	QULP-5-02	QULP-5-03	QULP-5-04	QULP-5-05	Mean	Median	Minimum	Maximum	95th Percentile	Standard Deviation	Standard Error	t*SE	
Date Sampled		**TEL**	**PEL**	**Sensitive**	**Typical**	**PRef1**	**PRef2**	13-Sep-14	14-Sep-14	17-Sep-14	18-Sep-14	18-Sep-14									20-Oct-14
Exchangeable & Adsorbed Metals																					
Aluminum	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Arsenic	mg/kg	5.9	17	11	20	0.059	<0.050	<0.050	<0.050	0.060	0.052	0.057	0.054	0.052	<0.050	0.060	0.059	0.0045	0.0020	0.0056	<0.050
Barium	mg/kg	-	-	-	-	<25	<12	<24	<25	<25	<25	<25	<25	<25	<24	<25	<25	0.45	0.20	0.56	<12
Beryllium	mg/kg	-	-	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Bismuth	mg/kg	-	-	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.131	0.092	0.111	0.118	0.116	0.132	0.129	0.121	0.118	0.111	0.132	0.131	0.00893	0.00399	0.0111	0.092
Calcium	mg/kg	-	-	-	-	2,566	3,110	2,210	2,310	2,400	2,570	2,550	2,408	2,400	2,210	2,570	2,566	154	69.0	192	3,110
Chromium	mg/kg	37	90	56	110	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Cobalt	mg/kg	-	-	-	-	0.39	0.28	0.32	0.39	0.31	0.39	0.38	0.36	0.38	0.31	0.39	0.39	0.040	0.018	0.049	0.28
Copper	mg/kg	36	197	120	240	0.77	<0.50	0.70	0.77	0.62	0.75	0.70	0.71	0.70	0.62	0.77	0.77	0.058	0.026	0.072	<0.50
Iron	mg/kg	21,200	43,776	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50
Lead	mg/kg	35	91	57	110	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Manganese	mg/kg	460	1,100	-	-	192	466	118	119	139	169	198	149	139	118	198	192	34.5	15.4	42.8	466
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Nickel	mg/kg	16	75	-	-	0.94	0.56	0.80	0.93	0.75	0.94	0.91	0.87	0.91	0.75	0.94	0.94	0.086	0.038	0.11	0.56
Phosphorus	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50
Potassium	mg/kg	-	-	-	-	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	0	0	0	<100
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Sodium	mg/kg	-	-	-	-	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	0	0	0	<100
Strontium	mg/kg	-	-	-	-	22.2	31.2	18.4	19.1	20.7	22.2	22.1	20.5	20.7	18.4	22.2	22.2	1.72	0.770	2.14	31.2
Thallium	mg/kg	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0	0	<0.05
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0	<1.0
Uranium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Vanadium	mg/kg	-	-	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Zinc	mg/kg	123	315	200	380	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0	<1.0
Carbonate Metals																					
Aluminum	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50
Antimony	mg/kg	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0	0	<0.1
Arsenic	mg/kg	5.9	17	11	20	0.386	<0.050	0.168	0.298	0.396	0.332	0.344	0.308	0.332	0.168	0.396	0.386	0.0856	0.0383	0.106	<0.050
Barium	mg/kg	-	-	-	-	17.7	10.9	15.5	16.2	17.8	17.4	16.8	16.7	16.8	15.5	17.8	17.7	0.921	0.412	1.14	10.9
Beryllium	mg/kg	-	-	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Bismuth	mg/kg	-	-	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.057	<0.050	<0.050	0.053	0.057	<0.050	0.055	0.053	0.053	<0.050	0.057	0.057	0.0031	0.0014	0.0038	<0.050
Calcium	mg/kg	-	-	-	-	434	495	351	412	440	364	348	383	364	348	440	434	40.9	18.3	50.8	495
Chromium	mg/kg	37	90	56	110	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Cobalt	mg/kg	-	-	-	-	0.96	0.13	0.58	0.83	0.95	0.96	0.90	0.84	0.90	0.58	0.96	0.96	0.16	0.070	0.19	0.13
Copper	mg/kg	36	197	120	240	1.73	<0.50	1.20	1.65	1.63	1.74	1.70	1.58	1.65	1.20	1.74	1.73	0.219	0.098	0.272	<0.50
Iron	mg/kg	21,200	43,776	-	-	840	<50	329	664	802	850	775	684	775	329	850	840	210	93.9	261	<50
Lead	mg/kg	35	91	57	110	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Manganese	mg/kg	460	1,100	-	-	47.0	215	24.7	33.1	44.3	43.2	47.7	38.6	43.2	24.7	47.7	47.0	9.49	4.24	11.8	215
Molybdenum	mg/kg	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0	0	0	<0.5
Nickel	mg/kg	16	75	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Phosphorus	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50
Selenium	mg/kg	2.0	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Silver	mg/kg	0.5	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0	0	<0.1
Strontium	mg/kg	-	-	-	-	5.1	9.0	<5.0	<5.0	5.1	<5.0	<5.0	<5.0	<5.0	<5.0	5.1	5.1	0.045	0.020	0.056	9.0
Thallium	mg/kg	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0	0	<0.05
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Uranium	mg/kg	-	-	-	-	0.354	0.209	0.294	0.343	0.355	0.347	0.349	0.338	0.347	0.294	0.355	0.354	0.0248	0.0111	0.0307	0.209
Vanadium	mg/kg	-	-	-	-	0.94	<0.20	0.360	0.920	0.950	0.880	0.830	0.788	0.880	0.360	0.950	0.944	0.243	0.109	0.302	<0.20
Zinc	mg/kg	123	315	200	380	2.08	<1.0	1.50	1.80	2.10	2.00	1.80	1.84	1.80	1.50	2.10	2.08	0.230	0.103	0.286	<1.0

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
Summary statistics were only calculated for sampling areas with replicate samples (PRef1, PNF,and PFF1) but not for single composite samples (PRef2, PFF2, and PFFF).
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996)
[4] Displayed reference values are the 95th percentiles of data from reference area PRef1 and are the single values available for reference area PRef2.

(blue)	Value is > TEL. Values shown in bold text also exceed Reference values.
(orange)	Value is > PEL. Values shown in bold text also exceed Reference values.

Table E.60: Raw selectively extracted (Tessier extraction) metals data for sediment from Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		Exposed												
								PNF (QULP-1)												PFF2 (QULP-4) Composite
								QULP-1-01	QULP-1-02	QULP-1-03	QULP-1-04	QULP-1-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	
Date Sampled		TEL	PEL	Sensitive	Typical	PRef1	PRef2	9-Sep-14	10-Sep-14	11-Sep-14	12-Sep-14	13-Sep-14								20-Oct-14
Exchangeable & Adsorbed Metals																				
Aluminum	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Arsenic	mg/kg	5.9	17	11	20	0.059	<0.050	0.065	0.073	0.057	<0.050	0.056	0.060	0.057	<0.050	0.073	0.0089	0.0040	0.011	0.055
Barium	mg/kg	-	-	-	-	<25	<12	<26	<25	<25	<21	<18	<26	<25	<18	<26	3.4	1.5	4.2	<28
Beryllium	mg/kg	-	-	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Bismuth	mg/kg	-	-	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.131	0.092	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Calcium	mg/kg	-	-	-	-	2,566	3,110	2,000	2,540	1,760	1,200	1,190	1,738	1,760	1,190	2,540	571	255	708	1,810
Chromium	mg/kg	37	90	56	110	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Cobalt	mg/kg	-	-	-	-	0.39	0.28	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Copper	mg/kg	36	197	120	240	0.77	<0.50	4.46	4.52	4.10	3.35	3.77	4.04	4.10	3.35	4.52	0.490	0.219	0.608	2.49
Iron	mg/kg	21,200	43,776	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50
Lead	mg/kg	35	91	57	110	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Manganese	mg/kg	460	1,100	-	-	192	466	17.2	22.7	14.5	10.5	11.8	15.3	14.5	10.5	22.7	4.86	2.17	6.03	26.7
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	<0.70	<0.70	<0.70	<0.60	<0.60	<0.70	<0.70	<0.60	<0.70	0.055	0.024	0.068	<1.0
Nickel	mg/kg	16	75	-	-	0.94	0.56	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Phosphorus	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50
Potassium	mg/kg	-	-	-	-	<100	<100	160	170	160	100	<100	138	160	<100	170	34.9	15.6	43.4	160
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Sodium	mg/kg	-	-	-	-	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	0	0	0	<100
Strontium	mg/kg	-	-	-	-	22.2	31.2	20.4	30.0	17.1	9.9	10.0	17.5	17.1	9.9	30.0	8.4	3.7	10.4	17.0
Thallium	mg/kg	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0	0	<0.05
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0	<1.0
Uranium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	0.054
Vanadium	mg/kg	-	-	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Zinc	mg/kg	123	315	200	380	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0	<1.0
Carbonate Metals																				
Aluminum	mg/kg	-	-	-	-	<50	<50	80	92	77	52	57	72	77	52	92	17	7.5	21	<50
Antimony	mg/kg	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0	0	<0.1
Arsenic	mg/kg	5.9	17	11	20	0.386	<0.050	0.075	0.071	0.059	0.073	0.081	0.072	0.073	0.059	0.081	0.0081	0.0036	0.010	<0.050
Barium	mg/kg	-	-	-	-	17.7	10.9	58.1	73.2	55.6	39.9	36.2	52.6	55.6	36.2	73.2	14.9	6.69	18.6	43.1
Beryllium	mg/kg	-	-	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Bismuth	mg/kg	-	-	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.057	<0.050	<0.050	0.061	<0.050	<0.050	<0.050	0.052	<0.050	<0.050	0.061	0.0049	0.0022	0.0061	<0.050
Calcium	mg/kg	-	-	-	-	434	495	14,200	14,900	14,400	12,700	10,700	13,380	14,200	10,700	14,900	1,708	764	2,120	7,680
Chromium	mg/kg	37	90	56	110	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Cobalt	mg/kg	-	-	-	-	0.96	0.13	0.32	0.40	0.29	0.19	0.22	0.28	0.29	0.19	0.40	0.083	0.037	0.10	<0.10
Copper	mg/kg	36	197	120	240	1.73	<0.50	51.4	65.7	48.2	37.2	39.5	**48.4**	**48.2**	**37.2**	**65.7**	11.3	5.06	14.1	3.56
Iron	mg/kg	21,200	43,776	-	-	840	<50	87	80	83	86	105	88	86	80	105	9.8	4.4	12	<50
Lead	mg/kg	35	91	57	110	<0.50	<0.50	0.88	0.91	0.78	0.62	0.92	0.82	0.88	0.62	0.92	0.13	0.056	0.16	<0.50
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Manganese	mg/kg	460	1,100	-	-	47.0	215	108	125	107	91	87	104	107	86.9	125	15.3	6.83	19.0	53.9
Molybdenum	mg/kg	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0	0	0	<0.5
Nickel	mg/kg	16	75	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Phosphorus	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50
Selenium	mg/kg	2.0	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Silver	mg/kg	0.5	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0	0	<0.1
Strontium	mg/kg	-	-	-	-	5.1	9.0	60.8	67.9	59.8	43.9	38.1	54.1	59.8	38.1	67.9	12.5	5.60	15.6	43.2
Thallium	mg/kg	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0	0	<0.05
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Uranium	mg/kg	-	-	-	-	0.354	0.209	0.101	0.120	0.079	0.053	<0.050	0.081	0.079	<0.050	0.120	0.030	0.014	0.038	0.053
Vanadium	mg/kg	-	-	-	-	0.94	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Zinc	mg/kg	123	315	200	380	2.08	<1.0	1.4	1.6	1.3	1.0	1.0	1.3	1.3	1.0	1.6	0.26	0.12	0.32	<1.0

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
Summary statistics were only calculated for sampling areas with replicate samples (PRef1, PNF,and PFF1) but not for single composite samples (PRef2, PFF2, and PFFF).
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996)
[4] Displayed reference values are the 95th percentiles of data from reference area PRef1 and are the single values available for reference area PRef2.

(blue)	Value is > TEL. Values shown in bold text also exceed Reference values.
(orange)	Value is > PEL. Values shown in bold text also exceed Reference values.

Table E.60: Raw selectively extracted (Tessier extraction) metals data for sediment from Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		Exposed												
								PFF1 (QULP-2)												PFFF (QULP-3)
								QULP-2-01	QULP-2-02	QULP-2-03	QULP-2-04	QULP-2-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	Composite
Date Sampled		**TEL**	**PEL**	**Sensitive**	**Typical**	**PRef1**	**PRef2**	19-Sep-14	19-Sep-14	19-Sep-14	20-Sep-14	20-Sep-14								18-Oct-14
Exchangeable & Adsorbed Metals																				
Aluminum	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50
Antimony	mg/kg	-	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Arsenic	mg/kg	5.9	17	11	20	0.059	<0.050	0.056	0.059	0.058	<0.050	0.067	0.058	0.058	<0.050	0.067	0.0061	0.0027	0.0076	0.061
Barium	mg/kg	-	-	-	-	<25	<12	<25	<30	<25	<20	<20	<30	<25	<20	<30	4.2	1.9	5.2	<12
Beryllium	mg/kg	-	-	-	-	<0.2	<0.2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Bismuth	mg/kg	-	-	-	-	<0.2	<0.2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.131	0.092	0.050	0.124	<0.050	<0.050	<0.050	0.065	<0.050	<0.050	0.124	0.033	0.015	0.041	0.234
Calcium	mg/kg	-	-	-	-	2,566	3,110	2,020	4,130	1,840	1,430	1,370	2,158	1,840	1,370	4,130	1,136	508	1,410	4,190
Chromium	mg/kg	37	90	56	110	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Cobalt	mg/kg	-	-	-	-	0.39	0.28	<0.10	0.16	<0.10	<0.10	<0.10	0.11	<0.10	<0.10	0.16	0.027	0.012	0.033	0.22
Copper	mg/kg	36	197	120	240	0.77	<0.50	1.34	1.02	1.00	1.41	1.94	1.34	1.34	1.00	1.94	0.382	0.171	0.474	<0.50
Iron	mg/kg	21,200	43,776	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50
Lead	mg/kg	35	91	57	110	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Manganese	mg/kg	460	1,100	-	-	192	466	43.3	195.0	40.3	22.9	20.3	64.4	40.3	20.3	195	73.7	33.0	91.5	**1,500**
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	<0.70	<0.80	<0.70	<0.70	<0.80	<0.78	<0.70	<0.70	<1.0	0	0	0	<0.50
Nickel	mg/kg	16	75	-	-	0.94	0.56	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	0.62
Phosphorus	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<5.0	0	0	0	<50
Potassium	mg/kg	-	-	-	-	<100	<100	110	160	<100	<100	120	118	110	<100	160	24.9	11.1	30.9	110
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Silver	mg/kg	0.5	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Sodium	mg/kg	-	-	-	-	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	0	0	0	<100
Strontium	mg/kg	-	-	-	-	22.2	31.2	18.4	40.8	15.4	11.8	12.1	19.7	15.4	11.8	40.8	12.1	5.41	15.0	41.5
Thallium	mg/kg	-	-	-	-	<0.05	<0.05	<0.050	<0.050	<0.050	<0.050	<0.050	<0.05	<0.05	<0.05	<0.05	0	0	0	<0.05
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0	<1.0
Uranium	mg/kg	-	-	-	-	<0.050	<0.050	0.052	0.130	<0.050	<0.050	<0.050	0.066	<0.050	<0.050	0.13	0.036	0.016	0.044	<0.050
Vanadium	mg/kg	-	-	-	-	<0.2	<0.2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Zinc	mg/kg	123	315	200	380	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0	<1.0
Carbonate Metals																				
Aluminum	mg/kg	-	-	-	-	<50	<50	78	65	74	64	66	69	66	64	78	6.2	2.8	7.7	<50
Antimony	mg/kg	-	-	-	-	<0.1	<0.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.1	<0.10	<0.10	<0.1	0	0	0	<0.1
Arsenic	mg/kg	5.9	17	11	20	0.386	<0.050	0.202	0.114	0.107	0.085	0.106	0.123	0.107	0.085	0.202	0.046	0.020	0.057	0.072
Barium	mg/kg	-	-	-	-	17.7	10.9	56.7	37.2	40.3	37.0	42.0	42.6	40.3	37.0	56.7	8.14	3.64	10.1	9.50
Beryllium	mg/kg	-	-	-	-	<0.2	<0.2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Bismuth	mg/kg	-	-	-	-	<0.2	<0.2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.057	<0.050	0.116	<0.050	<0.050	<0.050	<0.050	0.063	<0.050	<0.050	0.116	0.030	0.013	0.037	0.065
Calcium	mg/kg	-	-	-	-	434	495	11,100	10,700	11,500	11,200	9,550	10,810	11,100	9,550	11,500	760	340	944	620
Chromium	mg/kg	37	90	56	110	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Cobalt	mg/kg	-	-	-	-	0.96	0.13	1.27	0.52	0.56	0.40	0.28	0.61	0.52	0.28	1.3	0.39	0.17	0.48	0.15
Copper	mg/kg	36	197	120	240	1.73	<0.50	14.9	21.0	26.2	26.6	32.1	24.2	26.2	14.9	32.1	6.50	2.91	8.07	0.53
Iron	mg/kg	21,200	43,776	-	-	840	<50	379	226	246	193	128	234	226	128	379	92.4	41.3	115	<50
Lead	mg/kg	35	91	57	110	<0.50	<0.50	0.94	0.74	0.83	0.66	0.59	0.75	0.74	0.59	0.94	0.14	0.062	0.17	<0.50
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Manganese	mg/kg	460	1,100	-	-	47.0	215	237	104	119	96.4	88.2	129	104	88.2	237	61.5	27.5	76.3	**774**
Molybdenum	mg/kg	-	-	-	-	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.5	0	0	0	<0.5
Nickel	mg/kg	16	75	-	-	<2.0	<2.0	2.3	<2.0	<2.0	<2.0	<2.0	2.1	<2.0	<2.0	2.3	0.13	0.060	0.17	<2.0
Phosphorus	mg/kg	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	0	0	0	<50
Selenium	mg/kg	2.0	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Silver	mg/kg	0.5	-	-	-	<0.1	<0.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.1	<0.1	<0.1	<0.1	0	0	0	<0.1
Strontium	mg/kg	-	-	-	-	5.1	9.0	52.3	47.8	45.8	47.8	50.4	48.8	47.8	45.8	52.3	2.54	1.14	3.15	11.9
Thallium	mg/kg	-	-	-	-	<0.05	<0.05	<0.050	<0.050	<0.050	<0.050	<0.050	<0.05	<0.05	<0.05	<0.05	0	0	0	<0.05
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Uranium	mg/kg	-	-	-	-	0.354	0.209	0.405	0.121	0.128	0.074	0.076	0.161	0.121	0.074	0.405	0.139	0.062	0.172	0.251
Vanadium	mg/kg	-	-	-	-	0.94	<0.20	0.40	0.21	0.23	<0.20	<0.20	0.25	0.21	<0.20	0.40	0.086	0.038	0.11	<0.20
Zinc	mg/kg	123	315	200	380	2.08	<1.0	3.1	1.7	2.0	1.3	1.2	1.9	1.7	1.2	3.1	0.76	0.34	0.95	<1.0

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
Summary statistics were only calculated for sampling areas with replicate samples (PRef1, PNF,and PFF1) but not for single composite samples (PRef2, PFF2, and PFFF).
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996)
[4] Displayed reference values are the 95th percentiles of data from reference area PRef1 and are the single values available for reference area PRef2.
Value is > TEL. Values shown in bold text also exceed Reference values.
Value is > PEL. Values shown in bold text also exceed Reference values.

Table E.60: Raw selectively extracted (Tessier extraction) metals data for sediment from Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		Reference: PRef1 (QULP-5)													Reference: PRef2 (QULP-6)
								QULP-5-01	QULP-5-02	QULP-5-03	QULP-5-04	QULP-5-05	Mean	Median	Minimum	Maximum	95th Percentile	Standard Deviation	Standard Error	t*SE	Composite
Date Sampled		**TEL**	**PEL**	**Sensitive**	**Typical**	**PRef1**	**PRef2**	13-Sep-14	14-Sep-14	17-Sep-14	18-Sep-14	18-Sep-14									20-Oct-14
Easily Reducible Metals and Iron Oxides																					
Aluminum	mg/kg	-	-	-	-	999	1,200	1,000	977	995	972	960	981	977	960	1,000	999	16.5	7.40	20.5	1,200
Antimony	mg/kg	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0	0	<0.1
Arsenic	mg/kg	5.9	17	11	20	2.54	0.58	1.47	1.93	2.33	2.40	2.57	2.14	2.33	1.47	2.57	2.54	0.442	0.198	0.549	0.58
Barium	mg/kg	-	-	-	-	24.2	82.5	21.2	21.8	24.1	24.2	24.0	23.1	24.0	21.2	24.2	24.2	1.44	0.645	1.79	82.5
Beryllium	mg/kg	-	-	-	-	<0.20	0.34	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	0.34
Bismuth	mg/kg	-	-	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.207	0.179	0.204	0.192	0.204	0.208	0.199	0.201	0.204	0.192	0.208	0.207	0.00615	0.00275	0.00763	0.179
Calcium	mg/kg	-	-	-	-	805	626	806	771	802	727	732	768	771	727	806	805	37.4	16.7	46.4	626
Chromium	mg/kg	37	90	56	110	4.09	3.84	3.84	3.98	4.07	4.09	4.00	4.00	4.00	3.84	4.09	4.09	0.0986	0.0441	0.122	3.84
Cobalt	mg/kg	-	-	-	-	4.74	11.1	4.66	4.70	4.72	4.67	4.74	4.70	4.70	4.66	4.74	4.74	0.0335	0.0150	0.0415	11.1
Copper	mg/kg	36	197	120	240	5.47	10.8	5.38	5.23	5.49	5.09	5.08	5.25	5.23	5.08	5.49	5.47	0.180	0.080	0.223	10.8
Iron	mg/kg	21,200	43,776	-	-	7,516	28,000	6,670	6,790	7,190	7,520	7,500	7,134	7,190	6,670	7,520	7,516	394	176	489	28,000
Lead	mg/kg	35	91	57	110	2.42	5.66	2.44	2.15	2.36	2.30	2.30	2.31	2.30	2.15	2.44	2.42	0.106	0.048	0.132	5.66
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Manganese	mg/kg	460	1,100	-	-	112	3,670	95.4	99.6	105	109	113	104	105	95.4	113	112	7.06	3.16	8.77	3,670
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Nickel	mg/kg	16	75	-	-	9.73	14.6	9.76	9.36	9.60	9.18	9.23	9.43	9.36	9.18	9.76	9.73	0.248	0.111	0.307	14.6
Phosphorus	mg/kg	-	-	-	-	108	50	69	90	97	110	98	93	97	69	110	108	15	6.8	19	50.0
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Silver	mg/kg	0.50	-	-	-	<0.10	0.13	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	0.13
Strontium	mg/kg	-	-	-	-	8.41	15.2	8.08	7.74	8.45	8.15	8.23	8.13	8.15	7.74	8.45	8.41	0.259	0.116	0.321	15.2
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	1.30	<1.0	1.3	1.3	1.2	<1.0	<1.0	1.2	1.2	<1.0	1.3	1.3	0.15	0.07	0.19	<1.0
Uranium	mg/kg	-	-	-	-	0.307	1.44	0.309	0.270	0.300	0.295	0.290	0.293	0.295	0.270	0.309	0.307	0.0145	0.00651	0.0181	1.44
Vanadium	mg/kg	-	-	-	-	9.95	6.93	9.99	9.58	9.55	9.79	9.65	9.71	9.65	9.55	9.99	9.95	0.181	0.081	0.225	6.93
Zinc	mg/kg	123	315	200	380	18.9	17.0	18.3	18.9	18.8	18.4	18.6	18.6	18.6	18.3	18.9	18.9	0.255	0.114	0.317	17.0
Organic Bound Metals																					
Aluminum	mg/kg	-	-	-	-	1,944	1,340	2,000	1,480	1,660	1,720	1,720	1,716	1,720	1,480	2,000	1,944	187	83.5	232	1,340
Antimony	mg/kg	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0	0	<0.1
Arsenic	mg/kg	5.9	17	11	20	0.768	0.252	0.691	0.582	0.696	0.784	0.702	0.691	0.696	0.582	0.784	0.768	0.0719	0.0322	0.0893	0.252
Barium	mg/kg	-	-	-	-	17.3	29.3	15.9	13.9	16.3	17.5	16.7	16.1	16.3	13.9	17.5	17.3	1.34	0.601	1.67	29.3
Beryllium	mg/kg	-	-	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Bismuth	mg/kg	-	-	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Cadmium	mg/kg	0.60	3.5	2.2	4.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Calcium	mg/kg	-	-	-	-	1,095	226	1,130	752	830	957	857	905	857	752	1,130	1,095	145	65.1	181	226
Chromium	mg/kg	37	90	56	110	6.11	1.95	6.15	5.21	5.40	5.94	5.82	5.70	5.82	5.21	6.15	6.11	0.389	0.174	0.483	1.95
Cobalt	mg/kg	-	-	-	-	1.74	1.04	1.77	1.55	1.60	1.59	1.58	1.62	1.59	1.55	1.77	1.74	0.0870	0.0389	0.108	1.04
Copper	mg/kg	36	197	120	240	13.5	5.75	14.2	9.9	10.8	10.8	10.6	11.3	10.8	9.9	14.2	13.5	1.68	0.75	2.08	5.75
Iron	mg/kg	21,200	43,776	-	-	1,332	921	1,370	975	1,110	1,180	1,170	1,161	1,170	975	1,370	1,332	143	63.8	177	921
Lead	mg/kg	35	91	57	110	0.85	2.2	0.81	0.70	0.78	0.86	0.81	0.79	0.81	0.70	0.86	0.85	0.059	0.026	0.073	2.18
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Manganese	mg/kg	460	1,100	-	-	21.3	109	21.4	17.3	19.6	20.7	20.6	19.9	20.6	17.3	21.4	21.3	1.60	0.72	1.99	109
Molybdenum	mg/kg	-	-	-	-	0.50	0.62	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	0.62
Nickel	mg/kg	16	75	-	-	4.39	3.18	4.52	3.71	3.85	3.89	3.83	3.96	3.85	3.71	4.52	4.39	0.320	0.143	0.397	3.18
Selenium	mg/kg	2	-	-	-	0.79	0.43	0.61	0.67	0.72	0.80	0.77	0.71	0.72	0.61	0.80	0.79	0.076	0.034	0.095	0.43
Silver	mg/kg	0.5	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0	0	<0.1
Strontium	mg/kg	-	-	-	-	6.61	2.78	6.68	5.01	5.72	6.35	5.97	5.95	5.97	5.01	6.68	6.61	0.638	0.285	0.792	2.78
Thallium	mg/kg	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0	0	0	<0.5
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	7.6	22	8.0	5.6	5.9	5.7	5.8	6.2	5.8	5.6	8.0	7.6	1.0	0.45	1.3	21.6
Uranium	mg/kg	-	-	-	-	0.166	0.196	0.164	0.136	0.155	0.166	0.165	0.157	0.164	0.136	0.166	0.166	0.0126	0.0057	0.0157	0.196
Vanadium	mg/kg	-	-	-	-	4.47	2.77	4.56	3.15	4.09	3.70	3.98	3.90	3.98	3.15	4.56	4.47	0.520	0.232	0.645	2.77
Zinc	mg/kg	123	315	200	380	9.6	4.2	10	7.5	8.0	8.2	7.9	8.3	8.0	7.5	10	9.6	1.0	0.4	1.2	4.2

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
Summary statistics were only calculated for sampling areas with replicate samples (PRef1, PNF,and PFF1) but not for single composite samples (PRef2, PFF2, and PFFF).
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996)
[4] Displayed reference values are the 95th percentiles of data from reference area PRef1 and are the single values available for reference area PRef2.

(blue) Value is > TEL. Values shown in bold text also exceed Reference values.
(orange) Value is > PEL. Values shown in bold text also exceed Reference values.

Table E.60: Raw selectively extracted (Tessier extraction) metals data for sediment from Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		Exposed												
								PNF (QULP-1)												PFF2 (QULP-4) Composite
								QULP-1-01	QULP-1-02	QULP-1-03	QULP-1-04	QULP-1-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	
Date Sampled		**TEL**	**PEL**	**Sensitive**	**Typical**	**PRef1**	**PRef2**	9-Sep-14	10-Sep-14	11-Sep-14	12-Sep-14	13-Sep-14								20-Oct-14
Easily Reducible Metals and Iron Oxides																				
Aluminum	mg/kg	-	-	-	-	999	1,200	1,900	2,200	1,920	1,530	1,380	1,786	1,900	1,380	2,200	329	147	408	1,510
Antimony	mg/kg	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0	0	<0.1
Arsenic	mg/kg	5.9	17	11	20	2.54	0.58	2.67	2.85	3.02	2.62	1.68	2.57	2.67	1.68	3.02	0.521	0.233	0.647	1.86
Barium	mg/kg	-	-	-	-	24.2	82.5	33.7	48.1	34.3	25.5	20.4	32.4	33.7	20.4	48.1	10.5	4.71	13.1	24.5
Beryllium	mg/kg	-	-	-	-	<0.20	0.34	0.22	0.26	<0.20	<0.20	<0.20	0.22	<0.20	<0.20	0.26	0.026	0.012	0.032	<0.20
Bismuth	mg/kg	-	-	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.207	0.179	0.067	0.077	0.052	0.058	0.056	0.062	0.058	0.052	0.077	0.010	0.0045	0.012	0.064
Calcium	mg/kg	-	-	-	-	805	626	2,160	2,370	2,180	1,810	1,510	2,006	2,160	1,510	2,370	343	153	426	5,080
Chromium	mg/kg	37	90	56	110	4.09	3.84	2.10	2.49	1.91	1.63	1.86	2.00	1.91	1.63	2.49	0.322	0.144	0.400	2.23
Cobalt	mg/kg	-	-	-	-	4.74	11.1	2.01	2.59	1.74	1.16	1.36	1.77	1.74	1.16	2.59	0.564	0.252	0.700	1.90
Copper	mg/kg	36	197	120	240	5.47	10.8	140	156	153	123	108	**136**	**140**	**108**	**156**	20.4	9.10	25.3	**119**
Iron	mg/kg	21,200	43,776	-	-	7,516	28,000	3,200	3,950	2,800	2,150	2,750	2,970	2,800	2,150	3,950	664	297	824	2,860
Lead	mg/kg	35	91	57	110	2.42	5.66	2.92	3.87	2.53	1.78	2.32	2.68	2.53	1.78	3.87	0.780	0.349	0.969	2.64
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Manganese	mg/kg	460	1,100	-	-	112	3,670	91.3	117	80.0	56.7	60.5	81.1	80.0	56.7	117	24.6	11.0	30.5	120
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Nickel	mg/kg	16	75	-	-	9.73	14.6	2.67	3.44	2.41	1.82	2.31	2.53	2.41	1.82	3.44	0.595	0.266	0.738	2.69
Phosphorus	mg/kg	-	-	-	-	108	50	182	198	196	229	131	187	196	131	229	35.8	16.0	44.4	124
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Silver	mg/kg	0.50	-	-	-	<0.10	0.13	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Strontium	mg/kg	-	-	-	-	8.41	15.2	28.4	25.1	33.0	30.3	16.9	26.7	28.4	16.9	33.0	6.21	2.78	7.71	32.4
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	1.30	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	0	<1.0
Uranium	mg/kg	-	-	-	-	0.307	1.44	0.171	0.205	0.156	0.124	0.098	0.151	0.156	0.098	0.205	0.041	0.019	0.051	0.158
Vanadium	mg/kg	-	-	-	-	9.95	6.93	8.35	10.1	7.43	5.89	7.89	7.93	7.89	5.89	10.1	1.52	0.68	1.89	6.26
Zinc	mg/kg	123	315	200	380	18.9	17.0	10.2	12.6	9.2	6.6	6.8	9.1	9.2	6.6	12.6	2.5	1.1	3.1	9.2
Organic Bound Metals																				
Aluminum	mg/kg	-	-	-	-	1,944	1,340	1,740	2,130	1,550	1,070	1,040	1,506	1,550	1,040	2,130	462	207	573	878
Antimony	mg/kg	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0	0	<0.1
Arsenic	mg/kg	5.9	17	11	20	0.768	0.252	2.27	3.24	2.47	2.37	2.12	2.49	2.37	2.12	3.24	0.437	0.195	0.542	0.42
Barium	mg/kg	-	-	-	-	17.3	29.3	26.6	21.6	25.3	19.1	15.9	21.7	21.6	15.9	26.6	4.40	1.97	5.46	16.2
Beryllium	mg/kg	-	-	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Bismuth	mg/kg	-	-	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Cadmium	mg/kg	0.60	3.5	2.2	4.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Calcium	mg/kg	-	-	-	-	1,095	226	2,480	2,820	2,720	2,310	1,750	2,416	2,480	1,750	2,820	423	189	525	643
Chromium	mg/kg	37	90	56	110	6.11	1.95	0.51	0.77	<0.50	<0.50	<0.50	0.56	<0.50	<0.50	0.77	0.12	0.054	0.15	<0.50
Cobalt	mg/kg	-	-	-	-	1.74	1.04	2.20	2.88	2.08	1.75	1.48	2.08	2.08	1.48	2.88	0.530	0.237	0.658	1.48
Copper	mg/kg	36	197	120	240	13.5	5.75	481	590	410	339	454	**455**	**454**	**339**	**590**	92.7	41.5	115	**332**
Iron	mg/kg	21,200	43,776	-	-	1,332	921	750	1,090	731	754	845	834	754	731	1,090	150	67.0	186	356
Lead	mg/kg	35	91	57	110	0.85	2.2	1.31	1.72	1.24	1.03	1.17	1.29	1.24	1.03	1.72	0.260	0.116	0.322	0.74
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Manganese	mg/kg	460	1,100	-	-	21.3	109	25.8	31.4	22.0	14.9	15.6	21.9	22.0	14.9	31.4	6.97	3.12	8.65	11.1
Molybdenum	mg/kg	-	-	-	-	0.50	0.62	1.14	0.98	1.10	1.17	1.01	1.08	1.10	0.98	1.17	0.082	0.037	0.10	0.70
Nickel	mg/kg	16	75	-	-	4.39	3.18	0.89	1.07	0.74	0.62	0.67	0.80	0.74	0.62	1.1	0.18	0.082	0.23	<0.50
Selenium	mg/kg	2	-	-	-	0.79	0.43	0.89	1.15	0.82	0.66	0.61	0.83	0.82	0.61	1.2	0.21	0.10	0.27	0.71
Silver	mg/kg	0.5	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0	0	<0.1
Strontium	mg/kg	-	-	-	-	6.61	2.78	11.0	10.5	12.2	12.9	11.6	11.6	11.6	10.5	12.9	0.950	0.425	1.18	10.2
Thallium	mg/kg	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0	0	0	<0.5
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	7.6	22	3.8	4.7	4.1	3.1	2.4	3.6	3.8	2.4	4.7	0.89	0.40	1.1	1.2
Uranium	mg/kg	-	-	-	-	0.166	0.196	0.197	0.275	0.208	0.168	0.126	0.195	0.197	0.126	0.275	0.0549	0.0246	0.0682	0.114
Vanadium	mg/kg	-	-	-	-	4.47	2.77	2.27	2.50	1.99	1.56	1.51	1.97	1.99	1.51	2.50	0.433	0.194	0.538	0.64
Zinc	mg/kg	123	315	200	380	9.6	4.2	5.6	6.5	5.0	4.3	4.5	5.2	5.0	4.3	6.5	0.89	0.40	1.1	3.8

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
Summary statistics were only calculated for sampling areas with replicate samples (PRef1, PNF,and PFF1) but not for single composite samples (PRef2, PFF2, and PFFF).

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Displayed reference values are the 95th percentiles of data from reference area PRef1 and are the single values available for reference area PRef2.

[blue] Value is > TEL. Values shown in bold text also exceed Reference values.

[orange] Value is > PEL. Values shown in bold text also exceed Reference values.

Table E.60: Raw selectively extracted (Tessier extraction) metals data for sediment from Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		Exposed: PFF1 (QULP-2)												PFFF (QULP-3)
								QULP-2-01	QULP-2-02	QULP-2-03	QULP-2-04	QULP-2-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	Composite
Date Sampled		**TEL**	**PEL**	**Sensitive**	**Typical**	**PRef1**	**PRef2**	19-Sep-14	19-Sep-14	19-Sep-14	20-Sep-14	20-Sep-14								18-Oct-14
Easily Reducible Metals and Iron Oxides																				
Aluminum	mg/kg	-	-	-	-	999	1,200	2,000	1,530	1,640	1,500	1,570	1,648	1,570	1,500	2,000	204	91.1	253	1,240
Antimony	mg/kg	-	-	-	-	<0.1	<0.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.1	<0.1	<0.1	<0.1	0	0	0	<0.1
Arsenic	mg/kg	5.9	17	11	20	2.54	0.58	2.43	2.02	2.08	2.30	1.90	2.15	2.08	1.90	2.43	0.215	0.096	0.267	4.59
Barium	mg/kg	-	-	-	-	24.2	82.5	43.8	26.9	28.9	26.2	21.5	29.5	26.9	21.5	43.8	8.46	3.78	10.5	88.1
Beryllium	mg/kg	-	-	-	-	<0.20	0.34	0.28	<0.20	<0.20	<0.20	<0.20	0.22	<0.20	<0.20	0.28	0.036	0.016	0.044	0.37
Bismuth	mg/kg	-	-	-	-	<0.2	<0.2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Cadmium	mg/kg	0.60	3.5	2.2	4.2	0.207	0.179	0.119	0.064	0.061	<0.050	<0.050	0.069	0.061	<0.050	0.119	0.029	0.013	0.036	0.36
Calcium	mg/kg	-	-	-	-	805	626	2,070	1,620	1,760	1,670	1,640	1,752	1,670	1,620	2,070	186	83.0	230	851
Chromium	mg/kg	37	90	56	110	4.09	3.84	4.08	2.40	2.54	2.10	1.86	2.60	2.40	1.86	4.08	0.871	0.389	1.08	5.97
Cobalt	mg/kg	-	-	-	-	4.74	11.1	4.13	1.87	2.18	1.59	1.47	2.25	1.87	1.47	4.13	1.09	0.49	1.35	10.6
Copper	mg/kg	36	197	120	240	5.47	10.8	55.4	78.7	87.0	89.0	91.9	**80.4**	**87.0**	**55.4**	**91.9**	14.8	6.62	18.4	17.4
Iron	mg/kg	21,200	43,776	-	-	7,516	28,000	7,190	3,410	3,870	2,810	2,630	3,982	3,410	2,630	7,190	1,860	832	2,309	18,400
Lead	mg/kg	35	91	57	110	2.42	5.66	4.79	2.18	2.40	1.77	1.60	2.55	2.18	1.60	4.79	1.29	0.58	1.61	5.58
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Manganese	mg/kg	460	1,100	-	-	112	3,670	198	81.5	94.0	70.4	70.2	103	82	70.2	198	54.1	24.2	67.2	**7,690**
Molybdenum	mg/kg	-	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	1.2
Nickel	mg/kg	16	75	-	-	9.73	14.6	7.58	3.29	3.63	2.53	2.27	3.86	3.29	2.27	7.58	2.15	0.96	2.67	**17.7**
Phosphorus	mg/kg	-	-	-	-	108	50	90	156	171	190	178	157	171	90	190	39.4	17.6	48.9	137
Selenium	mg/kg	2	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	0.21
Silver	mg/kg	0.50	-	-	-	<0.10	0.13	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	0.13
Strontium	mg/kg	-	-	-	-	8.41	15.2	27.6	33.4	32.1	35.2	40.2	33.7	33.4	27.6	40.2	4.59	2.05	5.70	18.3
Thallium	mg/kg	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	0.065
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	1.30	<1.0	1.0	<1.0	<1.0	1.2	1.0	1.0	1.0	<1.0	1.2	0.089	0.040	0.11	<1.0
Uranium	mg/kg	-	-	-	-	0.307	1.44	0.336	0.135	0.153	0.123	0.120	0.173	0.135	0.120	0.336	0.0918	0.0411	0.114	2.01
Vanadium	mg/kg	-	-	-	-	9.95	6.93	14.1	7.18	8.49	6.31	5.81	8.38	7.18	5.81	14.1	3.36	1.50	4.17	12.8
Zinc	mg/kg	123	315	200	380	18.9	17.0	17.7	8.7	9.7	7.2	6.4	9.9	8.7	6.4	17.7	4.5	2.0	5.6	24
Organic Bound Metals																				
Aluminum	mg/kg	-	-	-	-	1,944	1,340	2,180	1,090	1,140	871	825	1,221	1,090	825	2,180	553	247	686	2,180
Antimony	mg/kg	-	-	-	-	<0.1	<0.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.1	<0.1	<0.1	<0.1	0	0	0	<0.1
Arsenic	mg/kg	5.9	17	11	20	0.768	0.252	2.53	1.73	1.83	1.67	0.86	1.72	1.73	0.86	2.53	0.59	0.27	0.74	1.20
Barium	mg/kg	-	-	-	-	17.3	29.3	16.3	14.3	14.8	13.3	12.5	14.2	14.3	12.5	16.3	1.46	0.651	1.81	47.2
Beryllium	mg/kg	-	-	-	-	<0.2	<0.2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Bismuth	mg/kg	-	-	-	-	<0.2	<0.2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Cadmium	mg/kg	0.60	3.5	2.2	4.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Calcium	mg/kg	-	-	-	-	1,095	226	2,020	1,970	1,930	1,890	1,090	1,780	1,930	1,090	2,020	389	174	483	432
Chromium	mg/kg	37	90	56	110	6.11	1.95	3.39	0.80	0.89	<0.50	<0.50	1.22	0.80	<0.50	3.39	1.23	0.55	1.52	4.26
Cobalt	mg/kg	-	-	-	-	1.74	1.04	2.36	1.42	1.68	1.34	1.13	1.59	1.42	1.13	2.36	0.475	0.213	0.590	1.36
Copper	mg/kg	36	197	120	240	13.5	5.75	486	274	335	248	245	**318**	**274**	**245**	**486**	101	45	125	19.2
Iron	mg/kg	21,200	43,776	-	-	1,332	921	1,100	454	595	391	273	563	454	273	1,100	322	144	400	980
Lead	mg/kg	35	91	57	110	0.85	2.2	2.04	0.90	1.04	0.72	0.52	1.04	0.90	0.52	2.04	0.59	0.26	0.73	1.67
Lithium	mg/kg	-	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	0	<5.0
Manganese	mg/kg	460	1,100	-	-	21.3	109	32.9	14.7	15.9	12.0	11.2	17.3	14.7	11.2	32.9	8.91	3.98	11.1	450
Molybdenum	mg/kg	-	-	-	-	0.50	0.62	1.01	0.77	0.81	0.77	0.85	0.84	0.81	0.77	1.0	0.10	0.04	0.12	2.34
Nickel	mg/kg	16	75	-	-	4.39	3.18	2.24	0.78	0.83	0.54	<0.50	0.98	0.78	<0.50	2.2	0.72	0.32	0.89	4.29
Selenium	mg/kg	2	-	-	-	0.79	0.43	1.59	0.72	0.84	0.59	0.49	0.85	0.72	0.49	1.59	0.44	0.20	0.54	1.22
Silver	mg/kg	0.5	-	-	-	<0.1	<0.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.1	<0.1	<0.1	<0.1	0	0	0	<0.1
Strontium	mg/kg	-	-	-	-	6.61	2.78	10.1	10.1	11.0	9.27	9.30	10.0	10.1	9.27	11.0	0.713	0.319	0.885	5.74
Thallium	mg/kg	-	-	-	-	<0.5	<0.5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.5	<0.5	<0.5	<0.5	0	0	0	<0.5
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	7.6	22	4.7	2.7	2.6	2.2	2.0	2.8	2.6	2.0	4.7	1.1	0.48	1.3	11
Uranium	mg/kg	-	-	-	-	0.166	0.196	0.268	0.148	0.166	0.146	0.110	0.168	0.148	0.110	0.268	0.0597	0.0267	0.0741	0.338
Vanadium	mg/kg	-	-	-	-	4.47	2.77	3.72	1.29	1.35	1.07	0.94	1.67	1.29	0.94	3.72	1.16	0.52	1.43	6.23
Zinc	mg/kg	123	315	200	380	9.6	4.2	8.3	4.4	4.8	3.6	3.3	4.9	4.4	3.3	8.3	2.0	0.90	2.5	6.7

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
Summary statistics were only calculated for sampling areas with replicate samples (PRef1, PNF,and PFF1) but not for single composite samples (PRef2, PFF2, and PFFF).

[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.

[3] Contaminated Sites Regulation (Government of British Columbia 1996)

[4] Displayed reference values are the 95th percentiles of data from reference area PRef1 and are the single values available for reference area PRef2.

(blue) Value is > TEL. Values shown in bold text also exceed Reference values.

(orange) Value is > PEL. Values shown in bold text also exceed Reference values.

Table E.60: Raw selectively extracted (Tessier extraction) metals data for sediment from Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		Reference													
								PRef1 (QULP-5)													PRef2 (QULP-6) Composite
								QULP-5-01	QULP-5-02	QULP-5-03	QULP-5-04	QULP-5-05	Mean	Median	Minimum	Maximum	95th Percentile	Standard Deviation	Standard Error	t*SE	
Date Sampled		**TEL**	**PEL**	**Sensitive**	**Typical**	**PRef1**	**PRef2**	13-Sep-14	14-Sep-14	17-Sep-14	18-Sep-14	18-Sep-14									20-Oct-14
Residual Metals																					
Aluminum	mg/kg	-	-	-	-	15,660	23,900	11,700	13,400	15,800	15,100	14,900	14,180	14,900	11,700	15,800	15,660	1,639	733	2,035	23,900
Antimony	mg/kg	-	-	-	-	0.26	0.32	0.26	0.24	0.24	0.23	0.21	0.24	0.24	0.21	0.26	0.26	0.018	0.0081	0.023	0.32
Arsenic	mg/kg	5.9	17	11	20	5.87	16.4	4.19	4.70	5.95	5.38	5.56	5.16	5.38	4.19	5.95	5.87	0.704	0.315	0.875	16.4
Barium	mg/kg	-	-	-	-	89.3	85.8	69.1	77.7	85.5	78.7	90.3	80.3	78.7	69.1	90.3	89.3	8.09	3.62	10.0	85.8
Beryllium	mg/kg	-	-	-	-	<0.20	0.48	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	0.48
Bismuth	mg/kg	-	-	-	-	<0.20	0.39	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	0.39
Cadmium	mg/kg	0.60	3.5	2.2	4.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Calcium	mg/kg	-	-	-	-	3,924	1,670	3,190	3,710	3,950	3,820	3,590	3,652	3,710	3,190	3,950	3,924	291	130	361	1,670
Chromium	mg/kg	37	90	56	110	47.4	49.3	41.1	43.9	48.0	45.1	44.3	44.5	44.3	41.1	48.0	47.4	2.48	1.11	3.08	49
Cobalt	mg/kg	-	-	-	-	7.00	12.1	5.99	6.25	7.06	6.70	6.77	6.55	6.70	5.99	7.06	7.00	0.429	0.192	0.532	12.1
Copper	mg/kg	36	197	120	240	27.9	30.2	21.7	24.2	27.9	27.2	27.9	25.8	27.2	21.7	27.9	27.9	2.75	1.23	3.41	30.2
Iron	mg/kg	21,200	43,776	-	-	22,760	53,900	19,500	20,500	22,900	21,500	22,200	21,320	21,500	19,500	22,900	22,760	1,350	604	1,676	53,900
Lead	mg/kg	35	91	57	110	3.89	13.1	3.02	3.28	3.62	3.62	3.96	3.50	3.62	3.02	3.96	3.89	0.360	0.161	0.447	13.1
Lithium	mg/kg	-	-	-	-	11.2	34.8	10.2	9.7	10.6	11.4	10.4	10.5	10.4	9.7	11.4	11.2	0.62	0.28	0.77	34.8
Manganese	mg/kg	460	1,100	-	-	204	377	177	187	207	193	188	190	188	177	207	204	10.9	4.89	13.6	377
Molybdenum	mg/kg	-	-	-	-	0.84	2.37	0.84	0.73	0.77	0.83	0.82	0.80	0.82	0.73	0.84	0.84	0.047	0.021	0.058	2.37
Nickel	mg/kg	16	75	-	-	24.0	40.7	21.3	21.8	24.1	23.2	23.5	22.8	23.2	21.3	24.1	24.0	1.18	0.529	1.47	40.7
Selenium	mg/kg	2	-	-	-	<0.20	0.25	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0	0.25
Silver	mg/kg	0.50	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	0	<0.10
Strontium	mg/kg	-	-	-	-	46.1	23.0	34.9	38.9	42.0	47.1	38.0	40.2	38.9	34.9	47.1	46.1	4.62	2.07	5.74	23.0
Thallium	mg/kg	-	-	-	-	0.139	0.242	0.112	0.124	0.133	0.127	0.141	0.127	0.127	0.112	0.141	0.139	0.0108	0.0048	0.0134	0.242
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	1,160	1,160	958	1,040	1,180	1,080	991	1,050	1,040	958	1,180	1,160	86.4	38.6	107	1,160
Uranium	mg/kg	-	-	-	-	0.557	1.02	0.482	0.524	0.561	0.531	0.540	0.528	0.531	0.482	0.561	0.557	0.0290	0.0130	0.0361	1.02
Vanadium	mg/kg	-	-	-	-	54.2	40.4	47.2	50.2	54.9	51.4	49.2	50.6	50.2	47.2	54.9	54.2	2.86	1.28	3.56	40.4
Zinc	mg/kg	123	315	200	380	51.3	78.6	42.7	46.2	51.5	49.8	50.3	48.1	49.8	42.7	51.5	51.3	3.61	1.61	4.48	78.6

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
Summary statistics were only calculated for sampling areas with replicate samples (PRef1, PNF,and PFF1) but not for single composite samples (PRef2, PFF2, and PFFF).
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996)
[4] Displayed reference values are the 95th percentiles of data from reference area PRef1 and are the single values available for reference area PRef2.

(blue)	Value is > TEL. Values shown in bold text also exceed Reference values.
(orange)	Value is > PEL. Values shown in bold text also exceed Reference values.

Table E.60: Raw selectively extracted (Tessier extraction) metals data for sediment from Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		Exposed												
								PNF (QULP-1)												PFF2 (QULP-4) Composite
								QULP-1-01	QULP-1-02	QULP-1-03	QULP-1-04	QULP-1-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	
Date Sampled		**TEL**	**PEL**	**Sensitive**	**Typical**	**PRef1**	**PRef2**	9-Sep-14	10-Sep-14	11-Sep-14	12-Sep-14	13-Sep-14								20-Oct-14
Residual Metals																				
Aluminum	mg/kg	-	-	-	-	15,660	23,900	18,900	22,600	18,100	13,000	12,300	16,980	18,100	12,300	22,600	4,309	1,927	5,349	19,000
Antimony	mg/kg	-	-	-	-	0.26	0.32	0.42	0.53	0.46	0.24	0.24	0.38	0.42	0.24	0.53	0.13	0.059	0.16	0.45
Arsenic	mg/kg	5.9	17	11	20	5.87	16.4	9.75	11.8	9.53	7.65	7.44	9.23	9.53	7.44	11.8	1.78	0.796	2.21	11.3
Barium	mg/kg	-	-	-	-	89.3	85.8	94.3	114	96.0	88.1	89.5	96.4	94.3	88.1	114	10.4	4.64	12.9	126
Beryllium	mg/kg	-	-	-	-	<0.20	0.48	0.58	0.68	0.58	0.46	0.40	0.54	0.58	0.40	0.68	0.11	0.049	0.14	0.53
Bismuth	mg/kg	-	-	-	-	<0.20	0.39	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	<0.20
Cadmium	mg/kg	0.60	3.5	2.2	4.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Calcium	mg/kg	-	-	-	-	3,924	1,670	13,500	15,600	14,700	12,100	9,780	13,136	13,500	9,780	15,600	2,291	1,024	2,844	15,400
Chromium	mg/kg	37	90	56	110	47.4	49.3	9.5	11.9	8.4	7.5	11.5	9.8	9.5	7.5	11.9	1.9	0.86	2.4	11.8
Cobalt	mg/kg	-	-	-	-	7.00	12.1	15.5	19.0	14.2	11.1	12.9	14.5	14.2	11.1	19.0	2.98	1.33	3.70	13.0
Copper	mg/kg	36	197	120	240	27.9	30.2	107	141	91.6	64.6	88.7	**98.6**	**91.6**	**64.6**	**141**	28.2	12.6	35.0	**95.3**
Iron	mg/kg	21,200	43,776	-	-	22,760	53,900	23,700	27,700	22,300	27,800	47,400	29,780	27,700	22,300	47,400	10,144	4,537	12,594	22,100
Lead	mg/kg	35	91	57	110	3.89	13.1	2.64	3.59	2.42	1.75	1.81	2.44	2.42	1.75	3.59	0.748	0.334	0.928	3.26
Lithium	mg/kg	-	-	-	-	11.2	34.8	21.9	26.2	20.6	14.5	14.7	19.6	20.6	14.5	26.2	5.00	2.23	6.20	18.3
Manganese	mg/kg	460	1,100	-	-	204	377	605	748	590	425	440	**562**	**590**	425	**748**	133	59.5	165	**512**
Molybdenum	mg/kg	-	-	-	-	0.84	2.37	2.33	2.93	2.37	2.06	2.76	2.49	2.37	2.06	2.93	0.350	0.157	0.435	2.38
Nickel	mg/kg	16	75	-	-	24.0	40.7	9.6	12.1	8.5	6.6	7.9	8.9	8.5	6.6	12.1	2.1	0.93	2.6	9.9
Selenium	mg/kg	2	-	-	-	<0.20	0.25	<0.2	<0.2	<0.2	<0.2	0.24	0.21	<0.2	<0.2	0.24	0.018	0.0080	0.022	<0.20
Silver	mg/kg	0.50	-	-	-	<0.10	<0.10	0.28	0.35	0.27	0.21	0.25	0.27	0.27	0.21	0.35	0.051	0.023	0.064	0.24
Strontium	mg/kg	-	-	-	-	46.1	23.0	77.8	91.5	79.6	57.3	52.3	71.7	77.8	52.3	91.5	16.4	7.33	20.4	86.3
Thallium	mg/kg	-	-	-	-	0.139	0.242	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Tin	mg/kg	-	-	-	-	<2.0	<2.0	2.4	3.0	3.2	<2.0	<2.0	2.5	2.4	<2.0	3.2	0.56	0.25	0.69	<2.0
Titanium	mg/kg	-	-	-	-	1,160	1,160	2,100	2,610	2,300	1,260	1,320	1,918	2,100	1,260	2,610	602	269	747	1,800
Uranium	mg/kg	-	-	-	-	0.557	1.02	1.05	1.31	1.15	0.73	0.65	0.98	1.05	0.65	1.31	0.28	0.13	0.35	0.991
Vanadium	mg/kg	-	-	-	-	54.2	40.4	95.0	110	94.0	108	185	118	108	94.0	185	37.9	17.0	47.1	84.2
Zinc	mg/kg	123	315	200	380	51.3	78.6	56.7	70.0	52.7	39.3	45.9	52.9	52.7	39.3	70.0	11.6	5.20	14.4	52.1

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
Summary statistics were only calculated for sampling areas with replicate samples (PRef1, PNF,and PFF1) but not for single composite samples (PRef2, PFF2, and PFFF).
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996)
[4] Displayed reference values are the 95th percentiles of data from reference area PRef1 and are the single values available for reference area PRef2.

(blue)	Value is > TEL. Values shown in bold text also exceed Reference values.
(orange)	Value is > PEL. Values shown in bold text also exceed Reference values.

Table E.60: Raw selectively extracted (Tessier extraction) metals data for sediment from Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Data are based on < 2mm fraction of sediment [1].

Sample ID	Units	BC SQGs [2]		CSR [3]		Reference Value [4]		Exposed												
								PFF1 (QULP-2)												PFFF (QULP-3) Composite
								QULP-2-01	QULP-2-02	QULP-2-03	QULP-2-04	QULP-2-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	
Date Sampled		**TEL**	**PEL**	**Sensitive**	**Typical**	**PRef1**	**PRef2**	19-Sep-14	19-Sep-14	19-Sep-14	20-Sep-14	20-Sep-14								18-Oct-14
Residual Metals																				
Aluminum	mg/kg	-	-	-	-	15,660	23,900	25,400	17,700	19,200	16,100	17,100	19,100	17,700	16,100	25,400	3,697	1,653	4,589	25,700
Antimony	mg/kg	-	-	-	-	0.26	0.32	0.38	0.30	0.31	0.28	0.34	0.32	0.31	0.28	0.38	0.039	0.017	0.048	0.75
Arsenic	mg/kg	5.9	17	11	20	5.87	16.4	12.0	8.78	9.24	8.62	8.63	9.45	8.78	8.62	12.0	1.45	0.65	1.79	**53.8**
Barium	mg/kg	-	-	-	-	89.3	85.8	138	102	134	103	116	119	116	102	138	16.9	7.55	21.0	103
Beryllium	mg/kg	-	-	-	-	<0.20	0.48	0.49	0.44	0.45	0.44	0.48	0.46	0.45	0.44	0.49	0.023	0.010	0.029	0.42
Bismuth	mg/kg	-	-	-	-	<0.20	0.39	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	0.27
Cadmium	mg/kg	0.60	3.5	2.2	4.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	0.059
Calcium	mg/kg	-	-	-	-	3,924	1,670	8,620	10,700	10,800	11,800	13,100	11,004	10,800	8,620	13,100	1,647	736	2,044	4,020
Chromium	mg/kg	37	90	56	110	47.4	49.3	26.9	14.2	15.1	11.6	10.6	15.7	14.2	10.6	26.9	6.54	2.92	8.11	**62.1**
Cobalt	mg/kg	-	-	-	-	7.00	12.1	17.3	10.4	12.0	9.84	10.8	12.1	10.8	9.84	17.3	3.03	1.36	3.76	14.0
Copper	mg/kg	36	197	120	240	27.9	30.2	134	62.9	77.3	56.3	66.1	**79.3**	**66.1**	**56.3**	**134**	31.5	14.1	39.1	**69.1**
Iron	mg/kg	21,200	43,776	-	-	22,760	53,900	31,000	21,400	25,500	21,200	19,900	23,800	21,400	19,900	31,000	4,540	2,031	5,637	47,500
Lead	mg/kg	35	91	57	110	3.89	13.1	4.78	2.59	2.85	2.23	2.53	3.00	2.59	2.23	4.78	1.02	0.457	1.27	12.7
Lithium	mg/kg	-	-	-	-	11.2	34.8	24.2	15.3	16.7	14.0	16.9	17.4	16.7	14.0	24.2	3.97	1.77	4.92	25.6
Manganese	mg/kg	460	1,100	-	-	204	377	573	404	446	404	412	448	412	404	**573**	72.1	32.2	89.5	**508**
Molybdenum	mg/kg	-	-	-	-	0.84	2.37	1.98	1.65	1.97	1.66	1.74	1.80	1.74	1.65	1.98	0.16	0.073	0.20	5.86
Nickel	mg/kg	16	75	-	-	24.0	40.7	20.6	10.3	11.2	8.4	8.7	12	10	8.4	21	5.0	2.2	6.2	**44.5**
Selenium	mg/kg	2	-	-	-	<0.20	0.25	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	0.32
Silver	mg/kg	0.50	-	-	-	<0.10	<0.10	0.37	0.24	0.28	0.20	0.20	0.26	0.24	0.20	0.37	0.071	0.032	0.088	0.15
Strontium	mg/kg	-	-	-	-	46.1	23.0	64.3	70.2	75.9	69.3	79.9	71.9	70.2	64.3	79.9	6.07	2.71	7.54	43.3
Thallium	mg/kg	-	-	-	-	0.139	0.242	0.076	<0.050	<0.050	<0.050	<0.050	0.055	<0.050	<0.050	0.076	0.012	0.0052	0.014	0.218
Tin	mg/kg	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Titanium	mg/kg	-	-	-	-	1,160	1,160	1,910	1,520	1,700	1,560	1,560	1,650	1,560	1,520	1,910	161	71.8	199	1,160
Uranium	mg/kg	-	-	-	-	0.557	1.02	0.831	0.822	0.913	0.900	0.848	0.863	0.848	0.822	0.913	0.0412	0.0184	0.0512	0.927
Vanadium	mg/kg	-	-	-	-	54.2	40.4	92.6	76.0	92.4	79.3	73.7	82.8	79.3	73.7	92.6	9.08	4.06	11.3	74.3
Zinc	mg/kg	123	315	200	380	51.3	78.6	76.0	43.7	48.5	39.2	41.3	49.7	43.7	39.2	76.0	15.1	6.75	18.7	93.7

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
Summary statistics were only calculated for sampling areas with replicate samples (PRef1, PNF,and PFF1) but not for single composite samples (PRef2, PFF2, and PFFF).
[2] British Columbia Working Sediment Quality Guidelines (BCMOE 2015a, 2015b); TEL = Threshold (or Lowest) Effect Level; PEL = Probable (or Severe) Effect Level.
[3] Contaminated Sites Regulation (Government of British Columbia 1996)
[4] Displayed reference values are the 95th percentiles of data from reference area PRef1 and are the single values available for reference area PRef2.

(blue) Value is > TEL. Values shown in bold text also exceed Reference values.
(orange) Value is > PEL. Values shown in bold text also exceed Reference values.

Table E.61: Raw leachable metals data for sediment from Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Data are based on bulk sediment [1].

Sample ID	Units	BCWQG [2]			HWR [3]	Reference Value [4]		Reference													
								PRef1 (QULP-5)													PRef2 Composite (QULP-6)
								QULP-5-01	QULP-5-02	QULP-5-03	QULP-5-04	QULP-5-05	Mean	Median	Minimum	Maximum	95th Percentile	Standard Deviation	Standard Error	t*SE	
Date Sampled		**Type**	**Chronic**	**Acute**		**PRef1**	**PRef2**	13-Sep-14	14-Sep-14	17-Sep-14	18-Sep-14	18-Sep-14									20-Oct-14
Aluminum	mg/L	-	-	-	-	<0.20	0.28	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	0	0.28
Antimony	mg/L	W	0.009	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0	0	<0.05
Arsenic	mg/L	A	-	0.0050	2.5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Barium	mg/L	W	1.0	-	100	0.055	0.015	0.053	0.046	0.055	0.050	0.048	0.050	0.050	0.046	0.055	0.055	0.0036	0.0016	0.0045	0.015
Beryllium	mg/L	W	0.00013	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0	0	0	<0.0050
Bismuth	mg/L	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0	0	<0.1
Cadmium	mg/L	A	0.00027	0.00081	0.50	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010
Calcium	mg/L	-	-	-	-	42.8	34.7	36.1	32.0	43.6	39.5	38.5	37.9	38.5	32.0	43.6	42.8	4.29	1.92	5.32	34.7
Chromium [5]	mg/L	W	0.001	-	5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0	0	0	<0.01
Cobalt	mg/L	A	0.0040	0.11	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010
Copper	mg/L	A	0.0055	0.015	100	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010
Iron	mg/L	A	-	1.0	-	2.37	1.01	0.21	0.51	1.42	2.60	1.47	1.24	1.42	0.21	2.60	2.37	0.94	0.42	1.17	1.01
Lead	mg/L	A	0.008	0.12	5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0	0	<0.05
Magnesium	mg/L	-	-	-	-	3.55	3.86	3.00	2.75	3.58	3.41	3.29	3.21	3.29	2.75	3.58	3.55	0.331	0.148	0.411	3.86
Manganese	mg/L	A	1.21	2.05	-	2.42	1.90	1.14	1.34	2.04	2.03	2.51	1.81	2.03	1.14	2.51	2.42	0.561	0.251	0.697	1.90
Mercury	mg/L	A	0.00002	-	0.1	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0	0	0	<0.00005
Molybdenum	mg/L	A	1	2	-	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0	0	0	<0.03
Nickel [6]	mg/L	W	-	0.121	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Phosphorus	mg/L	A	-	0.0050-0.015	-	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0	0	0	<0.30
Potassium	mg/L	-	-	-	-	2.4	<2.0	2.1	2.0	2.4	2.3	2.2	2.2	2.2	2.0	2.4	2.4	0.16	0.071	0.20	<2.0
Selenium	mg/L	A	0.002	-	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0	0	<0.05
Silicon	mg/L	-	-	-	-	<0.010	12.8	5.97	7.88	10.6	11.9	11.2	9.51	10.6	5.97	11.9	11.8	2.50	1.12	3.10	12.8
Silver	mg/L	A	0.0015	0.003	5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0	0	0	<0.01
Sodium	mg/L	-	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0	0	0	<2.0
Strontium	mg/L	-	-	-	-	0.336	0.287	0.278	0.249	0.341	0.318	0.303	0.298	0.303	0.249	0.341	0.336	0.0356	0.0159	0.0442	0.287
Thallium	mg/L	W	0.0008	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Tin	mg/L	-	-	-	-	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0	0	0	<0.03
Titanium	mg/L	-	-	-	-	0.016	0.014	<0.010	0.011	0.011	0.016	0.016	0.013	0.011	0.010	0.013	0.016	0.0029	0.0013	0.0037	0.014
Uranium	mg/L	W	0.0085	-	10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Vanadium	mg/L	-	-	-	-	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0	0	0	<0.03
Zinc	mg/L	A	0.043	0.068	500	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0	<0.020

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL.
Summary statistics were only calculated for sampling areas with replicate samples (PRef1, PNF,and PFF1) but not for single composite samples (PRef2, PFF2, and PFFF).

[2] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.

[3] Hazardous Waste Regulation (Government of British Columbia 1988)

[4] Displayed reference values are the 95th percentiles of data from reference area PRef1, and are the single values available for reference area PRef2.

[5] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.

[6] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)

(orange shading) Value is > either guideline (values < MDL excluded). Values shown in bold text also exceed Reference values.

Table E.61: Raw leachable metals data for sediment from Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Data are based on bulk sediment [1].

Sample ID	Units	BCWQG [2]			HWR [3]	Reference Value [4]		Exposed												PFF2 Composite (QULP-4)
								PNF (QULP-1)												
								QULP-1-01	QULP-1-02	QULP-1-03	QULP-1-04	QULP-1-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	
Date Sampled		**Type**	**Chronic**	**Acute**		**PRef1**	**PRef2**	9-Sep-14	10-Sep-14	11-Sep-14	12-Sep-14	13-Sep-14								20-Oct-14
Aluminum	mg/L	-	-	-	-	<0.20	0.28	<0.20	0.40	0.32	0.54	0.35	0.36	0.35	<0.20	0.54	0.12	0.06	0.15	0.29
Antimony	mg/L	W	0.009	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0	0	<0.05
Arsenic	mg/L	A	-	0.0050	2.5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Barium	mg/L	W	1.0	-	100	0.055	0.015	0.069	0.059	0.051	0.055	0.046	0.056	0.055	0.046	0.069	0.0087	0.0039	0.0108	0.043
Beryllium	mg/L	W	0.00013	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0	0	0	<0.0050
Bismuth	mg/L	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0	0	<0.1
Cadmium	mg/L	A	0.00027	0.00081	0.50	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010
Calcium	mg/L	-	-	-	-	42.8	34.7	42.8	29.0	20.8	16.3	18.0	25.4	20.8	16.3	42.8	10.9	4.9	13.5	23.6
Chromium [5]	mg/L	W	0.001	-	5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0	0	0	<0.01
Cobalt	mg/L	A	0.0040	0.11	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010
Copper	mg/L	A	0.0055	0.015	100	<0.010	<0.010	<0.010	0.030	0.030	0.051	0.054	**0.035**	**0.030**	<0.010	**0.054**	0.018	0.008	0.022	**0.050**
Iron	mg/L	A	-	1.0	-	2.37	1.01	0.097	0.119	0.112	0.229	0.185	0.148	0.119	0.097	0.229	0.0563	0.0252	0.0699	0.225
Lead	mg/L	A	0.008	0.12	5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0	0	<0.05
Magnesium	mg/L	-	-	-	-	3.55	3.86	47.4	3.11	2.20	1.67	1.94	11.3	2.20	1.67	47.4	20.2	9.0	25.1	2.68
Manganese	mg/L	A	1.21	2.05	-	2.42	1.90	0.711	0.0567	0.0368	0.0341	0.0454	0.177	0.0454	0.0341	0.711	0.299	0.134	0.371	0.105
Mercury	mg/L	A	0.00002	-	0.1	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0	0	0	<0.00005
Molybdenum	mg/L	A	1	2	-	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0	0	0	<0.03
Nickel [6]	mg/L	W	-	0.121	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Phosphorus	mg/L	A	-	0.0050-0.015	-	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0	0	0	<0.30
Potassium	mg/L	-	-	-	-	2.4	<2.0	29.3	4.7	4.6	4.0	3.4	9.2	4.6	3.4	29.3	11.2	5.0	14.0	3.8
Selenium	mg/L	A	0.002	-	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0	0	<0.05
Silicon	mg/L	-	-	-	-	<0.010	12.8	5.19	6.51	6.86	6.54	6.02	6.22	6.51	5.19	6.86	0.651	0.291	0.809	6.04
Silver	mg/L	A	0.0015	0.003	5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0	0	0	<0.01
Sodium	mg/L	-	-	-	-	<2.0	<2.0	624	10.2	9.0	7.5	6.3	131	9.0	6.3	624	275	123	342	8.6
Strontium	mg/L	-	-	-	-	0.336	0.287	0.467	0.323	0.236	0.192	0.200	0.284	0.236	0.192	0.467	0.115	0.051	0.143	0.248
Thallium	mg/L	W	0.0008	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Tin	mg/L	-	-	-	-	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0	0	0	<0.03
Titanium	mg/L	-	-	-	-	0.016	0.014	<0.010	0.011	0.010	0.018	0.014	0.013	0.011	<0.010	0.018	0.0034	0.0015	0.0043	0.015
Uranium	mg/L	W	0.0085	-	10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Vanadium	mg/L	-	-	-	-	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0	0	0	<0.03
Zinc	mg/L	A	0.043	0.068	500	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0	<0.020

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL. Summary statistics were only calculated for sampling areas with replicate samples (PRef1, PNF,and PFF1) but not for single composite samples (PRef2, PFF2, and PFFF).

[2] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.

[3] Hazardous Waste Regulation (Government of British Columbia 1988)

[4] Displayed reference values are the 95th percentiles of data from reference area PRef1, and are the single values available for reference area PRef2.

[5] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.

[6] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)

(orange shading) Value is > either guideline (values < MDL excluded). Values shown in bold text also exceed Reference values.

Table E.61: Raw leachable metals data for sediment from Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Data are based on bulk sediment [1].

Sample ID	Units	BCWQG [2]			HWR [3]	Reference Value [4]		Exposed												
								PFF1 (QULP-2)												PFFF Composite (QULP-3)
								QULP-2-01	QULP-2-02	QULP-2-03	QULP-2-04	QULP-2-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	
Date Sampled		**Type**	**Chronic**	**Acute**		**PRef1**	**PRef2**	19-Sep-14	19-Sep-14	19-Sep-14	20-Sep-14	20-Sep-14								18-Oct-14
Aluminum	mg/L	-	-	-	-	<0.20	0.28	<0.20	<0.20	<0.20	0.21	0.32	0.23	<0.20	<0.20	0.32	0.053	0.024	0.065	0.41
Antimony	mg/L	W	0.009	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0	0	<0.05
Arsenic	mg/L	A	-	0.0050	2.5	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Barium	mg/L	W	1.0	-	100	0.055	0.015	0.063	0.043	0.049	0.039	0.036	0.046	0.043	0.036	0.063	0.011	0.005	0.013	0.013
Beryllium	mg/L	W	0.00013	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0	0	0	<0.0050
Bismuth	mg/L	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0	0	<0.1
Cadmium	mg/L	A	0.00027	0.00081	0.50	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010
Calcium	mg/L	-	-	-	-	42.8	34.7	53.0	28.1	30.4	19.7	19.3	30.1	28.1	19.3	53.0	13.7	6.1	17.0	25.9
Chromium [5]	mg/L	W	0.001	-	5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0	0	0	<0.01
Cobalt	mg/L	A	0.0040	0.11	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010
Copper	mg/L	A	0.0055	0.015	100	<0.010	<0.010	0.014	0.031	0.036	0.047	0.050	**0.036**	**0.036**	**0.014**	**0.050**	0.014	0.006	0.018	<0.010
Iron	mg/L	A	-	1.0	-	2.37	1.01	0.034	0.277	0.233	0.381	0.399	0.265	0.277	0.034	0.399	0.147	0.066	0.182	0.558
Lead	mg/L	A	0.008	0.12	5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0	0	<0.05
Magnesium	mg/L	-	-	-	-	3.55	3.86	5.97	2.96	3.28	2.09	2.07	3.27	2.96	2.07	5.97	1.60	0.71	1.98	2.83
Manganese	mg/L	A	1.21	2.05	-	2.42	1.90	0.900	0.187	0.205	0.123	0.118	0.307	0.187	0.118	0.900	0.334	0.149	0.415	**4.78**
Mercury	mg/L	A	0.00002	-	0.1	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0	0	0	<0.00005
Molybdenum	mg/L	A	1	2	-	<0.03	<0.03	0.036	<0.03	<0.03	<0.03	<0.03	0.031	<0.03	<0.03	0.036	0.0027	0.0012	0.0033	<0.03
Nickel [6]	mg/L	W	-	0.121	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	0	<0.050
Phosphorus	mg/L	A	-	0.0050-0.015	-	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0	0	0	<0.30
Potassium	mg/L	-	-	-	-	2.4	<2.0	4.4	2.8	3.2	2.7	3.1	3.2	3.1	2.7	4.4	0.68	0.30	0.84	<2.0
Selenium	mg/L	A	0.002	-	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0	0	<0.05
Silicon	mg/L	-	-	-	-	<0.010	12.8	8.76	5.30	6.17	5.13	5.91	6.25	5.91	5.13	8.76	1.46	0.65	1.82	16.7
Silver	mg/L	A	0.0015	0.003	5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0	0	0	<0.01
Sodium	mg/L	-	-	-	-	<2.0	<2.0	11.2	6.8	7.7	6.4	7.1	7.8	7.1	6.4	11.2	1.9	0.9	2.4	3.4
Strontium	mg/L	-	-	-	-	0.336	0.287	0.510	0.252	0.293	0.187	0.178	0.284	0.252	0.178	0.510	0.135	0.060	0.168	0.221
Thallium	mg/L	W	0.0008	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	0	0	<0.2
Tin	mg/L	-	-	-	-	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0	0	0	<0.03
Titanium	mg/L	-	-	-	-	0.016	0.014	<0.010	0.012	0.011	0.018	0.021	0.014	0.012	<0.010	0.021	0.0048	0.0022	0.0060	0.011
Uranium	mg/L	W	0.0085	-	10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	<0.50
Vanadium	mg/L	-	-	-	-	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0	0	0	<0.03
Zinc	mg/L	A	0.043	0.068	500	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	0	<0.020

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < the highest displayed MDL if all the data used in their calculation were < MDL. Summary statistics were only calculated for sampling areas with replicate samples (PRef1, PNF,and PFF1) but not for single composite samples (PRef2, PFF2, and PFFF).

[2] British Columbia Water Quality Guidelines (BCMOE 2015a, 2015b); W=Working guideline; A=Approved guideline. See Appendix Table E.10 for derivation of hardness-based guidelines.

[3] Hazardous Waste Regulation (Government of British Columbia 1988)

[4] Displayed reference values are the 95th percentiles of data from reference area PRef1, and are the single values available for reference area PRef2.

[5] Applies to chromium as Cr (IV); guideline for Cr(III) is 0.0089 mg/L.

[6] Total nickel guideline value is for acute exposure, as described in guideline document (CCREM 1987)

(orange shading) Value is > either guideline (values < MDL excluded). Values shown in bold text also exceed Reference values.

Table E.62: Raw acid base accounting, sulphur, and carbon content data for sediment from profundal sampling areas in Quesnel Lake, Mount Polley, 2014 [1].

Parameter	Units	Reference												
		PRef1 (QULP-5)												PRef2 (QULP-6) Composite
		QULP-5-01	QULP-5-02	QULP-5-03	QULP-5-04	QULP-5-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	
Maximum Potential Acidity (MPA)	tCaCO3/1Kt	2.2	2.2	2.5	2.8	2.8	2.5	2.5	2.2	2.8	0.30	0.13	0.37	1.3
Fizz Rating	Unity	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0	0	0	1.0
Net Neutralization Potential (NNP)	tCaCO3/1Kt	7.0	8.0	7.0	7.0	7.0	7.2	7.0	7.0	8.0	0.45	0.20	0.56	11
pH	Unity	6.2	6.1	6.2	6.1	6.1	6.1	6.1	6.1	6.2	0.055	0.024	0.068	6.7
Neutralization Potential (NP)	tCaCO3/1Kt	9.0	10	9.0	10	10	9.6	10	9.0	10	0.55	0.24	0.68	12
Neutralization Potential Ratio (NP/MPA)	Unity	4.11	4.57	3.60	3.56	3.56	3.88	3.60	3.56	4.57	0.451	0.202	0.559	9.60
Total Sulphur (S) - Leco	%	0.070	0.070	0.080	0.090	0.090	0.080	0.080	0.070	0.090	0.010	0.0045	0.012	0.040
Sulphide Sulphur (S) - Calculated Leco	%	0.070	0.050	0.070	0.090	0.090	0.074	0.070	0.050	0.090	0.017	0.0075	0.021	0.030
Sulphate Sulphur (S) - Carbonate Leach	%	<0.010	0.020	0.010	<0.010	<0.010	0.012	<0.010	<0.010	0.020	0.0045	0.0020	0.0056	0.010
Inorganic Carbon (C)	%	0.080	0.050	0.060	0.060	0.060	0.062	0.060	0.050	0.080	0.011	0.0049	0.014	0.070
Carbon Dioxide (CO2)	%	0.30	0.20	0.20	0.20	0.20	0.22	0.20	0.20	0.30	0.045	0.020	0.056	0.30
Sulphate Sulphur (S) - HCl leachable	%	<0.010	<0.010	0.01	<0.010	<0.010	0.01	<0.010	<0.010	<0.010	0	0	0	0.010

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

NSS = Non-sufficient sample

[shaded cell] Indicates Neutralization Potential Ratio > 4; no potential for Acid Rock Drainage (Price 1997)

Table E.62: Raw acid base accounting, sulphur, and carbon content data for sediment from profundal sampling areas in Quesnel Lake, Mount Polley, 2014 [1].

Parameter	Units	Exposed												
		PNF (QULP-1)												PFF2 (QULP-4) Composite
		QULP-1-01	QULP-1-02	QULP-1-03	QULP-1-04	QULP-1-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	
Maximum Potential Acidity (MPA)	tCaCO3/1Kt	2.5	4.4	4.1	4.7	5.0	4.1	4.4	2.5	5	0.98	0.44	1.2	5.6
Fizz Rating	Unity	2.0	2.0	2.0	2.0	2.0	2	2	2	2	0	0	0	2.0
Net Neutralization Potential (NNP)	tCaCO3/1Kt	51	53	49	44	37	47	49	37	53	6.4	2.9	8.0	40
pH	Unity	8.5	8.3	8.2	8.3	8.2	8.3	8.3	8.2	8.5	0.12	0.055	0.15	7.9
Neutralization Potential (NP)	tCaCO3/1Kt	53	57	53	49	42	51	53	42	57	5.7	2.5	7.0	46
Neutralization Potential Ratio (NP/MPA)	Unity	21.2	13.0	13.1	10.5	8.40	13.2	13.0	8.40	21.2	4.86	2.18	6.04	8.18
Total Sulphur (S) - Leco	%	0.080	0.14	0.13	0.15	0.16	0.13	0.14	0.080	0.16	0.031	0.014	0.039	0.18
Sulphide Sulphur (S) - Calculated Leco	%	0.080	0.13	0.13	0.15	0.16	0.13	0.13	0.080	0.16	0.031	0.014	0.038	0.17
Sulphate Sulphur (S) - Carbonate Leach	%	<0.010	0.01	<0.010	<0.010	<0.010	0.010	<0.010	<0.010	0.010	0	0	0	0.010
Inorganic Carbon (C)	%	0.49	0.52	0.5	0.45	0.39	0.47	0.49	0.39	0.52	0.051	0.023	0.064	0.46
Carbon Dioxide (CO2)	%	1.8	1.9	1.8	1.7	1.4	1.7	1.8	1.4	1.9	0.19	0.086	0.24	1.7
Sulphate Sulphur (S) - HCl leachable	%	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0	0	0	0.01

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

NSS = Non-sufficient sample

[shaded] Indicates Neutralization Potential Ratio > 4; no potential for Acid Rock Drainage (Price 1997)

Table E.62: Raw acid base accounting, sulphur, and carbon content data for sediment from profundal sampling areas in Quesnel Lake, Mount Polley, 2014 [1].

Parameter	Units	Exposed												
		PFF1 (QULP-2)												PFFF (QULP-3) Composite
		QULP-2-01	QULP-2-02	QULP-2-03	QULP-2-04	QULP-2-05	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error	t*SE	
Maximum Potential Acidity (MPA)	tCaCO3/1Kt	5.3	3.8	4.4	3.4	3.1	4.0	3.8	3.1	5.3	0.87	0.39	1.1	3.1
Fizz Rating	Unity	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	0	0	0	1.0
Net Neutralization Potential (NNP)	tCaCO3/1Kt	41	39	40	40	36	39	40	36	41	1.9	0.86	2.4	17
pH	Unity	7.5	7.7	7.7	7.8	7.8	7.7	7.7	7.5	7.8	0.12	0.05	0.15	NSS
Neutralization Potential (NP)	tCaCO3/1Kt	46	43	44	43	39	43.0	43	39	46	2.5	1.1	3.2	20
Neutralization Potential Ratio (NP/MPA)	Unity	8.66	11.5	10.1	12.5	12.5	11.0	11.5	8.66	12.5	1.66	0.74	2.06	6.40
Total Sulphur (S) - Leco	%	0.17	0.12	0.14	0.11	0.10	0.13	0.12	0.10	0.17	0.028	0.012	0.034	0.10
Sulphide Sulphur (S) - Calculated Leco	%	0.17	0.10	0.13	0.11	0.090	0.12	0.11	0.090	0.17	0.032	0.014	0.039	0.10
Sulphate Sulphur (S) - Carbonate Leach	%	<0.010	0.020	0.010	<0.010	0.010	0.012	0.010	<0.010	0.020	0.0045	0.0020	0.0056	<0.010
Inorganic Carbon (C)	%	0.42	0.39	0.43	0.40	0.35	0.40	0.40	0.35	0.43	0.031	0.014	0.039	0.060
Carbon Dioxide (CO2)	%	1.5	1.4	1.6	1.5	1.3	1.5	1.5	1.3	1.6	0.11	0.051	0.14	0.20
Sulphate Sulphur (S) - HCl leachable	%	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	0	<0.010

[1] Data < method detection limit (< MDL) were used at the MDL for the calculation of summary statistics. Means are reported as < MDL if all the data used in their calculation were < MDL.

NSS = Non-sufficient sample

[shaded box] Indicates Neutralization Potential Ratio > 4; no potential for Acid Rock Drainage (Price 1997)

Table E.63: Raw sediment quality data for Quesnel Lake profundal sediment delineation sampling stations, Mount Polley Mine, 2014. Data are based on the < 2mm fraction of sediment.

Sample ID	Units	QULP-11	QULP-12	QULP-14	QULP-16	QULP-17	QULP-18	QULP-19	QULP-20	QULP-21	QULP-22	QULP-23	QULP-24	QULP-25	QULP-26	QULP-27	QULP-28	QULP-29	QULP-30
Date Sampled		5-Sep-14	5-Sep-14	5-Sep-14	5-Sep-14	5-Sep-14	5-Sep-14	5-Sep-14	5-Sep-14	5-Sep-14	5-Sep-14	5-Sep-14	5-Sep-14	8-Sep-14	8-Sep-14	8-Sep-14	8-Sep-14	8-Sep-14	8-Sep-14
Physical Tests																			
Moisture	%	30.3	26.7	26.5	30.5	40.3	30.8	30.7	29.6	27.0	31.5	20.9	42.3	81.9	59.8	67.0	61.3	50.1	64.4
pH (1:2 soil:water)	pH	8.57	8.65	8.80	8.56	8.47	8.49	8.35	8.50	8.57	8.58	8.78	8.51	6.66	7.83	7.78	7.78	7.86	7.74
Particle Size																			
% Gravel (>2mm)	%	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
% Sand (2.0mm - 0.063mm)	%	0.35	1.18	22.6	0.16	0.13	0.68	4.61	1.12	22.3	3.28	41.0	0.18	0.45	0.35	0.31	0.17	0.43	0.47
% Silt (0.063mm - 4um)	%	82.6	93.5	70.3	83.4	79.2	88.5	89.0	91.5	74.0	85.9	55.9	81.4	66.7	74.9	76.9	73.3	85.5	76.2
% Clay (<4um)	%	17.1	5.34	7.16	16.4	20.7	10.9	6.41	7.35	3.71	10.9	3.19	18.4	32.8	24.7	22.8	26.5	14.1	23.3
Texture	-	Silt	Silt	Silt loam	Silt	Silt	Silt	Silt	Silt	Silt loam	Silt	Silt loam	Silt	Silt loam	Silt loam	Silt loam	Silt loam	Silt	Silt loam
Leachable Anions & Nutrients																			
pH	pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anions and Nutrients																			
Total Nitrogen by LECO	%	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.031	<0.020	<0.020	<0.020	<0.020	0.023	0.319	0.122	0.142	0.115	0.095	0.134
Organic / Inorganic Carbon																			
Total Organic Carbon	%	0.22	<0.10	<0.10	0.15	0.36	0.24	0.38	0.11	0.10	<0.10	<0.10	0.21	3.22	1.72	1.86	1.40	1.34	1.54
Metals																			
Aluminum	mg/kg	20,700	17,300	15,800	19,800	22,700	19,500	16,000	16,800	15,000	20,700	13,500	23,300	28,400	24,100	24,700	27,700	18,900	27,100
Antimony	mg/kg	0.48	0.38	0.35	0.44	0.51	0.49	0.43	0.41	0.37	0.51	0.35	0.50	0.88	0.68	0.63	0.68	0.53	0.72
Arsenic	mg/kg	13.6	12.9	11.0	14.2	15.3	14.0	12.4	11.9	11.8	14.6	11.5	15.4	21.9	16.8	15.4	15.4	13.8	14.8
Barium	mg/kg	228	210	193	217	262	213	175	187	173	229	153	251	188	232	249	251	184	236
Beryllium	mg/kg	0.73	0.67	0.58	0.70	0.88	0.72	0.58	0.63	0.59	0.77	0.57	0.86	0.88	0.85	0.88	0.94	0.6	0.90
Bismuth	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.35	<0.20	0.22	0.21	<0.20	0.21
Boron	mg/kg	11	<10	<10	<10	10	10	<10	<10	<10	11	<10	11	<10	<10	<10	<10	<10	<10
Cadmium	mg/kg	0.118	0.120	0.102	0.149	0.185	0.175	0.166	0.134	0.140	0.160	0.110	0.189	0.634	0.405	0.488	0.442	0.304	0.491
Calcium	mg/kg	33,000	31,500	25,900	33,600	35,300	33,000	27,100	28,400	27,300	33,900	26,600	35,500	10,300	27,900	22,200	24,900	24,300	24,400
Chromium	mg/kg	8.95	9.22	8.76	10.1	14.3	12.5	18.1	13.2	13.2	12.5	11.1	14.9	68.9	36.3	38.6	38.5	30.5	42.8
Cobalt	mg/kg	15.7	13.9	13.2	16.6	20.1	15.4	14.2	12.9	15.0	17.7	14.0	20.1	25.9	21.8	23.0	26.0	16.7	24.5
Copper	mg/kg	554	547	548	603	672	547	462	418	560	655	581	721	112	523	483	520	386	461
Iron	mg/kg	22,500	24,900	31,500	23,600	26,700	25,300	38,500	24,600	52,200	28,800	53,100	28,200	53,800	39,500	40,000	41,000	36,400	42,000
Lead	mg/kg	5.18	4.73	4.39	5.91	7.82	5.82	5.86	4.98	4.88	6.67	4.25	7.71	20.9	12.1	13.4	12.5	9.41	12.0
Lithium	mg/kg	21.1	18.0	16.1	21.0	24.6	20.2	15.8	16.3	14.8	22.0	13.2	25.5	31.3	28.6	27.3	33.0	22.0	30.8
Magnesium	mg/kg	12,100	10,400	9,240	12,000	14,400	11,200	8,870	9,140	8,590	12,600	7,400	14,700	12,600	13,800	13,600	15,600	10,400	14,600
Manganese	mg/kg	706	618	547	716	844	712	627	590	574	773	518	881	19,400	1,230	1,480	1,310	829	1,200
Mercury	mg/kg	0.0598	0.0687	0.0667	0.0726	0.0721	0.0871	0.0730	0.0616	0.0720	0.0752	0.0664	0.0863	0.197	0.136	0.120	0.110	0.104	0.110
Molybdenum	mg/kg	3.29	3.41	3.27	3.43	3.57	3.43	3.07	2.72	3.59	3.72	3.78	3.78	6.39	3.26	2.96	3.31	2.67	3.13
Nickel	mg/kg	9.36	9.02	7.59	10.5	14.5	12.0	14.1	11.6	10.3	12.3	7.99	15.2	64.4	32.6	37.7	40.2	25.7	43.0
Phosphorus	mg/kg	1,430	1,650	1,230	1,530	1,720	1,650	1,660	1,460	1,540	1,590	1,500	1,550	1,260	1,460	1,300	1,400	1,460	1,470
Potassium	mg/kg	2,200	1,700	1,590	1,720	2,140	1,780	1,480	1,660	1,400	2,040	1,190	2,240	3,000	2,230	2,470	2,660	1,660	2,740
Selenium	mg/kg	0.74	0.82	0.65	0.91	1.09	0.88	0.86	0.67	0.88	1.02	0.90	1.07	1.77	1.55	1.44	1.47	1.10	1.51
Silver	mg/kg	0.25	0.26	0.26	0.28	0.32	0.28	0.26	0.23	0.28	0.31	0.27	0.34	0.35	0.37	0.35	0.37	0.29	0.36
Sodium	mg/kg	1,260	980	1,170	1,000	1,020	970	770	860	830	1,140	800	1,210	520	790	710	990	640	860
Strontium	mg/kg	212	190	169	184	191	197	164	185	165	194	152	207	123	172	162	189	144	171
Thallium	mg/kg	<0.050	<0.050	<0.050	<0.050	0.051	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.33	0.127	0.166	0.172	0.087	0.186
Tin	mg/kg	2.1	<2.0	<2.0	<2.0	3.0	<2.0	<2.0	<2.0	<2.0	2.0	<2.0	<2.0	<2.0	<2.0	2.5	<2.0	<2.0	<2.0
Titanium	mg/kg	1,930	1,530	1,310	1,600	2,000	1,800	1,460	1,610	1,430	1,910	1,280	1,990	1,010	1,580	1,320	1,640	1,280	1,670
Uranium	mg/kg	1.32	1.19	0.925	1.30	1.43	1.40	1.23	1.22	1.12	1.42	1.02	1.49	3.48	1.86	2.32	2.48	1.45	2.49
Vanadium	mg/kg	91.5	94.6	121	87.6	98.1	94.0	135	88.1	192	106	199	99.6	91.0	107	98.6	103	105	107
Zinc	mg/kg	57.8	50.5	48.4	61.6	73.7	58.8	54.5	49.6	50.6	65.9	45.8	76.3	122	92.7	96.7	106	73.6	106
Zirconium	mg/kg	-	-	-	-	10.3	-	-	-	-	-	-	-	-	-	5.70	-	-	-

[a] QULP-A composite is comprised of sediment collected and composited from sampling stations QULP-11, QULP-12, QULP-13, and QULP-15.

Table E.63: Raw sediment quality data for Quesnel Lake profundal sediment delineation sampling stations, Mount Polley Mine, 2014. Data are based on the < 2mm fraction of sediment.

Sample ID	Units	QULP-32	QULP-34	QULP-35	QULP-36	QULP-37	QULP-38	QULP-39	QULP-40	QULP-41	QULP-42	QULP-43	QULP-45	QULP-46	QULP-47	QULP-A Composite [a]
Date Sampled		8-Sep-14	8-Sep-14	8-Sep-14	8-Sep-14	8-Sep-14	8-Sep-14	8-Sep-14	8-Sep-14	8-Sep-14	9-Sep-14	9-Sep-14	9-Sep-14	9-Sep-14	9-Sep-14	5-Sep-14
Physical Tests																
Moisture	%	33.7	77.2	32.1	39.7	53.4	46.8	78.0	33.7	45.4	71.9	78.0	78.9	39.4	62.4	30.4
pH (1:2 soil:water)	pH	8.36	7.41	8.72	8.14	7.01	8.29	7.20	8.75	8.28	7.22	7.49	7.31	8.21	7.85	8.82
Particle Size																
% Gravel (>2mm)	%	<0.10	<0.10	<0.10	<0.10	4.32	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
% Sand (2.0mm - 0.063mm)	%	13.6	1.45	9.12	2.13	18.0	2.96	0.8	<0.10	<0.10	0.93	0.24	0.41	<0.10	3.35	1.28
% Silt (0.063mm - 4um)	%	78.1	73.3	82.1	89.0	58.6	84.4	71.3	88.8	84.1	78.3	71.4	68.7	89.8	85.1	84.4
% Clay (<4um)	%	8.31	25.3	8.83	8.88	19.1	12.6	27.9	11.1	15.9	20.8	28.3	30.9	10.2	11.6	14.3
Texture	-	Silt	Silt loam	Silt	Silt	Silt loam	Silt	Silt loam	Silt	Silt	Silt	Silt loam	Silt loam	Silt	Silt	Silt
Leachable Anions & Nutrients																
pH	pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.59
Anions and Nutrients																
Total Nitrogen by LECO	%	<0.020	0.263	<0.020	0.045	0.162	0.060	0.270	<0.020	0.045	0.208	0.260	0.266	0.036	0.170	<0.020
Organic / Inorganic Carbon																
Total Organic Carbon	%	0.20	2.65	<0.10	0.61	1.87	0.60	2.76	<0.10	0.61	2.28	2.81	2.69	0.43	2.02	<0.10
Metals																
Aluminum	mg/kg	16,900	26,000	16,900	16,900	20,800	20,800	25,800	18,000	21,400	23,900	25,500	26,700	17,700	19,900	20,800
Antimony	mg/kg	0.45	0.77	0.40	0.44	0.65	0.55	0.82	0.41	0.55	0.66	0.83	0.87	0.44	0.54	0.47
Arsenic	mg/kg	12.8	16.0	12.8	12.5	11.1	12.6	42.9	12.6	14.8	30.7	94.7	31.5	12.1	14.3	13.7
Barium	mg/kg	179	185	190	170	158	192	186	193	221	202	227	184	171	171	220
Beryllium	mg/kg	0.69	0.86	0.65	0.60	0.68	0.75	0.82	0.65	0.79	0.72	0.79	0.84	0.61	0.63	0.8
Bismuth	mg/kg	<0.20	0.31	<0.20	<0.20	0.23	<0.20	0.32	<0.20	<0.20	0.28	0.32	0.33	<0.20	<0.20	<0.20
Boron	mg/kg	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	11
Cadmium	mg/kg	0.146	0.594	0.114	0.209	0.481	0.293	0.593	0.101	0.239	0.627	0.651	0.701	0.194	0.377	0.143
Calcium	mg/kg	28,900	9,270	29,700	26,600	8,750	26,200	9,810	30,500	31,400	8,010	8,770	9,970	25,900	17,200	32,300
Chromium	mg/kg	13.7	65.3	10.7	22.0	51.1	26.1	65.2	9.02	21.3	67.9	67.1	67.1	21.8	39.2	10.7
Cobalt	mg/kg	14.4	24.0	14.9	15.0	18.5	18.0	24.7	13.7	19.3	22.2	25.0	25.1	14.1	17.4	17
Copper	mg/kg	495	90.4	547	415	86.8	443	78.7	462	593	65.2	76.6	78.9	355	255	609
Iron	mg/kg	30,000	49,800	39,100	37,300	46,200	32,200	56,800	20,700	31,100	50,400	64,200	56,400	28,900	40,400	25,600
Lead	mg/kg	5.22	21.0	4.72	6.90	12.9	7.59	19.2	4.35	8.55	14.8	18.5	20.5	6.59	10.2	6.01
Lithium	mg/kg	17.1	28.6	17.2	17.9	23.6	22.3	30.9	18.7	25.4	26.1	28.9	31.2	18.7	21.9	20.9
Magnesium	mg/kg	9,510	11,400	9,740	9,450	9,280	11,200	11,500	10,500	13,300	11,000	11,200	11,500	9,690	9,810	12,300
Manganese	mg/kg	630	6,610	599	657	954	733	18,500	587	819	3,410	12,500	15,900	624	2,410	738
Mercury	mg/kg	0.0688	0.148	0.068	0.0803	0.137	0.081	0.172	0.0584	0.0929	0.122	0.161	0.172	0.070	0.121	0.0673
Molybdenum	mg/kg	3.02	3.91	3.52	2.79	0.98	2.97	6.13	2.95	3.45	2.60	4.41	6.39	2.42	2.54	3.33
Nickel	mg/kg	12.1	61.7	8.79	18.2	46.4	25.1	62.1	8.92	20.3	59.2	63.1	64.3	18.2	35.1	11
Phosphorus	mg/kg	1,690	1,260	1,600	1,570	1,470	1,630	1,480	1,560	1,490	1,570	2,440	1,430	1,540	1,300	1,510
Potassium	mg/kg	1,600	2,720	1,640	1,570	2,070	1,980	2,700	1,660	2,010	2,470	2,840	2,950	1,600	1,920	2,130
Selenium	mg/kg	0.84	1.34	0.77	0.94	1.25	1.02	1.54	0.60	1.25	1.62	1.92	1.55	0.74	1.15	0.89
Silver	mg/kg	0.26	0.30	0.27	0.28	0.21	0.30	0.32	0.22	0.32	0.34	0.36	0.35	0.21	0.27	0.27
Sodium	mg/kg	920	390	1,050	710	380	840	420	1,100	910	470	420	420	740	550	1,260
Strontium	mg/kg	173	105	177	154	84.5	157	117	191	180	88.2	109	115	160	127	195
Thallium	mg/kg	<0.050	0.299	<0.050	0.062	0.233	0.118	0.285	<0.050	0.071	0.248	0.280	0.329	0.060	0.138	<0.050
Tin	mg/kg	<2.0	6.1	<2.0	<2.0	2.9	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium	mg/kg	1,600	972	1,660	1,440	953	1,580	857	1,560	1,600	1,070	903	906	1,490	1,160	1,930
Uranium	mg/kg	1.29	3.11	1.19	1.33	2.41	1.92	3.07	1.19	1.52	2.52	2.95	3.34	1.30	1.92	1.34
Vanadium	mg/kg	112	85.3	154	122	82.9	100	83.8	81.1	96	79.3	80.3	82.9	91.6	101	97.5
Zinc	mg/kg	54.3	112	52.4	60.0	85.3	73.4	114	50.9	76.0	114	118	120	59.8	80.4	62.4
Zirconium	mg/kg	-	1.60	-	-	2.90	-	-	-	-	-	-	-	-	-	-

[a] QULP-A composite is comprised of sediment collected and composited from sampling stations QULP-11, QULP-12, QULP-13, and QULP-15.

Table E.64: Raw sediment quality data for Quesnel Lake profundal sediment delineation sampling stations, Mount Polley Mine, 2014. Data are based on the < 63µm fraction of sediment.

Sample ID	Units	QULP-11	QULP-12	QULP-14	QULP-16	QULP-17	QULP-18	QULP-19	QULP-20	QULP-21	QULP-22	QULP-23	QULP-24	QULP-25	QULP-26	QULP-27
Date Sampled		5-Sep-14	5-Sep-14	5-Sep-14	5-Sep-14	5-Sep-14	5-Sep-14	5-Sep-14	5-Sep-14	5-Sep-14	5-Sep-14	5-Sep-14	5-Sep-14	8-Sep-14	8-Sep-14	8-Sep-14
Physical Tests																
pH (1:2 soil:water)	pH	8.79	8.80	8.72	8.70	-	8.57	8.46	8.62	8.60	8.61	8.73	8.58	7.27	7.90	-
Organic / Inorganic Carbon																
Total Organic Carbon	%	<0.10	<0.10	<0.10	<0.10	0.23	0.13	0.22	<0.10	<0.10	<0.10	<0.10	0.13	3.17	1.27	1.18
Metals																
Aluminum	mg/kg	19,300	15,000	16,000	18,500	24,500	16,800	14,200	15,300	13,700	17,900	13,100	19,400	27,300	23,300	24,900
Antimony	mg/kg	0.45	0.40	0.41	0.42	0.58	0.40	0.36	0.41	0.38	0.44	0.36	0.42	0.81	0.59	0.61
Arsenic	mg/kg	13.5	14	12.6	14.0	16.0	13.2	12.4	13.3	12.4	14.5	12.6	14.1	28.9	16.3	15.8
Barium	mg/kg	217	184	184	208	249	197	161	174	159	207	148	221	199	229	239
Beryllium	mg/kg	0.69	0.61	0.62	0.7	0.89	0.62	0.56	0.66	0.59	0.68	0.56	0.73	0.83	0.81	0.93
Bismuth	mg/kg	<0.10	<0.10	<0.10	<0.10	0.11	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.34	0.19	0.19
Boron	mg/kg	11	<10	<10	<10	11	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cadmium	mg/kg	0.118	0.121	0.115	0.13	0.178	0.131	0.152	0.136	0.136	0.134	0.133	0.141	0.658	0.358	0.367
Calcium	mg/kg	31,900	31,700	28,100	32,900	36,000	30,000	25,600	30,100	26,900	32,900	25,500	32,400	10,300	26,700	25,500
Chromium	mg/kg	8.24	8.28	11.9	9.72	14.7	10.5	16.5	13.9	15.6	11.1	18	11.9	67.6	34.2	36.5
Cobalt	mg/kg	14.4	12.3	15.2	15.1	20.2	13.7	13.8	12.9	16.5	15.4	19	16.5	25.9	20.8	22.4
Copper	mg/kg	519	476	534	542	702	485	450	429	535	556	585	599	107	512	498
Iron	mg/kg	21,700	24,900	46,500	22,400	27,900	23,200	40,200	29,800	70,900	31,900	96,500	24,500	53,900	36,900	39,000
Lead	mg/kg	4.74	4.25	4.6	5.18	7.71	4.98	5.18	5.05	4.76	5.25	4.96	6.06	19.9	11.7	11.7
Lithium	mg/kg	18.9	14.1	15.8	19.1	24.7	16.7	13.6	15.2	13.6	18.1	12.7	20.9	29.1	25.5	29.8
Magnesium	mg/kg	10,900	8,460	9,440	11,300	14,300	10,000	8,300	8,600	8,120	10,500	7,780	12,400	11,800	12,800	14,000
Manganese	mg/kg	657	569	593	659	864	614	571	573	556	671	556	710	21,200	1,170	1,370
Mercury	mg/kg	0.0598	0.0623	0.0732	0.0684	0.0725	0.0666	0.0792	0.0661	0.0686	0.0685	0.0706	0.0726	0.159	0.128	0.102
Molybdenum	mg/kg	3.11	3.35	3.36	3.24	3.83	3.04	2.81	2.83	3.53	3.39	3.8	3.45	6.57	3.12	3.15
Nickel	mg/kg	8.62	7.41	9.22	9.90	15.0	10.2	13.0	11.3	10.8	10.1	11.1	12.3	64.3	30.5	34.9
Phosphorus	mg/kg	1,550	1,990	1,600	1,840	1,710	1,800	1,750	1,990	1,820	1,940	1,920	1,690	1,380	1,410	1,310
Potassium	mg/kg	1,800	1,230	1,600	1,760	2,360	1,490	1,270	1,280	1,230	1,600	1,210	1,680	2,980	2,260	2,670
Selenium	mg/kg	0.76	0.85	0.79	0.86	1.17	0.80	0.86	0.84	0.95	0.87	1.05	0.95	1.76	1.53	1.49
Silver	mg/kg	0.232	0.251	0.271	0.259	0.323	0.254	0.262	0.25	0.276	0.292	0.303	0.273	0.342	0.353	0.321
Sodium	mg/kg	1,120	790	970	1,000	1,210	870	700	760	720	930	760	970	500	770	920
Strontium	mg/kg	202	160	164	181	202	174	141	165	142	175	133	179	128	170	189
Thallium	mg/kg	<0.050	<0.050	<0.050	<0.050	0.057	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.320	0.114	0.152
Tin	mg/kg	2.05	1.66	1.57	1.78	2.74	1.56	1.1	1.51	1.27	1.74	1.38	1.65	0.80	1.39	2.21
Titanium	mg/kg	1,880	1,410	1,490	1,570	2,330	1,440	1,150	1,320	1,170	1,620	1,220	1,480	884	1,450	1,730
Uranium	mg/kg	1.27	1.27	1.07	1.22	1.61	1.24	1.08	1.21	1.03	1.33	1.04	1.20	3.46	1.76	2.04
Vanadium	mg/kg	90.6	98.9	181	87.0	102	86.8	141	107	261	122	362	88.6	86.8	101	101
Zinc	mg/kg	53.4	44.0	54.6	56.0	75.5	51.3	50.7	48.7	53.3	55.9	58.3	68.8	115	87.4	92.2
Zirconium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[a] QULP-A composite is comprised of sediment collected and composited from sampling stations QULP-11, QULP-12, QULP-13, and QULP-15.

Table E.64: Raw sediment quality data for Quesnel Lake profundal sediment delineation sampling stations, Mount Polley Mine, 2014. Data are based on the < 63µm fraction of sediment.

Sample ID	Units	QULP-28	QULP-29	QULP-30	QULP-32	QULP-34	QULP-35	QULP-36	QULP-37	QULP-38	QULP-39	QULP-40	QULP-41	QULP-42	QULP-43	QULP-45	QULP-46	QULP-47	QULP-A Composite [a]
Date Sampled		8-Sep-14	8-Sep-14	8-Sep-14	8-Sep-14	8-Sep-14	8-Sep-14	8-Sep-14	8-Sep-14	8-Sep-14	8-Sep-14	8-Sep-14	8-Sep-14	9-Sep-14	9-Sep-14	9-Sep-14	9-Sep-14	9-Sep-14	5-Sep-14
Physical Tests																			
pH (1:2 soil:water)	pH	7.86	7.93	7.91	8.36	-	8.54	8.15	-	8.14	6.97	8.57	8.16	6.67	7.51	7.18	8.15	7.83	8.66
Organic / Inorganic Carbon																			
Total Organic Carbon	%	1.08	1.15	1.23	0.16	2.37	<0.10	0.57	1.99	0.47	2.54	<0.10	0.52	2.08	2.62	2.58	0.42	1.54	<0.10
Metals																			
Aluminum	mg/kg	25,800	18,300	24,400	16,100	25,300	17,300	16,200	23,100	18,000	23,800	17,200	21,500	21,700	23,400	24,100	17,400	18,800	21,300
Antimony	mg/kg	0.62	0.47	0.61	0.37	0.77	0.39	0.41	0.65	0.40	0.73	0.38	0.48	0.59	0.74	0.76	0.45	0.5	0.48
Arsenic	mg/kg	14	13.7	13.4	12.7	15.3	13.2	11.9	12.1	11.2	59.5	12.3	14.8	33.6	114	61.2	11.9	13.8	14.2
Barium	mg/kg	239	184	225	188	176	199	166	174	187	197	200	222	198	253	202	176	168	228
Beryllium	mg/kg	0.85	0.64	0.82	0.61	0.86	0.65	0.54	0.72	0.62	0.76	0.65	0.79	0.65	0.73	0.80	0.61	0.59	0.82
Bismuth	mg/kg	0.19	0.14	0.20	<0.10	0.31	<0.10	<0.10	0.25	0.13	0.3	<0.10	0.12	0.26	0.30	0.32	<0.10	0.17	<0.10
Boron	mg/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	11
Cadmium	mg/kg	0.373	0.275	0.395	0.155	0.539	0.118	0.197	0.497	0.241	0.580	0.102	0.242	0.513	0.571	0.699	0.180	0.383	0.138
Calcium	mg/kg	22,800	23,700	22,800	27,900	9,430	29,200	24,900	8,560	23,100	9,680	29,800	30,800	7,390	8,700	9,870	25,800	17,000	33,100
Chromium	mg/kg	34.8	29.6	37.8	13.1	66.6	11.4	21.0	59.8	22.3	63.6	9.70	21.7	64.0	64.1	61.6	21.9	38.5	11.2
Cobalt	mg/kg	22.9	16.3	22.1	14.5	22.9	15.1	14.2	20.9	16.1	22.6	13.0	18.8	20.1	24.3	23.1	13.6	16.1	17.1
Copper	mg/kg	481	379	431	475	88.1	500	398	107	436	70.9	443	592	57.0	68.0	71.3	346	249	614
Iron	mg/kg	36,400	35,100	37,100	28,800	49,300	40,700	35,700	53,200	29,400	57,000	19,700	30,600	47,100	64,100	59,500	28,700	38,400	26,000
Lead	mg/kg	10.9	9.11	11.2	5.17	20.2	4.77	6.47	13.3	7.10	17.9	4.31	8.27	13.2	16.9	18.2	6.47	9.41	6.03
Lithium	mg/kg	28.1	20.3	27.1	16.9	28.8	16.0	15.4	24.8	18.9	27.2	17.3	23.6	22.1	25.4	26.6	17.8	19.7	21.5
Magnesium	mg/kg	14,000	9,790	13,000	9,360	11,200	9,880	9,010	10,400	10,500	10,200	9,750	12,900	9,740	9,940	10,100	9,220	9,040	12,600
Manganese	mg/kg	1,170	803	1,070	611	6,470	601	624	1,020	646	19,500	600	885	3,580	19,200	17,600	636	2,240	741
Mercury	mg/kg	0.0907	0.101	0.0940	0.0671	0.142	0.0650	0.0758	0.128	0.0718	0.148	0.0671	0.0903	0.111	0.151	0.140	0.0682	0.0968	0.0694
Molybdenum	mg/kg	3.02	2.57	2.79	2.99	4.21	3.27	2.67	1.08	2.81	6.36	2.98	3.45	2.57	5.44	6.58	2.22	2.56	3.45
Nickel	mg/kg	34.9	24.6	36.8	11.9	61.4	9.15	17.6	55.1	22.1	59.4	9.33	20.2	52.3	59.8	59.8	18.3	32.4	11.2
Phosphorus	mg/kg	1,180	1,450	1,280	1,800	1,170	1,700	1,620	1,500	1,750	1,760	1,530	1,500	1,450	2,750	2,140	1,410	1,290	1,710
Potassium	mg/kg	2,630	1,630	2,400	1,530	2,640	1,540	1,410	2,200	1,670	2,660	1,590	2,060	2,290	2,720	2,810	1,610	1,860	2,110
Selenium	mg/kg	1.40	1.15	1.35	0.84	1.29	0.80	0.91	1.47	0.97	1.56	0.67	1.22	1.53	1.77	1.45	0.76	1.04	0.94
Silver	mg/kg	0.331	0.265	0.328	0.256	0.309	0.285	0.258	0.243	0.302	0.28	0.206	0.327	0.298	0.338	0.318	0.218	0.247	0.273
Sodium	mg/kg	940	620	830	870	460	1,020	650	430	760	380	940	840	420	390	370	690	520	1,350
Strontium	mg/kg	180	144	164	166	106	181	142	83.1	137	121	193	184	84.9	114	121	165	126	199
Thallium	mg/kg	0.139	0.079	0.162	0.05	0.295	<0.050	0.052	0.236	0.088	0.294	<0.050	0.072	0.230	0.280	0.316	0.067	0.128	<0.050
Tin	mg/kg	1.49	1.04	1.29	1.30	3.25	1.89	1.30	1.19	1.01	0.83	1.84	1.73	0.55	0.61	0.68	1.49	1.03	2
Titanium	mg/kg	1,540	1,110	1,380	1,130	960	1,590	1,250	892	922	870	1,660	1,790	1,090	873	869	1,560	1,200	1,900
Uranium	mg/kg	2.21	1.43	2.31	1.16	3.08	1.18	1.22	2.68	1.47	2.88	1.17	1.45	2.17	2.62	2.98	1.32	1.72	1.35
Vanadium	mg/kg	93.3	100	93.2	103	81.8	156	116	88.2	83.6	77.9	79.1	97.6	73.4	75.2	76.5	90.2	99.3	103
Zinc	mg/kg	93.7	70.3	93.3	51.5	108	51.0	56.3	98.1	65.3	99.1	46.1	71.5	97.6	104	104	55.2	71.8	63.6
Zirconium	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[a] QULP-A composite is comprised of sediment collected and composited from sampling stations QULP-11, QULP-12, QULP-13, and QULP-15.

Appendix Table E.65: Semi-quantitative X-ray diffraction results for size-fractioned Hazeltine Creek sediment sample HAC50.

Mineral	HAC50 +2mm (wt %)	HAC50 +2mm/+125um (wt %)	HAC50 -25/+63um (wt %)	HAC50 -63/+25um (wt %)	HAC50 -25um (wt %)
Albite	29.3	32.0	32.3	32.9	29.8
Microcline	11.0	16.6	16.5	18.1	17.7
Muscovite	10.5	14.2	14.4	11.3	9.3
Quartz	20.4	8.1	3.5	2.3	2.5
Diopside	7.6	5.1	7.8	8.5	5.4
Orthoclase	3.6	7.3	7.3	5.8	5.8
Magnetite	1.3	2.5	2.8	5.4	4.8
Clinochlore	4.9	1.3	1.2	1.4	5.1
Cuspidine	-	3.3	3.4	2.6	4.3
Calcite	1.5	2.4	2.6	2.7	3.4
Epidote	2.6	2.0	2.2	2.4	2.6
Dolomite	1.7	1.8	1.8	2.0	2.3
Maghemite	2.7	0.5	1.2	1.3	1.5
Ankerite	0.2	1.5	1.6	1.7	2.0
Hematite	2.0	0.7	1.0	1.1	1.3
Rutile	0.7	0.6	0.6	0.7	0.8
Montmorillonite	-	-	-	-	1.6
TOTAL	100	100	100	100	100

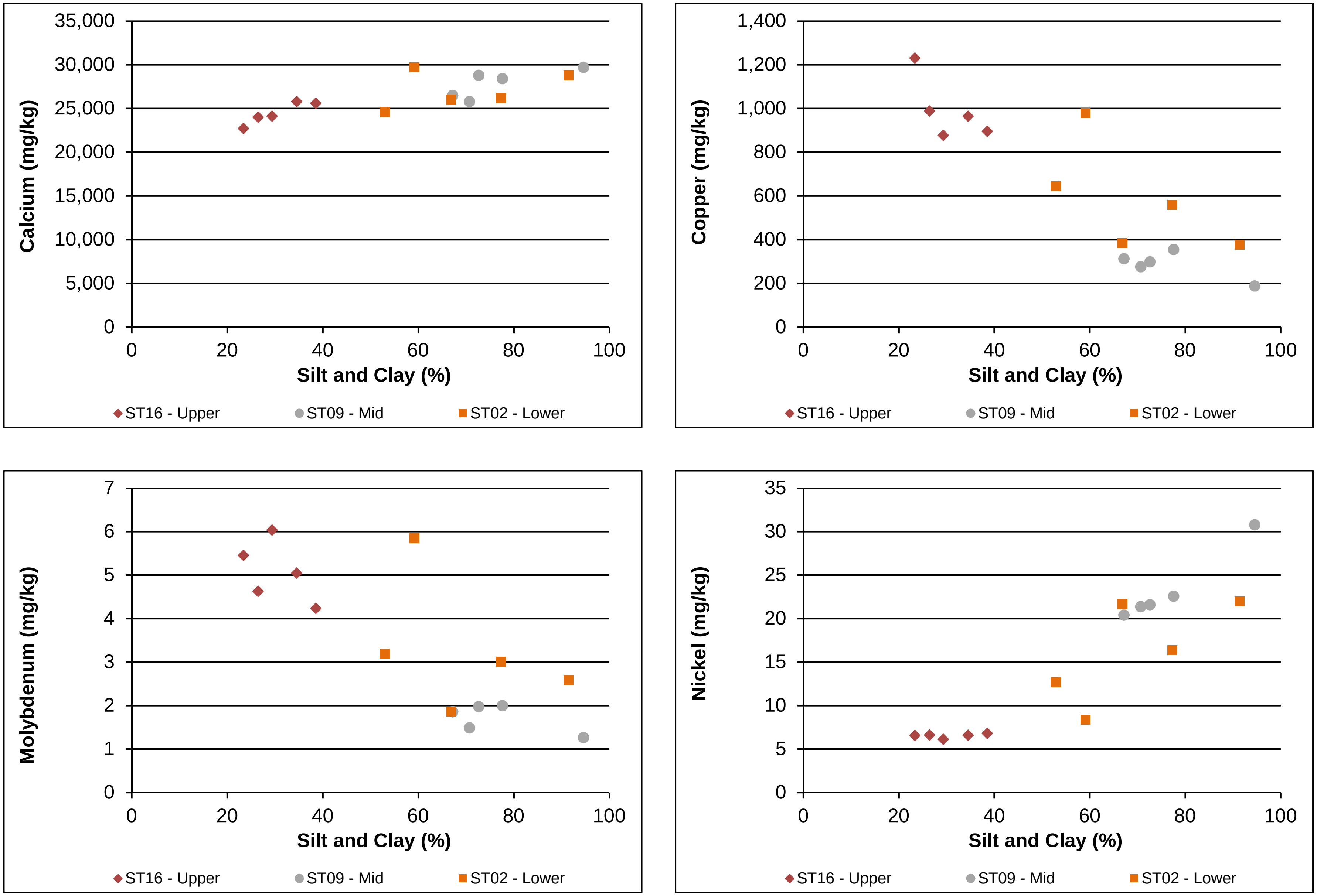


Figure E.1: Spearman's correlation relationships between concentrations of metals in sediment (in < 2mm fraction) and % fines (silt and clay) in sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014.

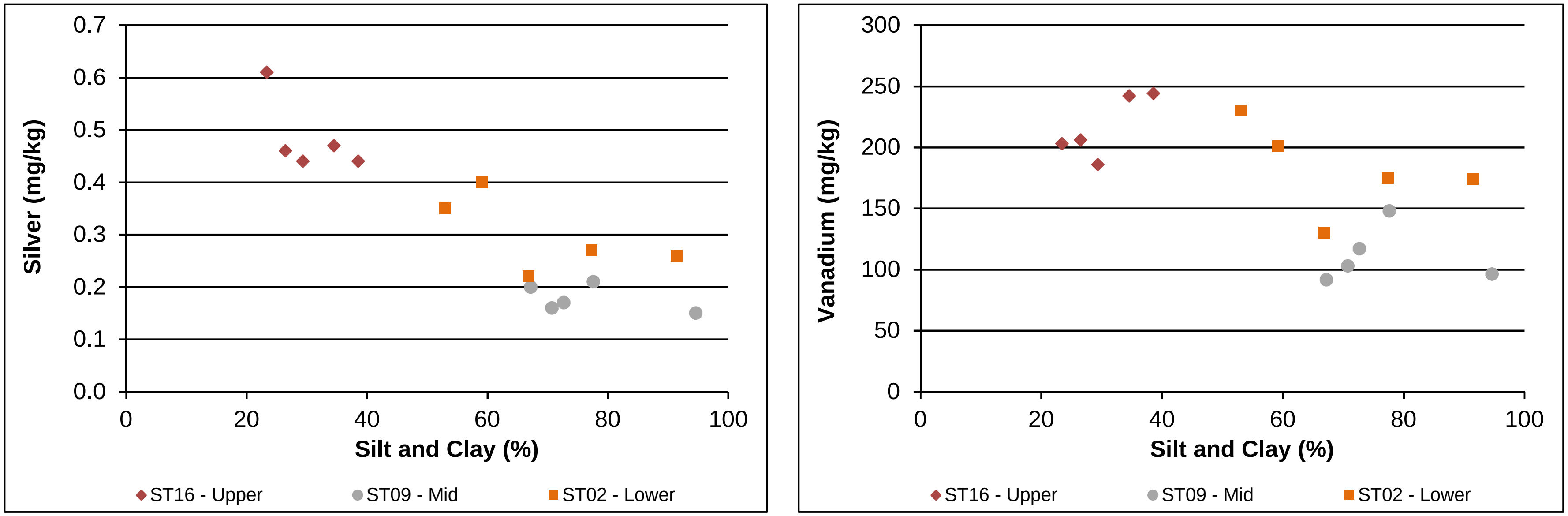


Figure E.1: Spearman's correlation relationships between concentrations of metals in sediment (in < 2mm fraction) and % fines (silt and clay) in sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014.

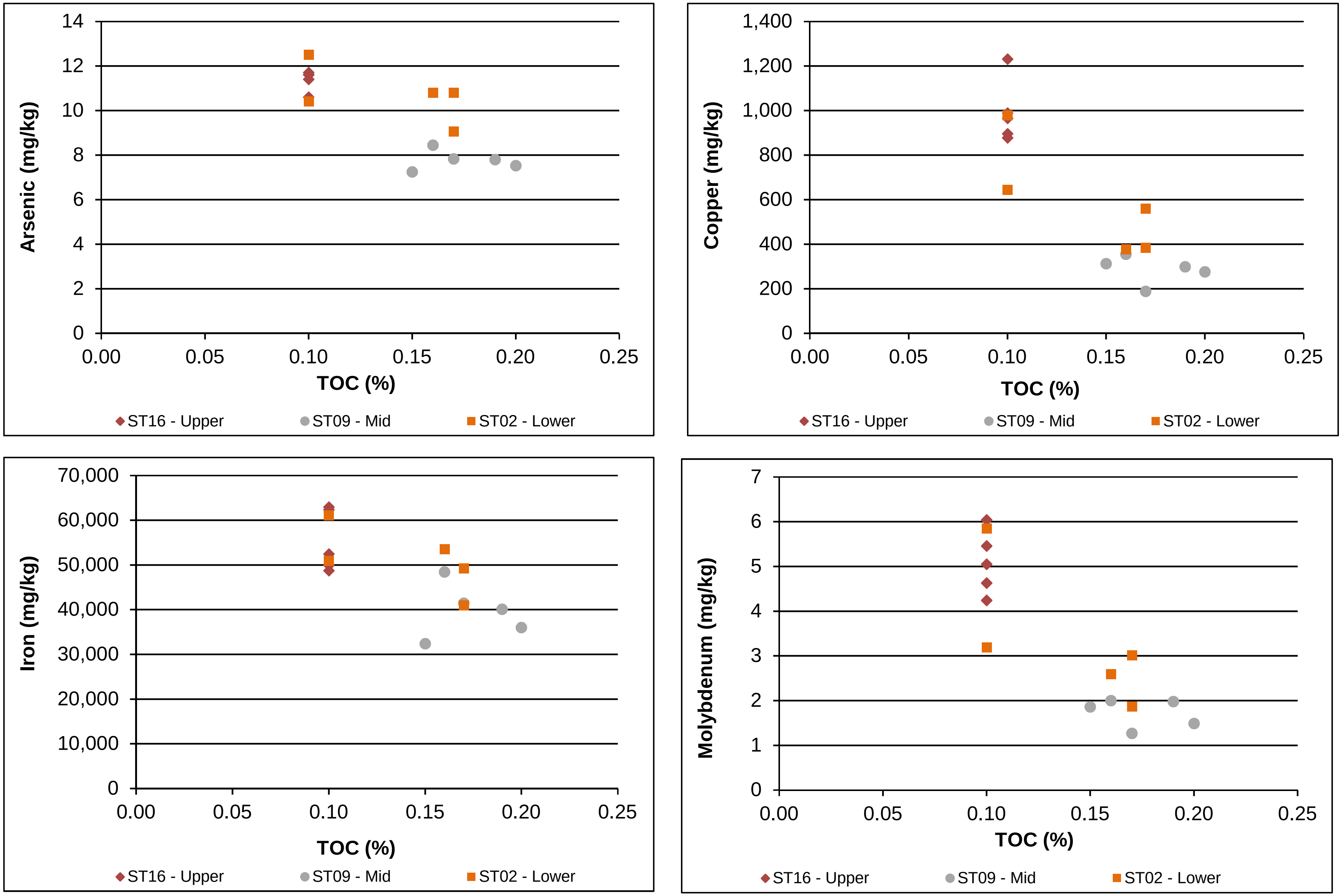


Figure E.2: Spearman's correlation relationships between concentrations of metals in sediment (in < 2mm fraction) and total organic carbon (%) in sediment from Hazeltine Creek sampling areas , Mount Polley Mine, 2014.

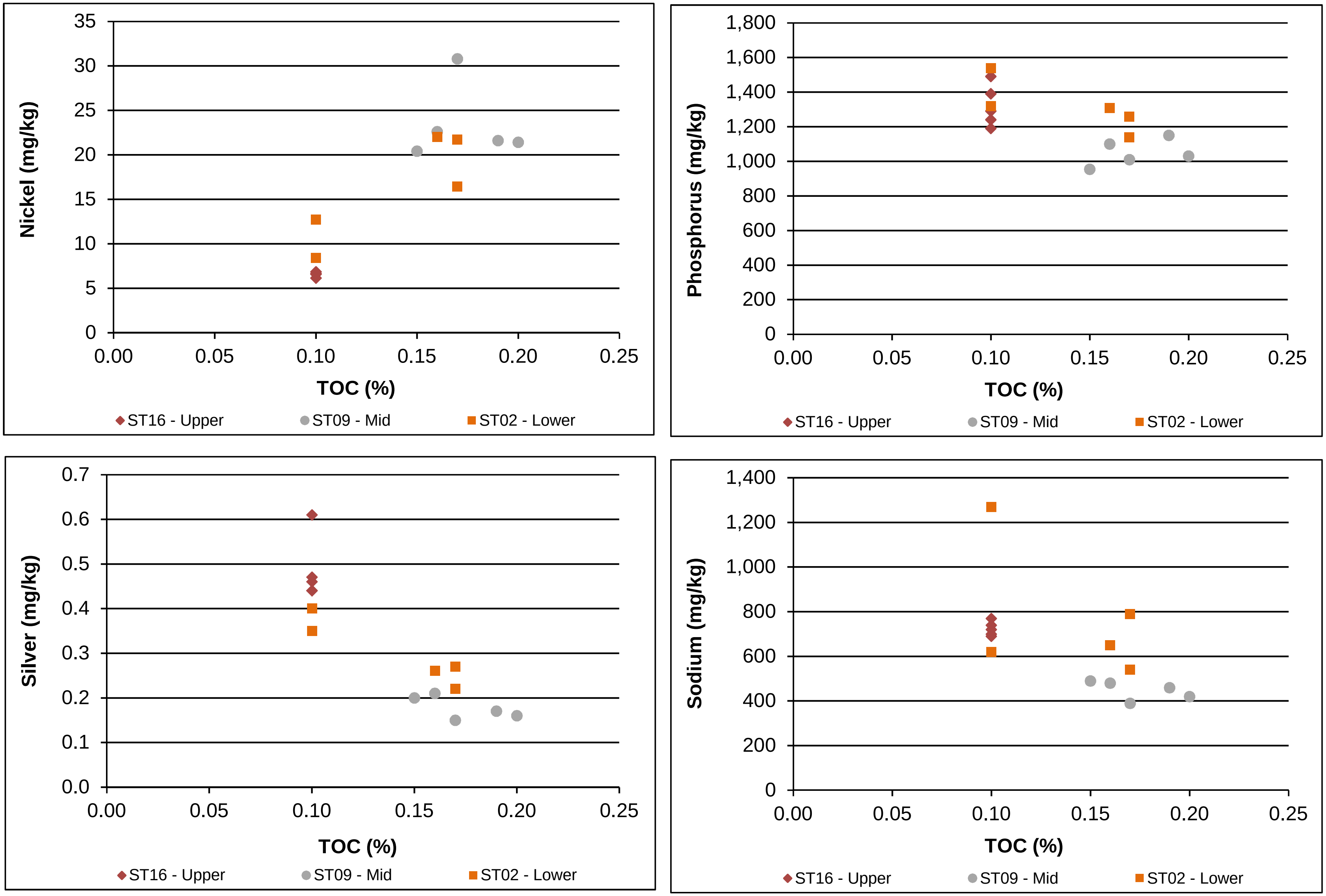


Figure E.2: Spearman's correlation relationships between concentrations of metals in sediment (in < 2mm fraction) and total organic carbon (%) in sediment from Hazeltine Creek sampling areas , Mount Polley Mine, 2014.

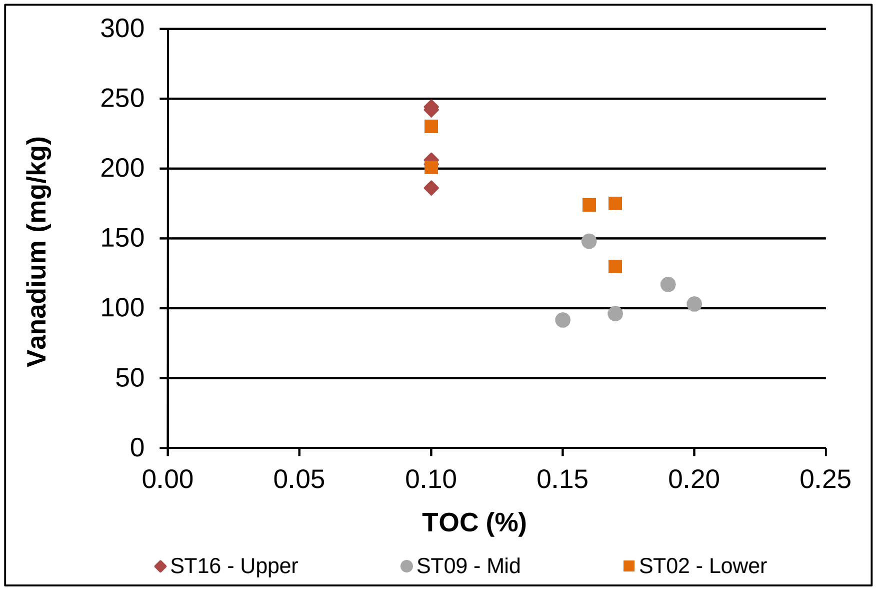


Figure E.2: Spearman's correlation relationships between concentrations of metals in sediment (in < 2mm fraction) and total organic carbon (%) in sediment from Hazeltine Creek sampling areas , Mount Polley Mine, 2014.

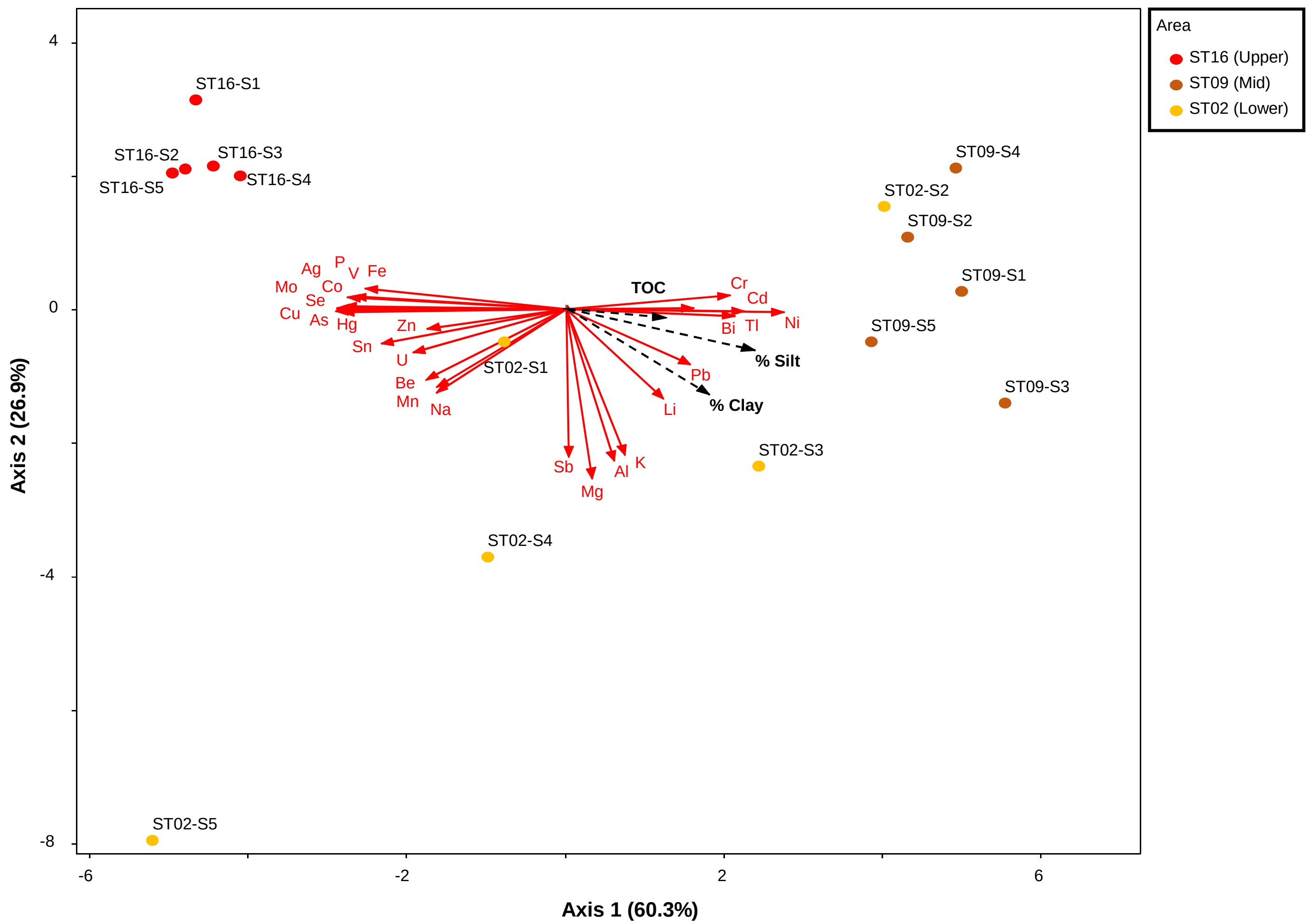


Figure E.3: Biplot of principal component analysis (PCA) of metal concentrations in sediment (<63 µm fraction) from Hazeltine Creek sampling stations, Mount Polley Mine, 2014. Vector length is proportional to the magnitude of direct correlation of metals (solid red vector lines) and indirect correlation of sediment physical characteristics (black dashed vector lines) with PCA values of each axis (Appendix Tables E.5-E.6). Only metals with significant (p-value <0.010) Spearman's correlation and r-values > 0.7 with either axis are displayed, all sediment physical characteristics are displayed.

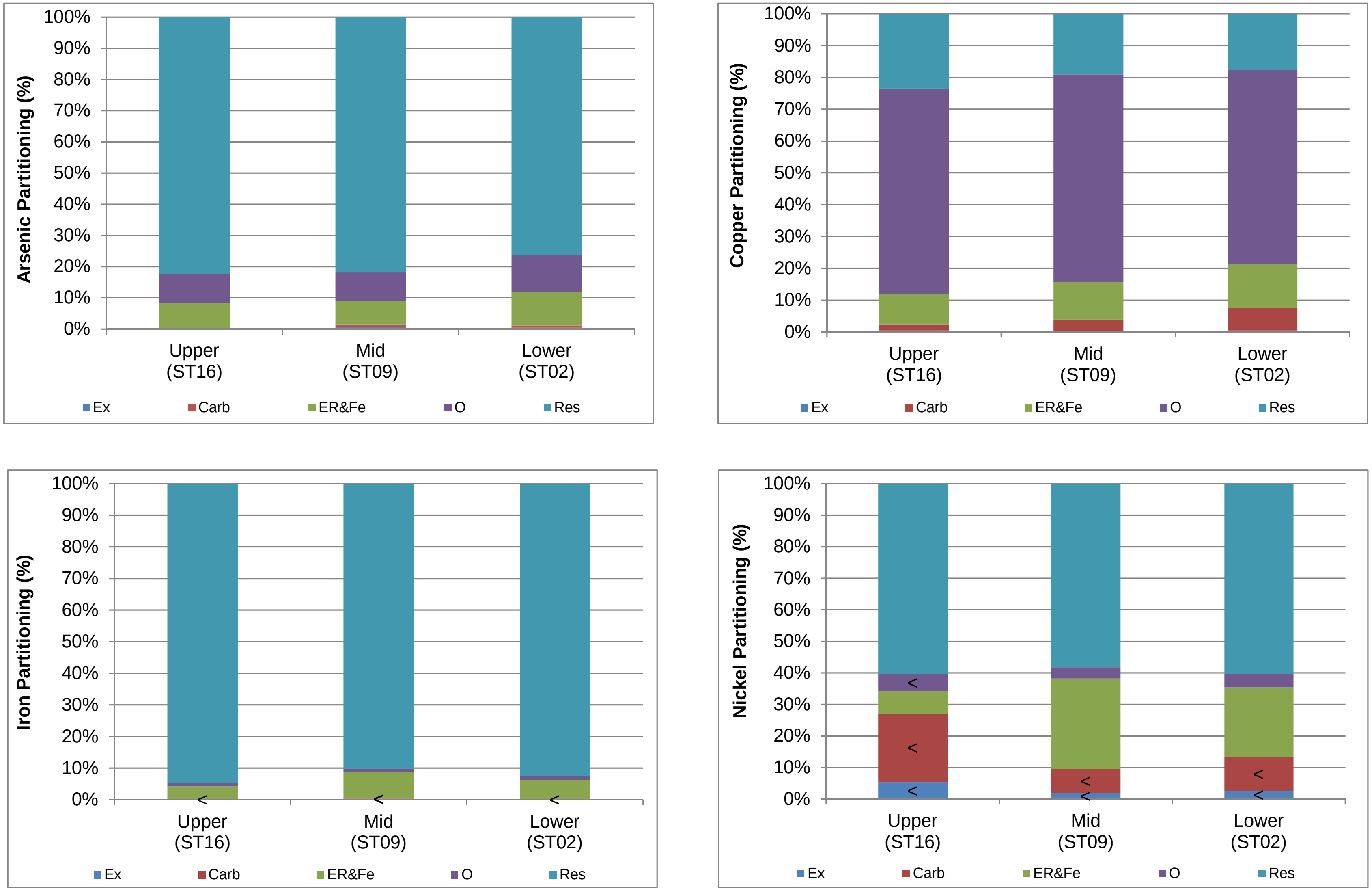


Figure E.4 (a): Partitioning of selectively extracted parameters of interest in sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Selective extractions included Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe), Organic Bound Metals (O), and Residual Metals (Res).

Mean values < MDL are indicated with a < symbol. Means are reported as < MDL if all data used in their calculation were < MDL.

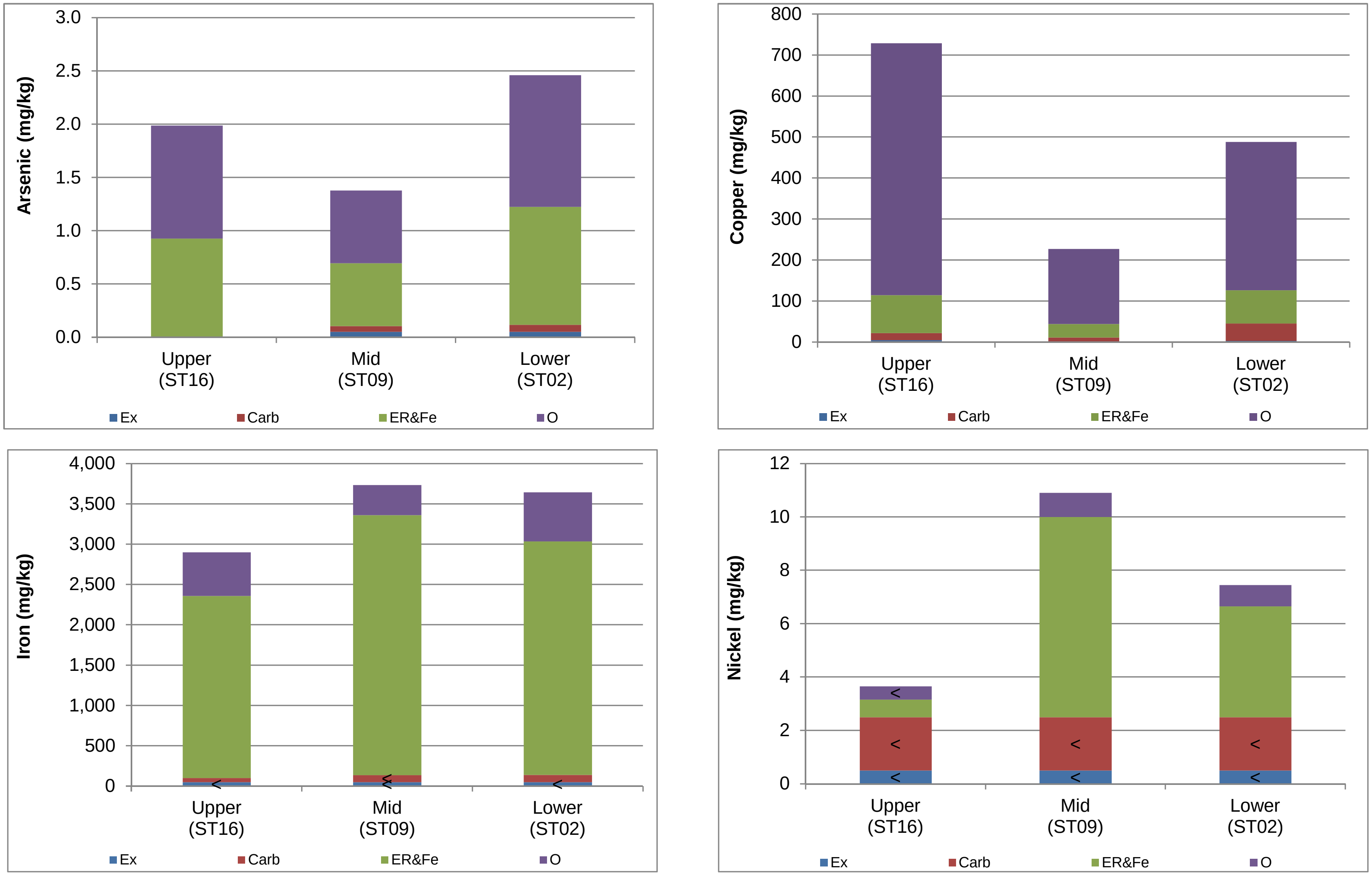


Figure E.4 (b): Mean concentrations of selectively extracted parameters of interest in sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Only metals within the Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe) and Organic Bound Metals (O) fractions are shown (Residual metals are excluded).

Mean values < MDL are indicated with a < symbol. Means are reported as < MDL if all data used in their calculation were < MDL.

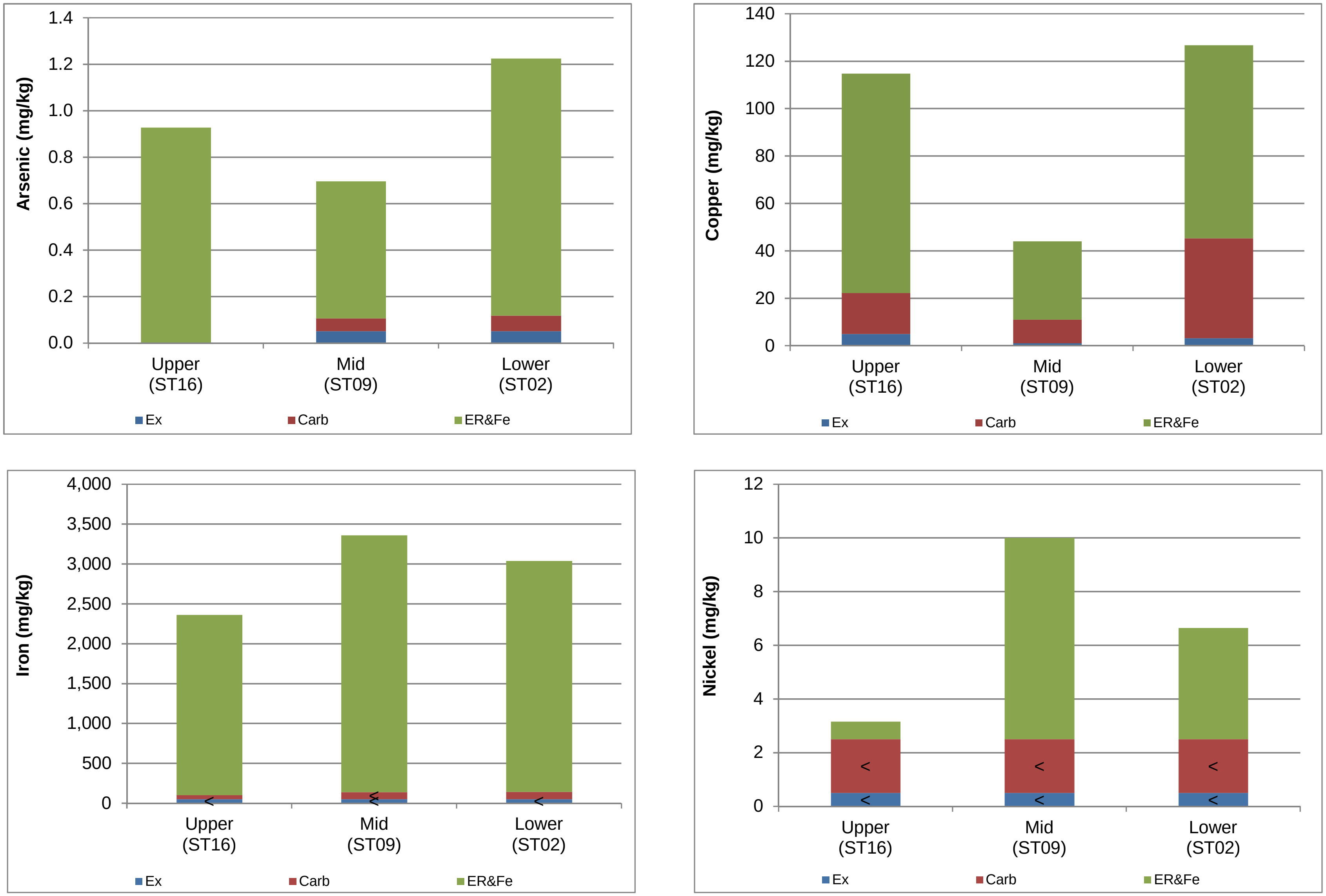


Figure E.4 (c): Mean concentrations of selectively extracted parameters of interest in sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Only metals within the Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe) fractions are shown (Organic Bound and Residual metals are excluded).

Mean values < MDL are indicated with a < symbol. Means are reported as < MDL if all data used in their calculation were < MDL.

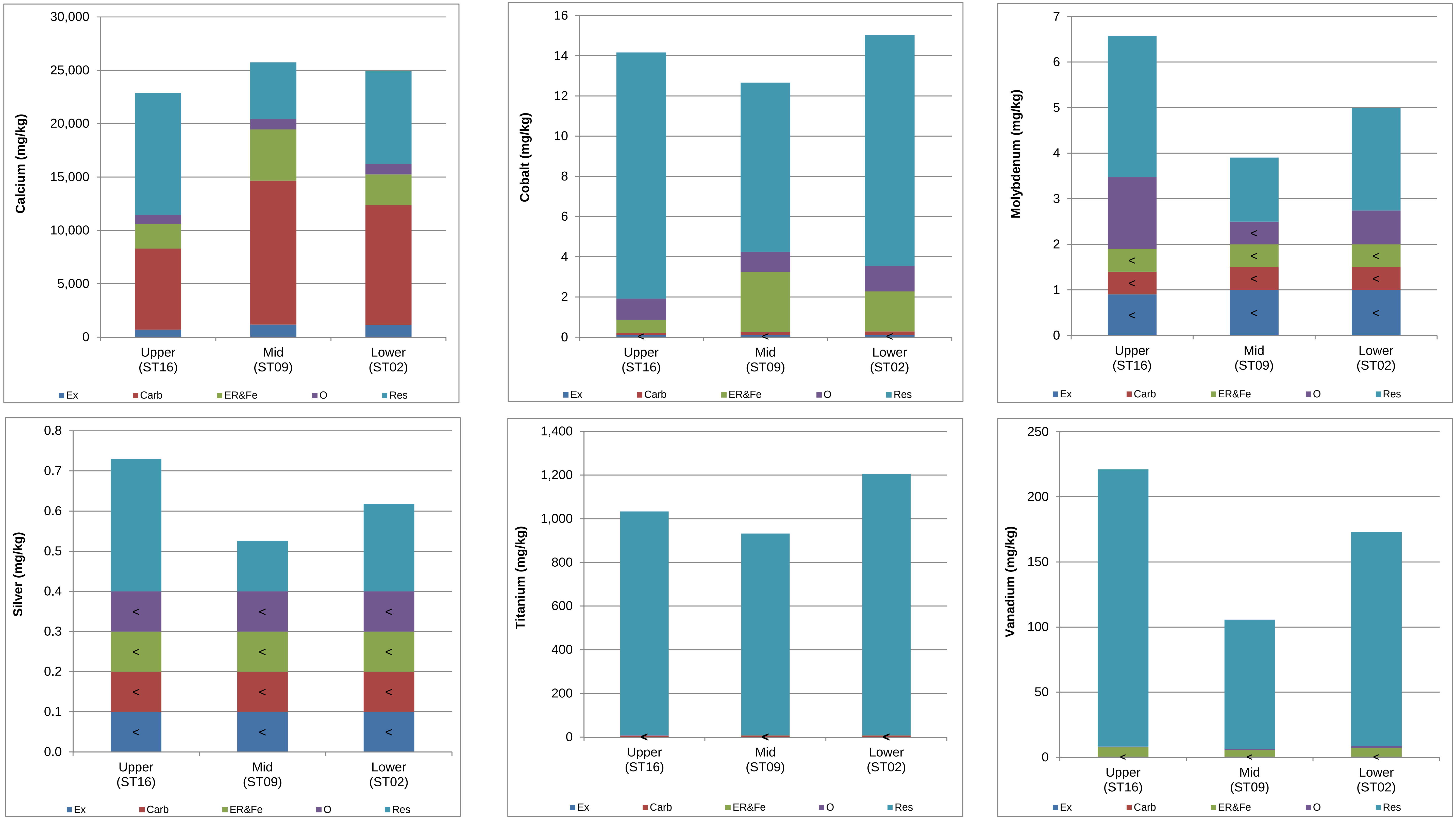


Figure E.5 (a): Mean concentrations of selectively extracted indicator parameters in sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Selective extractions included Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe), Organic Bound Metals (O), and Residual Metals (Res).

Values < MDL are indicated with a < symbol. Data for boron were not available, sodium data were available only for the Ex fraction due to the use of sodium in the second extraction step; sodium was not plotted as a result. Phosphorus data was only available for Ex, Carb, and ER&Fe fractions and was not plotted as a result.

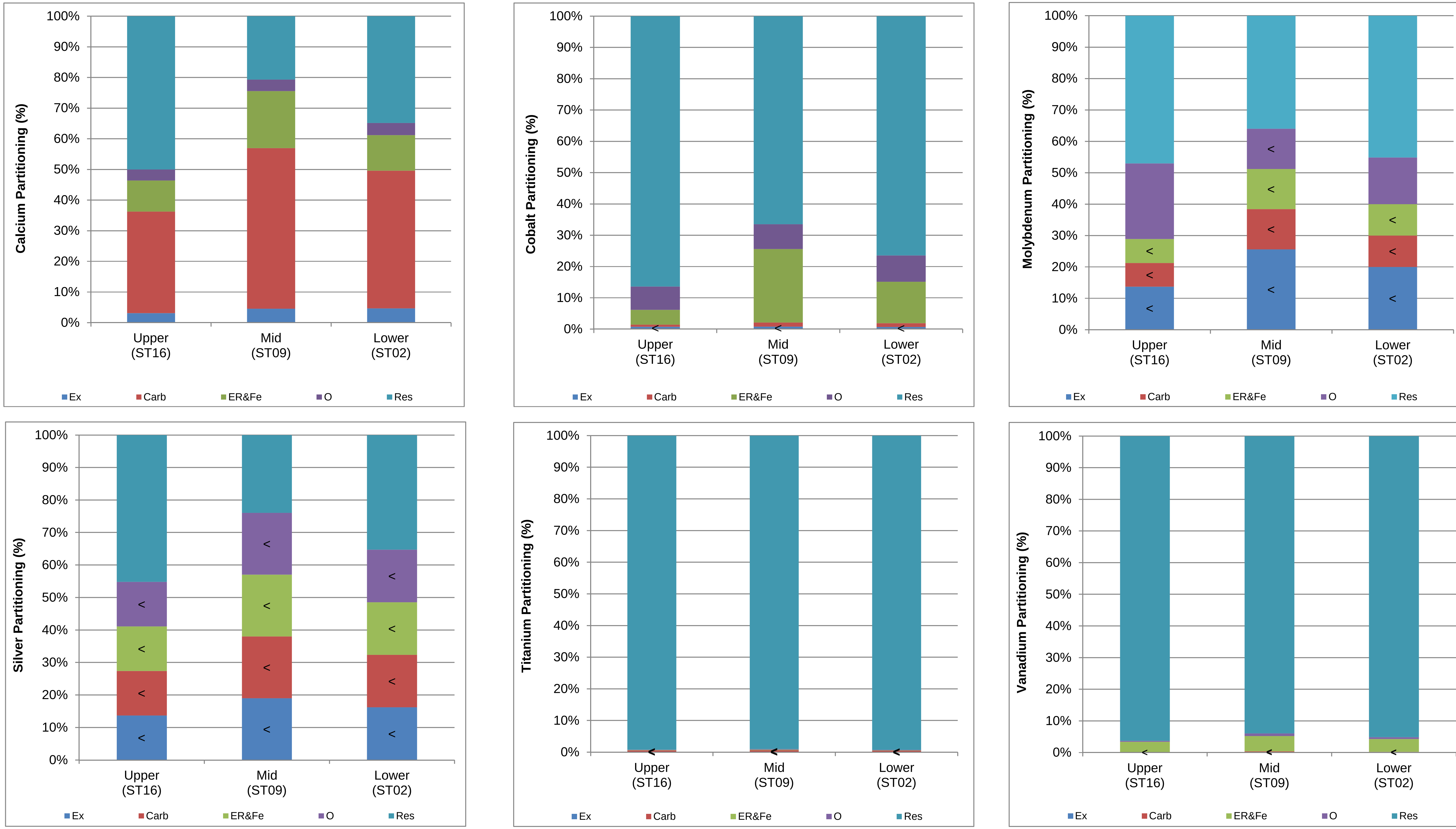


Figure E.5 (b): Partitioning of indicator parameters within selectively extracted fractions of sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Selective extractions included Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe), Organic Bound Metals (O), and Residual Metals (Res).

Values < MDL are indicated with a < symbol. Data for boron were not available, sodium data were available only for the Ex fraction due to the use of sodium in the second extraction step; sodium was not plotted as a result. Phosphorus data was only available for Ex, Carb, and ER&Fe fractions and was not plotted as a result.

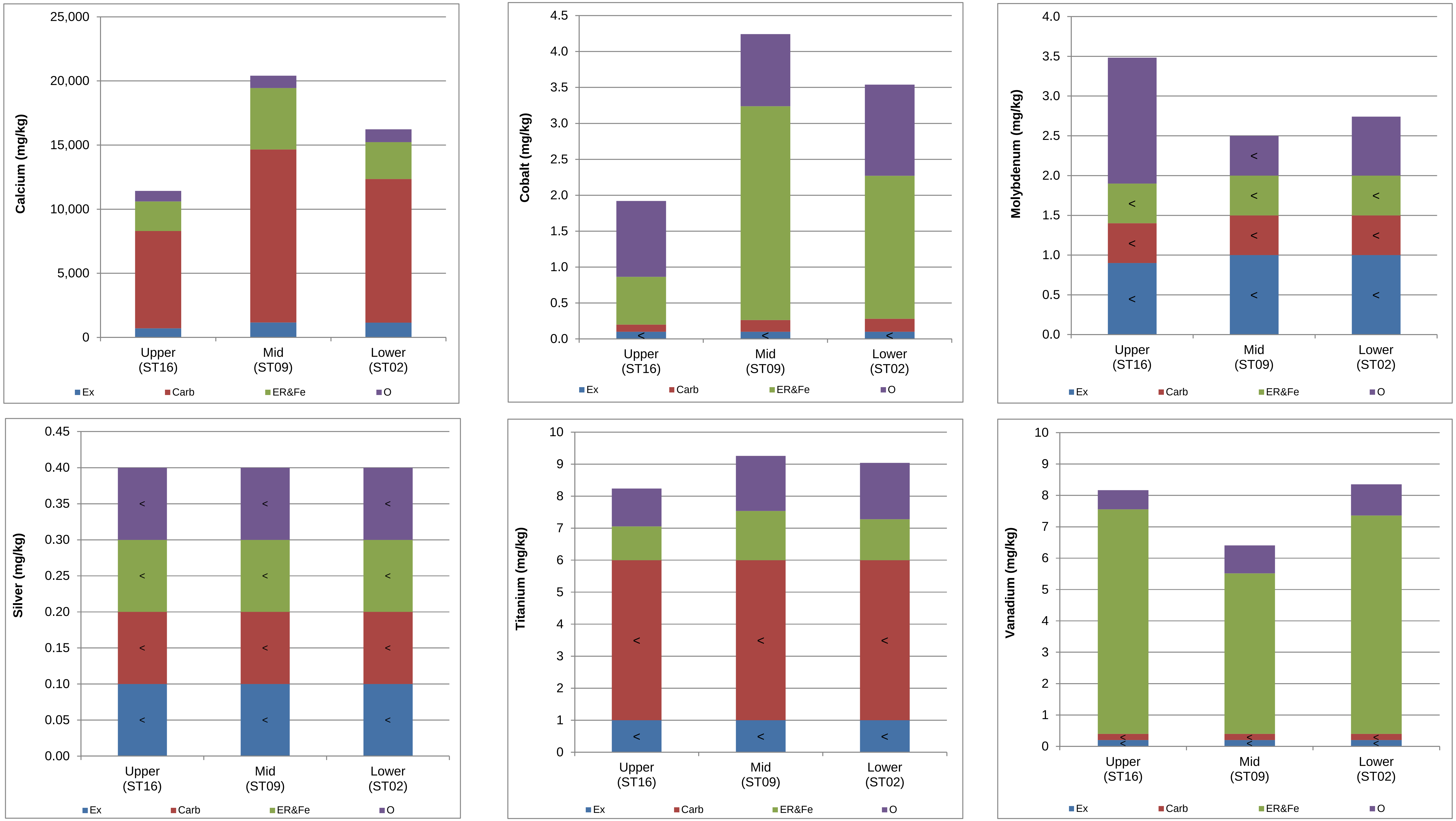


Figure E.5 (c): Mean concentrations of selectively extracted indicator parameters in sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Only metals within the Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe) and Organic Bound Metals (O) fractions are shown (Residual metals are excluded).

Values < MDL are indicated with a < symbol. Data for boron were not available, sodium data were available only for the Ex fraction due to the use of sodium in the second extraction step; sodium was not plotted as a result. Phosphorus data was only available for Ex, Carb, and ER&Fe fractions and was not plotted as a result.

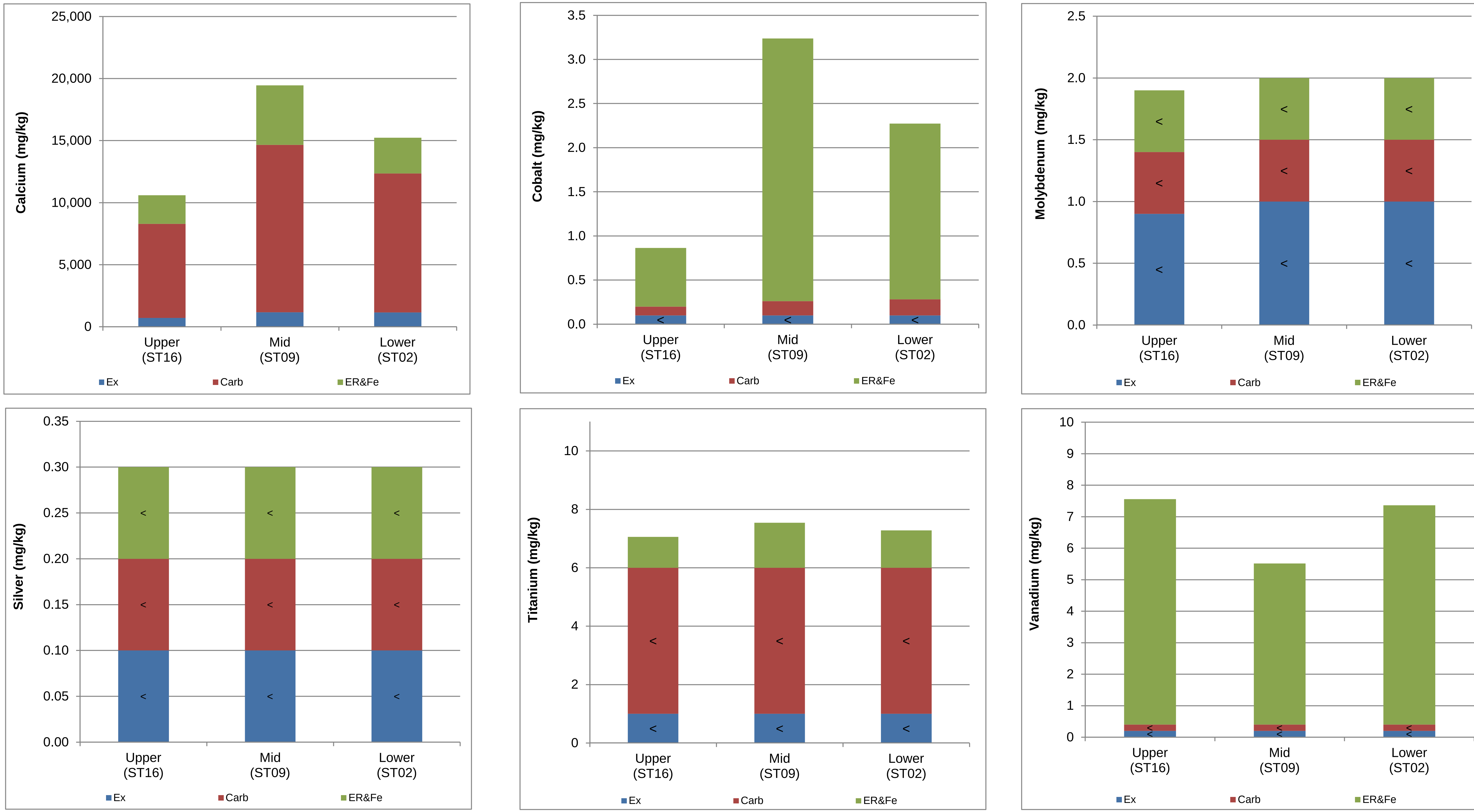


Figure E.5 (d): Mean concentrations of selectively extracted indicator parameters in sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Only metals within the Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe) fractions are shown (Organic Bound and Residual metals are excluded).

Values < MDL are indicated with a < symbol. Data for boron were not available, sodium data were available only for the Ex fraction due to the use of sodium in the second extraction step; sodium was not plotted as a result. Phosphorus data was only available for Ex, Carb, and ER&Fe fractions and was not plotted as a result.

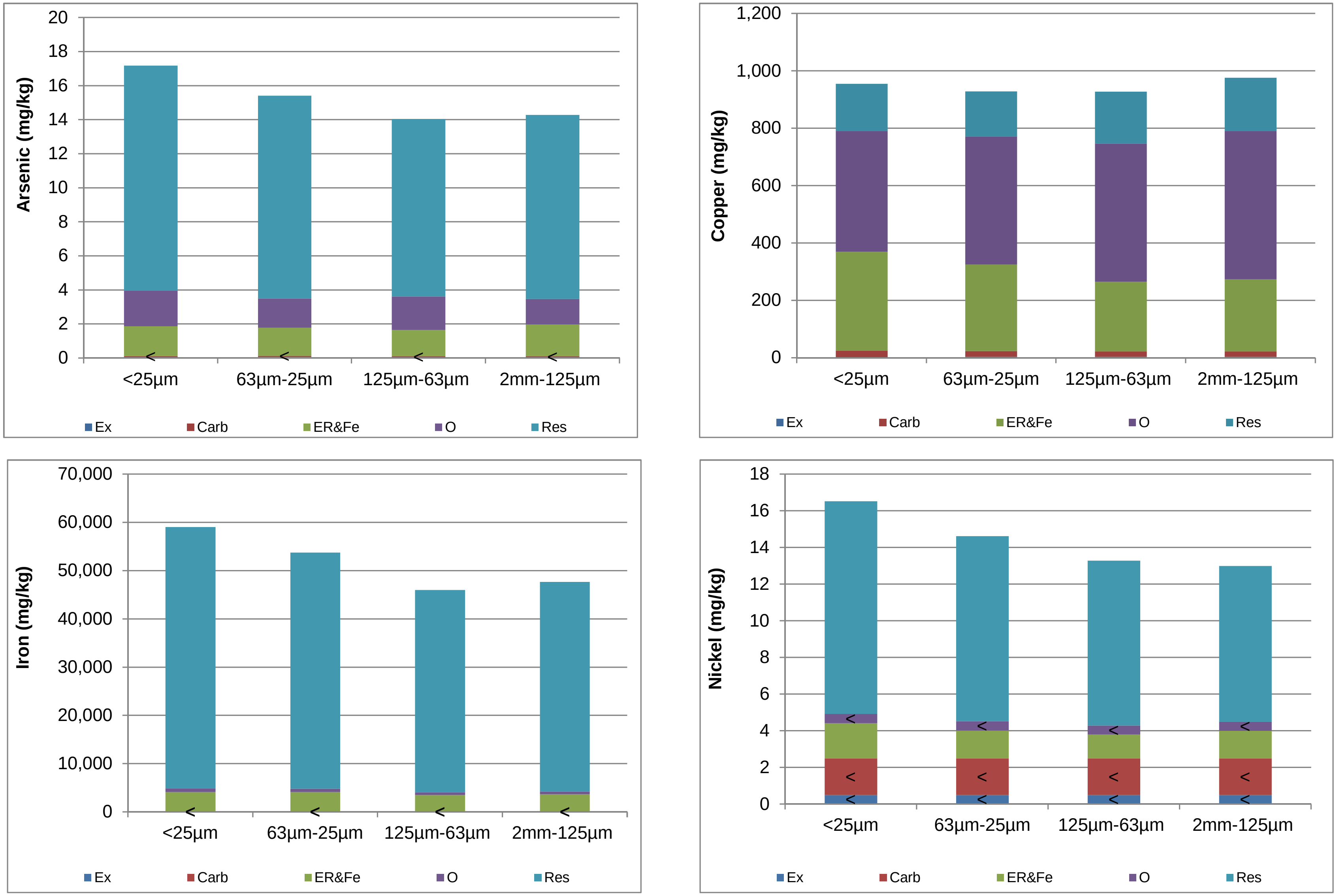


Figure E.6 (a): Mean concentrations of selectively extracted parameters of interest in sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Only metals within the Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe) and Organic Bound Metals (O) fractions are shown (Residual metals are excluded).

Mean values < MDL are indicated with a < symbol. Means are reported as < MDL if all data used in their calculation were < MDL.

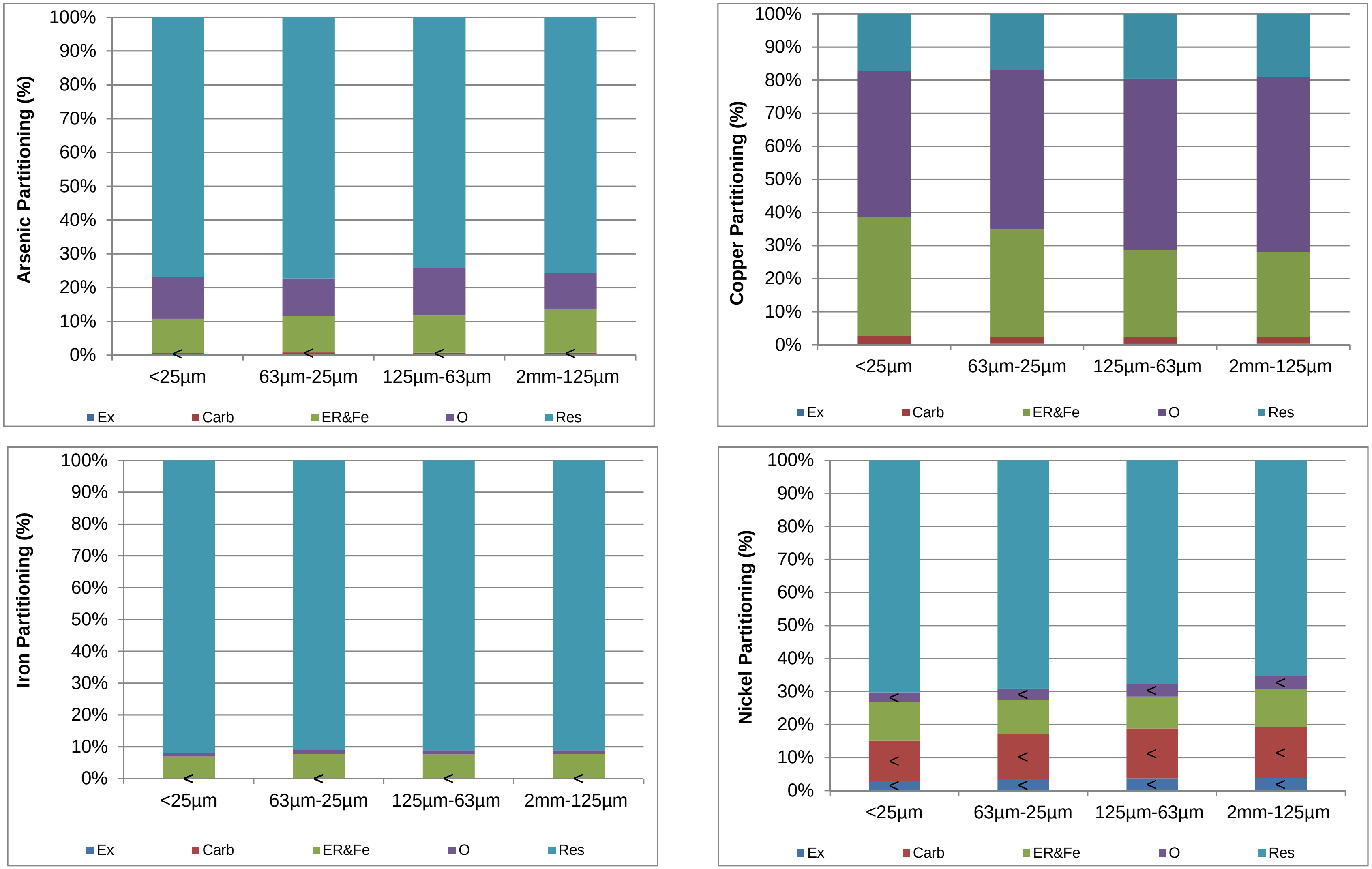


Figure E.6 (b): Partitioning of selectively extracted parameters of interest in sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Selective extractions included Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe), Organic Bound Metals (O), and Residual Metals (Res).

Mean values < MDL are indicated with a < symbol. Means are reported as < MDL if all data used in their calculation were < MDL.

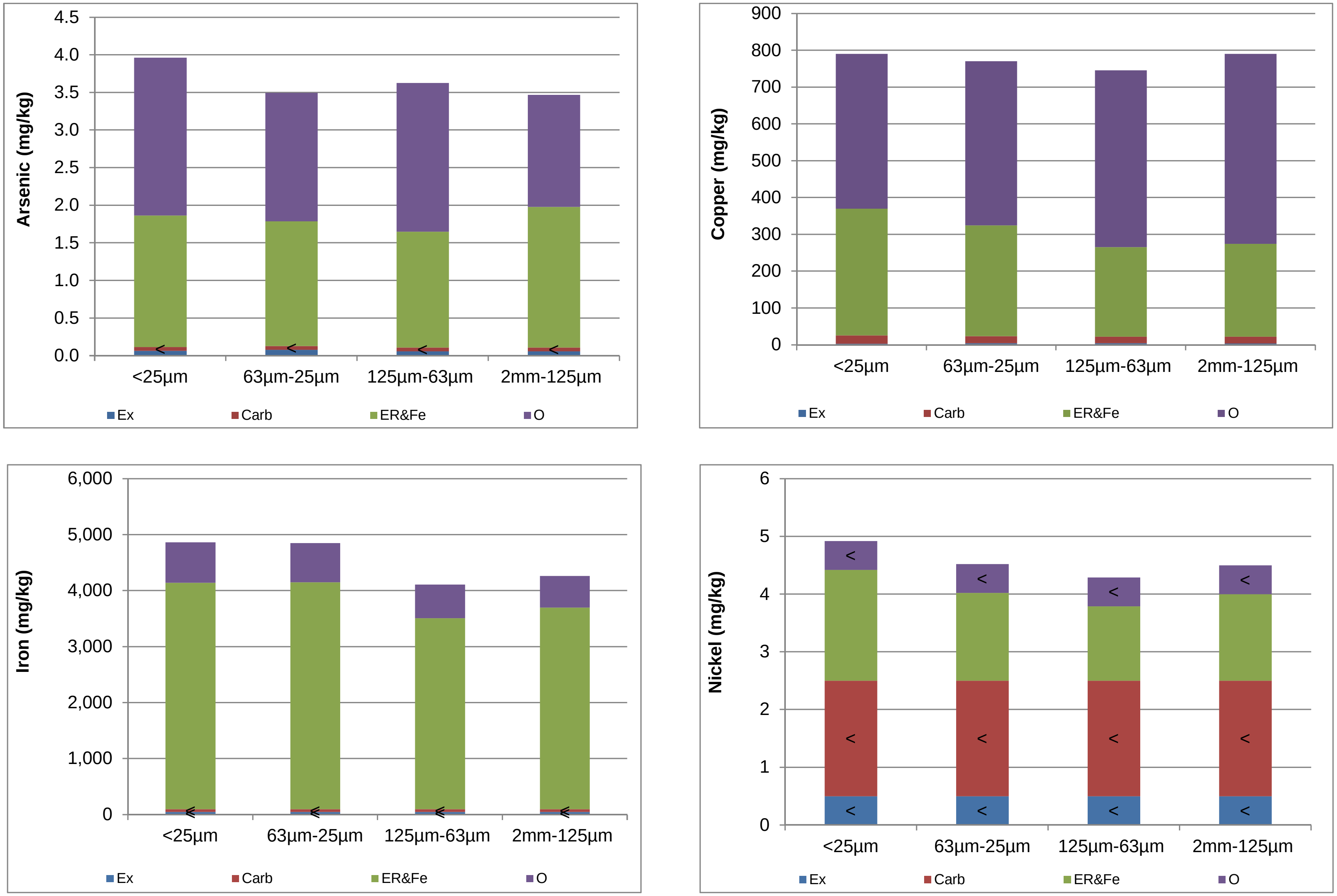


Figure E.6 (c): Mean concentrations of selectively extracted parameters of interest in sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Only metals within the Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe) and Organic Bound Metals (O) fractions are shown (Residual metals are excluded).

Mean values < MDL are indicated with a < symbol. Means are reported as < MDL if all data used in their calculation were < MDL.

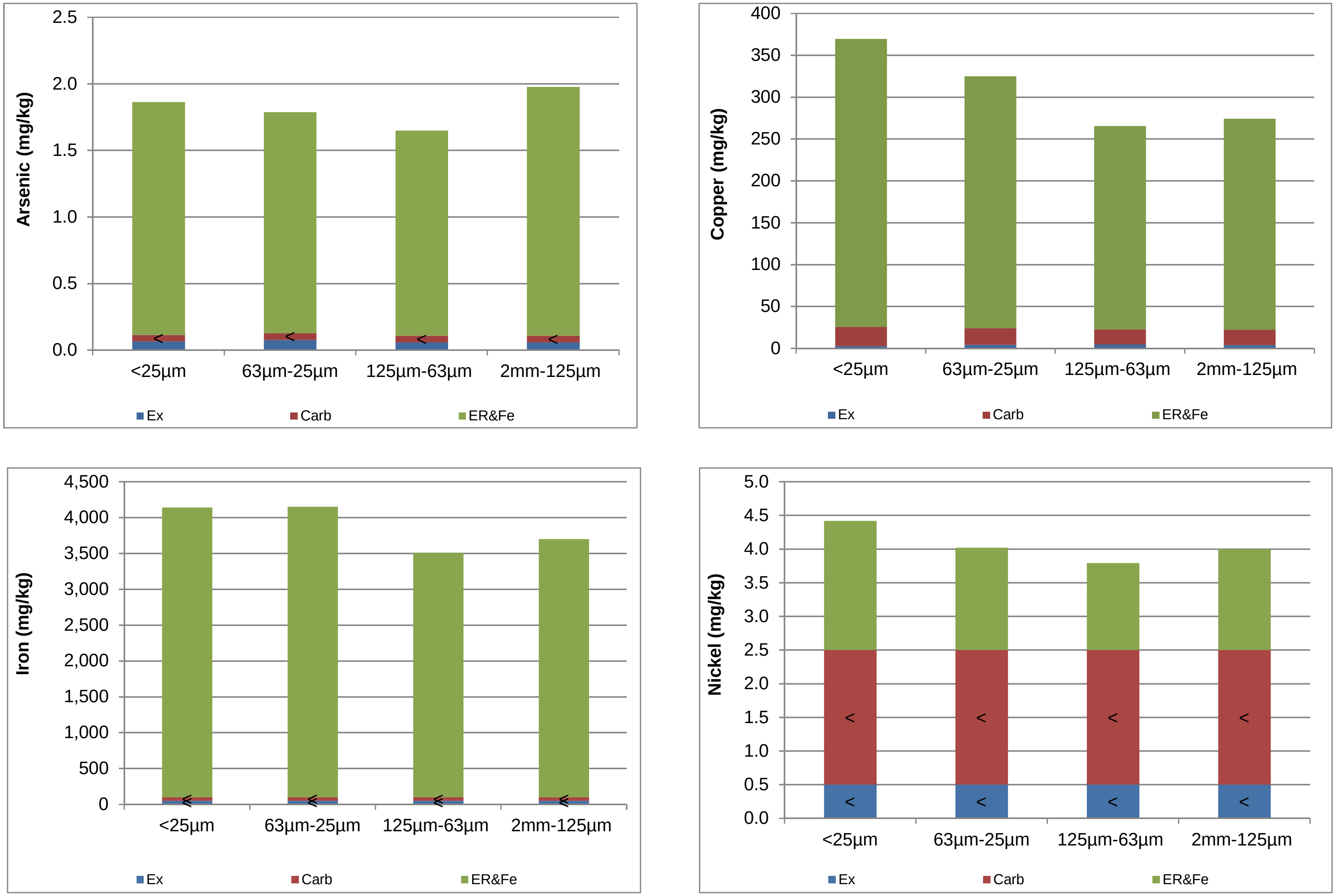


Figure E.6 (d): Mean concentrations of selectively extracted parameters of interest in sediment from Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Only metals within the Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe) fractions are shown (Organic Bound and Residual metals are excluded).

Mean values < MDL are indicated with a < symbol. Means are reported as < MDL if all data used in their calculation were < MDL.

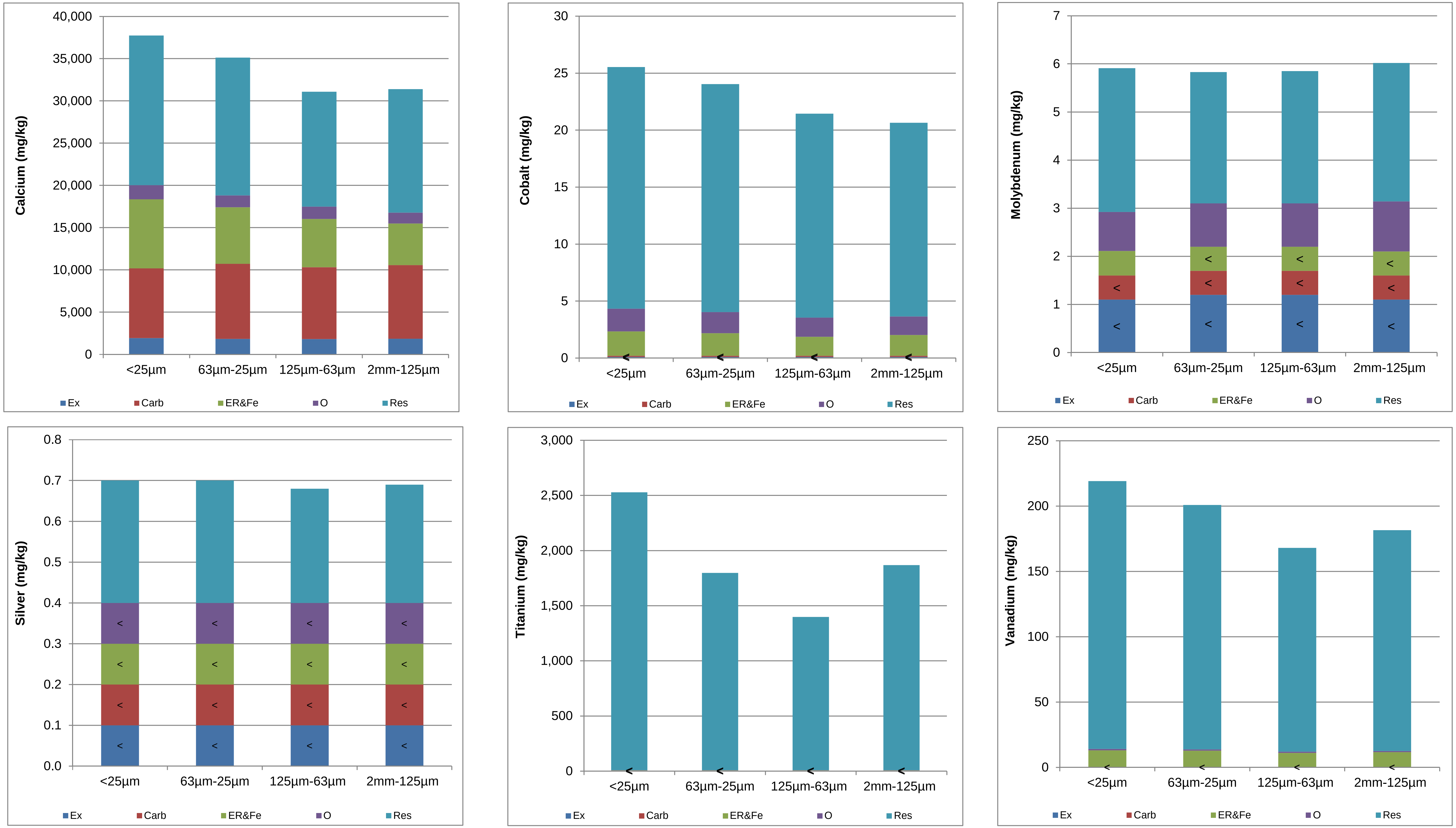


Figure E.7 (a): Concentrations of selectively extracted indicator parameters in Hazeltine Creek size-fractioned sediment HAC50, Mount Polley Mine, 2014. Selective extractions included Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe), Organic Bound Metals (O), and Residual Metals (Res).

Values < MDL are indicated with a < symbol. Data for boron were not available, sodium data were available only for the Ex fraction due to the use of sodium in the second extraction step; sodium was not plotted as a result. Phosphorus data was only available for Ex, Carb, and ER&Fe fractions and was not plotted as a result.

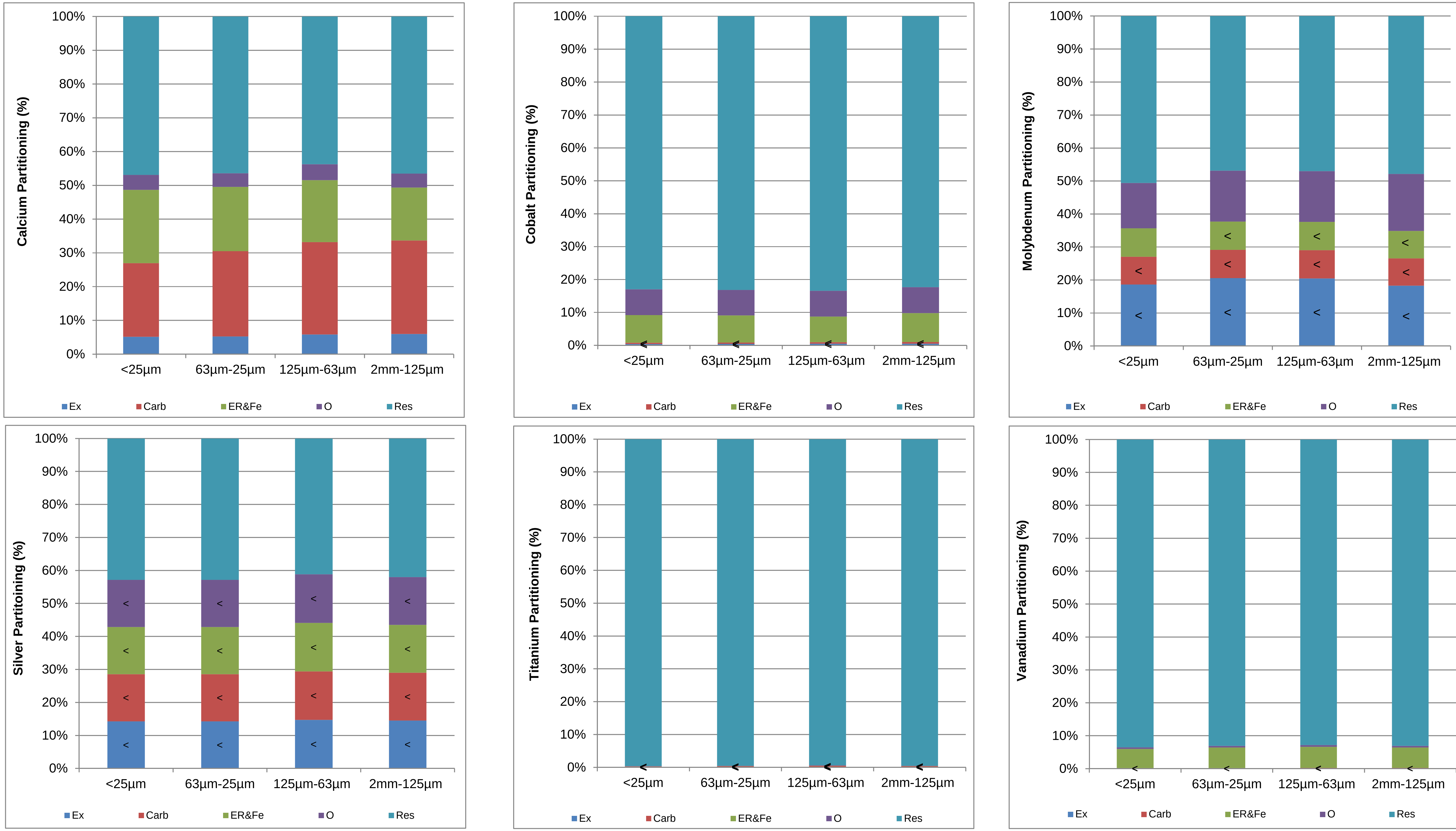


Figure E.7 (b): Partitioning of indicator parameters in Hazeltine Creek size-fractioned sediment sample HAC50, Mount Polley Mine, 2014. Selective extractions included Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe), Organic Bound Metals (O), and Residual Metals (Res).

Values < MDL are indicated with a < symbol. Data for boron were not available, sodium data were available only for the Ex fraction due to the use of sodium in the second extraction step; sodium was not plotted as a result. Phosphorus data was only available for Ex, Carb, and ER&Fe fractions and was not plotted as a result.

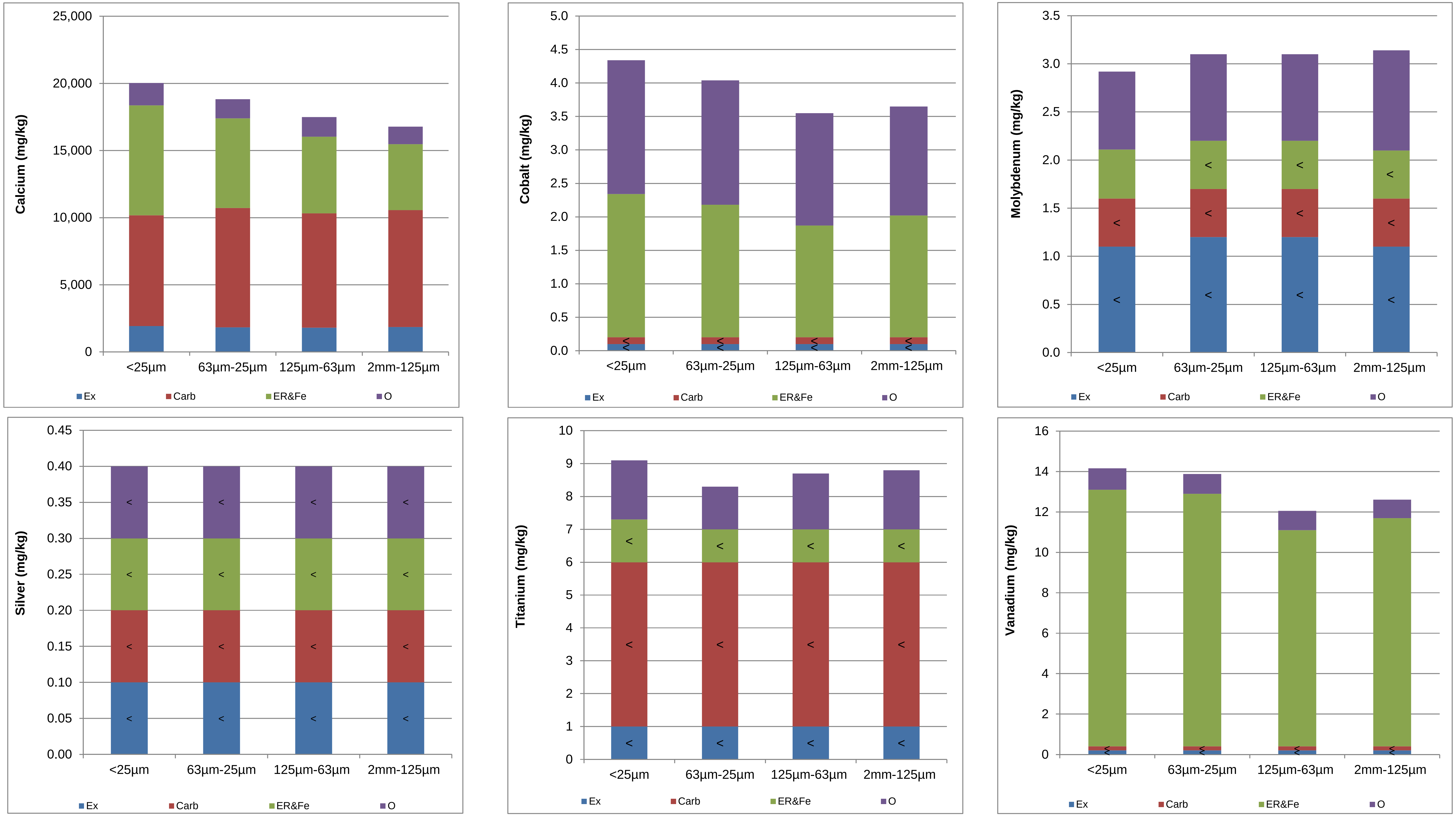


Figure E.7 (c): Concentrations of selectively extracted indicator parameters in Hazeltine Creek size-fractioned sediment sample HAC50, Mount Polley Mine, 2014. Only metals within the Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe) and Organic Bound Metals (O) fractions are shown (Residual metals are excluded).

Values < MDL are indicated with a < symbol. Data for boron were not available, sodium data were available only for the Ex fraction due to the use of sodium in the second extraction step; sodium was not plotted as a result. Phosphorus data was only available for Ex, Carb, and ER&Fe fractions and was not plotted as a result.

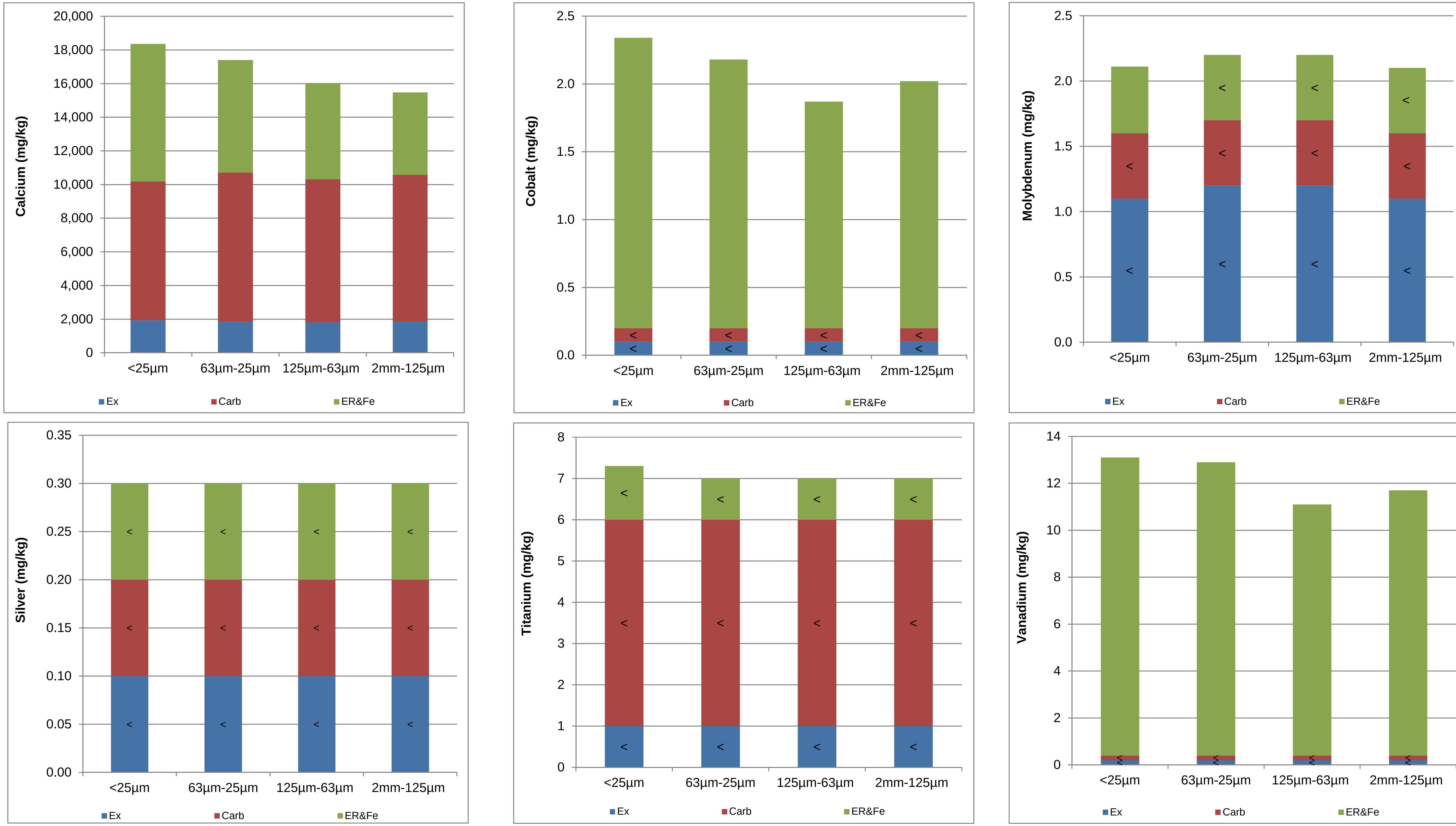


Figure E.7 (d): Concentrations of selectively extracted indicator parameters in Hazeltine Creek size-fractioned sediment sample HAC50, Mount Polley Mine, 2014. Only metals within the Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe) fractions are shown (Organic Bound and Residual metals are excluded).

Values < MDL are indicated with a < symbol. Data for boron were not available, sodium data were available only for the Ex fraction due to the use of sodium in the second extraction step; sodium was not plotted as a result. Phosphorus data was only available for Ex, Carb, and ER&Fe fractions and was not plotted as a result.

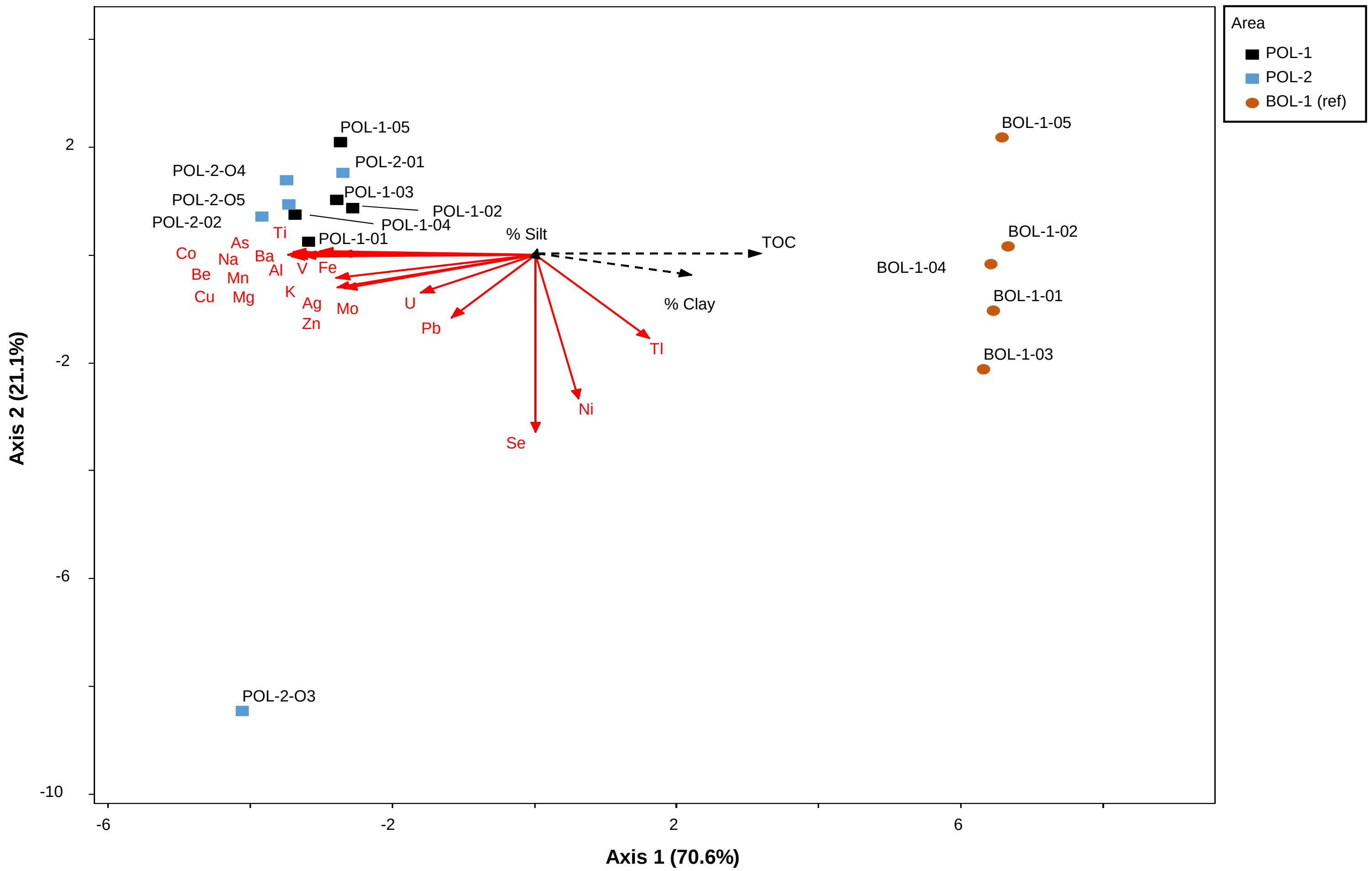


Figure E.8: Biplot of principal component analysis (PCA) of metal concentrations in sediment (<63 µm fraction) from Polley and Bootjack Lake mid-depth sampling stations, Mount Polley Mine, 2014. Vector length is proportional to the magnitude of direct correlation of metals (solid red vector lines) and indirect correlation of sediment physical characteristics (black dashed vector lines) with PCA values of each axis (Appendix Tables E.27-E.28). Only metals with significant (p-value <0.010) Spearman's correlation and r-values > 0.7 with either axis are displayed, all sediment physical characteristics are displayed.

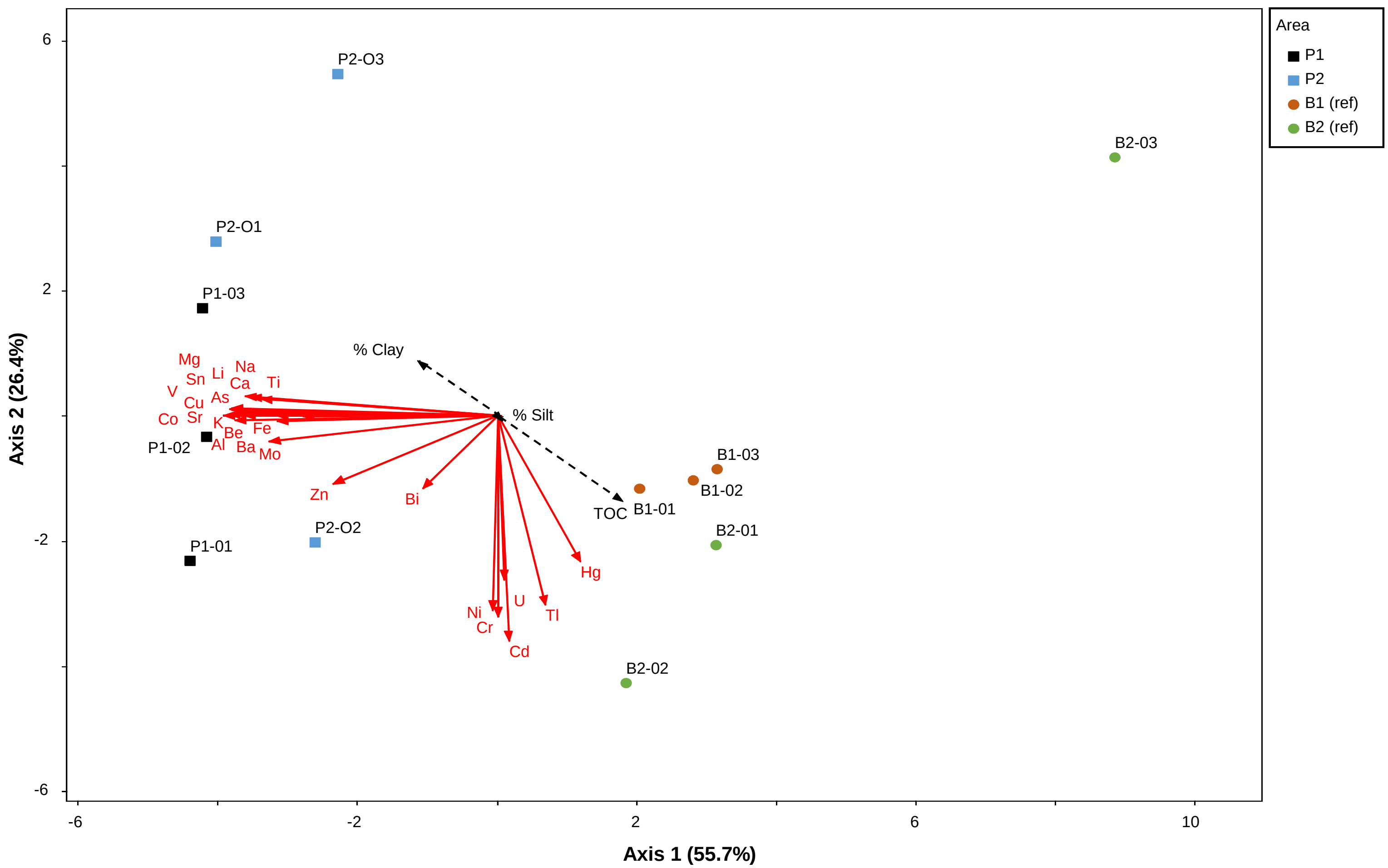


Figure E.9: **Biplot of principal component analysis (PCA) of metal concentrations in sediment (<63 µm fraction) from Polley and Bootjack Lake deep sampling stations, Mount Polley Mine, 2014. Vector length is proportional to the magnitude of direct correlation of metals (solid red vector lines) and indirect correlation of sediment physical characteristics (black dashed vector lines) with PCA values of each axis (Appendix Tables E.29-E.30). Only metals with significant (p-value <0.010) Spearman's correlation and r-values > 0.7 with either axis are displayed, all sediment physical characteristics are displayed**

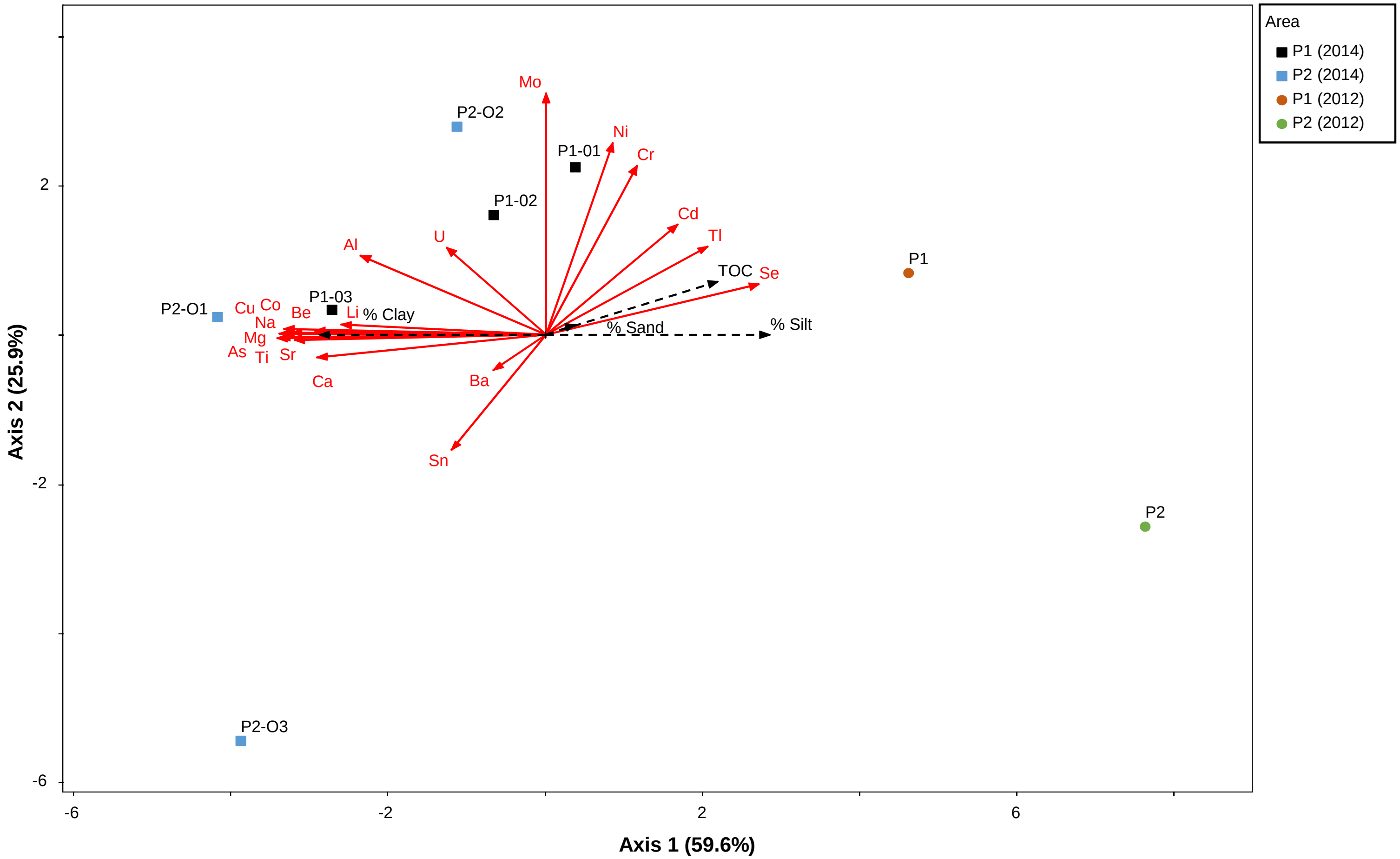


Figure E.10: Biplot of principal component analysis (PCA) of metal concentrations in sediment from Polley Lake deep sampling stations in 2014 (<2mm fraction) and in 2012 (bulk sediment), Mount Polley Mine, 2014. Vector length is proportional to the magnitude of direct correlation of metals (solid red vector lines) and indirect correlation of sediment physical characteristics (black dashed vector lines) with PCA values of each axis (Appendix Tables E.31-E.32). Only metals with significant (p-value <0.010) Spearman's correlation and r-values > 0.7 with either axis are displayed, all sediment physical characteristics are displayed [a]

[a] Bismuth, boron, and mercury were excluded from calculations due to a lack of variability in the data (all values for each analyte were the same), or an incomplete data set among years.

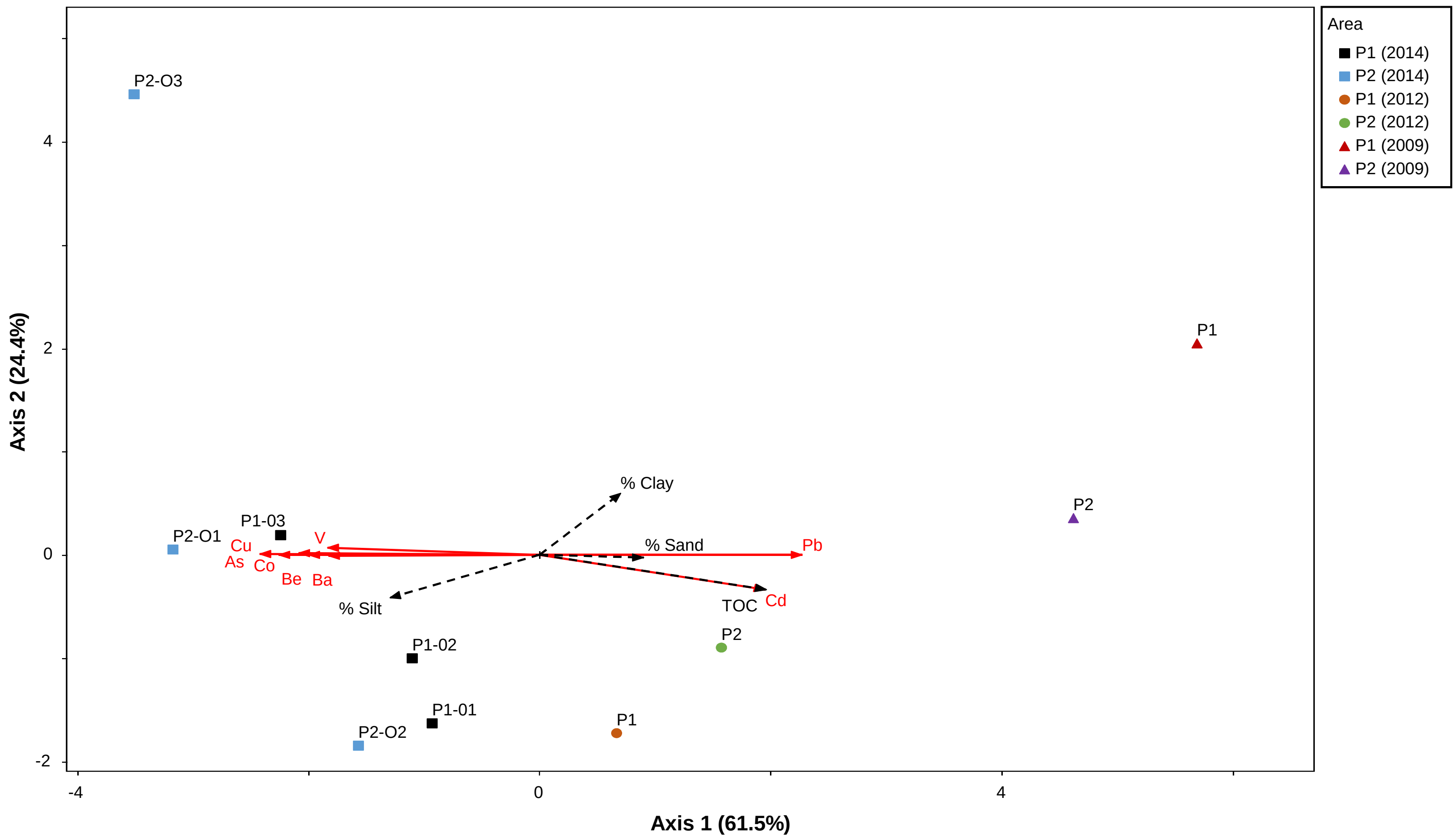


Figure E.11: Biplot of principal component analysis (PCA) of metal concentrations in sediment from Polley Lake deep sampling stations in 2014 (<2mm fraction) and in 2012 and in 2009 (bulk sediment), Mount Polley Mine, 2014. Vector length is proportional to the magnitude of direct correlation of metals (solid red vector lines) and indirect correlation of sediment physical characteristics (black dashed vector lines) with PCA values of each axis (Appendix Tables E.33-E.34). Only metals with significant (p-value <0.010) Spearman's correlation and r-values > 0.7 with either axis are displayed, all sediment physical characteristics are displayed [a].

[a] Aluminum, bismuth, boron, calcium, iron, lithium, mercury, magnesium, manganese, phosphorus, potassium, sodium, strontium, thallium, titanium, and uranium were excluded from calculations due to a lack of variability in the data (all values for each analyte were the same), or an incomplete data set among years.

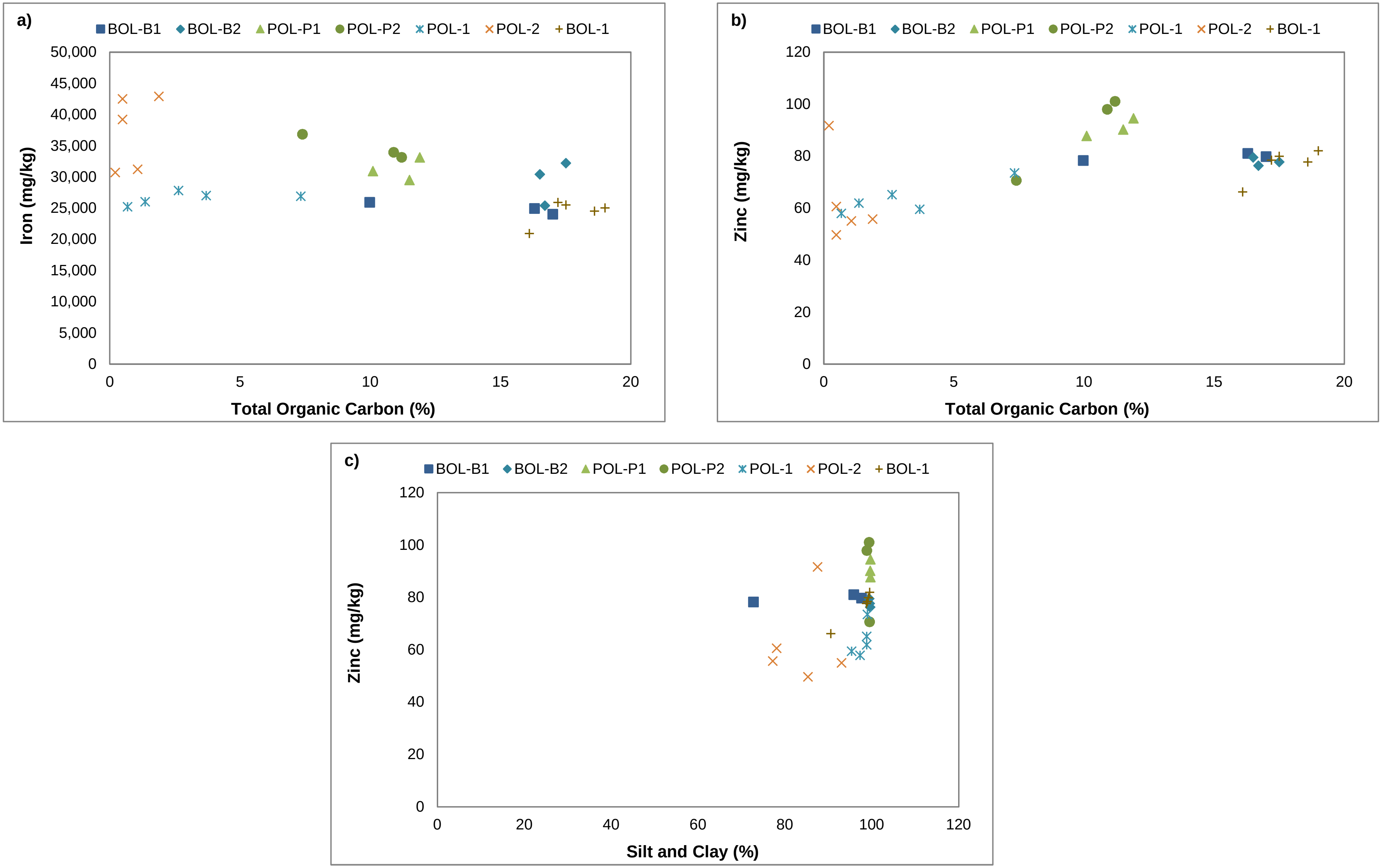


Figure E.12: Scatterplots of Spearman's correlation relationships ($p < 0.01$) between total organic carbon (%) or silt and clay (%) and parameters of interest, Mount Polley Study 2014. Polley and Bootjack Lake mid-depth and basin sampling areas.

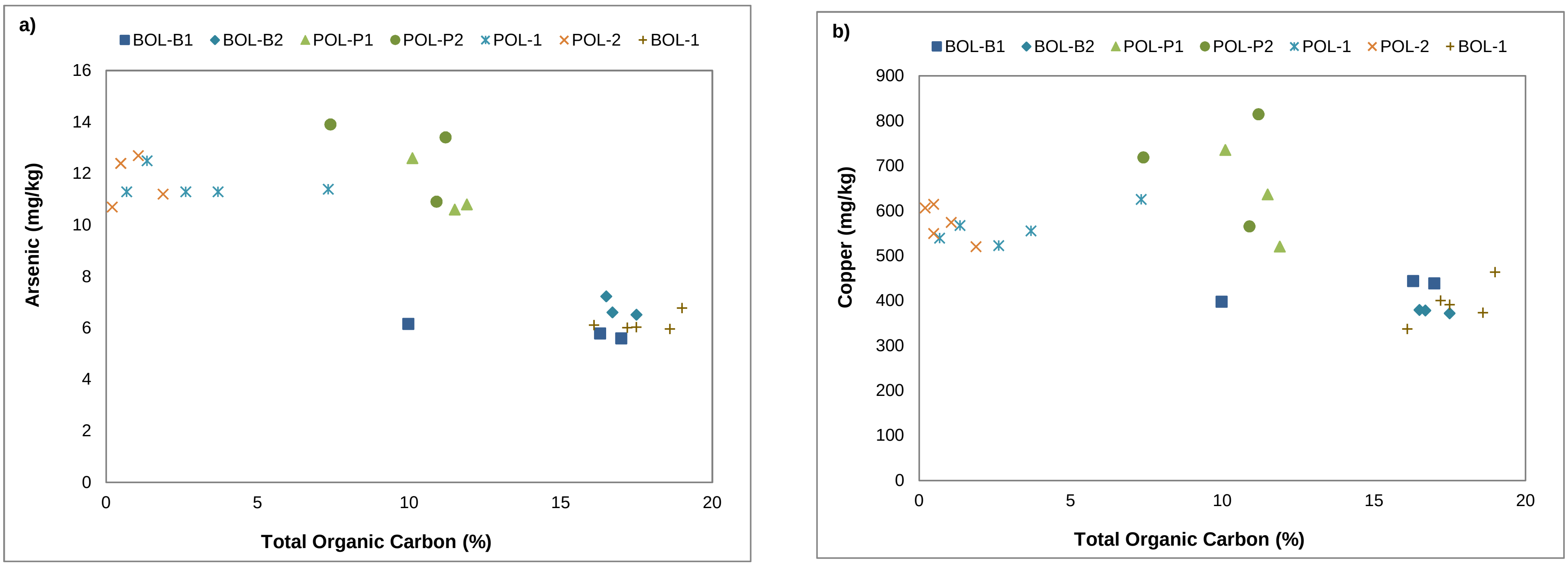


Figure E.13: Scatterplots of significant Spearman's correlation relationships (p<0.003) between total organic carbon (%) and parameters of interest, Polley and Bootjack Lake mid-depth and basin sampling areas, Mount Polley Mine, 2014.

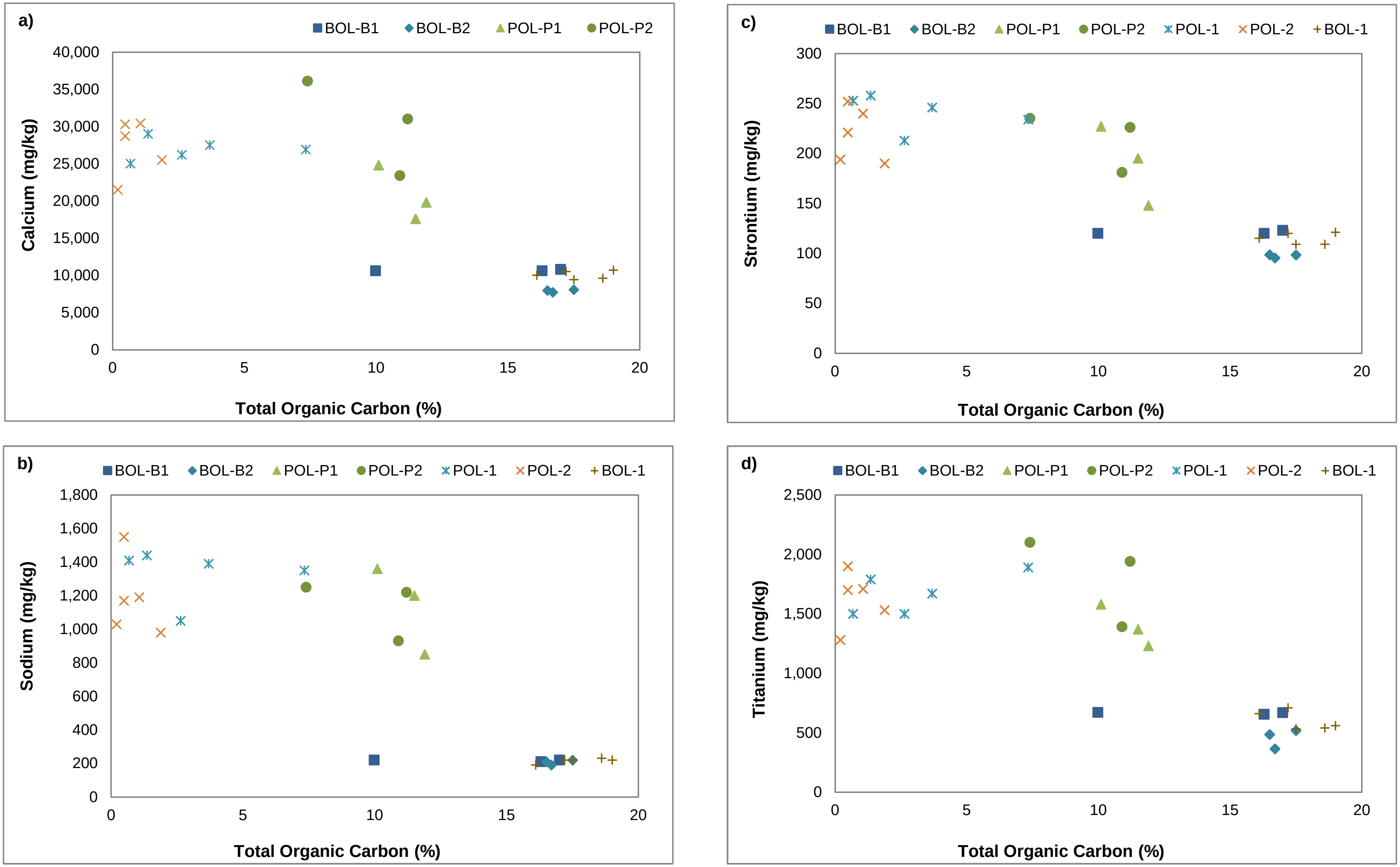


Figure E.14: Scatterplots of significant Spearman's correlation relationships ($p < 0.003$) between total organic carbon (%) and indicator parameters, Polley and Bootjack Lake mid-depth and basin sampling areas, Mount Polley Mine, 2014.

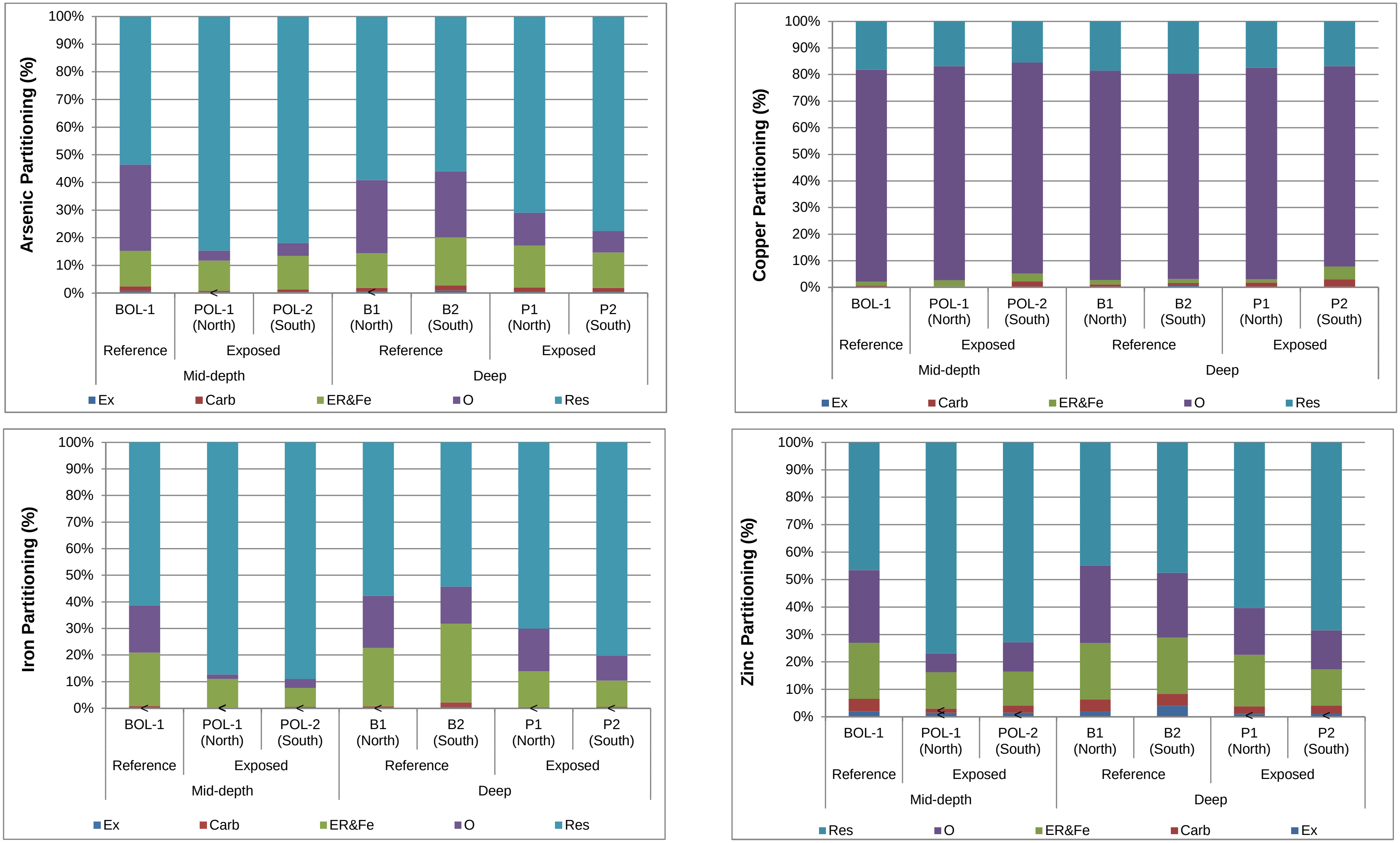


Figure E.15 (a): Partitioning of selectively extracted parameters of interest in sediment from mid-depth and deep sampling areas of Polley Lake, Mount Polley Mine, 2014. Selective extractions included Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe), Organic Bound Metals (O), and Residual Metals (Res).

Mean values < MDL are indicated with a < symbol. Means are reported as < MDL if all data used in their calculation were < MDL.

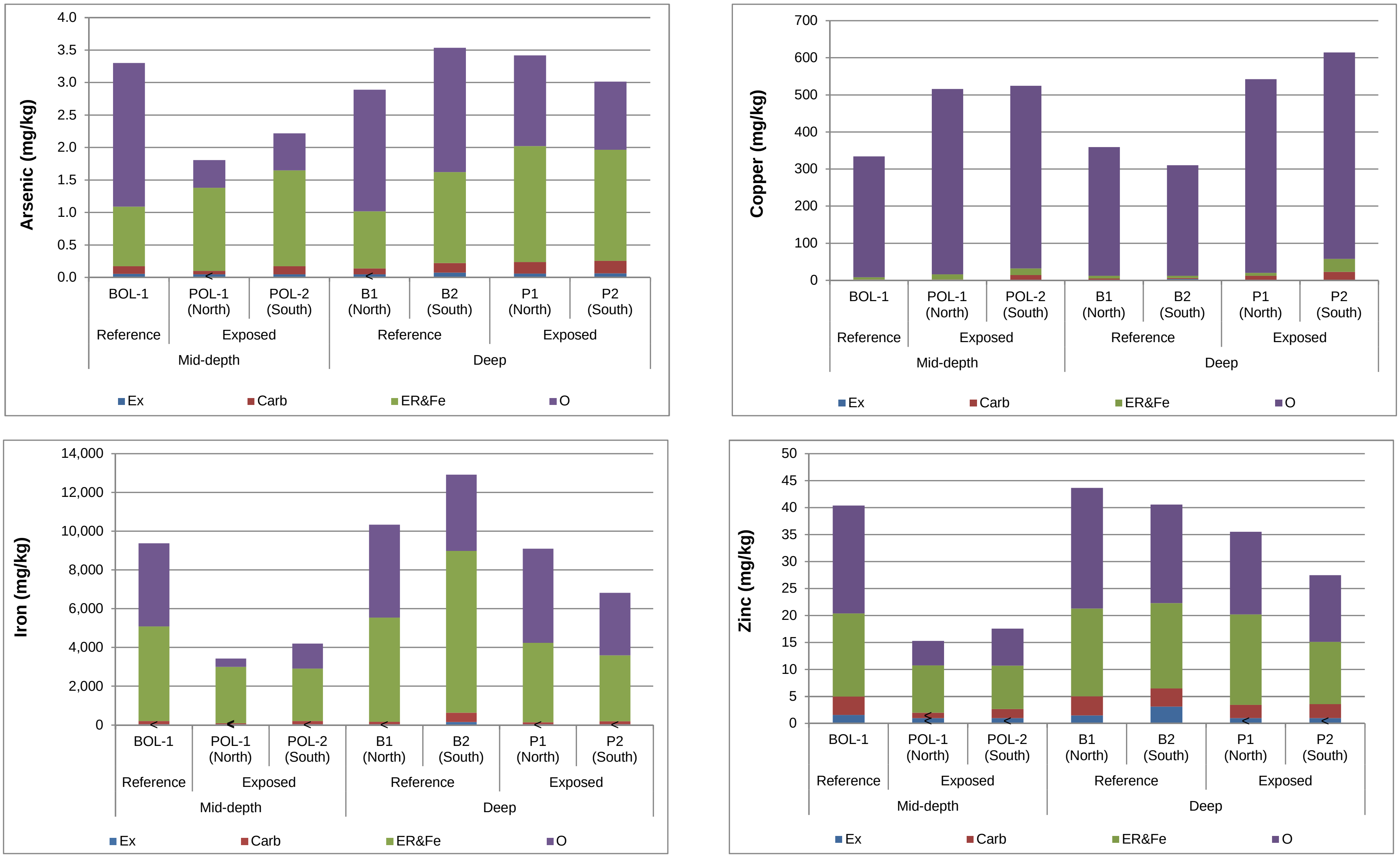


Figure E.15 (b): Mean concentrations of selectively extracted parameters of interest in sediment from mid-depth and deep sampling areas of Polley Lake, Mount Polley Mine, 2014. Only metals within the Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe) and Organic Bound Metals (O) fractions are shown (Residual metals are excluded).

Mean values < MDL are indicated with a < symbol. Means are reported as < MDL if all data used in their calculation were < MDL.

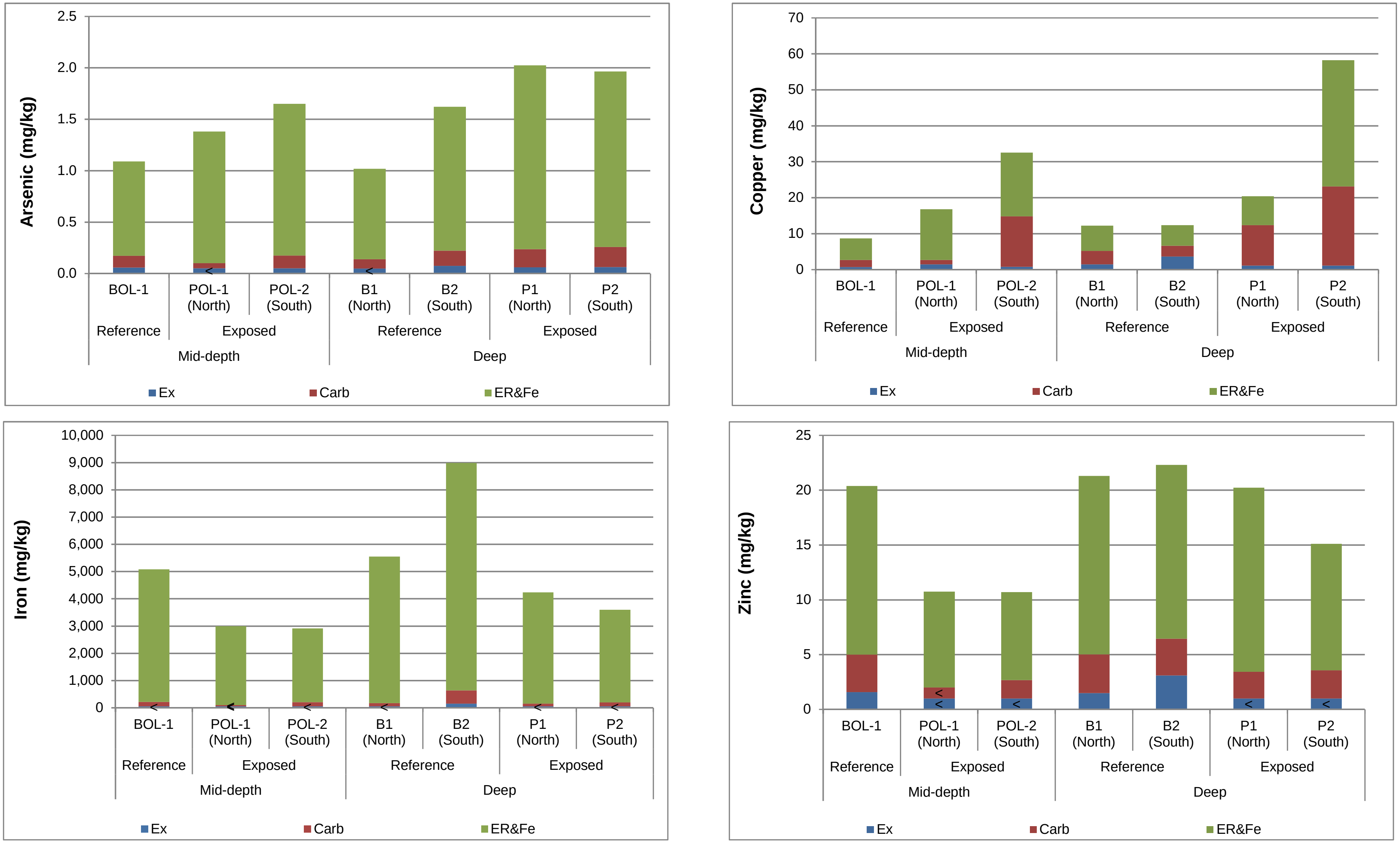


Figure E.15 (c): Mean concentrations of selectively extracted parameters of interest in sediment from mid-depth and deep sampling areas of Polley Lake, Mount Polley Mine, 2014. Only metals within the Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe) fractions are shown (Organic Bound and Residual metals are excluded).

Mean values < MDL are indicated with a < symbol. Means are reported as < MDL if all data used in their calculation were < MDL.

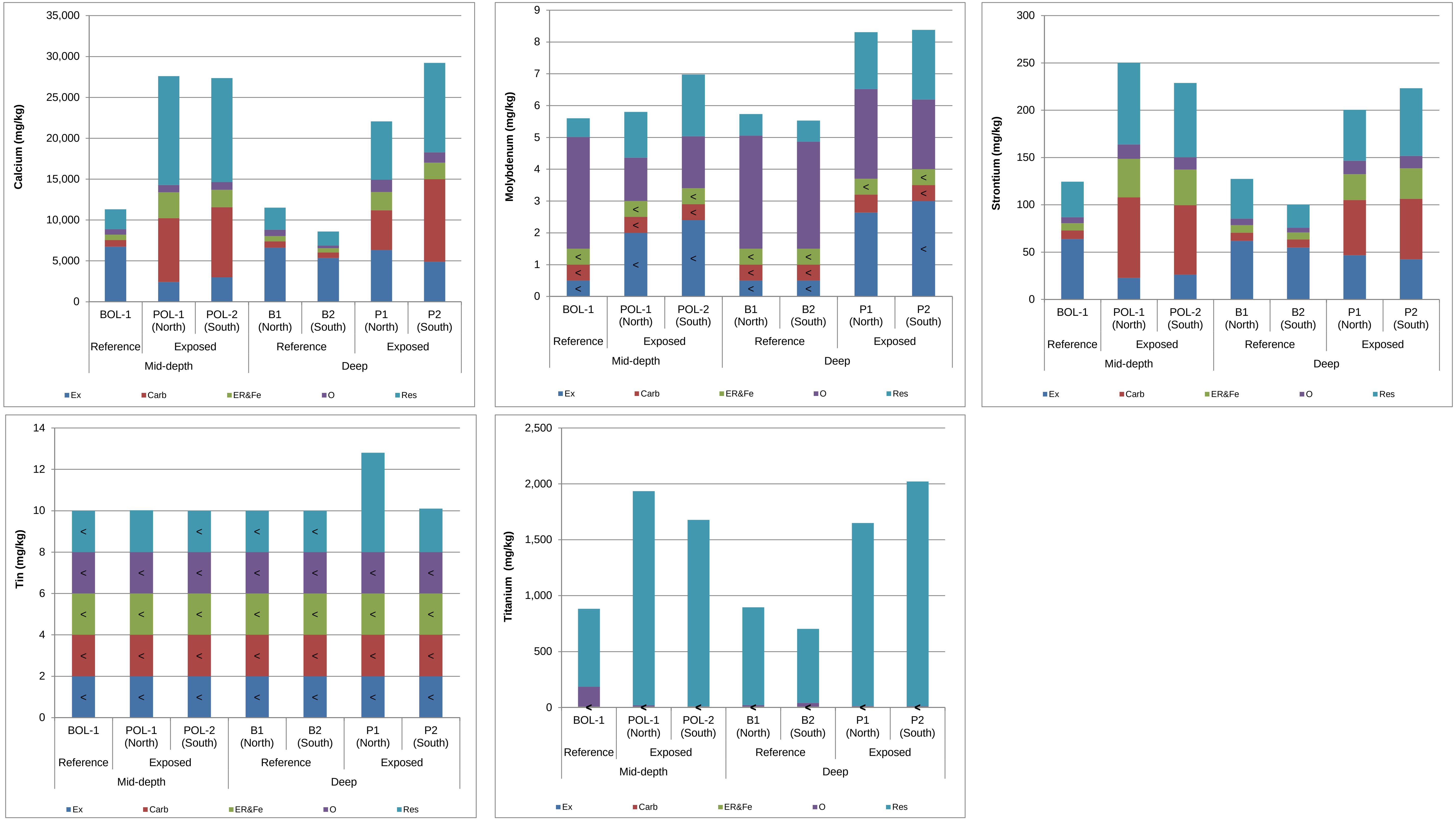


Figure E.16 (a): Mean concentrations of selectively extracted indicator parameters in sediment from mid-depth and deep sampling areas of Polley Lake, Mount Polley Mine, 2014. Selective extractions included Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe), Organic Bound Metals (O), and Residual Metals (Res).

Mean values < MDL are indicated with a < symbol. Means are reported as < MDL if all data used in their calculation were < MDL. Sodium data were available only for the Exchangeable & Adsorbed Metals fraction due to the use of sodium in the second extraction step; sodium was not plotted as a result.

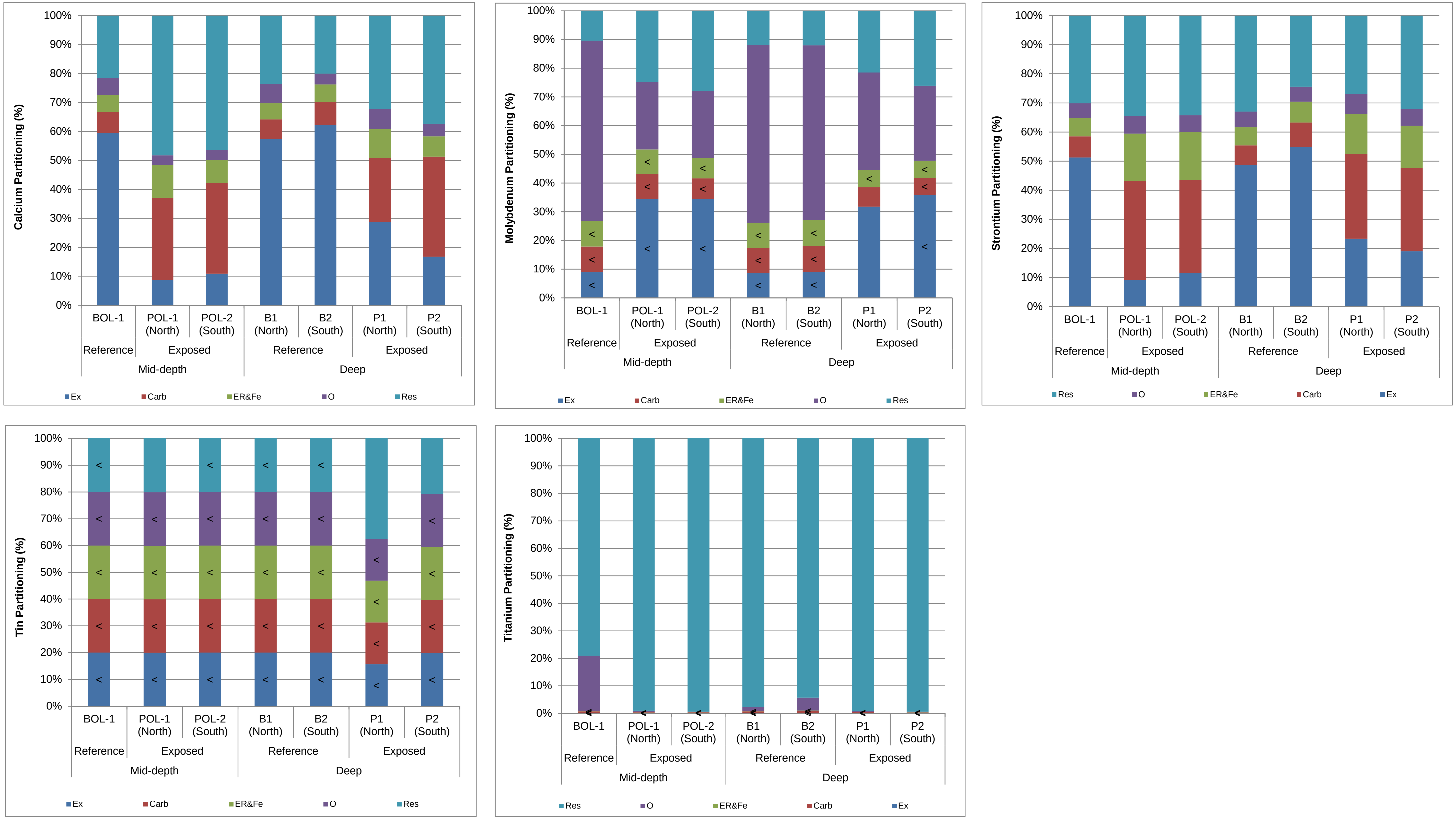


Figure E.16 (b): Partitioning of selectively extracted indicator parameters in sediment from mid-depth and deep sampling areas of Polley Lake, Mount Polley Mine, 2014. Selective extractions included Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe), Organic Bound Metals (O), and Residual Metals (Res).

Mean values < MDL are indicated with a < symbol. Means are reported as < MDL if all data used in their calculation were < MDL. Sodium data were available only for the Exchangeable & Adsorbed Metals fraction due to the use of sodium in the second extraction step; sodium was not plotted as a result.

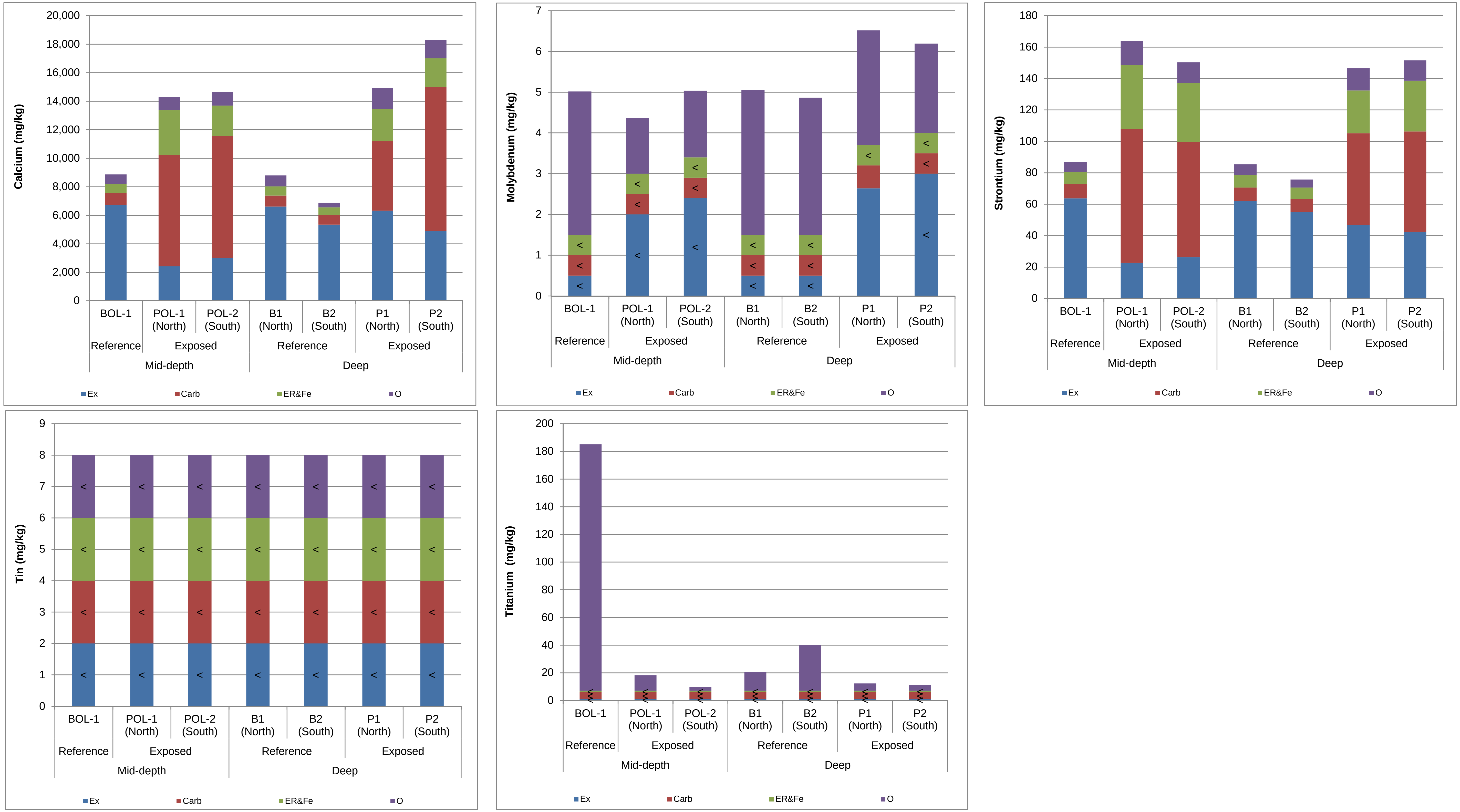


Figure E.16 (c): Mean concentrations of selectively extracted indicator parameters in sediment from mid-depth and deep sampling areas of Polley Lake, Mount Polley Mine, 2014. Only metals within the Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe) and Organic Bound Metals (O) fractions are shown (Residual metals are excluded).

Mean values < MDL are indicated with a < symbol. Means are reported as < MDL if all data used in their calculation were < MDL. Sodium data were available only for the Exchangeable & Adsorbed Metals fraction due to the use of sodium in the second extraction step; sodium was not plotted as a result.

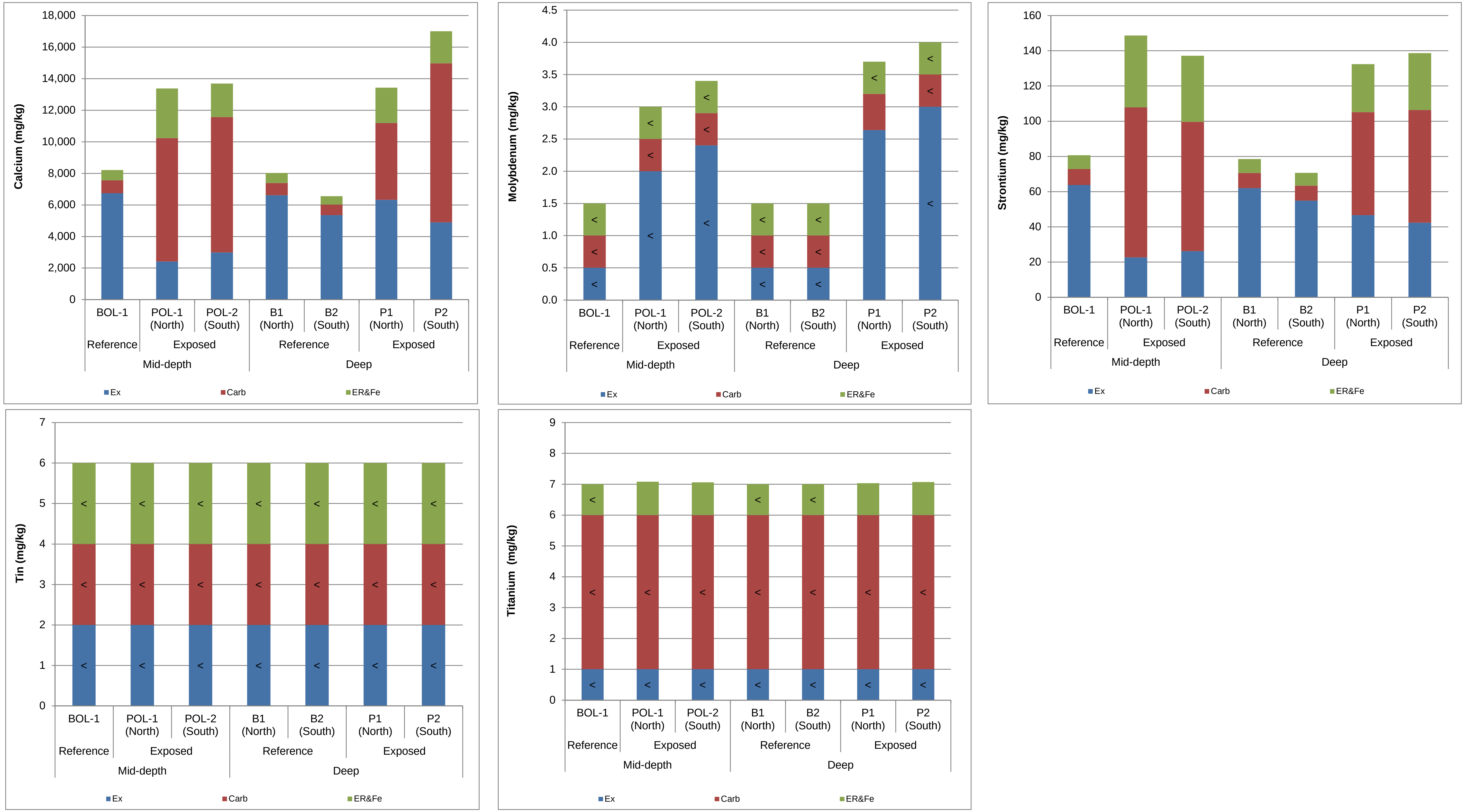


Figure E.16 (d): Mean concentrations of selectively extracted indicator parameters in sediment from mid-depth and deep sampling areas of Polley Lake, Mount Polley Mine, 2014. Only metals within the Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe) fractions are shown (Organic Bound and Residual metals are excluded).

Mean values < MDL are indicated with a < symbol. Means are reported as < MDL if all data used in their calculation were < MDL. Sodium data were available only for the Exchangeable & Adsorbed Metals fraction due to the use of sodium in the second extraction step; sodium was not plotted as a result.

Figure E.17: Sediment cores collected from Polley Lake north basin (POL-P1) for profiles of sediment chemistry (left core) and pore-water chemistry (right core).

Figure E.18: Sediment cores collected from Polley Lake south basin (POL-P2) for profiles of sediment chemistry (left core) and pore-water chemistry (right core).

Figure E.19: The 9 to 10 cm sediment section of the core collected from Polley Lake south basin (POL-P2) and used for sediment chemistry analysis. The sediment section shows clay-like sediments (to the left) at the same sediment horizon as grey tailings material (to the right).

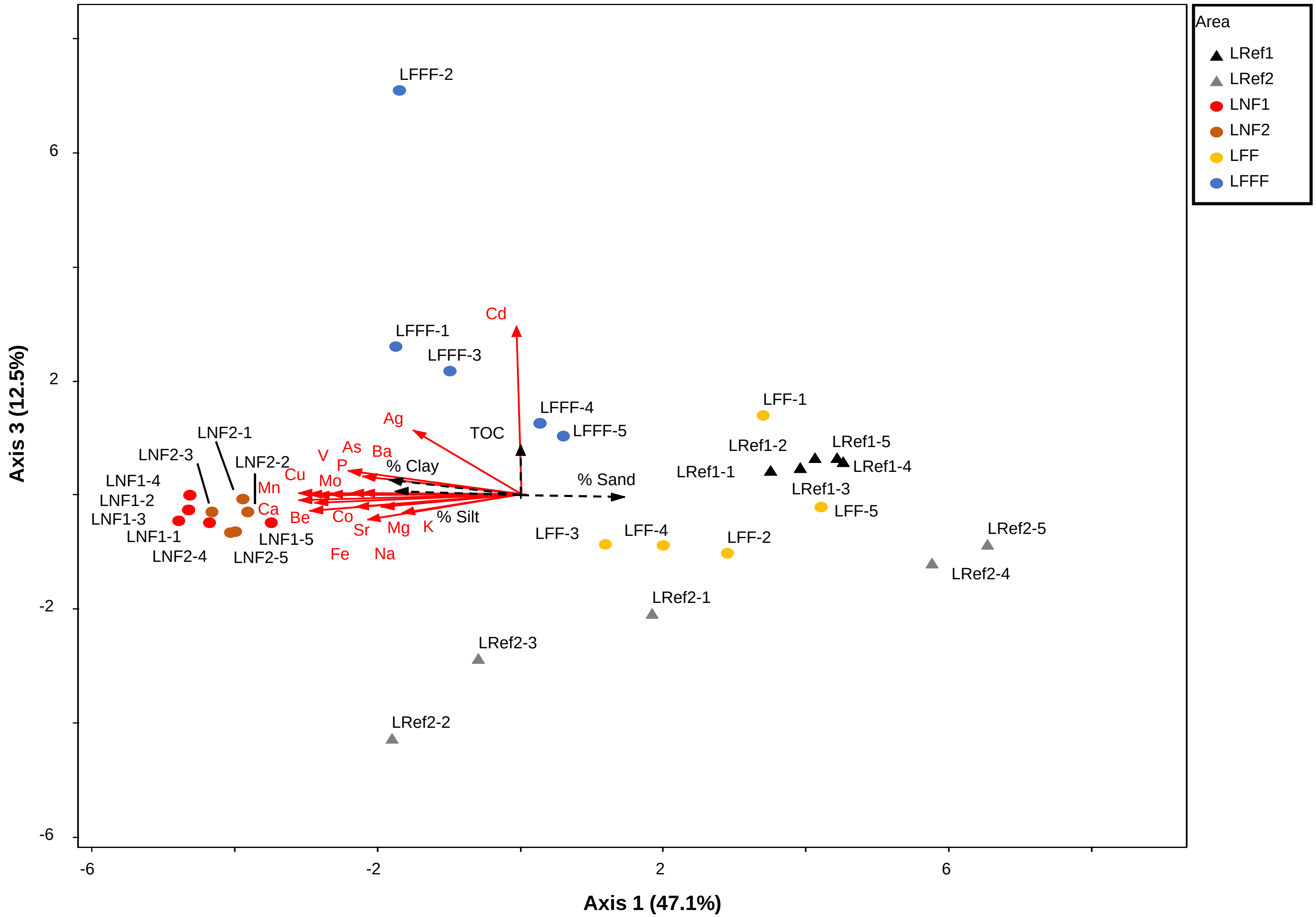


Figure E.20: **Biplot of principal component analysis (PCA) of metal concentrations in sediment (<2 mm fraction) from Quesnel Lake littoral sampling stations, Mount Polley Mine, 2014. Vector length is proportional to the magnitude of direct correlation of metals (solid red vector lines) and indirect correlation of sediment physical characteristics (black dashed vector lines) with PCA values of each axis (Appendix Tables E.47-E.48). Only metals with significant (p-value <0.010) Spearman's correlation and r-values > 0.7 with either axis are displayed, all sediment physical characteristics are displayed [a].**

[a] Boron, mercury, and tin were excluded from calculations due to a lack of variability in the data (all values for each analyte were the same), or an incomplete data set.

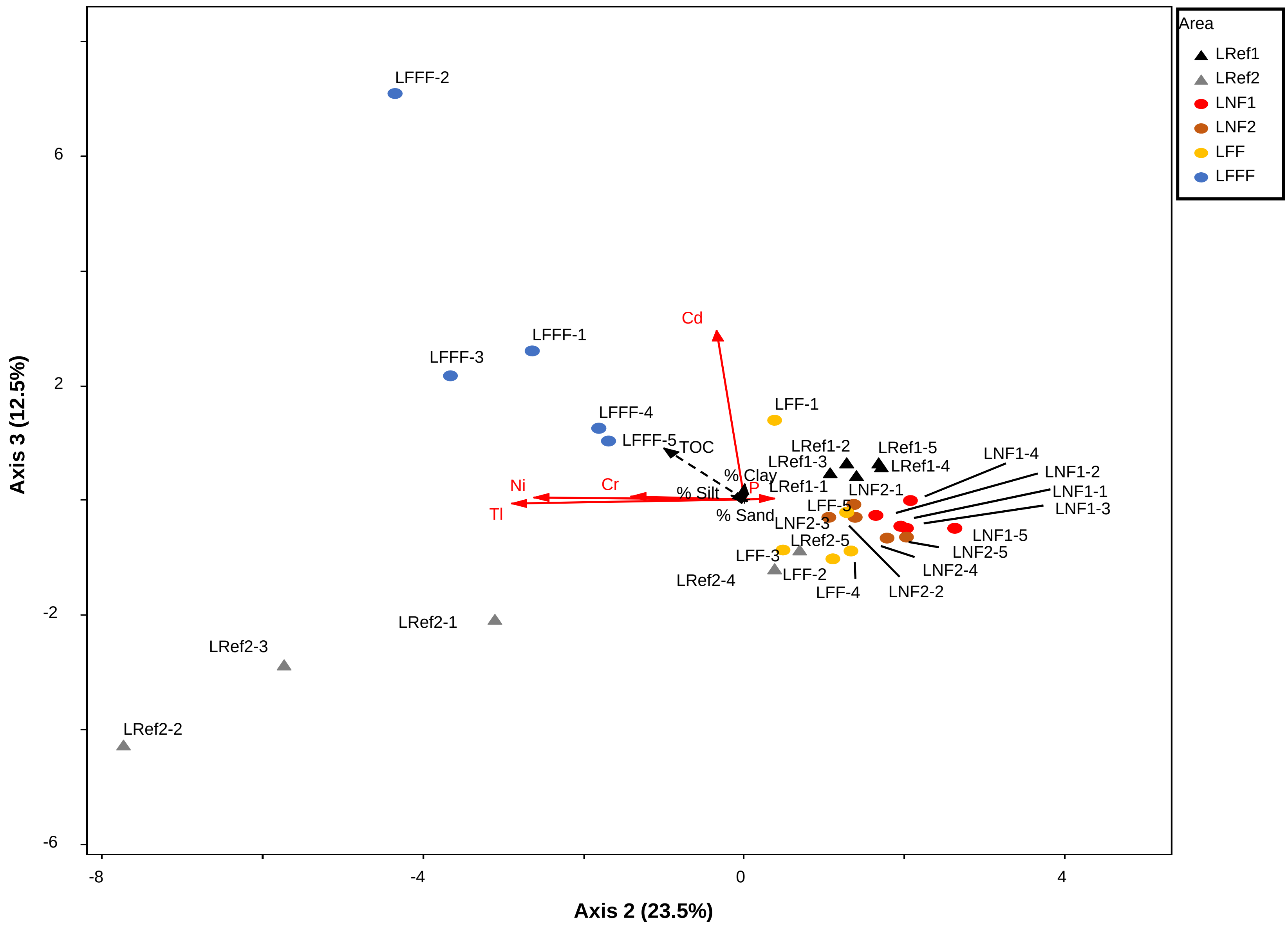


Figure E.21: Biplot of principal component analysis (PCA) of metal concentrations in sediment (<2 mm fraction) from Quesnel Lake littoral sampling stations, Mount Polley Mine, 2014. Vector length is proportional to the magnitude of direct correlation of metals (solid red vector lines) and indirect correlation of sediment physical characteristics (black dashed vector lines) with PCA values of each axis (Appendix Tables E.47-E.48). Only metals with significant (p-value <0.010) Spearman's correlation and r-values > 0.7 with either axis are displayed, all sediment physical characteristics are displayed [a].

[a] Boron, mercury, and tin were excluded from calculations due to a lack of variability in the data (all values for each analyte were the same), or an incomplete data set.

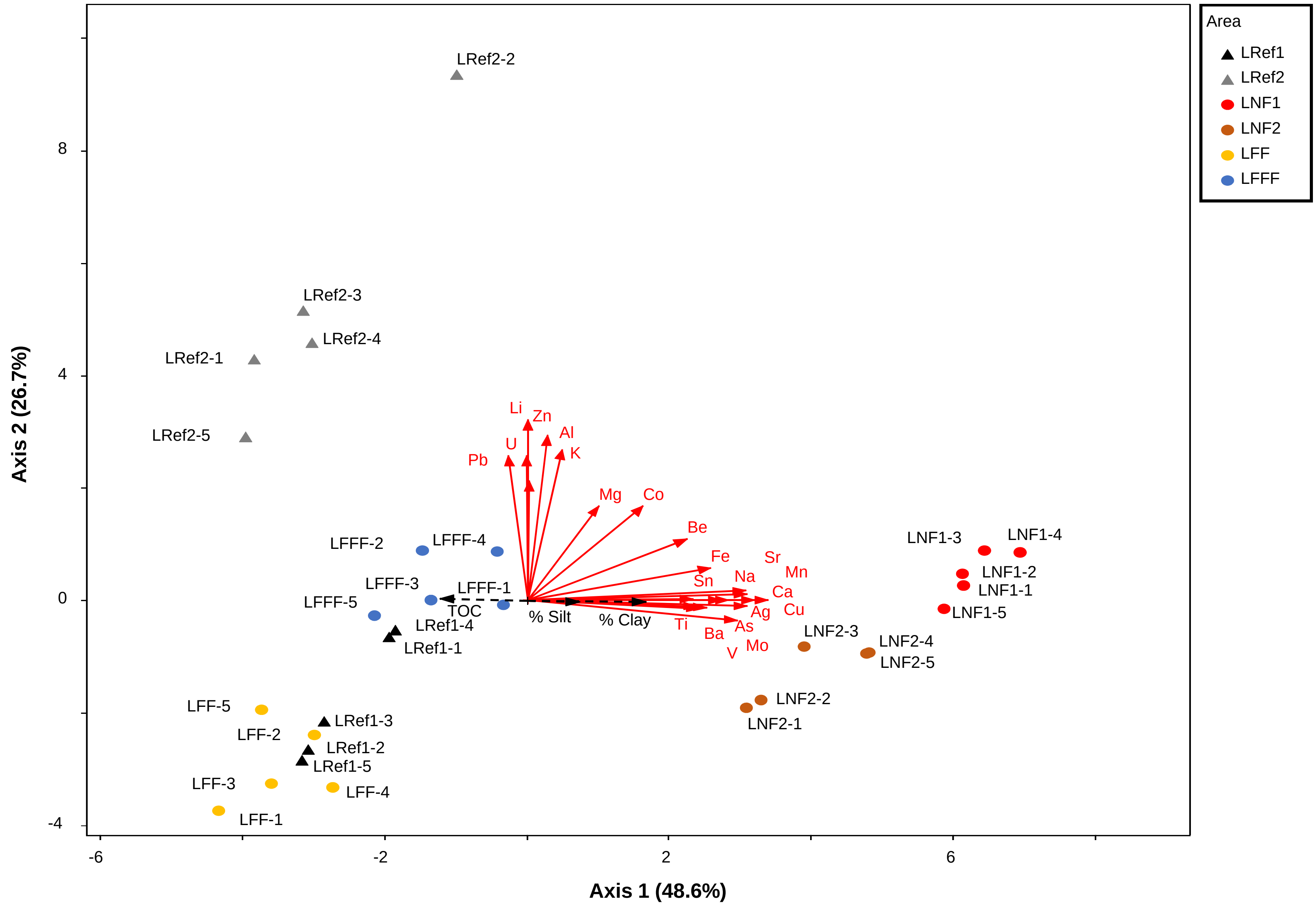


Figure E.22: Biplot of principal component analysis (PCA) of metal concentrations in sediment (<63 µm fraction) from Quesnel Lake littoral sampling stations, Mount Polley Mine, 2014. Vector length is proportional to the magnitude of direct correlation of metals (solid red vector lines) and indirect correlation of sediment physical characteristics (black dashed vector lines) with PCA values of each axis (Appendix Tables E.49-E.50). Only metals with significant (p-value <0.010) Spearman's correlation and r-values > 0.7 with either axis are displayed, all sediment physical characteristics are displayed [a].

[a] Boron was excluded from calculations due to a lack of variability in the data (all values were the same).

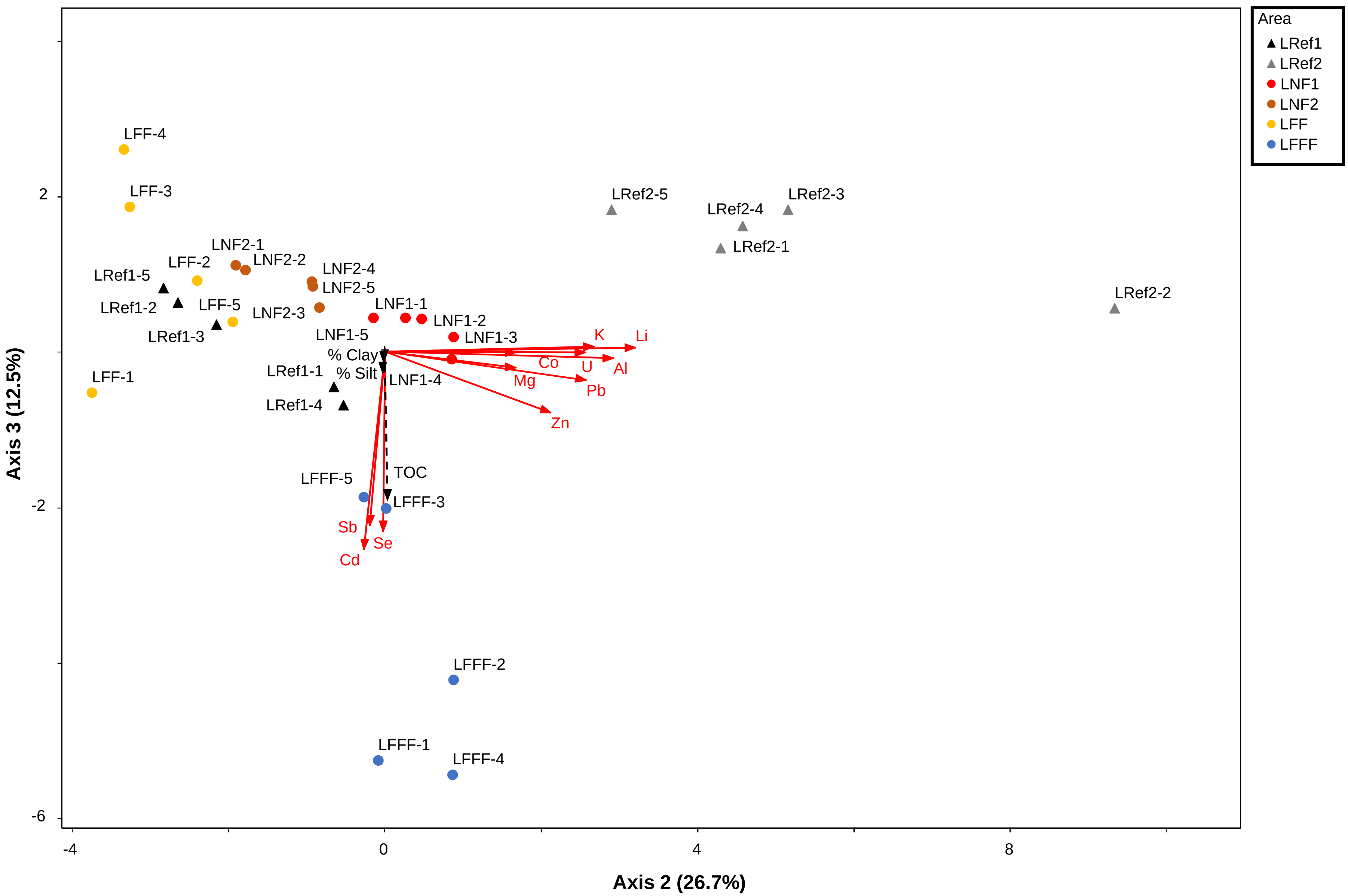


Figure E.23: Biplot of principal component analysis (PCA) of metal concentrations in sediment (<63 µm fraction) from Quesnel Lake littoral sampling stations, Mount Polley Mine, 2014. Vector length is proportional to the magnitude of direct correlation of metals (solid red vector lines) and indirect correlation of sediment physical characteristics (black dashed vector lines) with PCA values of each axis (Appendix Tables E.49-E.50). Only metals with significant (p-value <0.010) Spearman's correlation and r-values > 0.7 with either axis are displayed, all sediment physical characteristics are displayed [a].

[a] Boron was excluded from calculations due to a lack of variability in the data (all values were the same).

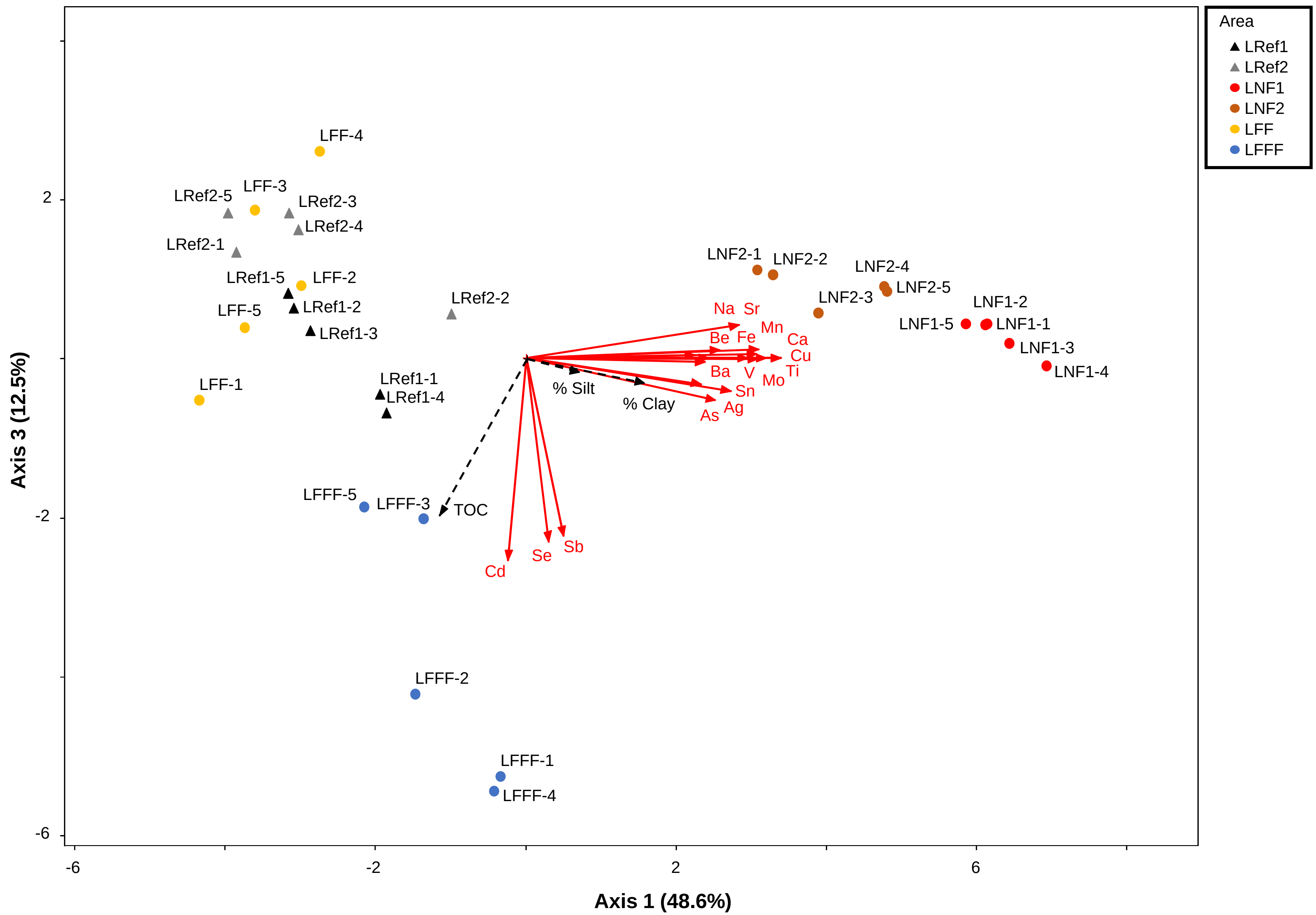


Figure E.24: **Biplot of principal component analysis (PCA) of metal concentrations in sediment (<63 µm fraction) from Quesnel Lake littoral sampling stations, Mount Polley Mine, 2014. Vector length is proportional to the magnitude of direct correlation of metals (solid red vector lines) and indirect correlation of sediment physical characteristics (black dashed vector lines) with PCA values of each axis (Appendix Tables E.49-E.50). Only metals with significant (p-value <0.010) Spearman's correlation and r-values > 0.7 with either axis are displayed, all sediment physical characteristics are displayed [a].**

[a] Boron was excluded from calculations due to a lack of variability in the data (all values were the same).

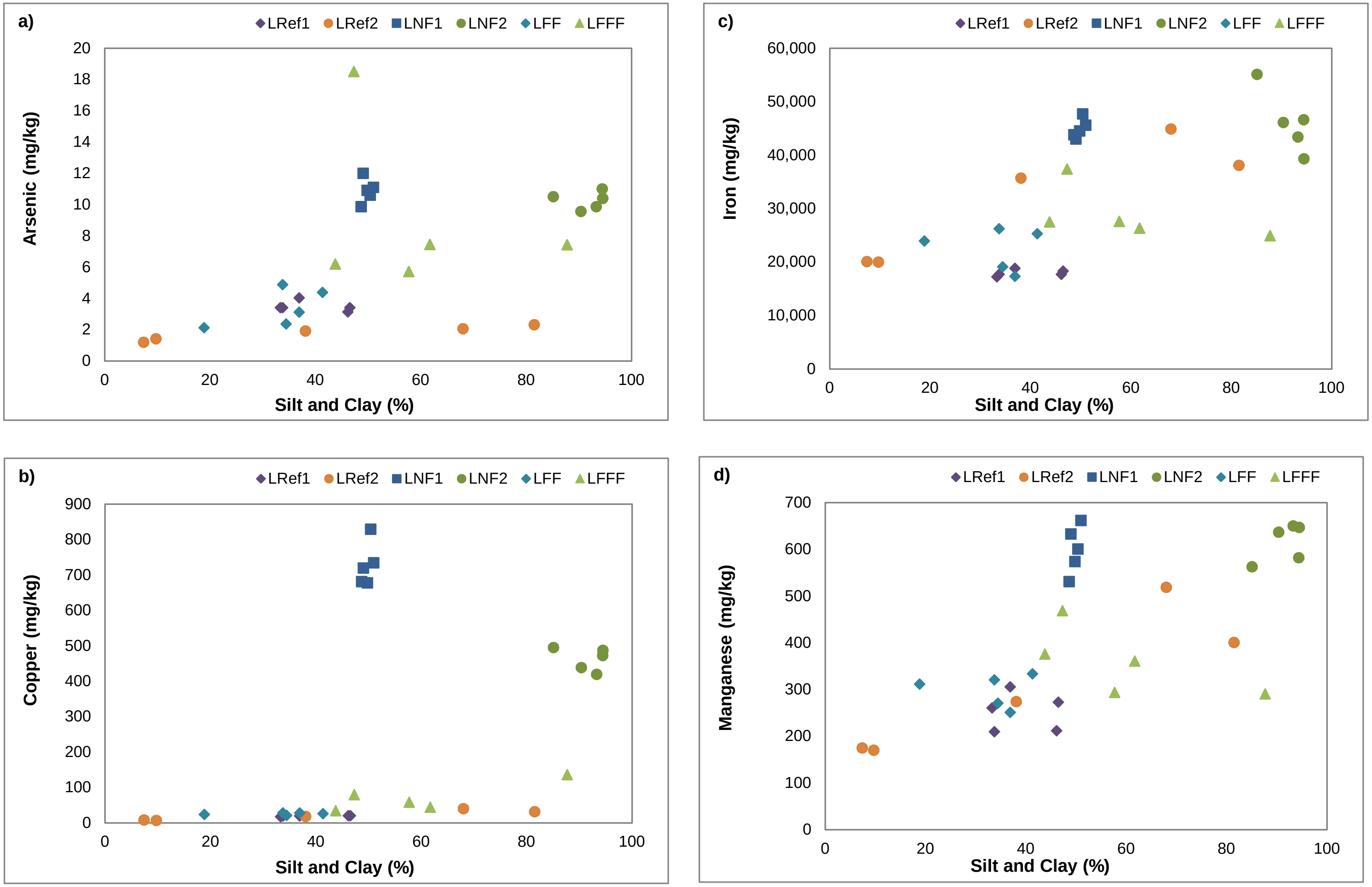


Figure E.25: Scatterplots of significant Spearman correlation relationships (p < 0.002) between silt and clay (%) or total organic carbon (%), and parameters of interest or indicator parameters, Mount Polley Mine 2014. Quesnel Lake Littoral sampling areas. Hollow symbols indicate values < MDL.

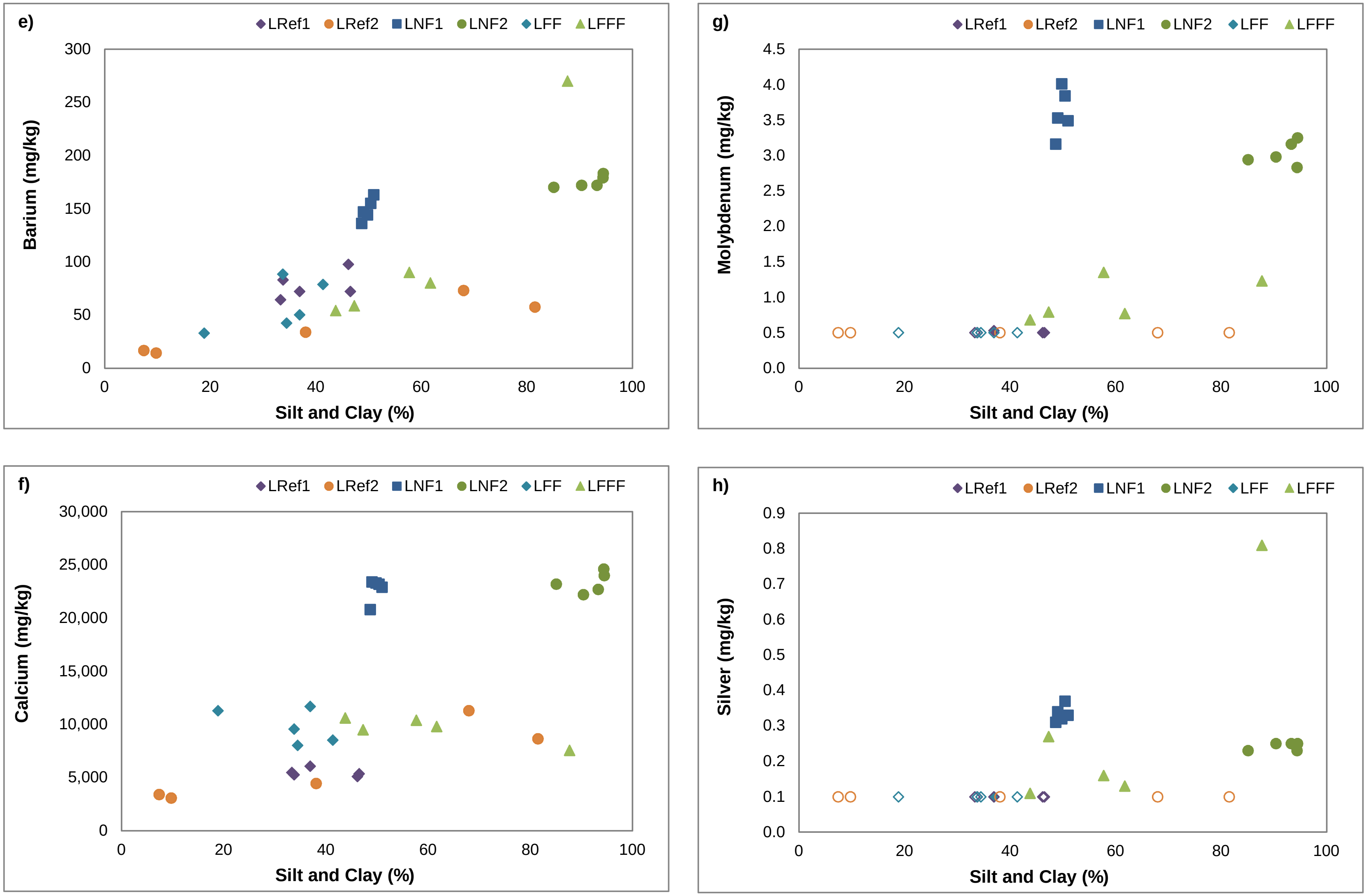
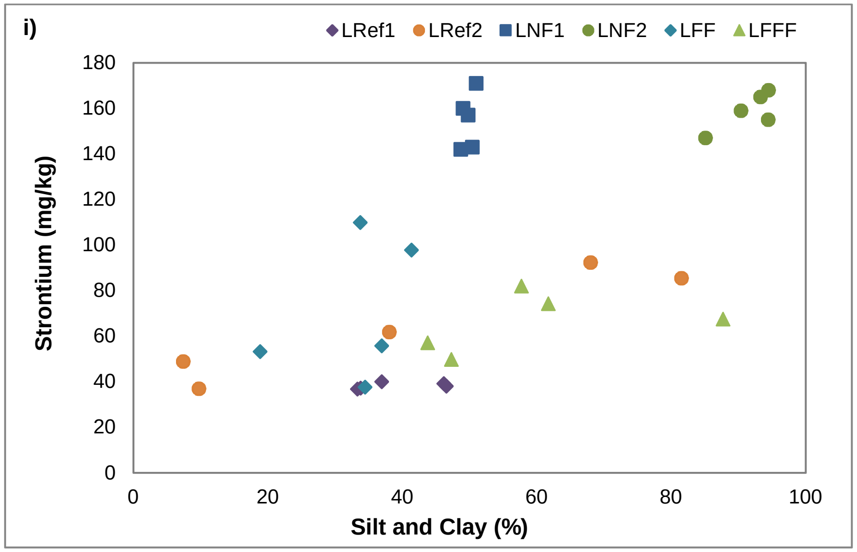
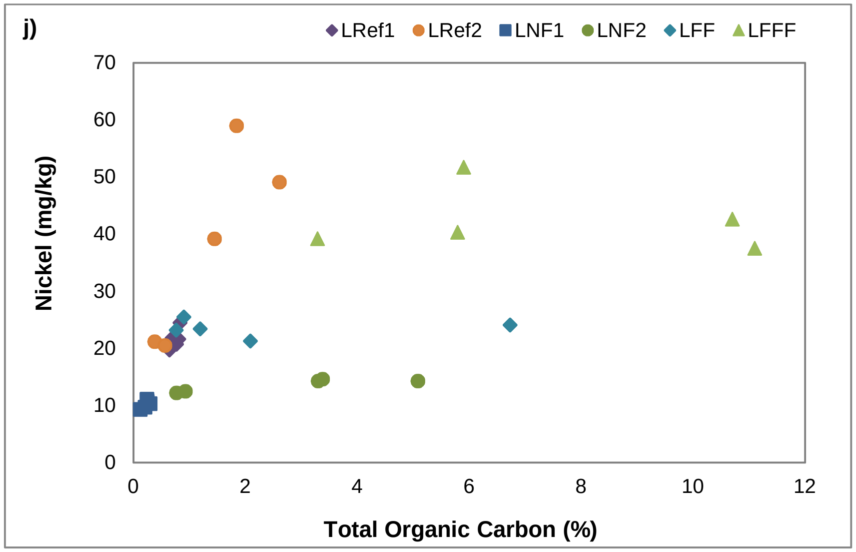


Figure E.25: Scatterplots of significant Spearman correlation relationships ($p < 0.002$) between silt and clay (%) or total organic carbon (%), and parameters of interest or indicator parameters, Mount Polley Mine 2014. Quesnel Lake Littoral sampling areas. Hollow symbols indicate values < MDL.





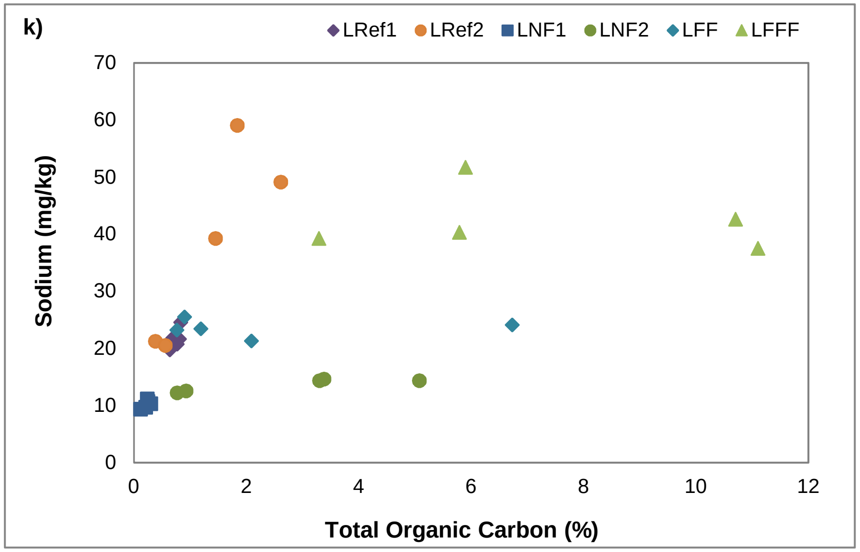


Figure E.25: Scatterplots of significant Spearman correlation relationships ($p < 0.002$) between silt and clay (%) or total organic carbon (%), and parameters of interest or indicator parameters, Mount Polley Mine 2014. Quesnel Lake Littoral sampling areas. Hollow symbols indicate values < MDL.

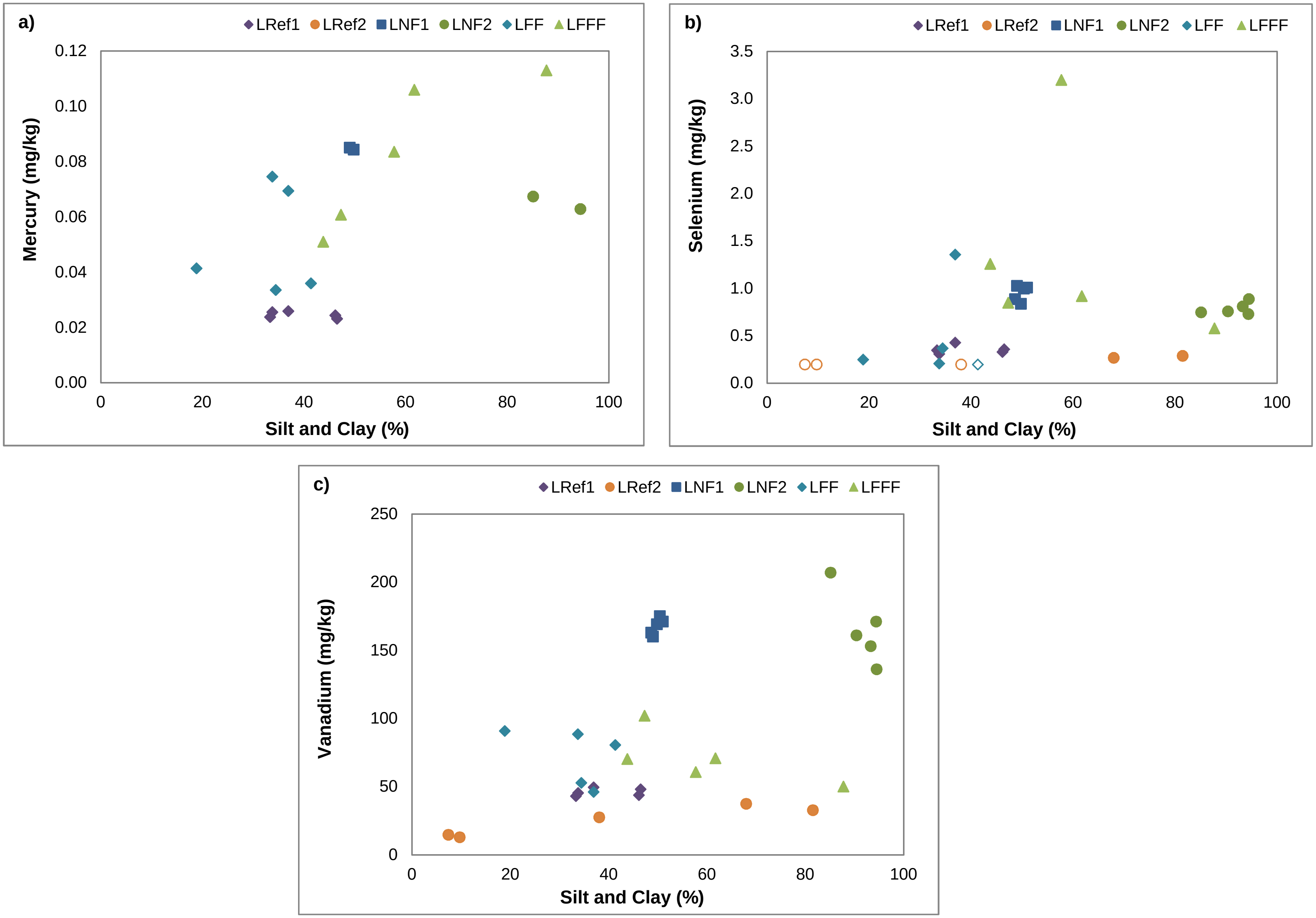


Figure E.26: Scatterplots of Spearman correlation relationships (p < 0.01) between silt and clay (%) and indicator parameters, Mount Polley Mine, 2014. Quesnel Lake Littoral sampling areas. Hollow symbols indicate values < MDL.

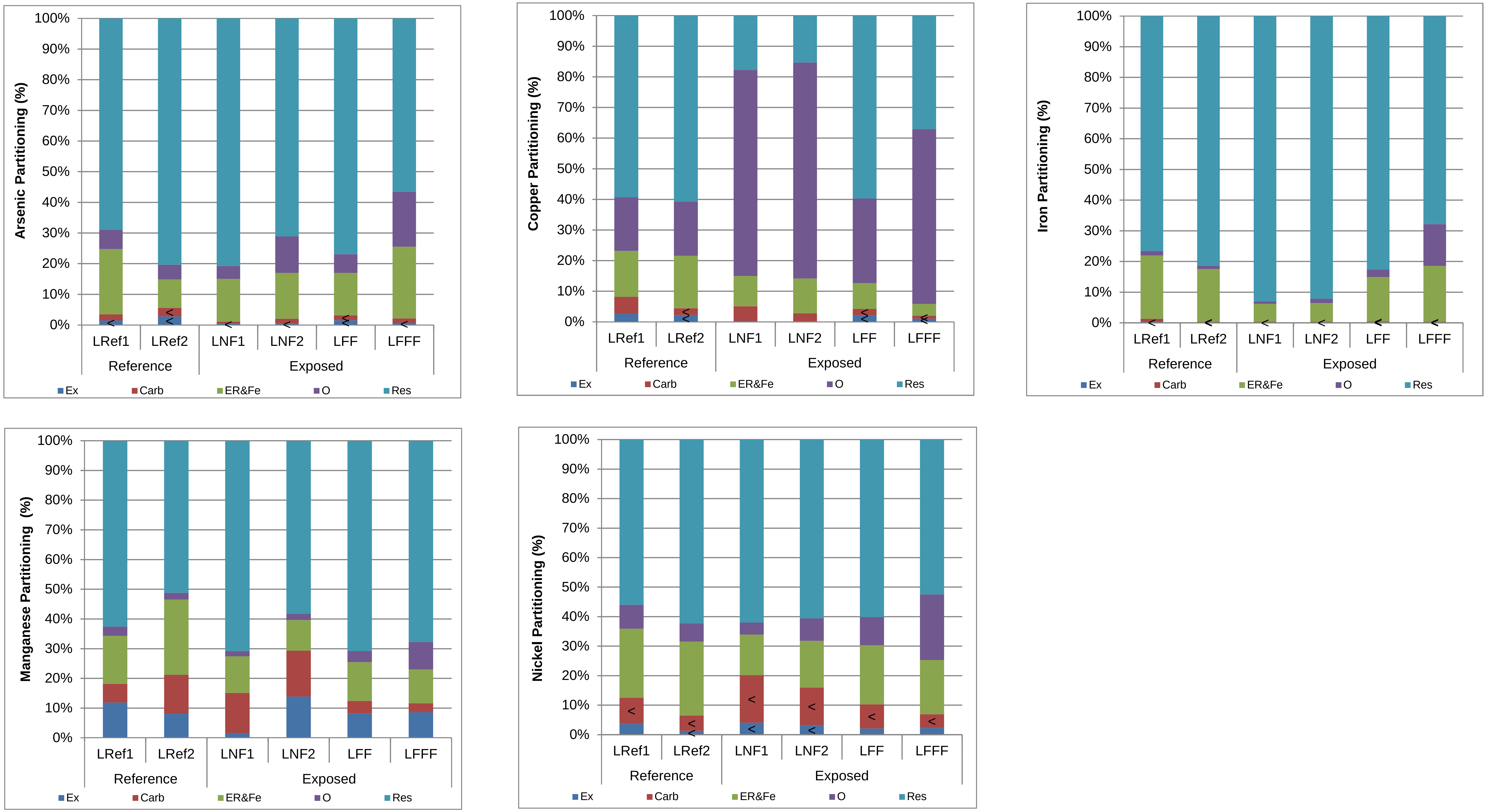


Figure E.27 (a): Partitioning of parameters of interest within selectively extracted fractions of sediment from the littoral sampling areas of Quesnel Lake, Mount Polley Mine, 2014. Selective extractions included Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe), Organic Bound Metals (O), and Residual Metals (Res).

Mean values < MDL are indicated with a < symbol. Means are reported as < MDL if all data used in their calculation were < MDL. Mean values are plotted for areas with replicate samples (LRef1, LNF1, LNF2), single values are plotted for composite samples (LRef2, LFF, LFFF).

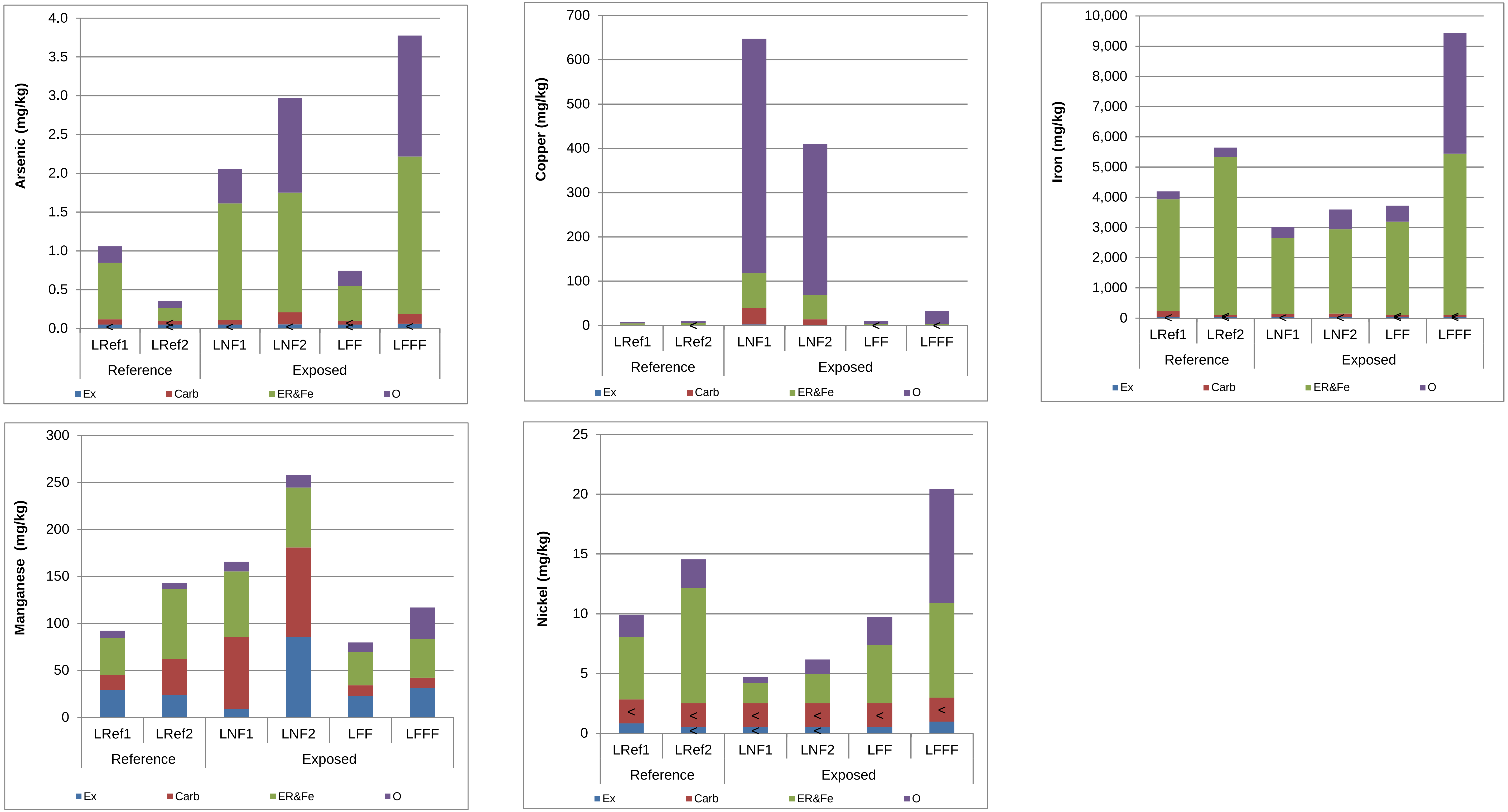


Figure E.27 (b): Mean concentrations of selectively extracted parameters of interest in sediment from the littoral sampling areas of Quesnel Lake, Mount Polley Mine, 2014. Only metals within the Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe) and Organic Bound Metals (O) fractions are shown (Residual metals are excluded).

Mean values < MDL are indicated with a < symbol. Means are reported as < MDL if all data used in their calculation were < MDL. Mean values are plotted for areas with replicate samples (LRef1, LNF1, LNF2), single values are plotted for composite samples (LRef2, LFF, LFFF).

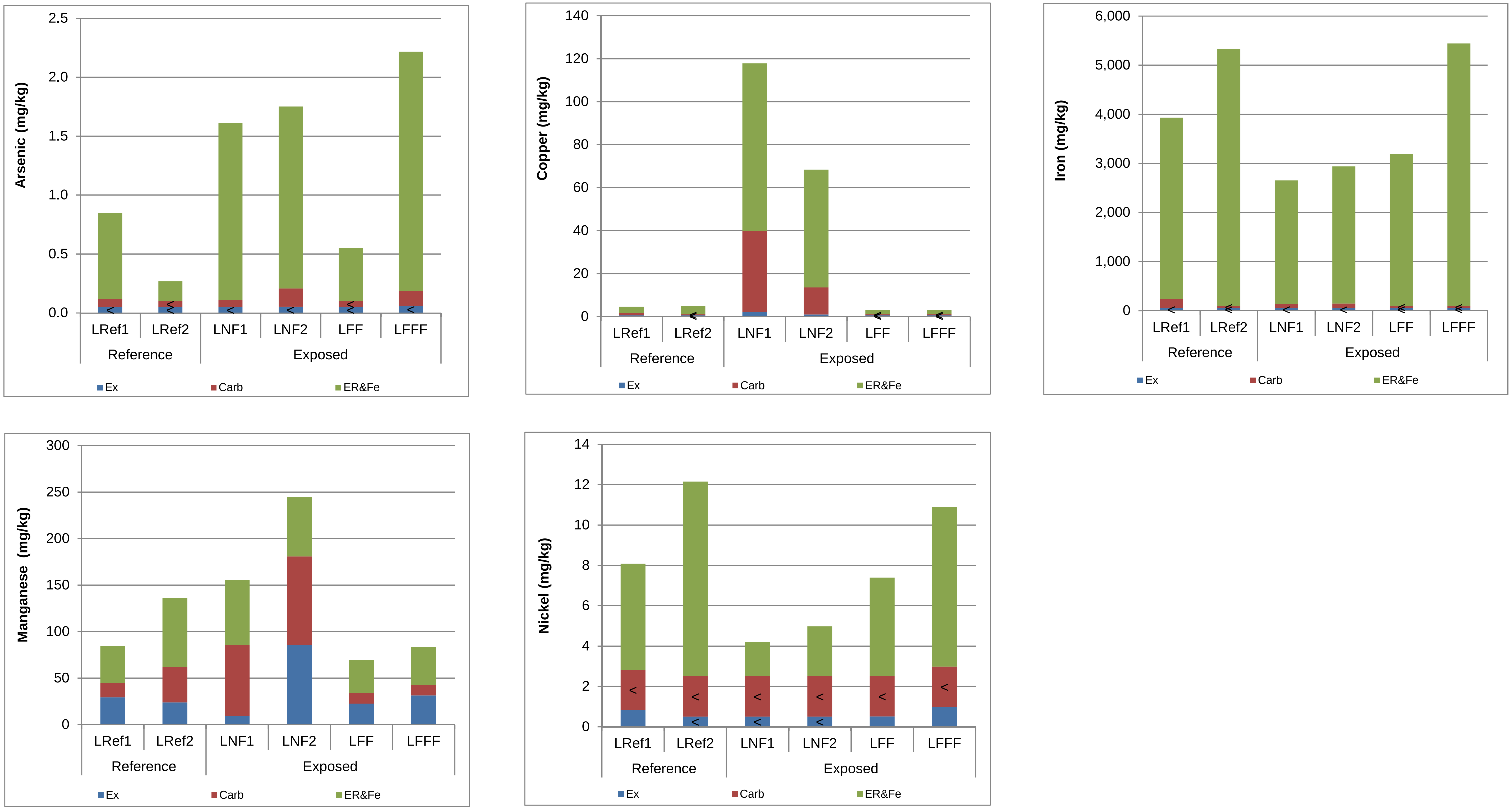


Figure E.27 (c): Mean concentrations of selectively extracted parameters of interest in sediment from the littoral sampling areas of Quesnel Lake, Mount Polley Mine, 2014. Only metals within the Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe) fractions are shown (Organic Bound and Residual metals are excluded).

Mean values < MDL are indicated with a < symbol. Means are reported as < MDL if all data used in their calculation were < MDL. Mean values are plotted for areas with replicate samples (LRef1, LNF1, LNF2), single values are plotted for composite samples (LRef2, LFF, LFFF).

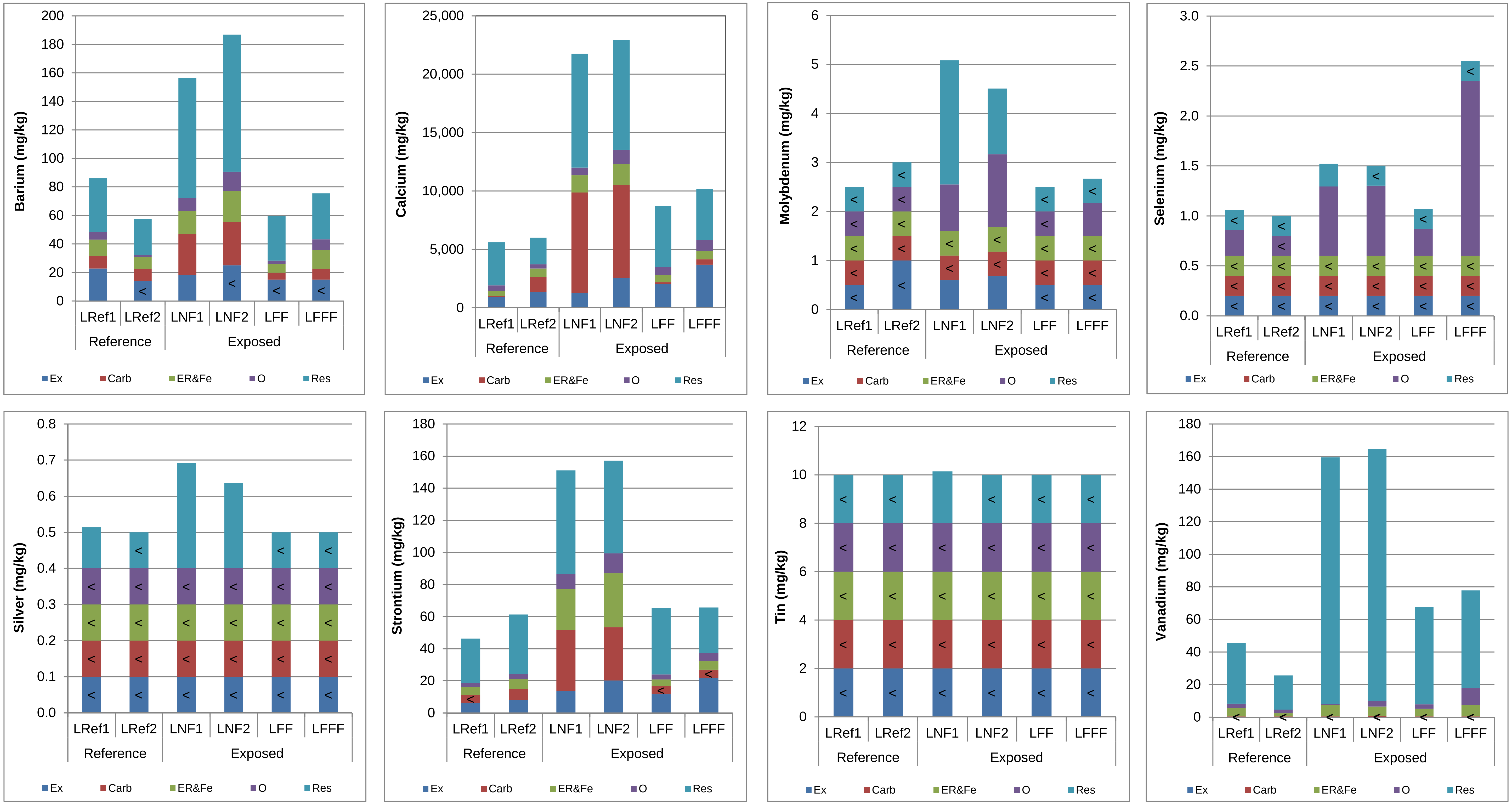


Figure E.28 (a): Mean concentrations of selectively extracted indicator parameters in sediment from the littoral sampling areas of Quesnel Lake, Mount Polley Mine, 2014. Selective extractions included Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe), Organic Bound Metals (O), and Residual Metals (Res).

Values < MDL are indicated with a < symbol. Mean values are plotted for areas with replicate samples (LRef1, LNF1, LNF2), single values are plotted for composite samples (LRef2, LFF, LFFF). Data for mercury were not available, sodium data were available only for the Exchangeable & Adsorbed Metals fraction due to the use of sodium in the second extraction step; sodium was not plotted as a result.

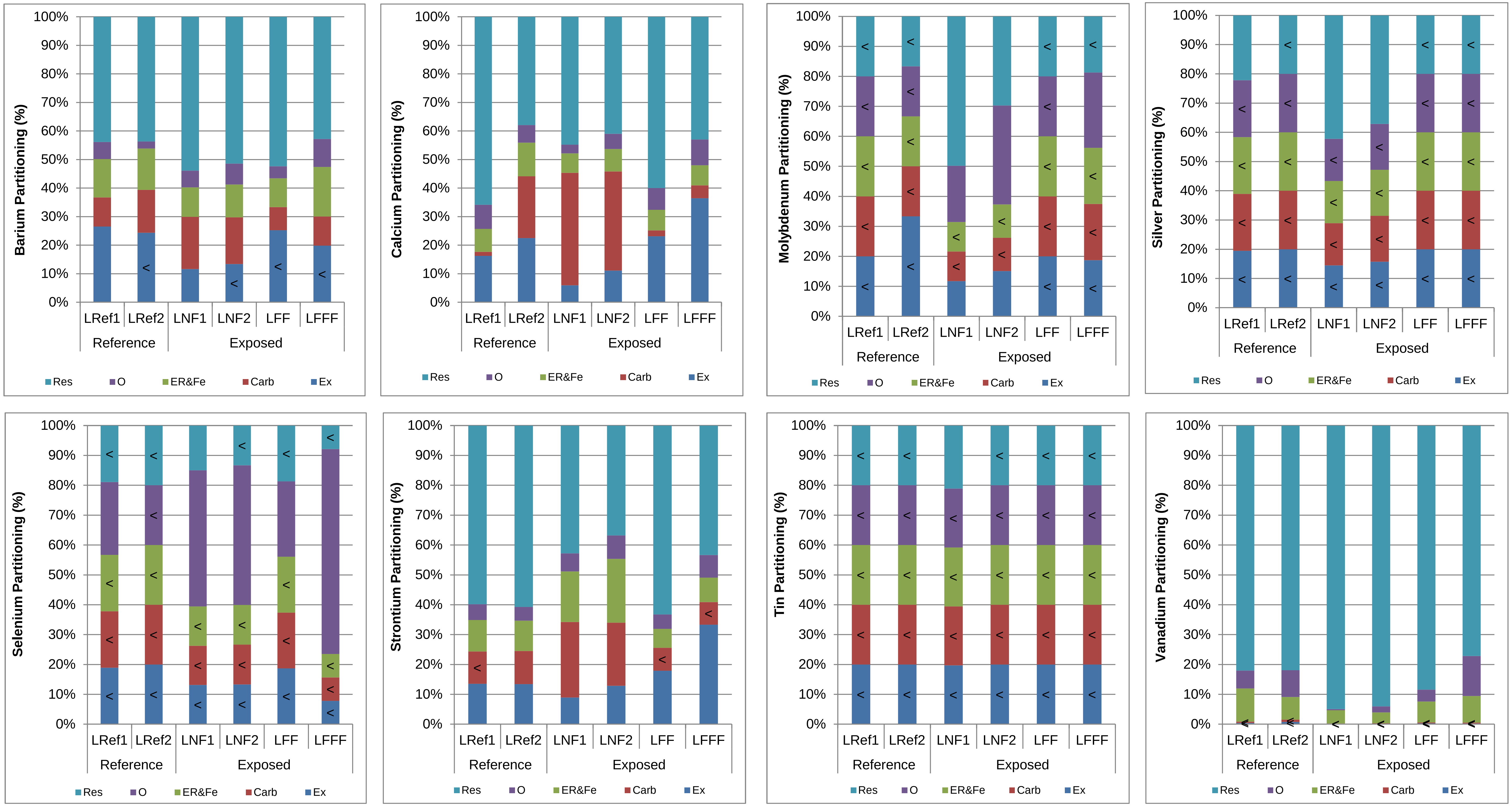


Figure E.28 (b): Partitioning of indicator parameters within selectively extracted fractions of sediment from the littoral sampling areas of Quesnel Lake, Mount Polley Mine, 2014. Selective extractions included Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe), Organic Bound Metals (O), and Residual Metals (Res).

Values < MDL are indicated with a < symbol. Mean values are plotted for areas with replicate samples (LRef1, LNF1, LNF2), single values are plotted for composite samples (LRef2, LFF, LFFF). Data for mercury were not available, sodium data were available only for the Exchangeable & Adsorbed Metals fraction due to the use of sodium in the second extraction step; sodium was not plotted as a result.

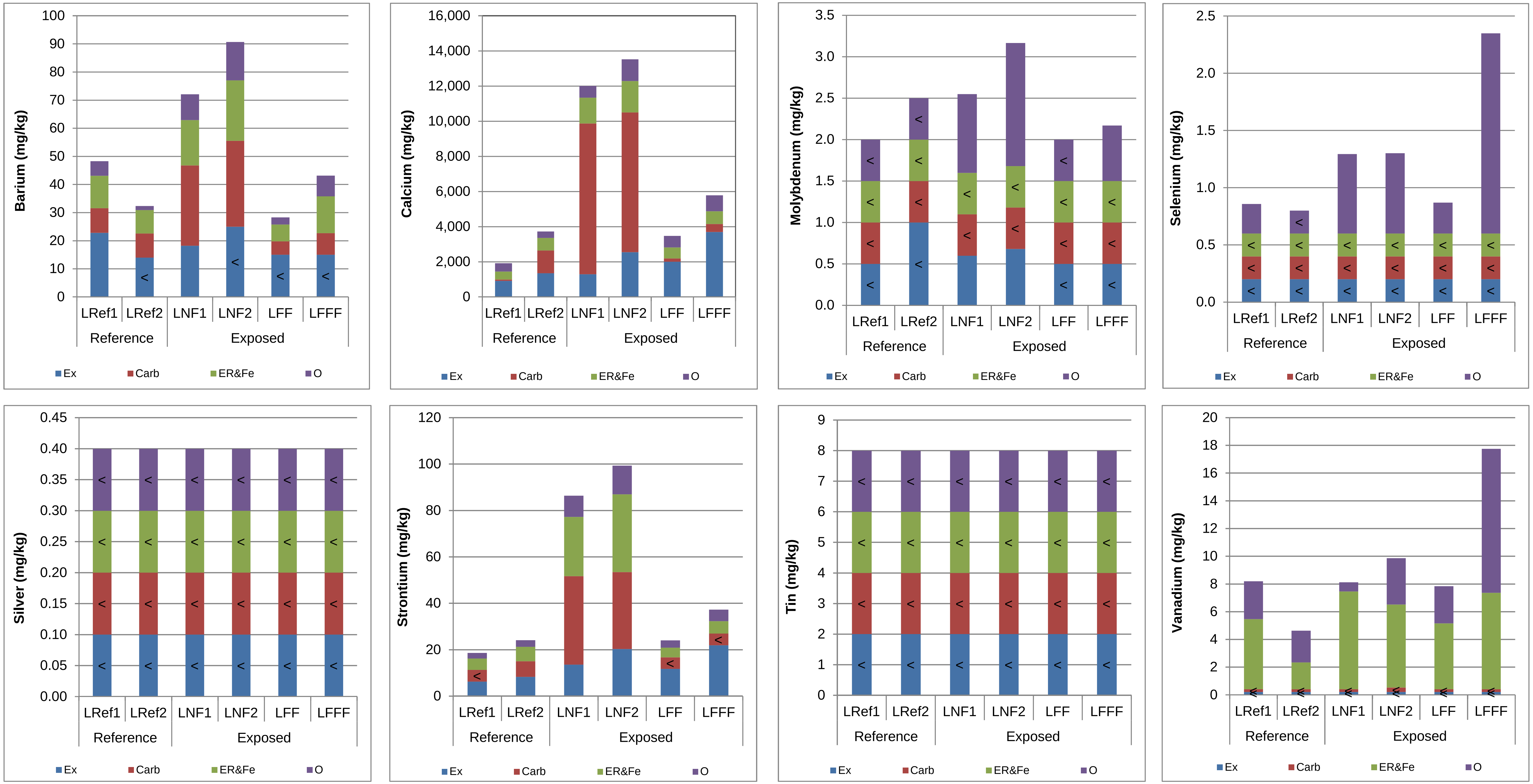


Figure E.28 (c): Mean concentrations of selectively extracted indicator parameters in sediment from the littoral sampling areas of Quesnel Lake, Mount Polley Mine, 2014. Only metals within the Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe) and Organic Bound Metals (O) fractions are shown (Residual metals are excluded).

Values < MDL are indicated with a < symbol. Mean values are plotted for areas with replicate samples (LRef1, LNF1, LNF2), single values are plotted for composite samples (LRef2, LFF, LFFF). Data for mercury were not available, sodium data were available only for the Exchangeable & Adsorbed Metals fraction due to the use of sodium in the second extraction step; sodium was not plotted as a result.

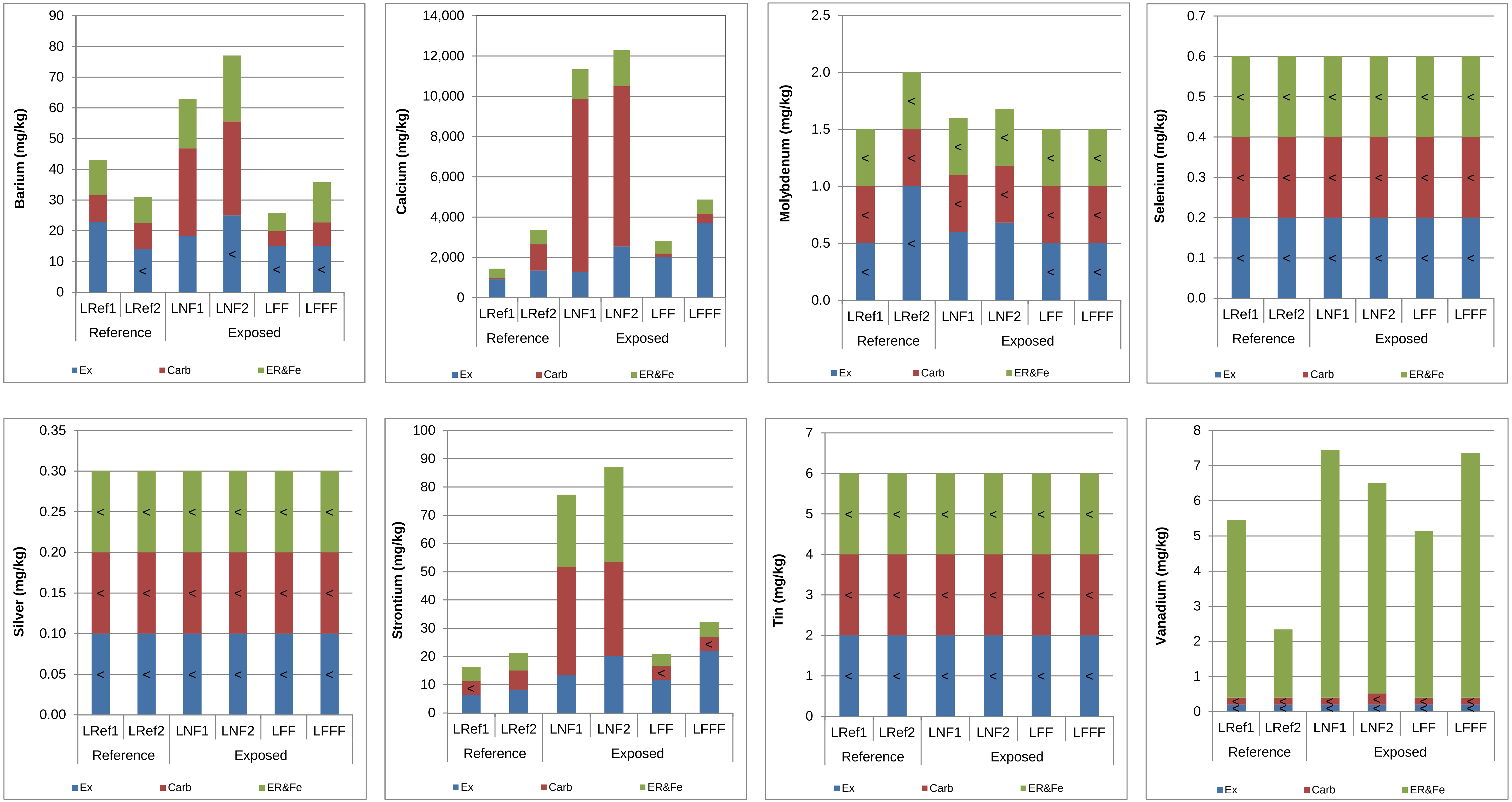


Figure E.28 (d): Mean concentrations of selectively extracted indicator parameters in sediment from the littoral sampling areas of Quesnel Lake, Mount Polley Mine, 2014. Only metals within the Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe) fractions are shown (Organic Bound and Residual metals are excluded).

Values < MDL are indicated with a < symbol. Mean values are plotted for areas with replicate samples (LRef1, LNF1, LNF2), single values are plotted for composite samples (LRef2, LFF, LFFF). Data for mercury were not available, sodium data were available only for the Exchangeable & Adsorbed Metals fraction due to the use of sodium in the second extraction step; sodium was not plotted as a result.

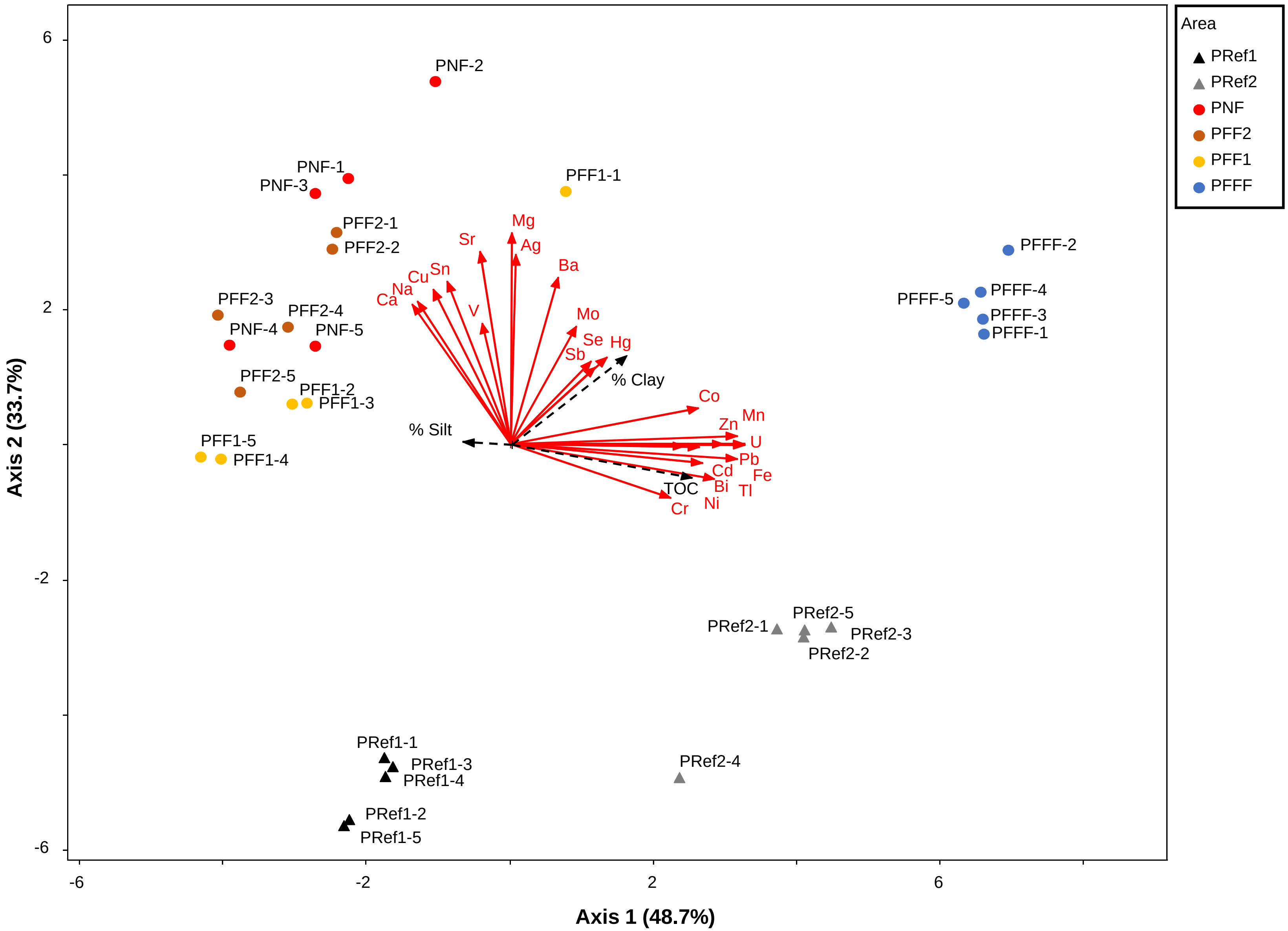


Figure E.29: Biplot of principal component analysis (PCA) of metal concentrations in sediment (<63 µm fraction) from Quesnel Lake profundal sampling stations, Mount Polley Mine, 2014. Vector length is proportional to the magnitude of direct correlation of metals (solid red vector lines) and indirect correlation of sediment physical characteristics (black dashed vector lines) with PCA values of each axis (Appendix Tables E.58-E.59). Only metals with significant (p-value <0.010) Spearman's correlation and r-values > 0.7 with either axis are displayed, all sediment physical characteristics are displayed.

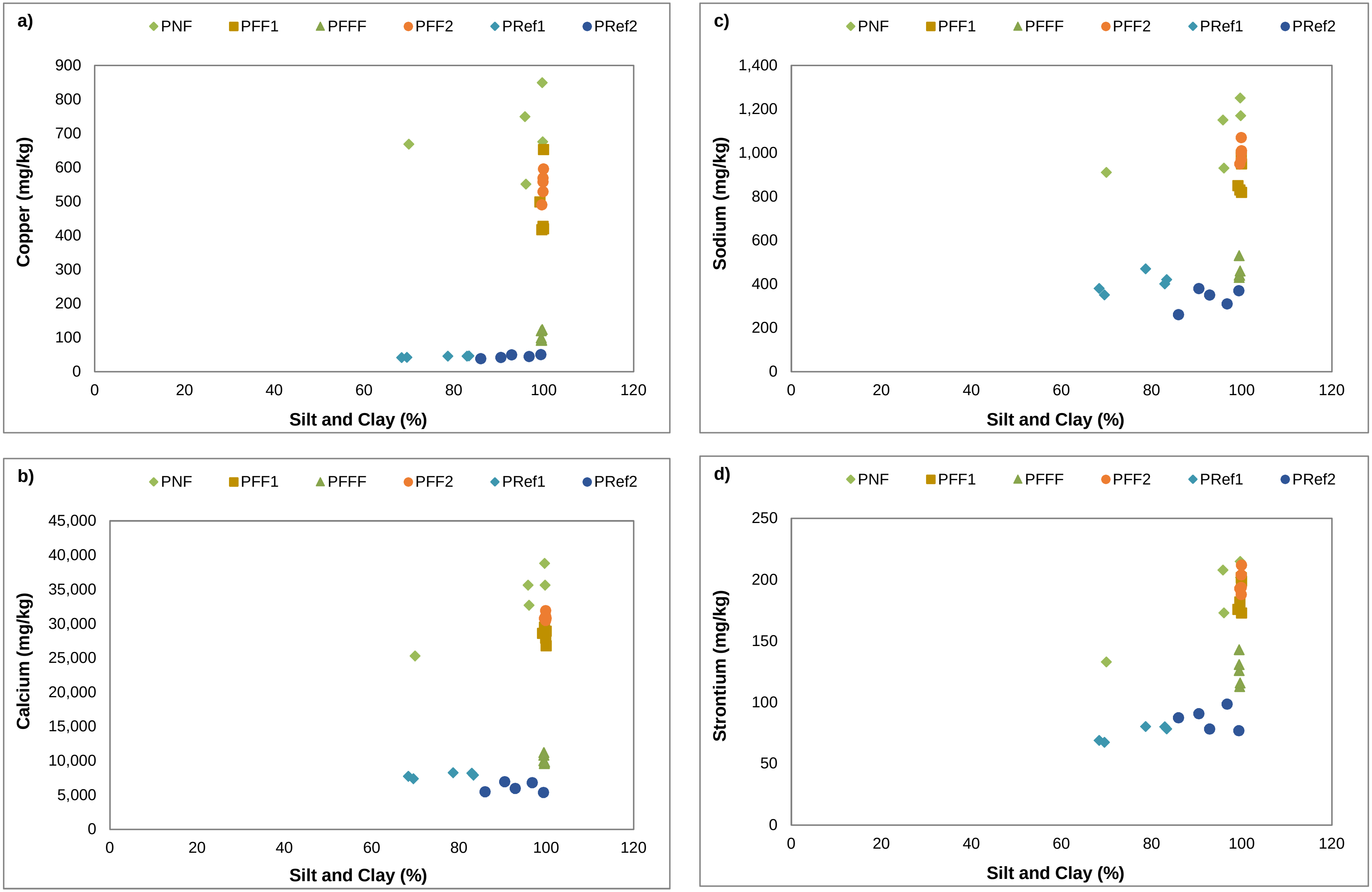


Figure E.30: Scatterplots of significant Spearman's correlation relationships ($p < 0.003$) between silt and clay (%) or total organic carbon (%), and parameters of interest or indicator parameters, Mount Polley Mine, 2014. Quesnel Lake profundal sampling areas. Hollow symbols indicate values < MDL.

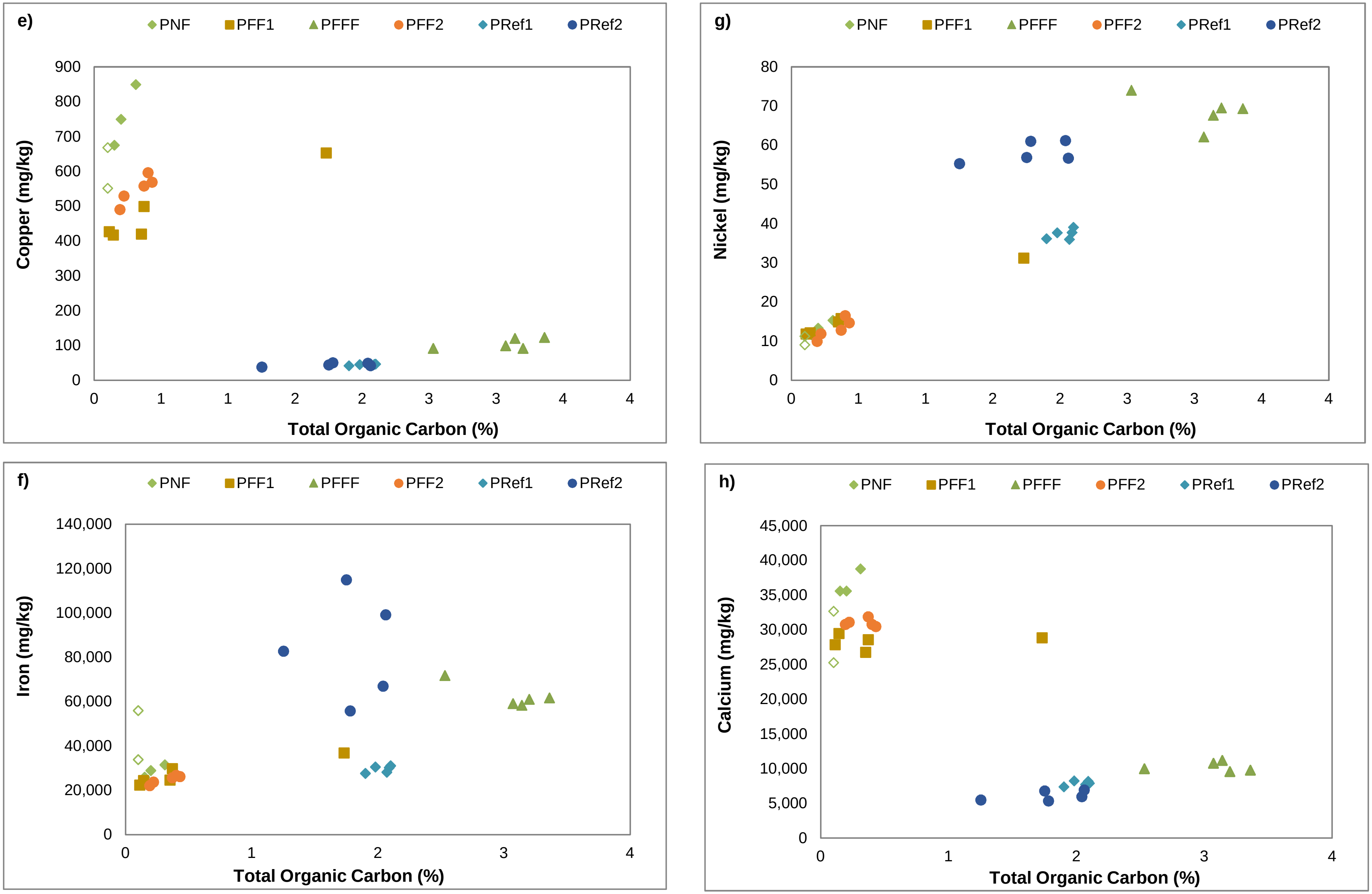


Figure E.30: Scatterplots of significant Spearman's correlation relationships (p < 0.003) between silt and clay (%) or total organic carbon (%), and parameters of interest or indicator parameters, Mount Polley Mine, 2014. Quesnel Lake profundal sampling areas. Hollow symbols indicate values < MDL.

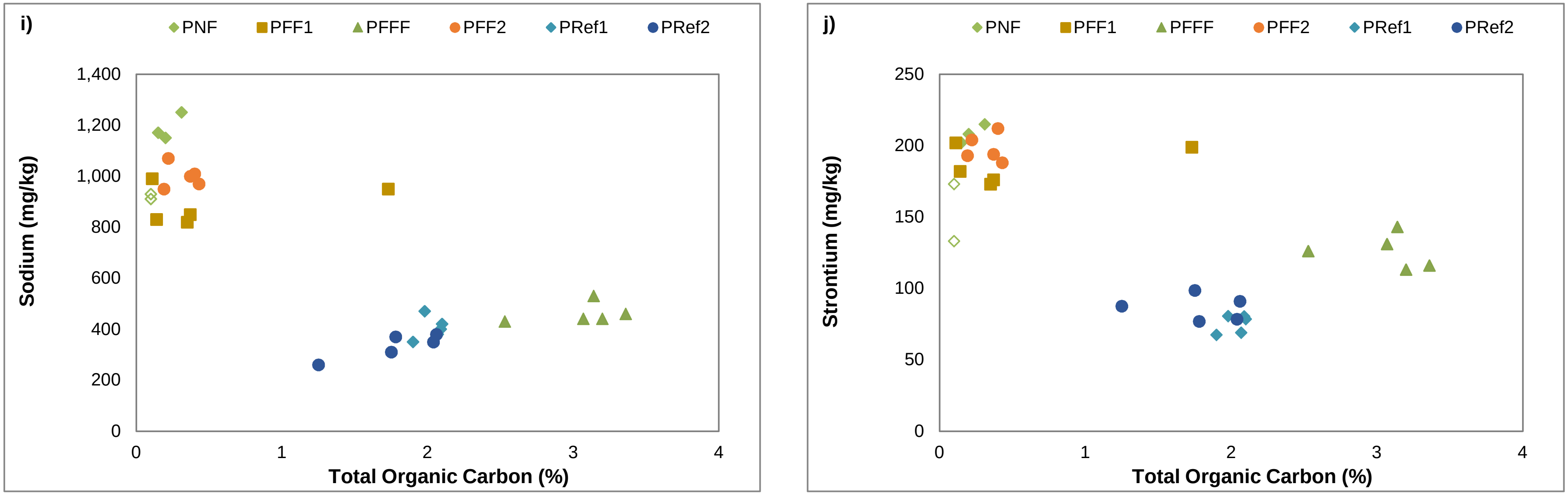


Figure E.30: Scatterplots of significant Spearman's correlation relationships ($p < 0.003$) between silt and clay (%) or total organic carbon (%), and parameters of interest or indicator parameters, Mount Polley Mine, 2014. Quesnel Lake profundal sampling areas. Hollow symbols indicate values < MDL.

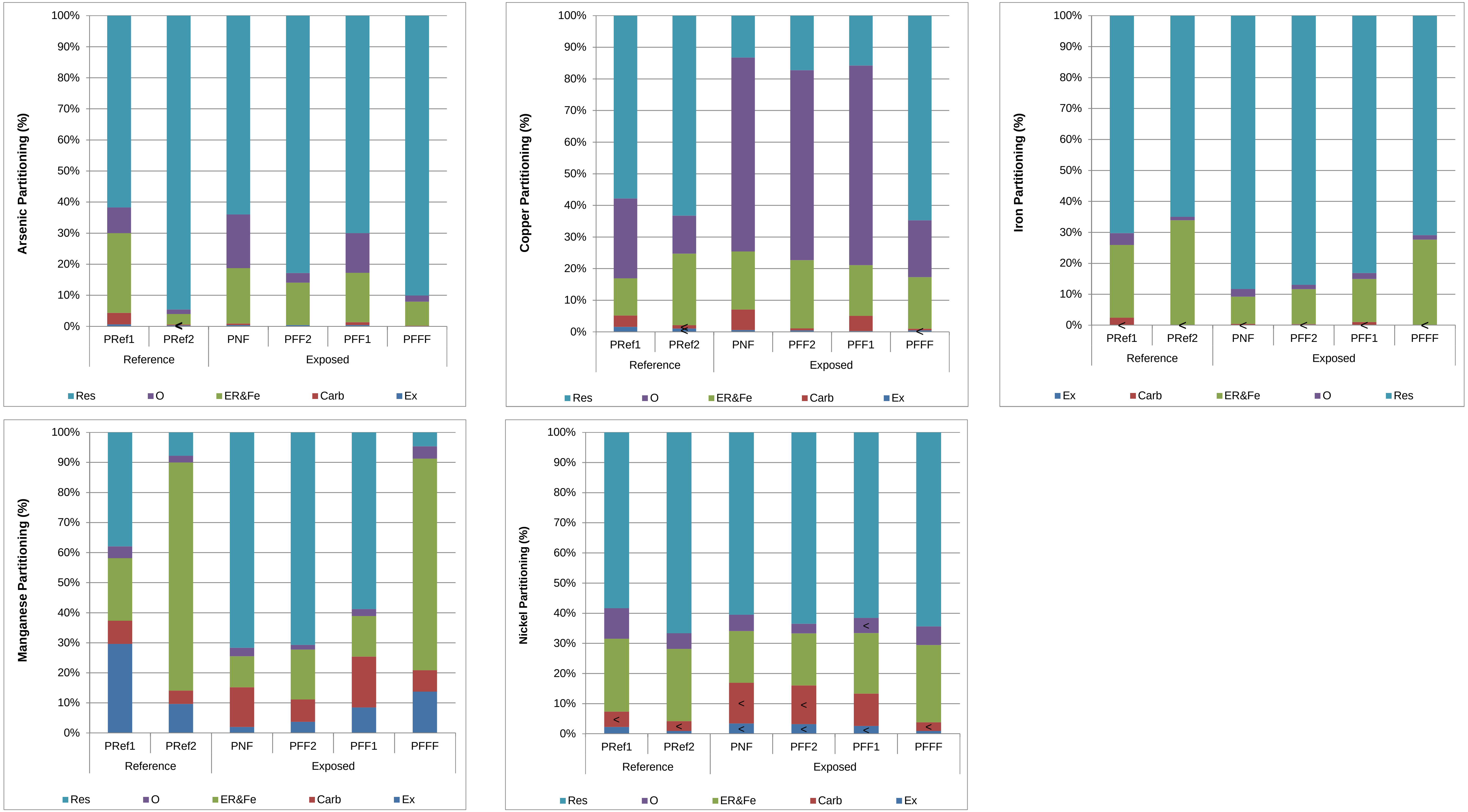


Figure E.31 (a): Partitioning of parameters of interest within selectively extracted fractions of sediment from the profundal sampling areas of Quesnel Lake, Mount Polley Mine, 2014. Selective extractions included Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe), Organic Bound Metals (O), and Residual Metals (Res).

Values < MDL are indicated with a < symbol. Mean values are plotted for areas with replicate samples (PRef1, PNF, PFF1), single values are plotted for composite samples (PRef2, PFF2, PFFF).

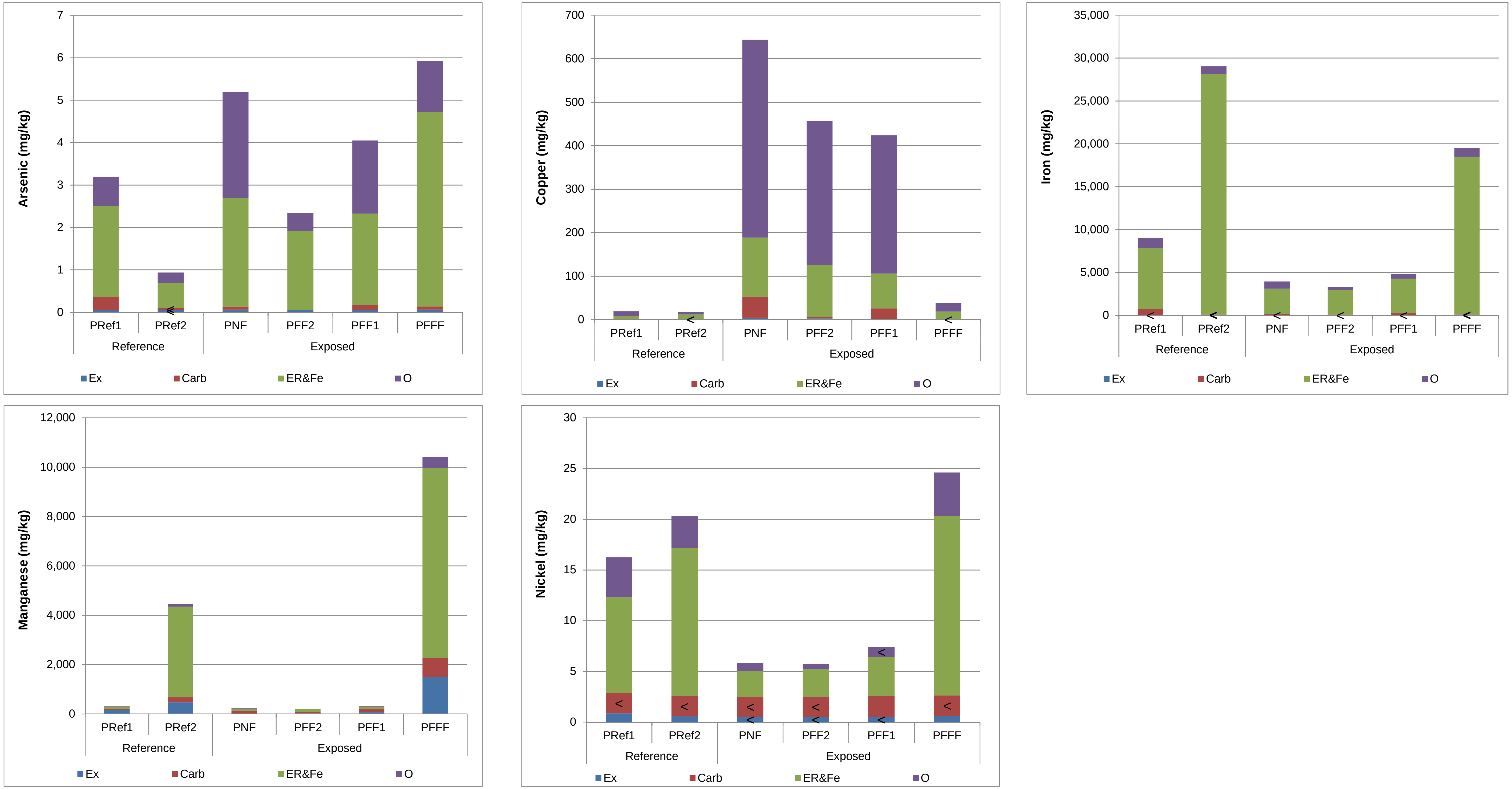


Figure E.31 (b): Mean concentrations of selectively extracted parameters of interest in sediment from the profundal sampling areas of Quesnel Lake, Mount Polley Mine, 2014. Only metals within the Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe) and Organic Bound Metals (O) fractions are shown (Residual metals are excluded).

Values < MDL are indicated with a < symbol. Mean values are plotted for areas with replicate samples (PRef1, PNF, PFF1), single values are plotted for composite samples (PRef2, PFF2, PFFF).

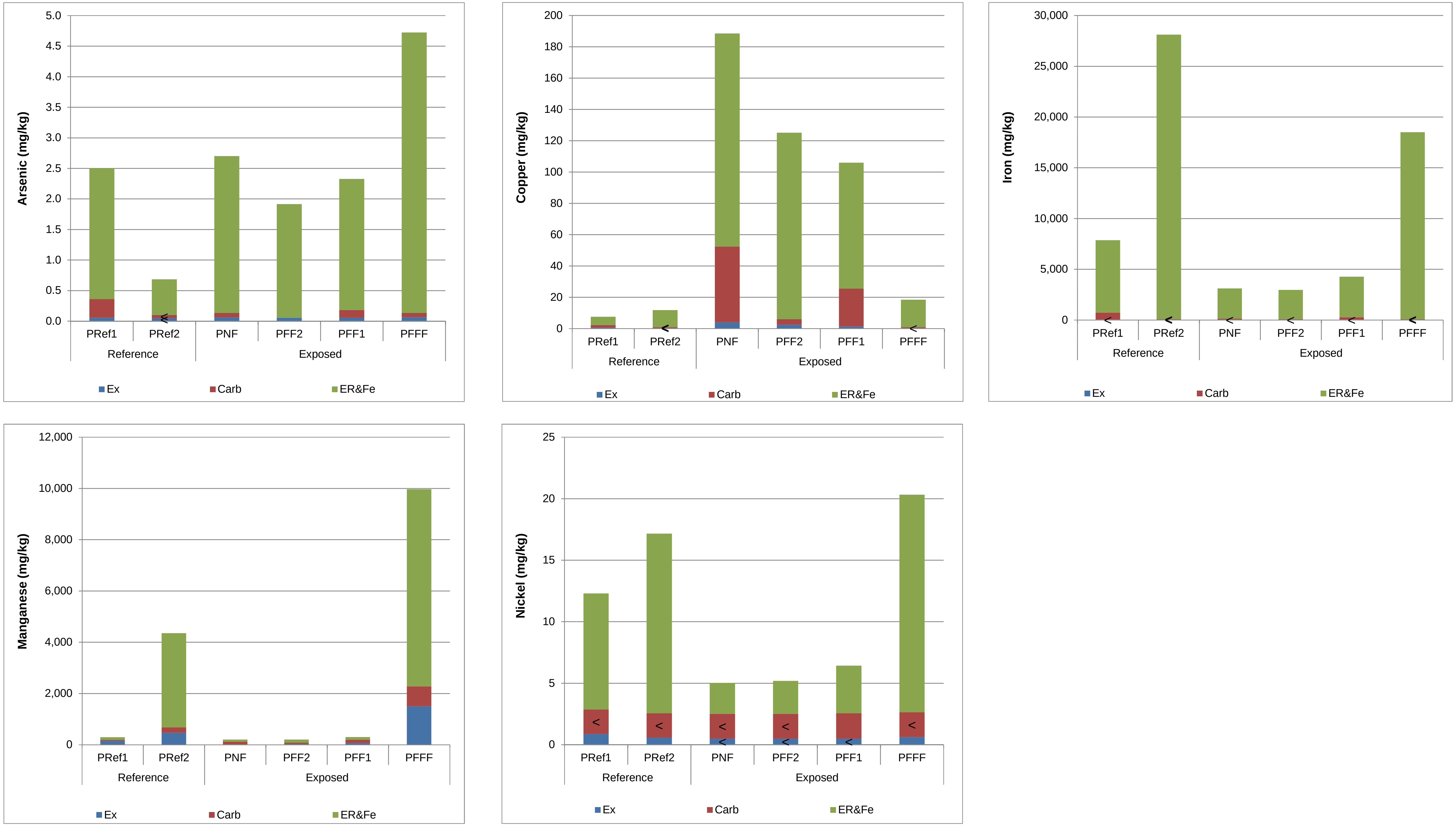


Figure E.31 (c): Mean concentrations of selectively extracted parameters of interest in sediment from the profundal sampling areas of Quesnel Lake, Mount Polley Mine, 2014. Only metals within the Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe) fractions are shown (Organic Bound and Residual metals are excluded).

Values < MDL are indicated with a < symbol. Mean values are plotted for areas with replicate samples (PRef1, PNF, PFF1), single values are plotted for composite samples (PRef2, PFF2, PFFF).

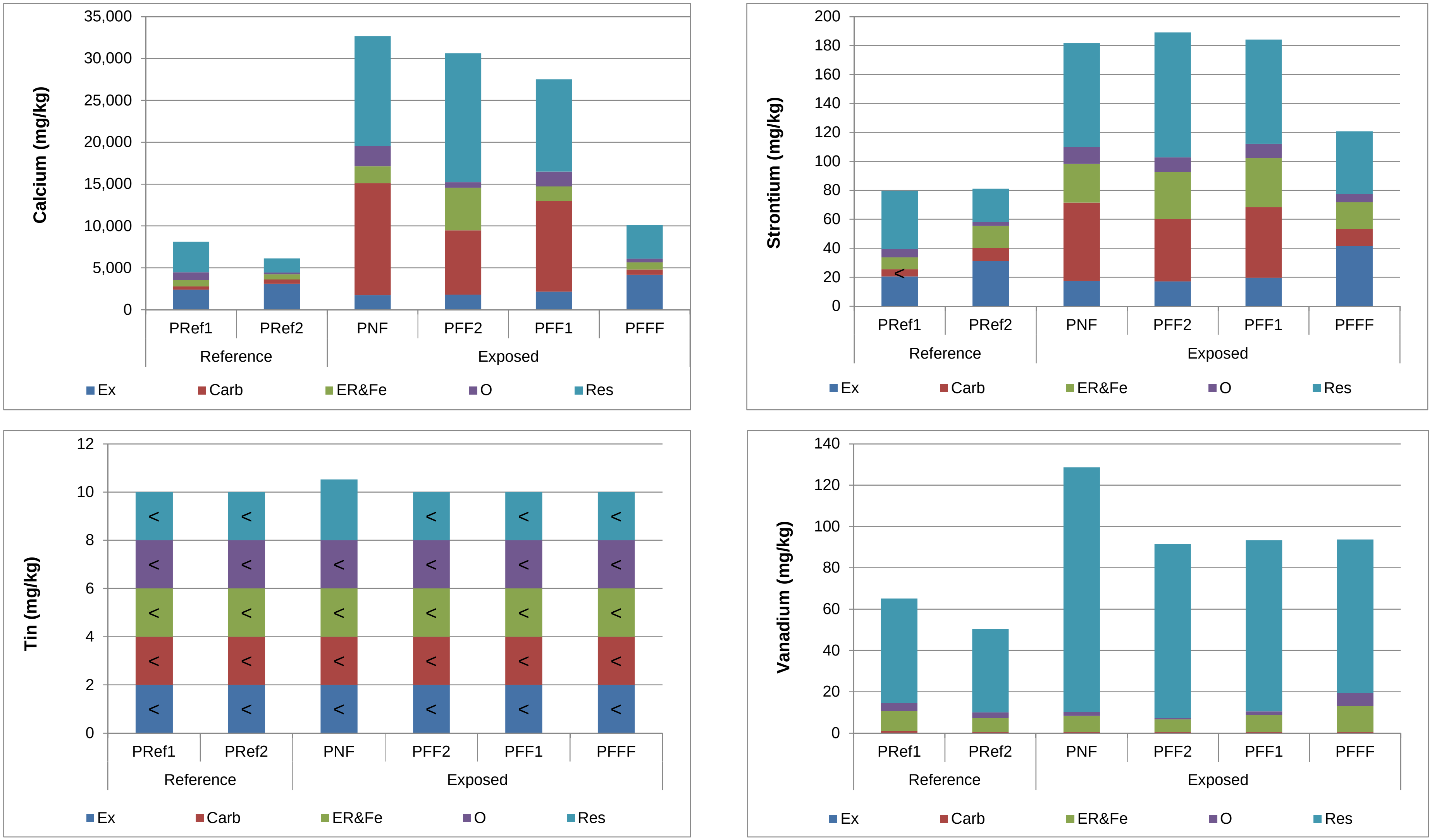


Figure E.32 (a): Mean concentrations of selectively extracted indicator parameters in sediment from the profundal sampling areas of Quesnel Lake, Mount Polley Mine, 2014. Selective extractions included Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe), Organic Bound Metals (O), and Residual Metals (Res).

Values < MDL are indicated with a < symbol. Mean values are plotted for areas with replicate samples (PRef1, PNF, PFF1), single values are plotted for composite samples (PRef2, PFF2, PFFF). Sodium data were available only for the Exchangeable & Adsorbed Metals fraction due to the use of sodium in the second extraction step; sodium was not plotted as a result.

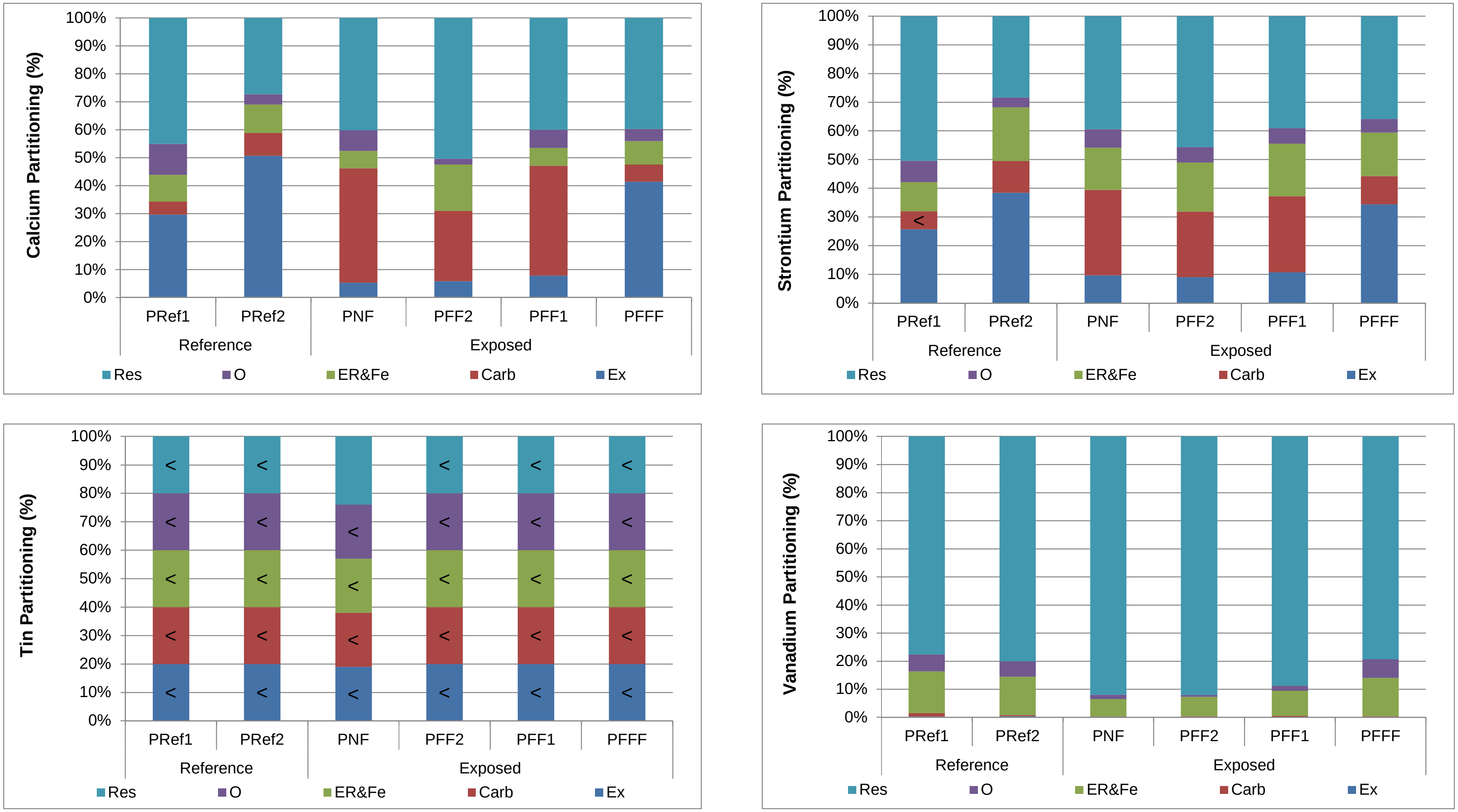


Figure E.32 (b): Partitioning of indicator parameters within selectively extracted fractions of sediment from the profundal sampling areas of Quesnel Lake, Mount Polley Mine, 2014. Selective extractions included Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe), Organic Bound Metals (O), and Residual Metals (Res).

Values < MDL are indicated with a < symbol. Mean values are plotted for areas with replicate samples (PRef1, PNF, PFF1), single values are plotted for composite samples (PRef2, PFF2, PFFF). Sodium data were available only for the Exchangeable & Adsorbed Metals fraction due to the use of sodium in the second extraction step; sodium was not plotted as a result.

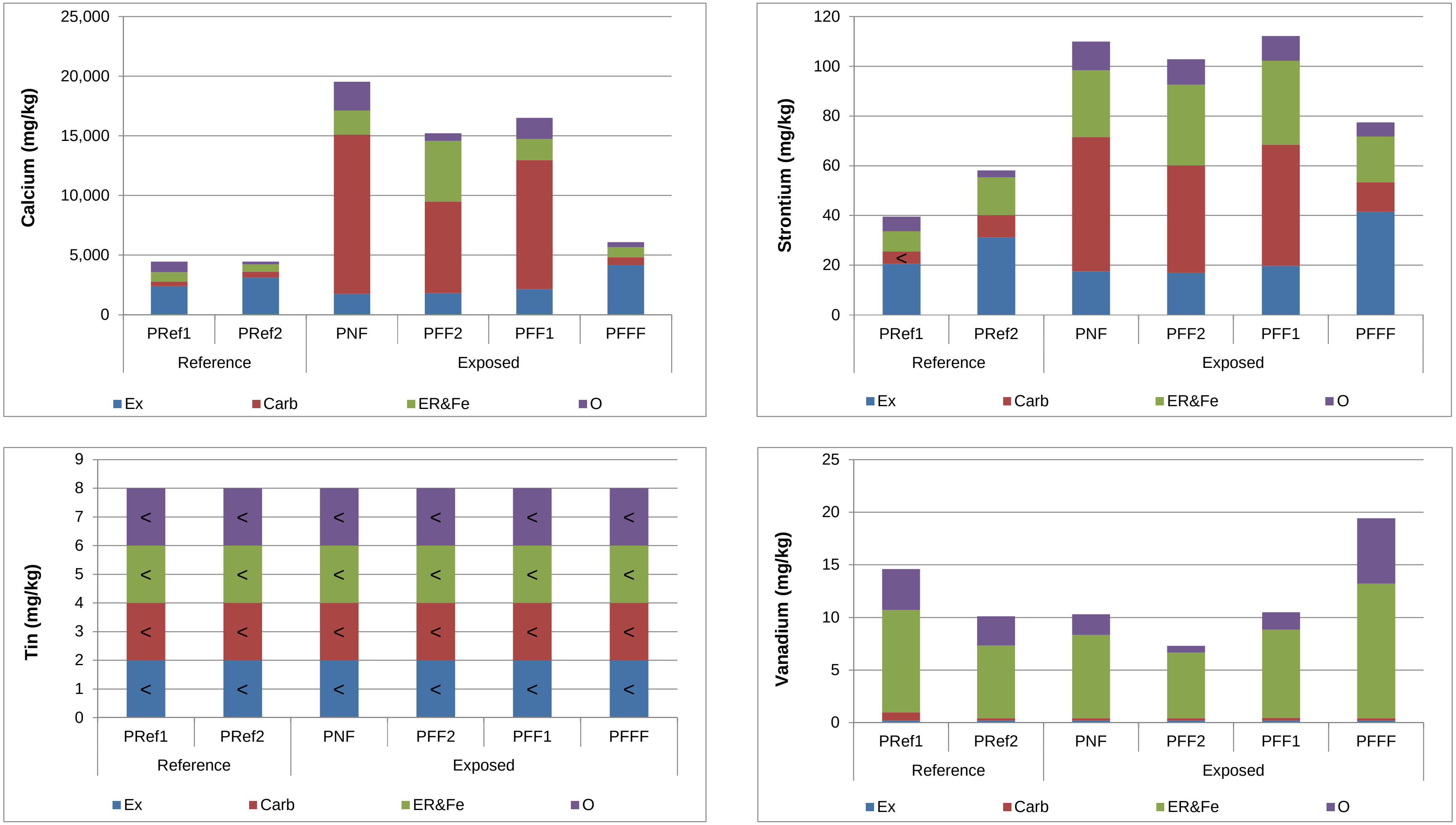


Figure E.32 (c): Mean concentrations of selectively extracted indicator parameters in sediment from the profundal sampling areas of Quesnel Lake, Mount Polley Mine, 2014. Only metals within the Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe) and Organic Bound Metals (O) fractions are shown (Residual metals are excluded).

Values < MDL are indicated with a < symbol. Mean values are plotted for areas with replicate samples (PRef1, PNF, PFF1), single values are plotted for composite samples (PRef2, PFF2, PFFF). Sodium data were available only for the Exchangeable & Adsorbed Metals fraction due to the use of sodium in the second extraction step; sodium was not plotted as a result.

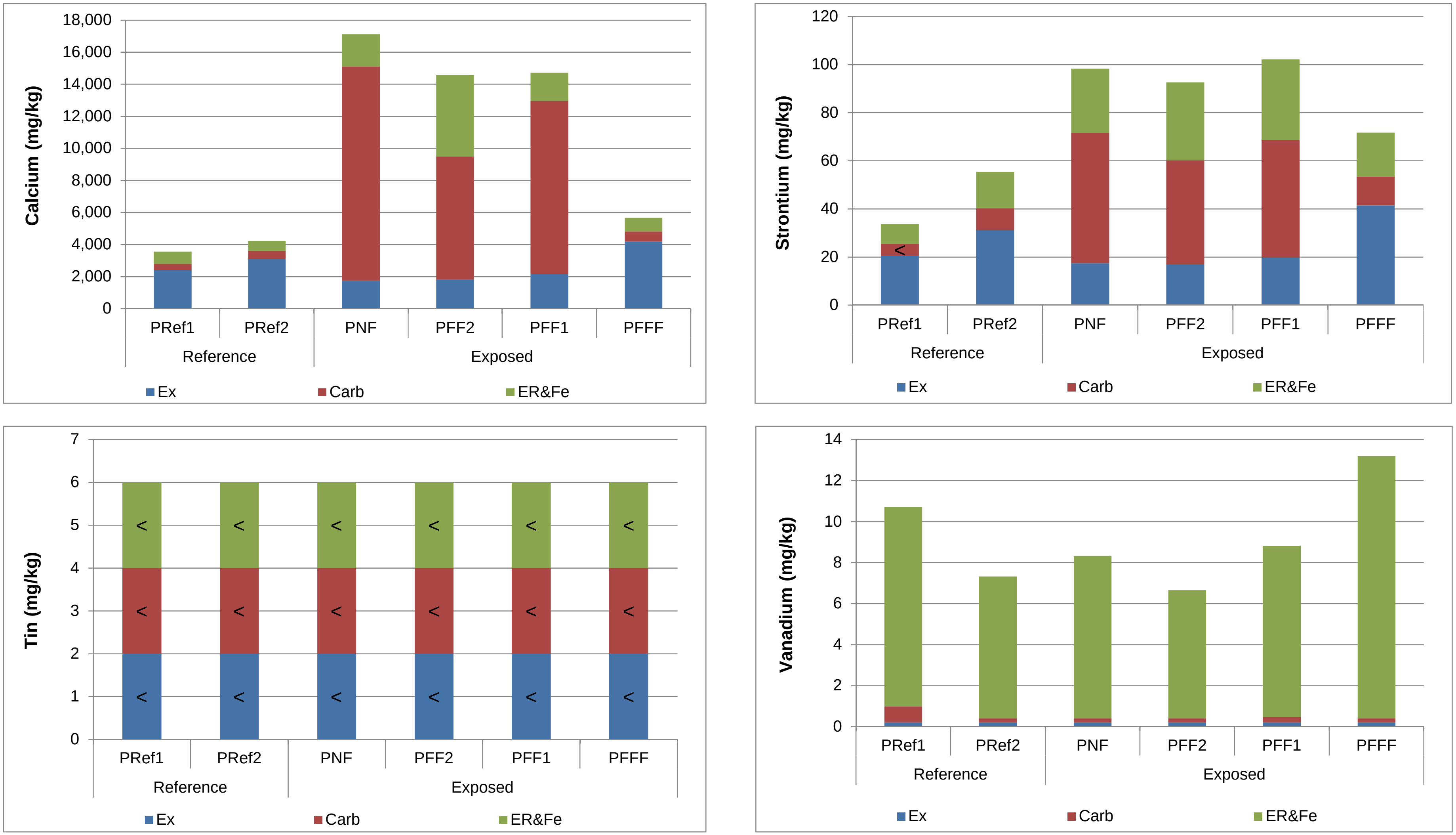


Figure E.32 (d): Mean concentrations of selectively extracted indicator parameters in sediment from the profundal sampling areas of Quesnel Lake, Mount Polley Mine, 2014. Only metals within the Exchangeable & Adsorbed Metals (Ex), Carbonate Metals (Carb), Easily Reducible Metals and Iron Oxides (ER&Fe) fractions are shown (Organic Bound and Residual metals are excluded).

Values < MDL are indicated with a < symbol. Mean values are plotted for areas with replicate samples (PRef1, PNF, PFF1), single values are plotted for composite samples (PRef2, PFF2, PFFF). Sodium data were available only for the Exchangeable & Adsorbed Metals fraction due to the use of sodium in the second extraction step; sodium was not plotted as a result.

Figure E.33: Sediment cores collected from Quesnel Lake near field (QUL-PW-1) for profiles of pore-water (left core) and sediment chemistry (right core).

APPENDIX F

SEDIMENT TOXICITY TEST DATA

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<u>TABLES</u>

FIGURES

Table F.1: Sediment toxicity testing statistical results for *Hyalella azteca* and *Chironomus dilutus*, lake sampling areas relative to applicable field references and lab controls. P-values from statistical comparisons are displayed.

Water Body	Area	Code	Applicable Field Reference(s)	*Hyalella azteca*						*Chironomus dilutus*					
				Survival			Growth			Survival			Growth		
				Lab Control	Field Ref 1	Field Ref 2	Lab Control	Field Ref 1	Field Ref 2	Lab Control	Field Ref 1	Field Ref 2	Lab Control	Field Ref 1	Field Ref 2
Hazeltine Creek	Upper	ST16	n/a	<0.001	-	-	0.003	-	-	0.002	-	-	0.753	-	-
	Middle	ST09	n/a	0.500	-	-	0.270	-	-	0.001	-	-	0.998	-	-
	Lower	ST02	n/a	0.290	-	-	0.098	-	-	0.016	-	-	0.871	-	-
	Lower	HAC50	n/a	0.010	-	-	0.002	-	-	0.002	-	-	0.002	-	-
Polley Lake Deep	North	POL-P1	BOL-B1, BOL-B2	0.187	1.000	1.000	0.091	0.004	0.005	0.379	1.000	0.001	0.600	0.288	0.443
	South	POL-P2	BOL-B1, BOL-B2	0.500	1.000	1.000	0.969	0.374	0.318	0.1057	0.301	0.414	0.887	0.619	0.843
Polley Lake Mid Depth	North	POL-1	BOL-1	0.179	0.218	-	0.863	0.436	-	0.1578	1.000	-	1.000	0.163	-
	South	POL-2	BOL-1	0.500	1.000	-	0.679	0.503	-	0.0089	<0.001	-	0.980	0.443	-
Quesnel Lake Littoral	Near-Field 1	QUL-45	QUL-51, QUL-52	<0.001	0.673	0.098	0.065	0.004	0.637	<0.001	0.096	<0.001	0.002	<0.001	0.000
	Near-Field 2	QUL-49	QUL-51, QUL-52	<0.001	0.582	0.042	0.032	0.215	0.165	1.000	0.001	0.014	1.000	0.140	0.132
	Far-Field	QUL-47	QUL-51, QUL-52	0.500	0.016	0.478	0.984	0.002	<0.001	0.437	<0.001	0.451	0.999	0.135	0.137
	Far-Far-Field	QUL-48	QUL-51, QUL-52	0.813	0.000	0.076	0.500	<0.000	<0.001	0.500	<0.001	0.242	0.849	<0.001	0.048
Quesnel Lake Profundal	Near-Field 1	QULP-1	QULP-5, QULP-6	<0.001	0.006	<0.001	0.006	<0.001	0.368	<0.001	<0.001	<0.001	0.007	<0.001	<0.001
	Downstream Far-Field	QULP-2	QULP-5, QULP-6	0.047	0.190	1.000	0.579	0.003	0.001	<0.001	<0.001	<0.001	0.994	0.823	0.438
	Upstream Far-Field	QULP-3	QULP-5, QULP-6	0.043	1.000	0.139	0.008	<0.001	0.546	0.193	0.166	0.689	0.985	0.621	0.612
	Far-Far-Field	QULP-4	QULP-5, QULP-6	0.005	0.228	0.001	0.001	<0.001	0.011	0.016	<0.001	0.003	0.402	0.024	0.002

Highlighted values indicate significance at the $p < 0.05$ level.

Table F.2: Sediment toxicity test results for *Hyalella azteca and Chironomus dilutus,* Hazeltine Creek, Mount Polley Mine, 2014.

Site	*Hyalella azteca*		*Chironomus dilutus*	
	Survival	**Dry Weight (mg)**	**Survival**	**Dry Weight (mg)**
Lab Control	9	0.066	9	1.6
Lab Control	10	0.086	10	1.5
Lab Control	10	0.12	10	1.9
Lab Control	9	0.052	8	1.7
Lab Control	10	0.12	10	1.9
Mean	**9.6**	**0.089**	**9.4**	**1.7**
Standard Deviation	**0.55**	**0.031**	**0.89**	**0.19**
ST16	4	0.0067	7	2.0
ST16	0	0.0	0	0
ST16	4	0.0075	6	1.3
ST16	0	0.0	2	2.4
ST16	3	0.020	4	1.8
Mean	**2.2**	**0.0068**	**3.8**	**1.5**
Standard Deviation	**2.0**	**0.0082**	**2.9**	**0.94**
% of Lab Control	**23%**	**8%**	**40%**	**87%**
ST09	9	0.076	8	2.1
ST09	10	0.093	7	2.8
ST09	10	0.058	5	2.5
ST09	9	0.084	7	2.1
ST09	10	0.085	5	2.8
Mean	**9.6**	**0.08**	**6.4**	**2.4**
Standard Deviation	**0.55**	**0.013**	**1.3**	**0.33**
% of Lab Control	**100%**	**89%**	**68%**	**140%**
ST02	9	0.042	6	1.7
ST02	9	0.070	10	2.3
ST02	10	0.065	7	2.1
ST02	9	0.090	3	2.3
ST02	10	0.065	3	1.4
Mean	**9.4**	**0.07**	**5.8**	**2.0**
Standard Deviation	**0.55**	**0.017**	**2.9**	**0.39**
% of Lab Control	**98%**	**75%**	**62%**	**113%**
Lab Control for HAC50	10	0.065	10	1.7
Lab Control for HAC50	7	0.086	10	1.8
Lab Control for HAC50	9	0.10	10	1.6
Lab Control for HAC50	10	0.063	10	1.7
Lab Control for HAC50	10	0.11	10	1.5
Mean	**9.2**	**0.086**	**10.0**	**1.7**
Standard Deviation	**1.3**	**0.022**	**0.0**	**0.13**
HAC50	6	0.043	8	0.82
HAC50	4	0.020	6	1.4
HAC50	8	0.031	8	1.3
HAC50	7	0.029	9	0.86
HAC50	7	0.053	9	0.94
Mean	**6.4**	**0.035**	**8.0**	**1.1**
Standard Deviation	**1.5**	**0.013**	**1.2**	**0.27**
% of Lab Control	**70%**	**41%**	**80%**	**63%**

Table F.3: Sediment toxicity test results on *Hyalella azteca* for Polley and Bootjack Lake mid-depth areas. Absolute and normalized data presented for survival and dry weight (mg)

Site	Survival	Dry Weight (mg)	Normalized Survival	Normalized Dry Weight (mg)
Lab Control (Mesh)	10	0.09	8	0.092
Lab Control (Mesh)	10	0.15	8	0.15
Lab Control (Mesh)	10	0.069	8	0.069
Lab Control (Mesh)	10	0.10	8	0.10
Lab Control (Mesh)	9	0.10	7	0.10
Mean	**9.8**	**0.10**	**8.0**	**0.10**
Standard Deviation	**0.45**	**0.031**	**0.37**	**0.031**
BOL-B1-1	9	0.10	7	0.099
BOL-B1-2	10	0.11	8	0.11
BOL-B1-3	9	0.15	7	0.15
BOL-B1-4	10	0.13	8	0.13
BOL-B1-5	10	0.14	8	0.14
Mean	**9.6**	**0.13**	**7.8**	**0.13**
Standard Deviation	**0.55**	**0.021**	**0.45**	**0.021**
BOL-B2-1	10	0.13	8	0.13
BOL-B2-2	8	0.13	7	0.13
BOL-B2-3	9	0.082	7	0.082
BOL-B2-4	10	0.15	8	0.15
BOL-B2-5	10	0.13	8	0.13
Mean	**9.4**	**0.12**	**7.7**	**0.12**
Standard Deviation	**0.89**	**0.025**	**0.73**	**0.025**
POL-P2-1	9	0.11	7	0.11
POL-P2-2	10	0.15	8	0.15
POL-P2-3	10	0.16	8	0.16
POL-P2-4	10	0.17	8	0.17
POL-P2-5	9	0.12	7	0.12
Mean	**9.6**	**0.14**	**7.8**	**0.14**
Standard Deviation	**0.55**	**0.025**	**0.45**	**0.025**
Lab Control for POL-P1	10	0.12	8	0.053
Lab Control for POL-P1	10	0.22	8	0.098
Lab Control for POL-P1	10	0.19	8	0.086
Lab Control for POL-P1	10	0.23	8	0.10
Lab Control for POL-P1	10	0.21	8	0.097
Mean	**10.0**	**0.19**	**8.0**	**0.087**
Standard Deviation	**0.0**	**0.045**	**0.0**	**0.020**
POL-P1-1	10	0.18	8	0.081
POL-P1-2	10	0.14	8	0.064
POL-P1-3	10	0.20	8	0.090
POL-P1-4	9	0.13	7	0.059
POL-P1-5	10	0.14	8	0.063
Mean	**9.8**	**0.16**	**7.8**	**0.071**
Standard Deviation	**0.45**	**0.030**	**0.36**	**0.013**

Table F.4: Sediment toxicity test results on *Hyalella azteca* for Polley and Bootjack Lake deep areas. Absolute and normalized data presented for survival and dry weight (mg)

Site	Survival	Dry Weight (mg)	Normalized Survival	Normalized Dry Weight (mg)
Lab Control (Mesh)	10	0.09	8	0.09
Lab Control (Mesh)	10	0.15	8	0.15
Lab Control (Mesh)	10	0.069	8	0.069
Lab Control (Mesh)	10	0.10	8	0.10
Lab Control (Mesh)	9	0.10	7	0.10
Mean	**9.8**	**0.10**	**8.0**	**0.10**
Standard Deviation	**0.45**	**0.031**	**0.37**	**0.031**
BOL-1-1	10	0.14	8	0.14
BOL-1-2	10	0.14	8	0.14
BOL-1-3	10	0.10	8	0.10
BOL-1-4	10	0.11	8	0.11
BOL-1-5	9	0.11	7	0.11
Mean	**9.8**	**0.12**	**8.0**	**0.12**
Standard Deviation	**0.45**	**0.018**	**0.37**	**0.018**
POL-2-1	10	0.11	8	0.11
POL-2-2	10	0.15	8	0.15
POL-2-3	10	0.094	8	0.094
POL-2-4	10	0.11	8	0.11
POL-2-5	9	0.084	7	0.084
Mean	**9.8**	**0.11**	**8.0**	**0.11**
Standard Deviation	**0.45**	**0.025**	**0.37**	**0.025**
POL-1-1	10	0.20	8	0.20
POL-1-2	9	0.16	7	0.16
POL-1-3	9	0.11	7	0.11
POL-1-4	8	0.069	7	0.069
POL-1-5	9	0.13	7	0.13
Mean	**9.0**	**0.13**	**7.3**	**0.13**
Standard Deviation	**0.71**	**0.049**	**0.58**	**0.049**

Table F.5: Sediment toxicity test results on *Chironomus dilutus* for Polley and Bootjack Lake mid-depth areas. Absolute and normalized data presented for survival and dry weight (mg)

Site	Survival	Dry Weight (mg)	Normalized Survival	Normalized Dry Weight (mg)
Lab Control (Sediment)	10	1.7	8	1.7
Lab Control (Sediment)	9	1.8	7	1.8
Lab Control (Sediment)	9	1.7	7	1.7
Lab Control (Sediment)	7	1.8	6	1.8
Lab Control (Sediment)	9	1.9	7	1.9
Mean	**8.8**	**1.8**	**7.0**	**1.8**
Standard Deviation	**1.1**	**0.10**	**0.87**	**0.10**
BOL-B1-1	9	2.0	7	2.0
BOL-B1-2	10	1.3	8	1.3
BOL-B1-3	9	2.2	7	2.2
BOL-B1-4	7	2.4	6	2.4
BOL-B1-5	8	2.4	6	2.4
Mean	**8.6**	**2.1**	**6.8**	**2.1**
Standard Deviation	**1.1**	**0.43**	**0.91**	**0.43**
BOL-B2-1	7	1.6	6	1.6
BOL-B2-2	5	2.0	4	2.0
BOL-B2-3	6	2.0	5	2.0
BOL-B2-4	9	2.3	7	2.3
BOL-B2-5	8	2.2	6	2.2
Mean	**7.0**	**2.0**	**5.6**	**2.0**
Standard Deviation	**1.6**	**0.26**	**1.3**	**0.26**
POL-P2-1	9	1.6	7	1.6
POL-P2-2	8	2.1	6	2.1
POL-P2-3	7	1.8	6	1.8
POL-P2-4	9	2.1	7	2.1
POL-P2-5	6	2.2	5	2.2
Mean	**7.8**	**2.0**	**6.2**	**2.0**
Standard Deviation	**1.3**	**0.25**	**1.0**	**0.25**
Lab Control for POL-P1	10	1.8	8	1.8
Lab Control for POL-P1	9	1.5	7	1.5
Lab Control for POL-P1	8	1.9	6	2.0
Lab Control for POL-P1	10	1.6	8	1.7
Lab Control for POL-P1	9	2.0	7	2.0
Mean	**9.2**	**1.7**	**7.0**	**1.8**
Standard Deviation	**0.84**	**0.20**	**0.64**	**0.21**
POL-P1-1	10	1.6	8	1.7
POL-P1-2	8	2.1	6	2.2
POL-P1-3	9	1.8	7	1.8
POL-P1-4	10	1.8	8	1.8
POL-P1-5	8	1.7	6	1.7
Mean	**9.0**	**1.8**	**6.8**	**1.8**
Standard Deviation	**1.0**	**0.20**	**0.76**	**0.20**

Table F.6: Sediment toxicity test results on *Chironomus dilutus* for Polley and Bootjack Lake deep areas. Absolute and normalized data presented for survival and dry weight (mg)

Site	Survival	Dry Weight (mg)	Normalized Survival	Normalized Dry Weight (mg)
Lab Control (Sediment)	10	1.7	8	1.7
Lab Control (Sediment)	9	1.8	7	1.8
Lab Control (Sediment)	9	1.7	7	1.7
Lab Control (Sediment)	7	1.8	6	1.8
Lab Control (Sediment)	9	1.9	7	1.9
Mean	**8.8**	**1.8**	**7.0**	**1.8**
Standard Deviation	**1.1**	**0.10**	**0.87**	**0.10**
BOL-1-1	8	2.1	6	2.1
BOL-1-2	9	2.3	7	2.3
BOL-1-3	9	2.1	7	2.1
BOL-1-4	9	2.5	7	2.5
BOL-1-5	8	2.3	6	2.3
Mean	**8.6**	**2.2**	**6.8**	**2.2**
Standard Deviation	**0.55**	**0.15**	**0.44**	**0.15**
POL-2-1	6	2.8	5	2.8
POL-2-2	8	1.7	6	1.7
POL-2-3	5	2.3	4	2.3
POL-2-4	8	2.1	6	2.1
POL-2-5	5	3.1	4	3.1
Mean	**6.4**	**2.4**	**5.1**	**2.4**
Standard Deviation	**1.5**	**0.55**	**1.21**	**0.55**
POL-1-1	8	2.3	6	2.3
POL-1-2	9	2.7	7	2.7
POL-1-3	8	2.5	6	2.5
POL-1-4	9	2.2	7	2.2
POL-1-5	7	3.0	6	3.0
Mean	**8.2**	**2.6**	**6.5**	**2.6**
Standard Deviation	**0.84**	**0.31**	**0.67**	**0.31**

Table F.7: Sediment toxicity test results on *Hyalella azteca* for Quesnel Lake Littoral Areas. Absolute and normalized data presented for survival and dry weight (mg)

Site	Survival	Dry Weight (mg)	Normalized Survival	Normalized Dry Weight (mg)
Lab Control for LRef2	10	0.12	8	0.053
Lab Control for LRef2	10	0.22	8	0.10
Lab Control for LRef2	10	0.19	8	0.086
Lab Control for LRef2	10	0.23	8	0.10
Lab Control for LRef2	10	0.21	8	0.10
Mean	**10.0**	**0.19**	**8.0**	**0.087**
Standard Deviation	**0.0**	**0.045**	**0.0**	**0.020**
Lab Control for LFFF	10	0.078	8	0.084
Lab Control for LFFF	9	0.10	7	0.11
Lab Control for LFFF	10	0.10	8	0.11
Lab Control for LFFF	10	0.12	8	0.12
Lab Control for LFFF	10	0.12	8	0.13
Mean	**9.8**	**0.10**	**8.0**	**0.11**
Standard Deviation	**0.45**	**0.016**	**0.37**	**0.017**
Lab Control for LFF	9	0.086	8	0.10
Lab Control for LFF	10	0.081	8	0.10
Lab Control for LFF	10	0.11	8	0.13
Lab Control for LFF	9	0.12	8	0.14
Lab Control for LFF	10	0.073	8	0.087
Mean	**9.6**	**0.093**	**8.0**	**0.11**
Standard Deviation	**0.55**	**0.018**	**0.46**	**0.022**
Lab Control for LNF1	10	0.071	9	0.10
Lab Control for LNF1	10	0.050	9	0.073
Lab Control for LNF1	9	0.053	8	0.078
Lab Control for LNF1	8	0.15	7	0.22
Lab Control for LNF1	10	0.055	9	0.080
Mean	**9.4**	**0.076**	**8.0**	**0.11**
Standard Deviation	**0.89**	**0.043**	**0.76**	**0.062**
Lab Control for LRef1, LNF2	9	0.089	8	0.089
Lab Control for LRef1, LNF2	10	0.11	8	0.11
Lab Control for LRef1, LNF2	10	0.13	8	0.13
Lab Control for LRef1, LNF2	9	0.10	8	0.10
Lab Control for LRef1, LNF2	10	0.13	8	0.13
Mean	**9.6**	**0.11**	**8.0**	**0.11**
Standard Deviation	**0.55**	**0.017**	**0.46**	**0.017**
LRef1-1-01	10	0.040	8	0.040
LRef1-1-02	10	0.10	8	0.10
LRef1-1-03	10	0.083	8	0.083
LRef1-1-04	9	0.10	8	0.10
LRef1-1-05	2	0.060	2	0.060
Mean/Station	8.2	0.077	6.8	0.077
Standard Deviation/Station	3.5	0.026	2.9	0.026
LRef1-2-01	10	0.12	8	0.12
LRef1-2-02	9	0.17	8	0.174
LRef1-2-03	10	0.15	8	0.15
LRef1-2-04	9	0.12	8	0.12
LRef1-2-05	10	0.079	8	0.079
Mean/Station	9.6	0.13	8.0	0.13
Standard Deviation/Station	0.55	0.035	0.46	0.035
LRef1-3-01	10	0.10	8	0.10
LRef1-3-02	9	0.088	8	0.088
LRef1-3-03	9	0.031	8	0.031
LRef1-3-04	9	0.13	8	0.13
LRef1-3-05	2	0.065	2	0.065
Mean/Station	7.8	0.081	6.5	0.081
Standard Deviation/Station	3.3	0.036	2.7	0.036
LRef1-4-01	9	0.10	8	0.10
LRef1-4-02	10	0.098	8	0.098
LRef1-4-03	7	0.077	6	0.077
LRef1-4-04	4	0.075	3	0.075
LRef1-4-05	7	0.076	6	0.076
Mean/Station	7.4	0.086	6.2	0.086
Standard Deviation/Station	2.3	0.014	1.9	0.014
LRef1-5-01	10	0.14	8	0.14
LRef1-5-02	10	0.13	8	0.13
LRef1-5-03	10	0.14	8	0.14
LRef1-5-04	10	0.10	8	0.10
LRef1-5-05	8	0.16	7	0.16
Mean/Station	9.6	0.13	8.0	0.13
Standard Deviation/Station	0.89	0.020	0.75	0.020
Mean/Area [a]	**8.5**	**0.10**	**7.1**	**0.10**
Standard Deviation/Area [a]	**2.1**	**0.026**	**1.8**	**0.026**

Table F.7: Sediment toxicity test results on *Hyalella azteca* for Quesnel Lake Littoral Areas.
Absolute and normalized data presented for survival and dry weight (mg)

Site	Survival	Dry Weight (mg)	Normalized Survival	Normalized Dry Weight (mg)
LRef2-1	10	0.13	8	0.074
LRef2-2	9	0.11	7	0.063
LRef2-3	10	0.10	8	0.055
LRef2-4	8	0.15	6	0.086
LRef2-5	10	0.13	8	0.075
Mean	**9.4**	**0.12**	**7.5**	**0.070**
Standard Deviation	**0.89**	**0.021**	**0.72**	**0.012**
LNF1-1-01	10	0.040	8.5	0.058
LNF1-1-02	9	0.037	8	0.053
LNF1-1-03	8	0.032	7	0.047
LNF1-1-04	6	0.053	5	0.078
LNF1-1-05	10	0.036	9	0.052
Mean/Station	8.6	0.040	7.3	0.058
Standard Deviation/Station	1.7	0.0081	1.4	0.012
LNF1-2-01	7	0.066	6	0.096
LNF1-2-02	8	0.069	7	0.10
LNF1-2-03	6	0.065	5	0.095
LNF1-2-04	8	0.060	7	0.087
LNF1-2-05	7	0.056	6	0.081
Mean/Station	7.2	0.063	6.1	0.092
Standard Deviation/Station	0.84	0.0052	0.71	0.0075
LNF1-3-01	9	0.034	8	0.050
LNF1-3-02	8	0.050	7	0.073
LNF1-3-03	8	0.066	7	0.096
LNF1-3-04	10	0.074	9	0.11
LNF1-3-05	9	0.061	8	0.089
Mean/Station	8.8	0.057	7.5	0.083
Standard Deviation/Station	0.84	0.015	0.71	0.022
LNF1-4-01	8	0.032	7	0.047
LNF1-4-02	10	0.045	9	0.066
LNF1-4-03	5	0.042	4	0.061
LNF1-4-04	9	0.044	8	0.065
LNF1-4-05	7	0.076	6	0.11
Mean/Station	7.8	0.048	6.6	0.070
Standard Deviation/Station	1.9	0.016	1.6	0.024
LNF1-5-01	7	0.033	6	0.048
LNF1-5-02	6	0.058	5	0.085
LNF1-5-03	8	0.043	7	0.062
LNF1-5-04	10	0.043	9	0.063
LNF1-5-05	7	0.079	6	0.11
Mean/Station	7.6	0.051	6.5	0.074
Standard Deviation/Station	1.5	0.018	1.3	0.026
Mean/Area [a]	**8.0**	**0.052**	**6.8**	**0.075**
Standard Deviation/Area [a]	**1.4**	**0.013**	**1.2**	**0.018**

Table F.7: Sediment toxicity test results on *Hyalella azteca* for Quesnel Lake Littoral Areas. Absolute and normalized data presented for survival and dry weight (mg)

Site	Survival	Dry Weight (mg)	Normalized Survival	Normalized Dry Weight (mg)
LNF2-1-01	10	0.14	8	0.14
LNF2-1-02	9	0.11	8	0.11
LNF2-1-03	9	0.10	8	0.10
LNF2-1-04	0	0.0	0	0.0
LNF2-1-05	3	0.040	3	0.040
Mean/Station	6.2	0.077	5.2	0.077
Standard Deviation/Station	4.4	0.057	3.7	0.057
LNF2-2-01	9	0.13	8	0.13
LNF2-2-02	9	0.089	8	0.089
LNF2-2-03	10	0.088	8	0.088
LNF2-2-04	10	0.12	8	0.12
LNF2-2-05	9	0.10	8	0.10
Mean/Station	9.4	0.11	7.8	0.11
Standard Deviation/Station	0.55	0.019	0.46	0.019
LNF2-3-01	8	0.051	7	0.051
LNF2-3-02	10	0.10	8	0.10
LNF2-3-03	10	0.13	8	0.13
LNF2-3-04	8	0.13	7	0.13
LNF2-3-05	7	0.09	6	0.09
Mean/Station	8.6	0.099	7.2	0.099
Standard Deviation/Station	1.3	0.032	1.1	0.032
LNF2-4-01	9	0.061	8	0.061
LNF2-4-02	10	0.071	8	0.071
LNF2-4-03	9	0.12	8	0.12
LNF2-4-04	9	0.064	8	0.064
LNF2-4-05	8	0.088	7	0.088
Mean/Station	9.0	0.081	7.5	0.081
Standard Deviation/Station	0.71	0.025	0.59	0.025
LNF2-5-01	7	0.049	6	0.049
LNF2-5-02	10	0.059	8	0.059
LNF2-5-03	7	0.061	6	0.061
LNF2-5-04	5	0.052	4	0.052
LNF2-5-05	6	0.063	5	0.063
Mean/Station	7.0	0.057	5.8	0.057
Standard Deviation/Station	1.9	0.0063	1.6	0.0063
Mean/Area [a]	**8.0**	**0.084**	**6.7**	**0.084**
Standard Deviation/Area [a]	**1.8**	**0.028**	**1.5**	**0.028**
LFF-1	10	0.11	8	0.13
LFF-2	10	0.15	8	0.18
LFF-3	9	0.11	8	0.13
LFF-4	10	0.13	8	0.16
LFF-5	9	0.11	8	0.13
Mean	**9.6**	**0.12**	**8.0**	**0.15**
Standard Deviation	**0.55**	**0.018**	**0.46**	**0.0220**
LFFF-1	10	0.18	8	0.19
LFFF-2	10	0.16	8	0.17
LFFF-3	10	0.16	8	0.17
LFFF-4	10	0.16	8	0.18
LFFF-5	10	0.17	8	0.19
Mean	**10.0**	**0.17**	**8.2**	**0.181**
Standard Deviation	**0.0**	**0.0086**	**0.0**	**0.0093**

[a] For areas with replication within a station, the mean and standard deviation per area were calculated by taking the mean of each station's mean and standard deviation.

Table F.8: Sediment toxicity test results on *Chironomus dilutus* for Quesnel Lake Littoral Areas. Absolute and normalized data presented for survival and dry weight (mg)

Site	Survival	Dry Weight (mg)	Normalized Survival	Normalized Dry Weight (mg)
Lab Control for LRef2	10	1.8	8	1.8
Lab Control for LRef2	9	1.5	7	1.5
Lab Control for LRef2	8	1.9	6	2.0
Lab Control for LRef2	10	1.6	8	1.7
Lab Control for LRef2	9	2.0	7	2.0
Mean	**9.2**	**1.7**	**7.0**	**1.8**
Standard Deviation	**0.84**	**0.20**	**0.64**	**0.21**
Lab Control for LFFF	9	1.9	7	1.6
Lab Control for LFFF	9	2.2	7	1.8
Lab Control for LFFF	10	1.9	7	1.5
Lab Control for LFFF	10	1.9	7	1.6
Lab Control for LFFF	9	2.3	7	1.9
Mean	**9.4**	**2.0**	**7.0**	**1.7**
Standard Deviation	**0.55**	**0.18**	**0.41**	**0.15**
Lab Control for LFF	8	1.7	6	1.6
Lab Control for LFF	9	1.8	7	1.8
Lab Control for LFF	10	1.7	7	1.6
Lab Control for LFF	10	1.6	7	1.6
Lab Control for LFF	10	1.8	7	1.7
Mean	**9.4**	**1.7**	**7.0**	**1.7**
Standard Deviation	**0.89**	**0.083**	**0.67**	**0.081**
Lab Control for LNF1	7	2.0	7	1.7
Lab Control for LNF1	9	1.6	9	1.4
Lab Control for LNF1	6	2.1	6	1.8
Lab Control for LNF1	9	1.6	9	1.4
Lab Control for LNF1	6	2.2	6	1.9
Mean	**7.4**	**1.9**	**7.0**	**1.7**
Standard Deviation	**1.5**	**0.25**	**1.4**	**0.22**
Lab Control for LRef1, LNF2	10	1.8	7	1.8
Lab Control for LRef1, LNF2	9	1.5	7	1.5
Lab Control for LRef1, LNF2	10	1.8	7	1.8
Lab Control for LRef1, LNF2	9	1.8	7	1.8
Lab Control for LRef1, LNF2	10	1.6	7	1.6
Mean	**9.6**	**1.7**	**7.0**	**1.7**
Standard Deviation	**0.55**	**0.13**	**0.40**	**0.13**
LRef1-1-01	9	2.7	7	2.7
LRef1-1-02	7	2.5	5	2.5
LRef1-1-03	5	3.4	4	3.4
LRef1-1-04	7	2.4	5	2.4
LRef1-1-05	7	2.8	5	2.8
Mean/Station	7.0	2.8	5.1	2.8
Standard Deviation/Station	1.4	0.39	1.0	0.39
LRef1-2-01	6	2.6	4	2.6
LRef1-2-02	6	3.3	4	3.3
LRef1-2-03	9	2.6	7	2.6
LRef1-2-04	9	3.0	7	3.0
LRef1-2-05	9	2.4	7	2.4
Mean/Station	7.8	2.8	5.7	2.8
Standard Deviation/Station	1.6	0.35	1.2	0.35
LRef1-3-01	6	3.2	4	3.2
LRef1-3-02	9	3.0	7	3.0
LRef1-3-03	10	2.8	7	2.8
LRef1-3-04	4	3.3	3	3.3
LRef1-3-05	10	2.7	7	2.7
Mean/Station	7.8	3.0	5.7	3.0
Standard Deviation/Station	2.7	0.23	2.0	0.23
LRef1-4-01	2	4.9	1	4.9
LRef1-4-02	7	3.2	5	3.2
LRef1-4-03	2	5.5	1	5.5
LRef1-4-04	5	4.1	4	4.1
LRef1-4-05	3	5.4	2	5.4
Mean/Station	3.8	4.6	2.8	4.6
Standard Deviation/Station	2.2	0.96	1.6	0.96
LRef1-5-01	8	3.6	6	3.6
LRef1-5-02	8	3.5	6	3.5
LRef1-5-03	8	3.4	6	3.4
LRef1-5-04	6	3.2	4	3.2
LRef1-5-05	10	3.3	7	3.3
Mean/Station	8.0	3.4	5.8	3.4
Standard Deviation/Station	1.4	0.18	1.0	0.18
Mean/Area [a]	**6.9**	**3.3**	**5.0**	**3.3**
Standard Deviation/Area [a]	**1.9**	**0.42**	**1.4**	**0.42**

Table F.8: Sediment toxicity test results on *Chironomus dilutus* for Quesnel Lake Littoral Areas. Absolute and normalized data presented for survival and dry weight (mg)

Site	Survival	Dry Weight (mg)	Normalized Survival	Normalized Dry Weight (mg)
LRef2-1	9	2.6	7	2.5
LRef2-2	10	2.3	8	2.2
LRef2-3	10	2.1	8	2.0
LRef2-4	8	3.1	6	3.0
LRef2-5	10	2.6	8	2.5
Mean	**9.4**	**2.5**	**7.2**	**2.4**
Standard Deviation	**0.89**	**0.39**	**0.68**	**0.37**
LNF1-1-01	3	1.6	2.8	1.4
LNF1-1-02	5	2.0	5	1.7
LNF1-1-03	7	1.5	7	1.3
LNF1-1-04	2	0.6	2	0.6
LNF1-1-05	5	1.2	5	1.0
Mean/Station	4.4	1.4	4.2	1.2
Standard Deviation/Station	1.9	0.50	1.8	0.44
LNF1-2-01	6	2.2	6	1.9
LNF1-2-02	5	2.1	5	1.9
LNF1-2-03	4	1.4	4	1.23
LNF1-2-04	8	1.8	8	1.5
LNF1-2-05	1	0.7	1	0.6
Mean/Station	4.8	1.6	4.5	1.4
Standard Deviation/Station	2.6	0.62	2.4	0.55
LNF1-3-01	1	1.0	1	0.9
LNF1-3-02	4	1.0	4	0.9
LNF1-3-03	1	0.7	1	0.6
LNF1-3-04	6	1.8	6	1.6
LNF1-3-05	3	0.9	3	0.8
Mean/Station	3.0	1.1	2.8	0.9
Standard Deviation/Station	2.1	0.43	2.0	0.37
LNF1-4-01	5	2.0	5	1.8
LNF1-4-02	4	1.0	4	0.8
LNF1-4-03	3	1.0	3	0.9
LNF1-4-04	5	1.1	5	0.9
LNF1-4-05	4	1.2	4	1.0
Mean/Station	4.2	1.2	4.0	1.1
Standard Deviation/Station	0.84	0.43	0.79	0.38
LNF1-5-01	6	1.2	6	1.0
LNF1-5-02	10	1.3	9	1.2
LNF1-5-03	5	1.3	5	1.2
LNF1-5-04	6	1.3	6	1.1
LNF1-5-05	3	0.9	3	0.8
Mean/Station	6.0	1.2	5.7	1.1
Standard Deviation/Station	2.5	0.17	2.4	0.15
Mean/Area [a]	**4.5**	**1.3**	**4.2**	**1.1**
Standard Deviation/Area [a]	**2.0**	**0.43**	**1.9**	**0.38**

Table F.8: Sediment toxicity test results on *Chironomus dilutus* for Quesnel Lake Littoral Areas. Absolute and normalized data presented for survival and dry weight (mg)

Site	Survival	Dry Weight (mg)	Normalized Survival	Normalized Dry Weight (mg)
LNF2-1-01	8	3.0	6	3.0
LNF2-1-02	6	2.5	4	2.5
LNF2-1-03	7	2.7	5	2.7
LNF2-1-04	9	2.3	7	2.3
LNF2-1-05	10	2.7	7	2.7
Mean/Station	8.0	2.6	5.8	2.6
Standard Deviation/Station	1.6	0.25	1.2	0.25
LNF2-2-01	9	3.0	7	3.0
LNF2-2-02	9	2.9	7	2.9
LNF2-2-03	9	3.1	7	3.1
LNF2-2-04	6	2.3	4	2.3
LNF2-2-05	10	2.8	7	2.8
Mean/Station	8.6	2.8	6.3	2.8
Standard Deviation/Station	1.5	0.30	1.1	0.30
LNF2-3-01	7	3.6	5	3.6
LNF2-3-02	8	3.6	6	3.6
LNF2-3-03	10	2.8	7	2.8
LNF2-3-04	9	3.1	7	3.1
LNF2-3-05	7	3.6	5	3.6
Mean/Station	8.2	3.3	6.0	3.3
Standard Deviation/Station	1.3	0.36	1.0	0.36
LNF2-4-01	7	3.4	5	3.4
LNF2-4-02	10	2.9	7	2.9
LNF2-4-03	8	3.1	6	3.1
LNF2-4-04	8	2.6	6	2.6
LNF2-4-05	9	2.0	7	2.0
Mean/Station	8.4	2.8	6.1	2.8
Standard Deviation/Station	1.1	0.55	0.83	0.55
LNF2-5-01	9	2.4	7	2.4
LNF2-5-02	9	3.6	7	3.6
LNF2-5-03	10	2.4	7	2.4
LNF2-5-04	10	2.5	7	2.5
LNF2-5-05	9	2.7	7	2.7
Mean/Station	9.4	2.7	6.9	2.7
Standard Deviation/Station	0.55	0.48	0.40	0.48
Mean/Area [a]	**8.5**	**2.9**	**6.2**	**2.9**
Standard Deviation/Area [a]	**1.2**	**0.39**	**0.89**	**0.39**
LFF-1	9	2.4	7	2.3
LFF-2	8	2.8	6	2.7
LFF-3	10	2.9	7	2.9
LFF-4	9	3.9	7	3.8
LFF-5	9	2.7	7	2.6
Mean	**9.0**	**2.9**	**6.7**	**2.9**
Standard Deviation	**0.71**	**0.58**	**0.53**	**0.56**
LFFF-1	6	2.0	4	1.7
LFFF-2	10	2.0	7	1.6
LFFF-3	9	2.1	7	1.7
LFFF-4	10	2.3	7	1.9
LFFF-5	9	2.8	7	2.3
Mean	**8.8**	**2.2**	**6.6**	**1.8**
Standard Deviation	**1.6**	**0.34**	**1.2**	**0.28**

[a] For areas with replication within a station, the mean and standard deviation per area were calculated by taking the mean of each station's mean and standard deviation.

Table F.9: Sediment toxicity testing statistical results for *Hyalella azteca* and *Chironomus dilutus from n*ear field station replicates against applicable field references and lab control replicates, Quesnel Lake littoral areas, Mount Polley Mine, 2014. P-values from statistical comparisons are displayed.

Water Body	Station	Code	*Hyalella azteca*												*Chironomus dilutus*											
			Survival						Growth						Survival						Growth					
			Lab Control	QUL-51					Lab Control	QUL-51					Lab Control	QUL-51					Lab Control	QUL-51				
				01	02	03	04	05		01	02	03	04	05		01	02	03	04	05		01	02	03	04	05
Quesnel Lake Littoral	Near-Field 1	QUL-45-01	0.198	1.000	0.683	0.326	0.008	0.683	0.040	0.275	<0.001	0.147	0.071	<0.001	0.014	0.163	<0.001	<0.001	0.001	<0.001	0.031	<0.001	<0.001	<0.001	<0.001	<0.001
		QUL-45-02	0.002	0.865	<0.001	1.000	1.000	<0.001	0.437	0.331	0.031	0.543	0.808	0.012	0.045	1.000	0.017	0.021	<0.001	0.005	0.190	<0.001	<0.001	<0.001	<0.001	<0.001
		QUL-45-03	0.148	0.761	1.000	0.055	0.001	1.000	0.500	0.626	0.009	0.903	0.808	0.003	0.003	<0.001	<0.001	<0.001	1.000	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001
		QUL-45-04	0.064	1.000	0.000	1.000	1.000	0.000	0.040	0.715	0.001	0.466	0.275	0.000	0.003	0.025	<0.001	<0.001	0.007	<0.001	0.009	<0.001	<0.001	<0.001	<0.001	<0.001
		QUL-45-05	0.030	1.000	<0.001	1.000	1.000	<0.001	0.179	0.808	0.001	0.543	0.331	0.000	0.200	1.000	1.000	1.000	<0.001	1.000	0.000	<0.001	<0.001	<0.001	<0.001	<0.001
	Near-Field 2	QUL-49-01	0.437	<0.001	<0.001	0.002	0.146	<0.001	0.262	0.903	0.003	0.808	0.543	0.001	0.032	0.820	1.000	1.000	<0.001	1.000	1.000	0.659	0.643	0.198	<0.001	0.010
		QUL-49-02	0.500	0.037	1.000	0.001	<0.001	1.000	0.356	0.071	0.183	0.147	0.275	0.091	0.093	0.011	1.000	1.000	<0.001	1.000	1.000	0.778	0.794	0.568	<0.001	0.057
		QUL-49-03	0.179	1.000	0.198	0.874	0.061	0.198	0.245	0.147	0.091	0.275	0.466	0.041	0.030	0.304	1.000	1.000	<0.001	1.000	1.000	0.042	0.044	0.229	<0.001	0.885
		QUL-49-04	0.437	0.761	1.000	0.055	0.001	1.000	0.030	0.808	0.005	0.903	0.626	0.002	0.035	0.086	1.000	1.000	<0.001	1.000	0.999	0.902	0.919	0.466	<0.001	0.040
		QUL-49-05	0.040	0.095	<0.001	0.892	1.000	<0.001	<0.001	0.225	<0.001	0.116	0.054	<0.001	0.290	<0.001	0.013	0.010	<0.001	0.041	0.999	0.851	0.834	0.299	<0.001	0.019

Highlighted values indicate significance at the $p < 0.05$ level.

Table F.10: Sediment toxicity test results on *Hyalella azteca* for Quesnel Lake profundal areas. Absolute and normalized data presented for survival and dry weight (mg)

Site	Survival	Dry Weight (mg)	Normalized Survival	Normalized Dry Weight (mg)
Lab Control for PRef2, PFFF, PFF2	10	0.12	8	0.053
Lab Control for PRef2, PFFF, PFF2	10	0.22	8	0.10
Lab Control for PRef2, PFFF, PFF2	10	0.19	8	0.086
Lab Control for PRef2, PFFF, PFF2	10	0.23	8	0.10
Lab Control for PRef2, PFFF, PFF2	10	0.21	8	0.10
Mean	**10.0**	**0.19**	**8.0**	**0.087**
Standard Deviation	**0.0**	**0.045**	**0.0**	**0.020**
Lab Control for PRef1, PNF, PFF1	10	0.078	8	0.078
Lab Control for PRef1, PNF, PFF1	9	0.10	7	0.10
Lab Control for PRef1, PNF, PFF1	10	0.10	8	0.10
Lab Control for PRef1, PNF, PFF1	10	0.12	8	0.12
Lab Control for PRef1, PNF, PFF1	10	0.12	8	0.12
Mean	**9.8**	**0.10**	**8.0**	**0.10**
Standard Deviation	**0.45**	**0.016**	**0.37**	**0.016**
PRef1-1-01	9	0.18	7	0.18
PRef1-1-02	10	0.097	8	0.097
PRef1-1-03	7	0.077	6	0.077
PRef1-1-04	9	0.079	7	0.079
PRef1-1-05	10	0.16	8	0.16
Mean/Station	9.0	0.12	7.3	0.12
Standard Deviation/Station	1.2	0.049	1.0	0.049
PRef1-2-01	10	0.12	8	0.12
PRef1-2-02	10	0.098	8	0.098
PRef1-2-03	7	0.14	6	0.14
PRef1-2-04	7	0.11	6	0.11
PRef1-2-05	10	0.13	8	0.13
Mean/Station	8.8	0.12	7.2	0.12
Standard Deviation/Station	1.6	0.016	1.3	0.016
PRef1-3-01	10	0.11	8	0.11
PRef1-3-02	9	0.13	7	0.13
PRef1-3-03	10	0.081	8	0.081
PRef1-3-04	9	0.12	7	0.12
PRef1-3-05	9	0.099	7	0.099
Mean/Station	9.4	0.11	7.7	0.11
Standard Deviation/Station	0.55	0.019	0.45	0.019
PRef1-4-01	9	0.17	7	0.17
PRef1-4-02	9	0.056	7	0.056
PRef1-4-03	6	0.082	5	0.082
PRef1-4-04	10	0.16	8	0.16
PRef1-4-05	8	0.064	7	0.064
Mean/Station	8.4	0.11	6.9	0.11
Standard Deviation/Station	1.5	0.053	1.2	0.053
PRef1-5-01	7	0.071	6	0.071
PRef1-5-02	10	0.12	8	0.12
PRef1-5-03	7	0.13	6	0.13
PRef1-5-04	10	0.19	8	0.19
PRef1-5-05	10	0.075	8	0.075
Mean/Station	8.8	0.12	7.2	0.12
Standard Deviation/Station	1.6	0.047	1.3	0.047
Mean/Area [a]	**8.9**	**0.11**	**7.2**	**0.11**
Standard Deviation/Area [a]	**1.3**	**0.037**	**1.1**	**0.037**
PRef2-1	10	0.12	8	0.066
PRef2-2	10	0.15	8	0.082
PRef2-3	10	0.11	8	0.059
PRef2-4	10	0.11	8	0.058
PRef2-5	9	0.15	7	0.080
Mean	**9.8**	**0.13**	**7.8**	**0.069**
Standard Deviation	**0.45**	**0.021**	**0.36**	**0.011**
PNF-1-01	9	0.052	7	0.052
PNF-1-02	10	0.056	8	0.056
PNF-1-03	9	0.052	7	0.052
PNF-1-04	10	0.046	8	0.046
PNF-1-05	9	0.071	7	0.071
Mean/Station	9.4	0.056	7.7	0.056
Standard Deviation/Station	0.55	0.0095	0.45	0.0095
PNF-2-01	5	0.062	4	0.062
PNF-2-02	7	0.070	6	0.070
PNF-2-03	7	0.054	6	0.054
PNF-2-04	10	0.081	8	0.081
PNF-2-05	8	0.060	7	0.060
Mean/Station	7.4	0.065	6.0	0.065
Standard Deviation/Station	1.8	0.010	1.5	0.010

Table F.10: Sediment toxicity test results on *Hyalella azteca* for Quesnel Lake profundal areas. Absolute and normalized data presented for survival and dry weight (mg)

Site	Survival	Dry Weight (mg)	Normalized Survival	Normalized Dry Weight (mg)
PNF-3-01	9	0.040	7	0.040
PNF-3-02	7	0.051	6	0.051
PNF-3-03	8	0.049	7	0.049
PNF-3-04	6	0.060	5	0.060
PNF-3-05	7	0.080	6	0.080
Mean/Station	7.4	0.056	6.0	0.056
Standard Deviation/Station	1.1	0.015	0.93	0.015
PNF-4-01	9	0.050	7	0.050
PNF-4-02	5	0.046	4	0.046
PNF-4-03	6	0.080	5	0.080
PNF-4-04	9	0.040	7	0.040
PNF-4-05	8	0.065	7	0.065
Mean/Station	7.4	0.056	6.0	0.056
Standard Deviation/Station	1.8	0.016	1.5	0.016
PNF-5-01	9	0.046	7	0.046
PNF-5-02	6	0.058	5	0.058
PNF-5-03	7	0.061	6	0.061
PNF-5-04	9	0.064	7	0.064
PNF-5-05	2	0.13	2	0.13
Mean/Station	6.6	0.072	5.4	0.072
Standard Deviation/Station	2.9	0.033	2.4	0.033
Mean/Area [a]	**7.6**	**0.061**	**6.2**	**0.061**
Standard Deviation/Area [a]	**1.6**	**0.017**	**1.3**	**0.017**
PFF1-1-01	10	0.10	8	0.10
PFF1-1-02	10	0.11	8	0.11
PFF1-1-03	10	0.11	8	0.11
PFF1-1-04	6	0.11	5	0.11
PFF1-1-05	10	0.11	8	0.11
Mean/Station	9.2	0.11	7.5	0.11
Standard Deviation/Station	1.8	0.0045	1.5	0.0045
PFF1-2-01	10	0.13	8	0.13
PFF1-2-02	10	0.053	8	0.053
PFF1-2-03	9	0.080	7	0.080
PFF1-2-04	10	0.10	8	0.10
PFF1-2-05	10	0.14	8	0.14
Mean/Station	9.8	0.10	8.0	0.10
Standard Deviation/Station	0.45	0.035	0.37	0.035
PFF1-3-01	9	0.089	7	0.089
PFF1-3-02	9	0.069	7	0.069
PFF1-3-03	10	0.064	8	0.064
PFF1-3-04	9	0.14	7	0.14
PFF1-3-05	10	0.13	8	0.13
Mean/Station	9.4	0.098	7.7	0.098
Standard Deviation/Station	0.55	0.035	0.45	0.035
PFF1-4-01	10	0.061	8	0.061
PFF1-4-02	10	0.089	8	0.089
PFF1-4-03	10	0.074	8	0.074
PFF1-4-04	10	0.083	8	0.083
PFF1-4-05	10	0.096	8	0.096
Mean/Station	10.0	0.081	8.2	0.081
Standard Deviation/Station	0	0.014	0	0.014
PFF1-5-01	9	0.062	7	0.062
PFF1-5-02	10	0.10	8	0.10
PFF1-5-03	10	0.085	8	0.085
PFF1-5-04	10	0.071	8	0.071
PFF1-5-05	9	0.066	7	0.066
Mean/Station	9.6	0.077	7.8	0.077
Standard Deviation/Station	0.55	0.016	0.45	0.016
Mean/Area [a]	**9.6**	**0.093**	**7.8**	**0.093**
Standard Deviation/Area [a]	**0.67**	**0.021**	**0.54**	**0.021**
PFF2-1	9	0.12	7	0.062
PFF2-2	7	0.10	6	0.055
PFF2-3	8	0.099	6	0.053
PFF2-4	9	0.090	7	0.048
PFF2-5	9	0.092	7	0.049
Mean	**8.4**	**0.10**	**6.7**	**0.053**
Standard Deviation	**0.89**	**0.011**	**0.72**	**0.0056**
PFFF-1	8	0.097	6	0.052
PFFF-2	10	0.099	8	0.053
PFFF-3	10	0.13	8	0.068
PFFF-4	9	0.13	7	0.070
PFFF-5	8	0.16	6	0.085
Mean	**9.0**	**0.12**	**7.2**	**0.066**
Standard Deviation	**1.0**	**0.026**	**0.80**	**0.014**

[a] For areas with replication within a station, the mean and standard deviation per area were calculated by taking the mean of each station's mean and standard deviation.

Table F.11: Sediment toxicity test results on *Chironomus dilutus* for Quesnel Lake profundal areas. Absolute and normalized data presented for survival and dry weight (mg)

Site	Survival	Dry Weight (mg)	Normalized Survival	Normalized Dry Weight (mg)
Lab Control for PRef2, PFFF, PFF2	10	1.8	8	1.8
Lab Control for PRef2, PFFF, PFF2	9	1.5	7	1.5
Lab Control for PRef2, PFFF, PFF2	8	1.9	6	2.0
Lab Control for PRef2, PFFF, PFF2	10	1.6	8	1.7
Lab Control for PRef2, PFFF, PFF2	9	2.0	7	2.0
Mean	**9.2**	**1.7**	**7.0**	**1.8**
Standard Deviation	**0.8**	**0.20**	**0.64**	**0.21**
Lab Control for PRef1, PNF, PFF1	9	1.9	7	1.9
Lab Control for PRef1, PNF, PFF1	9	2.2	7	2.2
Lab Control for PRef1, PNF, PFF1	10	1.9	7	1.9
Lab Control for PRef1, PNF, PFF1	10	1.9	7	1.9
Lab Control for PRef1, PNF, PFF1	9	2.3	7	2.3
Mean	**9.4**	**2.0**	**7.0**	**2.0**
Standard Deviation	**0.55**	**0.18**	**0.41**	**0.18**
PRef1-1-01	10	2.5	7	2.5
PRef1-1-02	7	2.7	5	2.7
PRef1-1-03	10	2.5	7	2.5
PRef1-1-04	9	2.5	7	2.5
PRef1-1-05	9	2.4	7	2.4
Mean/Station	9.0	2.5	6.7	2.5
Standard Deviation/Station	1.2	0.13	0.91	0.13
PRef1-2-01	10	2.4	7	2.4
PRef1-2-02	10	2.0	7	2.0
PRef1-2-03	10	2.1	7	2.1
PRef1-2-04	10	2.6	7	2.6
PRef1-2-05	10	2.6	7	2.6
Mean/Station	10.0	2.3	7.4	2.3
Standard Deviation/Station	0.0	0.28	0.0	0.28
PRef1-3-01	8	2.7	6	2.7
PRef1-3-02	10	2.4	7	2.4
PRef1-3-03	9	2.2	7	2.2
PRef1-3-04	10	2.1	7	2.1
PRef1-3-05	10	2.3	7	2.3
Mean/Station	9.4	2.3	7.0	2.3
Standard Deviation/Station	0.89	0.23	0.67	0.23
PRef1-4-01	9	2.8	7	2.8
PRef1-4-02	10	2.4	7	2.4
PRef1-4-03	10	2.4	7	2.4
PRef1-4-04	10	2.1	7	2.1
PRef1-4-05	10	2.3	7	2.3
Mean/Station	9.8	2.4	7.3	2.4
Standard Deviation/Station	0.45	0.24	0.33	0.24
PRef1-5-01	10	2.5	7	2.5
PRef1-5-02	10	2.3	7	2.3
PRef1-5-03	9	2.3	7	2.3
PRef1-5-04	10	2.1	7	2.1
PRef1-5-05	10	2.7	7	2.7
Mean/Station	9.8	2.4	7.3	2.4
Standard Deviation/Station	0.45	0.23	0.33	0.23
Mean/Area [a]	**9.6**	**2.4**	**7.1**	**2.4**
Standard Deviation/Area [a]	**0.60**	**0.22**	**0.45**	**0.22**
PRef2-1	10	2.2	8	2.5
PRef2-2	9	2.1	7	2.5
PRef2-3	9	2.2	7	2.5
PRef2-4	9	2.2	7	2.5
PRef2-5	7	2.3	5	2.7
Mean	**8.8**	**2.2**	**6.7**	**2.5**
Standard Deviation	**1.1**	**0.060**	**0.83**	**0.070**
PNF-1-01	8	0.52	6	0.52
PNF-1-02	7	1.2	5	1.2
PNF-1-03	9	1.5	7	1.5
PNF-1-04	7	1.3	5	1.3
PNF-1-05	7	1.4	5	1.4
Mean/Station	7.6	1.2	5.7	1.2
Standard Deviation/Station	0.89	0.40	0.67	0.40
PNF-2-01	4	1.1	3	1.1
PNF-2-02	7	1.2	5	1.2
PNF-2-03	5	0.75	4	0.75
PNF-2-04	5	2.0	4	2.0
PNF-2-05	4	2.2	3	2.2
Mean/Station	5.0	1.4	3.7	1.4
Standard Deviation/Station	1.2	0.63	0.91	0.63

Table F.11: Sediment toxicity test results on *Chironomus dilutus* for Quesnel Lake profundal areas. Absolute and normalized data presented for survival and dry weight (mg)

Site	Survival	Dry Weight (mg)	Normalized Survival	Normalized Dry Weight (mg)
PNF-3-01	7	2.5	5	2.5
PNF-3-02	9	1.7	7	1.7
PNF-3-03	5	1.8	4	1.8
PNF-3-04	7	1.1	5	1.1
PNF-3-05	6	1.1	4	1.1
Mean/Station	6.8	1.6	5.1	1.6
Standard Deviation/Station	1.5	0.57	1.1	0.57
PNF-4-01	8	1.6	6	1.6
PNF-4-02	8	1.6	6	1.6
PNF-4-03	5	1.3	4	1.3
PNF-4-04	9	1.5	7	1.5
PNF-4-05	8	1.0	6	1.0
Mean/Station	7.6	1.4	5.7	1.4
Standard Deviation/Station	1.5	0.26	1.1	0.26
PNF-5-01	9	1.2	7	1.2
PNF-5-02	6	1.9	4	1.9
PNF-5-03	7	1.1	5	1.1
PNF-5-04	9	2.5	7	2.5
PNF-5-05	4	2.1	3	2.1
Mean/Station	7.0	1.8	5.2	1.8
Standard Deviation/Station	2.1	0.57	1.6	0.57
Mean/Area [a]	**6.8**	**1.5**	**5.1**	**1.5**
Standard Deviation/Area [a]	**1.4**	**0.49**	**1.1**	**0.49**
PFF1-1-01	9	1.8	7	1.8
PFF1-1-02	9	2.1	7	2.1
PFF1-1-03	9	2.0	7	2.0
PFF1-1-04	9	1.9	7	1.9
PFF1-1-05	9	2.0	7	2.0
Mean/Station	9.0	2.0	6.7	2.0
Standard Deviation/Station	0	0.090	0	0.090
PFF1-2-01	4	3.3	3	3.3
PFF1-2-02	1	2.4	1	2.4
PFF1-2-03	6	2.5	4	2.5
PFF1-2-04	10	1.7	7	1.7
PFF1-2-05	7	2.3	5	2.3
Mean/Station	5.6	2.4	4.2	2.4
Standard Deviation/Station	3.4	0.59	2.5	0.59
PFF1-3-01	5	2.6	4	2.6
PFF1-3-02	6	2.3	4	2.3
PFF1-3-03	8	2.9	6	2.9
PFF1-3-04	8	2.2	6	2.2
PFF1-3-05	8	1.9	6	1.9
Mean/Station	7.0	2.4	5.2	2.4
Standard Deviation/Station	1.4	0.36	1.1	0.36
PFF1-4-01	3	3.1	2	3.1
PFF1-4-02	2	4.0	1	4.0
PFF1-4-03	5	2.6	4	2.6
PFF1-4-04	6	2.9	4	2.9
PFF1-4-05	6	2.5	4	2.5
Mean/Station	4.4	3.0	3.3	3.0
Standard Deviation/Station	1.8	0.60	1.4	0.60
PFF1-5-01	2	2.6	1	2.6
PFF1-5-02	5	2.1	4	2.1
PFF1-5-03	3	2.2	2	2.2
PFF1-5-04	3	1.9	2	1.9
PFF1-5-05	3	2.8	2	2.8
Mean/Station	3.2	2.3	2.4	2.3
Standard Deviation/Station	1.1	0.37	0.82	0.37
Mean/Area [a]	**5.8**	**2.4**	**4.3**	**2.4**
Standard Deviation/Area [a]	**1.5**	**0.40**	**1.1**	**0.40**
PFF2-1	8	1.3	6	1.5
PFF2-2	8	1.6	6	1.8
PFF2-3	7	1.8	5	2.2
PFF2-4	9	1.9	7	2.2
PFF2-5	6	2.0	5	2.3
Mean	**7.6**	**1.7**	**5.8**	**2.0**
Standard Deviation	**1.1**	**0.29**	**0.87**	**0.34**
PFFF-1	7	2.3	5	2.7
PFFF-2	9	2.3	7	2.7
PFFF-3	9	1.7	7	2.0
PFFF-4	10	2.0	8	2.4
PFFF-5	8	2.2	6	2.5
Mean	**8.6**	**2.1**	**6.5**	**2.5**
Standard Deviation	**1.1**	**0.23**	**0.87**	**0.26**

[a] For areas with replication within a station, the mean and standard deviation per area were calculated by taking the mean of each station's mean and standard deviation.

Table F.12: Sediment toxicity testing statistical results for *Hyalella azteca* and *Chironomus dilutus, for* Quesnel Lake near-field and far-field profundal station replicates against applicable field references and lab control replicates, Mount Polley Mine, 2014. P-values from statistical comparisons are displayed.

Water Body	Station	Code	*Hyalella azteca*												*Chironomus dilutus*											
			Survival						Growth						Survival						Growth					
			Lab Control	QULP-5					Lab Control	QULP-5					Lab Control	QULP-5					Lab Control	QULP-5				
				01	02	03	04	05		01	02	03	04	05		01	02	03	04	05		01	02	03	04	05
Quesnel Lake Profundal	Near-Field 1	QULP-1-01	0.123	1.000	1.000	1.000	0.309	1.000	0.004	0.003	0.003	0.012	0.016	0.003	0.040	0.058	<0.001	0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		QULP-1-02	0.020	0.002	0.013	<0.001	0.538	0.013	0.040	0.007	0.007	0.032	0.040	0.010	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	0.037	<0.001	0.001	0.001	0.001	0.001
		QULP-1-03	0.002	0.001	0.010	<0.001	0.463	0.010	0.040	0.003	0.003	0.012	0.016	0.003	0.040	<0.001	<0.001	<0.001	<0.001	<0.001	0.086	0.001	0.009	0.009	0.005	0.006
		QULP-1-04	0.016	0.001	0.010	<0.001	0.463	0.010	0.040	0.003	0.003	0.012	0.016	0.003	0.040	0.071	<0.001	0.002	<0.001	<0.001	0.001	<0.001	0.001	0.001	0.000	0.001
		QULP-1-05	0.025	<0.001	<0.001	<0.001	0.000	<0.001	0.040	0.020	0.020	0.077	0.094	0.025	0.179	0.000	<0.001	<0.001	<0.001	<0.001	0.152	0.004	0.025	0.025	0.014	0.018
	Downstream Far-Field	QULP-2-01	0.273	1.000	1.000	1.000	0.734	1.000	0.500	0.942	0.839	1.000	0.995	0.640	0.437	1.000	0.565	1.000	1.000	1.000	0.240	0.021	0.124	0.122	0.073	0.091
		QULP-2-02	0.500	0.653	0.217	1.000	0.003	0.217	0.437	0.963	0.933	0.925	0.779	0.913	0.040	<0.001	<0.001	<0.001	<0.001	<0.001	0.890	0.649	0.708	0.715	0.915	0.830
		QULP-2-03	0.123	1.000	1.000	1.000	0.309	1.000	0.437	0.966	0.942	0.965	0.925	0.933	0.004	0.000	<0.001	<0.001	<0.001	<0.001	0.947	0.533	0.837	0.844	0.950	0.964
		QULP-2-04	0.813	0.116	0.016	1.000	<0.001	0.016	0.040	0.626	0.567	0.680	0.614	0.560	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	0.996	0.029	0.004	0.004	0.007	0.006
		QULP-2-05	0.274	1.000	0.903	1.000	0.032	0.903	0.040	0.616	0.564	0.718	0.680	0.567	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	0.906	0.374	0.950	0.943	0.741	0.823

Highlighted values indicate significance at the $p < 0.05$ level.

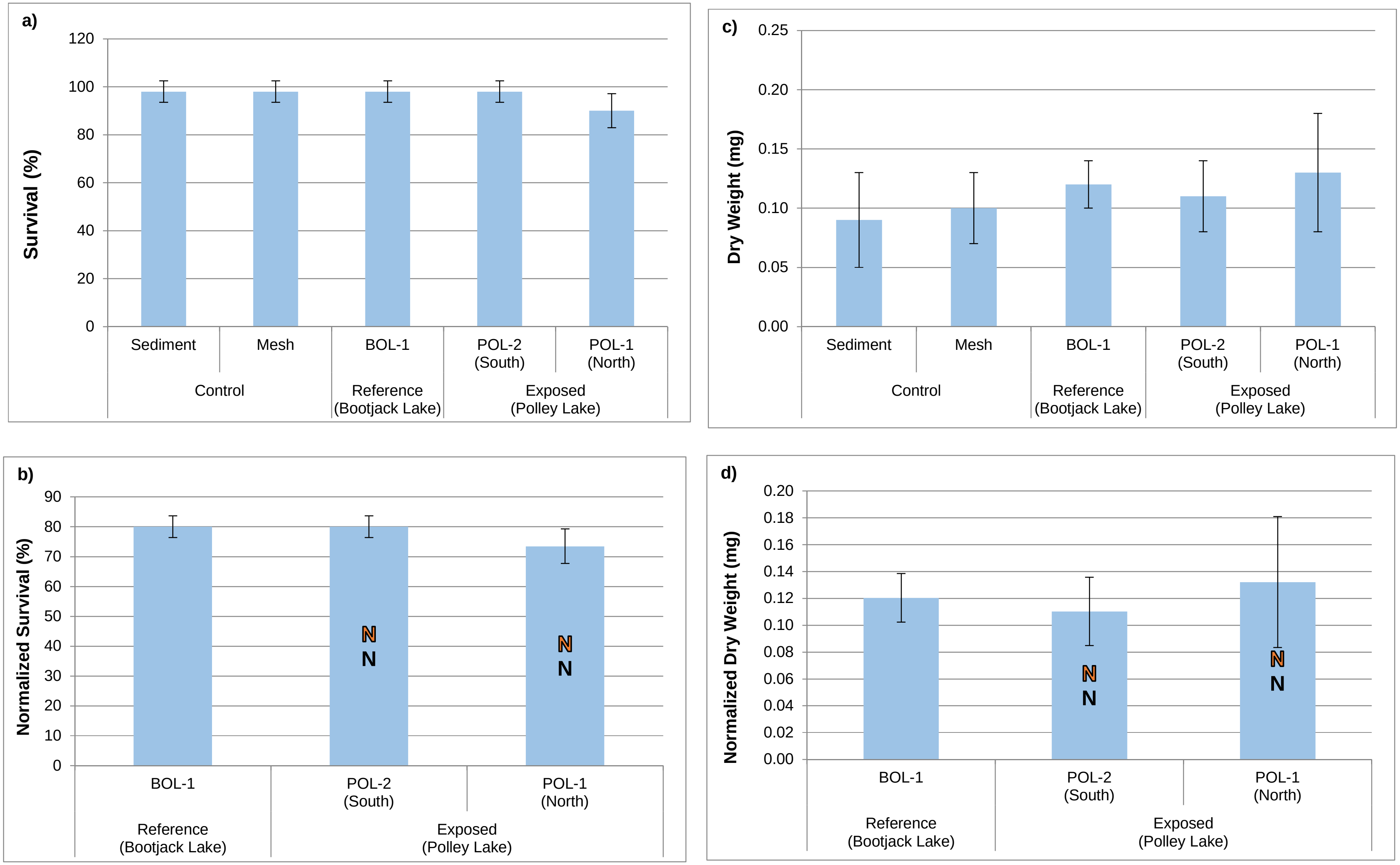

Figure F.1: Toxicity tests of Polley and Bootjack Mid-depth Sediment on *Hyalella azteca*, Mount Polley Mine, 2014. Results for a) Survival (%), b) Normalized Survival (%), c) Dry Weight (mg), d) Normalized Dry Weight (%). Error bars represent standard deviation and differing colours indicate different laboratory batches. Letters represent significant differences (Y) or no differences (N) between samples and the Control (Black) and Reference (Orange) ($p<0.05$).

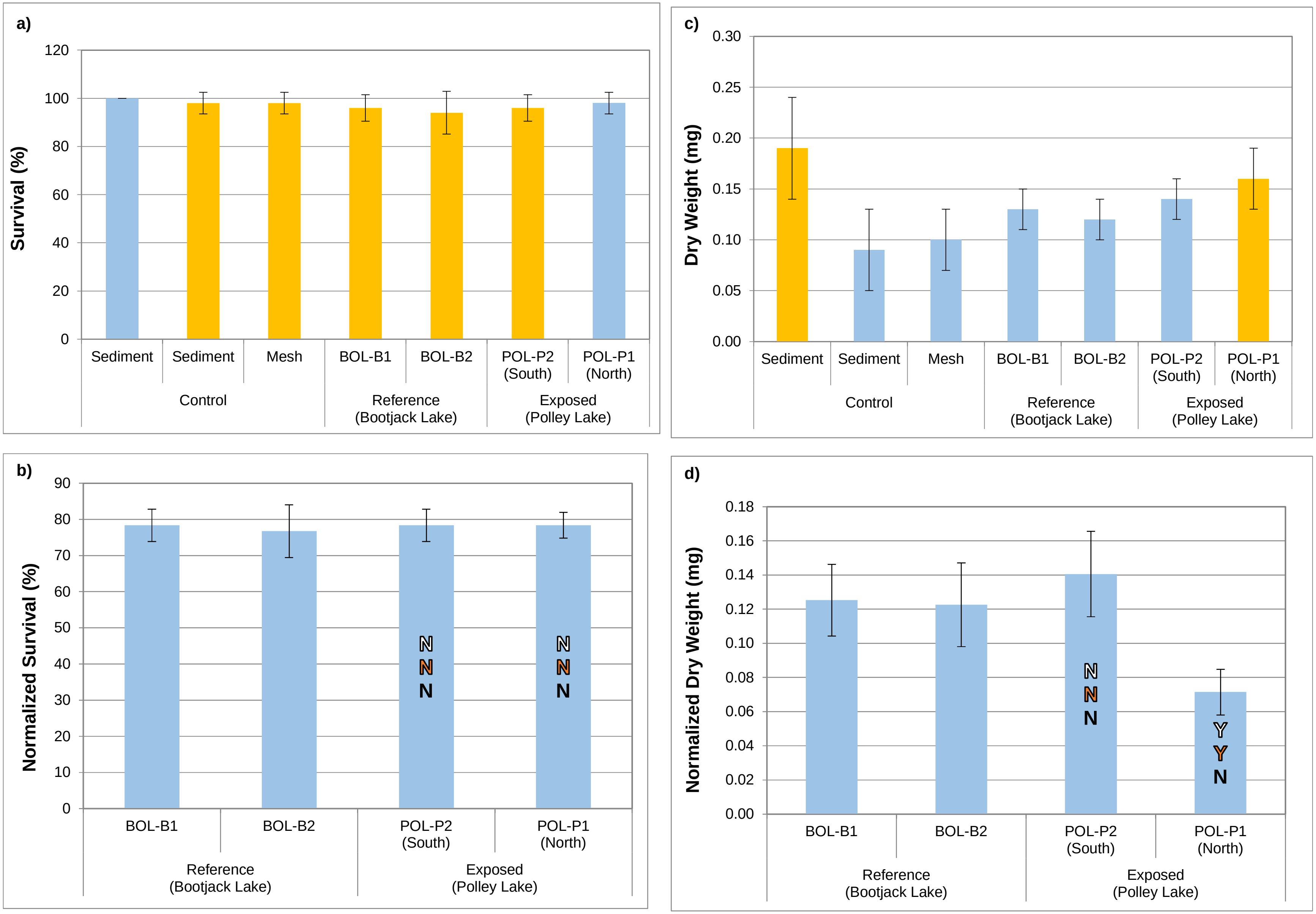

Figure F.2: Toxicity tests of Polley and Bootjack Deep Sediment on *Hyalella azteca* , Mount Polley Mine, 2014. Results for a) Survival (%), b) Normalized Survival (%), c) Dry Weight (mg), d) Normalized Dry Weight (%). Error bars represent standard deviation and differing colours indicate different laboratory batches. Letters represent significant differences (Y) or no differences (N) between samples and the Control (Black), Reference 1 (Orange) and Reference 2 (White) ($p < 0.05$).

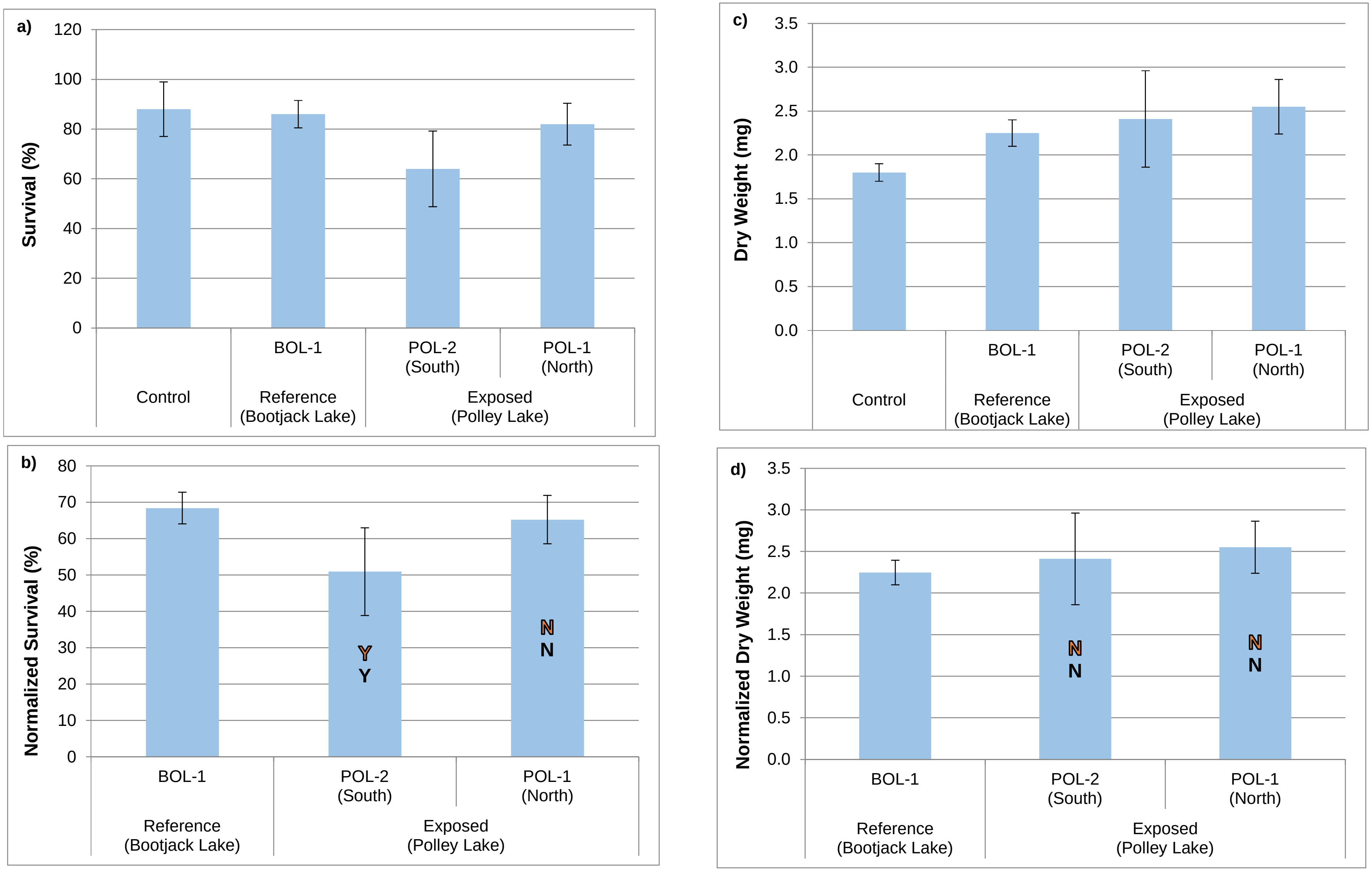

Figure F.3: Toxicity tests of Polley and Bootjack Mid-depth Sediment on *Chironomus dilutus* , Mount Polley Mine, 2014. Results for a) Survival (%), b) Normalized Survival (%), c) Dry Weight (mg), d) Normalized Dry Weight (%). Error bars represent standard deviation and differing colours indicate different laboratory batches. Letters represent significant differences (Y) or no differences (N) between samples and the Control (Black) and Reference (Orange) ($p < 0.05$).

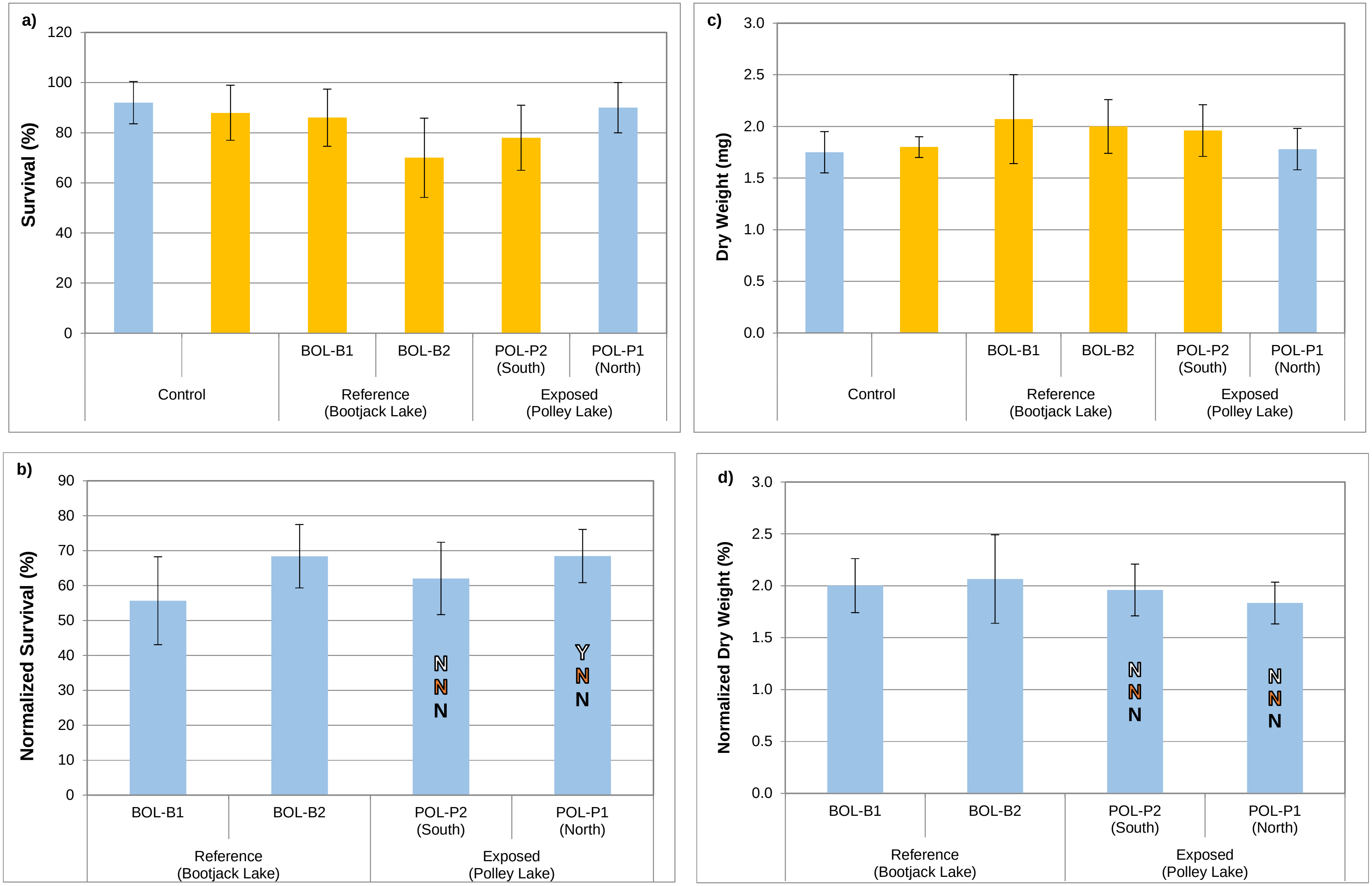

Figure F.4: Toxicity tests of Polley and Bootjack Deep Sediment on *Chironomus dilutus* , Mount Polley Mine, 2014. Results for a) Survival (%), b) Normalized Survival (%), c) Dry Weight (mg), d) Normalized Dry Weight (%). Error bars represent standard deviation and differing colours indicate different laboratory batches. Letters represent significant differences (Y) or no differences (N) between samples and the Control (Black), Reference 1 (Orange) and Reference 2 (White) ($p < 0.05$).

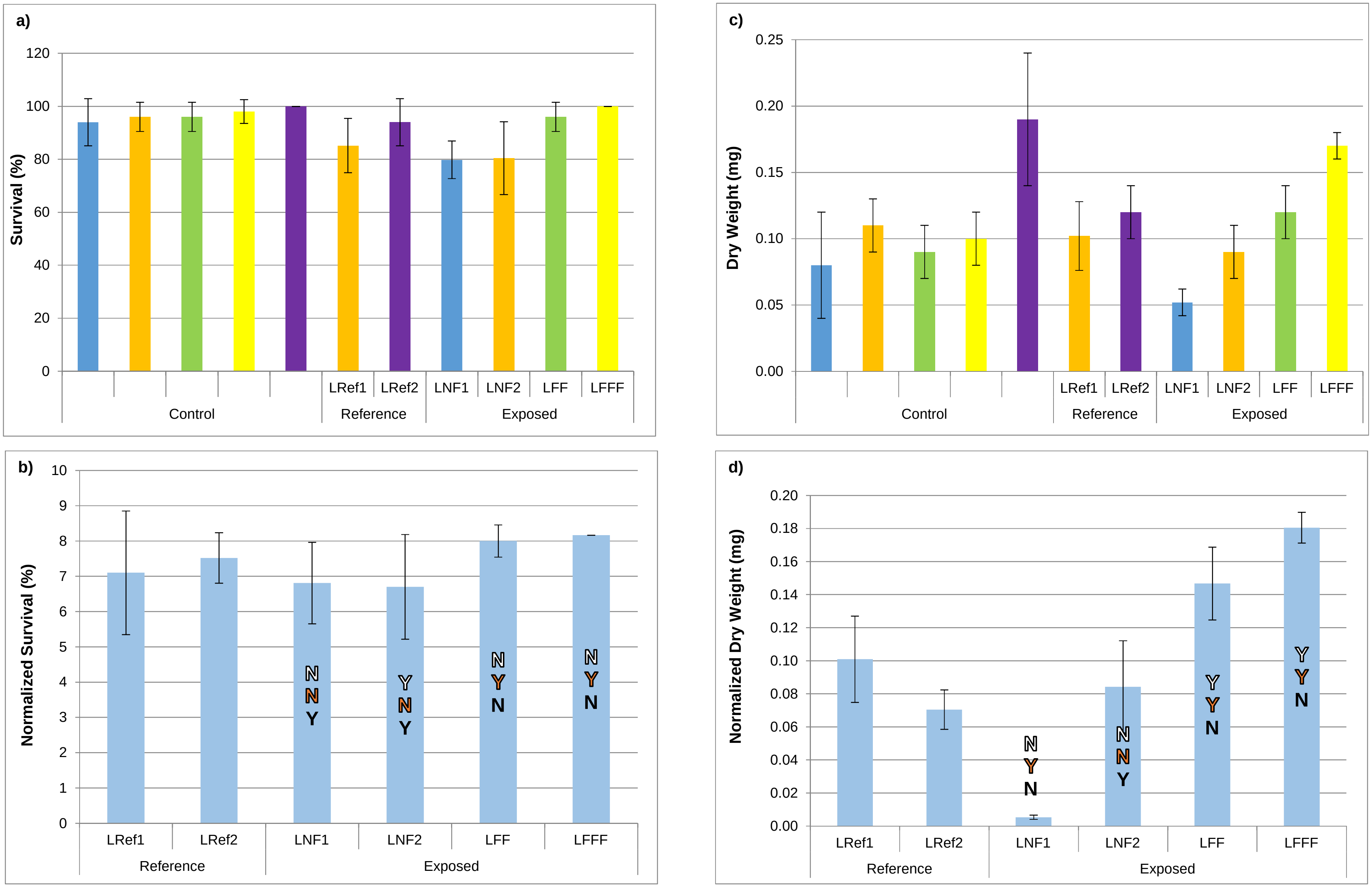

Figure F.5: Toxicity tests of Quesnel Lake littoral sediment on *Hyalella azteca*, Mount Polley Mine, 2014. Results for a) Survival (%), b) Normalized Survival (%), c) Dry Weight (mg), d) Nornalized Dry Weight (mg). Error bars represent standard deviation and differing colours indicate different laboratory batches. Letters represent significant differences (Y) or no differences and the Control (Black), Reference 1 (Orange) and Reference 2 (White) ($p < 0.05$).

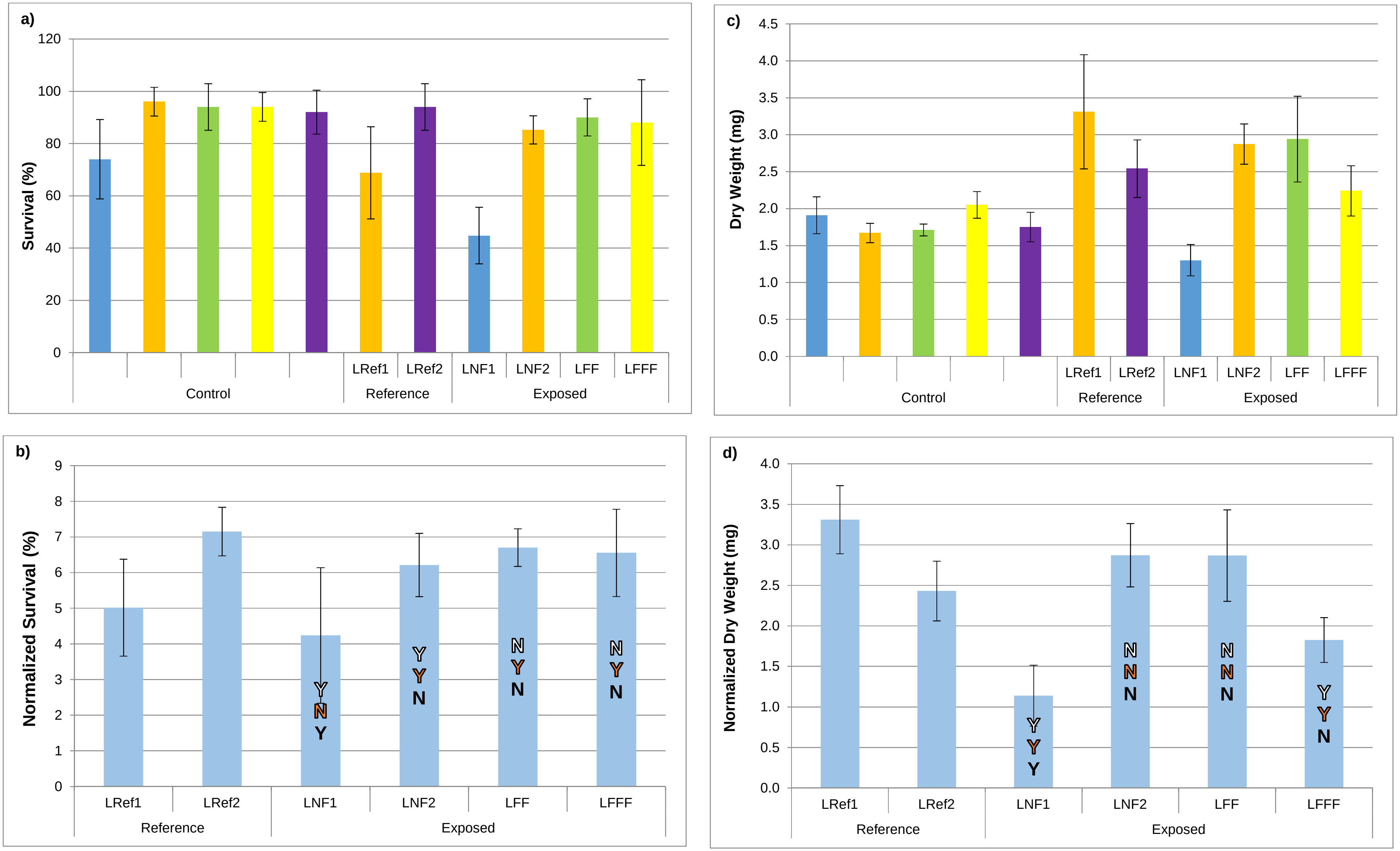

Figure F.6: Toxicity tests of Quesnel Lake littoral sediment on *Chironomus dilutus*, Mount Polley Mine, 2014. Results for a) Survival (%), b) Normalized Survival (%), c) Dry Weight (mg), d) Normalized Dry Weight (mg). Error bars represent standard deviation and differing colours indicate different laboratory batches. Letters represent significant differences (Y) or no differences (N) between samples and the Control (Black), Reference 1 (Orange) and Reference 2 (White) ($p < 0.05$).

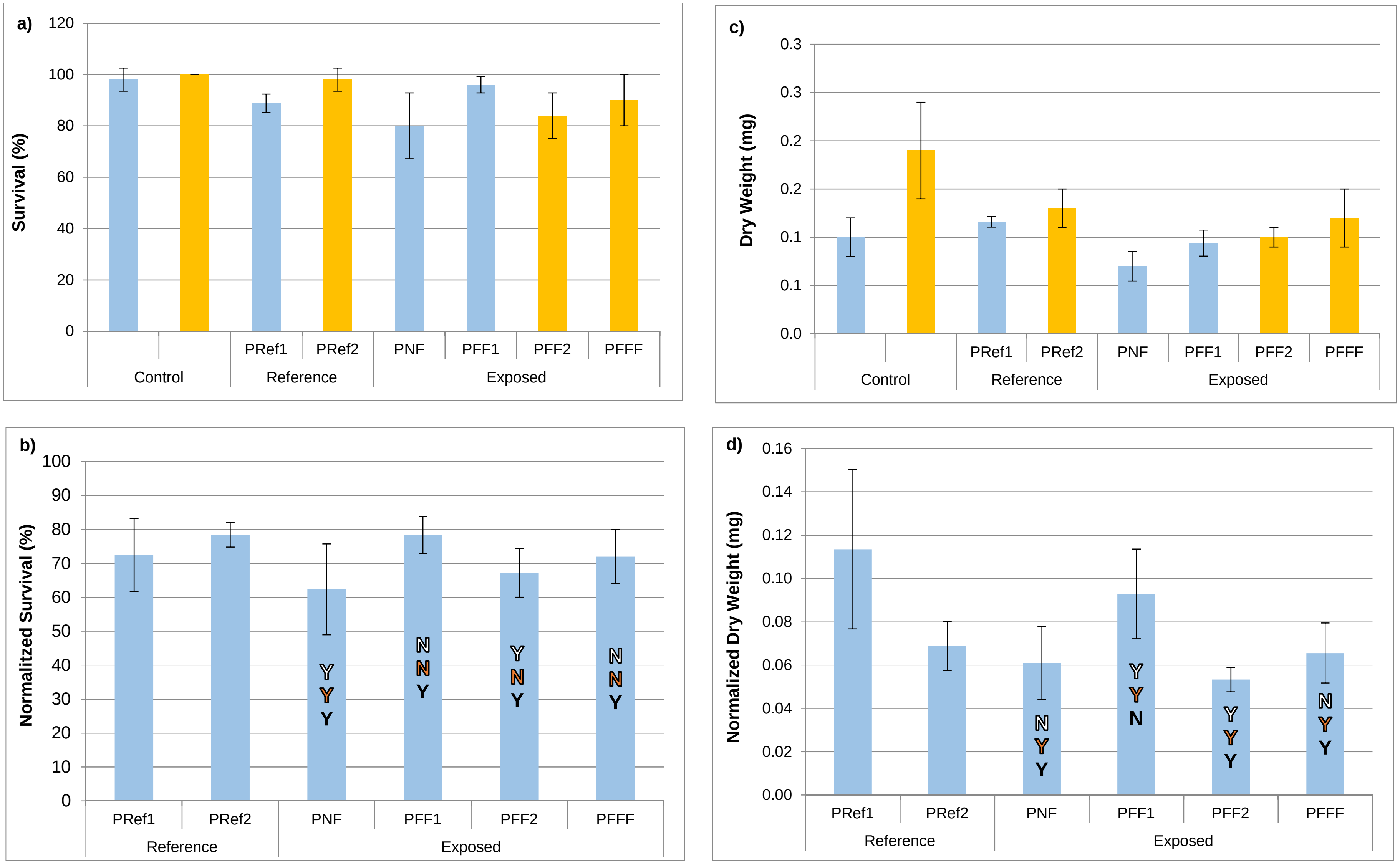

Figure F.7: Toxicity tests of Quesnel Lake profundal sediment on *Hyalella azteca* , Mount Polley Mine, 2014. Results for a) Survival (%), b) Normalized Survival (%), c) Dry Weight (mg), d) Normalized Dry Weight (mg). Error bars represent standard deviation and differing colours indicate different laboratory batches. Letters represent significant differences (Y) or no differences (N) between samples and the Control (Black), Reference 1 (Orange) and Reference 2 (White) ($p < 0.05$).

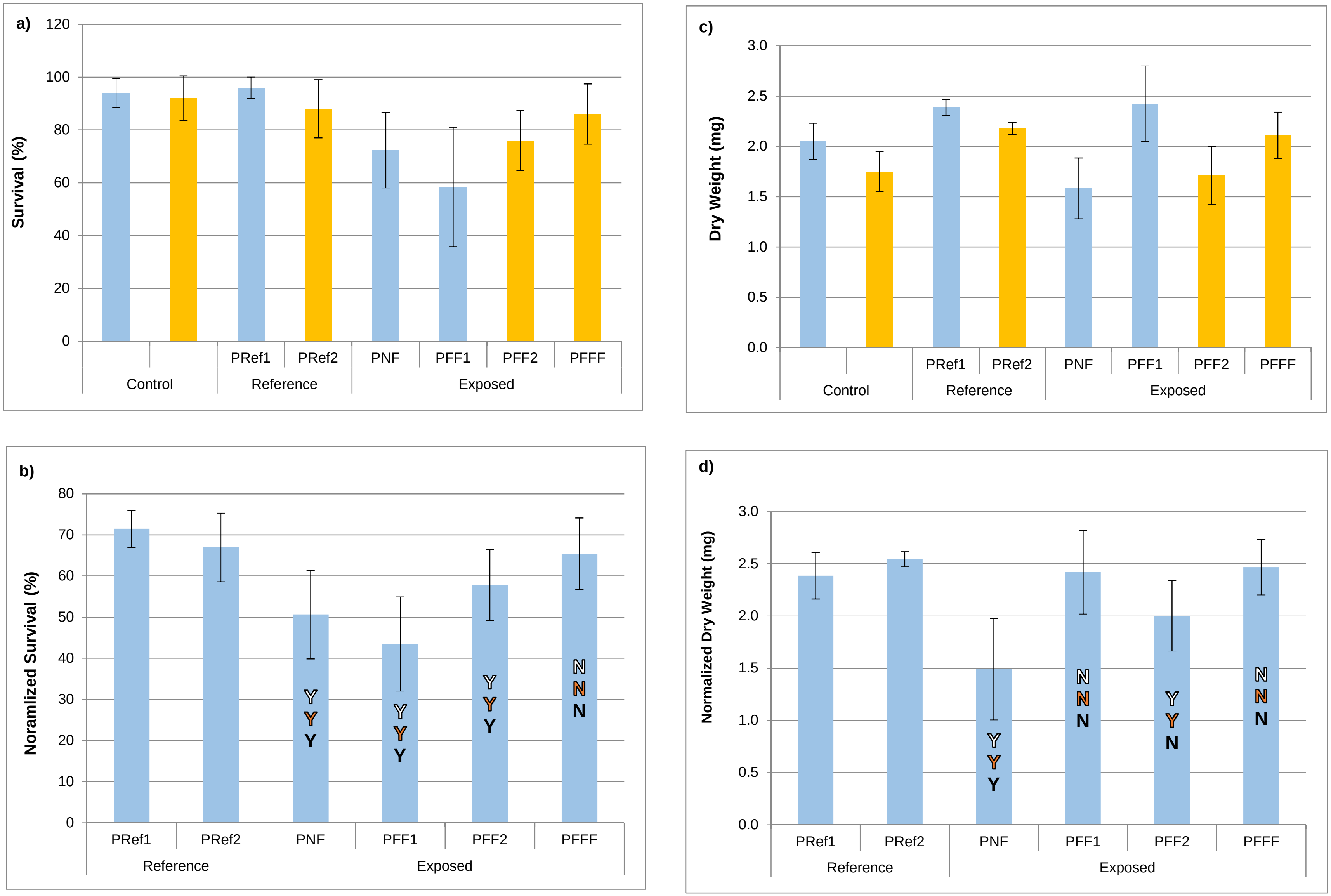

Figure F.8: Toxicity tests of Quesnel Lake profundal sediment on *Chironomus dilutus* , Mount Polley Mine, 2014. Results for a) Survival (%), b) Normalized Survival (%), c) Dry Weight (mg), d) Normalized Dry Weight (mg). Error bars represent standard deviation and differing colours indicate different laboratory batches. Letters represent significant differences (Y) or no differences (N) between samples and the Control (Black), Reference 1 (Orange) and Reference 2 (White) ($p < 0.05$).

APPENDIX G

BENTHIC INVERTEBRATE COMMUNITY DATA

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TABLES

FIGURES

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Cordillera Consulting Site:	QUL45	QUL45	QUL45	QUL45	QUL45	QUL47	QUL47	QUL49	QUL49	QUL49	QUL49	QUL49	QUL51	QUL51	QUL51	QUL51	QUL51	QULP-1	QULP-1	QULP-1	QULP-1	QULP-1	QULP-2
Sample:	1	2	3	4	5	1	2	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1
CC#:	CC150492	CC150493	CC150494	CC150495	CC150496	CC150497	CC150498	CC150499	CC150500	CC150501	CC150502	CC150503	CC150504	CC150505	CC150506	CC150507	CC150508	CC150934	CC150935	CC150936	CC150937	CC150938	CC150939
EMS:																							
No Invertebrates Found	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Salpingidae	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Hexapoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Insecta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Ephemeroptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Ameletidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ameletus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Baetidae	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Baetis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baetis bicaudatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callibaetis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
| Family: Caenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caenis sp.	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caenis youngi	0	0	0	0	0	7	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Ephemerellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drunella sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drunella spinifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemerella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemerella velmae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Ephemeridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Ephemera simulans	0	0	0	0	0	21	9	0	1	0	0	0	0	0	6	5	0	0	0	0	0	0	0
| Family: Heptageniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Heptagenia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhithrogena	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Leptophlebiidae	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leptophlebia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paraleptophlebia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Plecoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Capniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capnia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Chloroperlidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Suwallia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sweltsa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Nemouridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zapada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zapada cinctipes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Perlidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Claassenia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Doroneuria sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hesperoperla sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Perlodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diura sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Skwala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Pteronarcyidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pteronarcys	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Taeniopterygidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Cordillera Consulting Site:	QUL45	QUL45	QUL45	QUL45	QUL45	QUL47	QUL47	QUL49	QUL49	QUL49	QUL49	QUL49	QUL51	QUL51	QUL51	QUL51	QUL51	QULP-1	QULP-1	QULP-1	QULP-1	QULP-1	QULP-2
Sample:	1	2	3	4	5	1	2	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1
CC#:	CC150492	CC150493	CC150494	CC150495	CC150496	CC150497	CC150498	CC150499	CC150500	CC150501	CC150502	CC150503	CC150504	CC150505	CC150506	CC150507	CC150508	CC150934	CC150935	CC150936	CC150937	CC150938	CC150939
EMS:																							
| Order: Trichoptera	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Brachycentridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brachycentrus occidentalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brachycentrus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micrasema	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micrasema gelidum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Glossosomatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glossosoma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydropsychidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cheumatopsyche	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydropsyche	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydroptilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agraylea sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	1	0	0	0	0	0	0	0
Hydroptila	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxyethira sp.	0	0	0	0	0	6	3	0	0	0	0	0	5	0	4	3	2	0	0	0	0	0	0
| Family: Lepidostomatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidostoma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
| Family: Leptoceridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mystacides	0	0	0	0	0	2	1	0	0	0	0	0	5	1	4	6	0	0	0	0	0	0	0
Oecetis	0	0	0	0	0	5	7	1	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0
| Family: Limnephilidae	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chyranda centralis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnephilus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Phryganeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phryganea sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
| Family: Polycentropodidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Polycentropus	0	0	0	0	0	4	5	0	0	0	0	0	1	2	3	9	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Coleoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Dytiscidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydroporus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laccornis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oreodytes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Elmidae	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterlimnius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Optioservus sp.	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0
Zaitzevia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Gyrinidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gyrinus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Haliplidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haliplus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydrophilidae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Psephenidae	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Diptera	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Athericidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atherix	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Ceratopogonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bezzia/ Palpomyia	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Culicoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Probezzia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Sphaeromias sp.	0	0	0	0	0	16	19	0	0	0	1	0	7	31	3	12	1	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Cordillera Consulting Site:	QUL45	QUL45	QUL45	QUL45	QUL45	QUL47	QUL47	QUL49	QUL49	QUL49	QUL49	QUL49	QUL51	QUL51	QUL51	QUL51	QUL51	QULP-1	QULP-1	QULP-1	QULP-1	QULP-1	QULP-2
Sample:	1	2	3	4	5	1	2	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1
CC#:	CC150492	CC150493	CC150494	CC150495	CC150496	CC150497	CC150498	CC150499	CC150500	CC150501	CC150502	CC150503	CC150504	CC150505	CC150506	CC150507	CC150508	CC150934	CC150935	CC150936	CC150937	CC150938	CC150939
EMS:																							
Family: Chaoboridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chaoborus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0
Family: Chironomidae	0	0	0	0	0	2	1	0	0	0	0	0	1	1	3	1	0	0	1	0	0	0	0
Subfamily: Chironominae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tribe: Chironomini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chironomus	1	4	7	0	14	0	0	0	0	4	1	0	10	3	0	0	0	0	0	0	0	0	0
Cryptochironomus	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Demicryptochironomus sp.	0	0	0	0	0	3	1	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0	0
Dicrotendipes	0	0	0	0	0	6	42	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0
Harnischia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microtendipes pedellus	0	0	0	0	0	5	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nilothauma sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parachironomus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paracladopelma sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phaenopsectra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polypedilum sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stictochironomus	0	5	1	0	0	2	2	0	0	1	1	1	0	7	6	6	0	0	0	0	0	0	0
Tribe: Pseudochironomini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudochironomus sp.	0	0	0	0	0	22	73	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Tribe: Tanytarsini	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0
Cladotanytarsus	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corynocera sp.	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micropsectra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paratanytarsus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rheotanytarsus	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Stempellina sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tanytarsus	0	0	0	0	1	0	59	0	1	0	0	0	2	3	0	0	0	0	0	0	0	0	0
Subfamily: Diamesinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tribe: Diamesini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pagastia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potthastia gaedii group	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potthastia longimana group	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudodiamesa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subfamily: Orthocladiinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Cricotopus	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Diplocladius cultriger	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
Epoicocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eukiefferiella	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterotrissocladius sp.	2	0	0	0	0	4	4	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
Hydrobaenus	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnophyes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mesocricotopus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Nanocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Orthocladius complex	2	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Orthocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Parachaetocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parakiefferiella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parametriocnemus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paraphaenocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Psectrocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	1	0
Rheocricotopus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tvetenia	0	0	0	0	0	6	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Cordillera Consulting																							
Site:	QUL45	QUL45	QUL45	QUL45	QUL45	QUL47	QUL47	QUL49	QUL49	QUL49	QUL49	QUL49	QUL51	QUL51	QUL51	QUL51	QUL51	QULP-1	QULP-1	QULP-1	QULP-1	QULP-1	QULP-2
Sample:	1	2	3	4	5	1	2	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1
CC#:	CC150492	CC150493	CC150494	CC150495	CC150496	CC150497	CC150498	CC150499	CC150500	CC150501	CC150502	CC150503	CC150504	CC150505	CC150506	CC150507	CC150508	CC150934	CC150935	CC150936	CC150937	CC150938	CC150939
EMS:																							
| Tribe: Corynoneurini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corynoneura	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
| Subfamily: Prodiamesinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monodiamesa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odontomesa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Subfamily: Tanypodinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ablabesmyia	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0
| Tribe: Pentaneuriini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thienemannimyia group	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
| Tribe: Procladiini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Procladius	0	1	0	0	0	2	5	0	0	0	0	0	3	3	3	12	0	0	0	0	0	4	0
| Family: Empididae	0	0	0	0	1	0	0	6	0	4	2	0	0	0	0	0	1	0	0	0	0	1	1
Chelifera/ Metachela	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clinocera sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemerodromia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Neoplasta sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oreogeton sp.	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Roederiodes sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Simuliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Simulium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Tabanidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tabanus sp.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Tipulidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Antocha sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dicranota	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Hemiptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Corixidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sigara	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Lepidoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Megaloptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Sialidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sialis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Odonata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Coenagrionidae	0	0	0	0	0	0	4	0	0	0	0	0	3	0	1	1	0	0	0	0	0	0	0
| Family: Corduliidae	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Epitheca sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Somatochlora sp.	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Crustacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Malacostraca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Amphipoda	0	0	0	0	0	0	116	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
| Family: Gammaridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gammarus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hyalellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hyalella	5	0	0	0	0	181	0	2	5	0	4	0	80	14	71	43	1	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Chelicerata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Arachnida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
| Order: Trombidiformes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2
| Family: Arrenuridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arrenurus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Site:	QUL45	QUL45	QUL45	QUL45	QUL45	QUL47	QUL47	QUL49	QUL49	QUL49	QUL49	QUL49	QUL51	QUL51	QUL51	QUL51	QUL51	QULP-1	QULP-1	QULP-1	QULP-1	QULP-1	QULP-2
Sample:	1	2	3	4	5	1	2	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1
CC#:	CC150492	CC150493	CC150494	CC150495	CC150496	CC150497	CC150498	CC150499	CC150500	CC150501	CC150502	CC150503	CC150504	CC150505	CC150506	CC150507	CC150508	CC150934	CC150935	CC150936	CC150937	CC150938	CC150939
EMS:																							
| Family: Hydrachnidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrachna sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydryphantidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Albertathyas	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hygrobatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atractides	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
Hygrobates	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Lebertiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lebertia	0	0	0	0	0	8	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1
| Family: Limnesiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnesia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	5	2	0	1	0	0	0	0	0	0
| Family: Limnocharidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnochares sp.	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Mideopsidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mideopsis sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Oxidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Frontipoda sp.	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Pionidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Piona sp.	0	0	0	0	0	0	1	0	0	0	0	0	0	4	1	6	1	0	0	0	0	0	0
| Family: Sperchontidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sperchon	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Torrenticolidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Testudacarus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Torrenticola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Unionicolidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Neumania sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Unionicola sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Sarcoptiformes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydrozetidae	0	0	0	0	1	0	0	10	0	7	9	1	0	0	0	0	0	0	0	0	0	2	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Mollusca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Bivalvia	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0
| Order: Veneroida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Pisidiidae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pisidium	0	0	1	0	0	44	104	1	2	0	0	1	12	4	22	13	7	0	0	0	0	0	0
Sphaerium sp.	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Gastropoda	0	0	0	0	0	13	0	0	0	0	0	0	3	2	0	0	0	1	0	0	0	0	0
| Order: Basommatophora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Lymnaeidae	0	0	0	0	0	4	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Lymnaea sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stagnicola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Physidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physa	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Planorbidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	7	5	0	0	0	0	0	0
Gyraulus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Promenetus sp.	3	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Heterostropha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Valvatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Valvata sincera	2	0	4	0	0	24	42	2	2	2	0	0	2	2	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Site:	QUL45	QUL45	QUL45	QUL45	QUL45	QUL47	QUL47	QUL49	QUL49	QUL49	QUL49	QUL49	QUL51	QUL51	QUL51	QUL51	QUL51	QULP-1	QULP-1	QULP-1	QULP-1	QULP-1	QULP-2
Sample:	1	2	3	4	5	1	2	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1
CC#:	CC150492	CC150493	CC150494	CC150495	CC150496	CC150497	CC150498	CC150499	CC150500	CC150501	CC150502	CC150503	CC150504	CC150505	CC150506	CC150507	CC150508	CC150934	CC150935	CC150936	CC150937	CC150938	CC150939
EMS:																							
Phylum: Annelida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Clitellata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Hirudinea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Rhynchobdellida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Glossiphoniidae	0	0	0	0	0	3	20	0	10	0	0	2	10	1	13	7	1	0	0	0	0	0	0
Helobdella sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Lumbriculida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Lumbriculidae	0	0	5	0	3	0	2	5	11	0	4	6	6	20	17	2	2	0	0	2	1	0	0
Stylodrilus heringianus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Tubificida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Enchytraeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Enchytraeus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Naididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nais	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slavina appendiculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Tubificidae	1	1	12	0	1	8	7	0	8	0	7	15	21	55	65	25	7	0	0	0	0	0	0
Limnodrilus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spirosperma nikolskyi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Cnidaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Hydrozoa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Anthoathecatae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals:	**18**	**12**	**38**	**1**	**24**	**425**	**615**	**38**	**45**	**21**	**36**	**30**	**185**	**201**	**236**	**167**	**35**	**2**	**2**	**7**	**1**	**11**	**7**

Taxa present but not included:

Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Entognatha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Collembola	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Crustacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Ostracoda	0	0	0	0	0	0	0	1	0	0	0	0	10	0	1	0	0	0	0	0	0	0	0
| Class: Branchiopoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Cladocera	0	0	0	0	0	8	17	0	0	0	0	4	2	11	18	0	0	13	180	1	0	20	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Copepoda	0	0	0	0	0	0	1	0	0	0	0	0	5	3	8	5	0	0	200	0	200	150	20
| Class: Malacostraca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Copepoda	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Nemata	7	0	0	0	0	36	31	4	4	0	1	4	32	25	29	34	4	1	2	0	1	0	5
Phylum: Platyhelminthes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Turbellaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals:	**7**	**0**	**0**	**0**	**0**	**55**	**49**	**6**	**4**	**0**	**1**	**8**	**49**	**39**	**56**	**39**	**4**	**14**	**382**	**3**	**201**	**170**	**25**

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Cordillera Consulting	Site:	QULP-2	QULP-2	QULP-2	QULP-2	QULP-5	QULP-5	QULP-5	QULP-5	QULP-5	QUL47	QUL47	QUL47	QUL-48	QUL-48	QUL-48	QUL-48	QUL-48	QUL-52	QUL-52	QUL-52	QUL-52	QUL-52	QULP-3
	Sample:	2	3	4	5	1	2	3	4	5	3	4	5	1	2	3	4	5	1	2	3	4	5	1
	CC#:	CC150940	CC150941	CC150942	CC150943	CC150944	CC150945	CC150946	CC150947	CC150948	CC150949	CC150950	CC150951	CC150952	CC150953	CC150954	CC150955	CC150956	CC151480	CC151481	CC151482	CC151483	CC151484	CC151485
	EMS:																							
No Invertebrates Found		0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Salpingidae		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Arthropoda		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Hexapoda		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Insecta		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Ephemeroptera		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Ameletidae		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ameletus		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Baetidae		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baetis		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baetis bicaudatus		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callibaetis sp.		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0
| Family: Caenidae		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caenis sp.		0	0	0	0	0	0	0	0	0	1	11	13	1	0	4	0	0	0	0	0	0	0	0
Caenis youngi		0	0	0	0	0	0	0	0	0	0	3	6	8	0	20	2	19	0	0	0	0	0	0
| Family: Ephemerellidae		0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
Drunella sp.		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drunella spinifera		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemerella		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	4	0	0	0	0
Ephemerella velmae		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Ephemeridae		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemera simulans		0	0	0	0	0	0	0	0	0	9	6	14	0	0	0	0	0	0	0	0	0	0	0
| Family: Heptageniidae		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heptagenia		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhithrogena		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Leptophlebiidae		0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Leptophlebia sp.		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paraleptophlebia		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Plecoptera		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
| Family: Capniidae		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Capnia sp.		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Chloroperlidae		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Suwallia		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sweltsa sp.		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Nemouridae		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Zapada		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zapada cinctipes		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Perlidae		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Claassenia sp.		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Doroneuria sp.		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hesperoperla sp.		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Perlodidae		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diura sp.		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Skwala		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Pteronarcyidae		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pteronarcys		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Taeniopterygidae		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Site:	QULP-2	QULP-2	QULP-2	QULP-2	QULP-5	QULP-5	QULP-5	QULP-5	QULP-5	QUL47	QUL47	QUL47	QUL-48	QUL-48	QUL-48	QUL-48	QUL-48	QUL-52	QUL-52	QUL-52	QUL-52	QUL-52	QULP-3
Sample:	2	3	4	5	1	2	3	4	5	3	4	5	1	2	3	4	5	1	2	3	4	5	1
CC#:	CC150940	CC150941	CC150942	CC150943	CC150944	CC150945	CC150946	CC150947	CC150948	CC150949	CC150950	CC150951	CC150952	CC150953	CC150954	CC150955	CC150956	CC151480	CC151481	CC151482	CC151483	CC151484	CC151485
EMS:																							
| Order: Trichoptera	0	0	0	0	0	0	0	0	0	0	0	0	3	0	2	0	0	0	0	0	0	0	0
| Family: Brachycentridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brachycentrus occidentalis	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Brachycentrus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micrasema	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micrasema gelidum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Glossosomatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glossosoma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydropsychidae	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Cheumatopsyche	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Hydropsyche	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydroptilidae	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Agraylea sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydroptila	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxyethira sp.	0	0	0	0	0	0	0	0	0	2	56	58	66	2	14	0	12	8	0	0	0	0	0
| Family: Lepidostomatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidostoma	0	0	0	0	0	0	0	0	0	0	0	9	1	0	0	0	0	0	0	0	0	0	0
| Family: Leptoceridae	0	0	0	0	0	0	0	0	0	0	2	0	2	0	4	0	0	0	0	0	0	0	0
Mystacides	0	0	0	0	0	0	0	0	0	2	0	0	15	0	18	0	1	18	0	0	6	9	0
Oecetis	0	0	0	0	0	0	0	0	0	0	12	1	2	0	0	2	4	0	0	0	0	0	0
| Family: Limnephilidae	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0
Chyranda centralis	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnephilus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
| Family: Phryganeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phryganea sp.	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0	1	0	0	0	0	0	0
| Family: Polycentropodidae	0	0	0	0	0	0	0	0	0	9	0	0	3	1	2	6	3	0	0	0	0	0	0
Polycentropus	0	0	0	0	0	0	0	0	0	0	4	0	6	1	4	12	0	16	0	0	7	12	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Coleoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Dytiscidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydroporus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laccornis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oreodytes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Elmidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterlimnius sp.	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Optioservus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Zaitzevia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Gyrinidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gyrinus sp.	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
| Family: Haliplidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haliplus sp.	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
| Family: Hydrophilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Psephenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Diptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0
| Family: Athericidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atherix	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Ceratopogonidae	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Bezzia/ Palpomyia	0	0	0	0	2	0	4	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Culicoides	0	0	0	0	0	6	4	3	0	0	0	0	0	0	0	12	9	18	2	0	0	9	0
Probezzia	0	0	0	0	0	0	0	0	0	18	37	10	29	0	6	0	0	0	0	0	0	0	0
Sphaeromias sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Cordillera Consulting Site:	QULP-2	QULP-2	QULP-2	QULP-2	QULP-5	QULP-5	QULP-5	QULP-5	QULP-5	QUL47	QUL47	QUL47	QUL-48	QUL-48	QUL-48	QUL-48	QUL-48	QUL-52	QUL-52	QUL-52	QUL-52	QUL-52	QULP-3
Sample:	2	3	4	5	1	2	3	4	5	3	4	5	1	2	3	4	5	1	2	3	4	5	1
CC#:	CC150940	CC150941	CC150942	CC150943	CC150944	CC150945	CC150946	CC150947	CC150948	CC150949	CC150950	CC150951	CC150952	CC150953	CC150954	CC150955	CC150956	CC151480	CC151481	CC151482	CC151483	CC151484	CC151485
EMS:																							
| Family: Chaoboridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chaoborus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
| Family: Chironomidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Subfamily: Chironominae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Tribe: Chironomini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chironomus	0	0	0	0	46	0	0	0	0	0	75	0	0	0	0	0	0	0	2	12	0	0	0
Cryptochironomus	0	0	0	0	0	0	0	0	0	0	0	4	0	0	8	0	0	14	10	8	3	4	0
Demicryptochironomus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dicrotendipes	0	0	0	0	0	0	0	0	0	0	120	0	0	19	30	138	5	10	0	0	5	23	0
Harnischia sp.	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
Microtendipes pedellus	0	0	0	0	0	0	0	0	0	0	60	37	141	16	32	0	32	2	0	12	1	0	0
Nilothauma sp.	0	0	0	0	0	0	0	0	0	0	0	12	1	0	0	0	0	0	0	0	0	0	0
Parachironomus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paracladopelma sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	8	0	0	0
Phaenopsectra	0	0	0	0	480	878	562	395	200	34	0	0	13	0	0	0	0	0	0	0	0	0	0
Polypedilum sp.	0	1	0	0	0	0	0	0	0	0	0	9	0	0	0	12	0	96	336	576	40	62	0
Stictochironomus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	116	200	43	27	0
| Tribe: Pseudochironomini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudochironomus sp.	0	0	0	0	0	0	0	0	0	0	98	46	0	0	12	0	0	0	0	0	0	0	0
| Tribe: Tanytarsini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cladotanytarsus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corynocera sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micropsectra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paratanytarsus	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
Rheotanytarsus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stempellina sp.	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	4	0	4	1	0	0
Tanytarsus	0	0	0	0	0	2	0	0	0	0	80	22	2	17	34	72	23	246	202	616	187	192	0
| Subfamily: Diamesinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Tribe: Diamesini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pagastia	0	0	0	0	0	0	0	0	0	0	65	0	0	10	0	0	1	2	0	0	0	0	0
Potthastia gaedii group	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	4	0	0	2	7	0
Potthastia longimana group	0	0	0	0	0	0	0	0	0	2	4	0	0	0	2	0	0	0	0	0	0	0	0
Pseudodiamesa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Subfamily: Orthocladiinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cricotopus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diplocladius cultriger	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Epoicocladius sp.	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
Eukiefferiella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterotrissocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	12	48	2	2	23
Hydrobaenus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnophyes sp.	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mesocricotopus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nanocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Orthocladius complex	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Orthocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parachaetocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parakiefferiella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parametriocnemus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paraphaenocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Psectrocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Rheocricotopus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tvetenia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Cordillera Consulting Site:	QULP-2	QULP-2	QULP-2	QULP-2	QULP-5	QULP-5	QULP-5	QULP-5	QULP-5	QUL47	QUL47	QUL47	QUL-48	QUL-48	QUL-48	QUL-48	QUL-48	QUL-52	QUL-52	QUL-52	QUL-52	QUL-52	QULP-3
Sample:	2	3	4	5	1	2	3	4	5	3	4	5	1	2	3	4	5	1	2	3	4	5	1
CC#:	CC150940	CC150941	CC150942	CC150943	CC150944	CC150945	CC150946	CC150947	CC150948	CC150949	CC150950	CC150951	CC150952	CC150953	CC150954	CC150955	CC150956	CC151480	CC151481	CC151482	CC151483	CC151484	CC151485
EMS:																							
| **Tribe: Corynoneurini**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corynoneura	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
| **Subfamily: Prodiamesinae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monodiamesa sp.	0	0	0	0	0	0	2	0	1	0	0	0	0	13	0	0	0	2	18	48	1	0	0
Odontomesa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	12	0	0	0
| **Subfamily: Tanypodinae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ablabesmyia	0	0	0	0	0	0	0	0	0	0	0	0	7	0	8	0	0	4	0	0	1	0	0
| **Tribe: Pentaneuriini**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thienemannimyia group	0	0	0	0	0	2	16	0	1	0	0	0	0	0	0	0	0	0	0	8	0	2	0
| **Tribe: Procladiini**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Procladius	0	0	0	0	0	0	2	1	0	0	0	6	3	59	28	8	45	26	20	8	32	37	9
| **Family: Empididae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chelifera/ Metachela	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Clinocera sp.	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Hemerodromia sp.	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
Neoplasta sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oreogeton sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Roederiodes sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Family: Simuliidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Simulium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Family: Tabanidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tabanus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Family: Tipulidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Antocha sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dicranota	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Order: Hemiptera**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Family: Corixidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Sigara	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Order: Lepidoptera**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Order: Megaloptera**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Family: Sialidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sialis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Order: Odonata**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
| **Family: Coenagrionidae**	0	0	0	0	0	0	0	0	0	2	3	7	0	0	14	0	9	0	0	0	0	0	0
| **Family: Corduliidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Epitheca sp.	0	0	0	0	0	0	0	0	0	0	0	5	0	0	2	0	0	0	0	0	0	0	0
Somatochlora sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Crustacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Class: Malacostraca**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Order: Amphipoda**	0	0	0	0	0	0	0	0	0	5	0	43	0	1	16	42	24	10	0	0	2	0	0
| **Family: Gammaridae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gammarus	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0
| **Family: Hyalellidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hyalella	0	0	0	0	0	0	0	0	0	29	252	159	106	26	208	208	181	44	2	0	8	78	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Chelicerata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Class: Arachnida**	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	22	0	4	0	0	0
| **Order: Trombidiformes**	1	0	0	0	2	2	0	1	1	0	0	0	12	0	0	0	1	0	0	0	0	0	0
| **Family: Arrenuridae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arrenurus sp.	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3	2	0	0	0	2	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Cordillera Consulting Site:	QULP-2	QULP-2	QULP-2	QULP-2	QULP-5	QULP-5	QULP-5	QULP-5	QULP-5	QUL47	QUL47	QUL47	QUL-48	QUL-48	QUL-48	QUL-48	QUL-48	QUL-52	QUL-52	QUL-52	QUL-52	QUL-52	QULP-3
Sample:	2	3	4	5	1	2	3	4	5	3	4	5	1	2	3	4	5	1	2	3	4	5	1
CC#:	CC150940	CC150941	CC150942	CC150943	CC150944	CC150945	CC150946	CC150947	CC150948	CC150949	CC150950	CC150951	CC150952	CC150953	CC150954	CC150955	CC150956	CC151480	CC151481	CC151482	CC151483	CC151484	CC151485
EMS:																							
| Family: Hydrachnidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrachna sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
| Family: Hydryphantidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Albertathyas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hygrobatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atractides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hygrobates	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	40	172	3	2	0
| Family: Lebertiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lebertia	0	0	0	0	0	0	2	0	0	0	4	1	0	0	4	0	0	10	0	0	3	2	2
| Family: Limnesiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnesia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
| Family: Limnocharidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnochares sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Mideopsidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mideopsis sp.	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Oxidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Frontipoda sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
| Family: Pionidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Piona sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Sperchontidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sperchon	0	0	0	0	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0	0	0	0	0
| Family: Torrenticolidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Testudacarus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Torrenticola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
| Family: Unionicolidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Neumania sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	2	0
Unionicola sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Sarcoptiformes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydrozetidae	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Mollusca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Bivalvia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Veneroida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Pisidiidae	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	24	23	11	0
Pisidium	0	0	0	0	0	0	0	0	0	33	50	121	178	28	224	40	132	0	0	0	0	0	2
Sphaerium sp.	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	10	7	24	0	0	4	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Gastropoda	0	0	0	0	0	0	0	0	0	0	0	0	101	0	0	0	0	0	0	0	0	0	0
| Order: Basommatophora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Lymnaeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lymnaea sp.	0	0	0	0	0	0	0	0	0	0	24	8	0	6	0	0	0	0	0	0	0	0	0
Stagnicola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
| Family: Physidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physa	0	0	0	0	0	0	0	0	0	6	0	0	0	0	28	0	3	0	0	0	0	0	0
| Family: Planorbidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gyraulus	0	0	0	0	0	0	0	0	0	14	27	31	0	8	12	0	0	0	0	0	0	0	0
Promenetus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	126	31	20	0	0	6	7	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Heterostropha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Valvatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Valvata sincera	0	0	0	0	0	0	0	0	0	0	65	38	0	14	58	0	27	4	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Cordillera Consulting Site:	QULP-2	QULP-2	QULP-2	QULP-2	QULP-5	QULP-5	QULP-5	QULP-5	QULP-5	QUL47	QUL47	QUL47	QUL-48	QUL-48	QUL-48	QUL-48	QUL-48	QUL-52	QUL-52	QUL-52	QUL-52	QUL-52	QULP-3
Sample:	2	3	4	5	1	2	3	4	5	3	4	5	1	2	3	4	5	1	2	3	4	5	1
CC#:	CC150940	CC150941	CC150942	CC150943	CC150944	CC150945	CC150946	CC150947	CC150948	CC150949	CC150950	CC150951	CC150952	CC150953	CC150954	CC150955	CC150956	CC151480	CC151481	CC151482	CC151483	CC151484	CC151485
EMS:																							
Phylum: Annelida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Clitellata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Hirudinea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Rhynchobdellida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Glossiphoniidae	0	0	0	0	0	0	0	0	0	1	5	4	33	0	16	32	1	10	0	4	0	4	0
Helobdella sp.	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	68	0
| Order: Lumbriculida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Lumbriculidae	0	0	0	0	20	0	18	4	8	2	24	12	0	3	10	0	0	194	0	20	15	5	1
Stylodrilus heringianus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Tubificida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Enchytraeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Enchytraeus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Naididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nais	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slavina appendiculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Tubificidae	0	0	0	0	116	12	204	130	233	10	36	72	16	0	136	44	0	0	4	68	23	62	3
Limnodrilus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spirosperma nikolskyi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Cnidaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Hydrozoa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Anthoathecatae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0
Totals:	**3**	**3**	**1**	**1**	**668**	**902**	**816**	**537**	**450**	**195**	**1137**	**761**	**774**	**237**	**960**	**784**	**587**	**838**	**784**	**1860**	**424**	**633**	**40**

Taxa present but not included:

Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Entognatha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Collembola	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Crustacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Ostracoda	18	10	1	7	8	0	28	75	80	10	15	0	20	1	20	24	0	72	8	20	7	4	60
| Class: Branchiopoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Cladocera	150	20	50	40	0	100	34	2	13	1	74	2	0	32	20	4	0	0	0	4	11	11	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Copepoda	50	5	15	85	40	400	240	250	800	0	10	3	0	0	0	10	0	20	4	0	32	12	80
| Class: Malacostraca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Copepoda	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Nemata	0	5	0	1	8	40	12	15	13	9	24	29	15	1	100	12	13	4	0	4	2	2	8
Phylum: Platyhelminthes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Turbellaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals:	**218**	**40**	**66**	**133**	**58**	**540**	**314**	**342**	**906**	**23**	**123**	**34**	**35**	**34**	**140**	**50**	**13**	**96**	**12**	**28**	**52**	**29**	**148**

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Cordillera Consulting Site:	QULP-3	QULP-3	QULP-3	QULP-3	QULP-4	QULP-4	QULP-4	QULP-4	QULP-4	QULP-6	QULP-6	QULP-6	QULP-6	QULP-6	POL-P1	POL-P1	POL-P1	POL-1	POL-1	POL-1	POL-1	QUR1	QUR1
Sample:	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	1	2	3	4	R1	R2
CC#:	CC151486	CC151487	CC151488	CC151489	CC151490	CC151491	CC151492	CC151493	CC151494	CC151495	CC151496	CC151497	CC151498	CC151499	CC151500	CC151501	CC151502	CC151503	CC151504	CC151505	CC151506	CC151557	CC151558
EMS:																							
No Invertebrates Found	0	0	0	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Salpingidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Hexapoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Insecta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Ephemeroptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Ameletidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ameletus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Baetidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
Baetis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
Baetis bicaudatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
Callibaetis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Caenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caenis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caenis youngi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Ephemerellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	180	114
Drunella sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drunella spinifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemerella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	105
Ephemerella velmae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	187	41
| Family: Ephemeridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemera simulans	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Heptageniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	3
Heptagenia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0
Rhithrogena	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Leptophlebiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	5
Leptophlebia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paraleptophlebia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Plecoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Capniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capnia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Chloroperlidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
Suwallia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sweltsa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
| Family: Nemouridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Zapada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zapada cinctipes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	35
| Family: Perlidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
Claassenia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Doroneuria sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hesperoperla sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	14
| Family: Perlodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	62
Diura sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Skwala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Pteronarcyidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pteronarcys	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Taeniopterygidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Cordillera Consulting Site:	QULP-3	QULP-3	QULP-3	QULP-3	QULP-4	QULP-4	QULP-4	QULP-4	QULP-4	QULP-6	QULP-6	QULP-6	QULP-6	QULP-6	POL-P1	POL-P1	POL-P1	POL-1	POL-1	POL-1	POL-1	QUR1	QUR1
Sample:	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	1	2	3	4	R1	R2
CC#:	CC151486	CC151487	CC151488	CC151489	CC151490	CC151491	CC151492	CC151493	CC151494	CC151495	CC151496	CC151497	CC151498	CC151499	CC151500	CC151501	CC151502	CC151503	CC151504	CC151505	CC151506	CC151557	CC151558
EMS:																							
| Order: Trichoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Brachycentridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brachycentrus occidentalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brachycentrus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micrasema	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micrasema gelidum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
| Family: Glossosomatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glossosoma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydropsychidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cheumatopsyche	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5
Hydropsyche	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
| Family: Hydroptilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agraylea sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydroptila	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxyethira sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Lepidostomatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidostoma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Leptoceridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mystacides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oecetis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Limnephilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chyranda centralis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnephilus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Phryganeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phryganea sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Polycentropodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polycentropus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Coleoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Dytiscidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydroporus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laccornis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oreodytes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Elmidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterlimnius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Optioservus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zaitzevia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Gyrinidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gyrinus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Haliplidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haliplus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydrophilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Psephenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Diptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Athericidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atherix	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
| Family: Ceratopogonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bezzia/ Palpomyia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Culicoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Probezzia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sphaeromias sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Cordillera Consulting Site:	QULP-3	QULP-3	QULP-3	QULP-3	QULP-4	QULP-4	QULP-4	QULP-4	QULP-4	QULP-6	QULP-6	QULP-6	QULP-6	QULP-6	POL-P1	POL-P1	POL-P1	POL-1	POL-1	POL-1	POL-1	QUR1	QUR1
Sample:	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	1	2	3	4	R1	R2
CC#:	CC151486	CC151487	CC151488	CC151489	CC151490	CC151491	CC151492	CC151493	CC151494	CC151495	CC151496	CC151497	CC151498	CC151499	CC151500	CC151501	CC151502	CC151503	CC151504	CC151505	CC151506	CC151557	CC151558
EMS:																							
Family: Chaoboridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chaoborus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Chironomidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subfamily: Chironominae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tribe: Chironomini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chironomus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0
Cryptochironomus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Demicryptochironomus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dicrotendipes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harnischia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microtendipes pedellus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60	0
Nilothauma sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parachironomus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paracladopelma sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phaenopsectra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polypedilum sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stictochironomus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tribe: Pseudochironomini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudochironomus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tribe: Tanytarsini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cladotanytarsus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corynocera sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micropsectra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	57	30
Paratanytarsus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rheotanytarsus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Stempellina sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tanytarsus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subfamily: Diamesinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tribe: Diamesini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pagastia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	11
Potthastia gaedii group	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potthastia longimana group	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	5
Pseudodiamesa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subfamily: Orthocladiinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cricotopus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diplocladius cultriger	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Epoicocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eukiefferiella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	8
Heterotrissocladius sp.	14	32	11	33	0	2	0	0	0	50	19	49	54	22	0	0	0	0	0	0	0	20	0
Hydrobaenus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnophyes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mesocricotopus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nanocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Orthocladius complex	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Orthocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	16
Parachaetocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parakiefferiella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parametriocnemus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paraphaenocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Psectrocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rheocricotopus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tvetenia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Site:	QULP-3	QULP-3	QULP-3	QULP-3	QULP-4	QULP-4	QULP-4	QULP-4	QULP-4	QULP-6	QULP-6	QULP-6	QULP-6	QULP-6	POL-P1	POL-P1	POL-P1	POL-1	POL-1	POL-1	POL-1	QUR1	QUR1
Sample:	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	1	2	3	4	R1	R2
CC#:	CC151486	CC151487	CC151488	CC151489	CC151490	CC151491	CC151492	CC151493	CC151494	CC151495	CC151496	CC151497	CC151498	CC151499	CC151500	CC151501	CC151502	CC151503	CC151504	CC151505	CC151506	CC151557	CC151558
EMS:																							
| Tribe: Corynoneurini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corynoneura	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Subfamily: Prodiamesinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monodiamesa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odontomesa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Subfamily: Tanypodinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ablabesmyia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Tribe: Pentaneuriini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thienemannimyia group	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	290	178
| Tribe: Procladiini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Procladius	3	2	3	3	0	0	0	0	0	4	0	0	0	0	0	0	0	3	0	0	1	0	0
| Family: Empididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chelifera/ Metachela	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clinocera sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemerodromia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	8
Neoplasta sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oreogeton sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Roederiodes sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Simuliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Simulium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
| Family: Tabanidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tabanus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Tipulidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Antocha sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	16
Dicranota	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Hemiptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Corixidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sigara	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Lepidoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Megaloptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Sialidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sialis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Odonata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Coenagrionidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Corduliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Epitheca sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Somatochlora sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Crustacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Malacostraca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Amphipoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Gammaridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gammarus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hyalellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hyalella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Chelicerata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Arachnida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
| Order: Trombidiformes	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
| Family: Arrenuridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arrenurus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Cordillera Consulting — Site:	QULP-3	QULP-3	QULP-3	QULP-3	QULP-4	QULP-4	QULP-4	QULP-4	QULP-4	QULP-6	QULP-6	QULP-6	QULP-6	QULP-6	POL-P1	POL-P1	POL-P1	POL-1	POL-1	POL-1	POL-1	QUR1	QUR1
Sample:	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	1	2	3	4	R1	R2
CC#:	CC151486	CC151487	CC151488	CC151489	CC151490	CC151491	CC151492	CC151493	CC151494	CC151495	CC151496	CC151497	CC151498	CC151499	CC151500	CC151501	CC151502	CC151503	CC151504	CC151505	CC151506	CC151557	CC151558
EMS:																							
| **Family: Hydrachnidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrachna sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Family: Hydryphantidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Albertathyas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Family: Hygrobatidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atractides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hygrobates	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Family: Lebertiidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lebertia	0	0	2	2	0	0	0	0	0	1	1	0	0	2	0	0	0	0	0	0	0	0	0
| **Family: Limnesiidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnesia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Family: Limnocharidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnochares sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Family: Mideopsidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mideopsis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Family: Oxidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Frontipoda sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Family: Pionidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Piona sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Family: Sperchontidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sperchon	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
| **Family: Torrenticolidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Testudacarus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
Torrenticola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Family: Unionicolidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Neumania sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unionicola sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Order: Sarcoptiformes**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Family: Hydrozetidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Mollusca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Class: Bivalvia**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Order: Veneroida**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Family: Pisidiidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pisidium	0	7	0	3	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	3	0
Sphaerium sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Class: Gastropoda**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Order: Basommatophora**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Family: Lymnaeidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lymnaea sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0
Stagnicola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Family: Physidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Family: Planorbidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gyraulus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Promenetus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Order: Heterostropha**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Family: Valvatidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Valvata sincera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Site:	QULP-3	QULP-3	QULP-3	QULP-3	QULP-4	QULP-4	QULP-4	QULP-4	QULP-4	QULP-6	QULP-6	QULP-6	QULP-6	QULP-6	POL-P1	POL-P1	POL-P1	POL-1	POL-1	POL-1	POL-1	QUR1	QUR1
Sample:	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	1	2	3	4	R1	R2
CC#:	CC151486	CC151487	CC151488	CC151489	CC151490	CC151491	CC151492	CC151493	CC151494	CC151495	CC151496	CC151497	CC151498	CC151499	CC151500	CC151501	CC151502	CC151503	CC151504	CC151505	CC151506	CC151557	CC151558
EMS:																							
Phylum: Annelida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Clitellata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Hirudinea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Rhynchobdellida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Glossiphoniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helobdella sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Lumbriculida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Lumbriculidae	0	0	0	0	0	0	0	0	0	20	0	4	9	2	1	1	1	5	0	0	0	0	0
Stylodrilus heringianus	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Tubificida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Enchytraeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Enchytraeus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54
| Family: Naididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nais	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slavina appendiculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Tubificidae	1	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	28	0	0
Limnodrilus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spirosperma nikolskyi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Cnidaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Hydrozoa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Anthoathecatae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	105
Totals:	**18**	**41**	**16**	**44**	**1**	**2**	**1**	**1**	**1**	**79**	**22**	**53**	**64**	**26**	**1**	**1**	**2**	**9**	**4**	**7**	**29**	**1054**	**878**

Taxa present but not included:

Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Entognatha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Collembola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Crustacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Ostracoda	5	30	11	15	2	1	0	0	0	20	15	33	10	0	0	5	0	0	0	5	0	7	0
| Class: Branchiopoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Cladocera	0	1	0	0	7	5	8	6	0	0	10	0	0	0	150	50	150	200	2000	125	200	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Copepoda	35	35	40	75	400	100	100	300	150	50	30	0	60	24	200	100	200	500	1000	300	300	7	0
| Class: Malacostraca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Copepoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Nemata	5	1	7	2	0	0	0	0	0	0	10	18	10	7	0	0	0	0	0	0	0	17	3
Phylum: Platyhelminthes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Turbellaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
Totals:	**45**	**67**	**58**	**92**	**409**	**106**	**108**	**306**	**150**	**70**	**65**	**51**	**80**	**31**	**350**	**155**	**350**	**700**	**3000**	**430**	**500**	**34**	**3**

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Site:	QUR1	QUR2	QUR2	QUR2	QUR3	QUR3	QUR3	QUR4	QUR4	QUR4	QUR5	QUR5	QUR5	QUR6	QUR6	QUR6	CAR	CAR	CAR	CLR	CLR	CLR	POL-1
Sample:	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	5
CC#:	CC151559	CC151560	CC151561	CC151562	CC151563	CC151564	CC151565	CC151566	CC151567	CC151568	CC151569	CC151570	CC151571	CC151572	CC151573	CC151574	CC151575	CC151576	CC151577	CC151578	CC151579	CC151580	CC151615
EMS:																							
No Invertebrates Found	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Salpingidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Hexapoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Insecta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Ephemeroptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Ameletidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ameletus	0	1	0	0	0	0	0	0	0	2	17	9	34	5	0	29	4	6	4	5	7	18	0
| Family: Baetidae	16	3	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	3	2	0	0
Baetis	40	6	2	0	1	0	2	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Baetis bicaudatus	20	6	6	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2	0	0
Callibaetis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Caenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caenis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caenis youngi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Ephemerellidae	168	61	182	93	150	270	194	4	27	1	81	168	24	344	31	25	83	135	137	42	8	2	0
Drunella sp.	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drunella spinifera	12	2	14	0	1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemerella	132	52	102	67	118	246	64	0	9	0	11	4	2	4	0	2	2	21	7	12	0	0	0
Ephemerella velmae	28	28	10	159	12	44	4	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Ephemeridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemera simulans	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Heptageniidae	12	4	16	0	5	8	2	0	1	0	5	7	2	3	1	8	25	28	16	6	0	1	0
Heptagenia	0	0	0	0	0	0	0	0	1	0	2	4	1	0	0	0	0	0	0	0	0	0	0
Rhithrogena	0	0	0	0	0	0	0	0	5	0	4	9	0	0	0	1	0	0	0	0	0	0	0
| Family: Leptophlebiidae	32	5	4	4	4	10	2	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0
Leptophlebia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Paraleptophlebia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Plecoptera	0	0	0	0	0	0	0	0	0	0	0	2	0	4	0	0	0	3	0	1	0	0	0
| Family: Capniidae	0	1	0	0	0	0	0	1	4	1	5	25	6	22	15	48	10	8	4	5	2	0	0
Capnia sp.	0	0	0	0	0	0	0	0	0	0	7	13	3	8	22	27	1	0	1	0	0	0	0
| Family: Chloroperlidae	0	3	6	0	2	0	0	2	1	0	0	0	0	2	0	0	7	2	1	0	0	0	0
Suwallia	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sweltsa sp.	0	6	6	0	4	6	2	0	4	1	1	8	2	1	3	5	20	20	11	3	1	0	0
| Family: Nemouridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zapada	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zapada cinctipes	56	46	42	59	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Perlidae	44	7	10	4	9	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Claassenia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Doroneuria sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Hesperoperla sp.	12	2	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Perlodidae	100	98	126	7	24	24	9	0	0	1	0	0	0	4	0	0	1	2	0	0	0	0	0
Diura sp.	64	0	2	0	0	42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Skwala	0	0	0	0	0	2	0	0	2	2	0	1	1	0	0	2	2	0	7	0	0	0	0
| Family: Pteronarcyidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pteronarcys	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	1	0	0	0	0
| Family: Taeniopterygidae	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Cordillera Consulting																							
Site:	QUR1	QUR2	QUR2	QUR2	QUR3	QUR3	QUR3	QUR4	QUR4	QUR4	QUR5	QUR5	QUR5	QUR6	QUR6	QUR6	CAR	CAR	CAR	CLR	CLR	CLR	POL-1
Sample:	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	5
CC#:	CC151559	CC151560	CC151561	CC151562	CC151563	CC151564	CC151565	CC151566	CC151567	CC151568	CC151569	CC151570	CC151571	CC151572	CC151573	CC151574	CC151575	CC151576	CC151577	CC151578	CC151579	CC151580	CC151615
EMS:																							
Order: Trichoptera	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0
Family: Brachycentridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brachycentrus occidentalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brachycentrus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Micrasema	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micrasema gelidum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Glossosomatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Glossosoma	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Hydropsychidae	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cheumatopsyche	36	14	30	4	5	6	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0
Hydropsyche	12	14	22	0	8	14	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Hydroptilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agraylea sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydroptila	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0
Oxyethira sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Lepidostomatidae	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidostoma	0	0	0	0	1	0	2	0	0	0	1	2	1	0	0	0	2	10	4	0	0	1	0
Family: Leptoceridae	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mystacides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oecetis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Limnephilidae	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0
Chyranda centralis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnephilus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Phryganeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phryganea sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Polycentropodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polycentropus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Order: Coleoptera	4	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0
Family: Dytiscidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydroporus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Laccornis sp.	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oreodytes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Family: Elmidae	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterlimnius sp.	4	24	18	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	1	0
Optioservus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0
Zaitzevia sp.	0	1	22	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Gyrinidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gyrinus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Haliplidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haliplus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Hydrophilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Psephenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Order: Diptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0
Family: Athericidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atherix	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Ceratopogonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bezzia/ Palpomyia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Culicoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Probezzia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sphaeromias sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Site:	QUR1	QUR2	QUR2	QUR2	QUR3	QUR3	QUR3	QUR4	QUR4	QUR4	QUR5	QUR5	QUR5	QUR6	QUR6	QUR6	CAR	CAR	CAR	CLR	CLR	CLR	POL-1
Sample:	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	5
CC#:	CC151559	CC151560	CC151561	CC151562	CC151563	CC151564	CC151565	CC151566	CC151567	CC151568	CC151569	CC151570	CC151571	CC151572	CC151573	CC151574	CC151575	CC151576	CC151577	CC151578	CC151579	CC151580	CC151615
EMS:																							
| Family: Chaoboridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chaoborus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Chironomidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Subfamily: Chironominae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Tribe: Chironomini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chironomus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Cryptochironomus	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Demicryptochironomus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dicrotendipes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harnischia sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Microtendipes pedellus	4	0	0	22	2	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Nilothauma sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parachironomus	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paracladopelma sp.	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
Phaenopsectra	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Polypedilum sp.	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stictochironomus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Tribe: Pseudochironomini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudochironomus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Tribe: Tanytarsini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cladotanytarsus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corynocera sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micropsectra	28	5	0	89	12	28	304	0	0	0	4	0	0	0	0	0	28	3	2	9	1	0	0
Paratanytarsus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rheotanytarsus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0
Stempellina sp.	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tanytarsus	0	0	0	11	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Subfamily: Diamesinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Tribe: Diamesini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pagastia	28	3	0	0	5	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Potthastia gaedii group	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potthastia longimana group	0	2	4	7	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudodiamesa sp.	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
| Subfamily: Orthocladiinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cricotopus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diplocladius cultriger	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Epoicocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eukiefferiella	16	5	6	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterotrissocladius sp.	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	4	0	0	1	0	0
Hydrobaenus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnophyes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mesocricotopus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nanocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	12	0	0	0	0
Orthocladius complex	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Orthocladius sp.	24	7	24	0	4	0	6	0	0	1	3	0	0	5	6	2	8	15	38	7	0	0	0
Parachaetocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Parakiefferiella	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	3	6	0	0	0	0	0	0
Parametriocnemus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
Paraphaenocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Psectrocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rheocricotopus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	1	0	0
Tvetenia	16	0	0	15	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Cordillera Consulting — Site:	QUR1	QUR2	QUR2	QUR2	QUR3	QUR3	QUR3	QUR4	QUR4	QUR4	QUR5	QUR5	QUR5	QUR6	QUR6	QUR6	CAR	CAR	CAR	CLR	CLR	CLR	POL-1
Sample:	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	5
CC#:	CC151559	CC151560	CC151561	CC151562	CC151563	CC151564	CC151565	CC151566	CC151567	CC151568	CC151569	CC151570	CC151571	CC151572	CC151573	CC151574	CC151575	CC151576	CC151577	CC151578	CC151579	CC151580	CC151615
EMS:																							
| Tribe: Corynoneurini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corynoneura	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Subfamily: Prodiamesinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monodiamesa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odontomesa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Subfamily: Tanypodinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ablabesmyia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Tribe: Pentaneuriini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thienemannimyia group	156	72	92	267	32	52	6	0	0	0	0	2	0	2	0	0	4	3	1	1	1	1	0
| Tribe: Procladiini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Procladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
| Family: Empididae	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Chelifera/ Metachela	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clinocera sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemerodromia sp.	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Neoplasta sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Oreogeton sp.	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Roederiodes sp	0	0	0	0	5	6	2	0	0	0	0	0	0	0	0	0	5	6	2	0	0	0	0
| Family: Simuliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Simulium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
| Family: Tabanidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tabanus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Tipulidae	8	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	0	0	0	0
Antocha sp.	28	4	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dicranota	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Hemiptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Corixidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sigara	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Lepidoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0
| Order: Megaloptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Sialidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sialis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Odonata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Coenagrionidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Corduliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Epitheca sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Somatochlora sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Crustacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Malacostraca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Amphipoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Gammaridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gammarus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hyalellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hyalella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Chelicerata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Arachnida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Trombidiformes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Arrenuridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arrenurus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Cordillera Consulting Site:	QUR1	QUR2	QUR2	QUR2	QUR3	QUR3	QUR3	QUR4	QUR4	QUR4	QUR5	QUR5	QUR5	QUR6	QUR6	QUR6	CAR	CAR	CAR	CLR	CLR	CLR	POL-1
Sample:	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	5
CC#:	CC151559	CC151560	CC151561	CC151562	CC151563	CC151564	CC151565	CC151566	CC151567	CC151568	CC151569	CC151570	CC151571	CC151572	CC151573	CC151574	CC151575	CC151576	CC151577	CC151578	CC151579	CC151580	CC151615
EMS:																							
| Family: Hydrachnidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrachna sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydryphantidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Albertathyas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hygrobatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atractides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hygrobates	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	2	6	0
| Family: Lebertiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lebertia	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0
| Family: Limnesiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnesia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Limnocharidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnochares sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Mideopsidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mideopsis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Oxidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Frontipoda sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Pionidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Piona sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
| Family: Sperchontidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sperchon	32	7	6	15	6	6	0	0	0	0	0	0	0	1	0	0	7	2	19	0	0	0	0
| Family: Torrenticolidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Testudacarus sp.	0	8	2	0	1	6	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0
Torrenticola	0	0	4	0	3	10	4	0	0	0	1	2	0	3	1	2	0	1	0	3	0	1	0
| Family: Unionicolidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Neumania sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unionicola sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Sarcoptiformes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydrozetidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Mollusca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Bivalvia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Veneroida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Pisidiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pisidium	8	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Sphaerium sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Gastropoda	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Basommatophora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Lymnaeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lymnaea sp.	0	0	2	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	16	0
Stagnicola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Physidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Planorbidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gyraulus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Promenetus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Heterostropha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Valvatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Valvata sincera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Site:	QUR1	QUR2	QUR2	QUR2	QUR3	QUR3	QUR3	QUR4	QUR4	QUR4	QUR5	QUR5	QUR5	QUR6	QUR6	QUR6	CAR	CAR	CAR	CLR	CLR	CLR	POL-1
Sample:	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3	5
CC#:	CC151559	CC151560	CC151561	CC151562	CC151563	CC151564	CC151565	CC151566	CC151567	CC151568	CC151569	CC151570	CC151571	CC151572	CC151573	CC151574	CC151575	CC151576	CC151577	CC151578	CC151579	CC151580	CC151615
EMS:																							
Phylum: Annelida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Clitellata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Hirudinea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Rhynchobdellida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Glossiphoniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helobdella sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Lumbriculida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Lumbriculidae	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	3	1	0
Stylodrilus heringianus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Tubificida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Enchytraeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Enchytraeus	80	8	28	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Naididae	0	0	0	0	2	6	36	0	0	0	0	7	0	1	0	0	0	9	0	0	2	0	0
Nais	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Slavina appendiculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	7	0	9	4	0	0	0
| Family: Tubificidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnodrilus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spirosperma nikolskyi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Cnidaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Hydrozoa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Anthoathecatae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydra	44	26	80	344	14	16	32	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Totals:	**1268**	**552**	**878**	**1265**	**443**	**832**	**686**	**13**	**55**	**11**	**154**	**286**	**77**	**413**	**84**	**164**	**238**	**305**	**310**	**118**	**40**	**50**	**5**

Taxa present but not included:

Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Entognatha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Collembola	0	0	0	0	0	0	0	0	0	3	0	0	2	0	1	1	0	0	0	0	0	4	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Crustacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Ostracoda	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
| Class: Branchiopoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Cladocera	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1200
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Copepoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	500
| Class: Malacostraca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Copepoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Nemata	0	0	0	0	1	0	0	0	0	0	0	1	0	2	0	0	5	5	5	0	1	0	0
Phylum: Platyhelminthes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Turbellaria	8	0	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Totals:	**20**	**0**	**4**	**0**	**3**	**0**	**0**	**0**	**0**	**3**	**0**	**1**	**2**	**2**	**1**	**2**	**5**	**5**	**8**	**0**	**1**	**4**	**1700**

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Cordillera Consulting Site:	POL-2	POL-2	POL-2	POL-2	POL-2	POL-P2	POL-P2	POL-P2	BOL-1	BOL-1	BOL-1	BOL-1	BOL-1	BOL-B1	BOL-B1	BOL-B1	BOL-B2	BOL-B2	BOL-B2
Sample:	1	2	3	4	5	1	2	3	1	2	3	4	5	1	2	3	1	2	3
CC#:	CC151616	CC151617	CC151618	CC151619	CC151620	CC151621	CC151622	CC151623	CC151624	CC151625	CC151626	CC151627	CC151628	CC151629	CC151630	CC151631	CC151632	CC151633	CC151634
EMS:																			
No Invertebrates Found	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
| Family: Salpingidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Hexapoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Insecta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Ephemeroptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Ameletidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ameletus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Baetidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baetis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baetis bicaudatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callibaetis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Caenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caenis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caenis youngi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Ephemerellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drunella sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drunella spinifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemerella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemerella velmae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Ephemeridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemera simulans	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Heptageniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heptagenia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhithrogena	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Leptophlebiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leptophlebia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paraleptophlebia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Plecoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Capniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capnia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Chloroperlidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Suwallia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sweltsa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Nemouridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zapada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zapada cinctipes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Perlidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Claassenia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Doroneuria sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hesperoperla sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Perlodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diura sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Skwala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Pteronarcyidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pteronarcys	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Taeniopterygidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Cordillera Consulting Site:	POL-2	POL-2	POL-2	POL-2	POL-2	POL-P2	POL-P2	POL-P2	BOL-1	BOL-1	BOL-1	BOL-1	BOL-1	BOL-B1	BOL-B1	BOL-B1	BOL-B2	BOL-B2	BOL-B2
Sample:	1	2	3	4	5	1	2	3	1	2	3	4	5	1	2	3	1	2	3
CC#:	CC151616	CC151617	CC151618	CC151619	CC151620	CC151621	CC151622	CC151623	CC151624	CC151625	CC151626	CC151627	CC151628	CC151629	CC151630	CC151631	CC151632	CC151633	CC151634
EMS:																			
| Order: Trichoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Brachycentridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brachycentrus occidentalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brachycentrus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micrasema	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micrasema gelidum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Glossosomatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glossosoma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydropsychidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cheumatopsyche	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydropsyche	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydroptilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agraylea sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydroptila	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxyethira sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Lepidostomatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidostoma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Leptoceridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mystacides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oecetis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Limnephilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chyranda centralis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnephilus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Phryganeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phryganea sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Polycentropodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polycentropus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Coleoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Dytiscidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydroporus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laccornis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oreodytes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Elmidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterlimnius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Optioservus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zaitzevia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Gyrinidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gyrinus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Haliplidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haliplus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydrophilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Psephenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Diptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Athericidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atherix	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Ceratopogonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bezzia/ Palpomyia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Culicoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Probezzia	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Sphaeromias sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Site:	POL-2	POL-2	POL-2	POL-2	POL-2	POL-P2	POL-P2	POL-P2	BOL-1	BOL-1	BOL-1	BOL-1	BOL-1	BOL-B1	BOL-B1	BOL-B1	BOL-B2	BOL-B2	BOL-B2
Sample:	1	2	3	4	5	1	2	3	1	2	3	4	5	1	2	3	1	2	3
CC#:	CC151616	CC151617	CC151618	CC151619	CC151620	CC151621	CC151622	CC151623	CC151624	CC151625	CC151626	CC151627	CC151628	CC151629	CC151630	CC151631	CC151632	CC151633	CC151634
EMS:																			
Family: Chaoboridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chaoborus sp.	1	0	0	0	3	0	0	0	98	181	73	115	28	83	294	296	144	161	259
Family: Chironomidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subfamily: Chironominae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tribe: Chironomini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chironomus	2	4	1	4	2	0	0	0	12	25	123	68	56	16	57	9	2	12	14
Cryptochironomus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Demicryptochironomus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dicrotendipes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harnischia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microtendipes pedellus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nilothauma sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parachironomus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paracladopelma sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phaenopsectra	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Polypedilum sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stictochironomus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tribe: Pseudochironomini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudochironomus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tribe: Tanytarsini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cladotanytarsus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corynocera sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micropsectra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paratanytarsus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rheotanytarsus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stempellina sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tanytarsus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subfamily: Diamesinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tribe: Diamesini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pagastia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potthastia gaedii group	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potthastia longimana group	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudodiamesa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subfamily: Orthocladiinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cricotopus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diplocladius cultriger	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Epoicocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eukiefferiella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterotrissocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrobaenus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnophyes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mesocricotopus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nanocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Orthocladius complex	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Orthocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parachaetocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parakiefferiella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parametriocnemus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paraphaenocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Psectrocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rheocricotopus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tvetenia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Cordillera Consulting Site:	POL-2	POL-2	POL-2	POL-2	POL-2	POL-P2	POL-P2	POL-P2	BOL-1	BOL-1	BOL-1	BOL-1	BOL-1	BOL-B1	BOL-B1	BOL-B1	BOL-B2	BOL-B2	BOL-B2
Sample:	1	2	3	4	5	1	2	3	1	2	3	4	5	1	2	3	1	2	3
CC#:	CC151616	CC151617	CC151618	CC151619	CC151620	CC151621	CC151622	CC151623	CC151624	CC151625	CC151626	CC151627	CC151628	CC151629	CC151630	CC151631	CC151632	CC151633	CC151634
EMS:																			
Tribe: Corynoneurini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corynoneura	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subfamily: Prodiamesinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monodiamesa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odontomesa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subfamily: Tanypodinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ablabesmyia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tribe: Pentaneuriini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thienemannimyia group	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tribe: Procladiini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Procladius	0	0	0	0	3	0	0	0	4	7	0	7	7	15	13	30	2	0	0
Family: Empididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chelifera/ Metachela	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clinocera sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemerodromia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Neoplasta sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oreogeton sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Roederiodes sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Simuliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Simulium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Tabanidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tabanus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Tipulidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Antocha sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dicranota	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Order: Hemiptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Corixidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sigara	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Order: Lepidoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Order: Megaloptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Sialidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sialis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Order: Odonata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Coenagrionidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Corduliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Epitheca sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Somatochlora sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Crustacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Class: Malacostraca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Order: Amphipoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Gammaridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gammarus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Hyalellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hyalella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Chelicerata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Class: Arachnida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Order: Trombidiformes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family: Arrenuridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arrenurus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Site:	POL-2	POL-2	POL-2	POL-2	POL-2	POL-P2	POL-P2	POL-P2	BOL-1	BOL-1	BOL-1	BOL-1	BOL-1	BOL-B1	BOL-B1	BOL-B1	BOL-B2	BOL-B2	BOL-B2
Sample:	1	2	3	4	5	1	2	3	1	2	3	4	5	1	2	3	1	2	3
CC#:	CC151616	CC151617	CC151618	CC151619	CC151620	CC151621	CC151622	CC151623	CC151624	CC151625	CC151626	CC151627	CC151628	CC151629	CC151630	CC151631	CC151632	CC151633	CC151634
EMS:																			
| Family: Hydrachnidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrachna sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydryphantidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Albertathyas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hygrobatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atractides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hygrobates	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Lebertiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lebertia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Limnesiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnesia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Limnocharidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnochares sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Mideopsidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mideopsis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Oxidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Frontipoda sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Pionidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Piona sp.	0	0	0	0	0	0	0	0	0	10	0	3	1	0	4	0	0	0	1
| Family: Sperchontidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sperchon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Torrenticolidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Testudacarus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Torrenticola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Unionicolidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Neumania sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unionicola sp.	0	0	0	0	0	0	0	0	1	0	0	0	1	0	4	0	1	1	1
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Sarcoptiformes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydrozetidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Mollusca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Bivalvia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Veneroida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Pisidiidae	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0
Pisidium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sphaerium sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Gastropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Basommatophora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Lymnaeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lymnaea sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stagnicola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Physidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Planorbidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gyraulus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Promenetus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Heterostropha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Valvatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Valvata sincera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table G.1: Raw benthic invertebrate community data for lake and river sampling areas, Mount Polley Mine, 2014 (# per 0.116 m^2).

Cordillera Consulting Site:	POL-2	POL-2	POL-2	POL-2	POL-2	POL-P2	POL-P2	POL-P2	BOL-1	BOL-1	BOL-1	BOL-1	BOL-1	BOL-B1	BOL-B1	BOL-B1	BOL-B2	BOL-B2	BOL-B2
Sample:	1	2	3	4	5	1	2	3	1	2	3	4	5	1	2	3	1	2	3
CC#:	CC151616	CC151617	CC151618	CC151619	CC151620	CC151621	CC151622	CC151623	CC151624	CC151625	CC151626	CC151627	CC151628	CC151629	CC151630	CC151631	CC151632	CC151633	CC151634
EMS:																			
Phylum: Annelida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Clitellata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Hirudinea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Rhynchobdellida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Glossiphoniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helobdella sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Lumbriculida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Lumbriculidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stylodrilus heringianus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Tubificida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Enchytraeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Enchytraeus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Naididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nais	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slavina appendiculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Tubificidae	2	1	0	7	47	0	0	0	9	7	10	25	11	3	5	4	12	9	12
Limnodrilus	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0	0	0	0	7
Spirosperma nikolskyi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	3	2
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Cnidaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Hydrozoa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Anthoathecatae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals:	**5**	**5**	**1**	**13**	**55**	**1**	**1**	**1**	**125**	**230**	**209**	**218**	**108**	**117**	**377**	**339**	**166**	**186**	**296**

Taxa present but not included:

Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Entognatha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Collembola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Crustacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Ostracoda	0	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Branchiopoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Cladocera	100	0	1000	1000	150	500	500	600	750	100	200	100	150	500	750	500	250	250	300
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Copepoda	150	600	500	2000	200	500	500	500	750	200	200	150	200	1000	750	1000	300	300	400
| Class: Malacostraca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Copepoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Nemata	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Platyhelminthes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Turbellaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals:	**251**	**852**	**1500**	**3000**	**350**	**1000**	**1000**	**1100**	**1500**	**300**	**400**	**250**	**350**	**1500**	**1500**	**1500**	**550**	**550**	**700**

Table G.2: Summary of benthic invertebrate community characteristics and statistical comparisons among Polley and Bootjack Lake mid-depth sampling areas, Mount Polley Mine, 2014

Metric	Overall 3-group ANOVA			3-group ANOVA Post-hoc Comparisons [a]				2-group ANOVA for Estimation of Effect Size		
	Significant Difference Among Areas?	p-value	Power	(I) Area	(J) Area	Significant Difference Among Areas?	p-value [b]	Power	Magnitude of Difference (# of SDs) [c]	Minimum Detectable Effect Size (# of SDs) [d]
Density (Individuals/m^2)	YES	0.000	1.000	BOL-1	POL-1 (North)	YES	0.007	1.000	-2.9	~
				BOL-1	POL-2 (South)	YES	0.005	1.000	-2.8	~
				POL-1 (North)	POL-2 (South)	NO	0.963	0.129	~	0.0
Number of Taxa	YES	0.014	0.892	BOL-1	POL-1 (North)	YES	0.062	0.723	-1.3	~
				BOL-1	POL-2 (South)	YES	0.018	0.886	-1.7	~
				POL-1 (North)	POL-2 (South)	NO	1.000	0.190	~	1.4
Simpson's Diversity	NO	0.422	0.281	BOL-1	POL-1 (North)	NO	1.000	0.106	~	3.4
				BOL-1	POL-2 (South)	NO	0.687	0.378	~	3.1
				POL-1 (North)	POL-2 (South)	NO	0.919	0.221	~	7.6
Simpson's Evenness	YES	0.032	0.797	BOL-1	POL-1 (North)	YES	0.073	0.897	1.8	~
				BOL-1	POL-2 (South)	YES	0.057	0.713	1.9	~
				POL-1 (North)	POL-2 (South)	NO	1.000	0.102	~	1.9
Bray Curtis Index	YES	0.000	1.000	BOL-1	POL-1 (North)	YES	0.000	1.000	8.8	~
				BOL-1	POL-2 (South)	YES	0.000	1.000	8.5	~
				POL-1 (North)	POL-2 (South)	NO	1.000	0.194	~	53.5
EPT (%)	NO	0.397	0.295	BOL-1	POL-1 (North)	NO	0.755	0.238	~	~
				BOL-1	POL-2 (South)	N/A	-	0.000	~	~
				POL-1 (North)	POL-2 (South)	NO	0.755	0.238	~	0.3
Ceratopogonidae (%)	NO	0.397	0.295	BOL-1	POL-1 (North)	NO	0.755	0.238	~	1.5
				BOL-1	POL-2 (South)	NO	0.755	0.238	~	1.5
				POL-1 (North)	POL-2 (South)	N/A	-	0.000	~	~
Chironomidae (%)	NO	0.575	0.213	BOL-1	POL-1 (North)	NO	1.000	0.100	~	2.1
				BOL-1	POL-2 (South)	NO	1.000	0.197	~	3.0
				POL-1 (North)	POL-2 (South)	NO	1.000	0.207	~	0.1
Acari (%)	NO	0.461	0.261	BOL-1	POL-1 (North)	NO	0.855	0.187	~	16.9
				BOL-1	POL-2 (South)	NO	0.227	0.678	~	1.5
				POL-1 (North)	POL-2 (South)	NO	0.755	0.238	~	0.1
Bivalves (%)	NO	0.397	0.295	BOL-1	POL-1 (North)	NO	0.755	0.238	~	1.5
				BOL-1	POL-2 (South)	NO	0.755	0.238	~	1.5
				POL-1 (North)	POL-2 (South)	N/A	-	0.000	~	~
Oligochaetes (%)	YES	0.066	0.679	BOL-1	POL-1 (North)	NO	0.132	0.827	~	16.7
				BOL-1	POL-2 (South)	NO	0.237	0.659	~	16.0
				POL-1 (North)	POL-2 (South)	NO	0.952	0.134	~	0.0
CA-1 (44.3%)	NO	0.257	0.392	BOL-1	POL-1 (North)	NO	0.934	0.146	~	4.9
				BOL-1	POL-2 (South)	YES	0.023	0.945	2.1	~
				POL-1 (North)	POL-2 (South)	NO	0.793	0.215	~	2.3
CA-2 (22.6%)	YES	0.007	0.948	BOL-1	POL-1 (North)	YES	0.010	0.959	3.5	~
				BOL-1	POL-2 (South)	NO	1.000	0.145	~	2.9
				POL-1 (North)	POL-2 (South)	YES	0.024	0.817	-1.6	~
CA-3 (20.2%)	NO	0.219	0.428	BOL-1	POL-1 (North)	NO	0.750	0.448	~	4.8
				BOL-1	POL-2 (South)	NO	0.278	0.504	~	6.6
				POL-1 (North)	POL-2 (South)	NO	1.000	0.137	~	2.7

[a] Bonferroni post-hoc Test, or Tamhane's T2 Test where variances were found to be heterogenous by Levene's Test

[b] p-value obtained from post-hoc analysis of 1-way ANOVA among all areas (post-hoc analyses protected for multiple comparisons)

[c] Magnitude calculated by comparing the difference between the reference area (I) and exposure area (J) means to the reference area (I) standard deviation (SD) [(exposure mean - reference mean) / standard deviation of the reference mean]

[d] Minimum effect size detectable calculated based on variance as square root of MSE from ANOVA and alpha = beta = 0.10.
Minimum effect size reported as the minimum number of standard deviations detectable based on reference area standard deviation.

Table G.3: Descriptive statistics of benthic metrics values for mid-depth benthic sample stations in Bootjack and Polley Lakes, Mount Polley Mine, 2014.

Variable	Area	n	Mean	90% Confidence Interval for Mean		5% Trimmed Mean	Median	Variance	Std. Deviation	Minimum	Maximum
				Lower Bound	Upper Bound						
Density (Ind./m2)	Bootjack L. mid-depth-1	5	1,541	1,071	2,011	1,550	1,809	243,052	493	935	1,991
	Polley L. mid-depth-1	5	93.5	8.04	179	88.0	60.6	8,033	89.6	34.6	251
	Polley L. mid-depth-2	5	137	-47.6	321	125	43.3	37,408	193	8.66	476
Number of Taxa	Bootjack L. mid-depth-1	5	5.40	3.67	7.13	5.39	5.00	3.30	1.82	3.00	8.00
	Polley L. mid-depth-1	5	3.00	1.83	4.17	2.94	3.00	1.50	1.22	2.00	5.00
	Polley L. mid-depth-2	5	2.40	1.31	3.49	2.39	2.00	1.30	1.14	1.00	4.00
Simpson's D	Bootjack L. mid-depth-1	5	0.50	0.38	0.63	0.50	0.53	0.02	0.13	0.37	0.65
	Polley L. mid-depth-1	5	0.48	0.22	0.73	0.49	0.57	0.07	0.26	0.07	0.73
	Polley L. mid-depth-2	5	0.33	0.11	0.55	0.33	0.32	0.06	0.23	0.00	0.64
Simpson's E	Bootjack L. mid-depth-1	5	0.43	0.26	0.60	0.42	0.36	0.03	0.18	0.26	0.71
	Polley L. mid-depth-1	5	0.76	0.62	0.89	0.76	0.77	0.02	0.14	0.54	0.93
	Polley L. mid-depth-2	5	0.77	0.52	1.02	0.79	0.87	0.07	0.26	0.34	1.00
B-C Dissimilarity	Bootjack L. mid-depth-1	5	0.23	0.15	0.30	0.23	0.27	0.01	0.08	0.12	0.32
	Polley L. mid-depth-1	5	0.94	0.91	0.97	0.94	0.96	0.00	0.03	0.88	0.96
	Polley L. mid-depth-2	5	0.91	0.85	0.98	0.91	0.94	0.00	0.06	0.83	0.99
EPT (%)	Bootjack L. mid-depth-1	5	0.00								
	Polley L. mid-depth-1	5	2.86	-3.24	8.96	2.38	0.00	40.90	6.40	0.00	14.30
	Polley L. mid-depth-2	5	0.00								
Ceratopogonidae (%)	Bootjack L. mid-depth-1	5	0.18	-0.20	0.56	0.15	0.00	0.16	0.40	0.00	0.90
	Polley L. mid-depth-1	5	0.00								
	Polley L. mid-depth-2	5	0.00								
Chironomidae (%)	Bootjack L. mid-depth-1	5	35.8	14.4	57.2	35.8	34.4	504	22.4	13.6	58.9
	Polley L. mid-depth-1	5	35.1	14.5	55.8	35.5	42.9	469	21.6	3.40	60.0
	Polley L. mid-depth-2	5	52.0	16.6	87.4	51.7	40.0	1,380	37.2	9.10	100.0
Acari (%)	Bootjack L. mid-depth-1	5	1.68	0.13	3.23	1.63	1.40	2.65	1.63	0.00	4.30
	Polley L. mid-depth-1	5	8.00	-9.05	25.1	6.67	0.00	320	17.9	0.00	40.0
	Polley L. mid-depth-2	5	0.00								
Bivalves (%)	Bootjack L. mid-depth-1	5	0.56	-0.63	1.75	0.47	0.00	1.57	1.25	0.00	2.80
	Polley L. mid-depth-1	5	0.00								
	Polley L. mid-depth-2	5	0.00								
Oligochaetes (%)	Bootjack L. mid-depth-1	5	7.62	4.41	10.83	7.66	7.20	11.3	3.36	3.00	11.5
	Polley L. mid-depth-1	5	54.0	19.3	88.7	54.7	55.6	1,324	36.4	0.00	96.6
	Polley L. mid-depth-2	5	42.9	9.64	76.2	43.0	40.0	1,220	34.9	0.00	85.5
CA-1 (44.3%)	Bootjack L. mid-depth-1	5	-0.13	-0.40	0.14	-0.13	-0.21	0.08	0.28	-0.45	0.29
	Polley L. mid-depth-1	5	0.10	-0.71	0.91	0.13	0.49	0.72	0.85	-1.06	0.80
	Polley L. mid-depth-2	5	0.46	0.23	0.68	0.46	0.42	0.06	0.24	0.19	0.77
CA-2 (22.6%)	Bootjack L. mid-depth-1	5	-0.17	-0.35	0.01	-0.16	-0.12	0.04	0.19	-0.50	-0.03
	Polley L. mid-depth-1	5	0.49	0.16	0.83	0.48	0.31	0.13	0.35	0.20	0.95
	Polley L. mid-depth-2	5	-0.09	-0.37	0.20	-0.08	-0.03	0.09	0.30	-0.46	0.23
CA-3 (20.2%)	Bootjack L. mid-depth-1	5	-0.11	-0.24	0.02	-0.10	-0.05	0.02	0.14	-0.36	-0.04
	Polley L. mid-depth-1	5	0.21	-0.18	0.60	0.22	0.33	0.17	0.41	-0.40	0.72
	Polley L. mid-depth-2	5	0.37	-0.18	0.93	0.37	0.39	0.34	0.58	-0.31	1.19

Table G.4: Benthic metrics and supporting measures values for mid-depth benthic sample stations in Bootjack and Polley Lakes, Mount Polley Mine, 2014.

Station	Area	Exposure or Reference	Density (Ind./m2)	Number of Taxa	Simpson's D	Simpson's E	B-C Dissimilarity	EPT (%)	Ceratopogonidae (%)	Chironomidae (%)	Amphipoda (%)	Acari (%)	Bivalves (%)	Gastropods (%)	Hirudinea (%)
BOL-1-1	Bootjack L. mid-depth-1	Reference	1,082	6	0.370	0.265	0.175	0.00	0.00	13.6	0.00	0.80	0.00	0.00	0.00
BOL-1-2	Bootjack L. mid-depth-1	Reference	1,991	5	0.365	0.315	0.315	0.00	0.00	13.9	0.00	4.35	0.00	0.00	0.00
BOL-1-3	Bootjack L. mid-depth-1	Reference	1,809	3	0.528	0.706	0.267	0.00	0.00	58.9	0.00	0.00	0.00	0.00	0.00
BOL-1-4	Bootjack L. mid-depth-1	Reference	1,887	5	0.610	0.513	0.115	0.00	0.00	34.4	0.00	1.38	0.00	0.00	0.00
BOL-1-5	Bootjack L. mid-depth-1	Reference	935	8	0.648	0.355	0.267	0.00	0.93	58.3	0.00	1.85	2.78	0.00	0.00
POL-1-1	Polley L. mid-depth-1	Exposure	77.9	3	0.568	0.771	0.956	0.00	0.00	44.4	0.00	0.00	0.00	0.00	0.00
POL-1-2	Polley L. mid-depth-1	Exposure	34.6	2	0.375	0.800	0.955	0.00	0.00	25.0	0.00	0.00	0.00	0.00	0.00
POL-1-3	Polley L. mid-depth-1	Exposure	60.6	5	0.735	0.754	0.956	14.3	0.00	42.9	0.00	0.00	0.00	0.00	0.00
POL-1-4	Polley L. mid-depth-1	Exposure	251	2	0.067	0.536	0.881	0.00	0.00	3.45	0.00	0.00	0.00	0.00	0.00
POL-1-5	Polley L. mid-depth-1	Exposure	43.3	3	0.640	0.926	0.955	0.00	0.00	60.0	0.00	40.0	0.00	0.00	0.00
POL-2-1	Polley L. mid-depth-2	Exposure	43.3	3	0.640	0.926	0.944	0.00	0.00	40.0	0.00	0.00	0.00	0.00	0.00
POL-2-2	Polley L. mid-depth-2	Exposure	43.3	2	0.320	0.735	0.944	0.00	0.00	80.0	0.00	0.00	0.00	0.00	0.00
POL-2-3	Polley L. mid-depth-2	Exposure	8.66	1	0.000	1.000	0.989	0.00	0.00	100.0	0.00	0.00	0.00	0.00	0.00
POL-2-4	Polley L. mid-depth-2	Exposure	113	2	0.426	0.871	0.860	0.00	0.00	30.8	0.00	0.00	0.00	0.00	0.00
POL-2-5	Polley L. mid-depth-2	Exposure	476	4	0.263	0.339	0.833	0.00	0.00	9.09	0.00	0.00	0.00	0.00	0.00

Table G.4: Benthic metrics and supporting measures values for mid-depth benthic sample stations in Bootjack and Polley Lakes, Mount Polley Mine, 2014.

Station	Area	Exposure or Reference	Oligochaetes (%)	CA-1 (44.3%)	CA-2 (22.6%)	CA-3 (20.2%)	Sediment PC-1	Sediment PC-2	Station Depth (m)	Bottom Temperature (°C)	Bottom DO (mg/L)	Bottom DO (% sat.)	Bottom pH	Bottom Conductance (µS/cm)	Bottom Turbidity (NTU/FNU)
BOL-1-1	Bootjack L. mid-depth-1	Reference	7.20	0.003	-0.143	-0.357	6.038	0.497	13.0	9.44	8.82	77.1	6.85	108.5	-1.100
BOL-1-2	Bootjack L. mid-depth-1	Reference	3.04	-0.453	-0.119	-0.041	5.691	-0.137	11.4	9.43	8.83	77.3	7.08	108.4	-0.870
BOL-1-3	Bootjack L. mid-depth-1	Reference	6.22	0.286	-0.502	-0.073	6.008	1.509	10.6	9.43	8.77	76.6	7.18	108.3	-1.00
BOL-1-4	Bootjack L. mid-depth-1	Reference	11.5	-0.261	-0.080	-0.046	5.417	-0.705	11.1	9.41	9.47	82.7	7.41	107.6	0.060
BOL-1-5	Bootjack L. mid-depth-1	Reference	10.2	-0.214	-0.026	-0.035	5.296	-3.916	11.2	9.45	9.62	84.1	7.50	107.6	-0.440
POL-1-1	Polley L. mid-depth-1	Exposure	55.6	-0.534	0.794	0.068	-2.764	2.892	18.3	10.07	7.37	65.4	7.79	252.7	4.23
POL-1-2	Polley L. mid-depth-1	Exposure	75.0	0.802	0.204	0.329	-1.804	0.495	18.6	8.82	0.470	4.20	7.40	317.7	5.73
POL-1-3	Polley L. mid-depth-1	Exposure	42.9	0.802	0.204	0.329	-2.708	-0.099	19.6	8.43	0.820	7.10	7.37	336.4	6.24
POL-1-4	Polley L. mid-depth-1	Exposure	96.6	0.494	0.954	-0.395	-3.945	0.883	18.6	9.64	4.54	39.0	7.60	268.2	2.62
POL-1-5	Polley L. mid-depth-1	Exposure	0.00	-1.064	0.313	0.722	-3.070	0.041	19.0	9.06	0.500	4.60	7.40	277.7	4.91
POL-2-1	Polley L. mid-depth-2	Exposure	40.0	0.420	-0.320	-0.031	-2.728	-2.853	18.7	9.06	1.010	8.70	7.46	276.5	4.65
POL-2-2	Polley L. mid-depth-2	Exposure	20.0	0.626	-0.025	0.627	-4.135	1.235	20.5	8.81	0.890	7.70	7.45	280.3	4.55
POL-2-3	Polley L. mid-depth-2	Exposure	0.00	0.291	-0.462	1.193	0.522	5.163	24.2	8.84	0.350	3.00	7.42	282.4	4.89
POL-2-4	Polley L. mid-depth-2	Exposure	69.2	0.765	0.157	0.390	-4.206	-3.430	19.8	8.96	0.790	6.90	7.46	278.6	4.98
POL-2-5	Polley L. mid-depth-2	Exposure	85.5	0.192	0.225	-0.306	-3.611	-1.576	19.9	9.14	4.32	37.6	7.60	267.7	3.45

Table G.4: Benthic metrics and supporting measures values for mid-depth benthic sample stations in Bootjack and Polley Lakes, Mount Polley Mine, 2014.

Station	Area	Exposure or Reference	Bottom TDS (mg/L)	Surface Temperature (°C)	Surface DO (mg/L)	Surface DO (% sat.)	Surface pH	Surface Conductance (µS/cm)	Surface Turbidity (NTU/FNU)	Surface TDS (mg/L)
BOL-1-1	Bootjack L. mid-depth-1	Reference	70.0	9.43	8.96	78.3	6.88	108	-1.17	70.0
BOL-1-2	Bootjack L. mid-depth-1	Reference	70.0	9.45	8.85	77.4	7.08	108	-1.02	70.0
BOL-1-3	Bootjack L. mid-depth-1	Reference	70.0	9.44	8.96	78.5	7.28	108	-1.12	70.0
BOL-1-4	Bootjack L. mid-depth-1	Reference	70.0	9.46	9.58	83.8	7.41	108	-0.52	70.0
BOL-1-5	Bootjack L. mid-depth-1	Reference	70.0	9.47	9.63	84.3	7.51	108	-0.41	70.0
POL-1-1	Polley L. mid-depth-1	Exposure	164	10.2	7.91	70.4	7.84	251	3.25	163
POL-1-2	Polley L. mid-depth-1	Exposure	.	9.97	6.39	56.9	7.80	270	2.38	.
POL-1-3	Polley L. mid-depth-1	Exposure	.	10.2	7.12	63.4	7.94	266	2.33	.
POL-1-4	Polley L. mid-depth-1	Exposure	174	10.1	7.79	69.2	7.88	251	2.43	163
POL-1-5	Polley L. mid-depth-1	Exposure	181	9.66	7.19	63.3	7.85	248	2.19	161
POL-2-1	Polley L. mid-depth-2	Exposure	180	9.52	5.64	49.4	7.76	257	2.25	167
POL-2-2	Polley L. mid-depth-2	Exposure	182	9.37	4.44	38.6	7.63	264	2.82	171
POL-2-3	Polley L. mid-depth-2	Exposure	184	9.46	4.97	43.3	7.67	261	2.82	169
POL-2-4	Polley L. mid-depth-2	Exposure	181.000	9.49	5.84	50.8	7.75	255	2.34	166
POL-2-5	Polley L. mid-depth-2	Exposure	.	9.33	6.51	56.5	7.76	255	1.98	.

Table G.5: Benthic taxon scores from Correspondence Analysis of samples collected at mid-depth stations of Polley and Bootjack Lakes, Mount Polley Mine, 2014.

Taxon	CA-1 (44.3%)	CA-2 (22.6%)	CA-3 (20.2%)
Chaoborus sp.	-0.163	-0.457	-0.401
Chironomus	0.133	-0.151	0.368
Procladius	-0.504	0.542	-0.218
Piona sp.	-1.093	0.013	0.421
	Family: Tubificidae; incl. Limnodrilus	0.527	0.217	-0.082

Table G.6: Eigenvalues from Correspondence Analysis of samples collected at mid-depth stations of Polley and Bootjack Lakes, Mount Polley Mine, 2014.

	CA-1 (44.3%)	CA-2 (22.6%)	CA-3 (20.2%)	CA-4 (13.0%)
Eigenvalue	0.209	0.107	0.095	0.061
Relative Inertia (%)	44.3	22.6	20.2	13.0
Cumulative Inertia (%)	44.3	66.9	87.0	100

Table G.7: ANOVA results for benthic metrics for mid-depth benthic sample stations in Bootjack and Polley Lakes, Mount Polley Mine, 2014.

Source: Area	Dependent Variable	Mean Square	F (ANOVA)	p-value	Observed Power
Benthic Metrics	Density (Ind./m2)	3,390,172	35.3	0.000	1.00
	Number of Taxa	12.6	6.20	0.014	0.892
	Simpson's D	0.044	0.929	0.422	0.281
	Simpson's E	0.187	4.66	0.032	0.797
	B-C Dissimilarity	0.816	207	0.000	1.00
	EPT (%)	13.6	1.00	0.397	0.295
	Ceratopogonidae (%)	0.0540	1.00	0.397	0.295
	Chironomidae (%)	454	0.579	0.575	0.213
	Acari (%)	89.0	0.827	0.461	0.261
	Bivalves (%)	0.523	1.00	0.397	0.295
	Oligochaetes (%)	2,936	3.45	0.066	0.679
	CA-1 (44.3%)	0.437	1.53	0.257	0.392
	CA-2 (22.6%)	0.657	7.89	0.007	0.948
	CA-3 (20.2%)	0.304	1.73	0.219	0.428

Table G.8 (a): Before-After; Control-Impact (BACI) Analysis of effects on benthic metrics in Polley Lake deep sampling area POL-P1, Mount Polley Mine, 2014.

Tests of Between-Subjects Effects					
Source	**Dependent Variable**	**Mean Square**	**F-ratio**	**p-value**	**Power**
Exposure	Density (Individuals/m^2)	24,776,021	41.3	0.000	1.000
	Number of Taxa	56.3	5.73	0.031	0.605
	Simpson's Diversity	0.00	0.06	0.807	0.056
	Simpson's Evenness	0.56	57.2	0.000	1.000
	Bray Curtis Index (BOL-B1, BOL-B2)	0.79	193	0.000	1.000
	Bray Curtis Index (POL-P1-1999, POL-P2-1999)	0.05	6.00	0.028	0.625
	EPT (%)	11.1	0.64	0.437	0.116
	Ceratopogonidae (%)	0.17	0.47	0.506	0.098
	Chironomidae (%)	9.04	0.04	0.851	0.054
	Amphipoda (%)	0.12	0.02	0.885	0.052
	Acari (%)	153	1.03	0.328	0.157
	Bivalves (%)	0.89	1.35	0.264	0.192
	Gastropods (%)	0.01	0.47	0.506	0.098
	Hirudinea (%)	0.04	0.47	0.506	0.098
	Oligochaetes (%)	6,728	44.8	0.000	1.000
	CA-1 (30.7%)	45.4	59.9	0.000	1.000
	CA-2 (18.3%)	1.16	22.2	0.000	0.992
	CA-3 (14.9%)	2.84	70.5	0.000	1.000
Year	Density (Individuals/m^2)	2,557,958	4.27	0.058	0.486
	Number of Taxa	617	62.8	0.000	1.000
	Simpson's Diversity	1.57	60.0	0.000	1.000
	Simpson's Evenness	0.23	23.3	0.000	0.994
	Bray Curtis Index (BOL-B1, BOL-B2)	0.22	53.4	0.000	1.000
	Bray Curtis Index (POL-P1-1999, POL-P2-1999)	0.34	44.3	0.000	1.000
	EPT (%)	338	19.5	0.001	0.984
	Ceratopogonidae (%)	0.17	0.47	0.506	0.098
	Chironomidae (%)	8,806	35.5	0.000	1.000
	Amphipoda (%)	18.6	3.45	0.084	0.409
	Acari (%)	133	0.89	0.362	0.142
	Bivalves (%)	6.23	9.43	0.008	0.815
	Gastropods (%)	0.01	0.47	0.506	0.098
	Hirudinea (%)	0.04	0.47	0.506	0.098
	Oligochaetes (%)	3,865	25.7	0.000	0.997
	CA-1 (30.7%)	44.1	58.2	0.000	1.000
	CA-2 (18.3%)	4.65	89.1	0.000	1.000
	CA-3 (14.9%)	0.12	2.97	0.107	0.362
Exposure * Year (Test of BACI effect)	Density (Individuals/m^2)	528,832	0.88	0.363	0.142
	Number of Taxa	12.3	1.25	0.283	0.181
	Simpson's Diversity	0.00	0.15	0.705	0.065
	Simpson's Evenness	0.20	19.8	0.001	0.985
	Bray Curtis Index (BOL-B1, BOL-B2)	0.45	109	0.000	1.000
	Bray Curtis Index (POL-P1-1999, POL-P2-1999)	0.19	25.5	0.000	0.997
	EPT (%)	11.1	0.64	0.437	0.116
	Ceratopogonidae (%)	0.17	0.47	0.506	0.098
	Chironomidae (%)	415	1.67	0.217	0.226
	Amphipoda (%)	0.12	0.02	0.885	0.052
	Acari (%)	386	2.58	0.131	0.322
	Bivalves (%)	0.89	1.35	0.264	0.192
	Gastropods (%)	0.01	0.47	0.506	0.098
	Hirudinea (%)	0.04	0.47	0.506	0.098
	Oligochaetes (%)	5,629	37.4	0.000	1.000
	CA-1 (30.7%)	48.3	63.8	0.000	1.000
	CA-2 (18.3%)	0.34	6.59	0.022	0.666
	CA-3 (14.9%)	1.04	25.7	0.000	0.997

(light grey)	Main effect or interaction significant, p < 0.1
(dark grey)	Main effect significance is complicated by significant interaction, p < 0.1

Table G.8 (a): Before-After; Control-Impact (BACI) Analysis of effects on benthic metrics in Polley Lake deep sampling area POL-P2, Mount Polley Mine, 2014.

Tests of Between-Subjects Effects					
Source	**Dependent Variable**	**Mean Square**	**F-ratio**	**p-value**	**Power**
Exposure	Density (Individuals/m^2)	19,264,184	32.3	0.000	1.000
	Number of Taxa	173	19.0	0.001	0.982
	Simpson's Diversity	0.11	7.95	0.014	0.746
	Simpson's Evenness	0.11	14.3	0.002	0.940
	Bray Curtis Index (BOL-B1, BOL-B2)	0.80	196	0.000	1.000
	Bray Curtis Index (POL-P1-1999, POL-P2-1999)	0.06	17.5	0.001	0.973
	EPT (%)	22.6	1.22	0.288	0.178
	Ceratopogonidae (%)	0.17	0.47	0.506	0.098
	Chironomidae (%)	146	0.60	0.453	0.111
	Amphipoda (%)	0.03	0.01	0.933	0.051
	Acari (%)	0.21	0.01	0.939	0.051
	Bivalves (%)	2.96	7.35	0.017	0.713
	Gastropods (%)	0.01	0.47	0.506	0.098
	Hirudinea (%)	0.07	0.43	0.524	0.094
	Oligochaetes (%)	93.9	3.35	0.088	0.400
	CA-1 (30.7%)	0.01	1.13	0.305	0.168
	CA-2 (18.3%)	1.38	30.3	0.000	0.999
	CA-3 (14.9%)	0.87	20.7	0.000	0.988
Year	Density (Individuals/m^2)	4,888,086	8.20	0.012	0.759
	Number of Taxa	477	52.3	0.000	1.000
	Simpson's Diversity	1.68	124	0.000	1.000
	Simpson's Evenness	0.19	24.9	0.000	0.996
	Bray Curtis Index (BOL-B1, BOL-B2)	0.22	53.7	0.000	1.000
	Bray Curtis Index (POL-P1-1999, POL-P2-1999)	0.42	113	0.000	1.000
	EPT (%)	106	5.74	0.031	0.606
	Ceratopogonidae (%)	0.17	0.47	0.506	0.098
	Chironomidae (%)	11,863	48.6	0.000	1.000
	Amphipoda (%)	14.3	3.22	0.095	0.386
	Acari (%)	1,024	29.5	0.000	0.999
	Bivalves (%)	2.96	7.35	0.017	0.713
	Gastropods (%)	0.01	0.47	0.506	0.098
	Hirudinea (%)	0.41	2.51	0.136	0.314
	Oligochaetes (%)	163	5.83	0.030	0.613
	CA-1 (30.7%)	0.00	0.05	0.818	0.056
	CA-2 (18.3%)	2.08	45.5	0.000	1.000
	CA-3 (14.9%)	0.08	1.87	0.192	0.248
Exposure * Year (Test of BACI effect)	Density (Individuals/m^2)	13,379	0.02	0.883	0.052
	Number of Taxa	42.3	4.64	0.049	0.518
	Simpson's Diversity	0.01	0.85	0.373	0.138
	Simpson's Evenness	0.23	29.3	0.000	0.999
	Bray Curtis Index (BOL-B1, BOL-B2)	0.44	109	0.000	1.000
	Bray Curtis Index (POL-P1-1999, POL-P2-1999)	0.25	69.3	0.000	1.000
	EPT (%)	22.6	1.22	0.288	0.178
	Ceratopogonidae (%)	0.17	0.47	0.506	0.098
	Chironomidae (%)	1,257	5.15	0.040	0.561
	Amphipoda (%)	0.03	0.01	0.933	0.051
	Acari (%)	0.73	0.02	0.887	0.052
	Bivalves (%)	2.96	7.35	0.017	0.713
	Gastropods (%)	0.01	0.47	0.506	0.098
	Hirudinea (%)	0.07	0.43	0.524	0.094
	Oligochaetes (%)	0.01	0.00	0.989	0.050
	CA-1 (30.7%)	0.08	7.25	0.018	0.707
	CA-2 (18.3%)	1.70	37.1	0.000	1.000
	CA-3 (14.9%)	0.91	21.5	0.000	0.990

Main effect or interaction significant, $p < 0.1$

Main effect significance is complicated by significant interaction, $p < 0.1$

Table G.9: ANOVA of benthic invertebrate community characteristics for which a BACI area* time difference was not identified among Polley and Bootjack Lake deep sampling areas, Mount Polley Mine, 2014.

a)

Metric	Overall 3-group ANOVA			3-group ANOVA Post-hoc Comparisons [a]			
	Significant Difference Among Areas?	p-value	Power	(I) Area	(J) Area	Significant Difference Among Areas?	p-value [b]
Density (Individuals/m^2)	YES	0.001	0.997	POL-P1	POL-P2	NO	0.162
				POL-P1	BOL-B1+B2	YES	0.007
				POL-P2	BOL-B1+B2	YES	0.007
Diversity	NO	0.255	0.387	POL-P1	POL-P2	n/a	-
				POL-P1	BOL-B1+B2	n/a	-
				POL-P2	BOL-B1+B2	n/a	-

n/a - not applicable

[a] Bonferonni post-hoc statistic presented unless variances were found to be heterogenous by Levene's Test (then Tamhane's T2 Test statistic presented).

[b] p-value obtained from post-hoc analysis of 1-way ANOVA among all areas (post-hoc analyses protected for multiple comparisons)

b)

Metric	ANOVA				
	(I) Area	(J) Area	Significant Difference Among Areas?	p-value [b]	Power
Richness	POL-P1	BOL-B1+B2	YES	0.001	0.994

Table G.10: Descriptive statistics for benthic metrics at deep sampling areas of Polley and Bootjack Lakes, Mount Polley Mine, 2014.

Metric	Area & Year	Mean	90% Confidence Interval for Mean		Median	Variance	Std. Deviation	Minimum	Maximum	Range
			Lower Bound	Upper Bound						
Density (Ind./m2)	BOL-B1, 2014	2,404	354	4,453	2,935	1,477,822	1,216	1,013	3,264	2,251
	BOL-B2, 2014	1,870	848	2,891	1,610	367,185	606	1,437	2,562	1,125
	POL-P1, 2014	11.5	3.12	20.0	8.66	24.9	4.99	8.66	17.3	8.65
	BOL-B1, 1999	3,524	1,296	5,752	3,300	1,746,196	1,321	2,329	4,943	2,614
	BOL-B2, 1999	3,076	2,294	3,858	3,300	215,167	464	2,543	3,386	843
	POL-P1, 1999	448	181	714	429	24,967	158	300	614	314
	POL-P2, 1999	1,048	1,020	1,075	1,057	272	16	1,029	1,057	29
Number of Taxa	BOL-B1, 2014	3.333	2.36	4.31	3	0.333	0.577	3	4	1
	BOL-B2, 2014	3.333	2.36	4.31	3	0.333	0.577	3	4	1
	POL-P1, 2014	1.333	0.36	2.31	1	0.333	0.577	1	2	1
	BOL-B1, 1999	13.667	7.28	20.0	12	14.3	3.79	11	18	7
	BOL-B2, 1999	21.333	20.4	22.3	21	0.333	0.577	21	22	1
	POL-P1, 1999	12.000	6.94	17.1	12	9.00	3.00	9	15	6
	POL-P2, 1999	7.667	4.16	11.2	7	4.33	2.08	6	10	4
Simpson's D	BOL-B1, 2014	0.331	0.142	0.521	0.350	0.013	0.112	0.211	0.433	0.222
	BOL-B2, 2014	0.105	0.043	0.167	0.110	0.001	0.037	0.066	0.139	0.074
	POL-P1, 2014	0.167	-0.320	0.653	0.000	0.083	0.289	0.000	0.500	0.500
	BOL-B1, 1999	0.732	0.499	0.966	0.738	0.019	0.139	0.591	0.868	0.277
	BOL-B2, 1999	0.894	0.879	0.910	0.894	0.000	0.009	0.886	0.904	0.018
	POL-P1, 1999	0.825	0.668	0.981	0.866	0.009	0.093	0.718	0.889	0.171
	POL-P2, 1999	0.703	0.599	0.806	0.672	0.004	0.062	0.662	0.774	0.112
Simpson's E	BOL-B1, 2014	0.465	0.283	0.647	0.422	0.012	0.108	0.385	0.588	0.203
	BOL-B2, 2014	0.343	0.232	0.454	0.375	0.004	0.066	0.268	0.387	0.120
	BOL-B1, 1999	0.324	0.138	0.510	0.347	0.012	0.110	0.204	0.421	0.217
	BOL-B2, 1999	0.447	0.365	0.528	0.447	0.002	0.048	0.398	0.495	0.097
	POL-P1, 1999	0.540	0.327	0.752	0.601	0.016	0.126	0.394	0.623	0.229
	POL-P2, 1999	0.457	0.403	0.510	0.442	0.001	0.032	0.436	0.493	0.058
BC(BOL-B1, BOL-B2)	BOL-B1, 2014	0.278	0.097	0.459	0.233	0.012	0.108	0.200	0.401	0.201
	BOL-B2, 2014	0.158	0.069	0.247	0.142	0.003	0.053	0.116	0.217	0.101
	POL-P1, 2014	0.997	0.989	1.006	1.000	0.000	0.005	0.991	1.000	0.009
	BOL-B1, 1999	0.808	0.745	0.872	0.789	0.001	0.038	0.784	0.852	0.067
	BOL-B2, 1999	0.764	0.735	0.793	0.760	0.000	0.017	0.749	0.783	0.034
	POL-P1, 1999	0.896	0.867	0.926	0.906	0.000	0.018	0.876	0.907	0.031
	POL-P2, 1999	0.901	0.869	0.934	0.901	0.000	0.019	0.882	0.920	0.039
BC(BOL-B1-1999, BOL-B2-1999)	BOL-B1, 2014	0.691	0.577	0.805	0.656	0.005	0.068	0.648	0.769	0.121
	BOL-B2, 2014	0.788	0.763	0.814	0.794	0.000	0.015	0.771	0.800	0.029
	POL-P1, 2014	0.998	0.992	1.004	1.000	0.000	0.004	0.994	1.000	0.006
	BOL-B1, 1999	0.392	0.284	0.500	0.379	0.004	0.064	0.336	0.462	0.126
	BOL-B2, 1999	0.298	0.230	0.366	0.275	0.002	0.040	0.275	0.344	0.070
	POL-P1, 1999	0.820	0.734	0.905	0.800	0.003	0.051	0.782	0.877	0.095
	POL-P2, 1999	0.604	0.431	0.778	0.640	0.011	0.103	0.489	0.684	0.196
BC(POL-P1-1999, POL-P2-1999)	BOL-B1, 2014	0.836	0.683	0.989	0.788	0.008	0.091	0.780	0.941	0.161
	BOL-B2, 2014	0.913	0.856	0.970	0.903	0.001	0.034	0.886	0.951	0.065
	POL-P1, 2014	0.988	0.953	1.023	1.000	0.000	0.021	0.964	1.000	0.036
	BOL-B1, 1999	0.763	0.641	0.886	0.769	0.005	0.073	0.688	0.833	0.145
	BOL-B2, 1999	0.845	0.792	0.899	0.832	0.001	0.032	0.823	0.882	0.059
	POL-P1, 1999	0.477	0.196	0.758	0.570	0.028	0.167	0.285	0.576	0.292
	POL-P2, 1999	0.426	0.389	0.462	0.435	0.000	0.022	0.401	0.441	0.040

Table G.10: Descriptive statistics for benthic metrics at deep sampling areas of Polley and Bootjack Lakes, Mount Polley Mine, 2014.

Metric	Area & Year	Mean	90% Confidence Interval for Mean		Median	Variance	Std. Deviation	Minimum	Maximum	Range
			Lower Bound	Upper Bound						
EPT (%)	BOL-B1, 1999	1.88	-2.99	6.74	0.43	8.33	2.89	0.00	5.20	5.20
	BOL-B2, 1999	13.2	10.7	15.7	13.0	2.24	1.49	11.8	14.8	2.97
	POL-P1, 1999	10.9	4.34	17.4	11.6	15.0	3.87	6.67	14.3	7.62
	POL-P2, 1999	2.78	-5.33	10.9	0.00	23.1	4.81	0.00	8.33	8.33
Ceratopogonidae (%)	BOL-B1, 1999	0.82	-1.57	3.21	0.00	2.01	1.42	0.00	2.45	2.45
Chironomidae (%)	BOL-B1, 2014	18.9	6.21	31.5	18.6	56.2	7.50	11.5	26.5	15.0
	BOL-B2, 2014	4.53	1.11	7.95	4.73	4.11	2.03	2.41	6.45	4.04
	BOL-B1, 1999	67.2	48.1	86.4	66.9	129	11.4	56.1	78.8	22.7
	BOL-B2, 1999	29.6	7.93	51.3	31.2	165	12.9	16.0	41.6	25.6
	POL-P1, 1999	57.1	35.4	78.9	57.1	167	12.9	44.2	70.0	25.8
	POL-P2, 1999	72.2	52.5	91.9	68.9	136	11.7	62.5	85.1	22.6
Amphipoda (%)	BOL-B1, 1999	0.39	-0.74	1.51	0.00	0.45	0.67	0.00	1.16	1.16
	BOL-B2, 1999	3.58	-2.58	9.74	1.69	13.34	3.65	1.27	7.79	6.53
	POL-P1, 1999	2.33	-4.47	9.12	0.00	16.23	4.03	0.00	6.98	6.98
	POL-P2, 1999	1.80	-3.46	7.06	0.00	9.74	3.12	0.00	5.41	5.41
Acari (%)	BOL-B1, 2014	0.71	-1.36	2.77	0.00	1.50	1.23	0.00	2.12	2.12
	BOL-B2, 2014	0.61	0.49	0.72	0.60	0.01	0.07	0.54	0.68	0.14
	POL-P1, 2014	16.7	-32.0	65.3	0.00	833	28.9	0.00	50.0	50.0
	BOL-B1, 1999	11.0	-6.30	28.3	7.36	105	10.2	3.03	22.5	19.5
	BOL-B2, 1999	21.5	15.9	27.1	20.8	11.1	3.33	18.6	25.1	6.54
	POL-P1, 1999	12.6	6.42	18.8	11.6	13.5	3.67	9.52	16.7	7.14
	POL-P2, 1999	16.4	5.40	27.5	14.9	42.8	6.54	10.8	23.6	12.8
Bivalves (%)	BOL-B1, 1999	0.79	0.00	1.59	0.87	0.22	0.47	0.29	1.23	0.94
	BOL-B2, 1999	2.65	2.40	2.89	2.60	0.02	0.14	2.53	2.81	0.28
	POL-P1, 1999	0.78	-1.49	3.04	0.00	1.80	1.34	0.00	2.33	2.33
Gastropods (%)	BOL-B2, 1999	0.19	-0.36	0.73	0.00	0.11	0.32	0.00	0.56	0.56
Hirudinea (%)	BOL-B2, 1999	0.37	-0.72	1.47	0.00	0.42	0.65	0.00	1.12	1.12
	POL-P2, 1999	0.45	-0.86	1.77	0.00	0.61	0.78	0.00	1.35	1.35
Oligochaetes (%)	BOL-B1, 2014	1.69	0.41	2.97	1.33	0.58	0.76	1.18	2.56	1.38
	BOL-B2, 2014	7.93	4.51	11.3	7.09	4.11	2.03	6.45	10.2	3.79
	POL-P1, 2014	83.33	34.7	132	100	833	28.9	50.0	100	50.0
	BOL-B1, 1999	7.81	3.40	12.2	7.80	6.85	2.62	5.19	10.4	5.23
	BOL-B2, 1999	14.67	0.17	29.2	17.3	74.0	8.60	5.06	21.6	16.6
	POL-P1, 1999	14.74	0.74	28.7	14.3	69.0	8.30	6.67	23.3	16.6
	POL-P2, 1999	6.36	-5.09	17.8	5.56	46.1	6.79	0.00	13.5	13.5
CA-1 (30.7%)	BOL-B1, 2014	-0.209	-0.256	-0.161	-0.225	0.001	0.028	-0.225	-0.176	0.049
	BOL-B2, 2014	-0.187	-0.194	-0.180	-0.187	0.000	0.004	-0.191	-0.183	0.008
	POL-P1, 2014	6.645	2.791	10.5	7.965	5.226	2.286	4.005	7.965	3.960
	BOL-B1, 1999	-0.126	-0.179	-0.072	-0.130	0.001	0.032	-0.155	-0.092	0.063
	BOL-B2, 1999	0.038	-0.350	0.427	-0.087	0.053	0.231	-0.103	0.304	0.407
	POL-P1, 1999	-0.150	-0.189	-0.111	-0.162	0.001	0.023	-0.165	-0.124	0.042
	POL-P2, 1999	-0.129	-0.208	-0.050	-0.112	0.002	0.047	-0.183	-0.094	0.089

Table G.10: Descriptive statistics for benthic metrics at deep sampling areas of Polley and Bootjack Lakes, Mount Polley Mine, 2014.

Metric	Area & Year	Mean	90% Confidence Interval for Mean		Median	Variance	Std. Deviation	Minimum	Maximum	Range
			Lower Bound	Upper Bound						
CA-2 (18.3%)	BOL-B1, 2014	-1.220	-1.438	-1.002	-1.270	0.017	0.129	-1.317	-1.073	0.244
	BOL-B2, 2014	-1.259	-1.293	-1.225	-1.250	0.000	0.020	-1.282	-1.245	0.037
	POL-P1, 2014	-0.408	-0.572	-0.243	-0.464	0.009	0.097	-0.464	-0.295	0.169
	BOL-B1, 1999	-0.057	-0.511	0.397	-0.178	0.072	0.269	-0.244	0.252	0.496
	BOL-B2, 1999	0.322	0.229	0.415	0.295	0.003	0.055	0.285	0.386	0.100
	POL-P1, 1999	0.378	-0.286	1.041	0.442	0.155	0.394	-0.044	0.735	0.779
	POL-P2, 1999	0.070	-0.510	0.649	0.152	0.118	0.344	-0.308	0.365	0.673
CA-3 (14.9%)	BOL-B1, 2014	-0.020	-0.150	0.110	-0.004	0.006	0.077	-0.104	0.048	0.152
	BOL-B2, 2014	0.002	-0.041	0.046	-0.007	0.001	0.026	-0.018	0.031	0.049
	POL-P1, 2014	-0.343	-0.456	-0.230	-0.304	0.004	0.067	-0.420	-0.304	0.116
	BOL-B1, 1999	0.353	0.127	0.578	0.426	0.018	0.134	0.198	0.433	0.235
	BOL-B2, 1999	0.301	0.067	0.536	0.362	0.019	0.139	0.142	0.400	0.258
	POL-P1, 1999	-1.025	-1.836	-0.214	-1.247	0.231	0.481	-1.355	-0.473	0.882
	POL-P2, 1999	-0.617	-1.457	0.224	-0.452	0.249	0.499	-1.177	-0.222	0.955

Table G.11: Benthic metrics and supporting measures data for deep sampling areas of Polley and Bootjack Lakes, Mount Polley Mine, 2014.

Station	Area & Year	Area	Exposure	Year	Lake	Density (Ind./m2)	Number of Taxa	Simpson's D	Simpson's E	BC(BOL-B1)	BC(BOL-B2)	BC(POL-P1-1999)	BC(POL-P2-1999)	BC(BOL-B1-1999)	BC(BOL-B2-1999)	BC(BOL-B1, BOL-B2)	BC(BOL-B1-1999, BOL-B2-1999)
BOL-B1-1	BOL-B1, 2014	BOL-B1	Bootjack L. Reference	2014	Bootjack L.	1,013	3	0.433	0.588	0.481	0.340	0.805	0.817	0.637	0.637	0.401	0.656
BOL-B1-2	BOL-B1, 2014	BOL-B1	Bootjack L. Reference	2014	Bootjack L.	3,264	4	0.350	0.385	0.073	0.363	0.889	0.734	0.636	0.756	0.233	0.648
BOL-B1-3	BOL-B1, 2014	BOL-B1	Bootjack L. Reference	2014	Bootjack L.	2,935	3	0.211	0.422	0.036	0.332	0.943	0.943	0.783	0.733	0.200	0.769
BOL-B2-1	BOL-B2, 2014	BOL-B2	Bootjack L. Reference	2014	Bootjack L.	1,437	4	0.066	0.268	0.376	0.090	0.950	0.959	0.793	0.764	0.217	0.794
BOL-B2-2	BOL-B2, 2014	BOL-B2	Bootjack L. Reference	2014	Bootjack L.	1,610	3	0.139	0.387	0.307	0.000	0.877	0.904	0.768	0.744	0.142	0.771
BOL-B2-3	BOL-B2, 2014	BOL-B2	Bootjack L. Reference	2014	Bootjack L.	2,562	3	0.110	0.375	0.090	0.225	0.903	0.914	0.800	0.780	0.116	0.800
POL-P1-1	POL-P1, 2014	POL-P1	Polley L. Exposure	2014	Polley L.	8.7	1	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
POL-P1-2	POL-P1, 2014	POL-P1	Polley L. Exposure	2014	Polley L.	8.7	1	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
POL-P1-3	POL-P1, 2014	POL-P1	Polley L. Exposure	2014	Polley L.	17.3	2	0.500	1.000	1.000	0.989	0.950	0.980	0.993	0.994	0.991	0.994
POL-P2-1	POL-P2, 2014	POL-P2	Polley L. Exposure	2014	Polley L.	0.0	0	0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
POL-P2-2	POL-P2, 2014	POL-P2	Polley L. Exposure	2014	Polley L.	0.0	0	0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
POL-P2-3	POL-P2, 2014	POL-P2	Polley L. Exposure	2014	Polley L.	0.0	0	0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
BOL-B1-1999-1	BOL-B1, 1999	BOL-B1	Bootjack L. Reference	1999	Bootjack L.	4,943	18	0.868	0.421	0.846	0.863	0.897	0.762	0.395	0.424	0.852	0.336
BOL-B1-1999-2	BOL-B1, 1999	BOL-B1	Bootjack L. Reference	1999	Bootjack L.	2,329	11	0.738	0.347	0.791	0.800	0.839	0.568	0.080	0.598	0.789	0.379
BOL-B1-1999-3	BOL-B1, 1999	BOL-B1	Bootjack L. Reference	1999	Bootjack L.	3,300	12	0.591	0.204	0.786	0.793	0.882	0.662	0.214	0.639	0.784	0.462
BOL-B2-1999-1	BOL-B2, 1999	BOL-B2	Bootjack L. Reference	1999	Bootjack L.	2,543	21	0.894	0.447	0.774	0.766	0.809	0.779	0.579	0.208	0.760	0.275
BOL-B2-1999-2	BOL-B2, 1999	BOL-B2	Bootjack L. Reference	1999	Bootjack L.	3,386	21	0.904	0.495	0.756	0.754	0.853	0.796	0.596	0.120	0.749	0.275
BOL-B2-1999-3	BOL-B2, 1999	BOL-B2	Bootjack L. Reference	1999	Bootjack L.	3,300	22	0.886	0.398	0.794	0.788	0.866	0.834	0.647	0.186	0.783	0.344
POL-P1-1999-1	POL-P1, 1999	POL-P1	Polley L. Exposure	1999	Polley L.	300.0	12	0.866	0.623	0.936	0.896	0.227	0.750	0.890	0.877	0.906	0.877
POL-P1-1999-2	POL-P1, 1999	POL-P1	Polley L. Exposure	1999	Polley L.	614.3	15	0.889	0.601	0.933	0.894	0.364	0.706	0.833	0.768	0.907	0.782
POL-P1-1999-3	POL-P1, 1999	POL-P1	Polley L. Exposure	1999	Polley L.	428.6	9	0.718	0.394	0.897	0.883	0.346	0.523	0.779	0.854	0.876	0.800
POL-P2-1999-1	POL-P2, 1999	POL-P2	Polley L. Exposure	1999	Polley L.	1,029	7	0.672	0.436	0.898	0.911	0.660	0.200	0.517	0.701	0.882	0.489
POL-P2-1999-2	POL-P2, 1999	POL-P2	Polley L. Exposure	1999	Polley L.	1,057	6	0.662	0.493	0.913	0.911	0.684	0.267	0.648	0.832	0.901	0.684
POL-P2-1999-3	POL-P2, 1999	POL-P2	Polley L. Exposure	1999	Polley L.	1,057	10	0.774	0.442	0.928	0.912	0.688	0.182	0.633	0.795	0.920	0.640

Table G.11: Benthic metrics and supporting measures data for deep sampling areas of Polley and Bootjack Lakes, Mount Polley Mine, 2014.

Station	Area & Year	Area	Exposure	Year	Lake	BC(POL-P1-1999, POL-P2-1999)	EPT (%)	Ceratopogonidae (%)	Chironomidae (%)	Amphipoda (%)	Acari (%)	Bivalves (%)	Gastropods (%)	Hirudinea (%)	Oligochaetes (%)
BOL-B1-1	BOL-B1, 2014	BOL-B1	Bootjack L. Reference	2014	Bootjack L.	0.780	0.00	0.00	26.5	0.00	0.00	0.00	0.00	0.00	2.56
BOL-B1-2	BOL-B1, 2014	BOL-B1	Bootjack L. Reference	2014	Bootjack L.	0.788	0.00	0.00	18.6	0.00	2.12	0.00	0.00	0.00	1.33
BOL-B1-3	BOL-B1, 2014	BOL-B1	Bootjack L. Reference	2014	Bootjack L.	0.941	0.00	0.00	11.5	0.00	0.00	0.00	0.00	0.00	1.18
BOL-B2-1	BOL-B2, 2014	BOL-B2	Bootjack L. Reference	2014	Bootjack L.	0.951	0.00	0.00	2.41	0.00	0.60	0.00	0.00	0.00	10.2
BOL-B2-2	BOL-B2, 2014	BOL-B2	Bootjack L. Reference	2014	Bootjack L.	0.886	0.00	0.00	6.45	0.00	0.54	0.00	0.00	0.00	6.45
BOL-B2-3	BOL-B2, 2014	BOL-B2	Bootjack L. Reference	2014	Bootjack L.	0.903	0.00	0.00	4.73	0.00	0.68	0.00	0.00	0.00	7.09
POL-P1-1	POL-P1, 2014	POL-P1	Polley L. Exposure	2014	Polley L.	1.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
POL-P1-2	POL-P1, 2014	POL-P1	Polley L. Exposure	2014	Polley L.	1.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
POL-P1-3	POL-P1, 2014	POL-P1	Polley L. Exposure	2014	Polley L.	0.964	0.00	0.00	0.00	0.00	50.0	0.00	0.00	0.00	50.00
POL-P2-1	POL-P2, 2014	POL-P2	Polley L. Exposure	2014	Polley L.	1.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
POL-P2-2	POL-P2, 2014	POL-P2	Polley L. Exposure	2014	Polley L.	1.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
POL-P2-3	POL-P2, 2014	POL-P2	Polley L. Exposure	2014	Polley L.	1.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BOL-B1-1999-1	BOL-B1, 1999	BOL-B1	Bootjack L. Reference	1999	Bootjack L.	0.833	5.20	0.00	56.1	1.16	22.5	0.29	0.00	0.00	7.80
BOL-B1-1999-2	BOL-B1, 1999	BOL-B1	Bootjack L. Reference	1999	Bootjack L.	0.688	0.00	2.45	66.9	0.00	7.36	1.23	0.00	0.00	10.43
BOL-B1-1999-3	BOL-B1, 1999	BOL-B1	Bootjack L. Reference	1999	Bootjack L.	0.769	0.43	0.00	78.8	0.00	3.03	0.87	0.00	0.00	5.19
BOL-B2-1999-1	BOL-B2, 1999	BOL-B2	Bootjack L. Reference	1999	Bootjack L.	0.823	11.8	0.00	41.6	1.69	20.8	2.81	0.56	1.12	5.06
BOL-B2-1999-2	BOL-B2, 1999	BOL-B2	Bootjack L. Reference	1999	Bootjack L.	0.832	14.8	0.00	31.2	1.27	18.6	2.53	0.00	0.00	17.30
BOL-B2-1999-3	BOL-B2, 1999	BOL-B2	Bootjack L. Reference	1999	Bootjack L.	0.882	13.0	0.00	16.0	7.79	25.1	2.60	0.00	0.00	21.65
POL-P1-1999-1	POL-P1, 1999	POL-P1	Polley L. Exposure	1999	Polley L.	0.570	14.3	0.00	57.1	0.00	9.5	0.00	0.00	0.00	14.29
POL-P1-1999-2	POL-P1, 1999	POL-P1	Polley L. Exposure	1999	Polley L.	0.576	11.6	0.00	44.2	6.98	11.6	2.33	0.00	0.00	23.26
POL-P1-1999-3	POL-P1, 1999	POL-P1	Polley L. Exposure	1999	Polley L.	0.285	6.67	0.00	70.0	0.00	16.7	0.00	0.00	0.00	6.67
POL-P2-1999-1	POL-P2, 1999	POL-P2	Polley L. Exposure	1999	Polley L.	0.401	8.33	0.00	62.5	0.00	23.6	0.00	0.00	0.00	5.56
POL-P2-1999-2	POL-P2, 1999	POL-P2	Polley L. Exposure	1999	Polley L.	0.435	0.00	0.00	85.1	0.00	14.9	0.00	0.00	0.00	0.00
POL-P2-1999-3	POL-P2, 1999	POL-P2	Polley L. Exposure	1999	Polley L.	0.441	0.00	0.00	68.9	5.41	10.8	0.00	0.00	1.35	13.51

Table G.11: Benthic metrics and supporting measures data for deep sampling areas of Polley and Bootjack Lakes, Mount Polley Mine, 2014.

Station	Area & Year	Area	Exposure	Year	Lake	CA-1 (30.7%)	CA-2 (18.3%)	CA-3 (14.9%)	2014 Sediment PC-1	2014 Sediment PC-2	Station Depth (m)	Bottom Temperature (°C)	Bottom DO (mg/L)	Bottom DO (% sat.)	Bottom pH	Bottom Conductance (µS/cm)
BOL-B1-1	BOL-B1, 2014	BOL-B1	Bootjack L. Reference	2014	Bootjack L.	-0.225	-1.270	-0.004	3.34	0.58	16.8	8.81	9.69	83.40	7.77	90.60
BOL-B1-2	BOL-B1, 2014	BOL-B1	Bootjack L. Reference	2014	Bootjack L.	-0.176	-1.073	-0.104	3.68	0.06	16.0	8.68	9.59	82.30	7.53	90.60
BOL-B1-3	BOL-B1, 2014	BOL-B1	Bootjack L. Reference	2014	Bootjack L.	-0.225	-1.317	0.048	3.55	0.01	16.0	8.71	9.64	82.70	7.62	90.60
BOL-B2-1	BOL-B2, 2014	BOL-B2	Bootjack L. Reference	2014	Bootjack L.	-0.187	-1.245	0.031	4.03	0.74	16.2	9.43	8.80	76.90	7.28	108
BOL-B2-2	BOL-B2, 2014	BOL-B2	Bootjack L. Reference	2014	Bootjack L.	-0.191	-1.282	-0.007	4.47	1.44	16.2	9.44	8.84	77.30	7.25	108
BOL-B2-3	BOL-B2, 2014	BOL-B2	Bootjack L. Reference	2014	Bootjack L.	-0.183	-1.250	-0.018	4.20	0.69	16.2	9.09	8.99	77.80	7.21	91.50
POL-P1-1	POL-P1, 2014	POL-P1	Polley L. Exposure	2014	Polley L.	7.965	-0.464	-0.304	-1.76	-2.91	27.7	8.31	0.30	2.60	7.13	302
POL-P1-2	POL-P1, 2014	POL-P1	Polley L. Exposure	2014	Polley L.	7.965	-0.464	-0.304	-2.54	-1.79	27.7	8.24	0.37	3.20	7.35	290
POL-P1-3	POL-P1, 2014	POL-P1	Polley L. Exposure	2014	Polley L.	4.005	-0.295	-0.420	-4.35	-0.41	27.7	8.24	0.37	3.20	7.35	290
POL-P2-1	POL-P2, 2014	POL-P2	Polley L. Exposure	2014	Polley L.	0.000	0.000	0.000	-5.49	-0.60	29.3	8.57	0.55	4.80	7.45	303
POL-P2-2	POL-P2, 2014	POL-P2	Polley L. Exposure	2014	Polley L.	0.000	0.000	0.000	-2.63	-3.91	29.3	8.57	0.55	4.80	7.45	303
POL-P2-3	POL-P2, 2014	POL-P2	Polley L. Exposure	2014	Polley L.	0.000	0.000	0.000	-6.49	6.09	29.3	8.57	0.55	4.80	7.45	303
BOL-B1-1999-1	BOL-B1, 1999	BOL-B1	Bootjack L. Reference	1999	Bootjack L.	-0.092	0.252	0.426								
BOL-B1-1999-2	BOL-B1, 1999	BOL-B1	Bootjack L. Reference	1999	Bootjack L.	-0.130	-0.178	0.433								
BOL-B1-1999-3	BOL-B1, 1999	BOL-B1	Bootjack L. Reference	1999	Bootjack L.	-0.155	-0.244	0.198								
BOL-B2-1999-1	BOL-B2, 1999	BOL-B2	Bootjack L. Reference	1999	Bootjack L.	-0.087	0.295	0.400								
BOL-B2-1999-2	BOL-B2, 1999	BOL-B2	Bootjack L. Reference	1999	Bootjack L.	0.304	0.285	0.362								
BOL-B2-1999-3	BOL-B2, 1999	BOL-B2	Bootjack L. Reference	1999	Bootjack L.	-0.103	0.386	0.142								
POL-P1-1999-1	POL-P1, 1999	POL-P1	Polley L. Exposure	1999	Polley L.	-0.162	0.442	-1.247								
POL-P1-1999-2	POL-P1, 1999	POL-P1	Polley L. Exposure	1999	Polley L.	-0.124	0.735	-0.473								
POL-P1-1999-3	POL-P1, 1999	POL-P1	Polley L. Exposure	1999	Polley L.	-0.165	-0.044	-1.355								
POL-P2-1999-1	POL-P2, 1999	POL-P2	Polley L. Exposure	1999	Polley L.	-0.094	0.152	-0.222								
POL-P2-1999-2	POL-P2, 1999	POL-P2	Polley L. Exposure	1999	Polley L.	-0.183	-0.308	-1.177								
POL-P2-1999-3	POL-P2, 1999	POL-P2	Polley L. Exposure	1999	Polley L.	-0.112	0.365	-0.452								

Table G.11: Benthic metrics and supporting measures data for deep sampling areas of Polley and Bootjack Lakes, Mount Polley Mine, 2014.

Station	Area & Year	Area	Exposure	Year	Lake	Bottom Turbidity (NTU/FNU)	Bottom TDS (mg/L)	Surface Temperature (°C)	Surface DO (mg/L)	Surface DO (% sat.)	Surface pH	Surface Conductance (µS/cm)	Surface Turbidity (NTU/FNU)	Surface TDS (mg/L)
BOL-B1-1	BOL-B1, 2014	BOL-B1	Bootjack L. Reference	2014	Bootjack L.	2.02	0.00	8.91	9.67	83.5	7.76	90.8	1.76	0.00
BOL-B1-2	BOL-B1, 2014	BOL-B1	Bootjack L. Reference	2014	Bootjack L.	1.50	.	8.87	9.66	83.3	7.66	90.7	1.82	.
BOL-B1-3	BOL-B1, 2014	BOL-B1	Bootjack L. Reference	2014	Bootjack L.	1.47	.	8.84	9.68	83.4	7.70	90.7	1.90	.
BOL-B2-1	BOL-B2, 2014	BOL-B2	Bootjack L. Reference	2014	Bootjack L.	-1.18	70.0	9.44	8.85	77.4	7.38	108	-1.09	70.0
BOL-B2-2	BOL-B2, 2014	BOL-B2	Bootjack L. Reference	2014	Bootjack L.	-1.07	70.0	9.43	8.88	77.6	7.39	108	-1.22	70.0
BOL-B2-3	BOL-B2, 2014	BOL-B2	Bootjack L. Reference	2014	Bootjack L.	1.26	.	9.08	9.07	98.6	7.63	91.6	1.18	.
POL-P1-1	POL-P1, 2014	POL-P1	Polley L. Exposure	2014	Polley L.	29.8	196	12.09	9.00	83.8	8.58	216	1.41	140
POL-P1-2	POL-P1, 2014	POL-P1	Polley L. Exposure	2014	Polley L.	6.18	189	10.44	7.72	69.2	8.09	219	1.33	143
POL-P1-3	POL-P1, 2014	POL-P1	Polley L. Exposure	2014	Polley L.	6.18	189	10.44	7.72	69.2	8.09	219	1.33	143
POL-P2-1	POL-P2, 2014	POL-P2	Polley L. Exposure	2014	Polley L.	6.55	.	9.42	6.57	58.0	7.83	257	2.19	.
POL-P2-2	POL-P2, 2014	POL-P2	Polley L. Exposure	2014	Polley L.	6.55	.	9.42	6.57	58.0	7.83	257	2.19	.
POL-P2-3	POL-P2, 2014	POL-P2	Polley L. Exposure	2014	Polley L.	6.55	.	9.42	6.57	58.0	7.83	257	2.19	.
BOL-B1-1999-1	BOL-B1, 1999	BOL-B1	Bootjack L. Reference	1999	Bootjack L.									
BOL-B1-1999-2	BOL-B1, 1999	BOL-B1	Bootjack L. Reference	1999	Bootjack L.									
BOL-B1-1999-3	BOL-B1, 1999	BOL-B1	Bootjack L. Reference	1999	Bootjack L.									
BOL-B2-1999-1	BOL-B2, 1999	BOL-B2	Bootjack L. Reference	1999	Bootjack L.									
BOL-B2-1999-2	BOL-B2, 1999	BOL-B2	Bootjack L. Reference	1999	Bootjack L.									
BOL-B2-1999-3	BOL-B2, 1999	BOL-B2	Bootjack L. Reference	1999	Bootjack L.									
POL-P1-1999-1	POL-P1, 1999	POL-P1	Polley L. Exposure	1999	Polley L.									
POL-P1-1999-2	POL-P1, 1999	POL-P1	Polley L. Exposure	1999	Polley L.									
POL-P1-1999-3	POL-P1, 1999	POL-P1	Polley L. Exposure	1999	Polley L.									
POL-P2-1999-1	POL-P2, 1999	POL-P2	Polley L. Exposure	1999	Polley L.									
POL-P2-1999-2	POL-P2, 1999	POL-P2	Polley L. Exposure	1999	Polley L.									
POL-P2-1999-3	POL-P2, 1999	POL-P2	Polley L. Exposure	1999	Polley L.									

Table G.12 (a): MANOVA statistics for BACI Design at Polley Lake deep sampling area POL-P1, Mount Polley Mine, 2014.

Effect	Multivariate Tests[a]	F-ratio	Hypothesis df	Error df	p-value	Power
Intercept	Pillai's Trace	20543[b]	13	2	0.000	1.000
	Wilks' Lambda	20543[b]	13	2	0.000	1.000
	Hotelling's Trace	20543[b]	13	2	0.000	1.000
	Roy's Largest Root	20543[b]	13	2	0.000	1.000
Exposure	Pillai's Trace	980[b]	13	2	0.001	1.000
	Wilks' Lambda	980[b]	13	2	0.001	1.000
	Hotelling's Trace	980[b]	13	2	0.001	1.000
	Roy's Largest Root	980[b]	13	2	0.001	1.000
Year	Pillai's Trace	3070[b]	13	2	0.000	1.000
	Wilks' Lambda	3070[b]	13	2	0.000	1.000
	Hotelling's Trace	3070[b]	13	2	0.000	1.000
	Roy's Largest Root	3070[b]	13	2	0.000	1.000
Exposure * Year (Test of BACI effect)	Pillai's Trace	590[b]	13	2	0.002	1.000
	Wilks' Lambda	590[b]	13	2	0.002	1.000
	Hotelling's Trace	590[b]	13	2	0.002	1.000
	Roy's Largest Root	590[b]	13	2	0.002	1.000

a Design: Intercept + Exposure + Year + Exposure * Year
b Exact statistic

Table G.12 (b): MANOVA statistics for BACI Design at Polley Lake deep sampling area POL-P2, Mount Polley Mine, 2014.

Effect	Multivariate Tests[a]	F-ratio	Hypothesis df	Error df	p-value	Power
Intercept	Pillai's Trace	2375[b]	12	3	0.000	1.000
	Wilks' Lambda	2375[b]	12	3	0.000	1.000
	Hotelling's Trace	2375[b]	12	3	0.000	1.000
	Roy's Largest Root	2375[b]	12	3	0.000	1.000
Exposure	Pillai's Trace	203[b]	12	3	0.001	1.000
	Wilks' Lambda	203[b]	12	3	0.001	1.000
	Hotelling's Trace	203[b]	12	3	0.001	1.000
	Roy's Largest Root	203[b]	12	3	0.001	1.000
Year	Pillai's Trace	54.6[b]	12	3	0.004	1.000
	Wilks' Lambda	54.6[b]	12	3	0.004	1.000
	Hotelling's Trace	54.6[b]	12	3	0.004	1.000
	Roy's Largest Root	54.6[b]	12	3	0.004	1.000
Exposure * Year (Test of BACI effect)	Pillai's Trace	25.4[b]	12	3	0.011	0.969
	Wilks' Lambda	25.4[b]	12	3	0.011	0.969
	Hotelling's Trace	25.4[b]	12	3	0.011	0.969
	Roy's Largest Root	25.4[b]	12	3	0.011	0.969

a Design: Intercept + Exposure + Year + Exposure * Year
b Exact statistic

Table G.13: Benthic taxon scores from Correspondence Analysis of samples collected at deep lake stations of Polley and Bootjack Lakes

Taxon	CA-1 (30.7%)	CA-2 (18.3%)	CA-3 (14.9%)
Nais spp., incl. N. communis, N. variabilis	-0.084	0.415	0.086
Stylaria lacustris	-0.070	0.721	-0.213
Vejdovskyella comata	-0.172	0.887	-0.846
immatures with hair chaetae	0.006	0.369	0.631
immatures without hair chaetae	-0.175	0.117	0.375
F. Lumbriculidae	5.834	-0.263	-0.155
O. Hydracarina	0.033	-0.071	-0.274
Hyalella	-0.055	0.682	0.128
F. Baetidae, incl. Baetis, Callibaetis, immature Baetidae	-0.034	0.669	0.028
Caenis	-0.045	0.534	0.044
Leptophlebia	-0.047	0.600	0.257
Chaoborus (incl. C. flavicans, C. punctipennis, Chaoborus spp.)	-0.174	-1.108	0.272
Chironomus	-0.171	-0.450	-0.300
Cladopelma	-0.186	0.075	-0.629
?Einfeldia	-0.200	0.785	-1.843
Polypedilum	-0.001	0.468	-0.315
Sergentia	-0.069	0.208	0.645
Tanytarsus	-0.056	0.179	0.728
Protanypus	-0.232	0.053	-2.466
Cricotopus (Isocladius)	-0.006	0.531	0.672
Synorthocladius	0.057	0.486	0.778
S.F. Tanypodinae: incl. Ablabesmyia, ?Larsia, Natarsia, Procladius, Tanypus, Thienemannimyia complex, indeterminate Tanypodinae.	-0.146	-0.466	-0.070
Pisidium	-0.055	0.383	0.460

Table G.14: Eigenvalues from Correspondence Analysis of samples collected at deep lake stations of Polley and Bootjack Lakes

Cumulative Inertia (Variance explained, %)	CA-1 (30.7%)	CA-2 (18.3%)	CA-3 (14.9%)
Eigenvaue	0.5	0.3	0.3
Relative Inertia (Variance explained, %)	30.7	18.3	14.9
Cumulative Inertia (Variance explained, %)	30.7	49.0	63.9

Table G.15: Summary of benthic invertebrate community characteristics and statistical comparisons among areas, Quesnel Lake littoral areas, Mount Polley Mine, 2014.

Metric	Overall 6-group ANOVA			6-group ANOVA Post-hoc Comparisons [a]				2-group ANOVA for Estimation of Effect Size		
	Significant Difference Among Areas?	p-value	Power	(I) Area	(J) Area	Significant Difference Among Areas?	p-value [b]	Power	Magnitude of Difference (# of SDs) [c]	Minimum Detectable Effect Size (# of SDs) [d]
Density (Individuals/m^2)	YES	0.000	0.999	LRef1	LRef2	NO	0.455	0.854	~	11.2
				LRef1	LNF1	NO	0.166	0.985	~	1.6
				LRef1	LNF2	NO	0.245	0.963	~	1.5
				LRef1	LFF	NO	0.477	0.827	~	7.3
				LRef1	LFFF	NO	0.175	0.974	~	5.7
				LRef2	LNF1	NO	0.297	0.946	~	1.5
				LRef2	LNF2	NO	0.311	0.940	~	1.5
				LRef2	LFF	NO	0.999	0.226	~	1.8
				LRef2	LFFF	NO	1.000	0.204	~	1.7
				LNF1	LNF2	NO	0.698	0.602	~	1.8
				LNF1	LFF	NO	0.246	0.966	~	38.7
				LNF1	LFFF	YES	0.087	0.999	46.1	~
				LNF2	LFF	NO	0.265	0.959	~	60.5
				LNF2	LFFF	YES	0.096	0.999	70.3	~
				LFF	LFFF	NO	1.000	0.106	~	1.9
Number of Taxa	YES	0.000	1.000	LRef1	LRef2	NO	1.000	0.212	~	1.7
				LRef1	LNF1	YES	0.000	0.998	-2.8	~
				LRef1	LNF2	YES	0.012	0.934	-1.8	~
				LRef1	LFF	YES	0.086	0.716	1.4	~
				LRef1	LFFF	NO	1.000	0.121	~	1.9
				LRef2	LNF1	YES	0.000	1.000	-6.0	~
				LRef2	LNF2	YES	0.001	1.000	-4.2	~
				LRef2	LFF	NO	0.771	0.633	~	2.8
				LRef2	LFFF	NO	1.000	0.157	~	2.5
				LNF1	LNF2	NO	0.642	0.734	~	2.0
				LNF1	LFF	YES	0.000	1.000	6.0	~
				LNF1	LFFF	YES	0.000	1.000	4.3	~
				LNF2	LFF	YES	0.000	1.000	5.7	~
				LNF2	LFFF	YES	0.004	0.998	3.6	~
				LFF	LFFF	NO	0.244	0.741	~	2.0
Simpson's Diversity	YES	0.041	0.837	LRef1	LRef2	NO	0.735	0.562	~	2.2
				LRef1	LNF1	NO	0.908	0.494	~	11.6
				LRef1	LNF2	NO	0.995	0.271	~	2.7
				LRef1	LFF	NO	1.000	0.178	~	2.2
				LRef1	LFFF	NO	1.000	0.104	~	2.2
				LRef2	LNF1	NO	0.981	0.358	~	10.7
				LRef2	LNF2	NO	1.000	0.130	~	2.5
				LRef2	LFF	NO	0.354	0.784	~	2.0
				LRef2	LFFF	NO	0.712	0.588	~	2.0
				LNF1	LNF2	NO	0.968	0.391	~	1.6
				LNF1	LFF	NO	0.864	0.545	~	1.6
				LNF1	LFFF	NO	0.915	0.487	~	1.5
				LNF2	LFF	NO	0.888	0.460	~	1.7
				LNF2	LFFF	NO	0.997	0.259	~	1.7
				LFF	LFFF	NO	0.998	0.240	~	2.2
Simpson's Eveness	YES	0.068	0.779	LRef1	LRef2	NO	0.802	0.592	~	1.6
				LRef1	LNF1	NO	1.000	0.127	~	3.1
				LRef1	LNF2	NO	0.891	0.448	~	2.0
				LRef1	LFF	NO	1.000	0.183	~	1.8
				LRef1	LFFF	NO	1.000	0.144	~	1.9
				LRef2	LNF1	NO	0.926	0.470	~	11.6
				LRef2	LNF2	YES	0.098	0.995	8.4	~
				LRef2	LFF	NO	0.874	0.505	~	4.4
				LRef2	LFFF	NO	0.815	0.564	~	4.8
				LNF1	LNF2	NO	1.000	0.167	~	1.7
				LNF1	LFF	NO	0.999	0.231	~	1.6
				LNF1	LFFF	NO	1.000	0.197	~	1.7
				LNF2	LFF	NO	0.299	0.835	~	1.9
				LNF2	LFFF	NO	0.416	0.756	~	1.9
				LFF	LFFF	NO	1.000	0.109	~	2.3

Table G.15: Summary of benthic invertebrate community characteristics and statistical comparisons among areas, Quesnel Lake littoral areas, Mount Polley Mine, 2014.

Metric	Overall 6-group ANOVA			6-group ANOVA Post-hoc Comparisons [a]				2-group ANOVA for Estimation of Effect Size		
	Significant Difference Among Areas?	p-value	Power	(I) Area	(J) Area	Significant Difference Among Areas?	p-value [b]	Power	Magnitude of Difference (# of SDs) [c]	Minimum Detectable Effect Size (# of SDs) [d]
Bray Curtis Index (LRef1,2)	YES	0.000	0.999	LRef1	LRef2	NO	1.000	0.100	~	2.7
				LRef1	LNF1	YES	0.026	0.999	2.7	~
				LRef1	LNF2	YES	0.091	0.969	2.1	~
				LRef1	LFF	NO	0.627	0.718	~	1.6
				LRef1	LFFF	NO	0.586	0.679	~	1.8
				LRef2	LNF1	NO	0.162	0.970	~	1.6
				LRef2	LNF2	NO	0.378	0.833	~	1.7
				LRef2	LFF	NO	0.933	0.455	~	1.6
				LRef2	LFFF	NO	0.914	0.457	~	1.7
				LNF1	LNF2	NO	0.876	0.465	~	2.6
				LNF1	LFF	YES	0.013	1.000	-3.1	~
				LNF1	LFFF	YES	0.040	0.988	-2.9	~
				LNF2	LFF	NO	0.365	0.851	~	1.6
				LNF2	LFFF	NO	0.604	0.641	~	2.0
				LFF	LFFF	NO	1.000	0.109	~	3.5
EPT (%)	YES	0.000	0.998	LRef1	LRef2	NO	0.117	0.785	~	1.7
				LRef1	LNF1	YES	0.021	0.911	-1.7	~
				LRef1	LNF2	YES	0.053	0.840	-1.5	~
				LRef1	LFF	NO	1.000	0.190	~	1.9
				LRef1	LFFF	NO	1.000	0.170	~	2.1
				LRef2	LNF1	NO	1.000	0.243	~	2.2
				LRef2	LNF2	NO	1.000	0.130	~	2.3
				LRef2	LFF	YES	0.012	0.996	3.6	~
				LRef2	LFFF	NO	0.929	0.536	~	3.3
				LNF1	LNF2	NO	1.000	0.137	~	2.3
				LNF1	LFF	YES	0.002	1.000	4.0	~
				LNF1	LFFF	NO	0.202	0.754	~	3.2
				LNF2	LFF	YES	0.005	0.997	3.4	~
				LNF2	LFFF	NO	0.467	0.627	~	3.0
				LFF	LFFF	NO	1.000	0.457	~	2.6
Ceratopogonidae (%)	YES	0.015	0.920	LRef1	LRef2	NO	0.807	0.597	~	1.6
				LRef1	LNF1	NO	0.678	0.713	~	1.5
				LRef1	LNF2	NO	0.848	0.546	~	1.6
				LRef1	LFF	NO	1.000	0.167	~	1.7
				LRef1	LFFF	NO	0.904	0.487	~	1.6
				LRef2	LNF1	NO	0.866	0.549	~	1.5
				LRef2	LNF2	NO	1.000	0.116	~	2.9
				LRef2	LFF	NO	0.647	0.694	~	5.1
				LRef2	LFFF	NO	0.999	0.219	~	2.8
				LNF1	LNF2	NO	0.947	0.440	~	n/a
				LNF1	LFF	NO	0.431	0.877	~	n/a
				LNF1	LFFF	NO	0.690	0.704	~	n/a
				LNF2	LFF	NO	0.752	0.587	~	3.5
				LNF2	LFFF	NO	1.000	0.132	~	2.1
				LFF	LFFF	NO	0.880	0.486	~	1.7
Chironomidae (%)	YES	0.000	0.997	LRef1	LRef2	YES	0.015	1.000	10.5	~
				LRef1	LNF1	NO	0.887	0.518	~	10.2
				LRef1	LNF2	NO	1.000	0.101	~	2.7
				LRef1	LFF	NO	0.429	0.803	~	3.8
				LRef1	LFFF	NO	0.723	0.635	~	4.7
				LRef2	LNF1	NO	0.944	0.410	~	3.6
				LRef2	LNF2	YES	0.009	1.000	-3.4	~
				LRef2	LFF	YES	0.044	0.990	-2.4	~
				LRef2	LFFF	YES	0.062	0.974	-2.4	~
				LNF1	LNF2	NO	0.879	0.519	~	1.6
				LNF1	LFF	NO	1.000	0.191	~	1.6
				LNF1	LFFF	NO	1.000	0.185	~	1.7
				LNF2	LFF	NO	0.435	0.758	~	2.8
				LNF2	LFFF	NO	0.713	0.611	~	3.4
				LFF	LFFF	NO	1.000	0.100	~	2.5

Table G.15: Summary of benthic invertebrate community characteristics and statistical comparisons among areas, Quesnel Lake littoral areas, Mount Polley Mine, 2014.

Metric	Overall 6-group ANOVA			6-group ANOVA Post-hoc Comparisons [a]				2-group ANOVA for Estimation of Effect Size		
	Significant Difference Among Areas?	p-value	Power	(I) Area	(J) Area	Significant Difference Among Areas?	p-value [b]	Power	Magnitude of Difference (# of SDs) [c]	Minimum Detectable Effect Size (# of SDs) [d]
				LRef1	LRef2	NO	0.249	0.653	~	1.6
				LRef1	LNF1	NO	0.378	0.479	~	1.9
				LRef1	LNF2	NO	0.459	0.573	~	1.6
				LRef1	LFF	NO	1.000	0.126	~	1.8
				LRef1	LFFF	NO	1.000	0.105	~	1.8
				LRef2	LNF1	NO	1.000	0.106	~	4.0
				LRef2	LNF2	NO	1.000	0.150	~	2.1
Amphipoda (%)	YES	0.006	0.963	LRef2	LFF	YES	0.069	0.984	4.1	~
				LRef2	LFFF	NO	0.147	0.960	~	3.4
				LNF1	LNF2	NO	1.000	0.101	~	1.6
				LNF1	LFF	NO	0.108	0.813	~	2.0
				LNF1	LFFF	NO	0.226	0.731	~	2.0
				LNF2	LFF	NO	0.133	0.967	~	3.5
				LNF2	LFFF	NO	0.276	0.926	~	3.5
				LFF	LFFF	NO	1.000	0.116	~	2.2
				LRef1	LRef2	NO	1.000	0.100	~	2.5
				LRef1	LNF1	NO	0.329	0.809	~	1.9
				LRef1	LNF2	NO	0.721	0.671	~	10.9
				LRef1	LFF	NO	0.283	0.918	~	1.6
				LRef1	LFFF	NO	0.348	0.908	~	1.6
				LRef2	LNF1	NO	0.602	0.671	~	1.8
				LRef2	LNF2	NO	0.721	0.664	~	8.3
Acari (%)	YES	0.001	0.997	LRef2	LFF	NO	0.571	0.762	~	1.6
				LRef2	LFFF	NO	0.633	0.737	~	1.5
				LNF1	LNF2	NO	0.523	0.815	~	14.1
				LNF1	LFF	NO	1.000	0.100	~	1.7
				LNF1	LFFF	NO	1.000	0.106	~	1.6
				LNF2	LFF	NO	0.524	0.819	~	1.5
				LNF2	LFFF	NO	0.534	0.814	~	1.5
				LFF	LFFF	NO	1.000	0.135	~	1.8
				LRef1	LRef2	NO	0.576	0.723	~	1.7
				LRef1	LNF1	NO	0.339	0.911	~	1.6
				LRef1	LNF2	NO	0.799	0.538	~	1.8
				LRef1	LFF	NO	0.999	0.212	~	2.1
				LRef1	LFFF	NO	0.841	0.494	~	2.5
				LRef2	LNF1	NO	0.930	0.430	~	1.7
				LRef2	LNF2	NO	1.000	0.147	~	2.8
Bivalves (%)	YES	0.000	1.000	LRef2	LFF	NO	0.133	0.971	~	3.8
				LRef2	LFFF	NO	0.154	0.979	~	5.3
				LNF1	LNF2	NO	0.894	0.491	~	5.0
				LNF1	LFF	YES	0.089	0.998	10.5	~
				LNF1	LFFF	NO	0.118	0.996	~	10.6
				LNF2	LFF	NO	0.214	0.891	~	2.8
				LNF2	LFFF	NO	0.183	0.944	~	3.7
				LFF	LFFF	NO	0.996	0.263	~	2.7
				LRef1	LRef2	NO	0.934	0.450	~	1.6
				LRef1	LNF1	NO	1.000	0.203	~	4.8
				LRef1	LNF2	NO	1.000	0.104	~	2.8
				LRef1	LFF	NO	0.873	0.526	~	1.6
				LRef1	LFFF	NO	0.387	0.822	~	1.7
				LRef2	LNF1	NO	0.973	0.385	~	20.2
				LRef2	LNF2	NO	0.988	0.334	~	10.2
Gastropods (%)	NO	0.187	0.616	LRef2	LFF	YES	0.000	1.000	7.1	~
				LRef2	LFFF	YES	0.002	1.000	9.5	~
				LNF1	LNF2	NO	1.000	0.173	~	1.7
				LNF1	LFF	NO	1.000	0.110	~	1.5
				LNF1	LFFF	NO	1.000	0.103	~	1.6
				LNF2	LFF	NO	0.998	0.258	~	1.6
				LNF2	LFFF	NO	0.885	0.500	~	1.6
				LFF	LFFF	NO	0.636	0.669	~	3.6

Table G.15: Summary of benthic invertebrate community characteristics and statistical comparisons among areas, Quesnel Lake littoral areas, Mount Polley Mine, 2014.

Metric	Overall 6-group ANOVA			6-group ANOVA Post-hoc Comparisons [a]				2-group ANOVA for Estimation of Effect Size		
	Significant Difference Among Areas?	p-value	Power	(I) Area	(J) Area	Significant Difference Among Areas?	p-value [b]	Power	Magnitude of Difference (# of SDs) [c]	Minimum Detectable Effect Size (# of SDs) [d]
Hirudinea (%)	NO	0.257	0.552	LRef1	LRef2	NO	0.288	0.929	~	1.6
				LRef1	LNF1	NO	0.223	0.975	~	1.5
				LRef1	LNF2	NO	1.000	0.132	~	7.3
				LRef1	LFF	NO	0.567	0.694	~	1.8
				LRef1	LFFF	NO	0.984	0.316	~	2.2
				LRef2	LNF1	NO	0.909	0.498	~	1.5
				LRef2	LNF2	NO	0.993	0.309	~	29.1
				LRef2	LFF	NO	0.984	0.333	~	3.9
				LRef2	LFFF	NO	0.917	0.472	~	6.4
				LNF1	LNF2	NO	0.987	0.340	~	n/a
				LNF1	LFF	NO	0.764	0.645	~	n/a
				LNF1	LFFF	NO	0.762	0.647	~	n/a
				LNF2	LFF	NO	0.998	0.255	~	1.5
				LNF2	LFFF	NO	1.000	0.201	~	1.6
				LFF	LFFF	NO	1.000	0.194	~	3.1
Oligochaetes (%)	YES	0.047	0.824	LRef1	LRef2	NO	0.622	0.629	~	2.1
				LRef1	LNF1	NO	0.997	0.256	~	3.1
				LRef1	LNF2	NO	1.000	0.125	~	4.3
				LRef1	LFF	NO	0.121	0.983	~	1.6
				LRef1	LFFF	NO	0.101	0.969	~	1.8
				LRef2	LNF1	NO	1.000	0.129	~	3.1
				LRef2	LNF2	NO	0.959	0.396	~	4.4
				LRef2	LFF	NO	0.980	0.348	~	1.6
				LRef2	LFFF	NO	0.982	0.330	~	1.8
				LNF1	LNF2	NO	0.997	0.253	~	2.8
				LNF1	LFF	NO	0.988	0.332	~	1.6
				LNF1	LFFF	NO	0.986	0.330	~	1.6
				LNF2	LFF	NO	0.785	0.618	~	1.6
				LNF2	LFFF	NO	0.774	0.616	~	1.6
				LFF	LFFF	NO	1.000	0.101	~	2.9
CA-1 (19.0 %)	YES	0.000	0.999	LRef1	LRef2	NO	0.998	0.243	~	2.9
				LRef1	LNF1	NO	0.538	0.788	~	7.2
				LRef1	LNF2	NO	0.452	0.849	~	8.6
				LRef1	LFF	NO	0.249	0.883	~	1.8
				LRef1	LFFF	YES	0.079	0.971	2.1	~
				LRef2	LNF1	NO	0.713	0.641	~	4.6
				LRef2	LNF2	NO	0.577	0.747	~	5.5
				LRef2	LFF	NO	0.298	0.901	~	1.6
				LRef2	LFFF	NO	0.145	0.965	~	1.7
				LNF1	LNF2	NO	1.000	0.141	~	2.4
				LNF1	LFF	NO	0.302	0.938	~	1.5
				LNF1	LFFF	NO	0.244	0.960	~	1.6
				LNF2	LFF	NO	0.279	0.950	~	1.5
				LNF2	LFFF	NO	0.234	0.966	~	1.5
				LFF	LFFF	NO	0.982	0.324	~	2.4
CA-2 (16.3 %)	YES	0.000	1.000	LRef1	LRef2	YES	0.000	1.000	-6.2	~
				LRef1	LNF1	NO	1.000	0.213	~	3.4
				LRef1	LNF2	NO	1.000	0.306	~	4.2
				LRef1	LFF	NO	1.000	0.425	~	1.8
				LRef1	LFFF	NO	1.000	0.424	~	2.6
				LRef2	LNF1	YES	0.000	0.998	4.1	~
				LRef2	LNF2	YES	0.000	1.000	5.9	~
				LRef2	LFF	YES	0.000	1.000	5.4	~
				LRef2	LFFF	YES	0.001	1.000	3.8	~
				LNF1	LNF2	NO	0.399	0.453	~	2.5
				LNF1	LFF	NO	1.000	0.527	~	1.6
				LNF1	LFFF	NO	1.000	0.113	~	1.9
				LNF2	LFF	NO	1.000	0.144	~	1.6
				LNF2	LFFF	NO	0.193	0.609	~	1.8
				LFF	LFFF	NO	0.786	0.860	~	3.6

[a] Bonferroni post-hoc Test, or Tamhane's T2 Test where variances were found to be heterogenous by Levene's Test
[b] p-value obtained from post-hoc analysis of 1-way ANOVA among all areas (post-hoc analyses protected for multiple comparisons)
[c] Magnitude calculated by comparing the difference between the reference area (I) and exposure area (J) means to the reference area (I) standard deviation (SD) [(exposure mean - reference mean) / standard deviation of the reference mean]
[d] Minimum effect size detectable calculated based on variance as square root of MSE from ANOVA and alpha = beta = 0.10. Minimum effect size reported as the minimum number of standard deviations detectable based on reference area standard deviation.

Table G.16: Descriptive statistics for benthic metrics from Quesnel Lake littoral areas, Mount Polley Mine, 2014.

	Area Code	Mean	90% Confidence Interval for Mean		Median	Variance	Std. Deviation	Minimum	Maximum
			Lower Bound	Upper Bound					
Density (Individuals/m2)	LRef1	1,427	792	2,061	1,601	442,882	665	303	2,043
	LRef2	7,858	3,270	12,447	6,787	23,163,597	4,813	3,670	16,101
	LNF1	159	42.9	276	156	14,897	122	0	329
	LNF2	294	220	369	312	6,107	78.1	182	390
	LFF	5,424	2,490	8,358	5,324	9,472,314	3,078	1,688	9,842
	LFFF	5,786	3,517	8,055	6,700	5,662,798	2,380	2,052	8,310
Number of Taxa	LRef1	19.0	14.4	23.6	20.0	23.5	4.848	12.0	25.0
	LRef2	21.2	18.7	23.7	21.0	6.700	2.588	18.0	25.0
	LNF1	5.60	2.40	8.80	7.00	11.3	3.362	0.00	8.00
	LNF2	10.4	7.82	13.0	11.0	7.30	2.702	6.00	13.0
	LFF	25.8	22.0	29.6	27.0	15.7	3.962	19.0	29.0
	LFFF	20.0	16.8	23.2	20.0	11.0	3.317	15.0	23.0
Simpson's D	LRef1	0.845	0.803	0.887	0.872	0.002	0.044	0.780	0.880
	LRef2	0.787	0.741	0.833	0.771	0.002	0.048	0.720	0.840
	LNF1	0.579	0.264	0.894	0.694	0.109	0.331	0.000	0.810
	LNF2	0.804	0.739	0.869	0.837	0.005	0.068	0.700	0.860
	LFF	0.866	0.823	0.909	0.882	0.002	0.045	0.790	0.900
	LFFF	0.841	0.809	0.872	0.854	0.001	0.033	0.790	0.870
Simpson's E	LRef1	0.385	0.228	0.542	0.322	0.027	0.164	0.220	0.650
	LRef2	0.230	0.194	0.266	0.218	0.001	0.038	0.198	0.290
	LNF1	0.449	0.179	0.720	0.603	0.080	0.284	0.000	0.655
	LNF2	0.548	0.408	0.688	0.556	0.022	0.147	0.331	0.742
	LFF	0.318	0.221	0.416	0.314	0.010	0.102	0.168	0.446
	LFFF	0.336	0.228	0.443	0.298	0.013	0.113	0.241	0.532
BC(LRef1)	LRef1	0.367	0.176	0.559	0.306	0.040	0.201	0.153	0.652
	LRef2	0.824	0.711	0.937	0.812	0.014	0.118	0.698	0.953
	LNF1	0.884	0.781	0.987	0.902	0.012	0.108	0.717	1.000
	LNF2	0.757	0.641	0.873	0.772	0.015	0.122	0.615	0.934
	LFF	0.707	0.608	0.806	0.734	0.011	0.104	0.559	0.828
	LFFF	0.761	0.723	0.800	0.775	0.002	0.040	0.690	0.789
BC(LRef2)	LRef1	0.778	0.705	0.851	0.748	0.006	0.077	0.720	0.909
	LRef2	0.342	0.183	0.501	0.319	0.028	0.167	0.141	0.603
	LNF1	0.964	0.932	0.996	0.974	0.001	0.034	0.912	1.000
	LNF2	0.926	0.886	0.965	0.933	0.002	0.042	0.872	0.982
	LFF	0.802	0.773	0.831	0.810	0.001	0.031	0.759	0.832
	LFFF	0.781	0.729	0.832	0.776	0.003	0.054	0.722	0.861
BC(LRef1,2)	LRef1	0.584	0.463	0.706	0.549	0.016	0.128	0.466	0.801
	LRef2	0.587	0.410	0.764	0.611	0.034	0.186	0.348	0.812
	LNF1	0.929	0.867	0.991	0.945	0.004	0.065	0.829	1.000
	LNF2	0.848	0.768	0.928	0.863	0.007	0.084	0.742	0.962
	LFF	0.728	0.695	0.761	0.740	0.001	0.034	0.685	0.768
	LFFF	0.737	0.666	0.809	0.762	0.006	0.075	0.659	0.828
EPT (%)	LRef1	9.0	4.5	13.6	8.1	22.9	4.8	5.7	17.4
	LRef2	2.7	0.4	4.9	3.3	5.6	2.4	0.0	6.0
	LNF1	1.1	-1.3	3.5	0.0	6.2	2.5	0.0	5.6
	LNF2	1.9	-0.6	4.5	0.0	7.2	2.7	0.0	5.3
	LFF	11.1	8.0	14.2	11.3	10.4	3.2	7.2	14.9
	LFFF	7.0	2.7	11.2	6.8	20.1	4.5	3.0	14.2

Table G.16: Descriptive statistics for benthic metrics from Quesnel Lake littoral areas, Mount Polley Mine, 2014.

	Area Code	Mean	90% Confidence Interval for Mean		Median	Variance	Std. Deviation	Minimum	Maximum
			Lower Bound	Upper Bound					
Ceratopogonidae (%)	LRef1	6.1	0.7	11.5	3.8	31.8	5.6	1.3	15.4
	LRef2	0.8	-0.1	1.7	0.5	0.9	0.9	0.0	2.1
	LNF2	1.1	-0.3	2.5	0.0	2.2	1.5	0.0	2.8
	LFF	4.1	1.3	7.0	3.3	9.0	3.0	1.3	9.2
	LFFF	1.5	0.2	2.9	1.5	2.0	1.4	0.0	3.7
Chironomidae (%)	LRef1	11.5	6.1	17.0	10.3	32.4	5.7	5.9	20.9
	LRef2	71.5	54.4	88.5	75.0	319	17.8	50.1	91.8
	LNF1	42.8	7.1	78.5	27.8	1399	37.4	0.0	91.7
	LNF2	11.1	3.1	19.1	11.1	70.6	8.4	2.6	23.8
	LFF	28.6	16.5	40.7	23.1	161	12.7	17.2	44.4
	LFFF	28.5	12.8	44.2	22.2	272	16.5	16.0	56.5
Amphipoda (%)	LRef1	21.8	5.8	37.8	25.7	281	16.8	2.9	43.2
	LRef2	4.3	-0.7	9.2	2.4	26.9	5.2	0.0	12.3
	LNF1	5.6	-6.3	17.4	0.0	154	12.4	0.0	27.8
	LNF2	6.2	1.5	10.8	5.3	23.9	4.9	0.0	11.1
	LFF	25.5	15.8	35.2	22.2	103	10.2	17.4	42.6
	LFFF	23.4	13.6	33.1	23.3	104	10.2	11.4	34.9
Acari (%)	LRef1	4.6	2.3	6.9	4.5	5.9	2.4	2.5	8.6
	LRef2	4.6	1.6	7.7	5.1	10.4	3.2	1.3	9.5
	LNF1	0.8	-0.9	2.6	0.0	3.5	1.9	0.0	4.2
	LNF2	22.2	6.0	38.5	30.6	291	17.1	3.3	39.5
	LFF	0.8	0.1	1.5	0.5	0.6	0.8	0.1	2.1
	LFFF	1.0	0.6	1.4	1.0	0.2	0.4	0.4	1.6
Bivalves (%)	LRef1	9.6	3.8	15.4	7.8	36.9	6.1	4.5	20.0
	LRef2	2.5	0.1	4.8	1.7	5.8	2.4	0.0	6.4
	LNF1	0.5	-0.6	1.6	0.0	1.4	1.2	0.0	2.6
	LNF2	3.6	0.1	7.1	3.3	13.5	3.7	0.0	7.9
	LFF	12.9	7.7	18.1	15.9	30.0	5.5	4.4	16.9
	LFFF	17.6	10.0	25.3	23.0	64.6	8.0	6.4	23.7
Gastropods (%)	LRef1	5.1	0.1	10.0	2.7	27.4	5.2	2.0	14.3
	LRef2	1.1	-0.1	2.2	1.1	1.4	1.2	0.0	2.9
	LNF1	11.3	-3.5	26.2	0.0	242	15.5	0.0	28.9
	LNF2	5.8	-1.7	13.2	4.4	61.2	7.8	0.0	19.0
	LFF	9.5	8.4	10.7	10.1	1.4	1.2	7.5	10.3
	LFFF	12.4	10.0	14.7	11.8	6.3	2.5	10.2	16.3
Hirudinea (%)	LRef1	3.7	1.7	5.7	4.2	4.3	2.1	0.5	5.5
	LRef2	0.4	-0.1	0.9	0.2	0.3	0.5	0.0	1.2
	LNF2	5.8	-3.4	15.0	0.0	92.8	9.6	0.0	22.2
	LFF	1.2	0.0	2.3	0.7	1.4	1.2	0.4	3.3
	LFFF	2.0	0.1	4.0	1.7	4.2	2.1	0.0	4.3
Oligochaetes (%)	LRef1	25.7	15.8	35.6	25.7	107.7	10.4	14.6	37.3
	LRef2	11.7	2.1	21.3	9.0	101.3	10.1	0.5	23.2
	LNF1	15.9	-1.1	32.9	8.3	318	17.8	0.0	44.7
	LNF2	31.2	5.4	57.0	30.6	732	27.0	0.0	70.0
	LFF	5.2	1.5	8.9	5.3	15.0	3.9	1.5	11.0
	LFFF	4.8	-1.0	10.7	2.1	38.0	6.2	0.0	15.2

Table G.16: Descriptive statistics for benthic metrics from Quesnel Lake littoral areas, Mount Polley Mine, 2014.

	Area Code	Mean	90% Confidence Interval for Mean		Median	Variance	Std. Deviation	Minimum	Maximum
			Lower Bound	Upper Bound					
CA-1 (19.0 %)	LRef1	0.002	-0.166	0.169	-0.001	0.031	0.176	-0.219	0.222
	LRef2	-0.151	-0.422	0.121	-0.026	0.081	0.285	-0.533	0.167
	LNF1	-0.996	-1.770	-0.221	-0.937	0.660	0.812	-2.173	0.000
	LNF2	-1.301	-2.231	-0.371	-1.441	0.951	0.975	-2.637	0.033
	LFF	0.285	0.187	0.383	0.243	0.011	0.103	0.207	0.457
	LFFF	0.380	0.259	0.501	0.414	0.016	0.127	0.195	0.493
CA-2 (16.3 %)	LRef1	0.250	0.083	0.416	0.224	0.031	0.175	0.066	0.534
	LRef2	-0.840	-1.058	-0.621	-0.697	0.052	0.229	-1.164	-0.657
	LNF1	0.094	-0.235	0.423	0.169	0.119	0.345	-0.413	0.539
	LNF2	0.513	0.090	0.936	0.575	0.197	0.444	-0.002	1.019
	LFF	0.398	0.288	0.508	0.413	0.013	0.115	0.287	0.567
	LFFF	0.036	-0.198	0.270	0.102	0.060	0.245	-0.228	0.317

NOTE: where no variance (or zero values) occurred for a metric in a given area, descriptive statistics are not shown.

Table G.17: Benthic metrics and supporting measures data, Quesnel Lake littoral areas, Mount Polley Mine, 2014.

Station	Area	Exposure	Density (Ind./m2)	Number of Taxa	Simpson's D	Simpson's E	BC(LRef1)	BC(LRef2)	BC(LRef1,2)	EPT (%)	Ceratopogonidae (%)	Chironomidae (%)	Amphipoda (%)	Acari (%)	Bivalves (%)
LNF1-1	LNF1	QUL Exp.	156	8	0.810	0.653	0.853	0.953	0.908	5.6	0.0	27.8	27.8	0.0	0.0
LNF1-2	LNF1	QUL Exp.	104	5	0.690	0.655	0.902	0.974	0.945	0.0	0.0	91.7	0.0	0.0	0.0
LNF1-3	LNF1	QUL Exp.	329	7	0.760	0.603	0.717	0.912	0.829	0.0	0.0	23.7	0.0	0.0	2.6
LNF1-4	LNF1	QUL Exp.	0	0	0.000	0.000	1.000	1.000	1.000	0.0	0.0	0.0	0.0	0.0	0.0
LNF1-5	LNF1	QUL Exp.	208	8	0.630	0.336	0.949	0.982	0.962	0.0	0.0	70.8	0.0	4.2	0.0
LFF-1	LFF	QUL Exp.	3,679	28	0.790	0.168	0.654	0.832	0.768	11.3	3.8	17.2	42.6	2.1	10.4
LFF-2	LFF	QUL Exp.	5,324	29	0.890	0.314	0.734	0.759	0.685	7.2	3.1	39.8	18.9	0.5	16.9
LFF-3	LFF	QUL Exp.	1,688	19	0.880	0.446	0.559	0.827	0.700	14.9	9.2	23.1	17.4	0.5	16.9
LFF-4	LFF	QUL Exp.	9,842	27	0.900	0.368	0.828	0.783	0.740	8.7	3.3	44.4	22.2	0.8	4.4
LFF-5	LFF	QUL Exp.	6,588	26	0.870	0.296	0.760	0.810	0.747	13.5	1.3	18.3	26.5	0.1	15.9
LFFF-1	LFFF	QUL Exp.	6,700	23	0.860	0.311	0.775	0.861	0.828	14.2	3.7	22.2	15.2	1.6	23.0
LFFF-2	LFFF	QUL Exp.	2,052	15	0.870	0.532	0.690	0.743	0.660	3.0	0.0	56.5	11.4	1.3	11.8
LFFF-3	LFFF	QUL Exp.	8,310	23	0.850	0.298	0.789	0.776	0.762	7.3	0.6	16.0	23.3	0.4	23.3
LFFF-4	LFFF	QUL Exp.	6,787	19	0.820	0.296	0.772	0.722	0.659	3.6	1.5	29.6	31.9	0.8	6.4
LFFF-5	LFFF	QUL Exp.	5,081	20	0.790	0.241	0.780	0.802	0.777	6.8	1.7	18.2	34.9	1.0	23.7
LNF2-1	LNF2	QUL Exp.	329	12	0.860	0.579	0.788	0.941	0.879	5.3	2.6	2.6	5.3	39.5	7.9
LNF2-2	LNF2	QUL Exp.	390	11	0.840	0.556	0.615	0.872	0.742	4.4	0.0	4.4	11.1	4.4	6.7
LNF2-3	LNF2	QUL Exp.	182	6	0.780	0.742	0.934	0.982	0.962	0.0	0.0	23.8	0.0	33.3	0.0
LNF2-4	LNF2	QUL Exp.	312	13	0.860	0.532	0.772	0.933	0.863	0.0	2.8	11.1	11.1	30.6	0.0
LNF2-5	LNF2	QUL Exp.	260	10	0.700	0.331	0.678	0.901	0.794	0.0	0.0	13.3	3.3	3.3	3.3
LRef1-1	LRef1	QUL Ref.	1,601	21	0.780	0.220	0.241	0.784	0.549	8.1	3.8	10.3	43.2	2.7	6.5
LRef1-2	LRef1	QUL Ref.	1,740	25	0.880	0.322	0.486	0.748	0.573	6.0	15.4	20.9	7.0	4.5	4.5
LRef1-3	LRef1	QUL Ref.	2,043	17	0.810	0.314	0.306	0.731	0.532	8.1	1.3	5.9	30.1	2.5	9.3
LRef1-4	LRef1	QUL Ref.	1,446	20	0.880	0.421	0.153	0.720	0.466	17.4	7.2	12.0	25.7	4.8	7.8
LRef1-5	LRef1	QUL Ref.	303	12	0.870	0.650	0.652	0.909	0.801	5.7	2.9	8.6	2.9	8.6	20.0
LRef2-1	LRef2	QUL Ref.	7,254	25	0.840	0.243	0.812	0.319	0.611	6.0	2.1	50.1	6.4	5.3	2.9
LRef2-2	LRef2	QUL Ref.	6,787	18	0.720	0.201	0.953	0.349	0.703	0.8	0.5	91.8	0.3	5.1	0.0
LRef2-3	LRef2	QUL Ref.	16,101	20	0.770	0.218	0.937	0.603	0.812	0.0	0.0	84.1	0.0	9.5	1.3
LRef2-4	LRef2	QUL Ref.	3,670	22	0.770	0.198	0.721	0.141	0.348	3.3	0.0	75.0	2.4	2.1	6.4
LRef2-5	LRef2	QUL Ref.	5,480	21	0.840	0.290	0.698	0.298	0.461	3.3	1.4	56.2	12.3	1.3	1.7

Table G.17: Benthic metrics and supporting measures data, Quesnel Lake littoral areas, Mount Polley Mine, 2014.

Station	Area	Exposure	Gastropods (%)	Hirudinea (%)	Oligochaetes (%)	CA-1 (19.0 %)	CA-2 (16.3 %)	Sediment PC-1 score	Sediment PC-2 score	Sediment PC-3 score	Station Depth (m)	Bottom Temperature (°C)	Bottom DO (% sat.)	Bottom pH
LNF1-1	LNF1	QUL Exp.	27.8	0.0	5.6	-0.579	0.169	-4.37	2.020	-0.508	1.40	20.5	96.7	7.87
LNF1-2	LNF1	QUL Exp.	0.0	0.0	8.3	-1.290	-0.413	-4.66	1.643	-0.273	1.10	20.6	95.5	7.78
LNF1-3	LNF1	QUL Exp.	28.9	0.0	44.7	-0.937	0.173	-4.80	1.958	-0.465	1.40	21.4	96.4	7.95
LNF1-4	LNF1	QUL Exp.	0.0	0.0	0.0	0.000	0.000	-4.65	2.071	-0.010	0.90	20.2	94.9	8.00
LNF1-5	LNF1	QUL Exp.	0.0	0.0	20.8	-2.173	0.539	-3.50	2.629	-0.502	1.10	20.6	99.9	8.26
LFF-1	LFF	QUL Exp.	9.6	0.7	1.9	0.301	0.413	3.39	0.38	1.386	1.50	18.7	97.0	8.09
LFF-2	LFF	QUL Exp.	7.5	3.3	1.5	0.207	0.293	2.88	1.11	-1.036	1.50	18.8	98.2	8.15
LFF-3	LFF	QUL Exp.	10.3	0.5	6.2	0.457	0.567	1.17	0.49	-0.89	1.50	17.7	96.2	8.04
LFF-4	LFF	QUL Exp.	10.2	0.4	5.3	0.218	0.430	1.99	1.32	-0.89	1.50	17.8	96.8	8.16
LFF-5	LFF	QUL Exp.	10.1	0.9	11.0	0.243	0.287	4.20	1.27	-0.229	1.60	17.2	94.9	8.10
LFFF-1	LFFF	QUL Exp.	13.0	4.3	2.1	0.493	0.317	-1.76	-2.642	2.59	1.30	17.8	94.5	8.13
LFFF-2	LFFF	QUL Exp.	11.8	0.0	1.3	0.310	-0.228	-1.71	-4.343	7.07	1.60	16.8	92.2	7.38
LFFF-3	LFFF	QUL Exp.	10.2	1.7	15.2	0.414	0.200	-1.00	-3.654	2.15	1.40	17.3	93.0	7.81
LFFF-4	LFFF	QUL Exp.	16.3	4.1	5.6	0.195	-0.210	0.26	-1.812	1.25	1.60	17.1	93.3	7.85
LFFF-5	LFFF	QUL Exp.	10.4	0.2	0.0	0.487	0.102	0.58	-1.687	1.01	1.30	17.8	95.1	7.83
LNF2-1	LNF2	QUL Exp.	5.3	0.0	13.2	-1.441	0.849	-3.91	1.37	-0.08	1.80	20.4	99.8	8.24
LNF2-2	LNF2	QUL Exp.	4.4	22.2	42.2	0.033	0.125	-3.83	1.39	-0.30	1.30	20.5	98.6	8.25
LNF2-3	LNF2	QUL Exp.	19.0	0.0	0.0	-2.637	1.019	-4.33	1.047	-0.317	1.80	19.7	97.3	7.95
LNF2-4	LNF2	QUL Exp.	0.0	0.0	30.6	-1.556	0.575	-4.07	1.776	-0.671	1.50	19.1	95.7	8.02
LNF2-5	LNF2	QUL Exp.	0.0	6.7	70.0	-0.904	-0.002	-4.00	2.024	-0.662	1.40	17.9	95.5	8.09
LRef1-1	LRef1	QUL Ref.	2.7	5.4	14.6	-0.001	0.224	3.49	1.392	0.417	1.40	18.6	124	8.92
LRef1-2	LRef1	QUL Ref.	2.0	0.5	37.3	-0.112	0.066	4.11	1.29	0.637	1.50	18.9	147	9.33
LRef1-3	LRef1	QUL Ref.	2.1	5.5	34.7	0.118	0.165	3.90	1.08	0.461	1.40	18.0	114	8.96
LRef1-4	LRef1	QUL Ref.	4.2	4.2	16.2	0.222	0.260	4.51	1.717	0.575	1.50	18.0	115	8.96
LRef1-5	LRef1	QUL Ref.	14.3	2.9	25.7	-0.219	0.534	4.41	1.68	0.636	1.40	18.4	117	8.78
LRef2-1	LRef2	QUL Ref.	2.9	1.2	23.2	0.167	-0.657	1.82	-3.11	-2.09	1.20	9.94	109	8.28
LRef2-2	LRef2	QUL Ref.	0.0	0.0	0.5	-0.533	-1.164	-1.81	-7.74	-4.283	1.10	8.82	90.9	7.65
LRef2-3	LRef2	QUL Ref.	0.0	0.2	4.7	-0.353	-0.999	-0.60	-5.74	-2.88	1.30	8.80	90.8	7.79
LRef2-4	LRef2	QUL Ref.	1.4	0.0	9.0	-0.026	-0.697	5.75	0.38	-1.21	1.00	9.63	87.4	7.41
LRef2-5	LRef2	QUL Ref.	1.1	0.6	21.3	-0.007	-0.680	6.53	0.70	-0.89	1.21	10.5	89.8	7.63

Table G.17: Benthic metrics and supporting measures data, Quesnel Lake littoral areas, Mount Polley Mine, 2014.

Station	Area	Exposure	Bottom Conductance (µS/cm)	Bottom TDS (mg/L)	Surface Temperature (°C)	Surface DO (mg/L)	Surface DO (% sat.)	Surface pH	Surface Conductance (µS/cm)	Surface TDS (mg/L)
LNF1-1	LNF1	QUL Exp.	97.5	63.0						
LNF1-2	LNF1	QUL Exp.	98.0	64.0						
LNF1-3	LNF1	QUL Exp.	99.7	65.0						
LNF1-4	LNF1	QUL Exp.	98.9	64.0						
LNF1-5	LNF1	QUL Exp.	98.7	64.0						
LFF-1	LFF	QUL Exp.	102	66.0	18.7	9.07	97.1	8.14	102	67.0
LFF-2	LFF	QUL Exp.	102	66.0	18.8	9.12	97.9	8.19	102	66.0
LFF-3	LFF	QUL Exp.	103	67.0	17.7	9.18	96.3	7.91	103	67.0
LFF-4	LFF	QUL Exp.	102	66.0	18.0	9.08	95.9	8.14	102	66.0
LFF-5	LFF	QUL Exp.	102	66.0	18.0	9.05	95.6	8.11	102	66.0
LFFF-1	LFFF	QUL Exp.	107	71.0	18.1	8.92	94.7	8.13	108	70.0
LFFF-2	LFFF	QUL Exp.	109		17.2	8.90	92.5	7.49	107	
LFFF-3	LFFF	QUL Exp.	108		17.3	8.95	93.3	7.84	108	
LFFF-4	LFFF	QUL Exp.	108		17.1	8.99	93.2	7.90	108	
LFFF-5	LFFF	QUL Exp.	109		17.8	9.04	95.1	7.94	108	
LNF2-1	LNF2	QUL Exp.	99.0	64.0	20.4	9.01	99.8	8.23	99.0	64.0
LNF2-2	LNF2	QUL Exp.	98.7	64.0	20.6	8.82	98.1	8.23	96.2	63.0
LNF2-3	LNF2	QUL Exp.	102		19.7	8.94	97.6	7.87	102	
LNF2-4	LNF2	QUL Exp.	102	66.0	20.2	8.66	95.6	8.04	103	67.0
LNF2-5	LNF2	QUL Exp.	101	66.0	18.8	8.95	96.2	8.14	101	66.0
LRef1-1	LRef1	QUL Ref.	100	65.0	18.8	11.4	123	8.83	101	65.0
LRef1-2	LRef1	QUL Ref.	102	66.0	19.4	11.7	128	9.09	102	66.0
LRef1-3	LRef1	QUL Ref.	102	66.0	18.0	10.8	114	8.98	102	
LRef1-4	LRef1	QUL Ref.	102	66.0	18.3	9.71	103	8.54	104	67.0
LRef1-5	LRef1	QUL Ref.	103	67.0	18.4	10.2	109	8.56	104	67.0
LRef2-1	LRef2	QUL Ref.	112		10.6	12.0	107	8.37	109	
LRef2-2	LRef2	QUL Ref.	115		8.82	10.6	90.9	7.72	115	
LRef2-3	LRef2	QUL Ref.	116		8.82	10.5	90.8	7.95	116	
LRef2-4	LRef2	QUL Ref.	114		9.63	9.89	87.0	7.50	114	
LRef2-5	LRef2	QUL Ref.	111		10.6	10.0	89.9	7.70	111	

Table G.18: Benthic taxon scores from Correspondence Analysis of samples from Quesnel Lake littoral areas, Mount Polley Mine, 2014.

Taxon	CA-1 (19.0%)	CA-2 (16.3%)
Family: Baetidae: incl. Baetis, Callibaetis	0.022	-0.230
Caenis sp., incl. C. youngi	0.612	0.526
Ephemera simulans and Ephemeridae	0.440	0.658
Oxyethira sp.	0.483	0.420
Mystacides	0.392	-0.001
Oecetis	0.216	0.522
Family: Limnephilidae, incl. Chyranda centralis, Limnephilus, unident. Limnephilidae	0.396	0.540
Phryganea sp.	0.557	0.223
Family: Polycentropodidae, incl. Polycentropus	0.403	0.021
Family: Elmidae, incl. Heterlimnius, Optioservus	-0.556	0.615
Culicoides	0.161	-0.987
Probezzia	0.667	0.733
Sphaeromias sp.	-0.039	0.558
Chironomus	-1.52	0.146
Cryptochironomus	-0.133	-0.828
Demicryptochironomus sp.	0.056	0.651
Dicrotendipes	0.245	-0.067
Microtendipes pedellus	0.468	0.087
Polypedilum sp.	-0.180	-1.35
Stictochironomus	-0.731	-0.586
Pseudochironomus sp.	0.450	0.630
Stempellina sp.	0.011	-1.02
Tanytarsus	0.037	-0.503
Pagastia	0.499	0.003
Potthastia gaedii group	0.143	-1.14
Heterotrissocladius sp.	-0.327	-0.910
Orthocladius complex	-1.02	0.315
Monodiamesa sp.	-0.256	-1.55
Ablabesmyia	0.404	-0.171
Thienemannimyia group	-0.100	-0.794
Procladius	0.158	-0.398
Family: Empididae, incl. Chelifera/Metachela, Clinocera, Hemerodromia, Oreogeton	-1.74	0.800
Family: Coenagrionidae	0.515	0.538
Family: Corduliidae, incl. Epitheca, Somatochlora	0.524	0.575
Order: Amphipoda, incl. Gammarus, Hyalella	0.133	0.173
Class: Arachnida, incl. Acari	-0.050	-0.138
Family: Hydrozetidae	-3.25	1.33
Family: Pisidiidae, incl. Pisidium, Sphaerium	0.186	0.128
Class: Gastropoda, incl. Lymnaeidae, Physidae, Planorbidae, Valvatidae (all collapsed as no identified snails found in 874 gastropods in QUL-48-1)	0.026	0.297
Family: Glossiphoniidae, incl. Helobdella	0.239	0.124
Family: Lumbriculidae	-0.389	0.054
Family: Tubificidae	-0.230	0.053

Table G.19: MANOVA statistics for benthic metrics from Quesnel Lake littoral areas, Mount Polley Mine, 2014.

Effect	Statistic	F-ratio	Hypothesis df	Error df	p-value	Power
Intercept	Pillai's Trace	9,174	24	1	0.008	1.00
	Wilks' Lambda	9,174	24	1	0.008	1.00
	Hotelling's Trace	9,174	24	1	0.008	1.00
	Roy's Largest Root	9,174	24	1	0.008	1.00
Area	Pillai's Trace	4.41	120	25	0.000	1.00
	Wilks' Lambda	22.5	120	10	0.000	1.00
	Hotelling's Trace	.	120	.	.	.
	Roy's Largest Root	35,181	24	5	0.000	1.00

Table G.20: Eigenvalues of Correspondence Analysis for benthic community from Quesnel Lake littoral areas, Mount Polley Mine, 2014.

Statistic	CA-1 (19.0 %)	CA-2 (16.3 %)	CA-3 (9.4 %)	CA-4 7.7 %)	CA-5 6.4 %)
Eigenvalue	0.298	0.255	0.147	0.121	0.101
Relative inertia (% variance explained)	19.0	16.3	9.36	7.69	6.42
Cumulative Inertia (cumulative % variance explained)	19.0	35.2	44.6	52.3	58.7

Table G.21: ANOVA results for supplementary measures from Quesnel Lake littoral areas, Mount Polley Mine, 2014.

		df	Mean Square	F-ratio	p-value
Station Depth (m)	Between Groups	5	0.147	6.23	0.001
	Within Groups	24	0.024		
	Total	29			
Bottom Temperature (°C)	Between Groups	5	78.0	174	0.000
	Within Groups	24	0.448		
	Total	29			
Bottom DO (% sat.)	Between Groups	5	662	14.5	0.000
	Within Groups	24	45.667		
	Total	29			
Bottom pH	Between Groups	5	1.02	22.4	0.000
	Within Groups	24	0.045		
	Total	29			
Bottom Conductance (µS/cm)	Between Groups	5	161	93.2	0.000
	Within Groups	24	1.723		
	Total	29			
Bottom TDS (mg/L)	Between Groups	4	11.5	19.6	0.000
	Within Groups	15	0.587		
	Total	19			
Surface Temperature (°C)	Between Groups	4	82.3	203	0.000
	Within Groups	20	0.406		
	Total	24			
Surface DO (% sat.)	Between Groups	4	413	12.2	0.000
	Within Groups	20	33.780		
	Total	24			
Surface pH	Between Groups	4	0.753	14.4	0.000
	Within Groups	20	0.052		
	Total	24			
Surface Conductance (µS/cm)	Between Groups	4	139	38.0	0.000
	Within Groups	20	3.664		
	Total	24			
Surface TDS (mg/L)	Between Groups	3	6.80	4.88	0.024
	Within Groups	10	1.395		
	Total	13			

Table G.22: Summary of benthic invertebrate community characteristics and statistical comparisons among Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014.

Metric	Overall 6-group ANOVA			6-group ANOVA Post-hoc Comparisons [a]				2-group ANOVA for Estimation of Effect Size		
	Significant Difference Among Areas?	p-value	Power	(I) Area	(J) Area	Significant Difference Among Areas?	p-value [b]	Power	Magnitude of Difference (# of SDs)[b]	Minimum Detectable Effect Size (# of SDs)[c]
Density (Individuals/m^2)	YES	0.000	1.000	PRef1	PRef2	YES	0.023	1.00	-3.3	~
				PRef1	PNF	YES	0.020	1.00	-3.6	~
				PRef1	PFF1	YES	0.020	1.00	-3.6	~
				PRef1	PFFF	YES	0.023	1.00	-3.4	~
				PRef1	PFF2	YES	0.019	1.00	-3.6	~
				PRef2	PNF	NO	0.199	0.975	~	1.6
				PRef2	PFF1	NO	0.179	0.984	~	1.5
				PRef2	PFFF	NO	0.977	0.345	~	1.8
				PRef2	PFF2	NO	0.159	0.991	~	1.5
				PNF	PFF1	NO	1.000	0.203	~	1.9
				PNF	PFFF	NO	0.123	0.987	~	5.1
				PNF	PFF2	NO	0.766	0.626	~	1.6
				PFF1	PFFF	NO	0.107	0.996	~	7.4
				PFF1	PFF2	NO	0.934	0.442	~	1.6
				PFFF	PFF2	YES	0.094	0.999	-2.3	~
Number of Taxa	YES	0.000	1.000	PRef1	PRef2	YES	0.005	1.00	-3.7	~
				PRef1	PNF	YES	0.017	0.999	-4.0	~
				PRef1	PFF1	YES	0.015	1.00	-4.6	~
				PRef1	PFFF	YES	0.034	0.991	-2.9	~
				PRef1	PFF2	YES	0.001	1.00	-5.8	~
				PRef2	PNF	NO	1.00	0.130	~	4.2
				PRef2	PFF1	NO	0.991	0.307	~	4.7
				PRef2	PFFF	NO	0.970	0.365	~	3.4
				PRef2	PFF2	YES	0.002	1.00	-4.0	~
				PNF	PFF1	NO	1.00	0.160	~	2.3
				PNF	PFFF	NO	0.973	0.346	~	1.9
				PNF	PFF2	NO	0.456	0.834	~	1.6
				PFF1	PFFF	NO	0.749	0.564	~	1.9
				PFF1	PFF2	NO	0.923	0.467	~	1.6
				PFFF	PFF2	YES	0.038	1.00	-2.7	~
Simpson's Diversity	YES	0.058	0.799	PRef1	PRef2	NO	1.00	0.210	~	1.9
				PRef1	PNF	NO	1.00	0.100	~	3.3
				PRef1	PFF1	NO	1.00	0.115	~	3.0
				PRef1	PFFF	NO	1.00	0.168	~	1.7
				PRef1	PFF2	NO	0.152	0.992	~	1.5
				PRef2	PNF	NO	1.00	0.149	~	4.4
				PRef2	PFF1	NO	1.00	0.109	~	3.9
				PRef2	PFFF	NO	0.678	0.605	~	1.9
				PRef2	PFF2	NO	0.132	0.995	~	1.5
				PNF	PFF1	NO	1.00	0.113	~	2.0
				PNF	PFFF	NO	1.00	0.116	~	1.6
				PNF	PFF2	NO	0.699	0.698	~	1.5
				PFF1	PFFF	NO	1.00	0.192	~	1.6
				PFF1	PFF2	NO	0.738	0.667	~	1.5
				PFFF	PFF2	YES	0.009	1.00	-4.4	~
Simpson's Evenness	YES	0.004	0.970	PRef1	PRef2	YES	0.001	1.00	6.4	~
				PRef1	PNF	YES	0.000	1.00	16.7	~
				PRef1	PFF1	NO	0.983	0.354	~	17.1
				PRef1	PFFF	YES	0.050	0.999	6.4	~
				PRef1	PFF2	NO	1.000	0.101	~	16.3
				PRef2	PNF	YES	0.002	1.00	7.5	~
				PRef2	PFF1	NO	1.00	0.101	~	12.5
				PRef2	PFFF	NO	1.00	0.100	~	3.3
				PRef2	PFF2	NO	0.977	0.371	~	11.9
				PNF	PFF1	NO	0.853	0.547	~	7.2
				PNF	PFFF	YES	0.003	1.000	-4.2	~
				PNF	PFF2	NO	0.267	0.942	~	6.9
				PFF1	PFFF	NO	1.000	0.101	~	1.6
				PFF1	PFF2	NO	0.997	0.258	~	2.1
				PFFF	PFF2	NO	0.978	0.363	~	6.4

Table G.22: Summary of benthic invertebrate community characteristics and statistical comparisons among Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014.

Metric	Overall 6-group ANOVA			6-group ANOVA Post-hoc Comparisons [a]				2-group ANOVA for Estimation of Effect Size		
	Significant Difference Among Areas?	p-value	Power	(I) Area	(J) Area	Significant Difference Among Areas?	p-value [b]	Power	Magnitude of Difference (# of SDs)[b]	Minimum Detectable Effect Size (# of SDs)[c]
Bray Curtis Index (PRef1)	YES	0.000	1.000	PRef1	PRef2	YES	0.004	1.00	5.3	~
				PRef1	PNF	YES	0.004	1.00	5.4	~
				PRef1	PFF1	YES	0.004	1.00	5.4	~
				PRef1	PFFF	YES	0.004	1.00	5.4	~
				PRef1	PFF2	YES	0.004	1.00	5.4	~
				PRef2	PNF	NO	0.635	0.698	~	n/a
				PRef2	PFF1	NO	0.579	0.723	~	n/a
				PRef2	PFFF	NO	0.976	0.341	~	n/a
				PRef2	PFF2	NO	0.331	0.931	~	n/a
				PNF	PFF1	NO	1.000	0.109	~	n/a
				PNF	PFFF	NO	0.998	0.252	~	n/a
				PNF	PFF2	NO	0.544	0.808	~	n/a
				PFF1	PFFF	NO	0.993	0.290	~	n/a
				PFF1	PFF2	NO	0.820	0.595	~	n/a
				PFFF	PFF2	NO	0.667	0.722	~	n/a
Bray Curtis Index (PRef2)	YES	0.000	1.000	PRef1	PRef2	YES	0.014	1.00	-112.5	~
				PRef1	PNF	NO	0.385	0.879	~	n/a
				PRef1	PFF1	NO	1.00	0.205	~	n/a
				PRef1	PFFF	YES	0.029	1.00	-75.9	~
				PRef1	PFF2	NO	1.00	0.101	~	10.1
				PRef2	PNF	YES	0.015	1.00	3.7	~
				PRef2	PFF1	YES	0.014	1.00	3.9	~
				PRef2	PFFF	NO	0.608	0.641	~	2.0
				PRef2	PFF2	YES	0.012	1.00	3.9	~
				PNF	PFF1	NO	0.648	0.634	~	2.3
				PNF	PFFF	YES	0.034	1.000	-16.0	~
				PNF	PFF2	NO	0.674	0.599	~	2.3
				PFF1	PFFF	YES	0.029	1.00	-26.9	~
				PFF1	PFF2	NO	1.000	0.121	~	3.6
				PFFF	PFF2	YES	0.024	1.00	3.2	~
Bray Curtis Index (PRef1,2)	YES	0.000	1.000	PRef1	PRef2	NO	0.210	0.970	~	1.6
				PRef1	PNF	YES	0.015	1.00	3.6	~
				PRef1	PFF1	YES	0.013	1.00	3.8	~
				PRef1	PFFF	NO	0.150	0.976	~	1.6
				PRef1	PFF2	YES	0.011	1.00	3.9	~
				PRef2	PNF	YES	0.000	1.00	9.9	~
				PRef2	PFF1	YES	0.000	1.000	10.9	~
				PRef2	PFFF	NO	1.00	0.162	~	n/a
				PRef2	PFF2	YES	0.000	1.00	11.4	~
				PNF	PFF1	NO	0.829	0.498	~	n/a
				PNF	PFFF	YES	0.001	1.00	-10.0	~
				PNF	PFF2	NO	0.516	0.691	~	n/a
				PFF1	PFFF	YES	0.001	1.000	-12.0	~
				PFF1	PFF2	NO	1.00	0.177	~	n/a
				PFFF	PFF2	YES	0.000	1.000	5.8	~
EPT (%)	YES	0.063	0.788	PRef1	PRef2	NO	0.960	0.416	~	1.6
				PRef1	PNF	NO	0.960	0.416	~	1.6
				PRef1	PFF1	NO	0.960	0.416	~	1.6
				PRef1	PFFF	NO	0.960	0.416	~	1.6
				PRef1	PFF2	NO	0.960	0.416	~	1.6
				PRef2	PNF	N/A	-	n/a	~	n/a
				PRef2	PFF1	N/A	-	n/a	~	n/a
				PRef2	PFFF	N/A	-	n/a	~	n/a
				PRef2	PFF2	N/A	-	n/a	~	n/a
				PNF	PFF1	N/A	-	n/a	~	n/a
				PNF	PFFF	N/A	-	n/a	~	n/a
				PNF	PFF2	N/A	-	n/a	~	n/a
				PFF1	PFFF	N/A	-	n/a	~	n/a
				PFF1	PFF2	N/A	-	n/a	~	n/a
				PFFF	PFF2	N/A	-	n/a	~	n/a

Table G.22: Summary of benthic invertebrate community characteristics and statistical comparisons among Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014.

Metric	Overall 6-group ANOVA			6-group ANOVA Post-hoc Comparisons [a]				2-group ANOVA for Estimation of Effect Size		
	Significant Difference Among Areas?	p-value	Power	(I) Area	(J) Area	Significant Difference Among Areas?	p-value [b]	Power	Magnitude of Difference (# of SDs)[b]	Minimum Detectable Effect Size (# of SDs)[c]
Ceratopogonidae (%)	NO	0.457	0.416	PRef1	PRef2	NO	0.311	0.940	~	1.5
				PRef1	PNF	NO	0.311	0.940	~	1.5
				PRef1	PFF1	NO	1.000	0.210	~	48.9
				PRef1	PFFF	NO	0.311	0.940	~	1.5
				PRef1	PFF2	NO	0.311	0.940	~	1.5
				PRef2	PNF	N/A	-	n/a	~	n/a
				PRef2	PFF1	NO	0.999	0.238	~	n/a
				PRef2	PFFF	N/A	-	n/a	~	n/a
				PRef2	PFF2	N/A	-	n/a	~	n/a
				PNF	PFF1	NO	0.999	0.238	~	n/a
				PNF	PFFF	N/A	-	n/a	~	n/a
				PNF	PFF2	N/A	-	n/a	~	n/a
				PFF1	PFFF	NO	0.999	0.238	~	1.5
				PFF1	PFF2	NO	0.999	0.238	~	1.5
				PFFF	PFF2	N/A	-	n/a	~	n/a
Chironomidae (%)	YES	0.003	0.980	PRef1	PRef2	NO	0.998	0.254	~	1.7
				PRef1	PNF	NO	0.989	0.314	~	3.9
				PRef1	PFF1	NO	0.172	0.917	~	2.7
				PRef1	PFFF	NO	0.982	0.346	~	1.6
				PRef1	PFF2	NO	0.566	0.724	~	3.9
				PRef2	PNF	NO	0.889	0.511	~	7.8
				PRef2	PFF1	YES	0.094	0.994	-6.8	~
				PRef2	PFFF	NO	1.000	0.128	~	1.8
				PRef2	PFF2	NO	0.392	0.881	~	7.8
				PNF	PFF1	NO	0.999	0.233	~	1.8
				PNF	PFFF	NO	0.853	0.556	~	1.5
				PNF	PFF2	NO	0.999	0.217	~	2.2
				PFF1	PFFF	YES	0.095	0.997	2.2	~
				PFF1	PFF2	NO	1.000	0.102	~	2.9
				PFFF	PFF2	NO	0.369	0.904	~	11.9
Acari (%)	YES	0.029	0.871	PRef1	PRef2	NO	0.735	0.669	~	109.3
				PRef1	PNF	NO	0.913	0.493	~	752.3
				PRef1	PFF1	NO	0.766	0.643	~	1057.8
				PRef1	PFFF	NO	0.900	0.510	~	188.1
				PRef1	PFF2	YES	0.003	1.00	-5.6	~
				PRef2	PNF	NO	0.977	0.370	~	10.7
				PRef2	PFF1	NO	0.854	0.557	~	14.9
				PRef2	PFFF	NO	1.000	0.127	~	3.1
				PRef2	PFF2	NO	0.663	0.725	~	1.5
				PNF	PFF1	NO	1.00	0.182	~	2.6
				PNF	PFFF	NO	0.990	0.321	~	1.6
				PNF	PFF2	NO	0.906	0.502	~	1.5
				PFF1	PFFF	NO	0.884	0.519	~	1.6
				PFF1	PFF2	NO	0.759	0.649	~	1.5
				PFFF	PFF2	NO	0.868	0.547	~	1.5
Bivalves (%)	YES	0.066	0.783	PRef1	PRef2	NO	1.00	0.201	~	13.0
				PRef1	PNF	NO	0.995	0.296	~	1.5
				PRef1	PFF1	NO	0.995	0.296	~	1.5
				PRef1	PFFF	NO	0.917	0.486	~	22.3
				PRef1	PFF2	NO	0.995	0.296	~	1.5
				PRef2	PNF	NO	0.999	0.238	~	1.5
				PRef2	PFF1	NO	0.999	0.238	~	1.5
				PRef2	PFFF	NO	0.996	0.264	~	3.1
				PRef2	PFF2	NO	0.999	0.238	~	1.5
				PNF	PFF1	N/A	-	n/a	~	n/a
				PNF	PFFF	NO	0.893	0.517	~	n/a
				PNF	PFF2	N/A	-	n/a	~	n/a
				PFF1	PFFF	NO	0.893	0.517	~	n/a
				PFF1	PFF2	N/A	-	n/a	~	n/a
				PFFF	PFF2	NO	0.893	0.517	~	1.5

Table G.22: Summary of benthic invertebrate community characteristics and statistical comparisons among Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014.

Metric	Overall 6-group ANOVA			6-group ANOVA Post-hoc Comparisons [a]				2-group ANOVA for Estimation of Effect Size		
	Significant Difference Among Areas?	p-value	Power	(I) Area	(J) Area	Significant Difference Among Areas?	p-value [b]	Power	Magnitude of Difference (# of SDs)[b]	Minimum Detectable Effect Size (# of SDs)[c]
Gastropods (%)	NO	0.439	0.426	PRef1	PRef2	N/A	-	n/a	~	n/a
				PRef1	PNF	NO	0.999	0.238	~	n/a
				PRef1	PFF1	N/A	-	n/a	~	n/a
				PRef1	PFFF	N/A	-	n/a	~	n/a
				PRef1	PFF2	N/A	-	n/a	~	n/a
				PRef2	PNF	NO	0.999	0.238	~	n/a
				PRef2	PFF1	N/A	-	n/a	~	n/a
				PRef2	PFFF	N/A	-	n/a	~	n/a
				PRef2	PFF2	N/A	-	n/a	~	n/a
				PNF	PFF1	NO	0.999	0.238	~	1.5
				PNF	PFFF	NO	0.999	0.238	~	1.5
				PNF	PFF2	NO	0.999	0.238	~	1.5
				PFF1	PFFF	N/A	-	n/a	~	n/a
				PFF1	PFF2	N/A	-	n/a	~	n/a
				PFFF	PFF2	N/A	-	n/a	~	n/a
Oligochaetes (%)	NO	0.151	0.657	PRef1	PRef2	NO	0.966	0.368	~	1.8
				PRef1	PNF	NO	1.00	0.100	~	3.9
				PRef1	PFF1	NO	0.443	0.870	~	1.5
				PRef1	PFFF	NO	0.633	0.721	~	1.6
				PRef1	PFF2	NO	0.443	0.870	~	1.5
				PRef2	PNF	NO	1.00	0.169	~	6.3
				PRef2	PFF1	NO	0.691	0.703	~	1.5
				PRef2	PFFF	NO	0.979	0.349	~	1.7
				PRef2	PFF2	NO	0.691	0.703	~	1.5
				PNF	PFF1	NO	0.988	0.336	~	1.5
				PNF	PFFF	NO	0.998	0.263	~	1.5
				PNF	PFF2	NO	0.988	0.336	~	1.5
				PFF1	PFFF	NO	0.736	0.668	~	n/a
				PFF1	PFF2	N/A	-	n/a	~	n/a
				PFFF	PFF2	NO	0.736	0.668	~	1.5
CA-1 (41.3 %)	YES	0.000	1.000	PRef1	PRef2	YES	0.000	1.00	-9.9	~
				PRef1	PNF	YES	0.001	0.982	-7.5	~
				PRef1	PFF1	NO	0.107	1.00	~	2.8
				PRef1	PFFF	YES	0.000	1.00	-9.5	~
				PRef1	PFF2	YES	0.003	0.957	-7.0	~
				PRef2	PNF	NO	1.00	0.334	~	8.3
				PRef2	PFF1	YES	0.049	1.000	7.0	~
				PRef2	PFFF	NO	1.00	0.146	~	3.3
				PRef2	PFF2	NO	1.00	0.424	~	8.5
				PNF	PFF1	NO	1.00	0.393	~	1.6
				PNF	PFFF	NO	1.00	0.252	~	1.6
				PNF	PFF2	NO	1.00	0.107	~	2.2
				PFF1	PFFF	YES	0.091	0.999	-3.2	~
				PFF1	PFF2	NO	1.00	0.284	~	4.5
				PFFF	PFF2	NO	1.00	0.330	~	4.7
CA-2 (18.6 %)	YES	0.008	0.952	PRef1	PRef2	NO	0.883	0.489	~	3.9
				PRef1	PNF	NO	0.798	0.610	~	13.1
				PRef1	PFF1	NO	0.558	0.792	~	14.2
				PRef1	PFFF	NO	1.00	0.151	~	5.3
				PRef1	PFF2	NO	1.00	0.120	~	3.7
				PRef2	PNF	NO	0.960	0.403	~	5.7
				PRef2	PFF1	NO	0.758	0.624	~	6.1
				PRef2	PFFF	NO	0.905	0.440	~	2.6
				PRef2	PFF2	NO	0.994	0.275	~	2.1
				PNF	PFF1	NO	1.00	0.144	~	2.3
				PNF	PFFF	NO	0.699	0.644	~	1.6
				PNF	PFF2	NO	0.839	0.555	~	1.6
				PFF1	PFFF	NO	0.454	0.810	~	1.6
				PFF1	PFF2	NO	0.589	0.751	~	1.6
				PFFF	PFF2	NO	1.00	0.179	~	1.8

Table G.22: Summary of benthic invertebrate community characteristics and statistical comparisons among Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014.

Metric	Overall 6-group ANOVA			6-group ANOVA Post-hoc Comparisons [a]				2-group ANOVA for Estimation of Effect Size		
	Significant Difference Among Areas?	p-value	Power	(I) Area	(J) Area	Significant Difference Among Areas?	p-value [b]	Power	Magnitude of Difference (# of SDs)[b]	Minimum Detectable Effect Size (# of SDs)[c]
CA-3 (16.8 %)	NO	0.119	0.697	PRef1	PRef2	NO	0.796	0.583	~	5.1
				PRef1	PNF	NO	1.00	0.143	~	11.6
				PRef1	PFF1	NO	0.695	0.623	~	3.3
				PRef1	PFFF	YES	0.025	0.996	2.7	~
				PRef1	PFF2	NO	1.00	0.171	~	2.6
				PRef2	PNF	NO	1.00	0.114	~	4.0
				PRef2	PFF1	NO	0.250	0.877	~	1.8
				PRef2	PFFF	NO	0.187	0.973	~	1.6
				PRef2	PFF2	NO	0.932	0.432	~	1.7
				PNF	PFF1	NO	0.996	0.277	~	1.6
				PNF	PFFF	NO	0.986	0.342	~	1.5
				PNF	PFF2	NO	1.00	0.121	~	1.6
				PFF1	PFFF	NO	1.00	0.159	~	1.7
				PFF1	PFF2	NO	0.470	0.732	~	1.9
				PFFF	PFF2	YES	0.045	0.995	-4.1	~

[a] Bonferroni post-hoc Test, or Tamhane's T2 Test where variances were found to be heterogenous by Levene's Test

[b] p-value obtained from post-hoc analysis of 1-way ANOVA among all areas (post-hoc analyses protected for multiple comparisons)

[c] Magnitude calculated by comparing the difference between the reference area (I) and exposure area (J) means to the reference area (I) standard deviation (SD) [(exposure mean - reference mean) / standard deviation of the reference mean]

[d] Minimum effect size detectable calculated based on variance as square root of MSE from ANOVA and alpha = beta = 0.10. Minimum effect size reported as the minimum number of standard deviations detectable based on reference area standard deviation.

Table G.23: Descriptive statistics of benthic metrics for Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014.

	Area Code	Mean	90% Confidence Interval for Mean		Median	Variance	Std. Deviation	Minimum	Maximum
			Lower Bound	Upper Bound					
Density (Ind./m2)	PRef1	5,840	4,290	7,390	5,783	2,643,989	1,626	3,895	7,808
	PRef2	422	220	625	459	45,017	212	190	684
	PNF	39.8	4.50	75.1	17	1,371	37.0	9	95
	PFF1	22.6	-1.33	46.5	26	630	25.1	0	61
	PFFF	275	163	388	346	13,833	118	139	381
	PFF2	3.40	-3.85	10.6	0	57.8	7.60	0	17
Number of Taxa	PRef1	7.80	6.56	9.04	8	1.70	1.30	6	9
	PRef2	3.00	2.33	3.67	3	0.500	0.707	2	4
	PNF	2.60	0.870	4.33	2	3.30	1.82	1	5
	PFF1	1.80	-0.150	3.75	2	4.20	2.05	0	5
	PFFF	4.00	2.65	5.35	3	2.00	1.41	3	6
	PFF2	0.200	-0.230	0.630	0	0.200	0.447	0	1
Simpson's D	PRef1	0.379	0.199	0.559	0.448	0.036	0.189	0.052	0.534
	PRef2	0.287	0.156	0.417	0.268	0.019	0.137	0.140	0.512
	PNF	0.389	0.039	0.740	0.500	0.135	0.368	0.000	0.753
	PFF1	0.325	0.020	0.629	0.444	0.102	0.319	0.000	0.735
	PFFF	0.446	0.349	0.543	0.422	0.010	0.102	0.360	0.607
Simpson's E	PRef1	0.219	0.179	0.259	0.207	0.002	0.042	0.176	0.268
	PRef2	0.489	0.434	0.545	0.458	0.003	0.058	0.440	0.581
	PNF	0.925	0.828	1.02	1.00	0.010	0.102	0.810	1.00
	PFF1	0.511	0.063	0.959	0.754	0.221	0.470	0.000	0.900
	PFFF	0.490	0.385	0.596	0.521	0.012	0.111	0.346	0.637
	PFF2	0.200	-0.226	0.626	0.000	0.200	0.447	0.000	1.000
BC(PRef1)	PRef1	0.198	0.057	0.338	0.133	0.022	0.148	0.061	0.366
	PRef2	0.984	0.974	0.994	0.988	0.000	0.011	0.972	0.997
	PNF	0.996	0.992	0.999	0.997	0.000	0.004	0.991	1.00
	PFF1	0.996	0.992	1.00	0.997	0.000	0.004	0.991	1.00
	PFFF	0.992	0.984	0.999	0.994	0.000	0.008	0.982	1.00
BC(PRef2)	PRef1	0.987	0.981	0.994	0.986	0.000	0.007	0.980	0.998
	PRef2	0.226	0.040	0.412	0.188	0.038	0.195	0.009	0.473
	PNF	0.945	0.917	0.973	0.964	0.001	0.029	0.902	0.969
	PFF1	0.979	0.961	0.997	0.967	0.000	0.019	0.965	1.000
	PFFF	0.474	0.321	0.626	0.468	0.026	0.160	0.306	0.657
	PFF2	0.986	0.955	1.02	1.00	0.001	0.032	0.929	1.00
BC(PRef1,2)	PRef1	0.706	0.636	0.776	0.713	0.005	0.074	0.606	0.790
	PRef2	0.836	0.823	0.850	0.832	0.000	0.014	0.824	0.855
	PNF	0.973	0.961	0.986	0.978	0.000	0.013	0.954	0.984
	PFF1	0.987	0.976	0.999	0.984	0.000	0.012	0.976	1.00
	PFFF	0.845	0.821	0.869	0.842	0.001	0.025	0.816	0.884
	PFF2	0.994	0.980	1.01	1.00	0.000	0.014	0.968	1.000
EPT (%)	PRef1	0.097	-0.035	0.230	0.000	0.019	0.139	0.000	0.299
Ceratopogonidae (%)	PRef1	0.6	0.2	1.0	0.7	0.2	0.4	0.2	1.2
	PFF1	5.7	-6.5	17.9	0.0	163	12.8	0.0	28.6
Chironomidae (%)	PRef1	73.3	55.2	91.4	73.7	360	19.0	44.9	97.8
	PRef2	83.2	74.7	91.8	84.6	79.8	8.9	68.4	92.5
	PNF	46.0	3.37	88.6	57.1	1,997	44.7	0.0	100
	PFF1	22.9	-3.9	49.6	14.3	787	28.1	0.0	66.7
	PFFF	85.3	79.8	90.9	82.9	33.6	5.8	80.0	94.4
	PFF2	20.0	-22.6	62.6	0.0	2,000	44.7	0.0	100

Table G.23: Descriptive statistics of benthic metrics for Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014.

	Area Code	Mean	90% Confidence Interval for Mean		Median	Variance	Std. Deviation	Minimum	Maximum
			Lower Bound	Upper Bound					
Acari (%)	PRef1	0.2	0.2	0.3	0.2	0.0	0.0	0.2	0.3
	PRef2	3.3	0.4	6.1	2.5	8.8	3.0	0.0	7.7
	PNF	16.5	-3.0	36.0	14.3	419	20.5	0.0	50.0
	PFF1	28.6	1.1	56.0	33.3	828	28.8	0.0	66.7
	PFFF	4.4	-0.5	9.3	4.5	26.2	5.1	0.0	12.5
Bivalves (%)	PRef1	0.3	-0.2	0.7	0.0	0.2	0.5	0.0	1.1
	PRef2	1.8	-2.1	5.7	0.0	16.5	4.1	0.0	9.1
	PFFF	5.8	-0.9	12.5	5.0	49.0	7.0	0.0	17.1
Gastropods (%)	PNF	10.0	-11.3	31.3	0.0	500	22.4	0.0	50.0
Oligochaetes (%)	PRef1	25.5	7.6	43.3	25.0	350	18.7	1.3	53.6
	PRef2	11.7	1.2	22.1	7.7	120	10.9	0.0	29.1
	PNF	25.7	-15.6	67.0	0.0	1,878	43.3	0.0	100
	PFFF	4.5	0.3	8.7	5.6	19.3	4.4	0.0	10.0
CA-1 (41.3 %)	PRef1	0.807	0.657	0.957	0.735	0.025	0.157	0.678	1.06
	PRef2	-0.752	-0.864	-0.640	-0.688	0.014	0.118	-0.886	-0.629
	PNF	-0.377	-0.971	0.217	-0.071	0.388	0.623	-1.44	0.053
	PFF1	0.068	-0.156	0.292	0.000	0.055	0.235	-0.071	0.483
	PFFF	-0.688	-0.901	-0.474	-0.689	0.050	0.224	-0.964	-0.436
	PFF2	-0.288	-0.902	0.326	0.000	0.415	0.644	-1.44	0.000
CA-2 (18.6 %)	PRef1	0.154	0.048	0.261	0.178	0.012	0.112	0.034	0.284
	PRef2	-0.073	-0.327	0.180	-0.211	0.071	0.266	-0.360	0.219
	PNF	-0.744	-1.65	0.159	-0.829	0.896	0.947	-2.02	0.547
	PFF1	-1.09	-2.072	-0.113	-1.42	1.06	1.03	-2.02	0.000
	PFFF	0.257	-0.093	0.606	0.241	0.134	0.366	-0.271	0.711
	PFF2	0.109	-0.124	0.342	0.000	0.060	0.244	0.000	0.547
CA-3 (16.8 %)	PRef1	-0.012	-0.165	0.141	0.007	0.026	0.160	-0.255	0.161
	PRef2	-0.492	-0.972	-0.011	-0.580	0.254	0.504	-1.03	0.289
	PNF	-0.310	-1.46	0.840	-0.485	1.46	1.21	-1.95	1.09
	PFF1	0.324	0.027	0.620	0.381	0.097	0.311	0.000	0.619
	PFFF	0.421	0.301	0.540	0.414	0.016	0.125	0.295	0.579
	PFF2	-0.097	-0.304	0.110	0.000	0.047	0.217	-0.485	0.000

Table G.24: Benthic metrics and supporting measures data, Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014.

Station	Area	Area Code	Exposure	Density (Ind./m2)	Number of Taxa	Simpson's D	Simpson's E	BC(PRef1)	BC(PRef2)	BC(PRef1,2)	EPT (%)	Ceratopogonidae (%)	Chironomidae (%)
PNF-1	PNF	PNF	QULP Exp.	17	2	0.500	1.00	0.997	0.964	0.984	0.0	0.0	0.0
PNF-2	PNF	PNF	QULP Exp.	17	1	0.000	1.00	1.00	0.929	0.968	0.0	0.0	100
PNF-3	PNF	PNF	QULP Exp.	61	4	0.694	0.817	0.991	0.902	0.954	0.0	0.0	57.1
PNF-4	PNF	PNF	QULP Exp.	9	1	0.000	1.00	0.997	0.964	0.984	0.0	0.0	0.0
PNF-5	PNF	PNF	QULP Exp.	95	5	0.753	0.810	0.994	0.969	0.978	0.0	0.0	72.7
PFF1-1	PFF1	PFF1	QULP Exp.	61	5	0.735	0.754	0.991	0.967	0.977	0.0	28.6	14.3
PFF1-2	PFF1	PFF1	QULP Exp.	26	2	0.444	0.900	0.997	0.965	0.984	0.0	0.0	66.7
PFF1-3	PFF1	PFF1	QULP Exp.	26	2	0.444	0.900	0.994	0.965	0.976	0.0	0.0	33.3
PFF1-4	PFF1	PFF1	QULP Exp.	0	0	0.000	0.000	1.00	1.00	1.00	0.0	0.0	0.0
PFF1-5	PFF1	PFF1	QULP Exp.	0	0	0.000	0.000	1.00	1.00	1.00	0.0	0.0	0.0
PFFF-1	PFFF	PFFF	QULP Exp.	346	6	0.607	0.424	0.982	0.468	0.816	0.0	0.0	80.0
PFFF-2	PFFF	PFFF	QULP Exp.	156	3	0.364	0.524	0.997	0.611	0.851	0.0	0.0	94.4
PFFF-3	PFFF	PFFF	QULP Exp.	355	3	0.360	0.521	1.000	0.327	0.884	0.0	0.0	82.9
PFFF-4	PFFF	PFFF	QULP Exp.	139	3	0.477	0.637	0.994	0.657	0.842	0.0	0.0	87.5
PFFF-5	PFFF	PFFF	QULP Exp.	381	5	0.422	0.346	0.985	0.306	0.832	0.0	0.0	81.8
PFF2-1	PFF2	PFF2	QULP Exp.	0	0	0.000	0.000	1.00	1.000	1.000	0.0	0.0	0.0
PFF2-2	PFF2	PFF2	QULP Exp.	17	1	0.000	1.000	1.00	0.929	0.968	0.0	0.0	100
PFF2-3	PFF2	PFF2	QULP Exp.	0	0	0.000	0.000	1.00	1.00	1.00	0.0	0.0	0.0
PFF2-4	PFF2	PFF2	QULP Exp.	0	0	0.000	0.000	1.00	1.00	1.00	0.0	0.0	0.0
PFF2-5	PFF2	PFF2	QULP Exp.	0	0	0.000	0.000	1.00	1.00	1.00	0.0	0.0	0.0
PRef1-1	PRef1	PRef1	QULP Ref.	5,783	7	0.448	0.259	0.061	0.986	0.713	0.3	0.3	78.7
PRef1-2	PRef1	PRef1	QULP Ref.	7,808	6	0.052	0.176	0.348	0.998	0.790	0.0	0.7	97.8
PRef1-3	PRef1	PRef1	QULP Ref.	7,064	9	0.462	0.207	0.133	0.989	0.758	0.0	1.2	71.3
PRef1-4	PRef1	PRef1	QULP Ref.	4,649	9	0.400	0.185	0.081	0.983	0.664	0.2	0.7	73.7
PRef1-5	PRef1	PRef1	QULP Ref.	3,895	8	0.534	0.268	0.366	0.980	0.606	0.0	0.2	44.9
PRef2-1	PRef2	PRef2	QULP Ref.	684	4	0.512	0.512	0.972	0.188	0.832	0.0	0.0	68.4
PRef2-2	PRef2	PRef2	QULP Ref.	190	3	0.242	0.440	0.997	0.473	0.855	0.0	0.0	86.4
PRef2-3	PRef2	PRef2	QULP Ref.	459	2	0.140	0.581	0.988	0.009	0.847	0.0	0.0	92.5
PRef2-4	PRef2	PRef2	QULP Ref.	554	3	0.268	0.455	0.974	0.085	0.824	0.0	0.0	84.4
PRef2-5	PRef2	PRef2	QULP Ref.	225	3	0.272	0.458	0.988	0.375	0.826	0.0	0.0	84.6

Table G.24: Benthic metrics and supporting measures data, Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014.

Station	Area	Area Code	Exposure	Acari (%)	Bivalves (%)	Gastropods (%)	Oligochaetes (%)	CA-1 (41.3 %)	CA-2 (18.6 %)	CA-3 (16.8 %)	Sediment PC-1	Sediment PC-2
PNF-1	PNF	PNF	QULP Exp.	50.0	0.0	50.0	0.0	-0.071	-2.02	0.619	-1.89	4.44
PNF-2	PNF	PNF	QULP Exp.	0.0	0.0	0.0	0.0	-1.44	0.547	-0.485	-1.13	6.60
PNF-3	PNF	PNF	QULP Exp.	14.3	0.0	0.0	28.6	-0.002	-1.08	-0.825	-2.51	3.28
PNF-4	PNF	PNF	QULP Exp.	0.0	0.0	0.0	100	0.053	-0.337	-1.951	-3.92	1.00
PNF-5	PNF	PNF	QULP Exp.	18.2	0.0	0.0	0.0	-0.426	-0.829	1.09	-3.74	0.18
PFF1-1	PFF1	PFF1	QULP Exp.	42.9	0.0	0.0	0.0	0.483	-1.416	0.381	0.95	3.65
PFF1-2	PFF1	PFF1	QULP Exp.	33.3	0.0	0.0	0.0	-0.071	-2.02	0.619	-3.54	-0.32
PFF1-3	PFF1	PFF1	QULP Exp.	66.7	0.0	0.0	0.0	-0.071	-2.02	0.619	-2.98	0.70
PFF1-4	PFF1	PFF1	QULP Exp.	0.0	0.0	0.0	0.0	0.000	0.000	0.000	-4.13	-0.12
PFF1-5	PFF1	PFF1	QULP Exp.	0.0	0.0	0.0	0.0	0.000	0.000	0.000	-4.11	0.20
PFFF-1	PFFF	PFFF	QULP Exp.	5.0	5.0	0.0	10.0	-0.436	0.147	0.295	6.26	1.75
PFFF-2	PFFF	PFFF	QULP Exp.	0.0	0.0	0.0	5.6	-0.689	0.455	0.304	6.01	2.44
PFFF-3	PFFF	PFFF	QULP Exp.	0.0	17.1	0.0	0.0	-0.964	0.711	0.579	6.07	1.50
PFFF-4	PFFF	PFFF	QULP Exp.	12.5	0.0	0.0	0.0	-0.848	-0.271	0.414	5.78	1.57
PFFF-5	PFFF	PFFF	QULP Exp.	4.5	6.8	0.0	6.8	-0.501	0.241	0.511	6.09	1.60
PFF2-1	PFF2	PFF2	QULP Exp.	0.0	0.0	0.0	0.0	0.000	0.000	0.000	-2.37	2.10
PFF2-2	PFF2	PFF2	QULP Exp.	0.0	0.0	0.0	0.0	-1.44	0.547	-0.485	-1.80	2.41
PFF2-3	PFF2	PFF2	QULP Exp.	0.0	0.0	0.0	0.0	0.000	0.000	0.000	-4.36	0.24
PFF2-4	PFF2	PFF2	QULP Exp.	0.0	0.0	0.0	0.0	0.000	0.000	0.000	-3.07	1.75
PFF2-5	PFF2	PFF2	QULP Exp.	0.0	0.0	0.0	0.0	0.000	0.000	0.000	-3.46	2.06
PRef1-1	PRef1	PRef1	QULP Ref.	0.3	0.0	0.0	20.4	0.865	0.034	-0.255	-2.47	-5.77
PRef1-2	PRef1	PRef1	QULP Ref.	0.2	0.0	0.0	1.3	1.06	0.178	0.161	-2.30	-5.53
PRef1-3	PRef1	PRef1	QULP Ref.	0.2	0.0	0.0	27.2	0.735	0.045	-0.065	-1.62	-4.49
PRef1-4	PRef1	PRef1	QULP Ref.	0.2	0.2	0.0	25.0	0.678	0.231	0.094	-1.38	-4.41
PRef1-5	PRef1	PRef1	QULP Ref.	0.2	1.1	0.0	53.6	0.700	0.284	0.007	-1.51	-4.40
PRef2-1	PRef2	PRef2	QULP Ref.	2.5	0.0	0.0	29.1	-0.629	-0.215	-0.347	4.09	-1.99
PRef2-2	PRef2	PRef2	QULP Ref.	4.5	9.1	0.0	0.0	-0.871	0.201	0.289	4.60	-2.27
PRef2-3	PRef2	PRef2	QULP Ref.	0.0	0.0	0.0	7.5	-0.886	0.219	-1.03	4.85	-2.29
PRef2-4	PRef2	PRef2	QULP Ref.	1.6	0.0	0.0	14.1	-0.687	-0.211	-0.790	2.99	-3.64
PRef2-5	PRef2	PRef2	QULP Ref.	7.7	0.0	0.0	7.7	-0.688	-0.360	-0.580	4.62	-2.26

Table G.24: Benthic metrics and supporting measures data, Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014.

Station	Area	Area Code	Exposure	Station Depth (m)	Bottom Temperature (°C)	Bottom DO (mg/L)	Bottom DO (% sat.)	Bottom pH	Bottom Conductance (µS/cm)	Bottom Turbidity (NTU)	Bottom TDS (mg/L)
PNF-1	PNF	PNF	QULP Exp.	106	6.72	6.42	52.5	8.00	169	90.0	110
PNF-2	PNF	PNF	QULP Exp.	109	6.86	6.12	50.3	8.06	167	94.4	109
PNF-3	PNF	PNF	QULP Exp.	104	7.04	5.24	43.8	8.06	172	126	112
PNF-4	PNF	PNF	QULP Exp.	104	7.09	5.13	42.7	8.09	176	137	1.50
PNF-5	PNF	PNF	QULP Exp.	107	6.99	7.21	59.2	8.15	157	111	102
PFF1-1	PFF1	PFF1	QULP Exp.	95.5	6.68	5.86	47.9	7.91	169	85.2	110
PFF1-2	PFF1	PFF1	QULP Exp.	85.1	6.62	6.79	55.4	8.04	161	70.8	104
PFF1-3	PFF1	PFF1	QULP Exp.	95.8	6.65	5.99	49.0	8.02	167	90.3	108
PFF1-4	PFF1	PFF1	QULP Exp.	93.8	6.66	5.96	48.7	7.90	168	90.2	109
PFF1-5	PFF1	PFF1	QULP Exp.	90.5	6.63	6.33	51.6	7.91	165	95.5	107
PFFF-1	PFFF	PFFF	QULP Exp.	52.1	6.10	8.21	66.2	7.55	104	30.2	
PFFF-2	PFFF	PFFF	QULP Exp.	58.1	6.07	8.26	66.5	7.44	103	28.4	
PFFF-3	PFFF	PFFF	QULP Exp.	48.0	6.08	8.27	66.6	7.51	103	29.1	
PFFF-4	PFFF	PFFF	QULP Exp.	50.4	6.05	8.51	68.5	7.51	101	27.8	
PFFF-5	PFFF	PFFF	QULP Exp.	57.7	6.12	8.10	65.2	7.86	120	27.9	78.0
PFF2-1	PFF2	PFF2	QULP Exp.	94.0	6.53	0.63	5.20	8.09	203	222	132
PFF2-2	PFF2	PFF2	QULP Exp.	94.2	6.63	5.80	47.3	7.84	136	83.4	
PFF2-3	PFF2	PFF2	QULP Exp.	91.4	6.55	5.77	46.9	4.52	161	44.7	105
PFF2-4	PFF2	PFF2	QULP Exp.	92.0	6.43	6.55	53.1	7.63	154	42.3	100
PFF2-5	PFF2	PFF2	QULP Exp.	91.1	6.49	6.27	51.0	7.65	157	48.9	102
PRef1-1	PRef1	PRef1	QULP Ref.	115	4.61	10.8	83.8	7.71	116	7.30	75.0
PRef1-2	PRef1	PRef1	QULP Ref.	108	4.61	2.14	14.9	7.71	119	10.5	77.0
PRef1-3	PRef1	PRef1	QULP Ref.	117	4.48	10.8	83.8	7.48	117	6.50	76.0
PRef1-4	PRef1	PRef1	QULP Ref.	107	4.63	10.5	81.3	7.52	118	8.31	77.0
PRef1-5	PRef1	PRef1	QULP Ref.	103	4.57	10.8	83.5	7.61	115	7.48	75.0
PRef2-1	PRef2	PRef2	QULP Ref.	90.5	3.84	10.5	80.1	7.39	115	-0.070	75.0
PRef2-2	PRef2	PRef2	QULP Ref.	99.4	3.84	10.4	79.0	7.06	115	-0.500	75.0
PRef2-3	PRef2	PRef2	QULP Ref.	90.8	3.86	10.6	80.8	7.61	115	1.43	75.0
PRef2-4	PRef2	PRef2	QULP Ref.	90.2	3.83	10.5	80.1	7.40	115	-0.100	75.0
PRef2-5	PRef2	PRef2	QULP Ref.	93.9	3.19	10.6	80.4	6.97	115	-0.060	74.0

Table G.24: Benthic metrics and supporting measures data, Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014.

Station	Area	Area Code	Exposure	Surface Temperature (°C)	Surface DO (mg/L)	Surface DO (% sat.)	Surface pH	Surface Conductance (µS/cm)	Surface Turbidity (NTU)	Surface TDS (mg/L)
PNF-1	PNF	PNF	QULP Exp.	15.5	9.36	93.9	8.08	104	1.33	67.0
PNF-2	PNF	PNF	QULP Exp.	13.2	9.77	93.3	7.89	105	1.97	68.0
PNF-3	PNF	PNF	QULP Exp.	11.8	9.87	91.2	7.98	104	1.47	68.0
PNF-4	PNF	PNF	QULP Exp.	13.9	9.62	93.1	7.89	105	0.200	68.0
PNF-5	PNF	PNF	QULP Exp.	14.6	9.62	94.6	8.14	105	0.270	68.0
PFF1-1	PFF1	PFF1	QULP Exp.	14.8	9.53	94.1	8.11	104	0.360	67.0
PFF1-2	PFF1	PFF1	QULP Exp.	15.6	9.47	95.2	8.16	104	0.250	67.0
PFF1-3	PFF1	PFF1	QULP Exp.	15.7	9.42	94.9	8.16	104	0.330	67.0
PFF1-4	PFF1	PFF1	QULP Exp.	15.1	9.50	94.4	8.02	104	0.470	67.0
PFF1-5	PFF1	PFF1	QULP Exp.	15.8	9.49	95.0	8.07	104	0.400	68.0
PFFF-1	PFFF	PFFF	QULP Exp.	12.3	9.72	90.9	7.63	79.9	0.490	
PFFF-2	PFFF	PFFF	QULP Exp.	12.4	9.71	90.8	7.78	80.0	0.590	
PFFF-3	PFFF	PFFF	QULP Exp.	12.4	9.72	91.0	7.77	79.9	0.830	
PFFF-4	PFFF	PFFF	QULP Exp.	12.4	9.74	91.1	7.81	80.0	1.79	
PFFF-5	PFFF	PFFF	QULP Exp.	12.3	9.77	91.2		94.1	0.640	61.0
PFF2-1	PFF2	PFF2	QULP Exp.	13.1	9.74	92.7	7.90	90.6	1.14	59.0
PFF2-2	PFF2	PFF2	QULP Exp.	13.3	9.69	92.6	8.07	90.1	1.84	
PFF2-3	PFF2	PFF2	QULP Exp.	11.3	9.86	90.0	7.77	111	1.81	72.0
PFF2-4	PFF2	PFF2	QULP Exp.	11.3	9.92	90.7	7.82	111	1.76	72.0
PFF2-5	PFF2	PFF2	QULP Exp.	11.3	9.96	91.1	7.82	111	4.02	72.0
PRef1-1	PRef1	PRef1	QULP Ref.	15.2	9.51	94.7	8.04	105	0.330	68.0
PRef1-2	PRef1	PRef1	QULP Ref.	14.9	9.68	95.7	8.09	106	0.160	69.0
PRef1-3	PRef1	PRef1	QULP Ref.	15.1	9.50	94.4	7.92	107	0.340	70.0
PRef1-4	PRef1	PRef1	QULP Ref.	15.0	9.47	94.0	7.89	106	0.390	69.0
PRef1-5	PRef1	PRef1	QULP Ref.	15.2	9.51	94.8	7.98	105	0.390	68.0
PRef2-1	PRef2	PRef2	QULP Ref.	11.4	10.1	92.2	7.72	110	0.020	71.0
PRef2-2	PRef2	PRef2	QULP Ref.	11.2	10.1	92.1	7.66	109	0.000	71.0
PRef2-3	PRef2	PRef2	QULP Ref.	11.3	10.1	92.0	7.80	109	0.030	71.0
PRef2-4	PRef2	PRef2	QULP Ref.	11.5	10.1	92.2	7.71	110	0.020	71.0
PRef2-5	PRef2	PRef2	QULP Ref.	10.6	10.2	91.4	7.27	111	0.160	72.0

Table G.25: Correspondence Analysis scores for benthic taxa from Quesnel Lake profundal sampling stations, Mount Polley Mine, 2014.

Taxon	CA -1 (41.3 %)	CA-2 (18.6 %)	CA-3 (16.8 %)	CA-4 (9.3 %)	CA-5 (7.3 %)
Bezzia/ Palpomyia	0.953	-0.265	0.017	0.192	-0.129
Phaenopsectra	1.099	0.305	-0.022	0.057	0.295
Heterotrissocladius sp.	-1.065	0.271	-0.229	0.171	0.305
Procladius	-0.528	0.071	0.698	-0.852	-0.081
Class: Arachnida	-0.053	-1.003	0.292	0.207	0.053
Family: Pisidiidae, incl. Pisidium, Sphaerium sp.	-0.364	0.663	0.659	0.646	-0.790
Family: Lumbriculidae, incl. Stylodrilus herangiansus	0.039	-0.167	-0.920	-0.238	-0.395
Family: Tubificidae	0.694	0.355	0.128	-0.063	0.062

Table G.26: Eigenvalues of Correspondence Analysis for benthic community at Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014.

Statistic	CA -1 (41.3 %)	CA-2 (18.6 %)	CA-3 (16.8 %)	CA-4 (9.3 %)	CA-5 (7.3 %)
Eigenvalue	0.55	0.25	0.22	0.12	0.10
Relative inertia (% variance explained)	41.3	18.6	16.8	9.26	7.25
Cumulative Inertia (cumulative % variance explained)	41.3	59.8	76.6	85.9	93.1

Table G.27: MANOVA statistics for benthic metrics at Quesnel Lake Profundal sampling areas, Mount Polley Mine, 2014.

Effect	Statistic	F-ratio	Hypothesis df	Error df	p-value	Power
Intercept	Pillai's Trace	191,516	19	6	0.000	1.00
	Wilks' Lambda	191,516	19	6	0.000	1.00
	Hotelling's Trace	191,516	19	6	0.000	1.00
	Roy's Largest Root	191,516	19	6	0.000	1.00
Area	Pillai's Trace	2.04	95	50	0.003	1.00
	Wilks' Lambda	17.3	95	34	0.000	1.00
	Hotelling's Trace	948	95	22	0.000	1.00
	Roy's Largest Root	10,657	19	10	0.000	1.00

Table G.28: ANOVA results for supplementary measures at Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014.

Source	Dependent Variable	Mean Square	F-ratio	p-value	Power
	Station Depth (m)	364	23.2	0.000	1.00
	Bottom Temperature (°C)	10.2	418	0.000	1.00
	Bottom DO (mg/L)	26.5	5.84	0.003	0.945
	Bottom DO (% sat.)	1,287	4.45	0.010	0.863
	Bottom pH	0.95	2.13	0.117	0.519
	Bottom Conductance (µS/cm	3,891	40.1	0.000	1.00
	Bottom Turbidity (NTU)	12,909	9.66	0.000	0.997
	Bottom TDS (mg/L)	1,323	2.55	0.073	0.604
	Surface Temperature (°C)	17.4	28.4	0.000	1.00
	Surface DO (mg/L)	0.32	27.5	0.000	1.00
	Surface DO (% sat.)	11.9	17.1	0.000	1.00
	Surface pH	0.17	11.5	0.000	0.999
	Surface Conductance (µS/cm)	25.1	1.46	0.254	0.365
	Turbidity (NTU)	3.20	8.33	0.000	0.991
	TDS (mg/L)	11.6	1.68	0.197	0.417

Table G.29: Benthic invertebrate abundance at reference river sampling areas (# per 1-minute kick sample) lowest practical level of taxonomic resolution, Mount Polley, 2014.

Area	Clearwater River			Cariboo River		
Site Code	CLR	CLR	CLR	CAR	CAR	CAR
Replicate	1	2	3	1	2	3
| Class: Insecta						
| Order: Ephemeroptera						
| Family: Ameletidae						
Ameletus	5	7	18	4	6	4
| Family: Baetidae	3	2			2	
Baetis	1					
Baetis bicaudatus	4	2				
| Family: Ephemerellidae	42	8	2	83	135	137
Drunella sp.						
Drunella spinifera						
Ephemerella	12			2	21	7
Ephemerella velmae						
| Family: Heptageniidae	6		1	25	28	16
Heptagenia						
Rhithrogena						
| Family: Leptophlebiidae	1					
Leptophlebia sp.	1					
Paraleptophlebia						
| Order: Plecoptera	1				3	
| Family: Capniidae	5	2		10	8	4
Capnia sp.				1		1
| Family: Chloroperlidae				7	2	1
Suwallia						
Sweltsa sp.	3	1		20	20	11
| Family: Nemouridae						
Zapada						
Zapada cinctipes						
| Family: Perlidae						
Claassenia sp.						
Doroneuria sp.				2		
Hesperoperla sp.						
| Family: Perlodidae				1	2	
Diura sp.						
Skwala				2		7
| Family: Pteronarcyidae						
Pteronarcys					2	1
| Family: Taeniopterygidae						
| Order: Trichoptera				2		2
| Family: Brachycentridae						
Brachycentrus sp.					1	
| Family: Glossosomatidae				1		
Glossosoma						
| Family: Hydropsychidae						
Cheumatopsyche						
Hydropsyche						
| Family: Hydroptilidae						
Hydroptila					1	3
| Family: Lepidostomatidae						
Lepidostoma			1	2	10	4
| Family: Leptoceridae						
| Family: Limnephilidae	5					
| Order: Coleoptera	1					
| Family: Dytiscidae						
Hydroporus sp.						1
Laccornis sp.						
Oreodytes sp.				1		
| Family: Elmidae						
Heterlimnius sp.			1			
Optioservus sp.	1			1		
Zaitzevia sp.						
| Order: Diptera			1			
| Family: Athericidae						
Atherix						
| Family: Chironomidae						
| Subfamily: Chironominae						
| Tribe: Chironomini						
Cryptochironomus						
Harnischia sp.						
Microtendipes pedellus						1
Parachironomus						
Paracladopelma sp.						
Phaenopsectra						
Polypedilum sp.						
| Tribe: Tanytarsini						
Micropsectra	9	1		28	3	2
Rheotanytarsus				3		
Stempellina sp.						

Table G.29: Benthic invertebrate abundance at reference river sampling areas (# per 1-minute kick sample) lowest practical level of taxonomic resolution, Mount Polley, 2014.

Area	Clearwater River			Cariboo River		
Site Code	CLR	CLR	CLR	CAR	CAR	CAR
Replicate	1	2	3	1	2	3
Tanytarsus						
| Subfamily: Diamesinae						
| Tribe: Diamesini						
Pagastia						
Potthastia longimana group						
Pseudodiamesa sp.						
| Subfamily: Orthocladiinae						
Eukiefferiella						
Heterotrissocladius sp.		1			4	
Nanocladius					16	12
Orthocladius sp.	7			8	15	38
Parachaetocladius sp.						3
Parakiefferiella				6		
Parametriocnemus					4	
Paraphaenocladius sp.				1		
Rheocricotopus		1		2		2
Tvetenia						
| Tribe: Pentaneuriini						
Thienemannimyia group	1	1	1	4	3	1
| Family: Empididae						
Hemerodromia sp.	1					
Neoplasta sp.		1				
Oreogeton sp.						
Roederiodes sp				5	6	2
| Family: Simuliidae						
Simulium			1			
| Family: Tipulidae				1	1	1
Antocha sp.						
| Order: Lepidoptera		3				
Subphylum: Chelicerata						
| Class: Arachnida						
| Family: Hygrobatidae						
Hygrobates		2	6	2		1
| Family: Lebertiidae						
Lebertia						6
| Family: Sperchontidae						
Sperchon				7	2	19
| Family: Torrenticolidae						
Testudacarus sp.						13
Torrenticola	3		1		1	
Phylum: Mollusca						
| Class: Bivalvia						
| Order: Veneroida						
| Family: Pisidiidae						
Pisidium	1					
| Class: Gastropoda						
| Order: Basommatophora						
| Family: Lymnaeidae						
Lymnaea sp.		2	16			
| Family: Planorbidae						
Gyraulus		1				
| Order: Heterostropha						
| Family: Valvatidae						
Valvata sincera	1					
| Class: Oligochaeta						
| Order: Lumbriculida						
| Family: Lumbriculidae		3	1			1
| Order: Tubificida						
| Family: Enchytraeidae						
Enchytraeus						
| Family: Naididae		2			9	
Nais						
Slavina appendiculata	4			7		9
Phylum: Cnidaria						
| Class: Hydrozoa						
| Order: Anthoathecatae						
| Family: Hydridae						
Hydra						
Totals:	**118**	**40**	**50**	**238**	**305**	**310**

Table G.30: Benthic invertebrate abundance at Quesnel River areas (# per 1-minute kick sample) based on the lowest practical level of taxonomic resolution, Mount Polley Mine, 2014.

Area	Upper Reach - Quesnel River Upstream of the Forks									Lower Reach - Quesnel River Downstream of the Forks								
Site Code	**QUR1**	**QUR1**	**QUR1**	**QUR2**	**QUR2**	**QUR2**	**QUR3**	**QUR3**	**QUR3**	**QUR4**	**QUR4**	**QUR4**	**QUR5**	**QUR5**	**QUR5**	**QUR6**	**QUR6**	**QUR6**
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Class: Insecta																		
Order: Ephemeroptera																		
Family: Ameletidae																		
Ameletus				1								2	17	9	34	5		29
Family: Baetidae	3		16	3	2					1								
Baetis		14	40	6	2		1		2					1				
Baetis bicaudatus	3		20	6	6			2										
Family: Ephemerellidae	180	114	168	61	182	93	150	270	194	4	27	1	81	168	24	344	31	25
Drunella sp.							2											
Drunella spinifera			12	2	14		1	6										
Ephemerella		105	132	52	102	67	118	246	64		9		11	4	2	4		2
Ephemerella velmae	187	41	28	28	10	159	12	44	4			1	3					
Family: Heptageniidae	30	3	12	4	16		5	8	2		1		5	7	2	3	1	8
Heptagenia	7										1		2	4	1			
Rhithrogena											5		4	9				1
Family: Leptophlebiidae	10	5	32	5	4	4	4	10	2				1					
Leptophlebia sp.																		
Paraleptophlebia	3																	
Order: Plecoptera														2		4		
Family: Capniidae				1						1	4	1	5	25	6	22	15	48
Capnia sp.													7	13	3	8	22	27
Family: Chloroperlidae	3			3	6		2			2	1					2		
Suwallia				1														
Sweltsa sp.		5		6	6		4	6	2		4	1	1	8	2	1	3	5
Family: Nemouridae		5																
Zapada				1				2										
Zapada cinctipes	33	35	56	46	42	59	4	4										
Family: Perlidae		14	44	7	10	4	9	4										
Claassenia sp.																		1
Doroneuria sp.																		
Hesperoperla sp.	13	14	12	2	2		1											
Family: Perlodidae	23	62	100	98	126	7	24	24	9			1				4		
Diura sp.			64		2			42										
Skwala								2			2	2		1	1			2
Family: Pteronarcyidae																		
Pteronarcys																1		
Family: Taeniopterygidae						4												
Order: Trichoptera						4												
Family: Brachycentridae																		
Brachycentrus sp.																		
Family: Glossosomatidae																		
Glossosoma				2														
Family: Hydropsychidae					2													
Cheumatopsyche	3	5	36	14	30	4	5	6						3	1			
Hydropsyche		8	12	14	22		8	14		2		1						
Family: Hydroptilidae																		
Hydroptila						11												
Family: Lepidostomatidae								2										
Lepidostoma							1		2				1	2	1			
Family: Leptoceridae				1														
Family: Limnephilidae				3														
Order: Coleoptera			4										1					1
Family: Dytiscidae																		
Hydroporus sp.																		
Laccornis sp.						4												
Oreodytes sp.																		
Family: Elmidae				5														
Heterlimnius sp.			4	24	18								1	3				
Optioservus sp.																1		
Zaitzevia sp.				1	22	4		2										
Order: Diptera																		2
Family: Athericidae																		
Atherix		3																
Family: Chironomidae																		
Subfamily: Chironominae																		
Tribe: Chironomini																		
Cryptochironomus							1											
Harnischia sp.														1				
Microtendipes pedellus	60		4			22	2	2										
Parachironomus											1							
Paracladopelma sp.														4				
Phaenopsectra														1				
Polypedilum sp.						15												
Tribe: Tanytarsini																		
Micropsectra	57	30	28	5		89	12	28	304				4					
Rheotanytarsus																		
Stempellina sp.						11												
Tanytarsus						11		4										
Subfamily: Diamesinae																		
Tribe: Diamesini																		
Pagastia	13	11	28	3			5						2					
Potthastia longimana group	10	5		2	4	7			11									
Pseudodiamesa sp.													1					
Subfamily: Orthocladiinae																		
Eukiefferiella		8	16	5	6			2										
Heterotrissocladius sp.	20													8				
Nanocladius																		

Table G.30: Benthic invertebrate abundance at Quesnel River areas (# per 1-minute kick sample) based on the lowest practical level of taxonomic resolution, Mount Polley Mine, 2014.

Area	Upper Reach - Quesnel River Upstream of the Forks									Lower Reach - Quesnel River Downstream of the Forks								
Site Code	**QUR1**	**QUR1**	**QUR1**	**QUR2**	**QUR2**	**QUR2**	**QUR3**	**QUR3**	**QUR3**	**QUR4**	**QUR4**	**QUR4**	**QUR5**	**QUR5**	**QUR5**	**QUR6**	**QUR6**	**QUR6**
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Orthocladius sp.	20	16	24	7	24		4		6			1	3			5	6	2
Parachaetocladius sp.																		
Parakiefferiella																2	5	3
Parametriocnemus																		
Paraphaenocladius sp.																		
Rheocricotopus																		
Tvetenia			16			15			4									
| Tribe: Pentaneuriini																		
Thienemannimyia group	290	178	156	72	92	267	32	52	6					2		2		
| Family: Empididae				1										1				
Hemerodromia sp.	3	8	4	4														
Neoplasta sp.																		
Oreogeton sp.					2													
Roederiodes sp							5	6	2									
| Family: Simuliidae																		
Simulium	3																	
| Family: Tipulidae			8											1				
Antocha sp.	10	16	28	4	2					1								
| Order: Lepidoptera																		1
Subphylum: Chelicerata																		
| Class: Arachnida		14																
| Family: Hygrobatidae																		
Hygrobates							1											
| Family: Lebertiidae																		
Lebertia							2											
| Family: Sperchontidae																		
Sperchon			32	7	6	15	6	6								1		
| Family: Torrenticolidae																		
Testudacarus sp.	3			8	2		1	6										
Torrenticola					4		3	10	4				1	2		3	1	2
Phylum: Mollusca																		
| Class: Bivalvia																		
| Order: Veneroida																		
| Family: Pisidiidae																		
Pisidium	3		8	2														
| Class: Gastropoda				1														
| Order: Basommatophora																		
| Family: Lymnaeidae																		
Lymnaea sp.	27				2	26												
| Family: Planorbidae																		
Gyraulus																		
| Order: Heterostropha																		
| Family: Valvatidae																		
Valvata sincera																		
| Class: Oligochaeta																		
| Order: Lumbriculida																		
| Family: Lumbriculidae							2			2								
| Order: Tubificida																		
| Family: Enchytraeidae																		
Enchytraeus		54	80	8	28	19												
| Family: Naididae							2	6	36					7		1		
Nais																		2
Slavina appendiculata																		3
Phylum: Cnidaria																		
| Class: Hydrozoa																		
| Order: Anthoathecatae																		
| Family: Hydridae																		
Hydra	37	105	44	26	80	344	14	16	32				3					
Totals:	**1054**	**878**	**1268**	**552**	**878**	**1265**	**443**	**832**	**686**	**13**	**55**	**11**	**154**	**286**	**77**	**413**	**84**	**164**

Table G.31: Benthic invertebrate family proportion at reference areas, Mount Polley Mine, 2014.

Family	CAR-1	CAR-2	CAR-3	CLR-1	CLR-2	CLR-3
Ameletidae	1.69	1.99	1.30	4.31	17.50	36.73
Baetidae	0.00	0.66	0.00	6.90	10.00	0.00
Ephemerellidae	36.02	51.66	46.75	46.55	20.00	4.08
Heptageniidae	10.59	9.27	5.19	5.17	0.00	2.04
Leptophlebiidae	0.00	0.00	0.00	1.72	0.00	0.00
Capniidae	4.66	2.65	1.62	4.31	5.00	0.00
Chloroperlidae	11.44	7.28	3.90	2.59	2.50	0.00
Nemouridae	0.00	0.00	0.00	0.00	0.00	0.00
Perlidae	0.85	0.00	0.00	0.00	0.00	0.00
Perlodidae	1.27	0.66	2.27	0.00	0.00	0.00
Pteronarcyidae	0.00	0.66	0.32	0.00	0.00	0.00
Taeniopterygidae	0.00	0.00	0.00	0.00	0.00	0.00
Brachycentridae	0.00	0.33	0.00	0.00	0.00	0.00
Glossosomatidae	0.42	0.00	0.00	0.00	0.00	0.00
Hydropsychidae	0.00	0.00	0.00	0.00	0.00	0.00
Hydroptilidae	0.00	0.33	0.97	0.00	0.00	0.00
Lepidostomatidae	0.85	3.31	1.30	0.00	0.00	2.04
Leptoceridae	0.00	0.00	0.00	0.00	0.00	0.00
Limnephilidae	0.00	0.00	0.00	4.31	0.00	0.00
Dytiscidae	0.42	0.00	0.32	0.00	0.00	0.00
Elmidae	0.42	0.00	0.00	0.86	0.00	2.04
Athericidae	0.00	0.00	0.00	0.00	0.00	0.00
Chironomidae	22.03	14.90	19.16	14.66	10.00	2.04
Empididae	2.12	1.99	0.65	0.86	2.50	0.00
Simuliidae	0.00	0.00	0.00	0.00	0.00	2.04
Tipulidae	0.42	0.33	0.32	0.00	0.00	0.00
Lepidoptera	0.00	0.00	0.00	0.00	7.50	0.00
Hygrobatidae	0.85	0.00	0.32	0.00	5.00	12.24
Lebertiidae	0.00	0.00	1.95	0.00	0.00	0.00
Sperchontidae	2.97	0.66	6.17	0.00	0.00	0.00
Torrenticolidae	0.00	0.33	4.22	2.59	0.00	2.04
Pisidiidae	0.00	0.00	0.00	0.86	0.00	0.00
Lymnaeidae	0.00	0.00	0.00	0.00	5.00	32.65
Planorbidae	0.00	0.00	0.00	0.00	2.50	0.00
Valvatidae	0.00	0.00	0.00	0.86	0.00	0.00
Lumbriculidae	0.00	0.00	0.32	0.00	7.50	2.04
Enchytraeidae	0.00	0.00	0.00	0.00	0.00	0.00
Naididae	2.97	2.98	2.92	3.45	5.00	0.00

Table G.32: Benthic invertebrate family proportion at Quesnel River areas, Mount Polley Mine, 2014.

Family	QUR1-1	QUR1-2	QUR1-3	QUR2-1	QUR2-2	QUR2-3	QUR3-1	QUR3-2	QUR3-4	QUR4-1	QUR4-2	QUR4-3	QUR5-1	QUR5-2	QUR5-3	QUR6-1	QUR6-2	QUR6-3
Ameletidae	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.18	11.33	3.17	44.16	1.22	0.00	18.01
Baetidae	0.59	1.84	6.23	2.86	1.25	0.00	0.23	0.25	0.31	7.69	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00
Ephemerellidae	36.09	34.26	27.87	27.24	38.60	34.79	65.97	69.36	40.06	30.77	65.45	18.18	63.33	60.56	33.77	85.09	36.90	16.77
Heptageniidae	3.64	0.40	0.98	0.76	2.01	0.00	1.17	0.98	0.31	0.00	12.73	0.00	7.33	7.04	3.90	0.73	1.19	5.59
Leptophlebiidae	1.28	0.66	2.62	0.95	0.50	0.44	0.93	1.23	0.31	0.00	0.00	0.00	0.67	0.00	0.00	0.00	0.00	0.00
Capniidae	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	7.69	7.27	9.09	8.00	13.38	11.69	7.33	44.05	46.58
Chloroperlidae	0.29	0.66	0.00	1.90	1.50	0.00	1.40	0.74	0.31	15.38	9.09	9.09	0.67	2.82	2.60	0.73	3.57	3.11
Nemouridae	3.24	5.27	4.59	8.95	5.26	6.43	0.93	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Perlidae	1.28	3.69	4.59	1.71	1.50	0.44	2.33	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.62
Perlodidae	2.26	8.17	13.44	18.67	16.04	0.76	5.59	8.33	1.38	0.00	3.64	27.27	0.00	0.35	1.30	0.98	0.00	1.24
Pteronarcyidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00
Taeniopterygidae	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Brachycentridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Glossosomatidae	0.00	0.00	0.00	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydropsychidae	0.29	1.71	3.93	5.33	6.77	0.44	3.03	2.45	0.00	15.38	0.00	9.09	0.00	1.06	1.30	0.00	0.00	0.00
Hydroptilidae	0.00	0.00	0.00	0.00	0.00	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lepidostomatidae	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.25	0.31	0.00	0.00	0.00	0.67	0.70	1.30	0.00	0.00	0.00
Leptoceridae	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Limnephilidae	0.00	0.00	0.00	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dytiscidae	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Elmidae	0.00	0.00	0.33	5.71	5.01	0.44	0.00	0.25	0.00	0.00	0.00	0.00	0.67	1.06	0.00	0.24	0.00	0.00
Athericidae	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chironomidae	46.21	32.67	22.30	17.90	15.79	47.66	13.05	10.78	50.61	0.00	1.82	9.09	6.67	5.63	0.00	2.20	13.10	3.11
Empididae	0.29	1.05	0.33	0.95	0.25	0.00	1.17	0.74	0.31	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00
Simuliidae	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tipulidae	0.98	2.11	2.95	0.76	0.25	0.00	0.00	0.00	0.00	7.69	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00
Lepidoptera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.62
Hygrobatidae	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lebertiidae	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sperchontidae	0.00	0.00	2.62	1.33	0.75	1.64	1.40	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00
Torrenticolidae	0.29	0.00	0.00	1.52	0.75	0.00	0.93	1.96	0.61	0.00	0.00	0.00	0.67	0.70	0.00	0.73	1.19	1.24
Pisidiidae	0.29	0.00	0.66	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lymnaeidae	2.65	0.00	0.00	0.00	0.25	2.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Planorbidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Valvatidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lumbriculidae	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	15.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Enchytraeidae	0.00	7.11	6.56	1.52	3.51	2.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Naididae	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.74	5.50	0.00	0.00	0.00	0.00	2.46	0.00	0.24	0.00	3.11

Table G.33: Descriptive statistics of benthic invertebrate community for river sampling areas, Mount Polley Mine, 2014.

Community Endpoint	Area	n	Median	Mean	Standard Deviation	Standard Error	95% Confidence Interval (Mean)		Min	Max
							Lower Bound	Upper Bound		
Density (Individuals/ 1 min kick)	QUR1	3	1,017	1,005	226	130	444	1,565	773	1,224
	QUR2	3	798	748	202	117	246	1,250	526	921
	QUR3	3	654	633	194	112	150	1,116	429	816
	QUR4	3	13	26	25	14	-35	88	11	55
	QUR5	3	151	171	106	61	-92	435	77	286
	QUR6	3	164	220	172	99	-206	647	84	413
	CAR	3	305	284	40	23	184	384	238	310
	CLR	3	50	69	42	25	-36	175	40	118
Richness (# of Families)	QUR1	3	15	15.0	1.0	0.6	12.5	17.5	14	16
	QUR2	3	17	17.7	4.0	2.3	7.6	27.7	14	22
	QUR3	3	16	15.0	3.6	2.1	6.0	24.0	11	18
	QUR4	3	7	6.7	0.6	0.3	5.2	8.1	6	7
	QUR5	3	10	11.0	3.6	2.1	2.0	20.0	8	15
	QUR6	3	11	9.7	3.2	1.9	1.7	17.7	6	12
	CAR	3	17	17.7	1.2	0.7	14.8	20.5	17	19
	CLR	3	13	13.0	2.0	1.2	8.0	18.0	11	15
Diversity (Simpson's)	QUR1	3	0.76	0.75	0.09	0.05	0.52	0.98	0.65	0.84
	QUR2	3	0.79	0.76	0.10	0.06	0.51	1.01	0.65	0.84
	QUR3	3	0.54	0.54	0.04	0.02	0.44	0.64	0.50	0.58
	QUR4	3	0.82	0.73	0.16	0.09	0.32	1.13	0.54	0.83
	QUR5	3	0.60	0.62	0.05	0.03	0.48	0.75	0.57	0.67
	QUR6	3	0.65	0.55	0.24	0.14	-0.05	1.14	0.27	0.72
	CAR	3	0.73	0.74	0.05	0.03	0.62	0.86	0.69	0.79
	CLR	3	0.75	0.79	0.08	0.05	0.58	1.00	0.74	0.89
Evenness (Simpson's)	QUR1	3	0.30	0.30	0.12	0.07	0.01	0.58	0.18	0.41
	QUR2	3	0.28	0.26	0.05	0.03	0.14	0.37	0.20	0.29
	QUR3	3	0.12	0.15	0.05	0.03	0.02	0.29	0.12	0.22
	QUR4	3	0.78	0.65	0.25	0.15	0.02	1.29	0.36	0.82
	QUR5	3	0.23	0.26	0.11	0.06	-0.01	0.54	0.17	0.38
	QUR6	3	0.32	0.30	0.18	0.11	-0.15	0.76	0.11	0.48
	CAR	3	0.20	0.22	0.05	0.03	0.10	0.35	0.19	0.28
	CLR	3	0.35	0.43	0.22	0.13	-0.11	0.97	0.26	0.68
NMS-1	QUR1	3	0.85	0.83	0.04	0.02	0.73	0.93	0.78	0.85
	QUR2	3	0.60	0.70	0.27	0.15	0.03	1.36	0.49	1.00
	QUR3	3	0.54	0.65	0.19	0.11	0.18	1.11	0.54	0.86
	QUR4	3	-0.21	-0.28	0.36	0.21	-1.18	0.62	-0.67	0.04
	QUR5	3	-0.16	-0.39	0.45	0.26	-1.50	0.73	-0.90	-0.09
	QUR6	3	-0.23	-0.49	0.78	0.45	-2.43	1.45	-1.37	0.13
	CAR	3	0.22	0.25	0.07	0.04	0.07	0.44	0.20	0.34
	CLR	3	-0.99	-1.27	1.53	0.88	-5.06	2.52	-2.92	0.10
NMS-2	QUR1	3	-0.29	-0.34	0.29	0.17	-1.07	0.39	-0.65	-0.07
	QUR2	3	-0.32	-0.39	0.23	0.13	-0.97	0.19	-0.66	-0.21
	QUR3	3	0.41	0.33	0.24	0.14	-0.26	0.91	0.06	0.51
	QUR4	3	-0.74	-0.40	1.03	0.59	-2.95	2.15	-1.21	0.76
	QUR5	3	0.50	0.44	0.18	0.10	0.00	0.87	0.24	0.57
	QUR6	3	0.11	0.37	0.51	0.29	-0.89	1.62	0.05	0.95
	CAR	3	0.16	0.12	0.17	0.10	-0.31	0.54	-0.07	0.27
	CLR	3	-0.02	-0.13	0.32	0.18	-0.92	0.66	-0.48	0.13
% Ephemeroptera	QUR1	3	37.6	38.6	2.7	1.6	31.9	45.2	36	42
	QUR2	3	35.1	36.5	5.3	3.1	23.2	49.7	32	42
	QUR3	3	68.3	60.4	16.9	9.7	18.4	102.3	41	72
	QUR4	3	38.5	51.0	23.6	13.6	-7.5	109.5	36	78
	QUR5	3	81.8	78.2	6.5	3.8	61.9	94.5	71	82
	QUR6	3	39.6	54.6	27.3	15.8	-13.3	122.6	38	86
	CAR	3	52.9	54.6	7.7	4.4	35.5	73.6	48	63
	CLR	3	47.5	51.0	11.2	6.5	23.2	78.8	42	64
% Plecoptera	QUR1	3	17.5	15.7	7.9	4.6	-3.9	35.3	7	23
	QUR2	3	24.3	21.2	12.0	6.9	-8.5	51.0	8	31
	QUR3	3	10.3	7.4	5.0	2.9	-4.9	19.7	2	10
	QUR4	3	23.1	29.5	13.9	8.0	-5.0	64.0	20	45
	QUR5	3	15.6	13.8	4.5	2.6	2.5	25.1	9	17
	QUR6	3	47.6	36.1	22.5	13.0	-19.8	92.1	10	51
	CAR	3	12.1	12.8	5.0	2.9	0.3	25.3	8	18
	CLR	3	7.5	5.0	4.4	2.5	-5.8	15.9	0	8
% Trichoptera	QUR1	3	1.7	2.0	1.8	1.1	-2.6	6.5	0	4
	QUR2	3	6.5	5.1	2.6	1.5	-1.4	11.6	2	7
	QUR3	3	2.7	2.1	1.6	0.9	-1.8	6.0	0	3
	QUR4	3	9.1	8.2	7.7	4.5	-11.1	27.4	0	15
	QUR5	3	1.7	1.7	1.0	0.6	-0.7	4.1	1	3
	QUR6	3	0	0	0	0	0	0	0	0
	CAR	3	2.9	3.0	0.9	0.5	0.7	5.3	2	4
	CLR	3	2	2.1	2.1	1.2	-3.2	7.3	0	4
% Coleoptera	QUR1	3	0	0.2	0.4	0.2	-0.7	1.2	0	1
	QUR2	3	5.0	3.9	2.6	1.5	-2.6	10.4	1	6
	QUR3	3	0	0.1	0.1	0.1	-0.3	0.4	0	0
	QUR4	3		0	0	0	0	0	0	0
	QUR5	3	1.0	0.8	0.7	0.4	-0.9	2.5	0	1
	QUR6	3	0.2	0.3	0.3	0.2	-0.5	1.0	0	1
	CAR	3	0.3	0.4	0.4	0.2	-0.7	1.4	0	1
	CLR	3	1.7	1.2	1.1	0.6	-1.4	3.9	0	2

Table G.33: Descriptive statistics of benthic invertebrate community for river sampling areas, Mount Polley Mine, 2014.

Community Endpoint	Area	n	Median	Mean	Standard Deviation	Standard Error	95% Confidence Interval (Mean)		Min	Max
							Lower Bound	Upper Bound		
% Diptera	QUR1	3	35.6	36.3	11.2	6.4	8.5	64.0	25	48
	QUR2	3	19.6	27.8	17.1	9.9	-14.8	70.3	16	47
	QUR3	3	14.2	25.6	22.0	12.7	-29.1	80.2	12	51
	QUR4	3	7.7	6.2	3.9	2.2	-3.4	15.8	2	9
	QUR5	3	6.3	4.3	3.7	2.2	-5.0	13.6	0	7
	QUR6	3	4.3	6.5	5.8	3.3	-7.9	20.9	2	13
	CAR	3	20.0	20.5	3.7	2.1	11.3	29.6	17	24
	CLR	3	12.5	11.3	4.8	2.7	-0.6	23.1	6	15
% Lepidoptera	QUR1	3	0	0	0	0	0	0	0	0
	QUR2	3	0	0	0	0	0	0	0	0
	QUR3	3	0	0	0	0	0	0	0	0
	QUR4	3	0	0	0	0	0	0	0	0
	QUR5	3	0	0	0	0	0	0	0	0
	QUR6	3	0	0.2	0.4	0.2	-0.7	1.1	0	1
	CAR	3	0	0	0	0	0	0	0	0
	CLR	3	0	2.5	4.3	2.5	-8.3	13.3	0	8
% Arachnida	QUR1	3	1.8	1.6	1.2	0.7	-1.4	4.5	0	3
	QUR2	3	1.6	2.0	0.7	0.4	0.1	3.8	2	3
	QUR3	3	2.7	2.1	1.3	0.8	-1.1	5.4	1	3
	QUR4	3	0	0	0	0	0	0	0	0
	QUR5	3	0.7	0.5	0.4	0.2	-0.5	1.4	0	1
	QUR6	3	1.2	1.1	0.1	0.1	0.8	1.5	1	1
	CAR	3	3.8	5.8	6.1	3.5	-9.3	20.8	1	13
	CLR	3	5.0	7.2	6.0	3.5	-7.8	22.2	3	14
% Bivalvia	QUR1	3	0.3	0.3	0.3	0.2	-0.5	1.1	0	1
	QUR2	3	0	0.1	0.2	0.1	-0.4	0.7	0	0
	QUR3	3	0	0	0	0	0	0	0	0
	QUR4	3	0	0	0	0	0	0	0	0
	QUR5	3	0	0	0	0	0	0	0	0
	QUR6	3	0	0	0	0	0	0	0	0
	CAR	3	0	0	0	0	0	0	0	0
	CLR	3	0	0.3	0.5	0.3	-0.9	1.5	0	1
% Gastropoda	QUR1	3	0	0.9	1.5	0.9	-2.9	4.7	0	3
	QUR2	3	0.3	1.1	1.5	0.9	-2.6	4.8	0	3
	QUR3	3	0	0	0	0	0	0	0	0
	QUR4	3	0	0	0	0	0	0	0	0
	QUR5	3	0	0	0	0	0	0	0	0
	QUR6	3	0	0	0	0	0	0	0	0
	CAR	3	0	0	0	0	0	0	0	0
	CLR	3	7.5	13.4	16.4	9.5	-27.3	54.2	1	32
% Oligochaeta	QUR1	3	6.5	4.5	3.9	2.3	-5.2	14.2	0	7
	QUR2	3	2.1	2.4	1.0	0.6	-0.2	4.9	2	4
	QUR3	3	0.9	2.4	2.7	1.6	-4.3	9.1	1	6
	QUR4	3	0	5.1	8.9	5.1	-16.9	27.2	0	15
	QUR5	3	0	0.8	1.4	0.8	-2.7	4.3	0	2
	QUR6	3	0.2	1.1	1.7	1.0	-3.1	5.3	0	3
	CAR	3	3.0	3.0	0.2	0.1	2.6	3.4	3	3
	CLR	3	3.4	6.0	5.7	3.3	-8.2	20.1	2	13

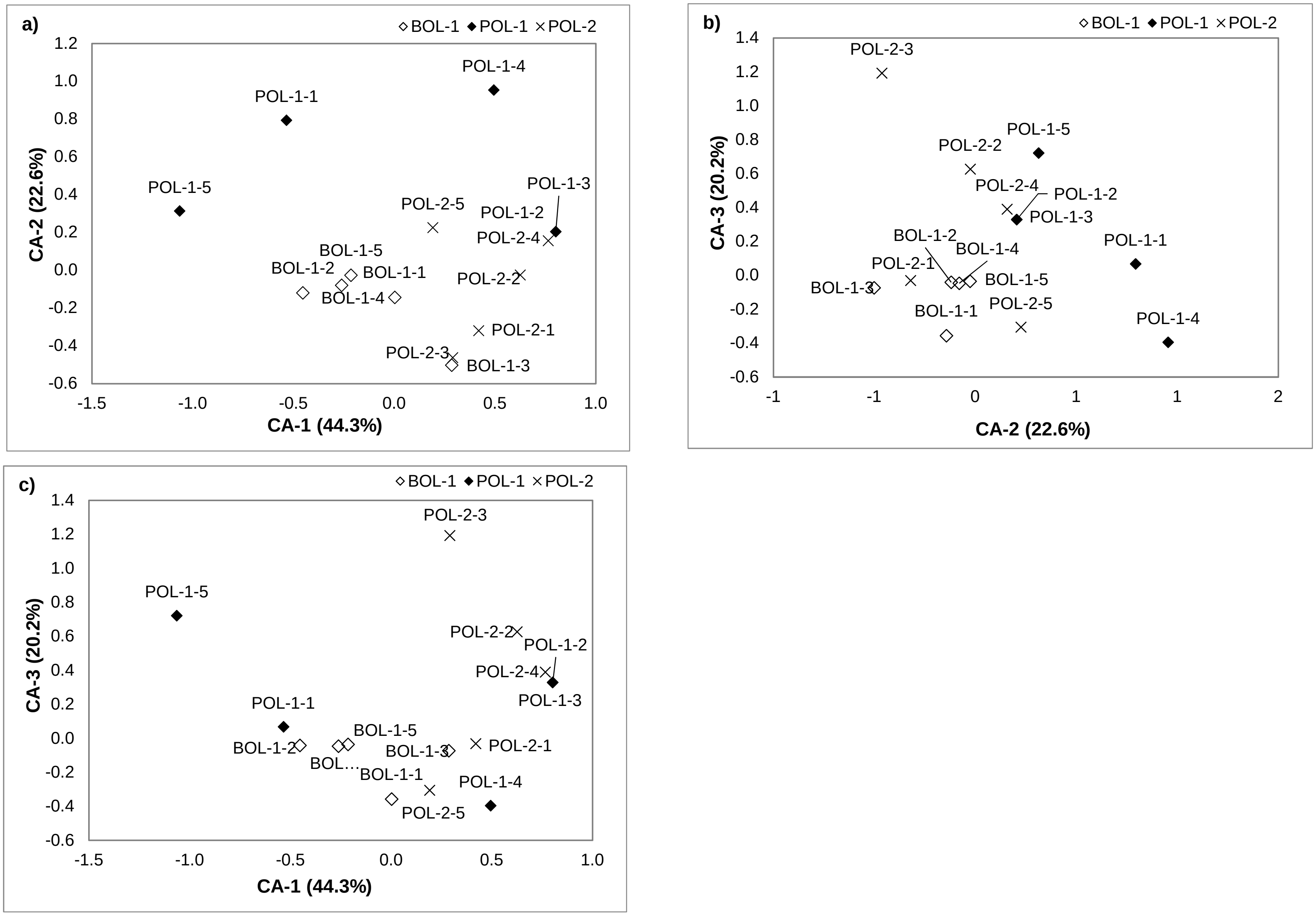

Figure G.1: Scatterplots of Correspondence Analysis scores for the benthic invertebrate community for Polley and Bootjack Lake mid-depth sampling areas, Mount Polley Mine, 2014.

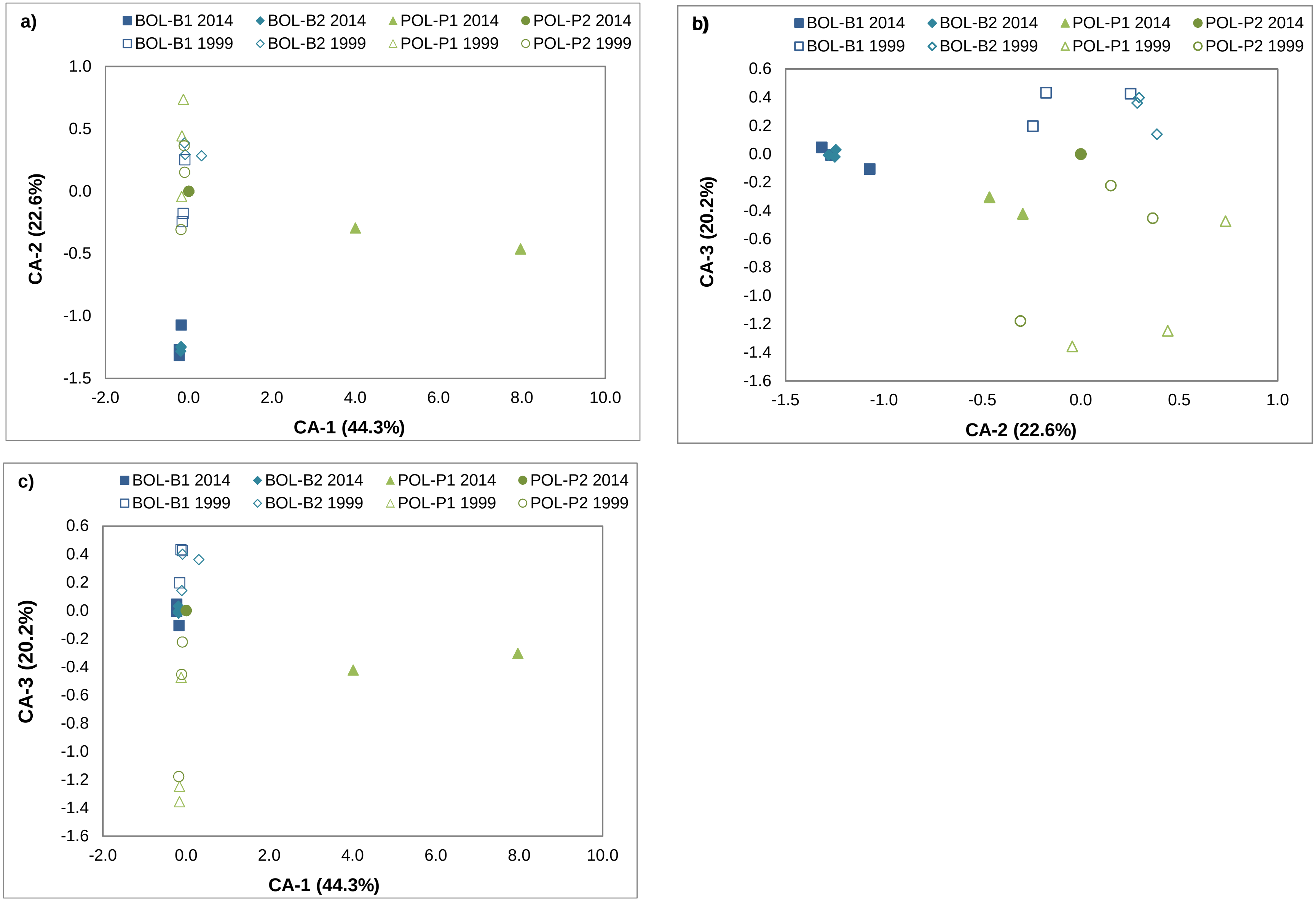

Figure G.2: Scatterplots of Correspondence Analysis scores for the benthic invertebrate community for Polley and Bootjack Lake mid-depth sampling areas, Mount Polley Mine, 2014.

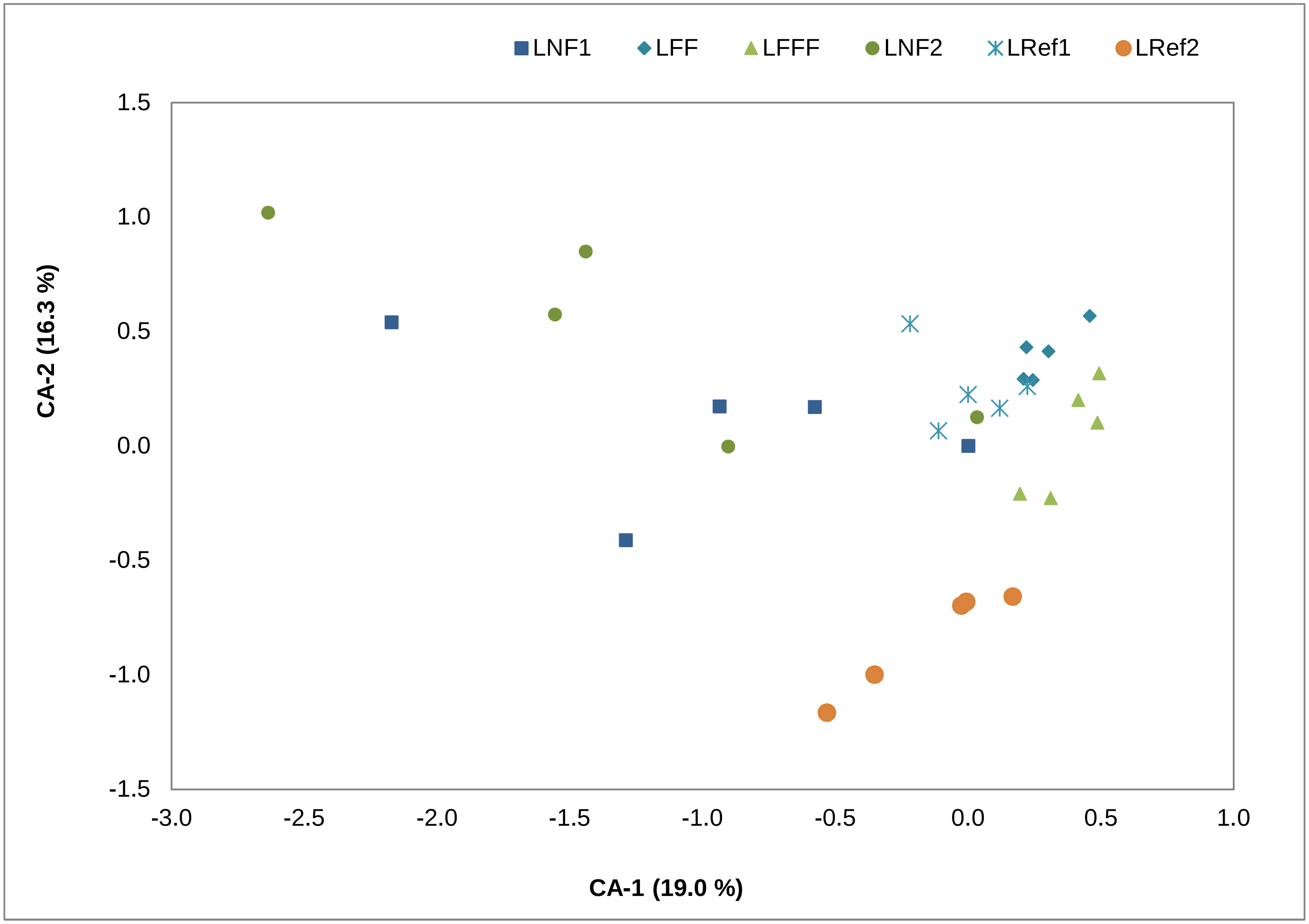

Figure G.3: Scatterplots of Correspondence Analysis scores for the benthic invertebrate community for Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014.

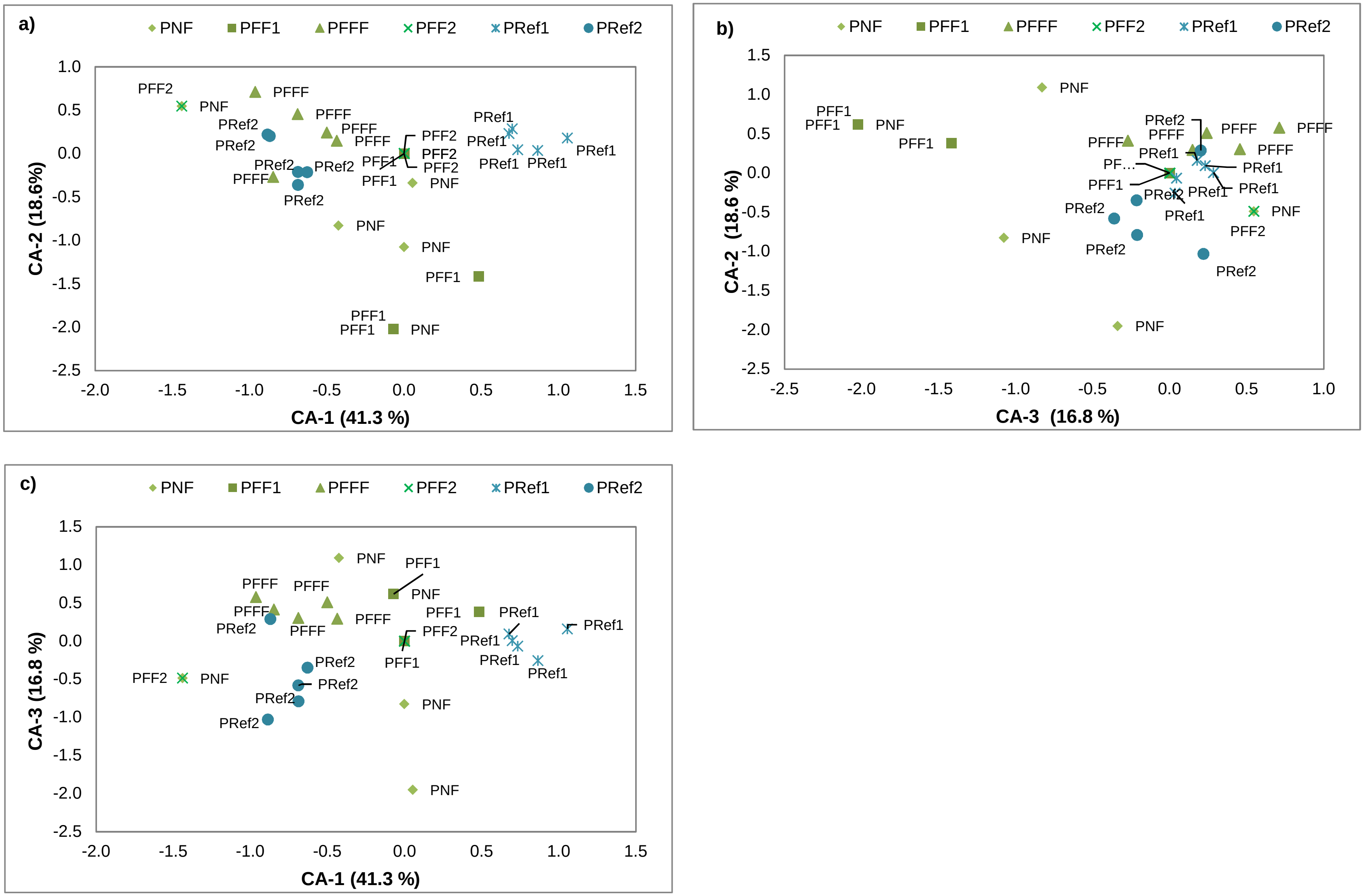

Figure G.4: Scatterplots of Correspondence Analysis scores for the benthic invertebrate community for Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014.

APPENDIX H

BENTHIC INVERTEBRATE TISSUE CHEMISTRY DATA

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Table H.1: Metal concentrations in whole sample benthic invertebrate composition tissue samples from river sampling areas, Mount Polley Mine, 2014.

Ref vs Exp	Location	Sample Code	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Molybdenum	Nickel	Selenium
			µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw
Reference	Blackwater Creek	BLC-R1C	1,000	<0.2	4.2	16	0.03	4	0.33	4	2	18	2,000	0.29	420	1.4	8.4	0.6
		BLC-R2C	1,800	<0.2	2.6	26	0.05	4	0.55	6	3	22	3,300	0.35	540	1.4	8.5	0.8
		BLC-R3C	2,400	<0.2	1.8	32	0.07	4	0.41	13	2.9	19	4,500	0.46	510	1.7	15	0.6
	Clearwater River	CLR-R1C	4,900	<1	1.3	38	<0.1	<10	1.9	12	9.2	24	7,000	1.0	160	<1	10	2.9
		CLR-R2C	480	<0.2	0.6	38	<0.02	<2	0.24	2	0.95	10	970	0.20	64	<0.2	2.5	0.7
		CLR-R3C	200	<0.2	0.6	37	<0.02	<2	0.12	<1	0.41	15	310	0.050	52	<0.2	1.2	0.4
	Cariboo River	CAR-R1C	3,000	<1	2.1	36	<0.1	<10	2.8	6	3.5	31	6,000	2.9	250	<1	8.8	2.4
		CAR-R2C	3,000	<1	2.2	36	<0.1	<10	3.2	7	3.6	28	5,000	3.4	230	<1	8.8	2.3
		CAR-R3C	4,800	<0.2	3.5	52	0.14	3	1.1	9	3.8	31	7,000	4.2	450	0.5	14	1.6
Quesnel River	Upper Reach (Quesnel River upstream of the forks)	QUR-1-R1C	2,400	<1	1.7	46	<0.1	<10	2	<5	2.4	60	2,200	0.80	150	<1	4.8	3.4
		QUR-1-R2C	2,000	<1	1.5	32	<0.1	<10	1.6	<5	2.1	54	1,900	0.60	130	<1	4	2.8
		QUR-1-R3C	2,000	<0.2	2.7	50	0.04	<2	0.75	5	1.9	44	3,000	0.82	180	0.4	5.2	3.7
		QUR-2-R1C	2,400	<1	4.4	66	<0.1	<10	2	<5	3.2	53	3,400	1.2	210	<1	5.5	2.9
		QUR-2-R2C	2,000	<0.2	3	52	0.07	2	0.97	4	1.8	43	2,600	0.92	160	0.4	3.8	2.7
		QUR-2-R3C	4,000	<1	5.5	52	<0.1	<10	2.2	8	3.9	61	6,000	1.9	220	<1	7.3	5
		QUR-3-R1C	5,000	<1	4.4	79	0.1	<10	2.4	13	5.3	57	8,000	2.4	360	<1	11	2.8
		QUR-3-R2C	5,000	<1	5.3	71	0.1	<10	4.6	12	5.8	65	7,000	1.9	330	<1	10	4.2
		QUR-3-R3C	5,000	<1	5.4	59	<0.1	<10	3.7	12	5.6	62	7,000	2.0	280	<1	11	2.9
	Lower Reach (Quesnel River downstream of the forks)	QUR-4-R1C	4,000	<1	5.8	38	<0.1	<10	3.8	12	4.2	43	7,000	2.5	340	<1	13	2
		QUR-4-R2C	3,400	<0.2	4.2	41	0.08	6	1.3	9	2	23	4,300	1.8	200	0.5	6.4	0.9
		QUR-4-R3C	7,000	<1	7.3	62	0.1	<10	17	19	6.4	50	11,100	3.3	380	<1	15	3.8
		QUR-5-R1C	7,000	<1	6.4	59	0.2	<10	23	<5	8.4	47	11,600	3.7	360	1	17	4.6
		QUR-5-R2C	7,000	<1	6.9	65	0.1	<10	20	18	7.5	44	11,400	3.5	390	<1	16	3.7
		QUR-5-R3C	7,000	<1	6.3	56	0.2	<10	15	19	8.1	46	11,800	3.5	330	<1	16	3
		QUR-6-R1C	4,800	<0.2	4	42	0.1	2	8.2	12	4.8	51	7,200	2.3	270	0.7	12	4.1
		QUR-6-R2C	7,000	<1	4.8	67	0.1	<10	15	17	6.4	42	10,000	2.8	320	<1	14	3.4
		QUR-6-R3C	8,000	<1	7.4	60	0.2	<10	19	<5	10	46	15,000	4.3	310	<1	18	3.5

Table H.1: Metal concentrations in whole sample benthic invertebrate composition tissue samples from river sampling areas, Mount Polley Mine, 2014.

Ref vs Exp	Location	Sample Code	Silver	Strontium	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc	Moisture
			µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	%
Reference	Blackwater Creek	BLC-R1C	0.04	13	<0.1	<0.1	110	0.11	4.6	90	74.0
		BLC-R2C	0.05	12	<0.1	<0.1	170	0.11	7.8	90	76.3
		BLC-R3C	0.04	13	<0.1	<0.1	200	0.12	9.9	90	73.5
	Clearwater River	CLR-R1C	<0.1	30	<0.5	<0.5	650	0.63	11	120	78.3
		CLR-R2C	0.08	490	<0.1	<0.1	55	0.15	1.3	20	51.0
		CLR-R3C	0.07	540	<0.1	<0.1	25	0.15	0.4	12	50.1
	Cariboo River	CAR-R1C	0.2	20	<0.5	<0.5	82	0.26	6	260	74.2
		CAR-R2C	0.3	20	<0.5	<0.5	46	0.22	5	250	84.2
		CAR-R3C	0.19	27	<0.1	<0.1	59	0.39	6.8	180	69.7
Quesnel River	Upper Reach (Quesnel River upstream of the forks)	QUR-1-R1C	0.2	30	<0.5	<0.5	89	0.21	6	270	87.6
		QUR-1-R2C	0.2	100	<0.5	<0.5	80	0.18	5	290	90.8
		QUR-1-R3C	0.16	21	<0.1	<0.1	110	0.14	7.4	280	82.3
		QUR-2-R1C	0.2	20	<0.5	<0.5	110	0.24	7	250	91.6
		QUR-2-R2C	0.17	23	<0.1	<0.1	77	0.15	5.7	260	82.4
		QUR-2-R3C	0.1	20	<0.5	<0.5	200	0.28	14	310	77.2
		QUR-3-R1C	0.1	30	<0.5	<0.5	260	0.29	20	160	84.2
		QUR-3-R2C	0.1	30	<0.5	<0.5	290	0.38	20	170	88.6
		QUR-3-R3C	0.1	30	<0.5	<0.5	300	0.31	20	180	77.7
	Lower Reach (Quesnel River downstream of the forks)	QUR-4-R1C	0.2	40	<0.5	<0.5	270	0.45	15	150	79.8
		QUR-4-R2C	0.05	58	<0.1	0.1	250	0.31	11	130	57.1
		QUR-4-R3C	0.1	40	<0.5	<0.5	540	0.59	20	290	81.8
		QUR-5-R1C	0.1	40	<0.5	<0.5	530	0.6	30	150	78.6
		QUR-5-R2C	0.1	40	<0.5	<0.5	490	0.73	20	140	83.2
		QUR-5-R3C	<0.1	40	<0.5	<0.5	500	0.86	20	140	82.4
		QUR-6-R1C	0.15	27	<0.1	0.2	260	0.31	15	220	83.8
		QUR-6-R2C	0.1	33	<0.5	<0.5	410	0.4	20	120	82.2
		QUR-6-R3C	0.1	40	<0.5	<0.5	640	0.7	30	120	81.1

Table H.2: Metal concentrations in Perlidae tissue samples from river sampling areas, Mount Polley Mine, 2014.

Ref vs Exp	Location	Sample ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Molybdenum	Nickel	Selenium
			µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw
Reference	Blackwater Creek	BLC-R1P	1,500	<0.2	2.4	24	0.04	5	0.27	5	2.1	22	3,100	0.29	540	1.3	8.6	0.6
		BLC-R2P	1,200	<0.2	1.6	18	0.03	5	0.24	4	2	18	2,300	0.21	420	0.9	6.4	0.5
		BLC-R3P	1,500	<0.2	1.7	22	0.03	3	0.28	5	1.8	22	2,600	0.25	460	1.2	7.1	0.6
	Cariboo River	CAR-R1P	2,600	<1	1.3	37	<0.1	<10	0.8	<5	1.7	38	2,600	1.5	190	<1	5.2	2.4
		CAR-R2P	300	<1	<0.5	9.6	<0.1	<10	1.1	<5	0.8	24	800	<0.1	40	<1	2.9	2.3
		CAR-R3P	4,000	<1	1.8	44	0.1	<10	0.7	7	2.3	27	4,000	3.1	180	<1	7.5	1.5
Quesnel River	Upper Reach (Quesnel River upstream of the forks)	QUR-1-R1P	770	<0.2	0.8	13	<0.02	<2	0.31	2	0.89	49	970	0.37	88	<0.2	2.8	3.7
		QUR-1-R2P	820	<0.2	0.9	13	<0.02	<2	0.45	2	1	47	1,000	0.34	94	<0.2	2.9	3.2
		QUR-1-R3P	1,000	<0.2	0.8	12	0.02	<2	0.37	2	0.91	44	1,100	0.37	97	0.2	2.7	3.1
		QUR-2-R1P	650	<0.2	0.8	12	<0.02	<2	0.41	1	0.76	42	680	0.23	73	0.2	1.8	3.3
		QUR-2-R2P	830	<0.2	0.9	17	<0.02	<2	0.44	2	1.1	45	1,000	0.4	96	0.2	2.6	3
		QUR-2-R3P	580	<0.2	0.7	8.7	<0.02	<2	0.6	1	0.96	40	750	0.24	56	<0.2	2	3
		QUR-3-R1P	1,200	<0.2	1.6	19	0.02	<2	1.1	3	1.6	50	1,600	0.47	100	0.3	3.6	3.7
		QUR-3-R2P	2,600	<0.2	2.4	24	0.05	<2	0.77	6	2.4	51	3,300	0.86	140	0.3	4.9	3.3
		QUR-3-R3P	2,000	<0.2	2.6	20	0.04	<2	1	5	2.4	58	2,900	0.68	130	0.3	5	3.7
	Lower Reach (Quesnel River downstream of the forks)	QUR-4-R1P	7,800	<1	6.8	73	0.1	<10	0.8	18	5.1	47	10,400	2.7	260	<1	14	1.4
		QUR-4-R2P	17,000	<1	10	170	0.4	<10	1.2	<5	8.6	54	19,600	5.9	460	1	26	1.6
		QUR-4-R3P	15,000	<1	11	150	0.3	<10	1.3	<5	7.7	49	17,300	5.2	400	1	24	1.6
		QUR-5-R1P	5,900	<1	3.5	50	<0.1	<10	1.6	15	4.4	49	8,800	1.9	230	<1	12	1.8
		QUR-5-R2P	1,200	<1	2.1	19	<0.1	<10	1.3	<5	1.3	38	2,100	0.5	80	<1	3.1	2
		QUR-5-R3P	5,000	<1	16	58	0.1	<10	2	10	8.2	64	10,400	2.8	440	<1	13	3.3
		QUR-6-R1P	7,700	<1	9.1	72	0.1	<10	7.6	21	8.1	180	12,500	2.9	350	1	29	13
		QUR-6-R2P	5,000	<1	3.6	43	<0.1	<10	0.9	12	3.5	36	7,200	1.7	190	<1	10	1.1
		QUR-6-R3P	3,700	<1	3	32	<0.1	<10	2.7	9	3.2	45	6,000	1.4	160	<1	25	2.3

Table H.2: Metal concentrations in Perlidae tissue samples from river sampling areas, Mount Polley Mine, 2014.

Ref vs Exp	Location	Sample ID	Silver	Strontium	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc	Moisture
			µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	µg/g dw	%
Reference	Blackwater Creek	BLC-R1P	0.05	16	<0.1	<0.1	160	0.09	7.1	90	79.7
		BLC-R2P	0.04	13	<0.1	<0.1	120	0.07	5	81	84.4
		BLC-R3P	0.05	18	<0.1	<0.1	180	0.09	6.1	90	80.3
	Cariboo River	CAR-R1P	0.4	20	<0.5	<0.5	40	0.19	4	400	84.9
		CAR-R2P	0.3	13	<0.5	<0.5	7.1	<0.05	<1	450	61.3
		CAR-R3P	0.2	12	<0.5	<0.5	52	0.2	6	210	93.0
Quesnel River	Upper Reach (Quesnel River upstream of the forks)	QUR-1-R1P	0.23	27	<0.1	<0.1	35	0.06	2.2	400	83.5
		QUR-1-R2P	0.21	26	<0.1	<0.1	39	0.07	2.5	360	78.8
		QUR-1-R3P	0.18	33	<0.1	<0.1	44	0.08	3	380	82.0
		QUR-2-R1P	0.19	30	<0.1	<0.1	22	0.06	1.6	360	82.3
		QUR-2-R2P	0.18	31	<0.1	<0.1	35	0.09	2.4	350	81.9
		QUR-2-R3P	0.19	12	<0.1	<0.1	26	0.06	1.6	340	78.4
		QUR-3-R1P	0.22	29	<0.1	<0.1	59	0.09	4.6	340	85.0
		QUR-3-R2P	0.19	19	<0.1	<0.1	140	0.13	10	300	77.7
		QUR-3-R3P	0.24	32	<0.1	<0.1	110	0.13	8.4	390	76.9
	Lower Reach (Quesnel River downstream of the forks)	QUR-4-R1P	<0.1	40	<0.5	<0.5	480	0.51	20	100	76.2
		QUR-4-R2P	0.1	70	<0.5	<0.5	1100	0.86	50	110	75.8
		QUR-4-R3P	0.1	60	<0.5	<0.5	1000	0.78	50	120	81.3
		QUR-5-R1P	<0.1	30	<0.5	<0.5	420	0.38	19	180	82.2
		QUR-5-R2P	0.1	30	<0.5	<0.5	79	0.11	4	340	74.6
		QUR-5-R3P	0.2	20	<0.5	<0.5	240	0.4	18	230	83.4
		QUR-6-R1P	0.4	50	<0.5	<0.5	490	0.49	20	700	85.2
		QUR-6-R2P	<0.1	20	<0.5	<0.5	290	0.28	15	120	84.7
		QUR-6-R3P	0.1	20	<0.5	<0.5	240	0.24	12	200	84.4

Table H.3: Descriptive statistics of tissue metal and metalloid concentrations of whole benthic invertebrate community samples that were tested for statistical difference, river sampling areas, Mount Polley Mine, 2014.

Metal	Area	n	Median	Mean	Standard Deviation	Standard Error	95% Confidence Interval (Mean)		Min	Max
							Lower Bound	Upper Bound		
Aluminum	QUR1	3	2,000	2,133	230.9	133.3	1,560	2,707	2,000	2,400
	QUR2	3	2,400	2,800	1,058.3	611.0	171	5,429	2,000	4,000
	QUR3	3	0	5,000	0.0	0.0	5,000	5,000	5,000	5,000
	QUR4	3	4,000	4,800	1,928.7	1,113.6	8.8	9,591	3,400	7,000
	QUR5	3	0	7,000	0.0	0.0	7,000	7,000	7,000	7,000
	QUR6	3	7,000	6,600	1,637.1	945.2	2,533	10,667	4,800	8,000
	CAR	3	3,000	3,600	1,039.2	600.0	1,018	6,182	3,000	4,800
	CLR	3	480	1,860	2,636.4	1,522.1	-4,689	8,409	200	4,900
	BLC	3	1,800	1,733	702.4	405.5	-11.5	3,478	1,000	2,400
Arsenic	QUR1	3	1.7	2.0	0.6	0.4	0.4	3.6	1.5	2.7
	QUR2	3	4.4	4.3	1.3	0.7	1.2	7.4	3.0	5.5
	QUR3	3	5.3	5.0	0.6	0.3	3.7	6.4	4.4	5.4
	QUR4	3	5.8	5.8	1.6	0.9	1.9	9.6	4.2	7.3
	QUR5	3	6.4	6.5	0.3	0.2	5.7	7.3	6.3	6.9
	QUR6	3	4.8	5.4	1.8	1.0	1.0	9.8	4.0	7.4
	CAR	3	2.2	2.6	0.8	0.5	0.7	4.5	2.1	3.5
	CLR	3	0.6	0.8	0.4	0.2	-0.2	1.8	0.6	1.3
	BLC	3	2.6	2.9	1.2	0.7	-0.2	5.9	1.8	4.2
Barium	QUR1	3	46	42.7	9.5	5.5	19.2	66.1	32	50
	QUR2	3	52	56.7	8.1	4.7	36.6	76.7	52	66
	QUR3	3	71	69.7	10.1	5.8	44.7	94.7	59	79
	QUR4	3	41	47.0	13.1	7.5	14.5	79.5	38	62
	QUR5	3	59	60.0	4.6	2.6	48.6	71.4	56	65
	QUR6	3	60	56.3	12.9	7.4	24.3	88.4	42	67
	CAR	3	36	41.3	9.2	5.3	18.4	64.3	36	52
	CLR	3	38	37.7	0.6	0.3	36.2	39.1	37	38
	BLC	3	26	24.7	8.1	4.7	4.6	44.7	16	32
Cadmium	QUR1	3	1.6	1.5	0.6	0.4	-0.1	3.0	0.8	2.0
	QUR2	3	2	1.7	0.7	0.4	0.1	3.4	1.0	2.2
	QUR3	3	3.7	3.6	1.1	0.6	0.8	6.3	2.4	4.6
	QUR4	3	3.8	7.4	8.4	4.9	-13.6	28.3	1.3	17.0
	QUR5	3	20	19.3	4.0	2.3	9.3	29.4	15.0	23.0
	QUR6	3	15	14.1	5.5	3.2	0.5	27.6	8.2	19.0
	CAR	3	2.8	2.4	1.1	0.6	-0.4	5.1	1.1	3.2
	CLR	3	0.24	0.8	1.0	0.6	-1.7	3.2	0.1	1.9
	BLC	3	0.41	0.4	0.1	0.1	0.2	0.7	0.3	0.6
Chromium	QUR1	3	0	0.3	0.0	0.0	0.3	0.3	0.3	0.3
	QUR2	3	0.25	2.8	4.5	2.6	-8.3	13.9	0.3	8.0
	QUR3	3	12	12.3	0.6	0.3	10.9	13.8	12.0	13.0
	QUR4	3	12	13.3	5.1	3.0	0.6	26.1	9.0	19.0
	QUR5	3	18	12.4	10.5	6.1	-13.8	38.6	0.3	19.0
	QUR6	3	12	9.8	8.6	5.0	-11.6	31.1	0.3	17.0
	CAR	3	7	7.3	1.5	0.9	3.5	11.1	6.0	9.0
	CLR	3	0.25	4.2	6.8	3.9	-12.7	21.0	0.3	12.0
	BLC	3	6	6.4	6.4	3.7	-9.4	22.3	0.3	13.0
Cobalt	QUR1	3	2.1	2.1	0.3	0.1	1.5	2.8	1.9	2.4
	QUR2	3	3.2	3.0	1.1	0.6	0.3	5.6	1.8	3.9
	QUR3	3	5.6	5.6	0.3	0.1	4.9	6.2	5.3	5.8
	QUR4	3	4.2	4.2	2.2	1.3	-1.3	9.7	2.0	6.4
	QUR5	3	8.1	8.0	0.5	0.3	6.9	9.1	7.5	8.4
	QUR6	3	6.4	7.1	2.7	1.5	0.5	13.7	4.8	10.0
	CAR	3	3.6	3.6	0.2	0.1	3.3	4.0	3.5	3.8
	CLR	3	0.95	3.5	4.9	2.8	-8.7	15.8	0.4	9.2
	BLC	3	2.9	2.6	0.6	0.3	1.3	4.0	2.0	3.0
Copper	QUR1	3	54	52.7	8.1	4.7	32.6	72.7	44	60
	QUR2	3	53	52.3	9.0	5.2	29.9	74.7	43	61
	QUR3	3	62	61.3	4.0	2.3	51.3	71.4	57	65
	QUR4	3	43	38.7	14.0	8.1	3.9	73.5	23	50
	QUR5	3	46	45.7	1.5	0.9	41.9	49.5	44	47
	QUR6	3	46	46.3	4.5	2.6	35.1	57.5	42	51
	CAR	3	31	30.0	1.7	1.0	25.7	34.3	28	31
	CLR	3	15	16.3	7.1	4.1	-1.3	34.0	10	24
	BLC	3	19	19.7	2.1	1.2	14.5	24.8	18	22
Iron	QUR1	3	2,200	2,367	569	328	954	3,779	1,900	3,000
	QUR2	3	3,400	4,000	1,778	1,026	-416	8,416	2,600	6,000
	QUR3	3	7,000	7,333	577	333	5,899	8,768	7,000	8,000
	QUR4	3	7,000	7,467	3,424	1,977	-1,039	15,972	4,300	11,100
	QUR5	3	11,600	11,600	200	115	11,103	12,097	11,400	11,800
	QUR6	3	10,000	10,733	3,951	2,281	918	20,549	7,200	15,000
	CAR	3	6,000	6,000	1,000	577	3,516	8,484	5,000	7,000
	CLR	3	970	2,760	3,687	2,129	-6,398	11,918	310	7,000
	BLC	3	3,300	3,267	1,250	722	161	6,373	2,000	4,500
Lead	QUR1	3	0.8	0.7	0.1	0.1	0.4	1.0	0.6	0.8
	QUR2	3	1.2	1.3	0.5	0.3	0.1	2.6	0.9	1.9
	QUR3	3	2	2.1	0.3	0.2	1.4	2.8	1.9	2.4
	QUR4	3	2.5	2.5	0.8	0.4	0.7	4.4	1.8	3.3
	QUR5	3	3.5	3.6	0.1	0.1	3.3	3.9	3.5	3.7
	QUR6	3	2.8	3.1	1.0	0.6	0.5	5.7	2.3	4.3
	CAR	3	3.4	3.5	0.7	0.4	1.9	5.1	2.9	4.2
	CLR	3	0.2	0.4	0.5	0.3	-0.9	1.7	0.1	1.0
	BLC	3	0.35	0.4	0.1	0.0	0.2	0.6	0.3	0.5

Table H.3: Descriptive statistics of tissue metal and metalloid concentrations of whole benthic invertebrate community samples that were tested for statistical difference, river sampling areas, Mount Polley Mine, 2014.

Metal	Area	n	Median	Mean	Standard Deviation	Standard Error	95% Confidence Interval (Mean)		Min	Max
							Lower Bound	Upper Bound		
Manganese	QUR1	3	150	153	25.2	14.5	90.8	216	130	180
	QUR2	3	210	197	32.1	18.6	117	277	160	220
	QUR3	3	330	323	40.4	23.3	223	424	280	360
	QUR4	3	340	307	94.5	54.6	72	541	200	380
	QUR5	3	360	360	30.0	17.3	285	435	330	390
	QUR6	3	310	300	26.5	15.3	234	366	270	320
	CAR	3	250	310	122	70.2	7.8	612	230	450
	CLR	3	64	92	59.2	34.2	-55	239	52	160
	BLC	3	510	490	62.4	36.1	335	645	420	540
Nickel	QUR1	3	4.8	4.7	0.6	0.4	3.1	6.2	4	5
	QUR2	3	5.5	5.5	1.8	1.0	1.2	9.9	4	7
	QUR3	3	11	10.7	0.6	0.3	9.2	12.1	10	11
	QUR4	3	13	11.5	4.5	2.6	0.3	22.6	6	15
	QUR5	3	16	16.3	0.6	0.3	14.9	17.8	16	17
	QUR6	3	14	14.7	3.1	1.8	7.1	22.3	12	18
	CAR	3	8.8	10.5	3.0	1.7	3.1	18.0	9	14
	CLR	3	2.5	4.6	4.8	2.7	-7.2	16.4	1	10
	BLC	3	8.5	10.6	3.8	2.2	1.2	20.0	8	15
Selenium	QUR1	3	3.4	3.3	0.5	0.3	2.2	4.4	2.8	3.7
	QUR2	3	2.9	3.5	1.3	0.7	0.4	6.7	2.7	5.0
	QUR3	3	2.9	3.3	0.8	0.5	1.4	5.2	2.8	4.2
	QUR4	3	2	2.2	1.5	0.8	-1.4	5.9	0.9	3.8
	QUR5	3	3.7	3.8	0.8	0.5	1.8	5.8	3.0	4.6
	QUR6	3	3.5	3.7	0.4	0.2	2.7	4.6	3.4	4.1
	CAR	3	2.3	2.1	0.4	0.3	1.0	3.2	1.6	2.4
	CLR	3	0.7	1.3	1.4	0.8	-2.1	4.7	0.4	2.9
	BLC	3	0.6	0.7	0.1	0.1	0.4	1.0	0.6	0.8
Silver	QUR1	3	0.2	0.2	0.0	0.0	0.1	0.2	0.2	0.2
	QUR2	3	0.17	0.2	0.1	0.0	0.0	0.3	0.1	0.2
	QUR3	3	0	0.1	0.0	0.0	0.1	0.1	0.1	0.1
	QUR4	3	0.1	0.1	0.1	0.0	-0.1	0.3	0.1	0.2
	QUR5	3	0.1	0.1	0.0	0.0	0.0	0.2	0.1	0.1
	QUR6	3	0.1	0.1	0.0	0.0	0.0	0.2	0.1	0.2
	CAR	3	0.2	0.2	0.1	0.0	0.1	0.4	0.2	0.3
	CLR	3	0.07	0.1	0.0	0.0	0.0	0.1	0.1	0.1
	BLC	3	0.04	0.0	0.0	0.0	0.0	0.1	0.0	0.1
Strontium	QUR1	3	30	50.3	43.2	25.0	-57.1	158	21	100
	QUR2	3	20	21.0	1.7	1.0	16.7	25.3	20	23
	QUR3	3	0	30.0	0.0	0.0	30.0	30.0	30	30
	QUR4	3	40	46.0	10.4	6.0	20.2	71.8	40	58
	QUR5	3	0	40.0	0.0	0.0	40.0	40.0	40	40
	QUR6	3	33	33.3	6.5	3.8	17.2	49.5	27	40
	CAR	3	20	22.3	4.0	2.3	12.3	32.4	20	27
	CLR	3	490	353	281	162	-345	1,052	30	540
	BLC	3	13	12.7	0.6	0.3	11.2	14.1	12	13
Titanium	QUR1	3	89	93.0	15.4	8.9	54.8	131	80	110
	QUR2	3	110	129	63.7	36.8	-29.1	287	77	200
	QUR3	3	290	283	20.8	12.0	232	335	260	300
	QUR4	3	270	353	162	93.5	-49.0	756	250	540
	QUR5	3	500	507	20.8	12.0	455	558	490	530
	QUR6	3	410	437	191	111	-38.8	912	260	640
	CAR	3	59	62.3	18.2	10.5	17.0	108	46	82
	CLR	3	55	243	353	204	-632	1,119	25	650
	BLC	3	170	160	45.8	26.5	46.2	274	110	200
Uranium	QUR1	3	0.18	0.2	0.0	0.0	0.1	0.3	0.1	0.2
	QUR2	3	0.24	0.2	0.1	0.0	0.1	0.4	0.2	0.3
	QUR3	3	0.31	0.3	0.0	0.0	0.2	0.4	0.3	0.4
	QUR4	3	0.45	0.5	0.1	0.1	0.1	0.8	0.3	0.6
	QUR5	3	0.73	0.7	0.1	0.1	0.4	1.1	0.6	0.9
	QUR6	3	0.4	0.5	0.2	0.1	0.0	1.0	0.3	0.7
	CAR	3	0.26	0.3	0.1	0.1	0.1	0.5	0.2	0.4
	CLR	3	0.15	0.3	0.3	0.2	-0.4	1.0	0.2	0.6
	BLC	3	0.11	0.1	0.0	0.0	0.1	0.1	0.1	0.1
Vanadium	QUR1	3	6	6.1	1.2	0.7	3.1	9.1	5	7
	QUR2	3	7	8.9	4.5	2.6	-2.2	20.0	6	14
	QUR3	3	0	20.0	0.0	0.0	20.0	20.0	20	20
	QUR4	3	15	15.3	4.5	2.6	4.1	26.5	11	20
	QUR5	3	20	23.3	5.8	3.3	9.0	37.7	20	30
	QUR6	3	20	21.7	7.6	4.4	2.7	40.6	15	30
	CAR	3	6	5.9	0.9	0.5	3.7	8.2	5	7
	CLR	3	1.3	4.2	5.9	3.4	-10.4	18.8	0	11
	BLC	3	7.8	7.4	2.7	1.5	0.8	14.1	5	10
Zinc	QUR1	3	280	280	10.0	5.8	255	305	270	290
	QUR2	3	260	273	32.1	18.6	193	353	250	310
	QUR3	3	170	170	10.0	5.8	145	195	160	180
	QUR4	3	150	190	87.2	50.3	-27	407	130	290
	QUR5	3	140	143	5.8	3.3	129	158	140	150
	QUR6	3	120	153	57.7	33.3	9.9	297	120	220
	CAR	3	250	230	43.6	25.2	122	338	180	260
	CLR	3	20	50.7	60.2	34.7	-98.8	200	12	120
	BLC	3	0	90.0	0.0	0.0	90.0	90.0	90	90

Table H.4: Descriptive statistics of tissue metal and metalloid concentrations of Perlidae samples that were tested for statistical difference, Mount Polley Mine, 2014.

Metal	Area	n	Median	Mean	Standard Deviation	Standard Error	95% Confidence Interval (Mean) Lower Bound	Upper Bound	Min	Max
Aluminum	QUR1	3	820	863	121	69.8	563	1,164	770	1,000
	QUR2	3	650	687	129	74.5	366	1,007	580	830
	QUR3	3	2,000	1,933	702	406	189	3,678	1,200	2,600
	QUR4	3	15,000	13,267	4,839	2,794	1,247	25,287	7,800	17,000
	QUR5	3	5,000	4,033	2,495	1,440	-2,164	10,230	1,200	5,900
	QUR6	3	5,000	5,467	2,040	1,178	398	10,535	3,700	7,700
	CAR	3	2,600	2,300	1,868	1,079	-2,341	6,941	300	4,000
	BLC	3	1,500	1,400	173	100	970	1,830	1,200	1,500
Arsenic	QUR1	3	0.8	0.8	0.1	0.0	0.7	1.0	0.8	0.9
	QUR2	3	0.8	0.8	0.1	0.1	0.6	1.0	0.7	0.9
	QUR3	3	2.4	2.2	0.5	0.3	0.9	3.5	1.6	2.6
	QUR4	3	10	9.3	2.2	1.3	3.8	14.7	6.8	11.0
	QUR5	3	3.5	7.2	7.7	4.4	-11.8	26.2	2.1	16.0
	QUR6	3	3.6	5.2	3.4	1.9	-3.1	13.6	3.0	9.1
	CAR	3	1.3	1.1	0.8	0.5	-0.8	3.1	0.3	1.8
	BLC	3	1.7	1.9	0.4	0.3	0.8	3.0	1.6	2.4
Barium	QUR1	3	13	12.7	0.6	0.3	11.2	14.1	12	13
	QUR2	3	12	12.6	4.2	2.4	2.2	22.9	9	17
	QUR3	3	20	21.0	2.6	1.5	14.4	27.6	19	24
	QUR4	3	150	131.0	51.2	29.6	3.8	258.2	73	170
	QUR5	3	50	42.3	20.6	11.9	-8.8	93.5	19	58
	QUR6	3	43	49.0	20.7	11.9	-2.3	100.3	32	72
	CAR	3	37	30.2	18.2	10.5	-15.0	75.4	10	44
	BLC	3	22	21.3	3.1	1.8	13.7	28.9	18	24
Cadmium	QUR1	3	0.37	0.38	0.07	0.04	0.20	0.55	0.31	0.45
	QUR2	3	0.44	0.48	0.10	0.06	0.23	0.74	0.41	0.60
	QUR3	3	1.00	0.96	0.17	0.10	0.54	1.38	0.77	1.10
	QUR4	3	1.20	1.10	0.26	0.15	0.44	1.76	0.80	1.30
	QUR5	3	1.60	1.63	0.35	0.20	0.76	2.51	1.30	2.00
	QUR6	3	2.70	3.73	3.47	2.00	-4.88	12.35	0.90	7.60
	CAR	3	0.80	0.87	0.21	0.12	0.35	1.38	0.70	1.10
	BLC	3	0.27	0.26	0.02	0.01	0.21	0.32	0.24	0.28
Chromium	QUR1	3	0.00	0.25	0.00	0.00	0.25	0.25	0.25	0.25
	QUR2	3	0.00	0.25	0.00	0.00	0.25	0.25	0.25	0.25
	QUR3	3	0.25	2.17	3.32	1.92	-6.08	10.41	0.25	6.00
	QUR4	3	0.25	6.17	10.25	5.92	-19.29	31.62	0.25	18.00
	QUR5	3	10.0	8.4	7.50	4.33	-10.22	27.05	0.25	15.00
	QUR6	3	12.0	14.0	6.24	3.61	-1.51	29.51	9.00	21.00
	CAR	3	0.25	2.50	3.90	2.25	-7.18	12.18	0.25	7.00
	BLC	3	0.00	0.25	0.00	0.00	0.25	0.25	0.25	0.25
Cobalt	QUR1	3	0.91	0.9	0.1	0.0	0.8	1.1	0.9	1.0
	QUR2	3	0.96	0.9	0.2	0.1	0.5	1.4	0.8	1.1
	QUR3	3	2.4	2.1	0.5	0.3	1.0	3.3	1.6	2.4
	QUR4	3	7.7	7.1	1.8	1.0	2.6	11.6	5.1	8.6
	QUR5	3	4.4	4.6	3.5	2.0	-4.0	13.2	1.3	8.2
	QUR6	3	3.5	4.9	2.7	1.6	-1.9	11.8	3.2	8.1
	CAR	3	1.7	1.6	0.8	0.4	-0.3	3.5	0.8	2.3
	BLC	3	2	2.0	0.2	0.1	1.6	2.3	1.8	2.1
Copper	QUR1	3	47	46.7	2.5	1.5	40.4	52.9	44	49
	QUR2	3	42	42.3	2.5	1.5	36.1	48.6	40	45
	QUR3	3	51	53.0	4.4	2.5	42.2	63.8	50	58
	QUR4	3	49	50.0	3.6	2.1	41.0	59.0	47	54
	QUR5	3	49	50.3	13.1	7.5	17.9	82.8	38	64
	QUR6	3	45	87.0	80.7	46.6	-113	287	36	180
	CAR	3	27	29.7	7.4	4.3	11.4	48.0	24	38
	BLC	3	22	20.7	2.3	1.3	14.9	26.4	18	22
Iron	QUR1	3	1,000	1,023	68	39.3	854	1,192	970	1,100
	QUR2	3	750	810	168	97.1	392	1,228	680	1,000
	QUR3	3	2,900	2,600	889	513	392	4,808	1,600	3,300
	QUR4	3	17,300	15,767	4,788	2,764	3,873	27,660	10,400	19,600
	QUR5	3	8,800	7,100	4,403	2,542	-3,839	18,039	2,100	10,400
	QUR6	3	7,200	8,567	3,459	1,997	-25	17,159	6,000	12,500
	CAR	3	2,600	2,467	1,604	926	-1,518	6,452	800	4,000
	BLC	3	2,600	2,667	404	233	1,663	3,671	2,300	3,100
Lead	QUR1	3	0.37	0.4	0.0	0.0	0.3	0.4	0.3	0.4
	QUR2	3	0.24	0.3	0.1	0.1	0.1	0.5	0.2	0.4
	QUR3	3	0.68	0.7	0.2	0.1	0.2	1.2	0.5	0.9
	QUR4	3	5.2	4.6	1.7	1.0	0.4	8.8	2.7	5.9
	QUR5	3	1.9	1.7	1.2	0.7	-1.1	4.6	0.5	2.8
	QUR6	3	1.7	2.0	0.8	0.5	0.0	4.0	1.4	2.9
	CAR	3	1.5	1.6	1.5	0.9	-2.2	5.3	0.1	3.1
	BLC	3	0.25	0.3	0.0	0.0	0.2	0.3	0.2	0.3
Manganese	QUR1	3	94	93.0	4.6	2.6	81.6	104	88	97
	QUR2	3	73	75.0	20.1	11.6	25.1	125	56	96
	QUR3	3	130	123	20.8	12.0	71.6	175	100	140
	QUR4	3	400	373	103	59.3	118	628	260	460
	QUR5	3	230	250	181	104	-199	699	80	440
	QUR6	3	190	233	102	59.0	-20.4	487	160	350
	CAR	3	180	137	83.9	48.4	-71.7	345	40	190
	BLC	3	460	473	61.1	35.3	322	625	420	540

Table H.4: Descriptive statistics of tissue metal and metalloid concentrations of Perlidae samples that were tested for statistical difference, Mount Polley Mine, 2014.

Metal	Area	n	Median	Mean	Standard Deviation	Standard Error	95% Confidence Interval (Mean)		Min	Max
							Lower Bound	Upper Bound		
Nickel	QUR1	3	2.8	2.8	0.1	0.1	2.6	3.0	2.7	2.9
	QUR2	3	2	2.1	0.4	0.2	1.1	3.2	1.8	2.6
	QUR3	3	4.9	4.5	0.8	0.5	2.6	6.4	3.6	5.0
	QUR4	3	24	21.3	6.4	3.7	5.4	37.3	14.0	26.0
	QUR5	3	12	9.4	5.5	3.1	-4.2	22.9	3.1	13.0
	QUR6	3	25	21.3	10.0	5.8	-3.5	46.2	10.0	29.0
	CAR	3	5.2	5.2	2.3	1.3	-0.5	10.9	2.9	7.5
	BLC	3	7.1	7.4	1.1	0.6	4.6	10.2	6.4	8.6
Selenium	QUR1	3	3.2	3.3	0.3	0.2	2.5	4.1	3.1	3.7
	QUR2	3	3.0	3.1	0.2	0.1	2.7	3.5	3.0	3.3
	QUR3	3	3.7	3.6	0.2	0.1	3.0	4.1	3.3	3.7
	QUR4	3	1.6	1.5	0.1	0.1	1.2	1.8	1.4	1.6
	QUR5	3	2.0	2.4	0.8	0.5	0.3	4.4	1.8	3.3
	QUR6	3	2.3	5.5	6.6	3.8	-10.8	21.7	1.1	13.0
	CAR	3	2.3	2.1	0.5	0.3	0.8	3.3	1.5	2.4
	BLC	3	0.6	0.6	0.1	0.0	0.4	0.7	0.5	0.6
Silver	QUR1	3	0.21	0.21	0.03	0.01	0.14	0.27	0.18	0.23
	QUR2	3	0.19	0.19	0.01	0.00	0.17	0.20	0.18	0.19
	QUR3	3	0.22	0.22	0.03	0.01	0.15	0.28	0.19	0.24
	QUR4	3	0.10	0.08	0.03	0.02	0.01	0.16	0.05	0.10
	QUR5	3	0.10	0.12	0.08	0.04	-0.07	0.31	0.05	0.20
	QUR6	3	0.10	0.18	0.19	0.11	-0.29	0.65	0.05	0.40
	CAR	3	0.30	0.30	0.10	0.06	0.05	0.55	0.20	0.40
	BLC	3	0.05	0.05	0.01	0.00	0.03	0.06	0.04	0.05
Strontium	QUR1	3	27	28.7	3.8	2.2	19.3	38.1	26	33
	QUR2	3	30	24.3	10.7	6.2	-2.2	50.9	12	31
	QUR3	3	29	26.7	6.8	3.9	9.8	43.6	19	32
	QUR4	3	60	56.7	15.3	8.8	18.7	94.6	40	70
	QUR5	3	30	26.7	5.8	3.3	12.3	41.0	20	30
	QUR6	3	20	30.0	17.3	10.0	-13.0	73.0	20	50
	CAR	3	13	15.0	4.4	2.5	4.2	25.8	12	20
	BLC	3	16	15.7	2.5	1.5	9.4	21.9	13	18
Titanium	QUR1	3	39	39.3	4.5	2.6	28.1	50.5	35	44
	QUR2	3	26	27.7	6.7	3.8	11.1	44.2	22	35
	QUR3	3	110	103	41.0	23.6	1.3	205	59	140
	QUR4	3	1,000	860	333	192	33.1	1,687	480	1,100
	QUR5	3	240	246	171	98.5	-177	670	79	420
	QUR6	3	290	340	132	76.4	11.4	669	240	490
	CAR	3	40.0	33.0	23.2	13.4	-25	90.8	7.1	52.0
	BLC	3	160	153	30.6	17.6	77.4	229	120	180
Uranium	QUR1	3	0.07	0.07	0.01	0.01	0.05	0.09	0.06	0.08
	QUR2	3	0.06	0.07	0.02	0.01	0.03	0.11	0.06	0.09
	QUR3	3	0.13	0.12	0.02	0.01	0.06	0.17	0.09	0.13
	QUR4	3	0.78	0.72	0.18	0.11	0.26	1.17	0.51	0.86
	QUR5	3	0.38	0.30	0.16	0.09	-0.11	0.70	0.11	0.40
	QUR6	3	0.28	0.34	0.13	0.08	0.00	0.67	0.24	0.49
	CAR	3	0.19	0.14	0.10	0.06	-0.11	0.38	0.03	0.20
	BLC	3	0.09	0.08	0.01	0.01	0.05	0.11	0.07	0.09
Vanadium	QUR1	3	2.5	2.6	0.4	0.2	1.6	3.6	2	3
	QUR2	3	1.6	1.9	0.5	0.3	0.7	3.0	2	2
	QUR3	3	8.4	7.7	2.8	1.6	0.8	14.6	5	10
	QUR4	3	50	40.0	17.3	10.0	-3.0	83.0	20	50
	QUR5	3	18	13.7	8.4	4.8	-7.2	34.5	4	19
	QUR6	3	15	15.7	4.0	2.3	5.6	25.7	12	20
	CAR	3	4	3.5	2.8	1.6	-3.4	10.4	1	6
	BLC	3	6.1	6.1	1.1	0.6	3.5	8.7	5	7
Zinc	QUR1	3	380	380	20.0	11.5	330	430	360	400
	QUR2	3	350	350	10.0	5.8	325	375	340	360
	QUR3	3	340	343	45.1	26.0	231	455	300	390
	QUR4	3	110	110	10.0	5.8	85.2	135	100	120
	QUR5	3	230	250	81.9	47.3	46.7	453	180	340
	QUR6	3	200	340	314	181	-441	1,121	120	700
	CAR	3	400	353	127	73.1	38.8	668	210	450
	BLC	3	90	87.0	5.2	3.0	74.1	99.9	81	90

APPENDIX I

STATISTICAL EXAMINATION OF RELATIONSHIPS

CONTENTS OF APPENDIX I

TABLES

FIGURES

Table I.1: Spearman's Rank Correlation results for correlation of toxicity test results and benthic invertebrate community metrics in Polley and Bootjack Lake mid-depth sampling areas, Mount Polley Mine, 2014 [1].

Physical/Chemical Parameter		Correlation Parameter	Toxicity Endpoints			
			Hyalella azteca		*Chironomus dilutus*	
			Normalized Survival	Normalized Growth	Normalized Survival	Normalized Growth
Benthic Invrtebrate Community Metric	Density (Ind./m^2)	Correlation Coefficient	0.161	-0.125	0.504	-0.333
		Sig. (2-tailed)	0.5655	0.6560	0.0552	0.2247
	Number of Taxa	Correlation Coefficient	-0.046	0.141	0.099	0.078
		Sig. (2-tailed)	0.8697	0.6174	0.7253	0.7810
	Simpson's D	Correlation Coefficient	-0.085	0.232	0.011	0.256
		Sig. (2-tailed)	0.7643	0.4047	0.9681	0.3579
	Simpson's E	Correlation Coefficient	0.068	-0.007	-0.398	0.309
		Sig. (2-tailed)	0.8094	0.9798	0.1423	0.2621
	Bray Curtis Index	Correlation Coefficient	-0.144	0.088	-0.419	0.350
		Sig. (2-tailed)	0.6075	0.7563	0.1199	0.2005
	EPT (%)	Correlation Coefficient	-0.286	-0.186	-0.033	0.186
		Sig. (2-tailed)	0.3019	0.5079	0.9082	0.5079
	Ceratopogonidae (%)	Correlation Coefficient	-0.286	0.062	-0.033	-0.124
		Sig. (2-tailed)	0.3019	0.8266	0.9082	0.6605
	Chironomidae (%)	Correlation Coefficient	0.289	0.154	-0.316	-0.107
		Sig. (2-tailed)	0.2967	0.5848	0.2509	0.7039
	Acari (%)	Correlation Coefficient	-0.032	0.287	0.137	0.081
		Sig. (2-tailed)	0.9101	0.2996	0.6271	0.7747
	Bivalves (%)	Correlation Coefficient	-0.286	0.062	-0.033	-0.124
		Sig. (2-tailed)	0.3019	0.8266	0.9082	0.6605
	Oligochaetes (%)	Correlation Coefficient	-0.419	-0.145	0.122	0.130
		Sig. (2-tailed)	0.1201	0.6067	0.6662	0.6430
	CA Axis 1 (44.3%)	Correlation Coefficient	-0.182	-0.245	0.069	-0.130
		Sig. (2-tailed)	0.5171	0.3791	0.8076	0.6430
	CA Axis 2 (22.6%)	Correlation Coefficient	-0.665	0.066	0.012	0.295
		Sig. (2-tailed)	0.0069	0.8149	0.9655	0.2860
	CA Axis 3 (20.2%)	Correlation Coefficient	0.144	0.270	-0.404	0.170
		Sig. (2-tailed)	0.6075	0.3307	0.1352	0.5452

Significant correlation; p-value < 0.0001 (Bonferroni corrected p-value for 408 comparisons among Table 6.7 and Appendix Table I.1).
Correlation scatterplot inspected; p <0.01.

[1] Values < method detection limit (MDL) were used at the MDL for calculations. Normalized survival and growth are relative to corresponding laboratory controls.

Note: n=15 for all correlations.

Table I.2: Spearman's Rank Correlation results for correlation of toxicity test results and benthic invertebrate community metrics in Polley and Bootjack Lake deep sampling areas, Mount Polley Mine, 2014 [1].

Physical/Chemical Parameter		Correlation Parameter	Toxicity Endpoints			
			Hyalella azteca		*Chironomus dilutus*	
			Normalized Survival	Normalized Growth	Normalized Survival	Normalized Growth
Benthic Invrtebrate Community Metric	Density (Ind./m^2)	Correlation Coefficient	-0.265	-0.131	0.050	-0.004
		Sig. (2-tailed)	0.4045	0.6860	0.8778	0.9913
	Number of Taxa	Correlation Coefficient	-0.103	-0.115	0.005	-0.194
		Sig. (2-tailed)	0.7491	0.7216	0.9866	0.5451
	Simpson's D	Correlation Coefficient	-0.280	-0.116	0.172	0.022
		Sig. (2-tailed)	0.3775	0.7195	0.5932	0.9465
	Simpson's E	Correlation Coefficient	-0.282	-0.723	0.279	0.284
		Sig. (2-tailed)	0.3752	0.0078	0.3797	0.3715
	Bray Curtis Index (BOL-B1 and BOL-B2)	Correlation Coefficient	0.443	-0.029	0.337	-0.094
		Sig. (2-tailed)	0.1490	0.9287	0.2848	0.7707
	Chironomidae (%)	Correlation Coefficient	-0.349	0.056	0.134	0.056
		Sig. (2-tailed)	0.2662	0.8628	0.6788	0.8628
	Acari (%)	Correlation Coefficient	0.098	-0.203	-0.169	-0.405
		Sig. (2-tailed)	0.7624	0.5274	0.5992	0.1910
	Oligochaetes (%)	Correlation Coefficient	-0.074	-0.787	-0.082	-0.004
		Sig. (2-tailed)	0.8199	0.0024	0.8004	0.9913
	CA Axis 1 (30.7%)	Correlation Coefficient	0.413	-0.399	0.149	-0.159
		Sig. (2-tailed)	0.1823	0.1993	0.6429	0.6222
	CA Axis 2 (18.3%)	Correlation Coefficient	0.560	0.109	0.107	-0.314
		Sig. (2-tailed)	0.0582	0.7351	0.7412	0.3203
	CA Axis 3 (14.9%)	Correlation Coefficient	0.022	0.815	-0.142	0.095
		Sig. (2-tailed)	0.9456	0.0012	0.6590	0.7684

Significant correlation; p-value < 0.0001 (Bonferroni corrected p-value for 336 comparisons among Table 6.8 and Appendix Table I.2).
Correlation scatterplot inspected; p <0.01.

[1] Values < method detection limit (MDL) were used at the MDL for calculations. Normalized survival and growth are relative to corresponding laboratory controls.

Note: n=12 for all correlations.

Table I.3: Spearman's Rank Correlation results for correlation of toxicity test results and benthic invertebrate community metrics in Quesnel Lake littoral sampling areas, Mount Polley Mine, 2014 [1].

	Physical/Chemical Parameter	Correlation Parameter	Toxicity Endpoints			
			Hyalella azteca		*Chironomus dilutus*	
			Normalized Survival	Normalized Growth	Normalized Survival	Normalized Growth
Benthic Invertebrate Community Metrics	Density (Ind./m^2)	Correlation Coefficient	0.649	0.315	0.613	0.030
		Sig. (2-tailed)	0.0001	0.0896	0.0003	0.8729
	Number of Taxa	Correlation Coefficient	0.616	0.441	0.328	0.265
		Sig. (2-tailed)	0.0003	0.0147	0.0772	0.1569
	Simpson's D	Correlation Coefficient	0.490	0.578	0.102	0.494
		Sig. (2-tailed)	0.0060	0.0008	0.5904	0.0056
	Simpson's E	Correlation Coefficient	-0.215	0.082	-0.339	0.155
		Sig. (2-tailed)	0.2531	0.6683	0.0667	0.4124
	Bray Curtis Index (LRef1 and LRef2)	Correlation Coefficient	-0.191	-0.174	-0.320	-0.444
		Sig. (2-tailed)	0.3111	0.3574	0.0851	0.0139
	EPT (%)	Correlation Coefficient	0.365	0.529	-0.052	0.381
		Sig. (2-tailed)	0.0474	0.0027	0.7860	0.0379
	Ceratopogonidae (%)	Correlation Coefficient	0.358	0.434	-0.032	0.458
		Sig. (2-tailed)	0.0521	0.0165	0.8665	0.0109
	Chironomidae (%)	Correlation Coefficient	0.160	-0.101	0.372	-0.323
		Sig. (2-tailed)	0.3972	0.5961	0.0430	0.0819
	Amphipoda (%)	Correlation Coefficient	0.417	0.461	0.088	0.198
		Sig. (2-tailed)	0.0219	0.0103	0.6435	0.2934
	Acari (%)	Correlation Coefficient	-0.200	-0.275	0.156	0.480
		Sig. (2-tailed)	0.2905	0.1419	0.4104	0.0072
	Bivalves (%)	Correlation Coefficient	0.452	0.742	0.100	0.233
		Sig. (2-tailed)	0.0122	<0.0000	0.5983	0.2143
	Gastropods (%)	Correlation Coefficient	0.440	0.585	-0.094	-0.014
		Sig. (2-tailed)	0.0150	0.0007	0.6208	0.9410
	Hirudinea (%)	Correlation Coefficient	0.224	0.264	0.071	0.382
		Sig. (2-tailed)	0.2339	0.1584	0.7085	0.0372
	Oligochaetes (%)	Correlation Coefficient	-0.301	-0.275	-0.160	0.246
		Sig. (2-tailed)	0.1066	0.1407	0.3973	0.1894
	CA Axis 1 (19.0 %)	Correlation Coefficient	0.620	0.674	0.239	0.057
		Sig. (2-tailed)	0.0003	<0.0000	0.2026	0.7649
	CA Axis 2 (16.3 %)	Correlation Coefficient	0.018	0.310	-0.338	0.325
		Sig. (2-tailed)	0.9233	0.0956	0.0675	0.0802

Significant correlation; p-value < 0.00009 (Bonferroni corrected p-value for 556 comparisons among Tables 7.8 and Appendix Table I.3).
Correlation scatterplot inspected; p <0.01.

[1] Values < method detection limit (MDL) were used at the MDL for calculations. Normalized survival and growth are relative to associated laboratory control.

Note: n=30 for all correlations.

Table I.4: Spearman's Rank Correlation results for correlation of toxicity test results and benthic invertebrate community metrics in Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014 [1,2].

	Physical/Chemical Parameter	Correlation Parameter	*Hyalella azteca*		*Chironomus dilutus*	
			Normalized Survival	Normalized Growth	Normalized Survival	Normalized Growth
Benthic Invertebrate Community Metrics	Density (Ind./m^2)	Correlation Coefficient	0.109	0.524	0.693	0.443
		Sig. (2-tailed)	0.5680	0.0030	<0.0000	0.0143
	Number of Taxa	Correlation Coefficient	-0.127	0.562	0.531	0.275
		Sig. (2-tailed)	0.5045	0.0012	0.0025	0.1418
	Simpson's D	Correlation Coefficient	-0.028	0.322	0.232	0.120
		Sig. (2-tailed)	0.8823	0.0831	0.2173	0.5292
	Simpson's E	Correlation Coefficient	-0.146	-0.077	-0.104	-0.291
		Sig. (2-tailed)	0.4429	0.6861	0.5859	0.1187
	Bray Curtis Index (PRef1 and PRef2)	Correlation Coefficient	0.034	-0.463	-0.647	-0.467
		Sig. (2-tailed)	0.8591	0.0101	0.0001	0.0093
	EPT (%)	Correlation Coefficient	-0.074	0.381	0.188	0.141
		Sig. (2-tailed)	0.6986	0.0380	0.3190	0.4575
	Ceratopogonidae (%)	Correlation Coefficient	-0.068	0.680	0.453	-0.019
		Sig. (2-tailed)	0.7211	<0.0000	0.0120	0.9215
	Chironomidae (%)	Correlation Coefficient	-0.048	0.110	0.383	0.327
		Sig. (2-tailed)	0.8004	0.5645	0.0366	0.0775
	Acari (%)	Correlation Coefficient	0.010	0.349	0.015	0.103
		Sig. (2-tailed)	0.9582	0.0587	0.9369	0.5875
	Bivalves (%)	Correlation Coefficient	-0.030	0.167	0.251	0.238
		Sig. (2-tailed)	0.8747	0.3776	0.1807	0.2056
	Gastropods (%)	Correlation Coefficient	0.087	-0.140	-0.064	-0.311
		Sig. (2-tailed)	0.6489	0.4609	0.7350	0.0942
	Oligochaetes (%)	Correlation Coefficient	-0.129	0.196	0.407	0.281
		Sig. (2-tailed)	0.4974	0.2983	0.0258	0.1330
	CA Axis 1 (41.3 %)	Correlation Coefficient	-0.130	0.425	0.044	-0.158
		Sig. (2-tailed)	0.4952	0.0192	0.8166	0.4049
	CA Axis 2 (18.6 %)	Correlation Coefficient	-0.084	0.001	0.307	0.167
		Sig. (2-tailed)	0.6592	0.9953	0.0994	0.3785
	CA Axis 3 (16.8 %)	Correlation Coefficient	0.120	0.220	-0.025	0.014
		Sig. (2-tailed)	0.5291	0.2423	0.8968	0.9402

Significant correlation; p-value < 0.0001 (Bonferroni corrected p-value for 432 comparisons among Table 8.8 and Appendix Table I.4).

Correlation scatterplot inspected; p <0.01.

[1] Values < method detection limit (MDL) were used at the MDL for calculations. Relative survival and growth are relative to associated laboratory control.

[2] For sampling areas where 5 toxicity field replicates were analysed for each station (Sampling areas PRef1, PNF, and PFF1), mean survival and growth measures (of the 5 replicates per station) were used for correlations with individual benthic invertebrate metrics from each station.

Note: n=30 for all correlations.

Table I.5: PCA results of total aqueous metals. Eigen value, percent variance explained, Monte Carlo randomization p-values of axis significance, and station scores of three reference and six exposed river areas, Mount Polley Mine, 2014.

Axis	PCA1	PCA2
Eigen Value	13.644	6.825
% Variance explained	62.0	31.0
Monte Carlo P	0.0001	0.0001
QUR1	2.48855	0.92035
QUR2	2.47969	1.06099
QUR3	2.4784	0.92027
QUR4	-5.53806	1.08818
QUR5	-6.79763	0.96402
QUR6	0.13095	0.86449
CAR	2.24398	1.1198
CLR	2.92704	-0.03398
BLC	-0.41292	-6.90414

Table I.6: Spearman's Rank correlation of total aqueous metal PCA axis scores with actual metal concentrations from river sampling areas, Mount Polley Mine, 2014.

Axis	**PCA1**		**PCA2**	
Statistic	r	p	r	p
Al	-0.733	0.025	0.183	0.637
As	-0.850	0.004	-0.183	0.637
Ba	-0.983	0.000	0.167	0.668
Ca	-0.879	0.002	0.510	0.160
Ch	-0.772	0.015	0.238	0.538
Co	-0.772	0.015	0.238	0.538
Cu	-0.542	0.131	0.356	0.347
Fe	-0.854	0.003	0.042	0.915
Pb	-0.644	0.061	0.357	0.346
Li	-0.683	0.042	-0.150	0.700
Mg	-0.946	0.000	0.025	0.949
Mn	-0.883	0.002	0.000	1.000
Mo	0.367	0.332	-0.733	0.025
Ni	-0.766	0.016	-0.131	0.738
K	-0.450	0.224	-0.367	0.332
Si	-0.667	0.050	-0.417	0.265
Na	-0.083	0.831	-0.350	0.356
Sr	0.000	1.000	0.383	0.308
Ti	-0.772	0.015	0.238	0.538
U	-0.820	0.007	-0.192	0.620
V	-0.913	0.001	-0.018	0.963
Zn	-0.730	0.025	0.388	0.302

[grey box] indicates a p-value below 0.05.

Table I.7: PCA results of dissolved aqueous metals. Eigen value, percent variance explained, Monte Carlo randomization p-values of axis significance, and station scores of three reference and six exposed river areas, Mount Polley Mine, 2014.

Axis	**PCA1**	**PCA2**
Eigen Value	9.729	2.581
% Variance explained	69.5	18.4
Monte Carlo P	0.0001	0.9073
QUR1	-1.37159	0.34277
QUR2	-1.4061	0.23191
QUR3	-1.42806	0.27526
QUR4	-0.44868	1.05627
QUR5	0.10504	1.69269
QUR6	-0.6457	1.14072
CAR	-1.36534	-0.36155
CLR	-1.61455	-3.83256
BLC	8.17498	-0.54551

Table I.8: Spearman's Rank correlation of dissloved aqueous metal PCA axis scores with actual metal concentrations from river sampling areas, Mount Polley Mine, 2014.

Axis	**PCA1**		**PCA2**	
Statistic	r	p	r	p
Al	-0.700	0.036	-0.200	0.606
As	0.793	0.011	0.439	0.237
Ba	0.917	0.001	0.383	0.308
Ca	0.787	0.012	0.594	0.092
Cu	-0.272	0.478	0.502	0.168
Li	0.717	0.030	0.400	0.286
Mg	0.900	0.001	0.300	0.433
Mn	0.833	0.005	0.367	0.332
Mo	-0.083	0.831	-0.450	0.224
K	-0.136	0.728	-0.458	0.215
Si	0.000	1.000	-0.410	0.273
Na	0.233	0.546	0.017	0.966
Sr	-0.059	0.881	0.714	0.031
U	0.883	0.002	0.217	0.576

[grey box] indicates a p-value below 0.05.

Table I.9: Statistical comparison summary of primary benthic invertebrate community metrics for reference area CLR and six Quesnel River areas. Metrics were calculated at the family level of taxonomic resolution, Mount Polley Mine, 2014.

Taxonomic Group (%)	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Total Abundance	Yes	0.208	Yes	0.000	1.000	CLR	QUR1	Yes	0.002	0.000	0.291	26,383	22	-	1.000
							QUR2	Yes	0.005	0.002	0.403	21,329	16	-	0.998
							QUR3	Yes	0.008	0.013	0.500	19,787	13	-	0.989
							QUR4	No	0.204	1.000	0.995	1,209	-	3.2	-
							QUR5	No	0.197	1.000	0.996	6,516	-	7.5	-
							QUR6	No	0.213	1.000	0.998	15,621	-	12	-
						QUR1	QUR2	No	0.217	1.000	0.994	45,910	-	3.7	-
							QUR3	Yes	0.097	0.245	0.886	44,369	-1.6	-	0.556
							QUR4	Yes	0.002	0.000	0.293	25,791	-4.3	-	1.000
							QUR5	Yes	0.004	0.000	0.222	31,097	-3.7	-	0.998
							QUR6	Yes	0.009	0.001	0.196	40,202	-3.5	-	0.986
						QUR2	QUR3	No	0.516	1.000	1.000	39,315	-	3.8	-
							QUR4	Yes	0.004	0.001	0.396	20,737	-3.6	-	0.999
							QUR5	Yes	0.012	0.010	0.369	26,043	-2.9	-	0.970
							QUR6	Yes	0.026	0.022	0.439	35,148	-2.6	-	0.878
						QUR3	QUR4	Yes	0.006	0.007	0.482	19,195	-3.1	-	0.996
							QUR5	Yes	0.023	0.061	0.523	24,502	-2.4	-	0.902
							QUR6	Yes	0.051	0.130	0.673	33,607	-2.1	-	0.732
						QUR4	QUR5	Yes	0.082	1.000	0.952	5,924	5.8	-	0.602
							QUR6	No	0.125	1.000	0.987	15,029	-	19	-
						QUR5	QUR6	No	0.695	1.000	1.000	20,335	-	5.3	-
Richness	Yes	0.144	Yes	0.006	0.976	CLR	QUR1	No	0.196	1.000	0.995	2.5	-	3.1	-
							QUR2	No	0.148	1.000	0.982	10	-	6.3	-
							QUR3	No	0.448	1.000	1.000	8.5	-	5.7	-
							QUR4	Yes	0.006	0.366	0.405	2.2	-3.2	-	0.995
							QUR5	No	0.448	1.000	1.000	8.5	-	5.7	-
							QUR6	No	0.202	1.000	0.994	7.2	-	5.3	-
						QUR1	QUR2	No	0.329	1.000	1.000	8.7	-	12	-
							QUR3	No	1.000	1.000	1.000	7.0	-	10	-
							QUR4	Yes	0.000	0.068	0.017	0.67	-8.3	-	1.000
							QUR5	No	0.138	1.000	0.987	7.0	-	10	-
							QUR6	Yes	0.052	0.831	0.867	5.7	-5.3	-	0.728
						QUR2	QUR3	No	0.442	1.000	1.000	15	-	3.7	-
							QUR4	Yes	0.010	0.007	0.574	8.3	-2.7	-	0.982
							QUR5	Yes	0.100	0.277	0.893	15	-1.6	-	0.547
							QUR6	Yes	0.055	0.090	0.715	13	-2.0	-	0.712
						QUR3	QUR4	Yes	0.017	0.068	0.687	6.7	-2.3	-	0.940
							QUR5	No	0.246	1.000	0.997	13	-	3.9	-
							QUR6	No	0.128	0.831	0.945	12	-	3.7	-
						QUR4	QUR5	No	0.109	1.000	0.980	6.7	-	18	-
							QUR6	No	0.187	1.000	0.997	5.3	-	16	-
						QUR5	QUR6	No	0.658	1.000	1.000	12	-	3.7	-
Diversity (Simpson's)	No	0.019	No	0.128	0.689	CLR	QUR1	-	-	-	-	0.0078	-	4.2	-
							QUR2	-	-	-	-	0.0086	-	4.4	-
							QUR3	-	-	-	-	0.0043	-	3.1	-
							QUR4	-	-	-	-	0.017	-	6.1	-
							QUR5	-	-	-	-	0.0049	-	3.3	-
							QUR6	-	-	-	-	0.033	-	8.5	-
						QUR1	QUR2	-	-	-	-	0.0095	-	4.1	-
							QUR3	-	-	-	-	0.0052	-	3.0	-
							QUR4	-	-	-	-	0.018	-	5.6	-
							QUR5	-	-	-	-	0.0058	-	3.2	-
							QUR6	-	-	-	-	0.033	-	7.7	-
						QUR2	QUR3	-	-	-	-	0.0060	-	3.0	-
							QUR4	-	-	-	-	0.018	-	5.2	-
							QUR5	-	-	-	-	0.0066	-	3.1	-
							QUR6	-	-	-	-	0.034	-	7.2	-
						QUR3	QUR4	-	-	-	-	0.014	-	11	-
							QUR5	-	-	-	-	0.0023	-	4.6	-
							QUR6	-	-	-	-	0.030	-	17	-
						QUR4	QUR5	-	-	-	-	0.015	-	2.9	-
							QUR6	-	-	-	-	0.042	-	5.0	-
						QUR5	QUR6	-	-	-	-	0.030	-	13	-

Table I.9: Statistical comparison summary of primary benthic invertebrate community metrics for reference area CLR and six Quesnel River areas. Metrics were calculated at the family level of taxonomic resolution, Mount Polley Mine, 2014.

Taxonomic Group (%)	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Evenness (Simpson's)	Yes	0.074	Yes	0.037	0.865	CLR	QUR1	No	0.405	1.000	1.000	0.031	-	3.1	-
							QUR2	No	0.251	1.000	0.999	0.025	-	2.8	-
							QUR3	No	0.102	1.000	0.971	0.025	-	2.9	-
							QUR4	No	0.308	1.000	1.000	0.056	-	4.3	-
							QUR5	No	0.303	1.000	1.000	0.030	-	3.1	-
							QUR6	No	0.490	1.000	1.000	0.040	-	3.6	-
						QUR1	QUR2	No	0.610	1.000	1.000	0.0079	-	3.0	-
							QUR3	No	0.128	1.000	0.972	0.0082	-	3.1	-
							QUR4	Yes	0.090	0.317	0.930	0.039	3.1	-	0.576
							QUR5	No	0.731	1.000	1.000	0.013	-	3.8	-
							QUR6	No	0.952	1.000	1.000	0.023	-	5.2	-
						QUR2	QUR3	Yes	0.070	1.000	0.787	0.0026	-2.2	-	0.647
							QUR4	Yes	0.056	0.172	0.910	0.033	8.5	-	0.709
							QUR5	No	0.937	1.000	1.000	0.0073	-	7.1	-
							QUR6	No	0.681	1.000	1.000	0.018	-	11	-
						QUR3	QUR4	Yes	0.029	0.036	0.784	0.034	9.3	-	0.859
							QUR5	No	0.205	1.000	0.996	0.0076	-	6.3	-
							QUR6	No	0.244	1.000	0.999	0.018	-	9.8	-
						QUR4	QUR5	Yes	0.070	0.188	0.889	0.038	-1.5	-	0.647
							QUR6	No	0.124	0.358	0.948	0.049	-	3.4	-
						QUR5	QUR6	No	0.749	1.000	1.000	0.023	-	5.3	-
NMS-1	No	0.008	Yes	0.019	0.923	CLR	QUR1	Yes	0.076	0.050	0.958	1.2	1.4	-	0.625
							QUR2	Yes	0.093	0.079	0.968	1.2	1.3	-	0.569
							QUR3	Yes	0.097	0.094	0.974	1.2	1.3	-	0.556
							QUR4	No	0.336	1.000	1.000	1.2	-	2.9	-
							QUR5	No	0.390	1.000	1.000	1.3	-	2.9	-
							QUR6	No	0.474	1.000	1.000	1.5	-	3.1	-
						QUR1	QUR2	No	0.447	1.000	1.000	0.037	-	19	-
							QUR3	No	0.172	1.000	0.996	0.018	-	13	-
							QUR4	Yes	0.006	1.000	0.499	0.066	-28	-	0.995
							QUR5	Yes	0.009	1.000	0.589	0.10	-30	-	0.983
							QUR6	Yes	0.043	0.747	0.888	0.31	-33	-	0.773
						QUR2	QUR3	No	0.800	1.000	1.000	0.053	-	3.4	-
							QUR4	Yes	0.020	1.000	0.386	0.10	-3.6	-	0.920
							QUR5	Yes	0.023	1.000	0.495	0.14	-4.0	-	0.899
							QUR6	Yes	0.067	1.000	0.906	0.34	-4.4	-	0.658
						QUR3	QUR4	Yes	0.017	1.000	0.465	0.083	-5.0	-	0.939
							QUR5	Yes	0.021	1.000	0.594	0.12	-5.6	-	0.911
							QUR6	Yes	0.070	1.000	0.933	0.32	-6.1	-	0.646
						QUR4	QUR5	No	0.766	1.000	1.000	0.17	-	4.4	-
							QUR6	No	0.696	1.000	1.000	0.37	-	6.6	-
						QUR5	QUR6	No	0.853	1.000	1.000	0.41	-	5.6	-
NMS-2	No	0.016	No	0.157	0.651	CLR	QUR1	-	-	-	-	0.094	-	3.8	-
							QUR2	-	-	-	-	0.078	-	3.4	-
							QUR3	-	-	-	-	0.078	-	3.5	-
							QUR4	-	-	-	-	0.58	-	9.4	-
							QUR5	-	-	-	-	0.066	-	3.2	-
							QUR6	-	-	-	-	0.18	-	5.2	-
						QUR1	QUR2	-	-	-	-	0.071	-	3.5	-
							QUR3	-	-	-	-	0.071	-	3.6	-
							QUR4	-	-	-	-	0.57	-	10	-
							QUR5	-	-	-	-	0.059	-	3.2	-
							QUR6	-	-	-	-	0.17	-	5.5	-
						QUR2	QUR3	-	-	-	-	0.055	-	3.9	-
							QUR4	-	-	-	-	0.55	-	13	-
							QUR5	-	-	-	-	0.043	-	3.5	-
							QUR6	-	-	-	-	0.16	-	6.6	-
						QUR3	QUR4	-	-	-	-	0.55	-	12	-
							QUR5	-	-	-	-	0.043	-	3.5	-
							QUR6	-	-	-	-	0.16	-	6.6	-
						QUR4	QUR5	-	-	-	-	0.54	-	2.8	-
							QUR6	-	-	-	-	0.65	-	3.1	-
						QUR5	QUR6	-	-	-	-	0.14	-	8.4	-

[a] Bonferroni post-hoc Test, or Dunnet's T3 Test where variances were found to be heterogenous by Levene's Test

[b] Due to low replication (3 per area) T-Tests are used as post-hoc test of significance between areas - Bonferroni and Tamhane post-hoc tests are reported for interest only.

[c] Magnitude calculated by comparing the difference between the control area and exposed area means to the control area standard deviation (SD) [(exposed mean - control mean) / standard deviation of the control mean]

[d] Minimum effect size detectable calculated based on variance as square root of MSE from ANOVA and alpha = beta = 0.10.
Minimum effect size reported as the minimum number of standard deviations detectable based on reference area standard deviation.

Highlighted values indicate significance at the *p* < 0.10 level.

Table I.10: Statistical comparison summary of primary benthic invertebrate community metrics for reference area CAR and six Quesnel River areas. Metrics were calculated at the family level of taxonomic resolution, Mount Polley Mine, 2014.

Taxonomic Group (%)	Overall 7-group ANOVA: Variance Equal?	Overall 7-group ANOVA: Variance Levene p-value	Overall 7-group ANOVA: Significant Difference Among Areas?	Overall 7-group ANOVA: p-value	Overall 7-group ANOVA: Power	Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]: Significant Difference Between Areas?[b]	p-value: T-Test	p-value: Bonferroni	p-value: Tahmane	2-group ANOVA for Estimation of Effect Size: MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
Total Abundance	Yes	0.203	Yes	0.000	1.000	CAR	QUR1	Yes	0.006	0.001	0.450	26,290	18	-	0.996
							QUR2	Yes	0.018	0.058	0.681	21,236	12	-	0.935
							QUR3	Yes	0.038	0.348	0.842	19,695	8.7	-	0.801
							QUR4	Yes	0.001	1.000	0.033	1,117	-6.4	-	1.000
							QUR5	No	0.159	1.000	0.990	6,423	-	7.8	-
							QUR6	No	0.563	1.000	1.000	15,528	-	12	-
						QUR1	QUR2	No	0.217	1.000	0.994	45,910	-	3.7	-
							QUR3	Yes	0.097	0.245	0.886	44,369	-1.6	-	0.556
							QUR4	Yes	0.002	0.000	0.293	25,791	-4.3	-	1.000
							QUR5	Yes	0.004	0.000	0.222	31,097	-3.7	-	0.998
							QUR6	Yes	0.009	0.001	0.196	40,202	-3.5	-	0.986
						QUR2	QUR3	No	0.516	1.000	1.000	39,315	-	3.8	-
							QUR4	Yes	0.004	0.001	0.396	20,737	-3.6	-	0.999
							QUR5	Yes	0.012	0.010	0.369	26,043	-2.9	-	0.970
							QUR6	Yes	0.026	0.022	0.439	35,148	-2.6	-	0.878
						QUR3	QUR4	Yes	0.006	0.007	0.482	19,195	-3.1	-	0.996
							QUR5	Yes	0.023	0.061	0.523	24,502	-2.4	-	0.902
							QUR6	Yes	0.051	0.130	0.673	33,607	-2.1	-	0.732
						QUR4	QUR5	Yes	0.082	1.000	0.952	5,924	5.8	-	0.602
							QUR6	No	0.125	1.000	0.987	15,029	-	19	-
						QUR5	QUR6	No	0.695	1.000	1.000	20,335	-	5.3	-
Richness	Yes	0.085	Yes	0.002	0.996	CAR	QUR1	Yes	0.039	1.000	0.576	1.2	-2.3	-	0.796
							QUR2	No	1.000	1.000	1.000	8.8	-	10	-
							QUR3	No	0.289	1.000	1.000	7.2	-	9.1	-
							QUR4	Yes	0.000	0.006	0.016	0.83	-9.5	-	1.000
							QUR5	Yes	0.038	0.243	0.799	7.2	-5.8	-	0.802
							QUR6	Yes	0.015	0.077	0.553	5.8	-6.9	-	0.949
						QUR1	QUR2	No	0.329	1.000	1.000	8.7	-	12	-
							QUR3	No	1.000	1.000	1.000	7.0	-	10	-
							QUR4	Yes	0.000	0.057	0.017	0.67	-8.3	-	1.000
							QUR5	No	0.138	1.000	0.987	7.0	-	10	-
							QUR6	Yes	0.052	0.750	0.867	5.7	-5.3	-	0.728
						QUR2	QUR3	No	0.442	1.000	1.000	15	-	3.7	-
							QUR4	Yes	0.010	0.006	0.574	8.3	-2.7	-	0.982
							QUR5	Yes	0.100	0.243	0.893	15	-1.6	-	0.547
							QUR6	Yes	0.055	0.077	0.715	13	-2.0	-	0.712
						QUR3	QUR4	Yes	0.017	0.057	0.687	6.7	-2.3	-	0.940
							QUR5	No	0.246	1.000	0.997	13	-	3.9	-
							QUR6	No	0.128	0.750	0.945	12	-	3.7	-
						QUR4	QUR5	No	0.109	1.000	0.980	6.7	-	18	-
							QUR6	No	0.187	1.000	0.997	5.3	-	16	-
						QUR5	QUR6	No	0.658	1.000	1.000	12	-	3.7	-
Diversity (Simpson's)	No	0.013	No	0.167	0.640	CAR	QUR1	-	-	-	-	0.0056	-	5.9	-
							QUR2	-	-	-	-	0.0064	-	6.3	-
							QUR3	-	-	-	-	0.0021	-	3.6	-
							QUR4	-	-	-	-	0.014	-	9.5	-
							QUR5	-	-	-	-	0.0027	-	4.1	-
							QUR6	-	-	-	-	0.030	-	14	-
						QUR1	QUR2	-	-	-	-	0.010	-	4.1	-
							QUR3	-	-	-	-	0.0052	-	3.0	-
							QUR4	-	-	-	-	0.018	-	5.6	-
							QUR5	-	-	-	-	0.0058	-	3.2	-
							QUR6	-	-	-	-	0.033	-	7.7	-
						QUR2	QUR3	-	-	-	-	0.0060	-	3.0	-
							QUR4	-	-	-	-	0.018	-	5.2	-
							QUR5	-	-	-	-	0.0066	-	3.1	-
							QUR6	-	-	-	-	0.034	-	7.2	-
						QUR3	QUR4	-	-	-	-	0.014	-	11	-
							QUR5	-	-	-	-	0.0023	-	4.6	-
							QUR6	-	-	-	-	0.030	-	17	-
						QUR4	QUR5	-	-	-	-	0.015	-	2.9	-
							QUR6	-	-	-	-	0.042	-	5.0	-
						QUR5	QUR6	-	-	-	-	0.030	-	13	-

Table I.10: Statistical comparison summary of primary benthic invertebrate community metrics for reference area CAR and six Quesnel River areas. Metrics were calculated at the family level of taxonomic resolution, Mount Polley Mine, 2014.

Taxonomic Group (%)	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Evenness (Simpson's)	No	0.048	Yes	0.013	0.944	CAR	QUR1	No	0.382	1.000	1.000	0.0081	-	6.9	-
							QUR2	No	0.472	1.000	1.000	0.0024	-	3.8	-
							QUR3	No	0.181	1.000	0.985	0.0028	-	4.0	-
							QUR4	Yes	0.045	0.037	0.873	0.034	8.4	-	0.762
							QUR5	No	0.621	1.000	1.000	0.0075	-	6.6	-
							QUR6	No	0.505	1.000	1.000	0.018	-	10	-
						QUR1	QUR2	No	0.610	1.000	1.000	0.0079	-	3.0	-
							QUR3	No	0.128	1.000	0.972	0.0082	-	3.1	-
							QUR4	Yes	0.090	0.133	0.930	0.039	3.1	-	0.576
							QUR5	No	0.731	1.000	1.000	0.013	-	3.8	-
							QUR6	No	0.952	1.000	1.000	0.023	-	5.2	-
						QUR2	QUR3	Yes	0.070	1.000	0.787	0.0026	-2.2	-	0.647
							QUR4	Yes	0.056	0.065	0.910	0.033	8.5	-	0.709
							QUR5	No	0.937	1.000	1.000	0.0073	-	7.1	-
							QUR6	No	0.681	1.000	1.000	0.018	-	11	-
						QUR3	QUR4	Yes	0.029	0.011	0.784	0.034	9.3	-	0.859
							QUR5	No	0.205	1.000	0.996	0.0076	-	6.3	-
							QUR6	No	0.244	1.000	0.999	0.018	-	9.8	-
						QUR4	QUR5	Yes	0.070	0.072	0.889	0.038	-1.5	-	0.647
							QUR6	No	0.124	0.153	0.948	0.049	-	3.4	-
						QUR5	QUR6	No	0.749	1.000	1.000	0.023	-	5.3	-
NMS-1	No	0.008	Yes	0.002	0.993	CAR	QUR1	Yes	0.000	1.000	0.025	0.0036	7.7	-	1.000
							QUR2	Yes	0.051	1.000	0.874	0.039	5.9	-	0.733
							QUR3	Yes	0.028	1.000	0.674	0.020	5.2	-	0.868
							QUR4	Yes	0.067	1.000	0.931	0.66	-7.1	-	0.661
							QUR5	Yes	0.071	1.000	0.944	0.10	-8.5	-	0.643
							QUR6	No	0.176	0.720	0.997	0.31	-	29	-
						QUR1	QUR2	No	0.447	1.000	1.000	0.037	-	19	-
							QUR3	No	0.172	1.000	0.996	0.018	-	13	-
							QUR4	Yes	0.006	0.074	0.499	0.066	-28	-	0.995
							QUR5	Yes	0.009	0.038	0.589	0.10	-30	-	0.983
							QUR6	Yes	0.043	0.020	0.888	0.31	-33	-	0.773
						QUR2	QUR3	No	0.800	1.000	1.000	0.053	-	3.4	-
							QUR4	Yes	0.020	0.169	0.386	0.10	-3.6	-	0.920
							QUR5	Yes	0.023	0.087	0.495	0.14	-4.0	-	0.899
							QUR6	Yes	0.067	0.046	0.906	0.34	-4.4	-	0.658
						QUR3	QUR4	Yes	0.017	0.233	0.465	0.083	-5.0	-	0.939
							QUR5	Yes	0.021	0.120	0.594	0.12	-5.6	-	0.911
							QUR6	Yes	0.070	0.063	0.933	0.32	-6.1	-	0.646
						QUR4	QUR5	No	0.766	1.000	1.000	0.17	-	4.4	-
							QUR6	No	0.696	1.000	1.000	0.37	-	6.6	-
						QUR5	QUR6	No	0.853	1.000	1.000	0.41	-	5.6	-
NMS-2	No	0.016	No	0.142	0.670	CAR	QUR1	-	-	-	-	0.058	-	5.5	-
							QUR2	-	-	-	-	0.042	-	4.7	-
							QUR3	-	-	-	-	0.042	-	4.7	-
							QUR4	-	-	-	-	0.54	-	17	-
							QUR5	-	-	-	-	0.030	-	4.0	-
							QUR6	-	-	-	-	0.14	-	8.7	-
						QUR1	QUR2	-	-	-	-	0.071	-	3.5	-
							QUR3	-	-	-	-	0.071	-	3.6	-
							QUR4	-	-	-	-	0.57	-	10	-
							QUR5	-	-	-	-	0.059	-	3.2	-
							QUR6	-	-	-	-	0.17	-	5.5	-
						QUR2	QUR3	-	-	-	-	0.055	-	3.9	-
							QUR4	-	-	-	-	0.55	-	13	-
							QUR5	-	-	-	-	0.043	-	3.5	-
							QUR6	-	-	-	-	0.16	-	6.6	-
						QUR3	QUR4	-	-	-	-	0.55	-	12	-
							QUR5	-	-	-	-	0.043	-	3.5	-
							QUR6	-	-	-	-	0.16	-	6.6	-
						QUR4	QUR5	-	-	-	-	0.54	-	2.8	-
							QUR6	-	-	-	-	0.65	-	3.1	-
						QUR5	QUR6	-	-	-	-	0.14	-	8.4	-

[a] Bonferroni post-hoc Test, or Dunnet's T3 Test where variances were found to be heterogenous by Levene's Test

[b] Due to low replication (3 per area) T-Tests are used as post-hoc test of significance between areas - Bonferroni and Tamhane post-hoc tests are reported for interest only.

[c] Magnitude calculated by comparing the difference between the control area and exposed area means to the control area standard deviation (SD) [(exposed mean - control mean) / standard deviation of the control mean]

[d] Minimum effect size detectable calculated based on variance as square root of MSE from ANOVA and alpha = beta = 0.10.
Minimum effect size reported as the minimum number of standard deviations detectable based on reference area standard deviation.

Highlighted values indicate significance at the *p* < 0.10 level.

Table I.11: Statistical comparison summary of benthic invertebrate major group proportion for reference area CAR and six Quesnel River areas. Metrics were calculated at the family level of taxonomic resolution, Mount Polley Mine, 2014.

Taxonomic Group (%)	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Ephemeroptera	No	0.003	Yes	0.084	0.759	CAR	QUR1	Yes	0.027	1.000	0.699	33	-2.1	-	0.873
							QUR2	Yes	0.028	1.000	0.512	44	-2.4	-	0.863
							QUR3	No	0.618	1.000	1.000	172	-	6.7	-
							QUR4	No	0.815	1.000	1.000	307	-	9.0	-
							QUR5	Yes	0.015	1.000	0.290	51	3.1	-	0.949
							QUR6	No	0.997	1.000	1.000	403	-	10	-
						QUR1	QUR2	No	0.577	1.000	1.000	18	-	6.2	-
							QUR3	Yes	0.092	1.000	0.968	146	8.1	-	0.572
							QUR4	No	0.415	1.000	1.000	281	-	24	-
							QUR5	Yes	0.001	0.167	0.077	25	15	-	1.000
							QUR6	No	0.368	1.000	1.000	377	-	28	-
						QUR2	QUR3	Yes	0.079	1.000	0.937	157	4.5	-	0.612
							QUR4	No	0.356	1.000	1.000	292	-	13	-
							QUR5	Yes	0.001	0.121	0.025	36	7.8	-	1.000
							QUR6	No	0.321	1.000	1.000	388	-	14	-
						QUR3	QUR4	No	0.606	1.000	1.000	420	-	4.8	-
							QUR5	No	0.163	1.000	0.991	164	-	3.0	-
							QUR6	No	0.773	1.000	1.000	516	-	5.3	-
						QUR4	QUR5	No	0.126	1.000	0.983	299	-	2.9	-
							QUR6	No	0.870	1.000	1.000	651	-	4.2	-
						QUR5	QUR6	No	0.220	1.000	0.999	395	-	12	-
Plecoptera	No	0.014	No	0.103	0.726	CAR	QUR1	-	-	-	-	44	-	5.2	-
							QUR2	-	-	-	-	84	-	7.2	-
							QUR3	-	-	-	-	25	-	3.9	-
							QUR4	-	-	-	-	109	-	8.1	-
							QUR5	-	-	-	-	23	-	3.7	-
							QUR6	-	-	-	-	267	-	13	-
						QUR1	QUR2	-	-	-	-	103	-	5.0	-
							QUR3	-	-	-	-	43	-	3.3	-
							QUR4	-	-	-	-	128	-	5.6	-
							QUR5	-	-	-	-	41	-	3.2	-
							QUR6	-	-	-	-	285	-	8.4	-
						QUR2	QUR3	-	-	-	-	84	-	3.0	-
							QUR4	-	-	-	-	168	-	4.3	-
							QUR5	-	-	-	-	82	-	3.0	-
							QUR6	-	-	-	-	326	-	5.9	-
						QUR3	QUR4	-	-	-	-	109	-	8.3	-
							QUR5	-	-	-	-	23	-	3.8	-
							QUR6	-	-	-	-	266	-	13	-
						QUR4	QUR5	-	-	-	-	107	-	2.9	-
							QUR6	-	-	-	-	350	-	5.3	-
						QUR5	QUR6	-	-	-	-	264	-	14	-
Trichoptera	No	0.018	No	0.126	0.692	CAR	QUR1	-	-	-	-	2.1	-	6.2	-
							QUR2	-	-	-	-	3.9	-	8.4	-
							QUR3	-	-	-	-	1.7	-	5.5	-
							QUR4	-	-	-	-	30	-	24	-
							QUR5	-	-	-	-	0.89	-	4.0	-
							QUR6	-	-	-	-	0.42	-	2.8	-
						QUR1	QUR2	-	-	-	-	5.1	-	4.9	-
							QUR3	-	-	-	-	2.9	-	3.7	-
							QUR4	-	-	-	-	32	-	12	-
							QUR5	-	-	-	-	2.1	-	3.1	-
							QUR6	-	-	-	-	1.7	-	2.8	-
						QUR2	QUR3	-	-	-	-	4.7	-	3.2	-
							QUR4	-	-	-	-	33	-	8.6	-
							QUR5	-	-	-	-	3.9	-	3.0	-
							QUR6	-	-	-	-	3.5	-	2.8	-
						QUR3	QUR4	-	-	-	-	31	-	14	-
							QUR5	-	-	-	-	1.7	-	3.3	-
							QUR6	-	-	-	-	1.2	-	2.8	-
						QUR4	QUR5	-	-	-	-	30	-	2.8	-
							QUR6	-	-	-	-	30	-	2.8	-
						QUR5	QUR6	-	-	-	-	0.47	-	2.8	-
Coleoptera	No	0.000	Yes	0.006	0.977	CAR	QUR1	No	0.632	1.000	1.000	0.16	-	3.7	-
							QUR2	Yes	0.086	0.026	0.963	3.5	8.2	-	0.591
							QUR3	No	0.301	1.000	1.000	0.10	-	2.9	-
							QUR4	No	0.188	1.000	0.998	0.090	-	2.8	-
							QUR5	No	0.441	1.000	1.000	0.33	-	5.3	-
							QUR6	No	0.749	1.000	1.000	0.14	-	3.4	-
						QUR1	QUR2	Yes	0.075	0.017	0.952	3.5	9.7	-	0.627
							QUR3	No	0.590	1.000	1.000	0.081	-	3.0	-
							QUR4	No	0.374	1.000	1.000	0.071	-	2.8	-
							QUR5	No	0.279	1.000	0.999	0.32	-	5.8	-
							QUR6	No	0.826	1.000	1.000	0.12	-	3.6	-
						QUR2	QUR3	Yes	0.067	0.013	0.945	3.4	-1.4	-	0.660
							QUR4	Yes	0.063	0.011	0.939	3.4	-1.5	-	0.677
							QUR5	No	0.121	0.064	0.981	3.7	-	2.9	-
							QUR6	Yes	0.078	0.020	0.957	3.5	-1.4	-	0.616
						QUR3	QUR4	No	0.374	1.000	1.000	0.010	-	2.8	-
							QUR5	No	0.160	1.000	0.994	0.25	-	14	-
							QUR6	No	0.359	1.000	1.000	0.057	-	6.6	-
						QUR4	QUR5	No	0.121	1.000	0.988	0.24	-[f]	-[f]	-
							QUR6	No	0.184	1.000	0.998	0.047	-[f]	-[f]	-
						QUR5	QUR6	No	0.314	1.000	1.000	0.29	-	3.0	-

Table I.11: Statistical comparison summary of benthic invertebrate major group proportion for reference area CAR and six Quesnel River areas. Metrics were calculated at the family level of taxonomic resolution, Mount Polley Mine, 2014.

Taxonomic Group (%)	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Diptera	No	0.007	Yes	0.028	0.892	CAR	QUR1	Yes	0.080	1.000	0.936	69	4.3	-	0.609
							QUR2	No	0.510	1.000	1.000	153	-	13	-
							QUR3	No	0.714	1.000	1.000	249	-	17	-
							QUR4	Yes	0.010	1.000	0.187	14	-3.9	-	0.981
							QUR5	Yes	0.006	1.000	0.117	14	-4.4	-	0.996
							QUR6	Yes	0.024	1.000	0.495	24	-3.8	-	0.889
						QUR1	QUR2	No	0.511	1.000	1.000	209	-	5.1	-
							QUR3	No	0.493	1.000	1.000	305	-	6.1	-
							QUR4	Yes	0.012	0.159	0.495	70	-2.7	-	0.972
							QUR5	Yes	0.009	0.108	0.454	69	-2.9	-	0.984
							QUR6	Yes	0.015	0.170	0.427	79	-2.7	-	0.952
						QUR2	QUR3	No	0.897	1.000	1.000	389	-	4.5	-
							QUR4	No	0.100	0.886	0.971	154	-	2.8	-
							QUR5	Yes	0.081	0.610	0.953	153	-1.4	-	0.606
							QUR6	No	0.111	0.942	0.971	163	-	2.9	-
						QUR3	QUR4	No	0.208	1.000	0.998	250	-	2.8	-
							QUR5	No	0.175	0.945	0.996	249	-	2.8	-
							QUR6	No	0.221	1.000	0.999	259	-	2.9	-
						QUR4	QUR5	No	0.574	1.000	1.000	14	-	3.9	-
							QUR6	No	0.942	1.000	1.000	24	-	5.0	-
						QUR5	QUR6	No	0.608	1.000	1.000	24	-	5.1	-
Lepidoptera	No	0.000	No	0.463	0.409	CAR	QUR1	-	-	-	-	-[e]	-	-	-
							QUR2	-	-	-	-	-[e]	-	-	-
							QUR3	-	-	-	-	-[e]	-	-	-
							QUR4	-	-	-	-	-[e]	-	-	-
							QUR5	-	-	-	-	-[e]	-	-	-
							QUR6	-	-	-	-	0.062	-	-[f]	-
						QUR1	QUR2	-	-	-	-	-[e]	-	-	-
							QUR3	-	-	-	-	-[e]	-	-	-
							QUR4	-	-	-	-	-[e]	-	-	-
							QUR5	-	-	-	-	-[e]	-	-	-
							QUR6	-	-	-	-	0.062	-	-[f]	-
						QUR2	QUR3	-	-	-	-	-[e]	-	-	-
							QUR4	-	-	-	-	-[e]	-	-	-
							QUR5	-	-	-	-	-[e]	-	-	-
							QUR6	-	-	-	-	0.062	-	-[f]	-
						QUR3	QUR4	-	-	-	-	-[e]	-	-	-
							QUR5	-	-	-	-	-[e]	-	-	-
							QUR6	-	-	-	-	0.062	-	-[f]	-
						QUR4	QUR5	-	-	-	-	0.000	-	-	-
							QUR6	-	-	-	-	0.062	-	-[f]	-
						QUR5	QUR6	-	-	-	-	0.062	-	-[f]	-
Arachnida	No	0.001	No	0.158	0.649	CAR	QUR1	-	-	-	-	19	-	2.8	-
							QUR2	-	-	-	-	19	-	2.8	-
							QUR3	-	-	-	-	19	-	2.8	-
							QUR4	-	-	-	-	18	-	2.8	-
							QUR5	-	-	-	-	18	-	2.8	-
							QUR6	-	-	-	-	18	-	2.8	-
						QUR1	QUR2	-	-	-	-	0.97	-	3.3	-
							QUR3	-	-	-	-	1.6	-	4.2	-
							QUR4	-	-	-	-	0.69	-	2.8	-
							QUR5	-	-	-	-	0.77	-	2.9	-
							QUR6	-	-	-	-	0.70	-	2.8	-
						QUR2	QUR3	-	-	-	-	1.1	-	5.6	-
							QUR4	-	-	-	-	0.28	-	2.8	-
							QUR5	-	-	-	-	0.35	-	3.1	-
							QUR6	-	-	-	-	0.29	-	2.8	-
						QUR3	QUR4	-	-	-	-	0.86	-	2.8	-
							QUR5	-	-	-	-	0.94	-	2.9	-
							QUR6	-	-	-	-	0.87	-	2.8	-
						QUR4	QUR5	-	-	-	-	0.077	-	-[f]	-
							QUR6	-	-	-	-	0.009	-	-[f]	-
						QUR5	QUR6	-	-	-	-	0.087	-	2.9	-

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Taxonomic Group (%)	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Bivalvia	No	0.004	No	0.137	0.677	CAR	QUR1	-	-	-	-	0.054	-	-[f]	-
							QUR2	-	-	-	-	0.024	-	-[f]	-
							QUR3	-	-	-	-	-[e]	-	-	-
							QUR4	-	-	-	-	-[e]	-	-	-
							QUR5	-	-	-	-	-[e]	-	-	-
							QUR6	-	-	-	-	-[e]	-	-	-
						QUR1	QUR2	-	-	-	-	0.078	-	3.3	-
							QUR3	-	-	-	-	0.054	-	2.8	-
							QUR4	-	-	-	-	0.054	-	2.8	-
							QUR5	-	-	-	-	0.054	-	2.8	-
							QUR6	-	-	-	-	0.054	-	2.8	-
						QUR2	QUR3	-	-	-	-	0.024	-	2.8	-
							QUR4	-	-	-	-	0.024	-	2.8	-
							QUR5	-	-	-	-	0.024	-	2.8	-
							QUR6	-	-	-	-	0.024	-	2.8	-
						QUR3	QUR4	-	-	-	-	-[e]	-	-	-
							QUR5	-	-	-	-	-[e]	-	-	-
							QUR6	-	-	-	-	-[e]	-	-	-
						QUR4	QUR5	-	-	-	-	-[e]	-	-	-
							QUR6	-	-	-	-	-[e]	-	-	-
						QUR5	QUR6	-	-	-	-	-[e]	-	-	-
Gastropoda	No	0.000	No	0.424	0.432	CAR	QUR1	-	-	-	-	1.2	-	-[f]	-
							QUR2	-	-	-	-	1.1	-	-[f]	-
							QUR3	-	-	-	-	-[e]	-	-	-
							QUR4	-	-	-	-	-[e]	-	-	-
							QUR5	-	-	-	-	-[e]	-	-	-
							QUR6	-	-	-	-	-[e]	-	-	-
						QUR1	QUR2	-	-	-	-	2.3	-	3.9	-
							QUR3	-	-	-	-	1.2	-	2.8	-
							QUR4	-	-	-	-	1.2	-	2.8	-
							QUR5	-	-	-	-	1.2	-	2.8	-
							QUR6	-	-	-	-	1.2	-	2.8	-
						QUR2	QUR3	-	-	-	-	1.1	-	2.8	-
							QUR4	-	-	-	-	1.1	-	2.8	-
							QUR5	-	-	-	-	1.1	-	2.8	-
							QUR6	-	-	-	-	1.1	-	2.8	-
						QUR3	QUR4	-	-	-	-	-[e]	-	-	-
							QUR5	-	-	-	-	-[e]	-	-	-
							QUR6	-	-	-	-	-[e]	-	-	-
						QUR4	QUR5	-	-	-	-	-[e]	-	-	-
							QUR6	-	-	-	-	-[e]	-	-	-
						QUR5	QUR6	-	-	-	-	-[e]	-	-	-
Oligocheata	No	0.000	No	0.793	0.252	CAR	QUR1	-	-	-	-	7.7	-	67	-
							QUR2	-	-	-	-	0.54	-	18	-
							QUR3	-	-	-	-	3.7	-	46	-
							QUR4	-	-	-	-	39	-	153	-
							QUR5	-	-	-	-	1.0	-	24	-
							QUR6	-	-	-	-	1.4	-	29	-
						QUR1	QUR2	-	-	-	-	8.2	-	2.9	-
							QUR3	-	-	-	-	11	-	3.4	-
							QUR4	-	-	-	-	47	-	6.9	-
							QUR5	-	-	-	-	8.6	-	3.0	-
							QUR6	-	-	-	-	9.1	-	3.0	-
						QUR2	QUR3	-	-	-	-	4.2	-	7.8	-
							QUR4	-	-	-	-	40	-	24	-
							QUR5	-	-	-	-	1.5	-	4.7	-
							QUR6	-	-	-	-	2.0	-	5.4	-
						QUR3	QUR4	-	-	-	-	43	-	9.5	-
							QUR5	-	-	-	-	4.6	-	3.1	-
							QUR6	-	-	-	-	5.1	-	3.3	-
						QUR4	QUR5	-	-	-	-	40	-	2.8	-
							QUR6	-	-	-	-	41	-	2.8	-
						QUR5	QUR6	-	-	-	-	2.4	-	4.3	-

[a] Bonferroni post-hoc Test, or Dunnet's T3 Test where variances were found to be heterogenous by Levene's Test

[b] Due to low replication (3 per area) T-Tests are used as post-hoc test of significance between areas - Bonferroni and Tamhane post-hoc tests are reported for interest only.

[c] Magnitude calculated by comparing the difference between the control area and exposed area means to the control area standard deviation (SD) [(exposed mean - control mean) / standard deviation of the control mean]

[d] Minimum effect size detectable calculated based on variance as square root of MSE from ANOVA and alpha = beta = 0.10.
Minimum effect size reported as the minimum number of standard deviations detectable based on reference area standard deviation.

[e] No observations in either Area1 or Area2; therefore, no statistic possible.

[f] Zero variance in Area1; therefore, calculation not possible.

Highlighted values indicate significance at the *p* < 0.10 level.

Table I.12: Statistical comparison summary of benthic invertebrate major group proportion for reference area CLR and six Quesnel River areas. Metrics were calculated at the family level of taxonomic resolution, Mount Polley Mine, 2014.

Taxonomic Group (%)	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Ephemeroptera	No	0.005	Yes	0.093	0.744	CLR	QUR1	No	0.134	1.000	0.988	66	-	2.9	-
							QUR2	No	0.112	1.000	0.957	77	-	3.1	-
							QUR3	No	0.469	1.000	1.000	205	-	5.0	-
							QUR4	No	0.999	1.000	1.000	340	-	6.5	-
							QUR5	Yes	0.022	1.000	0.495	84	2.4	-	0.904
							QUR6	No	0.842	1.000	1.000	436	-	7.3	-
						QUR1	QUR2	No	0.577	1.000	1.000	18	-	6.2	-
							QUR3	Yes	0.092	1.000	0.968	146	8.1	-	0.572
							QUR4	No	0.415	1.000	1.000	281	-	24	-
							QUR5	Yes	0.001	0.187	0.077	25	15	-	1.000
							QUR6	No	0.368	1.000	1.000	377	-	28	-
						QUR2	QUR3	Yes	0.079	1.000	0.937	157	4.5	-	0.612
							QUR4	No	0.356	1.000	1.000	292	-	13	-
							QUR5	Yes	0.001	0.136	0.025	36	7.8	-	1.000
							QUR6	No	0.321	1.000	1.000	388	-	14	-
						QUR3	QUR4	No	0.606	1.000	1.000	420	-	4.8	-
							QUR5	No	0.163	1.000	0.991	164	-	3.0	-
							QUR6	No	0.773	1.000	1.000	516	-	5.3	-
						QUR4	QUR5	No	0.126	1.000	0.983	299	-	2.9	-
							QUR6	No	0.870	1.000	1.000	651	-	4.2	-
						QUR5	QUR6	No	0.220	1.000	0.999	395	-	12	-
Plecoptera	No	0.012	Yes	0.053	0.822	CLR	QUR1	No	0.110	1.000	0.946	41	-	5.7	-
							QUR2	Yes	0.092	1.000	0.948	81	3.7	-	0.569
							QUR3	No	0.568	1.000	1.000	22	-	4.2	-
							QUR4	Yes	0.044	0.490	0.832	106	5.6	-	0.770
							QUR5	Yes	0.074	1.000	0.803	20	2.0	-	0.631
							QUR6	Yes	0.079	0.126	0.952	263	7.1	-	0.614
						QUR1	QUR2	No	0.540	1.000	1.000	103	-	5.0	-
							QUR3	No	0.198	1.000	0.993	43	-	3.3	-
							QUR4	No	0.209	1.000	0.995	128	-	5.6	-
							QUR5	No	0.733	1.000	1.000	41	-	3.2	-
							QUR6	No	0.212	1.000	0.998	285	-	8.4	-
						QUR2	QUR3	No	0.138	1.000	0.981	84	-	3.0	-
							QUR4	No	0.478	1.000	1.000	168	-	4.3	0.172
							QUR5	No	0.370	1.000	1.000	82	-	3.0	0.218
							QUR6	No	0.369	1.000	1.000	326	-	5.9	0.218
						QUR3	QUR4	Yes	0.060	0.786	0.883	109	4.5	-	0.687
							QUR5	No	0.177	1.000	0.983	23	-	3.8	0.390
							QUR6	Yes	0.097	0.206	0.969	266	5.8	-	0.555
						QUR4	QUR5	No	0.136	1.000	0.985	107	-	2.9	0.461
							QUR6	No	0.687	1.000	1.000	350	-	5.3	0.122
						QUR5	QUR6	No	0.167	0.747	0.995	264	-	14	0.404
Trichoptera	No	0.028	No	0.134	0.681	CLR	QUR1	-	-	-	-	3.9	-	3.7	-
							QUR2	-	-	-	-	5.7	-	4.4	-
							QUR3	-	-	-	-	3.5	-	3.5	-
							QUR4	-	-	-	-	32	-	10	-
							QUR5	-	-	-	-	2.7	-	3.1	-
							QUR6	-	-	-	-	2.2	-	2.8	-
						QUR1	QUR2	-	-	-	-	5.1	-	4.9	-
							QUR3	-	-	-	-	2.9	-	3.7	-
							QUR4	-	-	-	-	32	-	12	-
							QUR5	-	-	-	-	2.1	-	3.1	-
							QUR6	-	-	-	-	1.7	-	2.8	-
						QUR2	QUR3	-	-	-	-	4.7	-	3.2	-
							QUR4	-	-	-	-	33	-	8.6	-
							QUR5	-	-	-	-	3.9	-	3.0	-
							QUR6	-	-	-	-	3.5	-	2.8	-
						QUR3	QUR4	-	-	-	-	31	-	14	-
							QUR5	-	-	-	-	1.7	-	3.3	-
							QUR6	-	-	-	-	1.2	-	2.8	-
						QUR4	QUR5	-	-	-	-	30	-	2.8	-
							QUR6	-	-	-	-	30	-	2.8	-
						QUR5	QUR6	-	-	-	-	0.47	-	2.8	-
Coleoptera	No	0.000	Yes	0.010	0.959	CLR	QUR1	No	0.199	1.000	0.997	0.65	-	2.9	-
							QUR2	No	0.183	0.253	0.994	4.0	-	7.3	-
							QUR3	No	0.141	1.000	0.992	0.59	-	2.8	-
							QUR4	No	0.119	1.000	0.987	0.58	-	2.8	-
							QUR5	No	0.584	1.000	1.000	0.82	-	3.3	-
							QUR6	No	0.217	1.000	0.998	0.63	-	2.9	-
						QUR1	QUR2	Yes	0.075	0.028	0.952	3.5	9.7	-	0.627
							QUR3	No	0.590	1.000	1.000	0.081	-	3.0	-
							QUR4	No	0.374	1.000	1.000	0.071	-	2.8	-
							QUR5	No	0.279	1.000	0.999	0.32	-	5.8	-
							QUR6	No	0.826	1.000	1.000	0.12	-	3.6	-
						QUR2	QUR3	Yes	0.067	0.021	0.945	3.4	-1.4	-	0.660
							QUR4	Yes	0.063	0.018	0.939	3.4	-1.5	-	0.677
							QUR5	No	0.121	0.097	0.981	3.7	-	2.9	-
							QUR6	Yes	0.078	0.032	0.957	3.5	-1.4	-	0.616
						QUR3	QUR4	No	0.374	1.000	1.000	0.010	-	2.8	-
							QUR5	No	0.160	1.000	0.994	0.25	-	14	-
							QUR6	No	0.359	1.000	1.000	0.057	-	6.6	-
						QUR4	QUR5	No	0.121	1.000	0.988	0.24	-	-[f]	-
							QUR6	No	0.184	1.000	0.998	0.047	-	-[f]	-
						QUR5	QUR6	No	0.314	1.000	1.000	0.29	-	3.0	-

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	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Diptera	No	0.008	Yes	0.026	0.899	CLR	QUR1	Yes	0.023	0.456	0.614	74	1.2	-	0.896
							QUR2	No	0.183	1.000	0.996	158	-	3.1	-
							QUR3	No	0.333	1.000	1.000	253	-	4.0	-
							QUR4	No	0.226	1.000	0.996	19	-	1.1	-
							QUR5	No	0.117	1.000	0.934	18	-	1.1	-
							QUR6	No	0.335	1.000	1.000	28	-	1.3	-
						QUR1	QUR2	No	0.511	1.000	1.000	209	-	5.1	-
							QUR3	No	0.493	1.000	1.000	305	-	6.1	-
							QUR4	Yes	0.012	0.164	0.495	70	-2.7	-	0.972
							QUR5	Yes	0.009	0.111	0.454	69	-2.9	-	0.984
							QUR6	Yes	0.015	0.174	0.427	79	-2.7	-	0.952
						QUR2	QUR3	No	0.897	1.000	1.000	389	-	4.5	-
							QUR4	No	0.100	0.904	0.971	154	-	2.8	-
							QUR5	Yes	0.081	0.623	0.953	153	-1.4	-	0.606
							QUR6	No	0.111	0.960	0.971	163	-	2.9	-
						QUR3	QUR4	No	0.208	1.000	0.998	250	-	2.8	-
							QUR5	No	0.175	0.963	0.996	249	-	2.8	-
							QUR6	No	0.221	1.000	0.999	259	-	2.9	-
						QUR4	QUR5	No	0.574	1.000	1.000	14	-	3.9	-
							QUR6	No	0.942	1.000	1.000	24	-	5.0	-
						QUR5	QUR6	No	0.608	1.000	1.000	24	-	5.1	-
Lepidoptera	No	0.000	No	0.478	0.401	CLR	QUR1	-	-	-	-	9.4	-	2.8	-
							QUR2	-	-	-	-	9.4	-	2.8	-
							QUR3	-	-	-	-	9.4	-	2.8	-
							QUR4	-	-	-	-	9.4	-	2.8	-
							QUR5	-	-	-	-	9.4	-	2.8	-
							QUR6	-	-	-	-	9.4	-	2.8	-
						QUR1	QUR2	-	-	-	-	-[e]	-	-	-
							QUR3	-	-	-	-	-[e]	-	-	-
							QUR4	-	-	-	-	-[e]	-	-	-
							QUR5	-	-	-	-	-[e]	-	-	-
							QUR6	-	-	-	-	0.062	-	-[f]	-
						QUR2	QUR3	-	-	-	-	-[e]	-	-	-
							QUR4	-	-	-	-	-[e]	-	-	-
							QUR5	-	-	-	-	-[e]	-	-	-
							QUR6	-	-	-	-	0.062	-	-[f]	-
						QUR3	QUR4	-	-	-	-	-[e]	-	-	-
							QUR5	-	-	-	-	-[e]	-	-	-
							QUR6	-	-	-	-	0.062	-	-[f]	-
						QUR4	QUR5	-	-	-	-	-[e]	-	-	-
							QUR6	-	-	-	-	0.062	-	-[f]	-
						QUR5	QUR6	-	-	-	-	0.062	-	-[f]	-
Arachnida	No	0.000	Yes	0.044	0.846	CLR	QUR1	No	0.189	0.262	0.997	19	-	2.8	-
							QUR2	No	0.214	0.400	0.999	18	-	2.8	-
							QUR3	No	0.228	0.450	0.999	19	-	2.8	-
							QUR4	No	0.108	0.053	0.983	18	-1.2	-	0.525
							QUR5	No	0.126	0.084	0.989	18	-1.1	-	0.481
							QUR6	No	0.157	0.167	0.995	18	-	2.8	-
						QUR1	QUR2	No	0.628	1.000	1.000	0.97	-	3.3	-
							QUR3	No	0.624	1.000	1.000	1.6	-	4.2	-
							QUR4	Yes	0.082	1.000	0.964	0.69	-1.3	-	0.604
							QUR5	No	0.193	1.000	0.997	0.77	-	2.9	-
							QUR6	No	0.549	1.000	1.000	0.70	-	2.8	-
						QUR2	QUR3	No	0.899	1.000	1.000	1.1	-	5.6	-
							QUR4	Yes	0.010	1.000	0.607	0.28	-2.7	-	0.981
							QUR5	Yes	0.034	1.000	0.657	0.35	-2.1	-	0.827
							QUR6	No	0.118	1.000	0.983	0.29	-	2.8	-
						QUR3	QUR4	Yes	0.049	1.000	0.909	0.86	-1.6	-	0.741
							QUR5	No	0.104	1.000	0.968	0.94	-	2.9	-
							QUR6	No	0.265	1.000	1.000	0.87	-	2.8	-
						QUR4	QUR5	No	0.116	1.000	0.986	0.077	-	-[f]	-
							QUR6	Yes	0.000	1.000	0.098	0.0094	-[f]	-	1.000
						QUR5	QUR6	Yes	0.049	1.000	0.844	0.087	1.7	-	-

Table I.12: Statistical comparison summary of benthic invertebrate major group proportion for reference area CLR and six Quesnel River areas. Metrics were calculated at the family level of taxonomic resolution, Mount Polley Mine, 2014.

Taxonomic Group (%)	Overall 7-group ANOVA: Variance – Equal?	Overall 7-group ANOVA: Variance – Levene p-value	Overall 7-group ANOVA: Significant Difference Among Areas?	Overall 7-group ANOVA: p-value	Overall 7-group ANOVA: Power	Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]: Significant Difference Between Areas?[b]	p-value: T-Test	p-value: Bonferroni	p-value: Tahmane	2-group ANOVA for Estimation of Effect Size: MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
Bivalvia	No	0.001	No	0.425	0.431	CLR	QUR1	-	-	-	-	0.17	-	6.8	-
							QUR2	-	-	-	-	0.14	-	6.2	-
							QUR3	-	-	-	-	0.12	-	5.7	-
							QUR4	-	-	-	-	0.12	-	5.7	-
							QUR5	-	-	-	-	0.12	-	5.7	-
							QUR6	-	-	-	-	0.12	-	5.7	-
						QUR1	QUR2	-	-	-	-	0.078	-	3.3	-
							QUR3	-	-	-	-	0.054	-	2.8	-
							QUR4	-	-	-	-	0.054	-	2.8	-
							QUR5	-	-	-	-	0.054	-	2.8	-
							QUR6	-	-	-	-	0.054	-	2.8	-
						QUR2	QUR3	-	-	-	-	0.024	-	2.8	-
							QUR4	-	-	-	-	0.024	-	2.8	-
							QUR5	-	-	-	-	0.024	-	2.8	-
							QUR6	-	-	-	-	0.024	-	2.8	-
						QUR3	QUR4	-	-	-	-	-[e]	-	-	-
							QUR5	-	-	-	-	-[e]	-	-	-
							QUR6	-	-	-	-	-[e]	-	-	-
						QUR4	QUR5	-	-	-	-	-[e]	-	-	-
							QUR6	-	-	-	-	-[e]	-	-	-
						QUR5	QUR6	-	-	-	-	-[e]	-	-	-
Gastropoda	No	0.000	No	0.151	0.659	CLR	QUR1	-	-	-	-	136	-	2.8	-
							QUR2	-	-	-	-	136	-	2.8	-
							QUR3	-	-	-	-	135	-	2.8	-
							QUR4	-	-	-	-	135	-	2.8	-
							QUR5	-	-	-	-	135	-	2.8	-
							QUR6	-	-	-	-	135	-	2.8	-
						QUR1	QUR2	-	-	-	-	2.3	-	3.9	-
							QUR3	-	-	-	-	1.2	-	2.8	-
							QUR4	-	-	-	-	1.2	-	2.8	-
							QUR5	-	-	-	-	1.2	-	2.8	-
							QUR6	-	-	-	-	1.2	-	2.8	-
						QUR2	QUR3	-	-	-	-	1.1	-	2.8	-
							QUR4	-	-	-	-	1.1	-	2.8	-
							QUR5	-	-	-	-	1.1	-	2.8	-
							QUR6	-	-	-	-	1.1	-	2.8	-
						QUR3	QUR4	-	-	-	-	-[e]	-	-	-
							QUR5	-	-	-	-	-[e]	-	-	-
							QUR6	-	-	-	-	-[e]	-	-	-
						QUR4	QUR5	-	-	-	-	-[e]	-	-	-
							QUR6	-	-	-	-	-[e]	-	-	-
						QUR5	QUR6	-	-	-	-	-[e]	-	-	-
Oligocheata	No	0.002	No	0.716	0.286	CLR	QUR1	-	-	-	-	24	-	3.4	-
							QUR2	-	-	-	-	17	-	2.8	-
							QUR3	-	-	-	-	20	-	3.1	-
							QUR4	-	-	-	-	56	-	5.1	-
							QUR5	-	-	-	-	17	-	2.9	-
							QUR6	-	-	-	-	18	-	2.9	-
						QUR1	QUR2	-	-	-	-	8.2	-	2.9	-
							QUR3	-	-	-	-	11	-	3.4	-
							QUR4	-	-	-	-	47	-	6.9	-
							QUR5	-	-	-	-	8.6	-	3.0	-
							QUR6	-	-	-	-	9.1	-	3.0	-
						QUR2	QUR3	-	-	-	-	4.2	-	7.8	-
							QUR4	-	-	-	-	40	-	24	-
							QUR5	-	-	-	-	1.5	-	4.7	-
							QUR6	-	-	-	-	2.0	-	5.4	-
						QUR3	QUR4	-	-	-	-	43	-	9.5	-
							QUR5	-	-	-	-	4.6	-	3.1	-
							QUR6	-	-	-	-	5.1	-	3.3	-
						QUR4	QUR5	-	-	-	-	40	-	2.8	-
							QUR6	-	-	-	-	41	-	2.8	-
						QUR5	QUR6	-	-	-	-	2.4	-	4.3	-

[a] Bonferroni post-hoc Test, or Dunnet's T3 Test where variances were found to be heterogenous by Levene's Test
[b] Due to low replication (3 per area) T-Tests are used as post-hoc test of significance between areas - Bonferroni and Tamhane post-hoc tests are reported for interest only.
[c] Magnitude calculated by comparing the difference between the control area and exposed area means to the control area standard deviation (SD) [(exposed mean - control mean) / standard deviation of the control mean]
[d] Minimum effect size detectable calculated based on variance as square root of MSE from ANOVA and alpha = beta = 0.10. Minimum effect size reported as the minimum number of standard deviations detectable based on reference area standard deviation.
[e] No observations in either Area1 or Area2; therefore, no statistic possible.
[f] Zero variance in Area1; therefore, calculation not possible.
Highlighted values indicate significance at the *p* < 0.10 level.

Table I.13: Sample area axis scores of NMS ordination for river sampling areas, Mount Polley Mine, 2014.

Sample ID	NMS-1	NMS-2
CLR-1	0.098	0.125
CLR-2	-0.995	-0.484
CLR-3	-2.916	-0.020
CAR-1	0.222	-0.067
CAR-2	0.200	0.269
CAR-3	0.339	0.157
QUR1-1	0.851	-0.068
QUR1-2	0.855	-0.290
QUR1-3	0.783	-0.651
QUR2-1	0.602	-0.656
QUR2-2	0.491	-0.322
QUR2-3	1.001	-0.206
QUR3-1	0.542	0.407
QUR3-2	0.536	0.514
QUR3-4	0.862	0.063
QUR4-1	-0.206	-1.208
QUR4-2	0.038	0.758
QUR4-3	-0.675	-0.737
QUR5-1	-0.163	0.575
QUR5-2	-0.094	0.499
QUR5-3	-0.903	0.239
QUR6-1	0.127	0.951
QUR6-2	-0.228	0.045
QUR6-3	-1.367	0.109

Table I.14: Benthic invertebrate family axis scores of NMS ordination for river sampling areas, Mount Polley Mine, 2014.

Family	NMS-1	NMS-2
Ameletidae	-1.2613	0.00127
Baetidae	-0.02389	-0.50012
Ephemerellidae	0.18507	0.17168
Heptageniidae	-0.06317	0.26799
Leptophlebiidae	0.57041	-0.10922
Capniidae	-0.5515	0.09378
Chloroperlidae	-0.11567	-0.18225
Nemouridae	0.73883	-0.36341
Perlidae	0.62329	-0.26484
Perlodidae	0.24765	-0.33052
Pteronarcyidae	0.22226	0.37482
Hydropsychidae	0.08175	-0.6067
Hydroptilidae	0.63764	-0.002
Lepidostomatidae	-0.50097	0.20824
Dytiscidae	0.54084	-0.05689
Elmidae	0.04545	-0.25599
Chironomidae	0.5052	-0.08627
Empididae	0.1511	-0.05951
Tipulidae	0.25882	-0.75342
Hygrobatidae	-2.15863	-0.13821
Sperchontidae	0.48226	-0.05597
Torrenticolidae	-0.13287	0.14241
Pisidiidae	0.49177	-0.2684
Lymnaeidae	-2.18883	-0.0904
Lumbriculidae	-0.63043	-0.85631
Enchytraeidae	0.76675	-0.42794
Naididae	-0.0484	0.0599

Table I.15: Spearman's Rank correlation of NMS area scores with benthic invertebrate Family proportion (N = 24) from river sampling areas, Mount Polley Mine, 2014.

Family	NMS-1		NMS-2	
	r	p	r	p
Ameletidae	-0.73	0.00	0.11	0.59
Baetidae	0.26	0.21	-0.46	0.02
Ephemerellidae	0.30	0.15	0.79	0.00
Heptageniidae	-0.22	0.30	0.57	0.00
Leptophlebiidae	0.65	0.00	-0.12	0.58
Capniidae	-0.75	0.00	0.21	0.33
Chloroperlidae	-0.47	0.02	0.02	0.92
Nemouridae	0.73	0.00	-0.38	0.07
Perlidae	0.60	0.00	-0.34	0.10
Perlodidae	0.51	0.01	-0.21	0.33
Pteronarcyidae	0.05	0.83	0.36	0.08
Hydropsychidae	0.26	0.22	-0.52	0.01
Hydroptilidae	0.28	0.19	0.07	0.76
Lepidostomatidae	-0.14	0.52	0.45	0.03
Dytiscidae	0.29	0.16	-0.08	0.73
Elmidae	0.11	0.62	-0.04	0.86
Chironomidae	0.82	0.00	-0.33	0.11
Empididae	0.37	0.07	-0.08	0.71
Tipulidae	0.38	0.07	-0.47	0.02
Hygrobatidae	-0.23	0.29	-0.06	0.80
Sperchontidae	0.54	0.01	-0.05	0.83
Torrenticolidae	-0.08	0.72	0.34	0.11
Pisidiidae	0.32	0.13	-0.29	0.17
Lymnaeidae	-0.02	0.92	-0.34	0.11
Lumbriculidae	-0.31	0.14	-0.21	0.33
Enchytraeidae	0.57	0.00	-0.50	0.01
Naididae	-0.04	0.84	0.29	0.16

[grey box] indicates a p-value below 0.05.

Table I.16: PCA results of whole community benthic invertebrate tissue metal and metalloid concentrations. Eigen value, percent variance explained, Monte Carlo randomization p-values of axis significance, and area scores of three reference and six Quesnel River areas, Mount Polley Mine, 2014.

Axis	PCA1	PCA2
Eigen Value	10.013	2.96
% Variance explained	55.6	16.4
Monte Carlo P	0.0001	0.0005
BLC-1	-3.34124	-2.20909
BLC-2	-2.49193	-2.29331
BLC-3	-1.70837	-2.77631
CLR-1	0.7287	-1.84781
CLR-2	-5.39736	-2.32309
CLR-3	-5.81394	-2.3762
CAR-1	-1.42339	1.0644
CAR-2	-1.62557	1.6565
CAR-3	0.1632	-0.05928
QUR1-1	-2.41704	2.67437
QUR1-2	-3.19164	2.27757
QUR1-3	-2.34348	2.18066
QUR2-1	-1.45183	2.35525
QUR2-2	-2.6769	1.96253
QUR2-3	0.43532	2.33575
QUR3-1	1.60452	0.40616
QUR3-2	1.91663	0.96556
QUR3-3	1.42122	0.53578
QUR4-1	0.70309	-0.12737
QUR4-2	-1.52743	-1.4107
QUR4-3	4.46994	0.31853
QUR5-1	4.84336	-0.3007
QUR5-2	4.77804	-0.90129
QUR5-3	4.57395	-1.46918
QUR6-1	0.999	0.9682
QUR6-2	3.13381	-0.67689
QUR6-3	5.63935	-0.93003

Table I.17: Spearman's Rank correlation of whole community benthic invertebrate tissue PCA axis scores with actual tissue metal concentrations, river sampling areas, Mount Polley Mine, 2014.

Axis	PCA1		PCA2	
Statistic	r	p	r	p
Aluminum	0.982	0.000	0.006	0.978
Arsenic	0.813	0.000	0.065	0.748
Barium	0.723	0.000	0.275	0.164
Cadmium	0.911	0.000	0.215	0.281
Chromium	0.602	0.001	-0.216	0.278
Cobalt	0.943	0.000	-0.057	0.777
Copper	0.490	0.009	0.709	0.000
Iron	0.977	0.000	-0.076	0.708
Lead	0.836	0.000	0.151	0.453
Manganese	0.447	0.019	-0.337	0.086
Nickel	0.858	0.000	-0.273	0.169
Selenium	0.688	0.000	0.503	0.008
Silver	-0.018	0.931	0.823	0.000
Strontium	0.214	0.283	-0.246	0.216
Titanium	0.853	0.000	-0.214	0.285
Uranium	0.892	0.000	-0.055	0.784
Vanadium	0.938	0.000	-0.058	0.773
Zinc	0.068	0.735	0.924	0.000

[shaded box] indicates a p-value below 0.05.

Table I.18: Statistical comparison summary of whole benthic invertebrate community metal and metalloid tissue concentration for reference area BLC and six Quesnel River areas. Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Aluminum	No	0.004	Yes	<0.001	1.000	BLC	QUR1	No	0.402	1.000	1.000	273,333	-	2.9	-
							QUR2	No	0.219	1.000	0.996	806,667	-	5.0	-
							QUR3	Yes	0.001	0.047	0.273	246,667	-2.5	-	1.000
							QUR4	Yes	0.061	0.074	0.883	2,106,667	4.4	-	0.685
							QUR5	Yes	0.000	0.001	0.116	246,667	-2.5	-	1.000
							QUR6	Yes	0.009	0.001	0.378	1,586,667	6.9	-	0.984
						QUR1	QUR2	No	0.346	1.000	1.000	586,667	-	13	-
							QUR3	Yes	0.000	0.117	0.044	26,667	-9.2	-	1.000
							QUR4	Yes	0.076	0.184	0.955	1,886,667	12	-	0.624
							QUR5	Yes	0.000	0.001	0.016	26,667	-9.2	-	1.000
							QUR6	Yes	0.009	0.003	0.572	1,366,667	19	-	0.983
						QUR2	QUR3	Yes	0.023	0.525	0.778	560,000	-2.6	-	0.900
							QUR4	No	0.190	0.812	0.993	2,420,000	-	5.8	-
							QUR5	Yes	0.002	0.006	0.353	560,000	-2.6	-	1.000
							QUR6	Yes	0.028	0.014	0.531	1,900,000	3.6	-	0.866
						QUR3	QUR4	No	0.866	1.000	1.000	1,860,000	-	-[f]	-
							QUR5	-	-	-	-	-[e]	-	-	-
							QUR6	No	0.166	1.000	0.996	1,340,000	0.0	-[f]	-
						QUR4	QUR5	No	0.119	0.525	0.987	1,860,000	-2.5	2.8	-
							QUR6	No	0.285	1.000	0.999	3,200,000	0.93	3.6	-
						QUR5	QUR6	No	0.694	1.000	1.000	1,340,000	-	-[f]	-
Arsenic	Yes	0.257	Yes	0.003	0.990	BLC	QUR1	No	0.322	1.000	1.000	0.95	-	3.1	-
							QUR2	No	0.229	1.000	0.996	1.5	-	4.0	-
							QUR3	Yes	0.049	0.808	0.801	0.90	1.8	-	0.743
							QUR4	Yes	0.064	0.179	0.767	1.9	2.4	-	0.673
							QUR5	Yes	0.007	0.036	0.455	0.80	3.0	-	0.991
							QUR6	No	0.112	0.384	0.933	2.3	-	4.9	-
						QUR1	QUR2	Yes	0.045	0.578	0.753	0.99	3.6	-	0.760
							QUR3	Yes	0.003	0.126	0.072	0.36	4.8	-	1.000
							QUR4	Yes	0.017	0.027	0.541	1.4	5.9	-	0.937
							QUR5	Yes	0.000	0.006	0.036	0.26	7.1	-	1.000
							QUR6	Yes	0.035	0.059	0.757	1.8	5.3	-	0.823
						QUR2	QUR3	No	0.406	1.000	1.000	0.94	-	3.0	-
							QUR4	No	0.272	1.000	0.999	2.0	-	4.4	-
							QUR5	Yes	0.040	0.707	0.837	0.84	1.8	-	0.789
							QUR6	No	0.430	1.000	1.000	2.4	-	4.8	-
						QUR3	QUR4	No	0.483	1.000	1.000	1.4	-	8.3	-
							QUR5	Yes	0.015	1.000	0.390	0.20	2.7	-	0.951
							QUR6	No	0.750	1.000	1.000	1.7	-	9.4	-
						QUR4	QUR5	No	0.449	1.000	1.000	1.3	-	2.8	-
							QUR6	No	0.801	1.000	1.000	2.8	-	4.2	-
						QUR5	QUR6	No	0.338	1.000	1.000	1.6	-	16	-
Barium	Yes	0.499	Yes	0.002	0.994	BLC	QUR1	Yes	0.066	0.883	0.771	77	2.2	-	0.662
							QUR2	Yes	0.008	0.029	0.161	65	4.0	-	0.988
							QUR3	Yes	0.004	0.001	0.088	83	5.6	-	0.999
							QUR4	Yes	0.066	0.312	0.819	118	2.8	-	0.665
							QUR5	Yes	0.003	0.013	0.119	43	4.4	-	1.000
							QUR6	Yes	0.023	0.031	0.477	116	3.9	-	0.900
						QUR1	QUR2	No	0.123	1.000	0.939	77	-	3.7	-
							QUR3	Yes	0.028	0.099	0.447	95	2.9	-	0.868
							QUR4	No	0.666	1.000	1.000	130	-	4.7	-
							QUR5	Yes	0.046	1.000	0.770	55	1.8	-	0.757
							QUR6	No	0.213	1.000	0.994	128	-	4.7	-
						QUR2	QUR3	No	0.156	1.000	0.974	83	-	4.4	-
							QUR4	No	0.337	1.000	1.000	118	-	5.3	-
							QUR5	No	0.568	1.000	1.000	43	-	3.2	-
							QUR6	No	0.972	1.000	1.000	116	-	5.2	-
						QUR3	QUR4	Yes	0.076	0.288	0.828	136	-2.3	-	0.624
							QUR5	No	0.205	1.000	0.996	61	-	3.0	-
							QUR6	No	0.231	1.000	0.996	134	-	4.5	-
						QUR4	QUR5	No	0.179	1.000	0.995	96	-	2.9	-
							QUR6	No	0.428	1.000	1.000	169	-	3.9	-
						QUR5	QUR6	No	0.667	1.000	1.000	94	-	8.3	-
Cadmium	No	0.003	Yes	<0.001	1.000	BLC	QUR1	Yes	0.053	1.000	0.904	0.21	9.2	-	0.724
							QUR2	Yes	0.029	1.000	0.797	0.22	12	-	0.861
							QUR3	Yes	0.008	1.000	0.555	0.62	28	-	0.989
							QUR4	No	0.228	1.000	0.999	36	-	210	-
							QUR5	Yes	0.001	0.001	0.269	8.2	170	-	1.000
							QUR6	Yes	0.012	0.025	0.655	15	122	-	0.967
						QUR1	QUR2	No	0.633	1.000	1.000	0.42	-	4.0	-
							QUR3	Yes	0.045	1.000	0.723	0.82	3.3	-	0.761
							QUR4	No	0.292	1.000	1.000	36	-	37	-
							QUR5	Yes	0.002	0.002	0.269	8.4	28	-	1.000
							QUR6	Yes	0.016	0.046	0.697	15	20	-	0.942
						QUR2	QUR3	Yes	0.068	1.000	0.836	0.83	2.8	-	0.654
							QUR4	No	0.312	1.000	1.000	36	-	36	-
							QUR5	Yes	0.002	0.003	0.275	8.4	27	-	1.000
							QUR6	Yes	0.018	0.054	0.712	15	19	-	0.934
						QUR3	QUR4	No	0.482	1.000	1.000	36	-	21	-
							QUR5	Yes	0.003	0.008	0.285	8.8	14	-	1.000
							QUR6	Yes	0.031	0.160	0.802	16	9.5	-	0.846
						QUR4	QUR5	Yes	0.091	0.067	0.927	44	1.4	-	0.574
							QUR6	No	0.312	1.000	1.000	50	-	3.3	-
						QUR5	QUR6	No	0.250	1.000	0.998	23	-	4.7	-

Table I.18: Statistical comparison summary of whole benthic invertebrate community metal and metalloid tissue concentration for reference area BLC and six Quesnel River areas. Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Chromium	No	0.016	No	0.128	0.689	BLC	QUR1	-	-	-	-	20	-	2.8	-
							QUR2	-	-	-	-	30	-	3.4	-
							QUR3	-	-	-	-	21	-	2.8	-
							QUR4	-	-	-	-	34	-	3.6	-
							QUR5	-	-	-	-	76	-	5.4	-
							QUR6	-	-	-	-	57	-	4.7	-
						QUR1	QUR2	-	-	-	-	10	-	0.0	-
							QUR3	-	-	-	-	0.17	-	0.0	-
							QUR4	-	-	-	-	13	-	0.0	-
							QUR5	-	-	-	-	56	-	0.0	-
							QUR6	-	-	-	-	37	-	0.0	-
						QUR2	QUR3	-	-	-	-	10	-	2.8	-
							QUR4	-	-	-	-	23	-	4.2	-
							QUR5	-	-	-	-	66	-	7.1	-
							QUR6	-	-	-	-	47	-	6.0	-
						QUR3	QUR4	-	-	-	-	13	-	25	-
							QUR5	-	-	-	-	56	-	51	-
							QUR6	-	-	-	-	37	-	41	-
						QUR4	QUR5	-	-	-	-	69	-	6.3	-
							QUR6	-	-	-	-	50	-	5.4	-
						QUR5	QUR6	-	-	-	-	93	-	3.6	-
Cobalt	No	0.040	Yes	0.001	0.999	BLC	QUR1	No	0.226	1.000	0.998	0.18	-	3.1	-
							QUR2	No	0.656	1.000	1.000	0.72	-	6.1	-
							QUR3	Yes	0.001	0.470	0.092	0.18	5.3	-	1.000
							QUR4	No	0.298	1.000	1.000	2.6	-	11	-
							QUR5	Yes	0.000	0.007	0.005	0.26	9.7	-	1.000
							QUR6	Yes	0.048	0.035	0.881	3.7	8.0	-	0.749
						QUR1	QUR2	No	0.259	1.000	1.000	0.60	-	12	-
							QUR3	Yes	0.000	0.199	0.002	0.063	14	-	1.000
							QUR4	No	0.181	1.000	0.997	2.5	-	24	-
							QUR5	Yes	0.000	0.003	0.005	0.14	23	-	1.000
							QUR6	Yes	0.033	0.015	0.840	3.6	20	-	0.832
						QUR2	QUR3	Yes	0.015	0.823	0.625	0.60	2.4	-	0.953
							QUR4	No	0.432	1.000	1.000	3.0	-	6.3	-
							QUR5	Yes	0.002	0.013	0.136	0.68	4.7	-	1.000
							QUR6	Yes	0.069	0.062	0.895	4.1	3.8	-	0.653
						QUR3	QUR4	No	0.345	1.000	1.000	2.5	-	24	-
							QUR5	Yes	0.001	1.000	0.071	0.14	9.7	-	1.000
							QUR6	No	0.386	1.000	1.000	3.6	-	29	-
						QUR4	QUR5	Yes	0.043	0.105	0.863	2.5	1.7	-	0.775
							QUR6	No	0.224	0.526	0.995	6.0	-	4.4	-
						QUR5	QUR6	No	0.582	1.000	1.000	3.7	-	16	-
Copper	Yes	0.055	Yes	<0.001	1.000	BLC	QUR1	Yes	0.002	0.002	0.269	35	16	-	1.000
							QUR2	Yes	0.004	0.002	0.347	43	16	-	0.999
							QUR3	Yes	0.000	0.000	0.012	10	20	-	1.000
							QUR4	Yes	0.081	0.154	0.958	100	9.1	-	0.607
							QUR5	Yes	0.000	0.016	0.002	3.3	12	-	1.000
							QUR6	Yes	0.001	0.013	0.069	12	13	-	1.000
						QUR1	QUR2	No	0.964	1.000	1.000	73	-	4.2	-
							QUR3	No	0.172	1.000	0.990	41	-	3.1	-
							QUR4	No	0.208	0.772	0.995	131	-	5.6	-
							QUR5	No	0.215	1.000	0.999	34	-	2.8	-
							QUR6	No	0.302	1.000	1.000	43	-	3.2	-
						QUR2	QUR3	No	0.190	1.000	0.995	49	-	3.0	-
							QUR4	No	0.228	0.857	0.997	139	-	5.1	-
							QUR5	No	0.275	1.000	1.000	42	-	2.8	-
							QUR6	No	0.361	1.000	1.000	51	-	3.1	-
						QUR3	QUR4	Yes	0.055	0.046	0.884	106	-5.6	-	0.714
							QUR5	Yes	0.003	0.456	0.238	9.3	-3.9	-	1.000
							QUR6	Yes	0.013	0.564	0.241	18	-3.7	-	0.965
						QUR4	QUR5	No	0.438	1.000	1.000	99	-	2.8	-
							QUR6	No	0.418	1.000	1.000	108	-	2.9	-
						QUR5	QUR6	No	0.820	1.000	1.000	11	-	8.6	-
Iron	No	0.038	Yes	0.001	0.999	BLC	QUR1	No	0.320	1.000	1.000	943,333	-	3.0	-
							QUR2	No	0.590	1.000	1.000	2,361,667	-	4.8	-
							QUR3	Yes	0.007	0.781	0.300	948,333	3.3	-	0.993
							QUR4	No	0.117	0.676	0.972	6,643,333	-	8.1	-
							QUR5	Yes	0.000	0.007	0.125	801,667	6.7	-	1.000
							QUR6	Yes	0.036	0.018	0.785	8,588,333	6.0	-	0.817
						QUR1	QUR2	No	0.204	1.000	0.997	1,741,667	-	9.1	-
							QUR3	Yes	0.000	0.291	0.009	328,333	8.7	-	1.000
							QUR4	Yes	0.064	0.251	0.931	6,023,333	9.0	-	0.673
							QUR5	Yes	0.000	0.003	0.009	181,667	16	-	1.000
							QUR6	Yes	0.022	0.007	0.752	7,968,333	15	-	0.904
						QUR2	QUR3	Yes	0.037	1.000	0.789	1,746,667	1.9	-	0.811
							QUR4	No	0.195	1.000	0.994	7,441,667	-	6.0	-
							QUR5	Yes	0.002	0.015	0.299	1,600,000	4.3	-	1.000
							QUR6	Yes	0.055	0.040	0.829	9,386,667	3.8	-	0.714
						QUR3	QUR4	No	0.950	1.000	1.000	6,028,333	-	17	-
							QUR5	Yes	0.000	0.629	0.059	186,667	7.4	-	1.000
							QUR6	No	0.214	1.000	0.999	7,973,333	-	19	-
						QUR4	QUR5	No	0.105	0.727	0.981	5,881,667	-	2.8	-
							QUR6	No	0.340	1.000	1.000	13,668,333	-	4.2	-
						QUR5	QUR6	No	0.724	1.000	1.000	7,826,667	-	55	-

Table I.18: Statistical comparison summary of whole benthic invertebrate community metal and metalloid tissue concentration for reference area BLC and six Quesnel River areas. Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Lead	No	0.020	Yes	<0.001	1.000	BLC	QUR1	Yes	0.012	1.000	0.278	0.011	4.3	-	0.968
							QUR2	Yes	0.030	0.902	0.806	0.13	11	-	0.851
							QUR3	Yes	0.000	0.030	0.084	0.039	20	-	1.000
							QUR4	Yes	0.008	0.004	0.539	0.29	25	-	0.990
							QUR5	Yes	0.000	0.000	0.000	0.010	37	-	1.000
							QUR6	Yes	0.010	0.000	0.605	0.55	32	-	0.980
						QUR1	QUR2	No	0.116	1.000	0.980	0.13	-	12	-
							QUR3	Yes	0.001	0.161	0.100	0.042	11	-	1.000
							QUR4	Yes	0.015	0.023	0.663	0.29	15	-	0.951
							QUR5	Yes	0.000	0.000	0.000	0.014	23	-	1.000
							QUR6	Yes	0.017	0.002	0.701	0.55	20	-	0.940
						QUR2	QUR3	Yes	0.082	1.000	0.899	0.16	1.5	-	0.603
							QUR4	Yes	0.084	0.342	0.873	0.41	2.4	-	0.595
							QUR5	Yes	0.002	0.003	0.244	0.13	4.4	-	1.000
							QUR6	Yes	0.055	0.023	0.817	0.67	3.6	-	0.712
						QUR3	QUR4	No	0.399	1.000	1.000	0.32	-	8.3	-
							QUR5	Yes	0.001	0.099	0.088	0.042	5.5	-	1.000
							QUR6	No	0.171	0.695	0.995	0.58	-	11	-
						QUR4	QUR5	Yes	0.078	0.695	0.954	0.29	1.4	-	0.617
							QUR6	No	0.463	1.000	1.000	0.82	-	4.7	-
						QUR5	QUR6	No	0.513	1.000	1.000	0.55	-	25	-
Manganese	Yes	0.064	Yes	<0.001	1.000	BLC	QUR1	Yes	0.001	0.000	0.105	2,267	-5.4	-	1.000
							QUR2	Yes	0.002	0.000	0.110	2,467	-4.7	-	1.000
							QUR3	Yes	0.018	0.025	0.397	2,767	-2.7	-	0.933
							QUR4	Yes	0.049	0.011	0.710	6,417	-2.9	-	0.744
							QUR5	Yes	0.031	0.145	0.663	2,400	-2.1	-	0.843
							QUR6	Yes	0.008	0.008	0.364	2,300	-3.0	-	0.988
						QUR1	QUR2	No	0.140	1.000	0.962	833	-	4.5	-
							QUR3	Yes	0.003	0.021	0.121	1,133	6.8	-	0.999
							QUR4	Yes	0.053	0.047	0.886	4,783	6.1	-	0.721
							QUR5	Yes	0.001	0.004	0.019	767	8.2	-	1.000
							QUR6	Yes	0.002	0.065	0.046	667	5.8	-	1.000
						QUR2	QUR3	Yes	0.013	0.170	0.266	1,333	3.9	-	0.963
							QUR4	No	0.129	0.379	0.981	4,983	-	8.6	-
							QUR5	Yes	0.003	0.029	0.062	967	5.1	-	1.000
							QUR6	Yes	0.013	0.520	0.251	867	3.2	-	0.966
						QUR3	QUR4	No	0.793	1.000	1.000	5,283	-	7.1	-
							QUR5	No	0.276	1.000	0.999	1,267	-	3.5	-
							QUR6	No	0.450	1.000	1.000	1,167	-	3.3	-
						QUR4	QUR5	No	0.404	1.000	1.000	4,917	-	2.9	-
							QUR6	No	0.912	1.000	1.000	4,817	-	2.9	-
						QUR5	QUR6	Yes	0.060	1.000	0.734	800	-2.0	-	0.688
Nickel	No	0.012	Yes	0.001	0.999	BLC	QUR1	Yes	0.054	0.303	0.910	7.3	-1.6	-	1.000
							QUR2	No	0.101	0.667	0.946	8.7	-	3.1	-
							QUR3	No	0.989	1.000	1.000	7.3	-	2.8	-
							QUR4	No	0.818	1.000	1.000	17	-	4.3	-
							QUR5	Yes	0.061	0.387	0.928	7.3	1.5	-	0.683
							QUR6	No	0.224	1.000	0.996	12	-	3.6	-
						QUR1	QUR2	No	0.464	1.000	1.000	1.7	-	8.4	-
							QUR3	Yes	0.000	0.294	0.005	0.35	9.8	-	1.000
							QUR4	Yes	0.060	0.140	0.928	10	11	-	0.687
							QUR5	Yes	0.000	0.002	0.000	0.35	19	-	1.000
							QUR6	Yes	0.005	0.007	0.424	4.9	16	-	0.997
						QUR2	QUR3	Yes	0.008	0.647	0.438	1.7	2.9	-	0.987
							QUR4	No	0.100	0.313	0.955	12	-	7.7	-
							QUR5	Yes	0.001	0.004	0.096	1.7	6.2	-	1.000
							QUR6	Yes	0.011	0.016	0.318	6.2	5.2	-	0.976
						QUR3	QUR4	No	0.775	1.000	1.000	10	-	22	-
							QUR5	Yes	0.000	0.399	0.006	0.33	9.8	-	1.000
							QUR6	Yes	0.090	1.000	0.965	4.8	6.9	-	0.577
						QUR4	QUR5	No	0.137	0.820	0.991	10	-	2.8	-
							QUR6	No	0.366	1.000	1.000	15	-	3.4	-
						QUR5	QUR6	No	0.406	1.000	1.000	4.8	-	15	-
Selenium	Yes	0.064	Yes	0.007	0.971	BLC	QUR1	Yes	0.001	0.052	0.138	0.11	23	-	1.000
							QUR2	Yes	0.018	0.028	0.720	0.82	25	-	0.933
							QUR3	Yes	0.004	0.052	0.425	0.31	23	-	0.998
							QUR4	No	0.138	0.970	0.992	1.1	-	35	-
							QUR5	Yes	0.003	0.015	0.344	0.33	27	-	1.000
							QUR6	Yes	0.000	0.019	0.059	0.078	26	-	1.000
						QUR1	QUR2	No	0.780	1.000	1.000	0.92	-	8.2	-
							QUR3	No	1.000	1.000	1.000	0.41	-	5.5	-
							QUR4	No	0.295	1.000	1.000	1.2	-	9.3	-
							QUR5	No	0.431	1.000	1.000	0.43	-	5.6	-
							QUR6	No	0.346	1.000	1.000	0.18	-	3.6	-
						QUR2	QUR3	No	0.800	1.000	1.000	1.1	-	3.3	-
							QUR4	No	0.311	1.000	1.000	1.9	-	4.2	-
							QUR5	No	0.802	1.000	1.000	1.1	-	3.3	-
							QUR6	No	0.871	1.000	1.000	0.88	-	2.9	-
						QUR3	QUR4	No	0.328	1.000	1.000	1.4	-	5.9	-
							QUR5	No	0.510	1.000	1.000	0.63	-	4.0	-
							QUR6	No	0.505	1.000	1.000	0.38	-	3.1	-
						QUR4	QUR5	No	0.187	1.000	0.992	1.4	-	3.2	-
							QUR6	No	0.176	1.000	0.996	1.1	-	2.9	-
						QUR5	QUR6	No	0.855	1.000	1.000	0.39	-	3.1	-

Table I.18: Statistical comparison summary of whole benthic invertebrate community metal and metalloid tissue concentration for reference area BLC and six Quesnel River areas. Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Silver	No	0.016	Yes	0.011	0.952	BLC	QUR1	Yes	0.000	0.011	0.118	0.00028	25	-	1.000
							QUR2	Yes	0.019	0.067	0.729	0.0013	20	-	0.925
							QUR3	Yes	0.000	1.000	0.070	0.000017	-7.5	-	1.000
							QUR4	No	0.173	0.788	0.997	0.0029	-	37	-
							QUR5	Yes	0.078	1.000	0.951	0.00043	6.9	-	0.616
							QUR6	Yes	0.013	0.788	0.605	0.00043	13	-	0.967
						QUR1	QUR2	No	0.408	1.000	1.000	0.0016	-	6.8	-
							QUR3	Yes	0.003	0.352	0.385	0.00027	-8.1	-	1.000
							QUR4	No	0.203	0.960	0.998	0.0032	-	9.6	-
							QUR5	Yes	0.008	0.125	0.181	0.00068	-4.5	-	0.987
							QUR6	Yes	0.031	0.960	0.502	0.00068	-3.0	-	0.849
						QUR2	QUR3	No	0.128	1.000	0.990	0.0013	-	2.8	-
							QUR4	No	0.493	1.000	1.000	0.0042	-	5.0	-
							QUR5	Yes	0.097	0.788	0.924	0.0017	-1.4	-	0.555
							QUR6	No	0.305	1.000	1.000	0.0017	-	3.2	-
						QUR3	QUR4	No	0.725	1.000	1.000	0.0029	-	-[f]	-
							QUR5	No	0.374	1.000	1.000	0.00042	-	-[f]	-
							QUR6	No	0.374	1.000	1.000	0.00042	-	-[f]	-
						QUR4	QUR5	No	0.519	1.000	1.000	0.0033	-	3.0	-
							QUR6	No	1.000	1.000	1.000	0.0033	-	3.0	-
						QUR5	QUR6	No	0.230	1.000	0.996	0.00083	-	3.9	-
Strontium	No	<0.001	No	0.156	0.652	BLC	QUR1	-	-	-	-	935	-	208	-
							QUR2	-	-	-	-	1.7	-	8.8	-
							QUR3	-	-	-	-	0.17	-	2.8	-
							QUR4	-	-	-	-	54	-	50	-
							QUR5	-	-	-	-	0.17	-	2.8	-
							QUR6	-	-	-	-	21	-	31	-
						QUR1	QUR2	-	-	-	-	937	-	2.8	-
							QUR3	-	-	-	-	935	-	2.8	-
							QUR4	-	-	-	-	989	-	2.9	-
							QUR5	-	-	-	-	935	-	2.8	-
							QUR6	-	-	-	-	956	-	2.8	-
						QUR2	QUR3	-	-	-	-	1.5	-	2.8	-
							QUR4	-	-	-	-	56	-	17	-
							QUR5	-	-	-	-	1.5	-	2.8	-
							QUR6	-	-	-	-	23	-	11	-
						QUR3	QUR4	-	-	-	-	54	-	0.0	-
							QUR5	-	-	-	-	0.0	-	0.0	-
							QUR6	-	-	-	-	21	-	0.0	-
						QUR4	QUR5	-	-	-	-	54	-	2.8	-
							QUR6	-	-	-	-	75	-	3.3	-
						QUR5	QUR6	-	-	-	-	21	-	0.0	-
Titanium	No	0.010	Yes	0.001	0.999	BLC	QUR1	Yes	0.074	1.000	0.924	1,169	-1.5	-	0.631
							QUR2	No	0.531	1.000	1.000	3,077	-	4.7	-
							QUR3	Yes	0.013	1.000	0.445	1,267	2.7	-	0.963
							QUR4	No	0.118	0.692	0.979	14,167	-	10	-
							QUR5	Yes	0.000	0.017	0.037	1,267	7.6	-	1.000
							QUR6	Yes	0.072	0.093	0.936	19,367	6.0	-	0.641
						QUR1	QUR2	No	0.395	1.000	1.000	2,145	-	12	-
							QUR3	Yes	0.000	0.742	0.007	335	12	-	1.000
							QUR4	Yes	0.050	0.139	0.907	13,235	17	-	0.735
							QUR5	Yes	0.000	0.004	0.000	335	27	-	1.000
							QUR6	Yes	0.036	0.019	0.858	18,435	22	-	0.813
						QUR2	QUR3	Yes	0.016	1.000	0.589	2,243	2.4	-	0.944
							QUR4	Yes	0.089	0.332	0.940	15,143	3.5	-	0.579
							QUR5	Yes	0.001	0.008	0.105	2,243	5.9	-	1.000
							QUR6	Yes	0.057	0.044	0.881	20,343	4.8	-	0.701
						QUR3	QUR4	No	0.499	1.000	1.000	13,333	-	22	-
							QUR5	Yes	0.000	0.340	0.004	433	11	-	1.000
							QUR6	No	0.240	1.000	0.999	18,533	-	26	-
						QUR4	QUR5	No	0.179	1.000	0.997	13,333	-	2.8	-
							QUR6	No	0.596	1.000	1.000	31,433	-	4.3	-
						QUR5	QUR6	No	0.563	1.000	1.000	18,533	-	26	-
Uranium	Yes	0.059	Yes	<0.001	1.000	BLC	QUR1	Yes	0.037	1.000	0.846	0.00063	11	-	0.809
							QUR2	Yes	0.046	1.000	0.897	0.0022	19	-	0.756
							QUR3	Yes	0.001	0.706	0.270	0.0011	37	-	1.000
							QUR4	Yes	0.014	0.048	0.680	0.0098	58	-	0.957
							QUR5	Yes	0.001	0.000	0.262	0.0085	107	-	1.000
							QUR6	Yes	0.039	0.031	0.874	0.021	62	-	0.797
						QUR1	QUR2	No	0.343	1.000	1.000	0.0028	-	5.9	-
							QUR3	Yes	0.012	1.000	0.254	0.0017	4.3	-	0.972
							QUR4	Yes	0.031	0.194	0.780	0.010	7.8	-	0.849
							QUR5	Yes	0.002	0.001	0.243	0.0091	16	-	1.000
							QUR6	Yes	0.070	0.125	0.942	0.021	8.4	-	0.646
						QUR2	QUR3	Yes	0.093	1.000	0.893	0.0033	1.6	-	0.566
							QUR4	Yes	0.064	0.532	0.860	0.012	3.4	-	0.670
							QUR5	Yes	0.004	0.001	0.180	0.011	7.6	-	1.000
							QUR6	No	0.118	0.346	0.976	0.023	-	9.0	-
						QUR3	QUR4	No	0.222	1.000	0.998	0.011	-	8.7	-
							QUR5	Yes	0.007	0.011	0.380	0.0096	8.5	-	0.992
							QUR6	No	0.302	1.000	1.000	0.022	-	12	-
						QUR4	QUR5	Yes	0.064	0.167	0.753	0.018	2.0	-	0.671
							QUR6	No	0.895	1.000	1.000	0.031	-	4.9	-
						QUR5	QUR6	No	0.136	0.259	0.966	0.029	-	5.2	-

Table I.18: Statistical comparison summary of whole benthic invertebrate community metal and metalloid tissue concentration for reference area BLC and six Quesnel River areas. Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA: Variance Equal?	Overall 7-group ANOVA: Variance Levene p-value	Overall 7-group ANOVA: Significant Difference Among Areas?	Overall 7-group ANOVA: p-value	Overall 7-group ANOVA: Power	Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]: Significant Difference Between Areas?[b]	7-group ANOVA Post-hoc Comparisons[a]: p-value T-Test	7-group ANOVA Post-hoc Comparisons[a]: p-value Bonferroni	7-group ANOVA Post-hoc Comparisons[a]: p-value Tahmane	2-group ANOVA for Estimation of Effect Size: MSE (ANOVA)	2-group ANOVA for Estimation of Effect Size: Magnitude of Difference (# of Area1 SDs)[c]	2-group ANOVA for Estimation of Effect Size: Minimum Detectable Effect Size (# of Area1 SDs)[d]	2-group ANOVA for Estimation of Effect Size: Power
Vanadium	No	0.038	Yes	0.001	0.999	BLC	QUR1	No	0.485	1.000	1.000	4.3	-	3.0	-
							QUR2	No	0.651	1.000	1.000	14	-	5.4	-
							QUR3	Yes	0.001	0.084	0.267	3.6	-2.8	-	1.000
							QUR4	Yes	0.059	1.000	0.798	14	3.0	-	0.692
							QUR5	Yes	0.012	0.014	0.422	20	6.0	-	0.968
							QUR6	Yes	0.038	0.034	0.787	33	5.3	-	0.802
						QUR1	QUR2	No	0.359	1.000	1.000	11	-	11	-
							QUR3	Yes	0.000	0.042	0.051	0.73	-5.1	-	1.000
							QUR4	Yes	0.027	0.520	0.745	11	7.6	-	0.872
							QUR5	Yes	0.007	0.007	0.485	17	14	-	0.992
							QUR6	Yes	0.025	0.017	0.775	30	13	-	0.882
						QUR2	QUR3	Yes	0.013	0.187	0.659	10	-2.0	-	0.966
							QUR4	No	0.154	1.000	0.970	20	-	3.9	-
							QUR5	Yes	0.027	0.031	0.465	27	3.2	-	0.874
							QUR6	Yes	0.067	0.076	0.834	39	2.9	-	0.660
						QUR3	QUR4	No	0.148	1.000	0.994	10	-	-[f]	0.438
							QUR5	No	0.374	1.000	1.000	17	-	-[f]	0.216
							QUR6	No	0.725	1.000	1.000	29	-	-[f]	0.117
						QUR4	QUR5	No	0.132	0.971	0.953	27	-	4.5	-
							QUR6	No	0.284	1.000	0.999	39	-	5.5	-
						QUR5	QUR6	No	0.778	1.000	1.000	46	-	4.6	-
Zinc	No	<0.001	Yes	0.001	0.999	BLC	QUR1	Yes	0.000	0.001	0.019	50	-[f]	-	1.000
							QUR2	Yes	0.001	0.002	0.192	517	-[f]	-	1.000
							QUR3	Yes	0.000	0.717	0.103	50	-[f]	-	1.000
							QUR4	No	0.118	0.229	0.986	3,800	-	-[f]	-
							QUR5	Yes	0.000	1.000	0.078	17	-[f]	-	1.000
							QUR6	No	0.130	1.000	0.990	1,667	-	-[f]	-
						QUR1	QUR2	No	0.749	1.000	1.000	567	-	9.3	-
							QUR3	Yes	0.000	0.128	0.004	100	-11	-	1.000
							QUR4	No	0.150	0.407	0.994	3,850	-	24	-
							QUR5	Yes	0.000	0.027	0.003	67	-14	-	1.000
							QUR6	Yes	0.020	0.048	0.721	1,717	-13	-	0.918
						QUR2	QUR3	Yes	0.006	0.188	0.383	567	-3.2	-	0.995
							QUR4	No	0.195	0.595	0.996	4,317	-	8.0	-
							QUR5	Yes	0.002	0.040	0.306	533	-4.0	-	1.000
							QUR6	Yes	0.035	0.071	0.648	2,183	-3.7	-	0.823
						QUR3	QUR4	No	0.713	1.000	1.000	3,850	-	24	-
							QUR5	Yes	0.016	1.000	0.410	67	-2.7	-	0.944
							QUR6	No	0.648	1.000	1.000	1,717	-	16	-
						QUR4	QUR5	No	0.407	1.000	1.000	3,817	-	2.8	-
							QUR6	No	0.576	1.000	1.000	5,467	-	3.3	-
						QUR5	QUR6	No	0.780	1.000	1.000	1,683	-	28	-

[a] Bonferroni post-hoc Test, or Dunnet's T3 Test where variances were found to be heterogenous by Levene's Test

[b] Due to low replication (3 per area) T-Tests are used as post-hoc test of significance between areas - Bonferroni and Tamhane post-hoc tests are reported for interest only.

[c] Magnitude calculated by comparing the difference between the control area and exposed area means to the control area standard deviation (SD) [(exposed mean - control mean) / standard deviation of the control mean]

[d] Minimum effect size detectable calculated based on variance as square root of MSE from ANOVA and alpha = beta = 0.10. Minimum effect size reported as the minimum number of standard deviations detectable based on reference area standard deviation.

[e] All observations at MLD in both areas; therefore, no statistic possible.

[f] Zero variance in Area1; therefore, calculation not possible.

Highlighted values indicate significance at the *p* < 0.10 level.

Table I.19: Statistical comparison summary of whole benthic invertebrate community metal and metalloid tissue concentration for reference area CLR and six Quesnel River areas, Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Aluminum	Yes	0.002	Yes	0.002	0.993	CLR	QUR1	No	0.867	1.000	1.000	3,502,067	-	2.8	-
							QUR2	No	0.597	1.000	1.000	4,035,400	-	3.0	-
							QUR3	No	0.108	0.384	0.982	3,475,400	-	2.8	-
							QUR4	No	0.194	0.535	0.991	5,335,400	-	3.4	-
							QUR5	Yes	0.028	0.013	0.817	3,475,400	-0.71	-	0.866
							QUR6	Yes	0.057	0.026	0.777	4,815,400	1.8	-	0.702
						QUR1	QUR2	No	0.346	1.000	1.000	586,667	-	13	-
							QUR3	Yes	0.000	0.603	0.044	26,667	-9.2	-	1.000
							QUR4	Yes	0.076	0.834	0.955	1,886,667	12	-	0.624
							QUR5	Yes	0.000	0.021	0.016	26,667	-9.2	-	1.000
							QUR6	Yes	0.009	0.041	0.572	1,366,667	19	-	0.983
						QUR2	QUR3	Yes	0.023	1.000	0.778	560,000	-2.6	-	0.900
							QUR4	No	0.190	1.000	0.993	2,420,000	-	5.8	-
							QUR5	Yes	0.002	0.064	0.353	560,000	-2.6	-	1.000
							QUR6	Yes	0.028	0.127	0.531	1,900,000	3.6	-	0.866
						QUR3	QUR4	No	0.866	1.000	1.000	1,860,000	-	0.0	-
							QUR5	-	-	1.000	-	-[e]	-	-	-
							QUR6	No	0.166	1.000	0.996	1,340,000	-	0.0	-
						QUR4	QUR5	No	0.119	1.000	0.987	1,860,000	-	2.8	-
							QUR6	No	0.285	1.000	0.999	3,200,000	-	3.6	-
						QUR5	QUR6	No	0.694	1.000	1.000	1,340,000	-	-[f]	-
Arsenic	No	0.140	Yes	<0.001	1.000	CLR	QUR1	Yes	0.061	1.000	0.794	0.29	2.8	-	0.685
							QUR2	Yes	0.010	0.031	0.486	0.87	8.6	-	0.979
							QUR3	Yes	0.000	0.006	0.014	0.23	10	-	1.000
							QUR4	Yes	0.006	0.001	0.415	1.3	12	-	0.996
							QUR5	Yes	0.000	0.000	0.001	0.13	14	-	1.000
							QUR6	Yes	0.012	0.003	0.586	1.7	11	-	0.968
						QUR1	QUR2	Yes	0.045	0.397	0.753	0.99	3.6	-	0.760
							QUR3	Yes	0.003	0.076	0.072	0.36	4.8	-	1.000
							QUR4	Yes	0.017	0.015	0.541	1.4	5.9	-	0.937
							QUR5	Yes	0.000	0.003	0.036	0.26	7.1	-	1.000
							QUR6	Yes	0.035	0.033	0.757	1.8	5.3	-	0.823
						QUR2	QUR3	No	0.406	1.000	1.000	0.94	-	3.0	-
							QUR4	No	0.272	1.000	0.999	2.0	-	4.4	-
							QUR5	Yes	0.040	0.495	0.837	0.84	1.8	-	0.789
							QUR6	No	0.430	1.000	1.000	2.4	-	4.8	-
						QUR3	QUR4	No	0.483	1.000	1.000	1.4	-	8.3	-
							QUR5	Yes	0.015	1.000	0.390	0.20	2.7	-	0.951
							QUR6	No	0.750	1.000	1.000	1.7	-	9.4	-
						QUR4	QUR5	No	0.449	1.000	1.000	1.3	-	2.8	-
							QUR6	No	0.801	1.000	1.000	2.8	-	4.2	-
						QUR5	QUR6	No	0.338	1.000	1.000	1.6	-	16	-
Barium	No	0.085	Yes	0.013	0.994	CLR	QUR1	No	0.412	1.000	1.000	45	-	46	-
							QUR2	Yes	0.015	0.552	0.693	33	33	-	0.950
							QUR3	Yes	0.005	0.019	0.485	51	55	-	0.997
							QUR4	No	0.284	1.000	1.000	86	-	63	-
							QUR5	Yes	0.001	0.235	0.235	11	39	-	1.000
							QUR6	Yes	0.066	0.601	0.945	83	32	-	0.661
						QUR1	QUR2	No	0.123	1.000	0.939	77	-	3.7	-
							QUR3	Yes	0.028	0.070	0.447	95	2.9	-	0.868
							QUR4	No	0.666	1.000	1.000	130	-	4.7	-
							QUR5	Yes	0.046	0.837	0.770	55	1.8	-	0.757
							QUR6	No	0.213	1.000	0.994	128	-	4.7	-
						QUR2	QUR3	No	0.156	1.000	0.974	83	-	4.4	-
							QUR4	No	0.337	1.000	1.000	118	-	5.3	-
							QUR5	No	0.568	1.000	1.000	43	-	3.2	-
							QUR6	No	0.972	1.000	1.000	116	-	5.2	-
						QUR3	QUR4	Yes	0.076	0.216	0.828	136	-2.3	-	0.624
							QUR5	No	0.205	1.000	0.996	61	-	3.0	-
							QUR6	No	0.231	1.000	0.996	134	-	4.5	-
						QUR4	QUR5	No	0.179	1.000	0.995	96	-	2.9	-
							QUR6	No	0.428	1.000	1.000	169	-	3.9	-
						QUR5	QUR6	No	0.667	1.000	1.000	94	-	8.3	-
Cadmium	Yes	0.005	Yes	<0.001	1.000	CLR	QUR1	No	0.365	1.000	1.000	0.70	-	3.3	-
							QUR2	No	0.232	1.000	0.997	0.71	-	3.3	-
							QUR3	Yes	0.031	1.000	0.485	1.1	2.8	-	0.848
							QUR4	No	0.249	1.000	1.000	36	-	24	-
							QUR5	Yes	0.002	0.002	0.219	8.7	19	-	1.000
							QUR6	Yes	0.014	0.032	0.642	15	13	-	0.957
						QUR1	QUR2	No	0.633	1.000	1.000	0.42	-	4.0	-
							QUR3	Yes	0.045	1.000	0.723	0.82	3.3	-	0.761
							QUR4	No	0.292	1.000	1.000	36	-	37	-
							QUR5	Yes	0.002	0.002	0.269	8.4	28	-	1.000
							QUR6	Yes	0.016	0.047	0.697	15	20	-	0.942
						QUR2	QUR3	Yes	0.068	1.000	0.836	0.83	2.8	-	0.654
							QUR4	No	0.312	1.000	1.000	36	-	36	-
							QUR5	Yes	0.002	0.003	0.275	8.4	27	-	1.000
							QUR6	Yes	0.018	0.056	0.712	15	19	-	0.934
						QUR3	QUR4	No	0.482	1.000	1.000	36	-	21	-
							QUR5	Yes	0.003	0.008	0.285	8.8	14	-	1.000
							QUR6	Yes	0.031	0.164	0.802	16	9.5	-	0.846
						QUR4	QUR5	Yes	0.091	0.069	0.927	44	1.4	-	0.574
							QUR6	No	0.312	1.000	1.000	50	-	3.3	-
						QUR5	QUR6	No	0.250	1.000	0.998	23	-	4.7	-

Table I.19: Statistical comparison summary of whole benthic invertebrate community metal and metalloid tissue concentration for reference area CLR and six Quesnel River areas, Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Chromium	Yes	0.008	No	0.111	0.714	CLR	QUR1	-	-	-	-	23	-	2.8	-
							QUR2	-	-	-	-	33	-	3.3	-
							QUR3	-	-	-	-	23	-	2.8	-
							QUR4	-	-	-	-	36	-	3.5	-
							QUR5	-	-	-	-	79	-	5.1	-
							QUR6	-	-	-	-	60	-	4.5	-
						QUR1	QUR2	-	-	-	-	10	-	0.0	-
							QUR3	-	-	-	-	0.17	-	0.0	-
							QUR4	-	-	-	-	13	-	0.0	-
							QUR5	-	-	-	-	56	-	0.0	-
							QUR6	-	-	-	-	37	-	0.0	-
						QUR2	QUR3	-	-	-	-	10	-	2.8	-
							QUR4	-	-	-	-	23	-	4.2	-
							QUR5	-	-	-	-	66	-	7.1	-
							QUR6	-	-	-	-	47	-	6.0	-
						QUR3	QUR4	-	-	-	-	13	-	25	-
							QUR5	-	-	-	-	56	-	51	-
							QUR6	-	-	-	-	37	-	41	-
						QUR4	QUR5	-	-	-	-	69	-	6.3	-
							QUR6	-	-	-	-	50	-	5.4	-
						QUR5	QUR6	-	-	-	-	93	-	3.6	-
Cobalt	Yes	0.003	Yes	0.063	0.800	CLR	QUR1	No	0.652	1.000	1.000	12	-	2.8	-
							QUR2	No	0.858	1.000	1.000	13	-	2.8	-
							QUR3	No	0.512	1.000	1.000	12	-	2.8	-
							QUR4	No	0.838	1.000	1.000	15	-	3.0	-
							QUR5	No	0.192	0.693	0.998	12	-	2.8	-
							QUR6	No	0.334	1.000	1.000	16	-	3.2	-
						QUR1	QUR2	No	0.259	1.000	1.000	0.60	-	12	-
							QUR3	Yes	0.000	1.000	0.002	0.063	14	-	1.000
							QUR4	No	0.181	1.000	0.997	2.5	-	24	-
							QUR5	Yes	0.000	0.166	0.005	0.14	23	-	1.000
							QUR6	Yes	0.033	0.437	0.840	3.6	20	-	0.832
						QUR2	QUR3	Yes	0.015	1.000	0.625	0.60	2.4	-	0.953
							QUR4	No	0.432	1.000	1.000	3.0	-	6.3	-
							QUR5	Yes	0.002	0.394	0.136	0.68	4.7	-	1.000
							QUR6	Yes	0.069	1.000	0.895	4.1	3.8	-	0.653
						QUR3	QUR4	No	0.345	1.000	1.000	2.5	-	24	-
							QUR5	Yes	0.001	1.000	0.071	0.14	9.7	-	1.000
							QUR6	No	0.386	1.000	1.000	3.6	-	29	-
						QUR4	QUR5	Yes	0.043	1.000	0.863	2.5	1.7	-	0.775
							QUR6	No	0.224	1.000	0.995	6.0	-	4.4	-
						QUR5	QUR6	No	0.582	1.000	1.000	3.7	-	16	-
Copper	No	0.122	Yes	<0.001	1.000	CLR	QUR1	Yes	0.004	0.001	0.090	58	5.1	-	0.999
							QUR2	Yes	0.006	0.001	0.128	66	5.1	-	0.996
							QUR3	Yes	0.001	0.000	0.040	33	6.3	-	1.000
							QUR4	Yes	0.069	0.077	0.867	123	3.1	-	0.649
							QUR5	Yes	0.002	0.009	0.281	26	4.1	-	1.000
							QUR6	Yes	0.003	0.008	0.117	35	4.2	-	0.999
						QUR1	QUR2	No	0.964	1.000	1.000	73	-	4.2	-
							QUR3	No	0.172	1.000	0.990	41	-	3.1	-
							QUR4	No	0.208	0.980	0.995	131	-	5.6	-
							QUR5	No	0.215	1.000	0.999	34	-	2.8	-
							QUR6	No	0.302	1.000	1.000	43	-	3.2	-
						QUR2	QUR3	No	0.190	1.000	0.995	49	-	3.0	-
							QUR4	No	0.228	1.000	0.997	139	-	5.1	-
							QUR5	No	0.275	1.000	1.000	42	-	2.8	-
							QUR6	No	0.361	1.000	1.000	51	-	3.1	-
						QUR3	QUR4	Yes	0.055	0.070	0.884	106	-5.6	-	0.714
							QUR5	Yes	0.003	0.599	0.238	9.3	-3.9	-	1.000
							QUR6	Yes	0.013	0.730	0.241	18	-3.7	-	0.965
						QUR4	QUR5	No	0.438	1.000	1.000	99	-	2.8	-
							QUR6	No	0.418	1.000	1.000	108	-	2.9	-
						QUR5	QUR6	No	0.820	1.000	1.000	11	-	8.6	-
Iron	Yes	0.025	Yes	0.002	0.994	CLR	QUR1	No	0.864	1.000	1.000	6,957,717	-	2.8	-
							QUR2	No	0.627	1.000	1.000	8,376,050	-	3.1	-
							QUR3	No	0.101	0.922	0.975	6,962,717	-	2.8	-
							QUR4	No	0.180	0.816	0.985	12,657,717	-	3.8	-
							QUR5	Yes	0.014	0.016	0.681	6,816,050	2.4	-	0.956
							QUR6	Yes	0.063	0.036	0.746	14,602,717	2.2	-	0.676
						QUR1	QUR2	No	0.204	1.000	0.997	1,741,667	-	9.1	-
							QUR3	Yes	0.000	0.642	0.009	328,333	8.7	-	1.000
							QUR4	Yes	0.064	0.567	0.931	6,023,333	9.0	-	0.673
							QUR5	Yes	0.000	0.011	0.009	181,667	16	-	1.000
							QUR6	Yes	0.022	0.025	0.752	7,968,333	15	-	0.904
						QUR2	QUR3	Yes	0.037	1.000	0.789	1,746,667	1.9	-	0.811
							QUR4	No	0.195	1.000	0.994	7,441,667	-	6.0	-
							QUR5	Yes	0.002	0.052	0.299	1,600,000	4.3	-	1.000
							QUR6	Yes	0.055	0.120	0.829	9,386,667	3.8	-	0.714
						QUR3	QUR4	No	0.950	1.000	1.000	6,028,333	-	17	-
							QUR5	Yes	0.000	1.000	0.059	186,667	7.4	-	1.000
							QUR6	No	0.214	1.000	0.999	7,973,333	-	19	-
						QUR4	QUR5	No	0.105	1.000	0.981	5,881,667	-	2.8	-
							QUR6	No	0.340	1.000	1.000	13,668,333	-	4.2	-
						QUR5	QUR6	No	0.724	1.000	1.000	7,826,667	-	55	-

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Endpoint	Overall 7-group ANOVA: Variance: Equal?	Variance: Levene p-value	Significant Difference Among Areas?	p-value	Power	Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]: Significant Difference Between Areas?[b]	p-value: T-Test	p-value: Bonferroni	p-value: Tahmane	2-group ANOVA for Estimation of Effect Size: MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
Lead	Yes	0.046	Yes	<0.001	1.000	CLR	QUR1	No	0.346	1.000	1.000	0.14	-	2.9	-
							QUR2	Yes	0.090	1.000	0.862	0.26	1.8	-	0.577
							QUR3	Yes	0.007	0.058	0.269	0.17	3.3	-	0.992
							QUR4	Yes	0.016	0.009	0.346	0.41	4.1	-	0.948
							QUR5	Yes	0.000	0.000	0.127	0.14	6.2	-	1.000
							QUR6	Yes	0.015	0.001	0.456	0.67	5.3	-	0.949
						QUR1	QUR2	No	0.116	1.000	0.980	0.13	-	12	-
							QUR3	Yes	0.001	0.230	0.100	0.042	11	-	1.000
							QUR4	Yes	0.015	0.036	0.663	0.29	15	-	0.951
							QUR5	Yes	0.000	0.001	0.000	0.014	23	-	1.000
							QUR6	Yes	0.017	0.003	0.701	0.55	20	-	0.940
						QUR2	QUR3	Yes	0.082	1.000	0.899	0.16	1.5	-	0.603
							QUR4	Yes	0.084	0.465	0.873	0.41	2.4	-	0.595
							QUR5	Yes	0.002	0.006	0.244	0.13	4.4	-	1.000
							QUR6	Yes	0.055	0.036	0.817	0.67	3.6	-	0.712
						QUR3	QUR4	No	0.399	1.000	1.000	0.32	-	8.3	-
							QUR5	Yes	0.001	0.146	0.088	0.042	5.5	-	1.000
							QUR6	No	0.171	0.900	0.995	0.58	-	11	-
						QUR4	QUR5	Yes	0.078	0.900	0.954	0.29	1.4	-	0.617
							QUR6	No	0.463	1.000	1.000	0.82	-	4.7	-
						QUR5	QUR6	No	0.513	1.000	1.000	0.55	-	25	-
Manganese	No	0.054	Yes	<0.001	1.000	CLR	QUR1	No	0.174	1.000	0.992	2,069	-	3.0	-
							QUR2	Yes	0.055	0.462	0.792	2,269	1.8	-	0.714
							QUR3	Yes	0.005	0.001	0.141	2,569	3.9	-	0.998
							QUR4	Yes	0.029	0.002	0.554	6,219	3.6	-	0.858
							QUR5	Yes	0.002	0.000	0.123	2,202	4.5	-	1.000
							QUR6	Yes	0.005	0.003	0.259	2,102	3.5	-	0.997
						QUR1	QUR2	No	0.140	1.000	0.962	833	-	4.5	-
							QUR3	Yes	0.003	0.019	0.121	1,133	6.8	-	0.999
							QUR4	Yes	0.053	0.043	0.886	4,783	6.1	-	0.721
							QUR5	Yes	0.001	0.003	0.019	767	8.2	-	1.000
							QUR6	Yes	0.002	0.060	0.046	667	5.8	-	1.000
						QUR2	QUR3	Yes	0.013	0.159	0.266	1,333	3.9	-	0.963
							QUR4	No	0.129	0.357	0.981	4,983	-	8.6	-
							QUR5	Yes	0.003	0.027	0.062	967	5.1	-	1.000
							QUR6	Yes	0.013	0.492	0.251	867	3.2	-	0.966
						QUR3	QUR4	No	0.793	1.000	1.000	5,283	-	7.1	-
							QUR5	No	0.276	1.000	0.999	1,267	-	3.5	-
							QUR6	No	0.450	1.000	1.000	1,167	-	3.3	-
						QUR4	QUR5	No	0.404	1.000	1.000	4,917	-	2.9	-
							QUR6	No	0.912	1.000	1.000	4,817	-	2.9	-
						QUR5	QUR6	Yes	0.060	1.000	0.734	800	-2.0	-	0.688
Nickel	Yes	0.009	Yes	<0.001	1.000	CLR	QUR1	No	0.973	1.000	1.000	11	-	2.8	-
							QUR2	No	0.757	1.000	1.000	13	-	3.0	-
							QUR3	Yes	0.092	0.411	0.970	11	1.3	-	0.571
							QUR4	No	0.142	0.208	0.960	21	-	3.8	-
							QUR5	Yes	0.013	0.003	0.647	11	2.5	-	0.964
							QUR6	Yes	0.036	0.014	0.619	16	2.1	-	0.813
						QUR1	QUR2	No	0.464	1.000	1.000	1.7	-	8.4	-
							QUR3	Yes	0.000	0.447	0.005	0.35	9.8	-	1.000
							QUR4	Yes	0.060	0.227	0.928	10	11	-	0.687
							QUR5	Yes	0.000	0.004	0.000	0.35	19	-	1.000
							QUR6	Yes	0.005	0.015	0.424	4.9	16	-	0.997
						QUR2	QUR3	Yes	0.008	0.916	0.438	1.7	2.9	-	0.987
							QUR4	No	0.100	0.473	0.955	12	-	7.7	-
							QUR5	Yes	0.001	0.008	0.096	1.7	6.2	-	1.000
							QUR6	Yes	0.011	0.031	0.318	6.2	5.2	-	0.976
						QUR3	QUR4	No	0.775	1.000	1.000	10	-	22	-
							QUR5	Yes	0.000	0.591	0.006	0.33	9.8	-	1.000
							QUR6	Yes	0.090	1.000	0.965	4.8	6.9	-	0.577
						QUR4	QUR5	No	0.137	1.000	0.991	10	-	2.8	-
							QUR6	No	0.366	1.000	1.000	15	-	3.4	-
						QUR5	QUR6	No	0.406	1.000	1.000	4.8	-	15	-
Selenium	No	0.163	Yes	0.088	0.752	CLR	QUR1	Yes	0.077	0.688	0.929	1.0	1.4	-	0.620
							QUR2	No	0.111	0.400	0.916	1.7	-	3.8	-
							QUR3	Yes	0.096	0.688	0.921	1.2	1.4	-	0.558
							QUR4	No	0.480	1.000	1.000	2.0	-	4.1	-
							QUR5	Yes	0.056	0.230	0.784	1.3	1.8	-	0.706
							QUR6	Yes	0.046	0.292	0.857	1.0	1.7	-	0.756
						QUR1	QUR2	No	0.780	1.000	1.000	0.92	-	8.2	-
							QUR3	No	1.000	1.000	1.000	0.41	-	5.5	-
							QUR4	No	0.295	1.000	1.000	1.2	-	9.3	-
							QUR5	No	0.431	1.000	1.000	0.43	-	5.6	-
							QUR6	No	0.346	1.000	1.000	0.18	-	3.6	-
						QUR2	QUR3	No	0.800	1.000	1.000	1.1	-	3.3	-
							QUR4	No	0.311	1.000	1.000	1.9	-	4.2	-
							QUR5	No	0.802	1.000	1.000	1.1	-	3.3	-
							QUR6	No	0.871	1.000	1.000	0.88	-	2.9	-
						QUR3	QUR4	No	0.328	1.000	1.000	1.4	-	5.9	-
							QUR5	No	0.510	1.000	1.000	0.63	-	4.0	-
							QUR6	No	0.505	1.000	1.000	0.38	-	3.1	-
						QUR4	QUR5	No	0.187	1.000	0.992	1.4	-	3.2	-
							QUR6	No	0.176	1.000	0.996	1.1	-	2.9	-
						QUR5	QUR6	No	0.855	1.000	1.000	0.39	-	3.1	-

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Endpoint	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Silver	Yes	0.026	Yes	0.030	0.885	CLR	QUR1	Yes	0.002	0.048	0.059	0.0004	7.9	-	1.000
							QUR2	Yes	0.044	0.302	0.838	0.0014	5.9	-	0.770
							QUR3	Yes	0.019	1.000	0.747	0.00012	-4.4	-	0.922
							QUR4	No	0.329	1.000	1.000	0.0030	-	14	-
							QUR5	No	0.427	1.000	1.000	0.00053	-	5.9	-
							QUR6	Yes	0.057	1.000	0.809	0.00053	3.3	-	0.703
						QUR1	QUR2	No	0.408	1.000	1.000	0.0016	-	6.8	-
							QUR3	Yes	0.003	0.370	0.385	0.00027	-8.1	-	1.000
							QUR4	No	0.203	0.997	0.998	0.0032	-	9.6	-
							QUR5	Yes	0.008	0.133	0.181	0.00068	-4.5	-	0.987
							QUR6	Yes	0.031	0.997	0.502	0.00068	-3.0	-	0.849
						QUR2	QUR3	No	0.128	1.000	0.990	0.0013	-	2.8	-
							QUR4	No	0.493	1.000	1.000	0.0042	-	5.0	-
							QUR5	Yes	0.097	0.821	0.924	0.0017	-1.4	-	0.555
							QUR6	No	0.305	1.000	1.000	0.0017	-	3.2	-
						QUR3	QUR4	No	0.725	1.000	1.000	0.0029	-	-[f]	-
							QUR5	No	0.374	1.000	1.000	0.00042	-	-[f]	-
							QUR6	No	0.374	1.000	1.000	0.00042	-	-[f]	-
						QUR4	QUR5	No	0.519	1.000	1.000	0.0033	-	3.0	-
							QUR6	No	1.000	1.000	1.000	0.0033	-	3.0	-
						QUR5	QUR6	No	0.230	1.000	0.996	0.0008	-	3.9	-
Strontium	Yes	<0.001	Yes	0.020	0.919	CLR	QUR1	No	0.139	0.082	0.991	40,452	-	2.8	-
							QUR2	No	0.110	0.042	0.983	39,518	-	2.8	-
							QUR3	No	0.117	0.052	0.986	39,517	-	2.8	-
							QUR4	No	0.131	0.075	0.990	39,571	-	2.8	-
							QUR5	No	0.126	0.065	0.989	39,517	-	2.8	-
							QUR6	No	0.120	0.056	0.987	39,538	-	2.8	-
						QUR1	QUR2	No	0.306	1.000	1.000	937	-	2.8	-
							QUR3	No	0.461	1.000	1.000	935	-	2.8	-
							QUR4	No	0.874	1.000	1.000	989	-	2.9	-
							QUR5	No	0.700	1.000	1.000	935	-	2.8	-
							QUR6	No	0.538	1.000	1.000	956	-	2.8	-
						QUR2	QUR3	Yes	0.001	1.000	0.226	1.5	-12	-	1.000
							QUR4	Yes	0.015	1.000	0.656	56	14	-	0.953
							QUR5	Yes	0.000	1.000	0.056	1.5	-12	-	1.000
							QUR6	Yes	0.034	1.000	0.796	23	7.1	-	0.828
						QUR3	QUR4	Yes	0.056	1.000	0.926	54	-	-[f]	-
							QUR5	-	-	1.000	-	-[e]	-	-	-
							QUR6	No	0.425	1.000	1.000	21	-[f]	-	0.192
						QUR4	QUR5	No	0.374	1.000	1.000	54	-	2.8	-
							QUR6	No	0.148	1.000	0.975	75	-	3.3	-
						QUR5	QUR6	No	0.151	1.000	0.994	21	-[f]	-	0.433
Titanium	Yes	0.001	Yes	0.071	0.784	CLR	QUR1	No	0.501	1.000	1.000	62,248	-	2.8	-
							QUR2	No	0.610	1.000	1.000	64,156	-	2.8	-
							QUR3	No	0.854	1.000	1.000	62,346	-	2.8	-
							QUR4	No	0.649	1.000	1.000	75,246	-	3.1	-
							QUR5	No	0.266	1.000	1.000	62,346	-	2.8	-
							QUR6	No	0.451	1.000	1.000	80,446	-	3.2	-
						QUR1	QUR2	No	0.395	1.000	1.000	2,145	-	12	-
							QUR3	Yes	0.000	1.000	0.007	335	12	-	1.000
							QUR4	Yes	0.050	1.000	0.907	13,235	17	-	0.735
							QUR5	Yes	0.000	0.179	0.000	335	27	-	1.000
							QUR6	Yes	0.036	0.495	0.858	18,435	22	-	0.813
						QUR2	QUR3	Yes	0.016	1.000	0.589	2,243	2.4	-	0.944
							QUR4	Yes	0.089	1.000	0.940	15,143	3.5	-	0.579
							QUR5	Yes	0.001	0.303	0.105	2,243	5.9	-	1.000
							QUR6	Yes	0.057	0.825	0.881	20,343	4.8	-	0.701
						QUR3	QUR4	No	0.499	1.000	1.000	13,333	-	22	-
							QUR5	Yes	0.000	1.000	0.004	433	11	-	1.000
							QUR6	No	0.240	1.000	0.999	18,533	-	26	-
						QUR4	QUR5	No	0.179	1.000	0.997	13,333	-	2.8	-
							QUR6	No	0.596	1.000	1.000	31,433	-	4.3	-
						QUR5	QUR6	No	0.563	1.000	1.000	18,533	-	26	-
Uranium	Yes	0.027	Yes	0.010	0.959	CLR	QUR1	No	0.455	1.000	1.000	0.039	-	2.8	-
							QUR2	No	0.626	1.000	1.000	0.041	-	2.9	-
							QUR3	No	0.923	1.000	1.000	0.040	-	2.8	-
							QUR4	No	0.478	1.000	1.000	0.048	-	3.1	-
							QUR5	Yes	0.076	0.096	0.898	0.047	1.5	-	0.623
							QUR6	No	0.466	1.000	1.000	0.059	-	3.4	-
						QUR1	QUR2	No	0.343	1.000	1.000	0.0028	-	5.9	-
							QUR3	Yes	0.012	1.000	0.254	0.0017	4.3	-	0.972
							QUR4	Yes	0.031	0.957	0.780	0.010	7.8	-	0.849
							QUR5	Yes	0.002	0.012	0.243	0.0091	16	-	1.000
							QUR6	Yes	0.070	0.706	0.942	0.021	8.4	-	0.646
						QUR2	QUR3	Yes	0.093	1.000	0.893	0.0033	1.6	-	0.566
							QUR4	Yes	0.064	1.000	0.860	0.012	3.4	-	0.670
							QUR5	Yes	0.004	0.024	0.180	0.011	7.6	-	1.000
							QUR6	No	0.118	1.000	0.976	0.023	-	9.0	-
						QUR3	QUR4	No	0.222	1.000	0.998	0.011	-	8.7	-
							QUR5	Yes	0.007	0.125	0.380	0.0096	8.5	-	0.992
							QUR6	No	0.302	1.000	1.000	0.022	-	12	-
						QUR4	QUR5	Yes	0.064	0.865	0.753	0.018	2.0	-	0.671
							QUR6	No	0.895	1.000	1.000	0.031	-	4.9	-
						QUR5	QUR6	No	0.136	1.000	0.966	0.029	-	5.2	-

Table I.19: Statistical comparison summary of whole benthic invertebrate community metal and metalloid tissue concentration for reference area CLR and six Quesnel River areas, Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Vanadium	Yes	0.042	Yes	0.001	0.998	CLR	QUR1	No	0.613	1.000	1.000	18	-	2.8	-
							QUR2	No	0.335	1.000	1.000	27	-	3.5	-
							QUR3	Yes	0.010	0.031	0.606	17	-0.72	-	0.982
							QUR4	Yes	0.060	0.312	0.753	27	1.9	-	0.688
							QUR5	Yes	0.016	0.006	0.286	34	3.2	-	0.946
							QUR6	Yes	0.035	0.014	0.559	46	3.0	-	0.820
						QUR1	QUR2	No	0.359	1.000	1.000	11	-	11	-
							QUR3	Yes	0.000	0.079	0.051	0.73	-5.1	-	1.000
							QUR4	Yes	0.027	0.784	0.745	11	7.6	-	0.872
							QUR5	Yes	0.007	0.015	0.485	17	14	-	0.992
							QUR6	Yes	0.025	0.035	0.775	30	13	-	0.882
						QUR2	QUR3	Yes	0.013	0.312	0.659	10	-2.0	-	0.966
							QUR4	No	0.154	1.000	0.970	20	-	3.9	-
							QUR5	Yes	0.027	0.060	0.465	27	3.2	-	0.874
							QUR6	Yes	0.067	0.137	0.834	39	2.9	-	0.660
						QUR3	QUR4	No	0.148	1.000	0.994	10	-	-[f]	-
							QUR5	No	0.374	1.000	1.000	17	-	-[f]	-
							QUR6	No	0.725	1.000	1.000	29	-	-[f]	-
						QUR4	QUR5	No	0.132	1.000	0.953	27	-	4.5	-
							QUR6	No	0.284	1.000	0.999	39	-	5.5	-
						QUR5	QUR6	No	0.778	1.000	1.000	46	-	4.6	-
Zinc	Yes	0.002	Yes	0.001	0.999	CLR	QUR1	Yes	0.003	0.001	0.344	1,861	3.8	-	1.000
							QUR2	Yes	0.005	0.001	0.198	2,327	3.7	-	0.998
							QUR3	Yes	0.028	0.173	0.790	1,861	2.0	-	0.868
							QUR4	Yes	0.085	0.062	0.872	5,611	2.3	-	0.593
							QUR5	Yes	0.057	0.664	0.923	1,827	1.5	-	0.704
							QUR6	Yes	0.100	0.404	0.891	3,477	1.7	-	0.547
						QUR1	QUR2	No	0.749	1.000	1.000	567	-	9.3	-
							QUR3	Yes	0.000	0.279	0.004	100	-11	-	1.000
							QUR4	No	0.150	0.757	0.994	3,850	-	24	-
							QUR5	Yes	0.000	0.071	0.003	67	-14	-	1.000
							QUR6	Yes	0.020	0.119	0.721	1,717	-13	-	0.918
						QUR2	QUR3	Yes	0.006	0.390	0.383	567	-3.2	-	0.995
							QUR4	No	0.195	1.000	0.996	4,317	-	8.0	-
							QUR5	Yes	0.002	0.100	0.306	533	-4.0	-	1.000
							QUR6	Yes	0.035	0.167	0.648	2,183	-3.7	-	0.823
						QUR3	QUR4	No	0.713	1.000	1.000	3,850	-	24	-
							QUR5	Yes	0.016	1.000	0.410	67	-2.7	-	0.944
							QUR6	No	0.648	1.000	1.000	1,717	-	16	-
						QUR4	QUR5	No	0.407	1.000	1.000	3,817	-	2.8	-
							QUR6	No	0.576	1.000	1.000	5,467	-	3.3	-
						QUR5	QUR6	No	0.780	1.000	1.000	1,683	-	28	-

[a] Bonferroni post-hoc Test, or Dunnet's T3 Test where variances were found to be heterogenous by Levene's Test

[b] Due to low replication (3 per area) T-Tests are used as post-hoc test of significance between areas - Bonferroni and Tamhane post-hoc tests are reported for interest only.

[c] Magnitude calculated by comparing the difference between the control area and exposed area means to the control area standard deviation (SD) [(exposed mean - control mean) / standard deviation of the control mean]

[d] Minimum effect size detectable calculated based on variance as square root of MSE from ANOVA and alpha = beta = 0.10. Minimum effect size reported as the minimum number of standard deviations detectable based on reference area standard deviation.

[e] All observations at MLD in both areas; therefore, no statistic possible.

[f] Zero variance in Area1; therefore, calculation not possible.

Highlighted values indicate significance at the *p* < 0.10 level.

Table I.20: Statistical comparison summary of whole benthic invertebrate community metal and metalloid tissue concentration for reference area CAR and six Quesnel River areas, Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Aluminum	No	0.004	Yes	0.001	0.999	CAR	QUR1	Yes	0.075	1.000	0.944	566,667	-1.4	-	0.626
							QUR2	No	0.403	1.000	1.000	1,100,000	-	4.0	-
							QUR3	Yes	0.080	1.000	0.963	540,000	-3.5	-	0.610
							QUR4	No	0.397	1.000	1.000	2,400,000	-	5.8	-
							QUR5	Yes	0.005	0.046	0.470	540,000	-3.5	-	0.998
							QUR6	Yes	0.055	0.109	0.761	1,880,000	2.9	-	0.711
						QUR1	QUR2	No	0.346	1.000	1.000	586,667	-	13	-
							QUR3	Yes	0.000	0.147	0.044	26,667	-9.2	-	1.000
							QUR4	Yes	0.076	0.227	0.955	1,886,667	12	-	0.624
							QUR5	Yes	0.000	0.002	0.016	26,667	-9.2	-	1.000
							QUR6	Yes	0.009	0.005	0.572	1,366,667	19	-	0.983
						QUR2	QUR3	Yes	0.023	0.620	0.778	560,000	-2.6	-	0.900
							QUR4	No	0.190	0.942	0.993	2,420,000	-	5.8	-
							QUR5	Yes	0.002	0.008	0.353	560,000	-2.6	-	1.000
							QUR6	Yes	0.028	0.019	0.531	1,900,000	3.6	-	0.866
						QUR3	QUR4	No	0.866	1.000	1.000	1,860,000	-	-[f]	-
							QUR5	-	-	0.942	-	-[e]	-	-	-
							QUR6	No	0.166	1.000	0.996	1,340,000	-	-[f]	-
						QUR4	QUR5	No	0.119	0.620	0.987	1,860,000	-	2.8	-
							QUR6	No	0.285	1.000	0.999	3,200,000	-	3.6	-
						QUR5	QUR6	No	0.694	1.000	1.000	1,340,000	-	-[f]	-
Arsenic	Yes	0.206	Yes	0.001	0.996	CAR	QUR1	No	0.339	1.000	1.000	0.51	-	3.6	-
							QUR2	No	0.117	1.000	0.947	1.1	-	5.2	-
							QUR3	Yes	0.012	0.366	0.267	0.46	3.1	-	0.972
							QUR4	Yes	0.034	0.073	0.674	1.5	4.1	-	0.825
							QUR5	Yes	0.001	0.014	0.121	0.36	5.0	-	1.000
							QUR6	Yes	0.067	0.164	0.879	1.9	3.6	-	0.660
						QUR1	QUR2	Yes	0.045	0.455	0.753	0.99	3.6	-	0.760
							QUR3	Yes	0.003	0.091	0.072	0.36	4.8	-	1.000
							QUR4	Yes	0.017	0.018	0.541	1.4	5.9	-	0.937
							QUR5	Yes	0.000	0.004	0.036	0.26	7.1	-	1.000
							QUR6	Yes	0.035	0.041	0.757	1.8	5.3	-	0.823
						QUR2	QUR3	No	0.406	1.000	1.000	0.94	-	3.0	-
							QUR4	No	0.272	1.000	0.999	2.0	-	4.4	-
							QUR5	Yes	0.040	0.563	0.837	0.84	1.8	-	0.789
							QUR6	No	0.430	1.000	1.000	2.4	-	4.8	-
						QUR3	QUR4	No	0.483	1.000	1.000	1.4	-	8.3	-
							QUR5	Yes	0.015	1.000	0.390	0.20	2.7	-	0.951
							QUR6	No	0.750	1.000	1.000	1.7	-	9.4	-
						QUR4	QUR5	No	0.449	1.000	1.000	1.3	-	2.8	-
							QUR6	No	0.801	1.000	1.000	2.8	-	4.2	-
						QUR5	QUR6	No	0.338	1.000	1.000	1.6	-	16	-
Barium	Yes	0.504	Yes	0.036	0.866	CAR	QUR1	No	0.870	1.000	1.000	87	-	4.0	-
							QUR2	Yes	0.096	1.000	0.885	75	1.7	-	0.557
							QUR3	Yes	0.023	0.079	0.389	93	3.1	-	0.899
							QUR4	No	0.573	1.000	1.000	128	-	4.8	-
							QUR5	Yes	0.035	0.804	0.685	53	2.0	-	0.820
							QUR6	No	0.177	1.000	0.986	126	-	4.8	-
						QUR1	QUR2	No	0.123	1.000	0.939	77	-	3.7	-
							QUR3	Yes	0.028	0.109	0.447	95	2.9	-	0.868
							QUR4	No	0.666	1.000	1.000	130	-	4.7	-
							QUR5	Yes	0.046	1.000	0.770	55	1.8	-	0.757
							QUR6	No	0.213	1.000	0.994	128	-	4.7	-
						QUR2	QUR3	No	0.156	1.000	0.974	83	-	4.4	-
							QUR4	No	0.337	1.000	1.000	118	-	5.3	-
							QUR5	No	0.568	1.000	1.000	43	-	3.2	-
							QUR6	No	0.972	1.000	1.000	116	-	5.2	-
						QUR3	QUR4	Yes	0.076	0.312	0.828	136	-2.3	-	0.624
							QUR5	No	0.205	1.000	0.996	61	-	3.0	-
							QUR6	No	0.231	1.000	0.996	134	-	4.5	-
						QUR4	QUR5	No	0.179	1.000	0.995	96	-	2.9	-
							QUR6	No	0.428	1.000	1.000	169	-	3.9	-
						QUR5	QUR6	No	0.667	1.000	1.000	94	-	8.3	-
Cadmium	No	0.005	Yes	0.001	0.999	CAR	QUR1	No	0.284	1.000	0.999	0.83	-	3.2	-
							QUR2	No	0.438	1.000	1.000	0.84	-	3.2	-
							QUR3	No	0.256	1.000	0.998	1.2	-	3.9	-
							QUR4	No	0.366	1.000	1.000	36	-	21	-
							QUR5	Yes	0.002	0.004	0.247	8.8	15	-	1.000
							QUR6	Yes	0.022	0.082	0.729	16	10	-	0.905
						QUR1	QUR2	No	0.633	1.000	1.000	0.42	-	4.0	-
							QUR3	Yes	0.045	1.000	0.723	0.82	3.3	-	0.761
							QUR4	No	0.292	1.000	1.000	36	-	37	-
							QUR5	Yes	0.002	0.002	0.269	8.4	28	-	1.000
							QUR6	Yes	0.016	0.048	0.697	15	20	-	0.942
						QUR2	QUR3	Yes	0.068	1.000	0.836	0.83	2.8	-	0.654
							QUR4	No	0.312	1.000	1.000	36	-	36	-
							QUR5	Yes	0.002	0.003	0.275	8.4	27	-	1.000
							QUR6	Yes	0.018	0.056	0.712	15	19	-	0.934
						QUR3	QUR4	No	0.482	1.000	1.000	36	-	21	-
							QUR5	Yes	0.003	0.008	0.285	8.8	14	-	1.000
							QUR6	Yes	0.031	0.165	0.802	16	9.5	-	0.846
						QUR4	QUR5	Yes	0.091	0.070	0.927	44	1.4	-	0.574
							QUR6	No	0.312	1.000	1.000	50	-	3.3	-
						QUR5	QUR6	No	0.250	1.000	0.998	23	-	4.7	-

Table I.20: Statistical comparison summary of whole benthic invertebrate community metal and metalloid tissue concentration for reference area CAR and six Quesnel River areas, Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Chromium	No	0.003	Yes	0.090	0.749	CAR	QUR1	Yes	0.001	1.000	0.274	1.2	-4.8	-	1.000
							QUR2	No	0.175	1.000	0.994	11	-	8.6	-
							QUR3	Yes	0.006	1.000	0.336	1.3	3.3	-	0.995
							QUR4	No	0.124	1.000	0.981	14	-	9.7	-
							QUR5	No	0.455	1.000	1.000	57	-	19	-
							QUR6	No	0.657	1.000	1.000	38	-	16	-
						QUR1	QUR2	No	0.374	1.000	1.000	10	-	-[f]	-
							QUR3	Yes	0.000	0.478	0.016	0.17	-	-[f]	-
							QUR4	Yes	0.012	0.316	0.641	13	-	-[f]	-
							QUR5	No	0.116	0.462	0.986	56	-	-[f]	-
							QUR6	No	0.128	1.000	0.990	37	-	-[f]	-
						QUR2	QUR3	Yes	0.022	1.000	0.753	10	2.1	-	0.906
							QUR4	Yes	0.056	0.907	0.707	23	2.3	-	0.709
							QUR5	No	0.221	1.000	0.998	66	-	7.1	-
							QUR6	No	0.284	1.000	1.000	47	-	6.0	-
						QUR3	QUR4	No	0.754	1.000	1.000	13	-	25	-
							QUR5	No	0.990	1.000	1.000	56	-	51	-
							QUR6	No	0.631	1.000	1.000	37	-	41	-
						QUR4	QUR5	No	0.899	1.000	1.000	69	-	6.3	-
							QUR6	No	0.569	1.000	1.000	50	-	5.4	-
						QUR5	QUR6	No	0.751	1.000	1.000	93	-	3.6	-
Cobalt	No	0.028	Yes	0.001	0.998	CAR	QUR1	Yes	0.001	1.000	0.043	0.043	-9.8	-	1.000
							QUR2	No	0.345	1.000	1.000	0.58	-	20	-
							QUR3	Yes	0.000	1.000	0.019	0.043	13	-	1.000
							QUR4	No	0.679	1.000	1.000	2.4	-	40	-
							QUR5	Yes	0.000	0.036	0.034	0.12	29	-	1.000
							QUR6	Yes	0.090	0.187	0.971	3.6	22	-	0.578
						QUR1	QUR2	No	0.259	1.000	1.000	0.60	-	12	-
							QUR3	Yes	0.000	0.187	0.002	0.063	14	-	1.000
							QUR4	No	0.181	1.000	0.997	2.5	-	24	-
							QUR5	Yes	0.000	0.003	0.005	0.14	23	-	1.000
							QUR6	Yes	0.033	0.014	0.840	3.6	20	-	0.832
						QUR2	QUR3	Yes	0.015	0.787	0.625	0.60	2.4	-	0.953
							QUR4	No	0.432	1.000	1.000	3.0	-	6.3	-
							QUR5	Yes	0.002	0.012	0.136	0.68	4.7	-	1.000
							QUR6	Yes	0.069	0.058	0.895	4.1	3.8	-	0.653
						QUR3	QUR4	No	0.345	1.000	1.000	2.5	-	24	-
							QUR5	Yes	0.001	1.000	0.071	0.14	9.7	-	1.000
							QUR6	No	0.386	1.000	1.000	3.6	-	29	-
						QUR4	QUR5	Yes	0.043	0.098	0.863	2.5	1.7	-	0.775
							QUR6	No	0.224	0.501	0.995	6.0	-	4.4	-
						QUR5	QUR6	No	0.582	1.000	1.000	3.7	-	16	-
Copper	Yes	0.051	Yes	0.004	0.987	CAR	QUR1	Yes	0.009	0.046	0.526	34	13	-	0.985
							QUR2	Yes	0.014	0.051	0.627	42	13	-	0.961
							QUR3	Yes	0.000	0.003	0.038	9.7	18	-	1.000
							QUR4	No	0.348	1.000	1.000	100	-	23	-
							QUR5	Yes	0.000	0.452	0.007	2.7	9.0	-	1.000
							QUR6	Yes	0.004	0.364	0.271	12	9.4	-	0.999
						QUR1	QUR2	No	0.964	1.000	1.000	73	-	4.2	-
							QUR3	No	0.172	1.000	0.990	41	-	3.1	-
							QUR4	No	0.208	0.767	0.995	131	-	5.6	-
							QUR5	No	0.215	1.000	0.999	34	-	2.8	-
							QUR6	No	0.302	1.000	1.000	43	-	3.2	-
						QUR2	QUR3	No	0.190	1.000	0.995	49	-	3.0	-
							QUR4	No	0.228	0.851	0.997	139	-	5.1	-
							QUR5	No	0.275	1.000	1.000	42	-	2.8	-
							QUR6	No	0.361	1.000	1.000	51	-	3.1	-
						QUR3	QUR4	Yes	0.055	0.046	0.884	106	-5.6	-	0.714
							QUR5	Yes	0.003	0.452	0.238	9.3	-3.9	-	1.000
							QUR6	Yes	0.013	0.559	0.241	18	-3.7	-	0.965
						QUR4	QUR5	No	0.438	1.000	1.000	99	-	2.8	-
							QUR6	No	0.418	1.000	1.000	108	-	2.9	-
						QUR5	QUR6	No	0.820	1.000	1.000	11	-	8.6	-
Iron	No	0.032	Yes	0.001	0.997	CAR	QUR1	Yes	0.005	1.000	0.197	661,667	-3.6	-	0.997
							QUR2	No	0.165	1.000	0.986	2,080,000	-	5.7	-
							QUR3	No	0.116	1.000	0.951	666,667	-	3.2	-
							QUR4	No	0.516	1.000	1.000	6,361,667	-	9.9	-
							QUR5	Yes	0.001	0.135	0.163	520,000	5.6	-	1.000
							QUR6	No	0.115	0.360	0.979	8,306,667	-	11	-
						QUR1	QUR2	No	0.204	1.000	0.997	1,741,667	-	9.1	-
							QUR3	Yes	0.000	0.277	0.009	328,333	8.7	-	1.000
							QUR4	Yes	0.064	0.238	0.931	6,023,333	9.0	-	0.673
							QUR5	Yes	0.000	0.002	0.009	181,667	16	-	1.000
							QUR6	Yes	0.022	0.006	0.752	7,968,333	15	-	0.904
						QUR2	QUR3	Yes	0.037	1.000	0.789	1,746,667	1.9	-	0.811
							QUR4	No	0.195	1.000	0.994	7,441,667	-	6.0	-
							QUR5	Yes	0.002	0.014	0.299	1,600,000	4.3	-	1.000
							QUR6	Yes	0.055	0.037	0.829	9,386,667	3.8	-	0.714
						QUR3	QUR4	No	0.950	1.000	1.000	6,028,333	-	17	-
							QUR5	Yes	0.000	0.604	0.059	186,667	7.4	-	1.000
							QUR6	No	0.214	1.000	0.999	7,973,333	-	19	-
						QUR4	QUR5	No	0.105	0.699	0.981	5,881,667	-	2.8	-
							QUR6	No	0.340	1.000	1.000	13,668,333	-	4.2	-
						QUR5	QUR6	No	0.724	1.000	1.000	7,826,667	-	55	-

Table I.20: Statistical comparison summary of whole benthic invertebrate community metal and metalloid tissue concentration for reference area CAR and six Quesnel River areas, Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Lead	Yes	0.066	Yes	<0.001	1.000	CAR	QUR1	Yes	0.002	0.001	0.284	0.22	-4.2	-	1.000
							QUR2	Yes	0.011	0.011	0.229	0.34	-3.3	-	0.977
							QUR3	Yes	0.027	0.240	0.664	0.25	-2.1	-	0.875
							QUR4	No	0.168	1.000	0.980	0.50	-	4.2	-
							QUR5	No	0.871	1.000	1.000	0.22	-	2.8	-
							QUR6	No	0.633	1.000	1.000	0.76	-	5.2	-
						QUR1	QUR2	No	0.116	1.000	0.980	0.13	-	12	-
							QUR3	Yes	0.001	0.282	0.100	0.042	11	-	1.000
							QUR4	Yes	0.015	0.047	0.663	0.29	15	-	0.951
							QUR5	Yes	0.000	0.001	0.000	0.014	23	-	1.000
							QUR6	Yes	0.017	0.004	0.701	0.55	20	-	0.940
						QUR2	QUR3	Yes	0.082	1.000	0.899	0.16	1.5	-	0.603
							QUR4	Yes	0.084	0.555	0.873	0.41	2.4	-	0.595
							QUR5	Yes	0.002	0.008	0.244	0.13	4.4	-	1.000
							QUR6	Yes	0.055	0.047	0.817	0.67	3.6	-	0.712
						QUR3	QUR4	No	0.399	1.000	1.000	0.32	-	8.3	-
							QUR5	Yes	0.001	0.182	0.088	0.042	5.5	-	1.000
							QUR6	No	0.171	1.000	0.995	0.58	-	11	-
						QUR4	QUR5	Yes	0.078	1.000	0.954	0.29	1.4	-	0.617
							QUR6	No	0.463	1.000	1.000	0.82	-	4.7	-
						QUR5	QUR6	No	0.513	1.000	1.000	0.55	-	25	-
Manganese	No	0.009	Yes	0.014	0.939	CAR	QUR1	Yes	0.094	0.201	0.967	7,717	-1.3	-	0.564
							QUR2	No	0.194	1.000	0.997	7,917	-	2.9	-
							QUR3	No	0.866	1.000	1.000	8,217	-	2.9	-
							QUR4	No	0.972	1.000	1.000	11,867	-	3.5	-
							QUR5	No	0.527	1.000	1.000	7,850	-	2.9	-
							QUR6	No	0.896	1.000	1.000	7,750	-	2.8	-
						QUR1	QUR2	No	0.140	1.000	0.962	833	-	4.5	-
							QUR3	Yes	0.003	0.121	0.121	1,133	6.8	-	0.999
							QUR4	Yes	0.053	0.228	0.886	4,783	6.1	-	0.721
							QUR5	Yes	0.001	0.030	0.019	767	8.2	-	1.000
							QUR6	Yes	0.002	0.293	0.046	667	5.8	-	1.000
						QUR2	QUR3	Yes	0.013	0.617	0.266	1,333	3.9	-	0.963
							QUR4	No	0.129	1.000	0.981	4,983	-	8.6	-
							QUR5	Yes	0.003	0.156	0.062	967	5.1	-	1.000
							QUR6	Yes	0.013	1.000	0.251	867	3.2	-	0.966
						QUR3	QUR4	No	0.793	1.000	1.000	5,283	-	7.1	-
							QUR5	No	0.276	1.000	0.999	1,267	-	3.5	-
							QUR6	No	0.450	1.000	1.000	1,167	-	3.3	-
						QUR4	QUR5	No	0.404	1.000	1.000	4,917	-	2.9	-
							QUR6	No	0.912	1.000	1.000	4,817	-	2.9	-
						QUR5	QUR6	Yes	0.060	1.000	0.734	800	-2.0	-	0.688
Nickel	No	0.016	Yes	<0.001	1.000	CAR	QUR1	Yes	0.029	0.240	0.791	4.7	-2.0	-	0.855
							QUR2	Yes	0.067	0.557	0.836	6.0	-1.7	-	0.658
							QUR3	No	0.943	1.000	1.000	4.7	-	2.8	-
							QUR4	No	0.780	1.000	1.000	15	-	5.0	-
							QUR5	Yes	0.030	0.256	0.801	4.7	1.9	-	0.850
							QUR6	No	0.170	1.000	0.980	9.2	-	4.0	-
						QUR1	QUR2	No	0.464	1.000	1.000	1.7	-	8.4	-
							QUR3	Yes	0.000	0.211	0.005	0.35	9.8	-	1.000
							QUR4	Yes	0.060	0.096	0.928	10	11	-	0.687
							QUR5	Yes	0.000	0.001	0.000	0.35	19	-	1.000
							QUR6	Yes	0.005	0.004	0.424	4.9	16	-	0.997
						QUR2	QUR3	Yes	0.008	0.490	0.438	1.7	2.9	-	0.987
							QUR4	No	0.100	0.225	0.955	12	-	7.7	-
							QUR5	Yes	0.001	0.002	0.096	1.7	6.2	-	1.000
							QUR6	Yes	0.011	0.010	0.318	6.2	5.2	-	0.976
						QUR3	QUR4	No	0.775	1.000	1.000	10	-	22	-
							QUR5	Yes	0.000	0.292	0.006	0.33	9.8	-	1.000
							QUR6	Yes	0.090	1.000	0.965	4.8	6.9	-	0.577
						QUR4	QUR5	No	0.137	0.632	0.991	10	-	2.8	-
							QUR6	No	0.366	1.000	1.000	15	-	3.4	-
						QUR5	QUR6	No	0.406	1.000	1.000	4.8	-	15	-
Selenium	Yes	0.139	No	0.182	0.622	CAR	QUR1	-	-	-	-	0.20	-	4.0	-
							QUR2	-	-	-	-	0.91	-	8.6	-
							QUR3	-	-	-	-	0.40	-	5.7	-
							QUR4	-	-	-	-	1.2	-	9.7	-
							QUR5	-	-	-	-	0.42	-	5.8	-
							QUR6	-	-	-	-	0.17	-	3.7	-
						QUR1	QUR2	-	-	-	-	0.92	-	8.2	-
							QUR3	-	-	-	-	0.41	-	5.5	-
							QUR4	-	-	-	-	1.2	-	9.3	-
							QUR5	-	-	-	-	0.43	-	5.6	-
							QUR6	-	-	-	-	0.18	-	3.6	-
						QUR2	QUR3	-	-	-	-	1.1	-	3.3	-
							QUR4	-	-	-	-	1.9	-	4.2	-
							QUR5	-	-	-	-	1.1	-	3.3	-
							QUR6	-	-	-	-	0.88	-	2.9	-
						QUR3	QUR4	-	-	-	-	1.4	-	5.9	-
							QUR5	-	-	-	-	0.63	-	4.0	-
							QUR6	-	-	-	-	0.38	-	3.1	-
						QUR4	QUR5	-	-	-	-	1.4	-	3.2	-
							QUR6	-	-	-	-	1.1	-	2.9	-
						QUR5	QUR6	-	-	-	-	0.39	-	3.1	-

Table I.20: Statistical comparison summary of whole benthic invertebrate community metal and metalloid tissue concentration for reference area CAR and six Quesnel River areas, Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Silver	No	0.035	Yes	0.015	0.936	CAR	QUR1	No	0.313	1.000	1.000	0.0021	-	3.0	-
							QUR2	No	0.186	1.000	0.987	0.0032	-	3.6	-
							QUR3	Yes	0.021	0.072	0.761	0.0019	-3.8	-	0.913
							QUR4	No	0.115	0.177	0.929	0.0048	-	4.5	-
							QUR5	Yes	0.020	0.030	0.531	0.0023	-2.4	-	0.922
							QUR6	Yes	0.043	0.177	0.759	0.0023	-1.9	-	0.771
						QUR1	QUR2	No	0.408	1.000	1.000	0.0016	-	6.8	-
							QUR3	Yes	0.003	0.723	0.385	0.00027	-8.1	-	1.000
							QUR4	No	0.203	1.000	0.998	0.0032	-	9.6	-
							QUR5	Yes	0.008	0.302	0.181	0.00068	-4.5	-	0.987
							QUR6	Yes	0.031	1.000	0.502	0.00068	-3.0	-	0.849
						QUR2	QUR3	No	0.128	1.000	0.990	0.0013	-	2.8	-
							QUR4	No	0.493	1.000	1.000	0.0042	-	5.0	-
							QUR5	Yes	0.097	1.000	0.924	0.0017	-1.4	-	0.555
							QUR6	No	0.305	1.000	1.000	0.0017	-	3.2	-
						QUR3	QUR4	No	0.725	1.000	1.000	0.0029	-	-[f]	-
							QUR5	No	0.374	1.000	1.000	0.00042	-	-[f]	-
							QUR6	No	0.374	1.000	1.000	0.00042	-	-[f]	-
						QUR4	QUR5	No	0.519	1.000	1.000	0.0033	-	3.0	-
							QUR6	No	1.000	1.000	1.000	0.0033	-	3.0	-
						QUR5	QUR6	No	0.230	1.000	0.996	0.00083	-	3.9	-
Strontium	No	<0.001	No	0.315	0.504	CAR	QUR1	-	-	-	-	943	-	30	-
							QUR2	-	-	-	-	9.7	-	3.0	-
							QUR3	-	-	-	-	8.2	-	2.8	-
							QUR4	-	-	-	-	62	-	7.7	-
							QUR5	-	-	-	-	8.2	-	2.8	-
							QUR6	-	-	-	-	29	-	5.3	-
						QUR1	QUR2	-	-	-	-	937	-	2.8	-
							QUR3	-	-	-	-	935	-	2.8	-
							QUR4	-	-	-	-	989	-	2.9	-
							QUR5	-	-	-	-	935	-	2.8	-
							QUR6	-	-	-	-	956	-	2.8	-
						QUR2	QUR3	-	-	-	-	1.5	-	2.8	-
							QUR4	-	-	-	-	56	-	17	-
							QUR5	-	-	-	-	1.5	-	2.8	-
							QUR6	-	-	-	-	23	-	11	-
						QUR3	QUR4	-	-	-	-	54	-	0.0	-
							QUR5	-	-	-	-	0.0	-	0.0	-
							QUR6	-	-	-	-	21	-	0.0	-
						QUR4	QUR5	-	-	-	-	54	-	2.8	-
							QUR6	-	-	-	-	75	-	3.3	-
						QUR5	QUR6	-	-	-	-	21	-	0.0	-
Titanium	No	0.007	Yes	<0.001	1.000	CAR	QUR1	Yes	0.090	1.000	0.868	285	1.7	-	0.577
							QUR2	No	0.156	1.000	0.992	2,193	-	10	-
							QUR3	Yes	0.000	0.336	0.004	383	12	-	1.000
							QUR4	Yes	0.036	0.060	0.855	13,283	16	-	0.811
							QUR5	Yes	0.000	0.002	0.000	383	24	-	1.000
							QUR6	Yes	0.028	0.008	0.809	18,483	21	-	0.865
						QUR1	QUR2	No	0.395	1.000	1.000	2,145	-	12	-
							QUR3	Yes	0.000	0.701	0.007	335	12	-	1.000
							QUR4	Yes	0.050	0.128	0.907	13,235	17	-	0.735
							QUR5	Yes	0.000	0.003	0.000	335	27	-	1.000
							QUR6	Yes	0.036	0.017	0.858	18,435	22	-	0.813
						QUR2	QUR3	Yes	0.016	1.000	0.589	2,243	2.4	-	0.944
							QUR4	Yes	0.089	0.310	0.940	15,143	3.5	-	0.579
							QUR5	Yes	0.001	0.007	0.105	2,243	5.9	-	1.000
							QUR6	Yes	0.057	0.040	0.881	20,343	4.8	-	0.701
						QUR3	QUR4	No	0.499	1.000	1.000	13,333	-	22	-
							QUR5	Yes	0.000	0.317	0.004	433	11	-	1.000
							QUR6	No	0.240	1.000	0.999	18,533	-	26	-
						QUR4	QUR5	No	0.179	1.000	0.997	13,333	-	2.8	-
							QUR6	No	0.596	1.000	1.000	31,433	-	4.3	-
						QUR5	QUR6	No	0.563	1.000	1.000	18,533	-	26	-
Uranium	Yes	0.156	Yes	0.001	0.999	CAR	QUR1	No	0.109	1.000	0.963	0.0046	-	3.0	-
							QUR2	No	0.357	1.000	1.000	0.0062	-	3.5	-
							QUR3	No	0.562	1.000	1.000	0.0051	-	3.1	-
							QUR4	No	0.170	1.000	0.986	0.014	-	5.2	-
							QUR5	Yes	0.008	0.008	0.214	0.012	5.0	-	0.987
							QUR6	No	0.234	1.000	0.998	0.025	-	7.0	-
						QUR1	QUR2	No	0.343	1.000	1.000	0.0028	-	5.9	-
							QUR3	Yes	0.012	1.000	0.254	0.0017	4.3	-	0.972
							QUR4	Yes	0.031	0.250	0.780	0.010	7.8	-	0.849
							QUR5	Yes	0.002	0.001	0.243	0.0091	16	-	1.000
							QUR6	Yes	0.070	0.164	0.942	0.021	8.4	-	0.646
						QUR2	QUR3	Yes	0.093	1.000	0.893	0.0033	1.6	-	0.566
							QUR4	Yes	0.064	0.654	0.860	0.012	3.4	-	0.670
							QUR5	Yes	0.004	0.002	0.180	0.011	7.6	-	1.000
							QUR6	No	0.118	0.435	0.976	0.023	-	9.0	-
						QUR3	QUR4	No	0.222	1.000	0.998	0.011	-	8.7	-
							QUR5	Yes	0.007	0.017	0.380	0.0096	8.5	-	0.992
							QUR6	No	0.302	1.000	1.000	0.022	-	12	-
						QUR4	QUR5	Yes	0.064	0.217	0.753	0.018	2.0	-	0.671
							QUR6	No	0.895	1.000	1.000	0.031	-	4.9	-
						QUR5	QUR6	No	0.136	0.330	0.966	0.029	-	5.2	-

Table I.20: Statistical comparison summary of whole benthic invertebrate community metal and metalloid tissue concentration for reference area CAR and six Quesnel River areas, Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA: Variance: Equal?	Overall 7-group ANOVA: Variance: Levene p-value	Overall 7-group ANOVA: Significant Difference Among Areas?	Overall 7-group ANOVA: p-value	Overall 7-group ANOVA: Power	Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]: Significant Difference Between Areas?[b]	p-value: T-Test	p-value: Bonferroni	p-value: Tahmane	2-group ANOVA for Estimation of Effect Size: MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
Vanadium	No	0.019	Yes	<0.001	1.000	CAR	QUR1	No	0.829	1.000	1.000	1.1	-	4.6	-
							QUR2	No	0.322	1.000	1.000	10	-	14	-
							QUR3	Yes	0.000	0.031	0.028	0.41	-6.6	-	1.000
							QUR4	Yes	0.024	0.416	0.749	11	10	-	0.892
							QUR5	Yes	0.007	0.005	0.497	17	19	-	0.993
							QUR6	Yes	0.024	0.013	0.774	30	17	-	0.892
						QUR1	QUR2	No	0.359	1.000	1.000	11	-	11	-
							QUR3	Yes	0.000	0.035	0.051	0.73	-5.1	-	1.000
							QUR4	Yes	0.027	0.464	0.745	11	7.6	-	0.872
							QUR5	Yes	0.007	0.006	0.485	17	14	-	0.992
							QUR6	Yes	0.025	0.014	0.775	30	13	-	0.882
						QUR2	QUR3	Yes	0.013	0.163	0.659	10.0	-2.0	-	0.966
							QUR4	No	0.154	1.000	0.970	20	-	3.9	-
							QUR5	Yes	0.027	0.026	0.465	27	3.2	-	0.874
							QUR6	Yes	0.067	0.064	0.834	39	2.9	-	0.660
						QUR3	QUR4	No	0.148	1.000	0.994	10	-	-[f]	-
							QUR5	No	0.374	1.000	1.000	17	-	-[f]	-
							QUR6	No	0.725	1.000	1.000	29	-	-[f]	-
						QUR4	QUR5	No	0.132	0.882	0.953	27	-	4.5	-
							QUR6	No	0.284	1.000	0.999	39	-	5.5	-
						QUR5	QUR6	No	0.778	1.000	1.000	46	-	4.6	-
Zinc	No	0.002	Yes	0.008	0.965	CAR	QUR1	No	0.125	1.000	0.985	1,000	-	2.8	-
							QUR2	No	0.238	1.000	0.997	1,467	-	3.4	-
							QUR3	Yes	0.081	1.000	0.951	1,000	-1.4	-	0.607
							QUR4	No	0.516	1.000	1.000	4,750	-	6.2	-
							QUR5	Yes	0.027	0.693	0.794	967	-2.0	-	0.872
							QUR6	No	0.140	1.000	0.963	2,617	-	4.6	-
						QUR1	QUR2	No	0.749	1.000	1.000	567	-	9.3	-
							QUR3	Yes	0.000	0.200	0.004	100	-11	-	1.000
							QUR4	No	0.150	0.582	0.994	3,850	-	24	-
							QUR5	Yes	0.000	0.047	0.003	67	-14	-	1.000
							QUR6	Yes	0.020	0.081	0.721	1,717	-13	-	0.918
						QUR2	QUR3	Yes	0.006	0.286	0.383	567	-3.2	-	0.995
							QUR4	No	0.195	0.824	0.996	4,317	-	8.0	-
							QUR5	Yes	0.002	0.068	0.306	533	-4.0	-	1.000
							QUR6	Yes	0.035	0.116	0.648	2,183	-3.7	-	0.823
						QUR3	QUR4	No	0.713	1.000	1.000	3,850	-	24	-
							QUR5	Yes	0.016	1.000	0.410	67	-2.7	-	0.944
							QUR6	No	0.648	1.000	1.000	1,717	-	16	-
						QUR4	QUR5	No	0.407	1.000	1.000	3,817	-	2.8	-
							QUR6	No	0.576	1.000	1.000	5,467	-	3.3	-
						QUR5	QUR6	No	0.780	1.000	1.000	1,683	-	28	-

[a] Bonferroni post-hoc Test, or Dunnet's T3 Test where variances were found to be heterogenous by Levene's Test

[b] Due to low replication (3 per area) T-Tests are used as post-hoc test of significance between areas - Bonferroni and Tamhane post-hoc tests are reported for interest only.

[c] Magnitude calculated by comparing the difference between the control area and exposed area means to the control area standard deviation (SD) [(exposed mean - control mean) / standard deviation of the control mean]

[d] Minimum effect size detectable calculated based on variance as square root of MSE from ANOVA and alpha = beta = 0.10. Minimum effect size reported as the minimum number of standard deviations detectable based on reference area standard deviation.

[e] All observations at MLD in both areas; therefore, no statistic possible.

[f] Zero variance in Area1; therefore, calculation not possible.

Highlighted values indicate significance at the $p < 0.10$ level.

Table I.21: PCA results of Perlidae tissue metal and metalloid concentrations. Eigen value, percent variance explained, Monte Carlo randomization p-values of axis significance, and area scores of three reference and six Quesnel River areas, Mount Polley Mine, 2014.

Axis	PCA1	PCA2
Eigen Value	10.775	4.157
% Variance explained	59.9	23.1
Monte Carlo P	0.0001	0.0001
BLC-1	1.151	2.286
BLC-2	1.728	2.284
BLC-3	1.393	2.208
CAR-1	1.553	-0.939
CAR-2	3.139	-0.894
CAR-3	0.712	0.636
QUR1-1	2.451	-0.834
QUR1-2	2.396	-0.541
QUR1-3	2.279	-0.412
QUR2-1	2.548	-0.453
QUR2-2	2.250	-0.331
QUR2-3	2.844	-0.327
QUR3-1	1.888	-0.792
QUR3-2	1.158	-0.399
QUR3-3	1.251	-1.021
QUR4-1	-3.027	1.267
QUR4-2	-8.512	2.306
QUR4-3	-7.427	2.149
QUR5-1	-1.700	0.686
QUR5-2	1.879	0.095
QUR5-3	-3.090	-0.411
QUR6-1	-5.682	-7.802
QUR6-2	-0.559	1.320
QUR6-3	-0.624	-0.081

Table I.22: Spearman's Rank correlation of Perlidae tissue PCA axis scores with actual metal concentrations from river sampling areas, Mount Polley Mine, 2014.

Axis	PCA1		PCA2	
Statistic	r	p	r	p
Aluminum	-0.979	0.000	0.384	0.064
Arsenic	-0.965	0.000	0.382	0.066
Barium	-0.970	0.000	0.378	0.069
Cadmium	-0.556	0.005	-0.180	0.400
Chromium	-0.623	0.001	0.053	0.806
Cobalt	-0.976	0.000	0.385	0.063
Copper	-0.407	0.048	-0.383	0.065
Iron	-0.993	0.000	0.406	0.049
Lead	-0.857	0.000	0.147	0.493
Manganese	-0.801	0.000	0.581	0.003
Nickel	-0.945	0.000	0.405	0.050
Selenium	0.281	0.184	-0.864	0.000
Silver	0.316	0.132	-0.906	0.000
Strontium	-0.366	0.079	-0.103	0.634
Titanium	-0.943	0.000	0.515	0.010
Uranium	-0.956	0.000	0.311	0.140
Vanadium	-0.977	0.000	0.428	0.037
Zinc	0.500	0.013	-0.940	0.000

[shaded box] indicates a p-value below 0.05.

Table I.23: Statistical comparison summary of perlidae metal and metalloid tissue concentration for reference area BLC and six Quesnel River areas, Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Aluminum	No	0.001	Yes	<0.001	1.000	BLC	QUR1	Yes	0.012	1.000	0.272	22,317	-3.1	-	0.971
							QUR2	Yes	0.005	1.000	0.116	23,317	-4.1	-	0.998
							QUR3	No	0.271	1.000	1.000	261,667	-	12	-
							QUR4	Yes	0.013	0.000	0.667	11,721,667	69	-	0.963
							QUR5	No	0.142	1.000	0.993	3,126,667	-	40	-
							QUR6	Yes	0.026	0.865	0.799	2,096,667	23	-	0.876
						QUR1	QUR2	No	0.159	1.000	0.974	15,633	-	4.1	-
							QUR3	Yes	0.060	1.000	0.922	253,983	8.8	-	0.689
							QUR4	Yes	0.011	0.000	0.637	11,713,983	103	-	0.973
							QUR5	Yes	0.093	1.000	0.973	3,118,983	26	-	0.568
							QUR6	Yes	0.018	0.490	0.722	2,088,983	38	-	0.935
						QUR2	QUR3	Yes	0.039	1.000	0.852	254,983	9.7	-	0.796
							QUR4	Yes	0.011	0.000	0.627	11,714,983	98	-	0.976
							QUR5	Yes	0.081	1.000	0.963	3,119,983	26	-	0.606
							QUR6	Yes	0.015	0.405	0.696	2,089,983	37	-	0.949
						QUR3	QUR4	Yes	0.016	0.000	0.681	11,953,333	16	-	0.946
							QUR5	No	0.233	1.000	0.999	3,358,333	-	10	-
							QUR6	Yes	0.047	1.000	0.837	2,328,333	5.0	-	0.752
						QUR4	QUR5	Yes	0.042	0.003	0.732	14,818,333	-1.9	-	0.777
							QUR6	Yes	0.062	0.015	0.868	13,788,333	-1.6	-	0.681
						QUR5	QUR6	No	0.484	1.000	1.000	5,193,333	-	3.6	-
Arsenic	No	<0.001	Yes	0.037	0.865	BLC	QUR1	Yes	0.014	1.000	0.653	0.097	-2.4	-	0.960
							QUR2	Yes	0.013	1.000	0.599	0.10	-2.5	-	0.964
							QUR3	No	0.491	1.000	1.000	0.24	-	4.4	-
							QUR4	Yes	0.005	0.326	0.408	2.5	17	-	0.998
							QUR5	No	0.297	1.000	1.000	29	-	49	-
							QUR6	No	0.164	1.000	0.995	5.7	-	22	-
						QUR1	QUR2	No	0.643	1.000	1.000	0.0067	-	5.5	-
							QUR3	Yes	0.011	1.000	0.620	0.14	24	-	0.974
							QUR4	Yes	0.003	0.148	0.370	2.4	146	-	1.000
							QUR5	No	0.223	0.674	0.999	29	-	368	-
							QUR6	Yes	0.086	1.000	0.968	5.7	76	-	0.589
						QUR2	QUR3	Yes	0.011	1.000	0.579	0.15	14	-	0.976
							QUR4	Yes	0.003	0.145	0.366	2.4	85	-	1.000
							QUR5	No	0.221	0.658	0.999	29	-	212	-
							QUR6	Yes	0.085	1.000	0.967	5.7	44	-	0.595
						QUR3	QUR4	Yes	0.006	0.407	0.416	2.5	13	-	0.996
							QUR5	No	0.322	1.000	1.000	29	-	40	-
							QUR6	No	0.198	1.000	0.998	5.8	-	18	-
						QUR4	QUR5	No	0.676	1.000	1.000	32	-	10	-
							QUR6	No	0.157	1.000	0.979	8.1	-	5.1	-
						QUR5	QUR6	No	0.705	1.000	1.000	35	-	3.0	-
Barium	No	0.001	Yes	<0.001	1.000	BLC	QUR1	Yes	0.008	1.000	0.528	4.8	-2.8	-	0.987
							QUR2	Yes	0.043	1.000	0.641	13	-2.9	-	0.776
							QUR3	No	0.893	1.000	1.000	8.2	-	3.7	-
							QUR4	Yes	0.021	0.001	0.757	1,316	36	-	0.913
							QUR5	No	0.156	1.000	0.994	217	-	19	-
							QUR6	Yes	0.083	1.000	0.961	218	9.1	-	0.598
						QUR1	QUR2	No	0.969	1.000	1.000	8.9	-	20	-
							QUR3	Yes	0.006	1.000	0.442	3.7	14	-	0.995
							QUR4	Yes	0.016	0.000	0.709	1,312	205	-	0.945
							QUR5	Yes	0.067	1.000	0.946	212	51	-	0.658
							QUR6	Yes	0.038	1.000	0.871	214	63	-	0.801
						QUR2	QUR3	Yes	0.042	1.000	0.671	12.23	2.0	-	0.780
							QUR4	Yes	0.016	0.000	0.703	1,320	28	-	0.944
							QUR5	Yes	0.070	1.000	0.938	221	7.1	-	0.646
							QUR6	Yes	0.040	1.000	0.853	222	8.7	-	0.790
						QUR3	QUR4	Yes	0.021	0.001	0.756	1,315	42	-	0.915
							QUR5	No	0.150	1.000	0.993	216	-	22	-
							QUR6	Yes	0.080	1.000	0.959	217	11	-	0.608
						QUR4	QUR5	Yes	0.050	0.005	0.826	1,524	-1.7	-	0.738
							QUR6	Yes	0.062	0.011	0.874	1,525	-1.6	-	0.681
						QUR5	QUR6	No	0.712	1.000	1.000	426	-	3.93	-
Cadmium	No	<0.001	Yes	0.074	0.777	BLC	QUR1	Yes	0.055	1.000	0.884	0.0030	5.4	-	0.711
							QUR2	Yes	0.022	1.000	0.725	0.0054	11	-	0.907
							QUR3	Yes	0.002	1.000	0.318	0.015	33	-	1.000
							QUR4	Yes	0.005	1.000	0.485	0.035	40	-	0.997
							QUR5	Yes	0.003	1.000	0.358	0.062	66	-	1.000
							QUR6	No	0.158	0.132	0.995	6.0	-	462	-
						QUR1	QUR2	No	0.210	1.000	0.994	0.0077	-	4.9	-
							QUR3	Yes	0.005	1.000	0.289	0.017	8.3	-	0.997
							QUR4	Yes	0.010	1.000	0.523	0.037	10	-	0.979
							QUR5	Yes	0.004	1.000	0.368	0.064	18	-	0.999
							QUR6	No	0.169	0.162	0.996	6.0	-	137	-
						QUR2	QUR3	Yes	0.014	1.000	0.363	0.020	4.6	-	0.956
							QUR4	Yes	0.020	1.000	0.596	0.040	6.0	-	0.921
							QUR5	Yes	0.006	1.000	0.381	0.067	11	-	0.997
							QUR6	No	0.180	0.198	0.997	6.0	-	94	-
						QUR3	QUR4	No	0.473	1.000	1.000	0.049	-	5.1	-
							QUR5	Yes	0.040	1.000	0.730	0.076	4.0	-	0.793
							QUR6	No	0.238	0.467	0.999	6.0	-	57	-
						QUR4	QUR5	No	0.104	1.000	0.911	0.097	-	4.6	-
							QUR6	No	0.260	0.604	1.000	6.0	-	36	-
						QUR5	QUR6	No	0.356	1.000	1.000	6.1	-	28	-

Table I.23: Statistical comparison summary of perlidae metal and metalloid tissue concentration for reference area BLC and six Quesnel River areas, Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA: Variance Equal?	Overall 7-group ANOVA: Variance Levene p-value	Overall 7-group ANOVA: Significant Difference Among Areas?	Overall 7-group ANOVA: p-value	Overall 7-group ANOVA: Power	Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]: Significant Difference Between Areas?[b]	p-value: T-Test	p-value: Bonferroni	p-value: Tahmane	2-group ANOVA for Estimation of Effect Size: MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
Chromium	No	0.002	Yes	0.054	0.821	BLC	QUR1	-	-	1.000	-	-[e]	-	-	-
							QUR2	-	-	1.000	-	-[e]	-	-	-
							QUR3	No	0.374	1.000	1.000	5.5	-	-[f]	-
							QUR4	No	0.374	1.000	1.000	53	-	-[f]	-
							QUR5	No	0.132	1.000	0.991	28	-	-[f]	-
							QUR6	Yes	0.019	0.176	0.742	20	-[f]	-	0.926
						QUR1	QUR2	-	-	1.000	-	-[e]	-	-	-
							QUR3	No	0.374	1.000	1.000	5.5	-	-[f]	-
							QUR4	No	0.374	1.000	1.000	53	-	-[f]	-
							QUR5	No	0.132	1.000	0.991	28	-	-[f]	-
							QUR6	Yes	0.019	0.176	0.742	20	-[f]	-	0.926
						QUR2	QUR3	No	0.374	1.000	1.000	5.5	-	-[f]	-
							QUR4	No	0.374	1.000	1.000	53	-	-[f]	-
							QUR5	No	0.132	1.000	0.991	28	-	-[f]	-
							QUR6	Yes	0.019	0.176	0.742	20	-[f]	-	0.926
						QUR3	QUR4	No	0.555	1.000	1.000	58	-	9.0	-
							QUR5	No	0.257	1.000	0.999	34	-	6.9	-
							QUR6	Yes	0.044	0.409	0.736	25	3.6	-	0.767
						QUR4	QUR5	No	0.774	1.000	1.000	81	-	3.4	-
							QUR6	No	0.321	1.000	1.000	72	-	3.2	-
						QUR5	QUR6	No	0.378	1.000	1.000	48	-	3.6	-
Cobalt	No	0.011	Yes	0.006	0.976	BLC	QUR1	Yes	0.000	1.000	0.064	0.013	-6.8	-	1.000
							QUR2	Yes	0.001	1.000	0.032	0.026	-6.7	-	1.000
							QUR3	No	0.585	1.000	1.000	0.12	-	8.8	-
							QUR4	Yes	0.008	0.076	0.557	1.7	34	-	0.989
							QUR5	No	0.253	1.000	1.000	6.0	-	63	-
							QUR6	No	0.135	1.000	0.991	3.8	-	50	-
						QUR1	QUR2	No	0.952	1.000	1.000	0.016	-	8.6	-
							QUR3	Yes	0.011	1.000	0.612	0.11	20	-	0.974
							QUR4	Yes	0.004	0.019	0.442	1.7	106	-	0.999
							QUR5	No	0.137	0.538	0.992	6.0	-	164	-
							QUR6	Yes	0.065	0.363	0.943	3.8	68	-	0.667
						QUR2	QUR3	Yes	0.014	1.000	0.517	0.12	7.0	-	0.960
							QUR4	Yes	0.004	0.019	0.433	1.7	36	-	0.999
							QUR5	No	0.138	0.543	0.992	6.0	-	56	-
							QUR6	Yes	0.066	0.366	0.943	3.8	23	-	0.664
						QUR3	QUR4	Yes	0.010	0.095	0.523	1.8	11	-	0.981
							QUR5	No	0.282	1.000	1.000	6.1	-	21	-
							QUR6	No	0.157	1.000	0.994	3.9	-	17	-
						QUR4	QUR5	No	0.330	1.000	1.000	7.6	-	6.0	-
							QUR6	No	0.312	1.000	1.000	5.4	-	5.0	-
						QUR5	QUR6	No	0.912	1.000	1.000	9.7	-	3.5	-
Copper	No	<0.001	No	0.361	0.471	BLC	QUR1	-	-	-	-	5.8	-	4.1	-
							QUR2	-	-	-	-	5.8	-	4.1	-
							QUR3	-	-	-	-	12	-	5.9	-
							QUR4	-	-	-	-	9.2	-	5.1	-
							QUR5	-	-	-	-	88	-	16	-
							QUR6	-	-	-	-	3,256	-	97	-
						QUR1	QUR2	-	-	-	-	6.3	-	3.9	-
							QUR3	-	-	-	-	13	-	5.5	-
							QUR4	-	-	-	-	9.7	-	4.8	-
							QUR5	-	-	-	-	88	-	15	-
							QUR6	-	-	-	-	3,257	-	89	-
						QUR2	QUR3	-	-	-	-	13	-	5.5	-
							QUR4	-	-	-	-	9.7	-	4.8	-
							QUR5	-	-	-	-	88	-	15	-
							QUR6	-	-	-	-	3,257	-	89	-
						QUR3	QUR4	-	-	-	-	16	-	3.6	-
							QUR5	-	-	-	-	95	-	8.8	-
							QUR6	-	-	-	-	3,263	-	51	-
						QUR4	QUR5	-	-	-	-	92	-	10	-
							QUR6	-	-	-	-	3,260	-	62	-
						QUR5	QUR6	-	-	-	-	3,339	-	17	-
Iron	No	0.002	Yes	<0.001	1.000	BLC	QUR1	Yes	0.002	1.000	0.308	83,983	-4.1	-	1.000
							QUR2	Yes	0.002	1.000	0.149	95,817	-4.6	-	1.000
							QUR3	No	0.912	1.000	1.000	476,667	-	6.7	-
							QUR4	Yes	0.009	0.001	0.584	11,543,333	32	-	0.984
							QUR5	No	0.157	1.000	0.995	9,776,667	-	30	-
							QUR6	Yes	0.043	0.465	0.880	6,063,333	15	-	0.776
						QUR1	QUR2	No	0.111	1.000	0.965	16,467	-	7.4	-
							QUR3	Yes	0.038	1.000	0.864	397,317	23	-	0.805
							QUR4	Yes	0.006	0.000	0.510	11,463,983	217	-	0.996
							QUR5	Yes	0.075	0.401	0.957	9,697,317	89	-	0.627
							QUR6	Yes	0.019	0.113	0.747	5,983,983	111	-	0.922
						QUR2	QUR3	Yes	0.027	1.000	0.775	409,150	11	-	0.874
							QUR4	Yes	0.006	0.000	0.499	11,475,817	89	-	0.996
							QUR5	Yes	0.069	0.334	0.948	9,709,150	37	-	0.652
							QUR6	Yes	0.018	0.094	0.727	5,995,817	46	-	0.933
						QUR3	QUR4	Yes	0.009	0.001	0.552	11,856,667	15	-	0.983
							QUR5	No	0.158	1.000	0.994	10,090,000	-	14	-
							QUR6	Yes	0.044	0.440	0.855	6,376,667	6.7	-	0.766
						QUR4	QUR5	Yes	0.082	0.043	0.837	21,156,667	-1.8	-	0.602
							QUR6	No	0.102	0.152	0.912	17,443,333	-	3.4	-
						QUR5	QUR6	No	0.674	1.000	1.000	15,676,667	-	3.5	-

Table I.23: Statistical comparison summary of perlidae metal and metalloid tissue concentration for reference area BLC and six Quesnel River areas, Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Lead	No	0.003	Yes	<0.001	1.000	BLC	QUR1	Yes	0.012	1.000	0.437	0.0010	2.8	-	0.970
							QUR2	No	0.540	1.000	1.000	0.0054	-	7.2	-
							QUR3	Yes	0.022	1.000	0.726	0.020	11	-	0.907
							QUR4	Yes	0.011	0.000	0.631	1.4	109	-	0.975
							QUR5	Yes	0.091	0.980	0.972	0.67	37	-	0.573
							QUR6	Yes	0.019	0.463	0.739	0.32	44	-	0.926
						QUR1	QUR2	No	0.279	1.000	1.000	0.0047	-	16	-
							QUR3	Yes	0.052	1.000	0.912	0.019	18	-	0.727
							QUR4	Yes	0.012	0.000	0.649	1.4	245	-	0.970
							QUR5	No	0.109	1.000	0.983	0.67	-	186	-
							QUR6	Yes	0.023	0.633	0.782	0.32	95	-	0.897
						QUR2	QUR3	Yes	0.039	1.000	0.720	0.024	4.0	-	0.798
							QUR4	Yes	0.011	0.000	0.635	1.4	45	-	0.973
							QUR5	Yes	0.098	1.000	0.976	0.68	15	-	0.553
							QUR6	Yes	0.021	0.519	0.745	0.32	18	-	0.914
						QUR3	QUR4	Yes	0.016	0.001	0.690	1.4	20	-	0.946
							QUR5	No	0.192	1.000	0.998	0.69	-	17	-
							QUR6	Yes	0.048	1.000	0.873	0.33	6.8	-	0.747
						QUR4	QUR5	Yes	0.072	0.018	0.827	2.1	-1.7	-	0.640
							QUR6	Yes	0.073	0.039	0.887	1.7	-1.5	-	0.637
						QUR5	QUR6	No	0.759	1.000	1.000	0.99	-	3.4	-
Manganese	No	0.032	Yes	0.001	0.999	BLC	QUR1	Yes	0.000	0.003	0.159	1,877	-6.2	-	1.000
							QUR2	Yes	0.000	0.002	0.085	2,068	-6.5	-	1.000
							QUR3	Yes	0.001	0.007	0.110	2,083	-5.7	-	1.000
							QUR4	No	0.221	1.000	0.996	7,133	-	5.4	-
							QUR5	No	0.113	0.201	0.972	18,217	-	8.7	-
							QUR6	Yes	0.025	0.129	0.523	7,083	-3.9	-	0.884
						QUR1	QUR2	No	0.205	1.000	0.998	212	-	12	-
							QUR3	Yes	0.069	1.000	0.934	227	6.6	-	0.650
							QUR4	Yes	0.009	0.044	0.591	5,277	61	-	0.984
							QUR5	No	0.207	1.000	0.999	16,361	-	110	-
							QUR6	Yes	0.076	1.000	0.958	5,227	31	-	0.624
						QUR2	QUR3	Yes	0.044	1.000	0.615	418	2.4	-	0.766
							QUR4	Yes	0.008	0.027	0.508	5,468	15	-	0.990
							QUR5	No	0.171	0.714	0.996	16,552	-	25	-
							QUR6	Yes	0.058	1.000	0.914	5,418	7.9	-	0.699
						QUR3	QUR4	Yes	0.014	0.099	0.636	5,483	12	-	0.955
							QUR5	No	0.295	1.000	1.000	16,567	-	24	-
							QUR6	No	0.142	1.000	0.991	5,433	-	14	-
						QUR4	QUR5	No	0.362	1.000	1.000	21,617	-	5.6	-
							QUR6	No	0.169	1.000	0.980	10,483	-	3.9	-
						QUR5	QUR6	No	0.896	1.000	1.000	21,567	-	3.2	-
Nickel	No	0.001	Yes	0.001	0.999	BLC	QUR1	Yes	0.002	1.000	0.331	0.64	-4.1	-	1.000
							QUR2	Yes	0.002	1.000	0.162	0.72	-4.7	-	1.000
							QUR3	Yes	0.022	1.000	0.437	0.94	-2.6	-	0.904
							QUR4	Yes	0.021	0.084	0.727	21	12	-	0.914
							QUR5	No	0.567	1.000	1.000	15	-	14	-
							QUR6	Yes	0.074	0.084	0.953	51	12	-	0.630
						QUR1	QUR2	Yes	0.054	1.000	0.895	0.092	-6.7	-	0.716
							QUR3	Yes	0.020	1.000	0.736	0.31	17	-	0.918
							QUR4	Yes	0.008	0.009	0.555	21	185	-	0.991
							QUR5	No	0.105	1.000	0.981	15	-	151	-
							QUR6	Yes	0.033	0.009	0.846	50	185	-	0.834
						QUR2	QUR3	Yes	0.010	1.000	0.321	0.39	5.7	-	0.981
							QUR4	Yes	0.007	0.007	0.526	21	46	-	0.994
							QUR5	Yes	0.084	1.000	0.965	15	17	-	0.597
							QUR6	Yes	0.029	0.007	0.825	50	46	-	0.855
						QUR3	QUR4	Yes	0.011	0.021	0.607	21	22	-	0.976
							QUR5	No	0.201	1.000	0.998	15	-	20	-
							QUR6	Yes	0.044	0.021	0.890	50	22	-	0.768
						QUR4	QUR5	Yes	0.070	0.224	0.789	36	-1.9	-	0.648
							QUR6	No	1.000	1.000	1.000	71	-	5.1	-
						QUR5	QUR6	No	0.143	0.224	0.977	65	-	5.8	-
Selenium	No	<0.001	No	0.368	0.467	BLC	QUR1	-	-	-	-	0.053	-	16	-
							QUR2	-	-	-	-	0.017	-	8.8	-
							QUR3	-	-	-	-	0.028	-	11	-
							QUR4	-	-	-	-	0.0083	-	6.2	-
							QUR5	-	-	-	-	0.33	-	39	-
							QUR6	-	-	-	-	21	-	315	-
						QUR1	QUR2	-	-	-	-	0.067	-	3.2	-
							QUR3	-	-	-	-	0.078	-	3.4	-
							QUR4	-	-	-	-	0.058	-	2.9	-
							QUR5	-	-	-	-	0.38	-	7.6	-
							QUR6	-	-	-	-	22	-	57	-
						QUR2	QUR3	-	-	-	-	0.042	-	4.6	-
							QUR4	-	-	-	-	0.022	-	3.3	-
							QUR5	-	-	-	-	0.35	-	13	-
							QUR6	-	-	-	-	21	-	105	-
						QUR3	QUR4	-	-	-	-	0.033	-	3.1	-
							QUR5	-	-	-	-	0.36	-	10	-
							QUR6	-	-	-	-	21	-	79	-
						QUR4	QUR5	-	-	-	-	0.34	-	20	-
							QUR6	-	-	-	-	21	-	157	-
						QUR5	QUR6	-	-	-	-	22	-	22	-

Table I.23: Statistical comparison summary of perlidae metal and metalloid tissue concentration for reference area BLC and six Quesnel River areas, Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Silver	No	0.001	No	0.118	0.703	BLC	QUR1	-	-	-	-	0.0	-	0.0	-
							QUR2	-	-	-	-	0.000033	-	3.9	-
							QUR3	-	-	-	-	0.00033	-	12	-
							QUR4	-	-	-	-	0.00043	-	14	-
							QUR5	-	-	-	-	0.0029	-	37	-
							QUR6	-	-	-	-	0.018	-	91	-
						QUR1	QUR2	-	-	-	-	0.00033	-	2.8	-
							QUR3	-	-	-	-	0.00063	-	3.9	-
							QUR4	-	-	-	-	0.00073	-	4.2	-
							QUR5	-	-	-	-	0.0032	-	8.9	-
							QUR6	-	-	-	-	0.018	-	21	-
						QUR2	QUR3	-	-	-	-	0.00033	-	12	-
							QUR4	-	-	-	-	0.00043	-	14	-
							QUR5	-	-	-	-	0.0029	-	37	-
							QUR6	-	-	-	-	0.018	-	91	-
						QUR3	QUR4	-	-	-	-	0.00073	-	4.2	-
							QUR5	-	-	-	-	0.0032	-	8.9	-
							QUR6	-	-	-	-	0.018	-	21	-
						QUR4	QUR5	-	-	-	-	0.0033	-	7.8	-
							QUR6	-	-	-	-	0.018	-	18	-
						QUR5	QUR6	-	-	-	-	0.021	-	7.4	-
Strontium	No	0.022	Yes	0.009	0.961	BLC	QUR1	Yes	0.008	1.000	0.208	10	5.2	-	0.990
							QUR2	No	0.244	1.000	0.999	60	-	12	-
							QUR3	Yes	0.058	1.000	0.873	26	4.4	-	0.696
							QUR4	Yes	0.010	0.005	0.577	120	16	-	0.980
							QUR5	Yes	0.039	1.000	0.749	20	4.4	-	0.797
							QUR6	No	0.229	1.000	0.999	153	-	19	-
						QUR1	QUR2	No	0.544	1.000	1.000	64	-	8.3	-
							QUR3	No	0.680	1.000	1.000	30	-	5.7	-
							QUR4	Yes	0.037	0.107	0.822	124	7.4	-	0.809
							QUR5	No	0.642	1.000	1.000	24	-	5.1	-
							QUR6	No	0.903	1.000	1.000	157	-	13	-
						QUR2	QUR3	No	0.766	1.000	1.000	80	-	3.3	-
							QUR4	Yes	0.040	0.039	0.627	174	3.0	-	0.792
							QUR5	No	0.756	1.000	1.000	74	-	3.2	-
							QUR6	No	0.655	1.000	1.000	207	-	5.3	-
						QUR3	QUR4	Yes	0.036	0.067	0.722	140	4.4	-	0.815
							QUR5	No	1.000	1.000	1.000	40	-	3.6	-
							QUR6	No	0.772	1.000	1.000	173	-	7.6	-
						QUR4	QUR5	Yes	0.033	0.067	0.740	133	-2.0	-	0.830
							QUR6	No	0.116	0.146	0.927	267	-	4.2	-
						QUR5	QUR6	No	0.768	1.000	1.000	167	-	8.8	-
Titanium	No	0.002	Yes	<0.001	1.000	BLC	QUR1	Yes	0.003	1.000	0.362	477	-3.7	-	1.000
							QUR2	Yes	0.002	1.000	0.282	489	-4.1	-	1.000
							QUR3	No	0.163	1.000	0.979	1,305	-	4.6	-
							QUR4	Yes	0.022	0.001	0.759	55,867	23	-	0.908
							QUR5	No	0.405	1.000	1.000	15,017	-	16	-
							QUR6	Yes	0.076	1.000	0.944	9,217	6.1	-	0.625
						QUR1	QUR2	Yes	0.066	1.000	0.803	32	-2.6	-	0.664
							QUR3	Yes	0.055	1.000	0.919	849	14	-	0.710
							QUR4	Yes	0.013	0.000	0.665	55,410	182	-	0.964
							QUR5	No	0.104	1.000	0.980	14,560	-	105	-
							QUR6	Yes	0.017	0.606	0.719	8,760	67	-	0.938
						QUR2	QUR3	Yes	0.035	1.000	0.835	861	11	-	0.822
							QUR4	Yes	0.012	0.000	0.654	55,422	125	-	0.968
							QUR5	Yes	0.091	1.000	0.972	14,572	33	-	0.574
							QUR6	Yes	0.015	0.505	0.692	8,772	47	-	0.951
						QUR3	QUR4	Yes	0.017	0.001	0.707	56,239	18	-	0.936
							QUR5	No	0.230	1.000	0.999	15,389	-	12	-
							QUR6	Yes	0.041	1.000	0.822	9,589	5.8	-	0.783
						QUR4	QUR5	Yes	0.047	0.004	0.762	69,950	-1.8	-	0.753
							QUR6	Yes	0.066	0.018	0.888	64,150	-1.6	-	0.664
						QUR5	QUR6	No	0.494	1.000	1.000	23,300	-	3.5	-
Uranium	No	0.001	Yes	<0.001	1.000	BLC	QUR1	No	0.205	1.000	0.992	0.0	-	0.0	-
							QUR2	No	0.329	1.000	1.000	0.00022	-	5.0	-
							QUR3	Yes	0.089	1.000	0.920	0.00033	2.9	-	0.580
							QUR4	Yes	0.004	0.000	0.430	0.017	55	-	0.999
							QUR5	Yes	0.085	0.578	0.967	0.013	18	-	0.592
							QUR6	Yes	0.031	0.234	0.831	0.0091	22	-	0.844
						QUR1	QUR2	No	1.000	1.000	1.000	0.00020	-	5.5	-
							QUR3	Yes	0.033	1.000	0.701	0.00032	4.7	-	0.836
							QUR4	Yes	0.004	0.000	0.419	0.017	65	-	0.999
							QUR5	Yes	0.073	0.429	0.953	0.013	23	-	0.636
							QUR6	Yes	0.027	0.173	0.803	0.0091	27	-	0.875
						QUR2	QUR3	Yes	0.049	1.000	0.683	0.00042	2.7	-	0.743
							QUR4	Yes	0.004	0.000	0.411	0.017	37	-	0.999
							QUR5	Yes	0.074	0.429	0.952	0.013	13	-	0.634
							QUR6	Yes	0.027	0.173	0.796	0.0092	15	-	0.872
						QUR3	QUR4	Yes	0.005	0.000	0.451	0.017	26	-	0.998
							QUR5	No	0.129	1.000	0.989	0.013	-	20	-
							QUR6	Yes	0.049	0.498	0.893	0.0093	9.5	-	0.742
						QUR4	QUR5	Yes	0.041	0.005	0.592	0.030	-2.3	-	0.785
							QUR6	Yes	0.044	0.013	0.654	0.026	-2.1	-	0.767
						QUR5	QUR6	No	0.758	1.000	1.000	0.022	-	3.6	-

Table I.23: Statistical comparison summary of perlidae metal and metalloid tissue concentration for reference area BLC and six Quesnel River areas, Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Vanadium	No	<0.001	Yes	<0.001	1.000	BLC	QUR1	Yes	0.006	1.000	0.321	0.63	-3.3	-	0.996
							QUR2	Yes	0.003	1.000	0.195	0.66	-4.0	-	1.000
							QUR3	No	0.403	1.000	1.000	4.4	-	7.8	-
							QUR4	Yes	0.028	0.002	0.812	151	32	-	0.868
							QUR5	No	0.194	1.000	0.998	36	-	22	-
							QUR6	Yes	0.016	1.000	0.633	8.7	9.1	-	0.943
						QUR1	QUR2	No	0.119	1.000	0.933	0.19	-	4.2	-
							QUR3	Yes	0.034	1.000	0.838	3.9	13	-	0.824
							QUR4	Yes	0.020	0.001	0.753	150	93	-	0.918
							QUR5	Yes	0.084	1.000	0.966	35	27	-	0.597
							QUR6	Yes	0.005	1.000	0.464	8.2	32	-	0.997
						QUR2	QUR3	Yes	0.023	1.000	0.755	4.0	13	-	0.896
							QUR4	Yes	0.019	0.000	0.741	150	83	-	0.926
							QUR5	Yes	0.072	1.000	0.952	35	26	-	0.640
							QUR6	Yes	0.004	0.866	0.427	8.3	30	-	0.999
						QUR3	QUR4	Yes	0.033	0.003	0.827	154	12	-	0.832
							QUR5	No	0.305	1.000	1.000	39	-	8.8	-
							QUR6	Yes	0.047	1.000	0.693	12	2.9	-	0.750
						QUR4	QUR5	Yes	0.077	0.016	0.895	185	-1.5	-	0.621
							QUR6	Yes	0.077	0.030	0.945	158	-1.4	-	0.621
						QUR5	QUR6	No	0.729	1.000	1.000	43	-	3.1	-
Zinc	No	<0.001	Yes	0.050	0.831	BLC	QUR1	Yes	0.000	0.251	0.018	214	56	-	1.000
							QUR2	Yes	0.000	0.448	0.001	63.50	51	-	1.000
							QUR3	Yes	0.001	0.509	0.181	1,030	49	-	1.000
							QUR4	Yes	0.024	1.000	0.560	64	4.4	-	0.891
							QUR5	Yes	0.026	1.000	0.802	3,364	31	-	0.877
							QUR6	No	0.236	0.542	0.999	49,414	-	168	-
						QUR1	QUR2	Yes	0.081	1.000	0.901	250	-1.5	-	0.607
							QUR3	No	0.267	1.000	0.999	1,217	-	6.8	-
							QUR4	Yes	0.000	0.392	0.006	250	-14	-	1.000
							QUR5	Yes	0.056	1.000	0.898	3,550	-6.5	-	0.709
							QUR6	No	0.837	1.000	1.000	49,600	-	44	-
						QUR2	QUR3	No	0.815	1.000	1.000	1,067	-	13	-
							QUR4	Yes	0.000	0.694	0.000	100	-24	-	1.000
							QUR5	No	0.104	1.000	0.978	3,400	-	23	-
							QUR6	No	0.959	1.000	1.000	49,450	-	87	-
						QUR3	QUR4	Yes	0.001	0.786	0.182	1,067	-5.2	-	1.000
							QUR5	No	0.159	1.000	0.984	4,367	-	5.8	-
							QUR6	No	0.986	1.000	1.000	50,417	-	20	-
						QUR4	QUR5	Yes	0.042	1.000	0.878	3,400	14	-	0.777
							QUR6	No	0.274	0.836	1.000	49,450	-	87	-
						QUR5	QUR6	No	0.656	1.000	1.000	52,750	-	11	-

[a] Bonferroni post-hoc Test, or Dunnet's T3 Test where variances were found to be heterogenous by Levene's Test

[b] Due to low replication (3 per area) T-Tests are used as post-hoc test of significance between areas - Bonferroni and Tamhane post-hoc tests are reported for interest only.

[c] Magnitude calculated by comparing the difference between the control area and exposed area means to the control area standard deviation (SD) [(exposed mean - control mean) / standard deviation of the control mean]

[d] Minimum effect size detectable calculated based on variance as square root of MSE from ANOVA and alpha = beta = 0.10. Minimum effect size reported as the minimum number of standard deviations detectable based on reference area standard deviation.

[e] All observations at MLD in both areas; therefore, no statistic possible.

[f] Zero variance in Area1; therefore, calculation not possible.

Highlighted values indicate significance at the *p* < 0.10 level.

Table I.24: Statistical comparison summary of perlidae metal and metalloid tissue concentration for reference area CAR and six Quesnel River areas, Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Aluminum	No	0.005	Yes	<0.001	1.000	CAR	QUR1	No	0.255	1.000	1.000	1,752,317	-	2.8	0.299
							QUR2	No	0.210	1.000	0.999	1,753,317	-	2.8	0.346
							QUR3	No	0.766	1.000	1.000	1,991,667	-0.20	-	0.112
							QUR4	Yes	0.022	0.001	0.620	13,451,667	-	7.7	0.908
							QUR5	No	0.390	1.000	1.000	4,856,667	-	4.6	0.208
							QUR6	No	0.118	1.000	0.930	3,826,667	-	4.1	0.499
						QUR1	QUR2	No	0.159	1.000	0.974	15,633	-	4.1	0.419
							QUR3	Yes	0.060	1.000	0.922	253,983	8.8	-	0.689
							QUR4	Yes	0.011	0.000	0.637	11,713,983	103	-	0.973
							QUR5	Yes	0.093	1.000	0.973	3,118,983	26	-	0.568
							QUR6	Yes	0.018	0.617	0.722	2,088,983	38	-	0.935
						QUR2	QUR3	Yes	0.039	1.000	0.852	254,983	9.7	-	0.796
							QUR4	Yes	0.011	0.000	0.627	11,714,983	98	-	0.976
							QUR5	Yes	0.081	1.000	0.963	3,119,983	26	-	0.606
							QUR6	Yes	0.015	0.516	0.696	2,089,983	37	-	0.949
						QUR3	QUR4	Yes	0.016	0.001	0.681	11,953,333	16	-	0.946
							QUR5	No	0.233	1.000	0.999	3,358,333	-	10	0.320
							QUR6	Yes	0.047	1.000	0.837	2,328,333	5.0	-	0.752
						QUR4	QUR5	Yes	0.042	0.005	0.732	14,818,333	-1.9	-	0.777
							QUR6	Yes	0.062	0.022	0.868	13,788,333	-1.6	-	0.681
						QUR5	QUR6	No	0.484	1.000	1.000	5,193,333	-	-	0.170
Arsenic	No	<0.001	Yes	0.031	0.881	CAR	QUR1	No	0.570	1.000	1.000	0.31	-	2.8	0.145
							QUR2	No	0.529	1.000	1.000	0.32	-	2.8	0.156
							QUR3	No	0.120	1.000	0.947	0.45	-	3.3	0.496
							QUR4	Yes	0.004	0.186	0.269	2.7	10	-	0.999
							QUR5	No	0.243	0.835	0.999	30	-	27	0.310
							QUR6	No	0.108	1.000	0.976	6.0	-	12	0.525
						QUR1	QUR2	No	0.643	1.000	1.000	0.0067	-	5.5	0.130
							QUR3	Yes	0.011	1.000	0.620	0.14	24	-	0.974
							QUR4	Yes	0.003	0.151	0.370	2.4	146	-	1.000
							QUR5	No	0.223	0.683	0.999	29	-	368	0.330
							QUR6	Yes	0.086	1.000	0.968	5.7	76	-	0.589
						QUR2	QUR3	Yes	0.011	1.000	0.579	0.15	14	-	0.976
							QUR4	Yes	0.003	0.147	0.366	2.4	85	-	1.000
							QUR5	No	0.221	0.667	0.999	29	-	212	0.333
							QUR6	Yes	0.085	1.000	0.967	5.7	44	-	0.595
						QUR3	QUR4	Yes	0.006	0.413	0.416	2.5	13	-	0.996
							QUR5	No	0.322	1.000	1.000	29	-	40	0.246
							QUR6	No	0.198	1.000	0.998	5.8	-	18	0.361
						QUR4	QUR5	No	0.676	1.000	1.000	32	-	10	0.124
							QUR6	No	0.157	1.000	0.979	8.1	-	5.1	0.422
						QUR5	QUR6	No	0.705	1.000	1.000	35	-	3.0	0.120
Barium	No	0.002	Yes	<0.001	1.000	CAR	QUR1	No	0.170	1.000	0.997	165	-	2.8	0.400
							QUR2	No	0.177	1.000	0.996	174	-	2.8	0.389
							QUR3	No	0.435	1.000	1.000	169	-	2.8	0.188
							QUR4	Yes	0.033	0.002	0.745	1,477	5.5	-	0.836
							QUR5	No	0.487	1.000	1.000	377	-	4.2	0.169
							QUR6	No	0.302	1.000	0.999	379	-	4.2	0.260
						QUR1	QUR2	No	0.969	1.000	1.000	8.9	-	20	0.100
							QUR3	Yes	0.006	1.000	0.442	3.7	14	-	0.995
							QUR4	Yes	0.016	0.000	0.709	1,312	205	-	0.945
							QUR5	Yes	0.067	1.000	0.946	212	51	-	0.658
							QUR6	Yes	0.038	1.000	0.871	214	63	-	0.801
						QUR2	QUR3	Yes	0.042	1.000	0.671	12.23	2.0	-	0.780
							QUR4	Yes	0.016	0.000	0.703	1,320	28	-	0.944
							QUR5	Yes	0.070	1.000	0.938	221	7.1	-	0.646
							QUR6	Yes	0.040	1.000	0.853	222	8.7	-	0.790
						QUR3	QUR4	Yes	0.021	0.001	0.756	1,315	42	-	0.915
							QUR5	No	0.150	1.000	0.993	216	-	22	0.434
							QUR6	Yes	0.080	1.000	0.959	217	11	-	0.608
						QUR4	QUR5	Yes	0.050	0.008	0.826	1,524	-1.7	-	0.738
							QUR6	Yes	0.062	0.016	0.874	1,525	-1.6	-	0.681
						QUR5	QUR6	No	0.712	1.000	1.000	426	-	3.9	0.119
Cadmium	No	0.001	Yes	0.100	0.732	CAR	QUR1	Yes	0.018	1.000	0.608	0.024	-2.4	-	0.931
							QUR2	Yes	0.046	1.000	0.766	0.027	-1.8	-	0.759
							QUR3	No	0.592	1.000	1.000	0.036	-	3.6	0.140
							QUR4	No	0.296	1.000	0.999	0.057	-	4.5	0.264
							QUR5	Yes	0.031	1.000	0.596	0.083	3.7	-	0.844
							QUR6	No	0.226	0.401	0.999	6.0	-	46	0.327
						QUR1	QUR2	No	0.210	1.000	0.994	0.0077	-	4.9	0.345
							QUR3	Yes	0.005	1.000	0.289	0.017	8.3	-	0.997
							QUR4	Yes	0.010	1.000	0.523	0.037	10	-	0.979
							QUR5	Yes	0.004	1.000	0.368	0.064	18	-	0.999
							QUR6	No	0.169	0.164	0.996	6.0	-	137	0.402
						QUR2	QUR3	Yes	0.014	1.000	0.363	0.020	4.6	-	0.956
							QUR4	Yes	0.020	1.000	0.596	0.040	6.0	-	0.921
							QUR5	Yes	0.006	1.000	0.381	0.067	11	-	0.997
							QUR6	No	0.180	0.200	0.997	6.0	-	94	0.385
						QUR3	QUR4	No	0.473	1.000	1.000	0.049	-	5.1	0.173
							QUR5	Yes	0.040	1.000	0.730	0.076	4.0	-	0.793
							QUR6	No	0.238	0.471	0.999	6.0	-	57	0.314
						QUR4	QUR5	No	0.104	1.000	0.911	0.10	-	4.6	0.537
							QUR6	No	0.260	0.609	1.000	6.0	-	36	0.294
						QUR5	QUR6	No	0.356	1.000	1.000	6.1	-	28	0.226

Table I.24: Statistical comparison summary of perlidae metal and metalloid tissue concentration for reference area CAR and six Quesnel River areas, Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA: Variance Equal?	Overall 7-group ANOVA: Variance Levene p-value	Overall 7-group ANOVA: Significant Difference Among Areas?	Overall 7-group ANOVA: p-value	Overall 7-group ANOVA: Power	Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]: Significant Difference Between Areas?[b]	p-value: T-Test	p-value: Bonferroni	p-value: Tahmane	2-group ANOVA for Estimation of Effect Size: MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
Chromium	No	0.005	Yes	0.086	0.755	CAR	QUR1	No	0.374	1.000	1.000	7.6	-	2.8	0.216
							QUR2	No	0.374	1.000	1.000	7.6	-	2.8	0.216
							QUR3	No	0.916	1.000	1.000	13	-	3.6	0.102
							QUR4	No	0.593	1.000	1.000	60	-	7.8	0.140
							QUR5	No	0.292	1.000	1.000	36	-	6.0	0.267
							QUR6	Yes	0.054	0.560	0.757	27	3	-	0.718
						QUR1	QUR2	-	-	1.000	-	-[e]	-	-	-
							QUR3	No	0.374	1.000	1.000	5.5	-[f]	-	0.216
							QUR4	No	0.374	1.000	1.000	53	-[f]	-	0.216
							QUR5	No	0.132	1.000	0.991	28	-[f]	-	0.468
							QUR6	Yes	0.019	0.217	0.742	20	-	-[f]	0.926
						QUR2	QUR3	No	0.374	1.000	1.000	5.5	-[f]	-	0.216
							QUR4	No	0.374	1.000	1.000	53	-[f]	-	0.216
							QUR5	No	0.132	1.000	0.991	28	-[f]	-	0.468
							QUR6	Yes	0.019	0.217	0.742	20	-	-[f]	0.926
						QUR3	QUR4	No	0.555	1.000	1.000	58	-	9.0	0.149
							QUR5	No	0.257	1.000	0.999	34	-	6.9	0.296
							QUR6	Yes	0.044	0.488	0.736	25	3.6	-	0.767
						QUR4	QUR5	No	0.774	1.000	1.000	81	-	3.4	0.111
							QUR6	No	0.321	1.000	1.000	72	-	3.2	0.247
						QUR5	QUR6	No	0.378	1.000	1.000	48	-	3.6	0.214
Cobalt	No	0.017	Yes	0.006	0.977	CAR	QUR1	No	0.202	1.000	0.998	0.29	-	2.8	0.355
							QUR2	No	0.214	1.000	0.999	0.30	-	2.8	0.341
							QUR3	No	0.356	1.000	1.000	0.39	-	3.3	0.226
							QUR4	Yes	0.008	0.051	0.367	1.9	7	-	0.988
							QUR5	No	0.212	1.000	0.998	6.3	-	13	0.343
							QUR6	No	0.113	0.907	0.976	4.1	-	10	0.513
						QUR1	QUR2	No	0.952	1.000	1.000	0.016	-	8.6	0.100
							QUR3	Yes	0.011	1.000	0.612	0.11	20	-	0.974
							QUR4	Yes	0.004	0.021	0.442	1.7	106	-	0.999
							QUR5	No	0.137	0.569	0.992	6.0	-	164	0.458
							QUR6	Yes	0.065	0.386	0.943	3.8	68	-	0.667
						QUR2	QUR3	Yes	0.014	1.000	0.517	0.12	7.0	-	0.960
							QUR4	Yes	0.004	0.021	0.433	1.7	36	-	0.999
							QUR5	No	0.138	0.574	0.992	6.0	-	56	0.456
							QUR6	Yes	0.066	0.389	0.943	3.8	23	-	0.664
						QUR3	QUR4	Yes	0.010	0.103	0.523	1.8	11	-	0.981
							QUR5	No	0.282	1.000	1.000	6.1	-	21	0.275
							QUR6	No	0.157	1.000	0.994	3.9	-	17	0.422
						QUR4	QUR5	No	0.330	1.000	1.000	7.6	-	6.0	0.241
							QUR6	No	0.312	1.000	1.000	5.4	-	5.0	0.253
						QUR5	QUR6	No	0.912	1.000	1.000	9.7	-	3.5	0.102
Copper	No	<0.001	No	0.488	0.395	CAR	QUR1	-	-	-	-	30	-	2.9	-
							QUR2	-	-	-	-	30	-	2.9	-
							QUR3	-	-	-	-	37	-	3.2	-
							QUR4	-	-	-	-	34	-	3.1	-
							QUR5	-	-	-	-	112	-	5.6	-
							QUR6	-	-	-	-	3,281	-	30	-
						QUR1	QUR2	-	-	-	-	6.33	-	3.9	-
							QUR3	-	-	-	-	13	-	5.5	-
							QUR4	-	-	-	-	9.7	-	4.8	-
							QUR5	-	-	-	-	88	-	15	-
							QUR6	-	-	-	-	3,257	-	89	-
						QUR2	QUR3	-	-	-	-	13	-	5.5	-
							QUR4	-	-	-	-	9.7	-	4.8	-
							QUR5	-	-	-	-	88	-	15	-
							QUR6	-	-	-	-	3,257	-	89	-
						QUR3	QUR4	-	-	-	-	16	-	3.6	-
							QUR5	-	-	-	-	95	-	8.8	-
							QUR6	-	-	-	-	3,263	-	51	-
						QUR4	QUR5	-	-	-	-	92	-	10	-
							QUR6	-	-	-	-	3,260	-	62	-
						QUR5	QUR6	-	-	-	-	3,339	-	17	-
Iron	No	0.005	Yes	<0.001	1.000	CAR	QUR1	No	0.194	1.000	0.998	1,288,983	-	2.8	0.365
							QUR2	No	0.150	1.000	0.994	1,300,817	-	2.8	0.434
							QUR3	No	0.906	1.000	1.000	1,681,667	-	3.2	0.102
							QUR4	Yes	0.010	0.001	0.476	12,748,333	8.3	-	0.979
							QUR5	No	0.162	1.000	0.991	10,981,667	-	8.1	0.413
							QUR6	Yes	0.050	0.438	0.803	7,268,333	3.8	-	0.735
						QUR1	QUR2	No	0.111	1.000	0.965	16,467	-	7.4	0.516
							QUR3	Yes	0.038	1.000	0.864	397,317	23	-	0.805
							QUR4	Yes	0.006	0.000	0.510	11,463,983	217	-	0.996
							QUR5	Yes	0.075	0.447	0.957	9,697,317	89	-	0.627
							QUR6	Yes	0.019	0.130	0.747	5,983,983	111	-	0.922
						QUR2	QUR3	Yes	0.027	1.000	0.775	409,150	11	-	0.874
							QUR4	Yes	0.006	0.000	0.499	11,475,817	89	-	0.996
							QUR5	Yes	0.069	0.374	0.948	9,709,150	37	-	0.652
							QUR6	Yes	0.018	0.108	0.727	5,995,817	46	-	0.933
						QUR3	QUR4	Yes	0.009	0.001	0.552	11,856,667	15	-	0.983
							QUR5	No	0.158	1.000	0.994	10,090,000	-	14	-
							QUR6	Yes	0.044	0.489	0.855	6,376,667	6.7	-	0.766
						QUR4	QUR5	Yes	0.082	0.050	0.837	21,156,667	-1.8	-	0.602
							QUR6	No	0.102	0.174	0.912	17,443,333	-	3.4	-
						QUR5	QUR6	No	0.674	1.000	1.000	15,676,667	-	3.5	-

Table I.24: Statistical comparison summary of perlidae metal and metalloid tissue concentration for reference area CAR and six Quesnel River areas, Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA: Variance Equal?	Overall 7-group ANOVA: Levene p-value	Overall 7-group ANOVA: Significant Difference Among Areas?	Overall 7-group ANOVA: p-value	Overall 7-group ANOVA: Power	Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]: Significant Difference Between Areas?[b]	p-value: T-Test	p-value: Bonferroni	p-value: Tahmane	2-group ANOVA for Estimation of Effect Size: MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
Lead	No	0.029	Yes	0.002	0.994	CAR	QUR1	No	0.248	1.000	1.000	1.2	-	2.8	-
							QUR2	No	0.227	1.000	0.999	1.2	-	2.8	-
							QUR3	No	0.378	1.000	1.000	1.2	-	2.8	-
							QUR4	Yes	0.081	0.051	0.831	2.6	2.0	-	0.608
							QUR5	No	0.876	1.000	1.000	1.8	-	3.5	-
							QUR6	No	0.674	1.000	1.000	1.5	-	3.1	-
						QUR1	QUR2	No	0.279	1.000	1.000	0.0047	-	16	-
							QUR3	Yes	0.052	1.000	0.912	0.019	18	-	0.727
							QUR4	Yes	0.012	0.003	0.649	1.4	245	-	0.970
							QUR5	No	0.109	1.000	0.983	0.67	-	186	-
							QUR6	Yes	0.023	1.000	0.782	0.32	95	-	0.897
						QUR2	QUR3	Yes	0.039	1.000	0.720	0.024	4.0	-	0.798
							QUR4	Yes	0.011	0.003	0.635	1.4	45	-	0.973
							QUR5	Yes	0.098	1.000	0.976	0.68	15	-	0.553
							QUR6	Yes	0.021	1.000	0.745	0.32	18	-	0.914
						QUR3	QUR4	Yes	0.016	0.006	0.690	1.4	20	-	0.946
							QUR5	No	0.192	1.000	0.998	0.69	-	17	-
							QUR6	Yes	0.048	1.000	0.873	0.33	6.8	-	0.747
						QUR4	QUR5	Yes	0.072	0.079	0.827	2.1	-1.7	-	0.640
							QUR6	Yes	0.073	0.151	0.887	1.7	-1.5	-	0.637
						QUR5	QUR6	No	0.759	1.000	1.000	0.99	-	3.4	-
Manganese	No	0.032	Yes	0.017	0.930	CAR	QUR1	No	0.419	1.000	1.000	3,527	-	2.8	-
							QUR2	No	0.283	1.000	1.000	3,718	-	2.9	-
							QUR3	No	0.802	1.000	1.000	3,733	-	2.9	-
							QUR4	Yes	0.036	0.167	0.561	8,783	2.8	-	0.812
							QUR5	No	0.380	1.000	1.000	19,867	-	6.6	-
							QUR6	No	0.274	1.000	0.999	8,733	-	4.4	-
						QUR1	QUR2	No	0.205	1.000	0.998	212	-	12	-
							QUR3	Yes	0.069	1.000	0.934	227	6.6	-	0.650
							QUR4	Yes	0.009	0.054	0.591	5,277	61	-	0.984
							QUR5	No	0.207	1.000	0.999	16,361	-	110	-
							QUR6	Yes	0.076	1.000	0.958	5,227	31	-	0.624
						QUR2	QUR3	Yes	0.044	1.000	0.615	418	2.4	-	0.766
							QUR4	Yes	0.008	0.034	0.508	5,468	15	-	0.990
							QUR5	No	0.171	0.806	0.996	16,552	-	25	-
							QUR6	Yes	0.058	1.000	0.914	5,418	7.9	-	0.699
						QUR3	QUR4	Yes	0.014	0.118	0.636	5,483	12	-	0.955
							QUR5	No	0.295	1.000	1.000	16,567	-	24	-
							QUR6	No	0.142	1.000	0.991	5,433	-	14	-
						QUR4	QUR5	No	0.362	1.000	1.000	21,617	-	5.6	-
							QUR6	No	0.169	1.000	0.980	10,483	-	3.9	-
						QUR5	QUR6	No	0.896	1.000	1.000	21,567	-	3.2	-
Nickel	No	0.002	Yes	0.001	0.999	CAR	QUR1	No	0.145	1.000	0.993	2.7	-	2.8	-
							QUR2	Yes	0.085	1.000	0.961	2.7	-1.3	-	0.591
							QUR3	No	0.644	1.000	1.000	3.0	-	2.9	-
							QUR4	Yes	0.015	0.032	0.547	23	7.0	-	0.952
							QUR5	No	0.289	1.000	1.000	17	-	7.1	-
							QUR6	Yes	0.053	0.032	0.894	53	7.0	-	0.722
						QUR1	QUR2	Yes	0.054	1.000	0.895	0.092	-6.7	-	0.716
							QUR3	Yes	0.020	1.000	0.736	0.31	17	-	0.918
							QUR4	Yes	0.008	0.010	0.555	21	185	-	0.991
							QUR5	No	0.105	1.000	0.981	15	-	151	-
							QUR6	Yes	0.033	0.010	0.846	50	185	-	0.834
						QUR2	QUR3	Yes	0.010	1.000	0.321	0.39	5.7	-	0.981
							QUR4	Yes	0.007	0.008	0.526	21	46	-	0.994
							QUR5	Yes	0.084	1.000	0.965	15	17	-	0.597
							QUR6	Yes	0.029	0.008	0.825	50	46	-	0.855
						QUR3	QUR4	Yes	0.011	0.023	0.607	21	22	-	0.976
							QUR5	No	0.201	1.000	0.998	15	-	20	-
							QUR6	Yes	0.044	0.023	0.890	50	22	-	0.768
						QUR4	QUR5	Yes	0.070	0.239	0.789	36	-1.9	-	0.648
							QUR6	No	1.000	1.000	1.000	71	-	5.1	0.100
						QUR5	QUR6	No	0.143	0.239	0.977	65	-	5.8	0.446
Selenium	No	<0.001	No	0.593	0.342	CAR	QUR1	-	-	-	-	0.17	-	3.3	-
							QUR2	-	-	-	-	0.14	-	2.9	-
							QUR3	-	-	-	-	0.15	-	3.1	-
							QUR4	-	-	-	-	0.13	-	2.8	-
							QUR5	-	-	-	-	0.45	-	5.4	-
							QUR6	-	-	-	-	22	-	37	-
						QUR1	QUR2	-	-	-	-	0.067	-	3.2	-
							QUR3	-	-	-	-	0.078	-	3.4	-
							QUR4	-	-	-	-	0.058	-	2.9	-
							QUR5	-	-	-	-	0.38	-	7.6	-
							QUR6	-	-	-	-	22	-	57	-
						QUR2	QUR3	-	-	-	-	0.042	-	4.6	-
							QUR4	-	-	-	-	0.022	-	3.3	-
							QUR5	-	-	-	-	0.35	-	13	-
							QUR6	-	-	-	-	21	-	105	-
						QUR3	QUR4	-	-	-	-	0.033	-	3.1	-
							QUR5	-	-	-	-	0.36	-	10	-
							QUR6	-	-	-	-	21	-	79	-
						QUR4	QUR5	-	-	-	-	0.34	-	20	-
							QUR6	-	-	-	-	21	-	157	-
						QUR5	QUR6	-	-	-	-	22	-	22	-

Table I.24: Statistical comparison summary of perlidae metal and metalloid tissue concentration for reference area CAR and six Quesnel River areas, Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA: Variance Equal?	Overall 7-group ANOVA: Variance Levene p-value	Overall 7-group ANOVA: Significant Difference Among Areas?	Overall 7-group ANOVA: p-value	Overall 7-group ANOVA: Power	Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]: Significant Difference Between Areas?[b]	7-group ANOVA Post-hoc Comparisons[a]: p-value T-Test	7-group ANOVA Post-hoc Comparisons[a]: p-value Bonferroni	7-group ANOVA Post-hoc Comparisons[a]: p-value Tahmane	2-group ANOVA for Estimation of Effect Size: MSE (ANOVA)	2-group ANOVA for Estimation of Effect Size: Magnitude of Difference (# of Area1 SDs)[c]	2-group ANOVA for Estimation of Effect Size: Minimum Detectable Effect Size (# of Area1 SDs)[d]	2-group ANOVA for Estimation of Effect Size: Power
Silver	No	0.005	No	0.145	0.666	CAR	QUR1	-	-	-	-	0.0053	-	2.9	-
							QUR2	-	-	-	-	0.0050	-	2.8	-
							QUR3	-	-	-	-	0.0053	-	2.9	-
							QUR4	-	-	-	-	0.0054	-	2.9	-
							QUR5	-	-	-	-	0.0079	-	3.5	-
							QUR6	-	-	-	-	0.023	-	5.9	-
						QUR1	QUR2	-	-	-	-	0.00033	-	2.8	-
							QUR3	-	-	-	-	0.00063	-	3.9	-
							QUR4	-	-	-	-	0.00073	-	4.2	-
							QUR5	-	-	-	-	0.0032	-	8.9	-
							QUR6	-	-	-	-	0.018	-	21	-
						QUR2	QUR3	-	-	-	-	0.00033	-	12	-
							QUR4	-	-	-	-	0.00043	-	14	-
							QUR5	-	-	-	-	0.0029	-	37	-
							QUR6	-	-	-	-	0.018	-	91	-
						QUR3	QUR4	-	-	-	-	0.00073	-	4.2	-
							QUR5	-	-	-	-	0.0032	-	8.9	-
							QUR6	-	-	-	-	0.018	-	21	-
						QUR4	QUR5	-	-	-	-	0.0033	-	7.8	-
							QUR6	-	-	-	-	0.018	-	18	-
						QUR5	QUR6	-	-	-	-	0.021	-	7.4	-
Strontium	No	0.035	Yes	0.009	0.961	CAR	QUR1	Yes	0.015	1.000	0.279	17	3.1	-	0.953
							QUR2	No	0.234	1.000	0.999	67	-	7.3	-
							QUR3	Yes	0.067	1.000	0.817	33	2.7	-	0.660
							QUR4	Yes	0.010	0.005	0.515	126	9.6	-	0.978
							QUR5	Yes	0.049	1.000	0.684	26	2.7	-	0.741
							QUR6	No	0.219	1.000	0.999	160	-	11	-
						QUR1	QUR2	No	0.544	1.000	1.000	64	-	8.3	-
							QUR3	No	0.680	1.000	1.000	30	-	5.7	-
							QUR4	Yes	0.037	0.113	0.822	124	7.4	-	0.809
							QUR5	No	0.642	1.000	1.000	24	-	5.1	-
							QUR6	No	0.903	1.000	1.000	157	-	13	-
						QUR2	QUR3	No	0.766	1.000	1.000	80	-	3.3	-
							QUR4	Yes	0.040	0.041	0.627	174	3.0	-	0.792
							QUR5	No	0.756	1.000	1.000	74	-	3.2	-
							QUR6	No	0.655	1.000	1.000	207	-	5.3	-
						QUR3	QUR4	Yes	0.036	0.071	0.722	140	4.4	-	0.815
							QUR5	No	1.000	1.000	1.000	40	-	3.6	-
							QUR6	No	0.772	1.000	1.000	173	-	7.6	-
						QUR4	QUR5	Yes	0.033	0.071	0.740	133	-2.0	-	0.830
							QUR6	No	0.116	0.154	0.927	267	-	4.2	-
						QUR5	QUR6	No	0.768	1.000	1.000	167	-	8.8	-
Titanium	No	0.002	Yes	<0.001	1.000	CAR	QUR1	No	0.669	1.000	1.000	280	-	2.8	-
							QUR2	No	0.720	1.000	1.000	292	-	2.9	-
							QUR3	Yes	0.062	1.000	0.818	1,109	3.0	-	0.681
							QUR4	Yes	0.013	0.000	0.655	55,670	35.6	-	0.966
							QUR5	Yes	0.098	1.000	0.975	14,820	9.2	-	0.551
							QUR6	Yes	0.017	0.546	0.680	9,020	13	-	0.941
						QUR1	QUR2	Yes	0.066	1.000	0.803	32	-2.6	-	0.664
							QUR3	Yes	0.055	1.000	0.919	849	14	-	0.710
							QUR4	Yes	0.013	0.000	0.665	55,410	182	-	0.964
							QUR5	No	0.104	1.000	0.980	14,560	-	105	-
							QUR6	Yes	0.017	0.603	0.719	8,760	67	-	0.938
						QUR2	QUR3	Yes	0.035	1.000	0.835	861	11	-	0.822
							QUR4	Yes	0.012	0.000	0.654	55,422	125	-	0.968
							QUR5	Yes	0.091	1.000	0.972	14,572	33	-	0.574
							QUR6	Yes	0.015	0.502	0.692	8,772	47	-	0.951
						QUR3	QUR4	Yes	0.017	0.001	0.707	56,239	18	-	0.936
							QUR5	No	0.230	1.000	0.999	15,389	-	12	-
							QUR6	Yes	0.041	1.000	0.822	9,589	5.8	-	0.783
						QUR4	QUR5	Yes	0.047	0.004	0.762	69,950	-1.8	-	0.753
							QUR6	Yes	0.066	0.018	0.888	64,150	-1.6	-	0.664
						QUR5	QUR6	No	0.494	1.000	1.000	23,300	-	3.5	-
Uranium	No	0.004	Yes	<0.001	1.000	CAR	QUR1	No	0.297	1.000	1.000	0.0049	-	2.8	-
							QUR2	No	0.301	1.000	1.000	0.0050	-	2.8	-
							QUR3	No	0.729	1.000	1.000	0.0051	-	2.9	-
							QUR4	Yes	0.009	0.000	0.292	0.022	5.9	-	0.987
							QUR5	No	0.221	1.000	0.996	0.018	-	5.3	-
							QUR6	No	0.108	1.000	0.922	0.014	-	4.7	-
						QUR1	QUR2	No	1.000	1.000	1.000	0.00020	-	5.5	-
							QUR3	Yes	0.033	1.000	0.701	0.00032	4.7	-	0.836
							QUR4	Yes	0.004	0.000	0.419	0.017	65	-	0.999
							QUR5	Yes	0.073	0.568	0.953	0.013	23	-	0.636
							QUR6	Yes	0.027	0.242	0.803	0.0091	27	-	0.875
						QUR2	QUR3	Yes	0.049	1.000	0.683	0.00042	2.7	-	0.743
							QUR4	Yes	0.004	0.000	0.411	0.017	37	-	0.999
							QUR5	Yes	0.074	0.568	0.952	0.013	13	-	0.634
							QUR6	Yes	0.027	0.242	0.796	0.0092	15	-	0.872
						QUR3	QUR4	Yes	0.005	0.000	0.451	0.017	26	-	0.998
							QUR5	No	0.129	1.000	0.989	0.013	-	20	-
							QUR6	Yes	0.049	0.653	0.893	0.0093	9.5	-	0.742
						QUR4	QUR5	Yes	0.041	0.009	0.592	0.030	-2.3	-	0.785
							QUR6	Yes	0.044	0.021	0.654	0.026	-2.1	-	0.767
						QUR5	QUR6	No	0.758	1.000	1.000	0.022	-	3.6	-

Table I.24: Statistical comparison summary of perlidae metal and metalloid tissue concentration for reference area CAR and six Quesnel River areas, Mount Polley Mine, 2014.

Endpoint	Overall 7-group ANOVA					Area1 ID	Area2 ID	7-group ANOVA Post-hoc Comparisons[a]				2-group ANOVA for Estimation of Effect Size			
	Variance		Significant Difference Among Areas?	p-value	Power			Significant Difference Between Areas?[b]	p-value			MSE (ANOVA)	Magnitude of Difference (# of Area1 SDs)[c]	Minimum Detectable Effect Size (# of Area1 SDs)[d]	Power
	Equal?	Levene p-value							T-Test	Bonferroni	Tahmane				
Vanadium	No	<0.001	Yes	<0.001	1.000	CAR	QUR1	No	0.596	1.000	1.000	4.0	-	2.8	-
							QUR2	No	0.373	1.000	1.000	4.0	-	2.8	-
							QUR3	No	0.140	1.000	0.958	7.7	-	3.9	-
							QUR4	Yes	0.023	0.001	0.751	154	13	-	0.901
							QUR5	No	0.117	1.000	0.975	39	-	8.8	-
							QUR6	Yes	0.013	1.000	0.293	12	4.4	-	0.966
						QUR1	QUR2	No	0.119	1.000	0.933	0.19	-	4.2	-
							QUR3	Yes	0.034	1.000	0.838	3.9	13	-	0.824
							QUR4	Yes	0.020	0.001	0.753	150	93	-	0.918
							QUR5	Yes	0.084	1.000	0.966	35	27	-	0.597
							QUR6	Yes	0.005	1.000	0.464	8.2	32	-	0.997
						QUR2	QUR3	Yes	0.023	1.000	0.755	4.0	13	-	0.896
							QUR4	Yes	0.019	0.001	0.741	150	83	-	0.926
							QUR5	Yes	0.072	1.000	0.952	35	26	-	0.640
							QUR6	Yes	0.004	0.897	0.427	8.3	30	-	0.999
						QUR3	QUR4	Yes	0.033	0.003	0.827	154	12	-	0.832
							QUR5	No	0.305	1.000	1.000	39	-	8.8	-
							QUR6	Yes	0.047	1.000	0.693	12	2.9	-	0.750
						QUR4	QUR5	Yes	0.077	0.017	0.895	185	-1.5	-	0.621
							QUR6	Yes	0.077	0.032	0.945	158	-1.4	-	0.621
						QUR5	QUR6	No	0.729	1.000	1.000	43	-	3.1	-
Zinc	No	<0.001	No	0.224	0.561	CAR	QUR1	-	-	-	-	8,217	-	2.8	-
							QUR2	-	-	-	-	8,067	-	2.8	-
							QUR3	-	-	-	-	9,033	-	2.9	-
							QUR4	-	-	-	-	8,067	-	2.8	-
							QUR5	-	-	-	-	11,367	-	3.3	-
							QUR6	-	-	-	-	57,417	-	7.4	-
						QUR1	QUR2	-	-	-	-	250	-	3.1	-
							QUR3	-	-	-	-	1,217	-	6.8	-
							QUR4	-	-	-	-	250	-	3.1	-
							QUR5	-	-	-	-	3,550	-	12	-
							QUR6	-	-	-	-	49,600	-	44	-
						QUR2	QUR3	-	-	-	-	1,067	-	13	-
							QUR4	-	-	-	-	100	-	3.9	-
							QUR5	-	-	-	-	3,400	-	23	-
							QUR6	-	-	-	-	49,450	-	87	-
						QUR3	QUR4	-	-	-	-	1,067	-	2.8	-
							QUR5	-	-	-	-	4,367	-	5.8	-
							QUR6	-	-	-	-	50,417	-	20	-
						QUR4	QUR5	-	-	-	-	3,400	-	23	-
							QUR6	-	-	-	-	49,450	-	87	-
						QUR5	QUR6	-	-	-	-	52,750	-	11	-

[a] Bonferroni post-hoc Test, or Dunnet's T3 Test where variances were found to be heterogenous by Levene's Test

[b] Due to low replication (3 per area) T-Tests are used as post-hoc test of significance between areas - Bonferroni and Tamhane post-hoc tests are reported for interest only.

[c] Magnitude calculated by comparing the difference between the control area and exposed area means to the control area standard deviation (SD) [(exposed mean - control mean) / standard deviation of the control mean]

[d] Minimum effect size detectable calculated based on variance as square root of MSE from ANOVA and alpha = beta = 0.10. Minimum effect size reported as the minimum number of standard deviations detectable based on reference area standard deviation.

[e] All observations at MLD in both areas; therefore, no statistic possible.

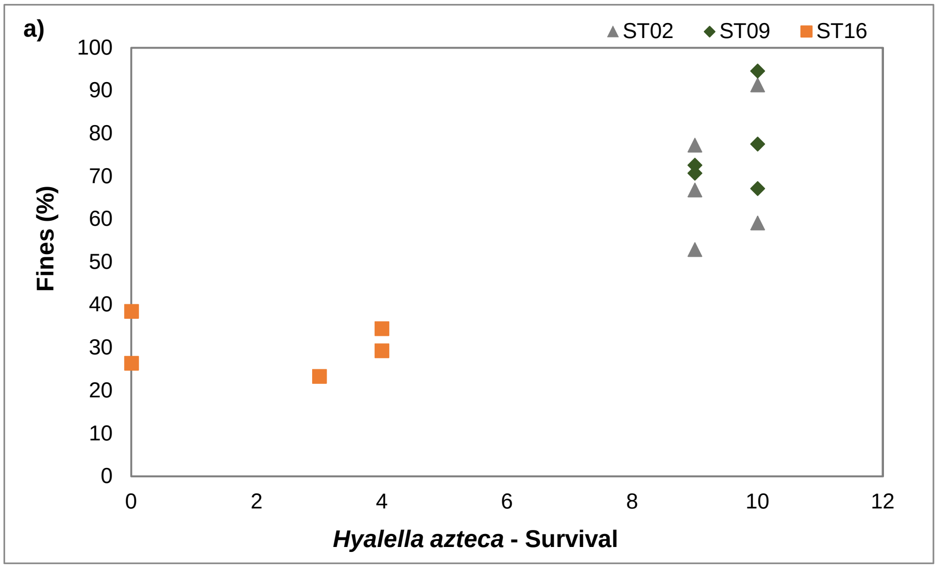
[f] Zero variance in Area1; therefore, calculation not possible.

Highlighted values indicate significance at the *p* < 0.10 level.

Table I.25: Spearman's Rank correlation of metal and metalloid concentrations between whole community benthic invertebrate tissue and Perlidae only tissue from river sampling areas, Mount Polley Mine, 2014.

Statistic	r	p
Al	0.541	0.006
As	0.590	0.002
Ba	0.073	0.733
Cd	0.840	0.000
Cr	0.216	0.310
Co	0.483	0.017
Cu	0.657	0.000
Fe	0.560	0.004
Pb	0.573	0.003
Mn	0.545	0.006
Ni	0.634	0.001
Se	0.489	0.015
Ag	0.550	0.005
St	0.510	0.011
Ti	0.715	0.000
U	0.699	0.000
V	0.607	0.002
Zn	0.693	0.000

(grey box) indicates a p-value below 0.05.



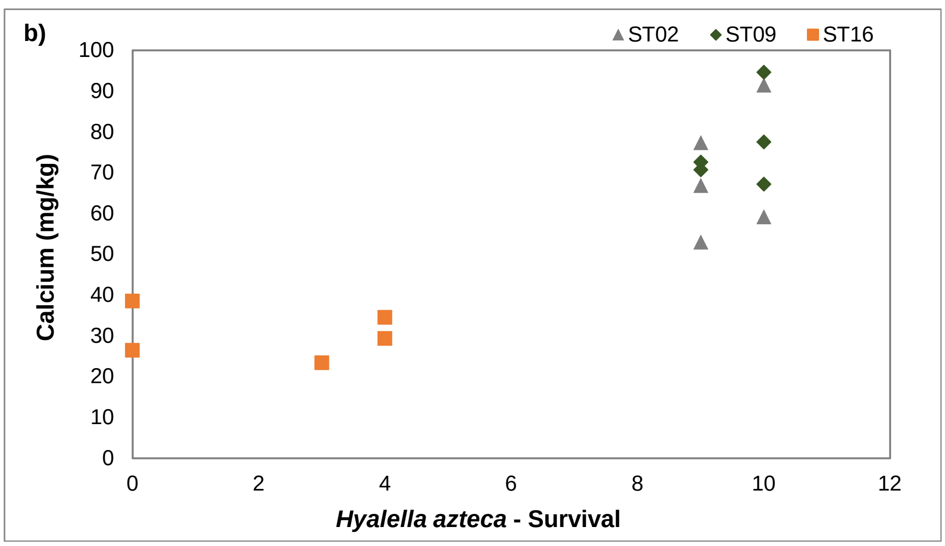


Figure I.1: Scatterplots of significant Spearman's correlation relationships ($p < 0.0006$) between toxicity endpoints and physical endpoints, parameters of interest, indicator parameters, PCA axes and copper extracts (Tessier extraction), Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Hollow symbols indicate values < MDL.

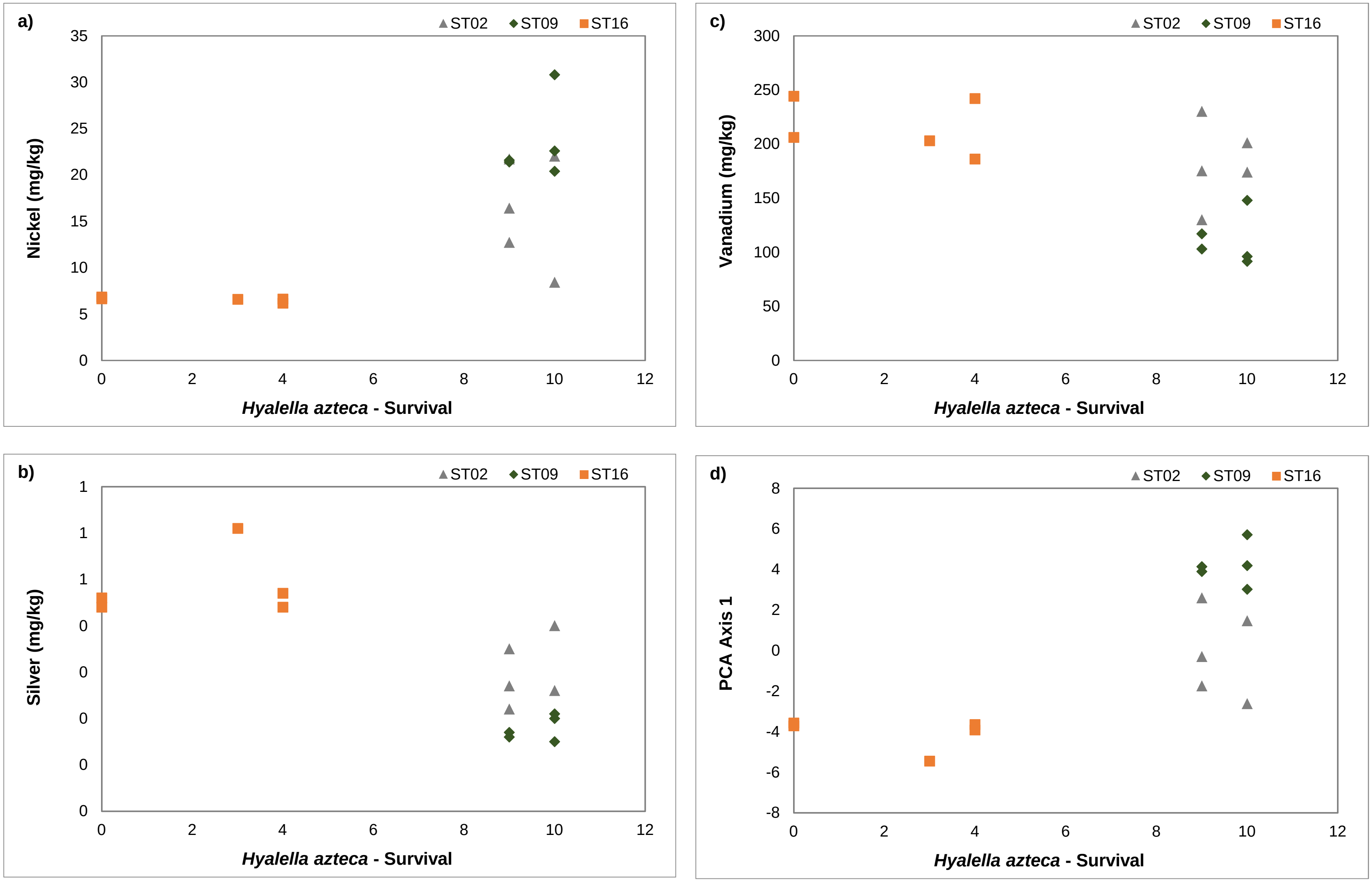


Figure I.2: Scatterplots of significant Spearman's correlation relationships ($p < 0.01$) between toxicity endpoints and physical endpoints, parameters of interest, indicator parameters, PCA axes and copper extracts (Tessier extraction), Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Hollow symbols indicate values < MDL.

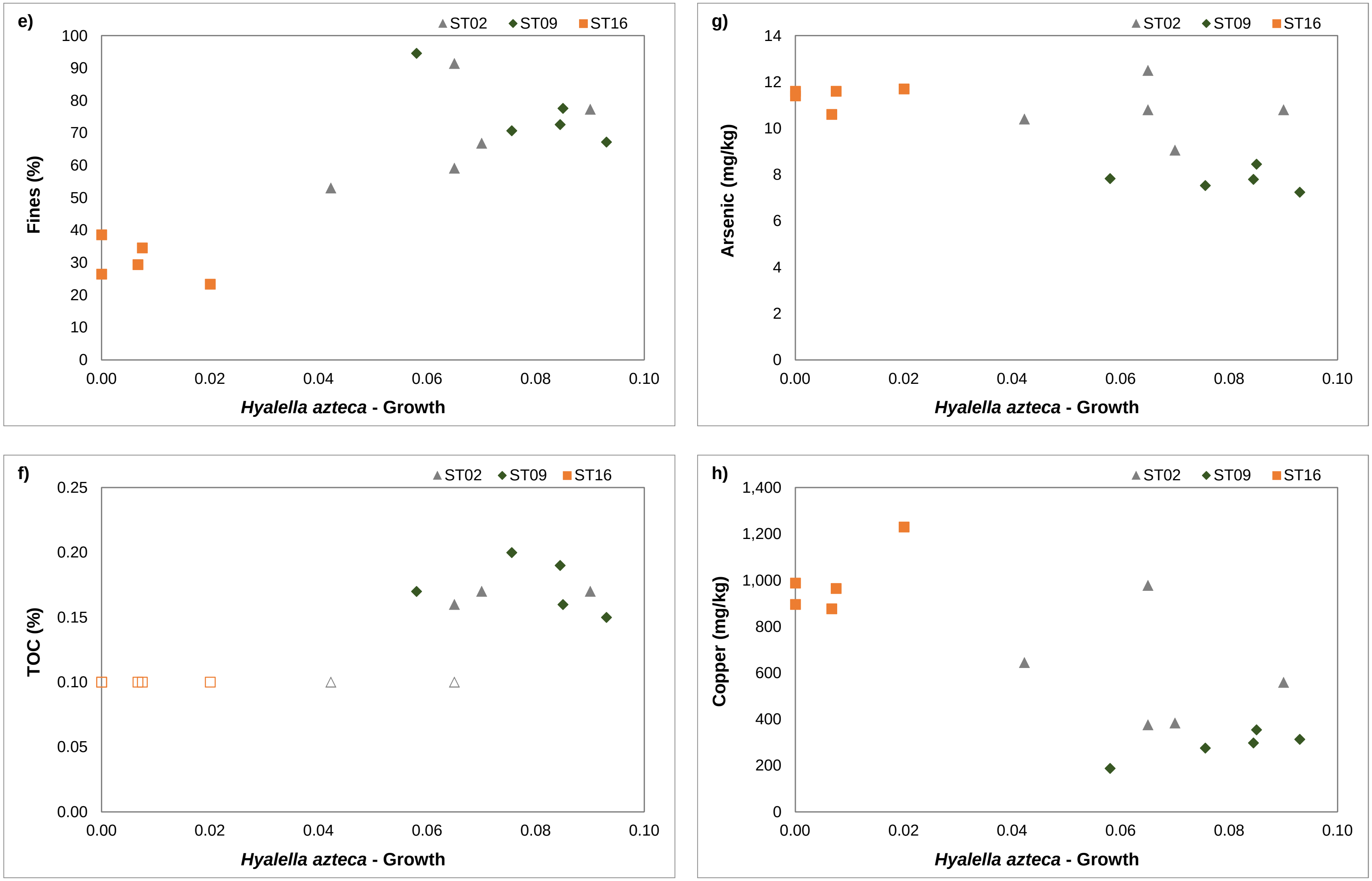


Figure I.2: Scatterplots of significant Spearman's correlation relationships ($p < 0.01$) between toxicity endpoints and physical endpoints, parameters of interest, indicator parameters, PCA axes and copper extracts (Tessier extraction), Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Hollow symbols indicate values < MDL.

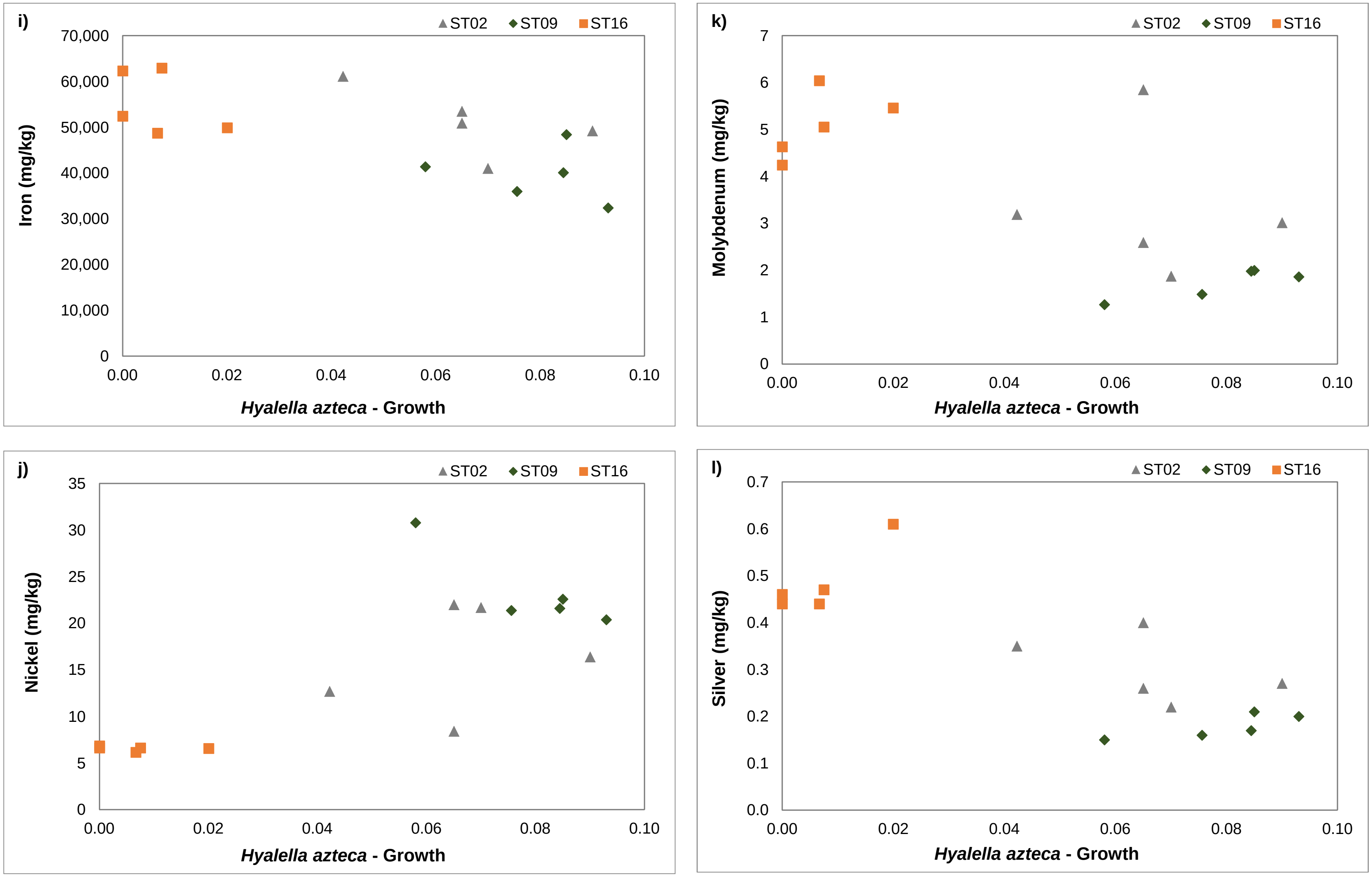


Figure I.2: Scatterplots of significant Spearman's correlation relationships ($p < 0.01$) between toxicity endpoints and physical endpoints, parameters of interest, indicator parameters, PCA axes and copper extracts (Tessier extraction), Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Hollow symbols indicate values < MDL.

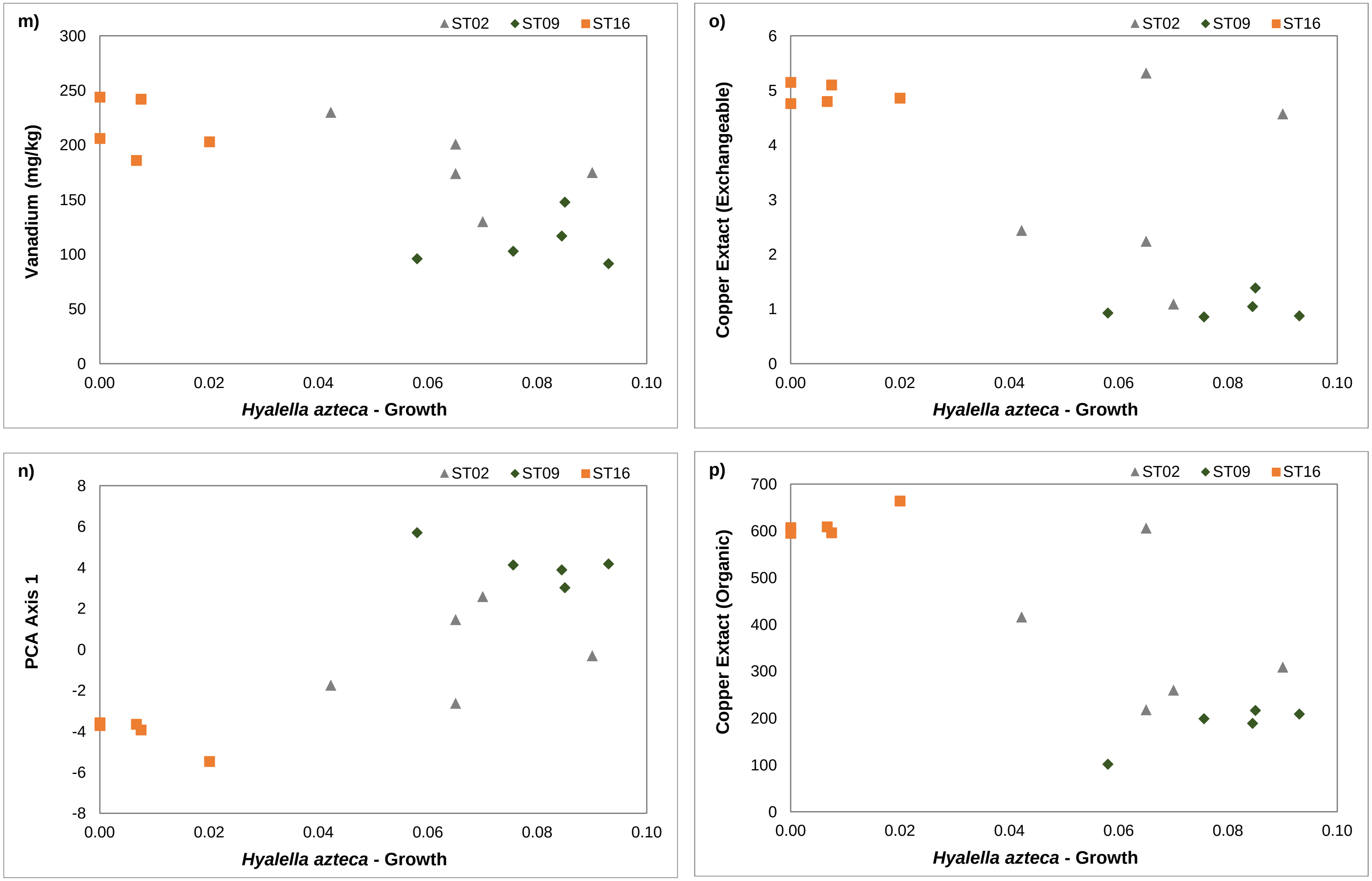


Figure I.2: Scatterplots of significant Spearman's correlation relationships ($p < 0.01$) between toxicity endpoints and physical endpoints, parameters of interest, indicator parameters, PCA axes and copper extracts (Tessier extraction), Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Hollow symbols indicate values < MDL.

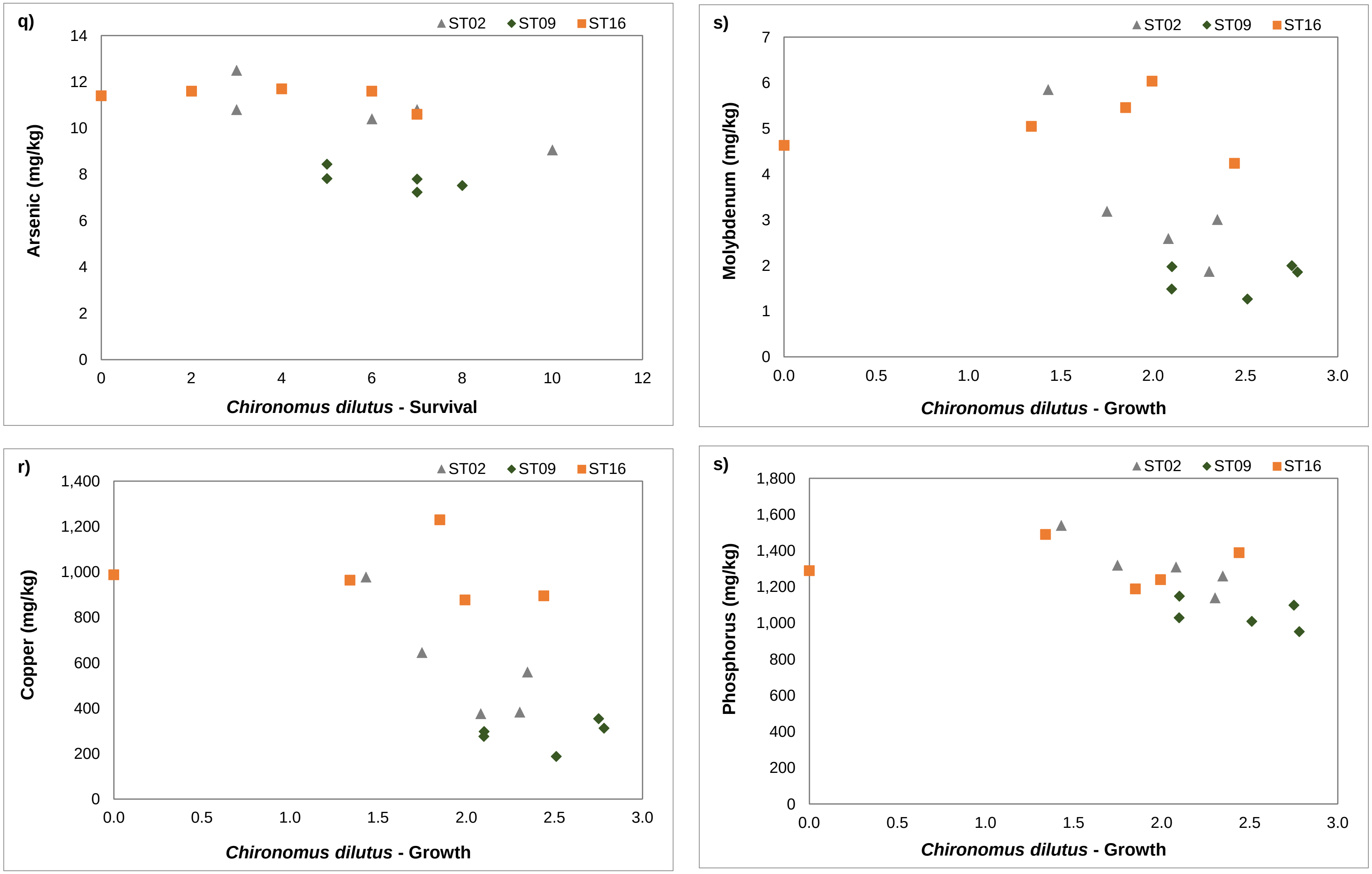


Figure I.2: Scatterplots of significant Spearman's correlation relationships (p < 0.01) between toxicity endpoints and physical endpoints, parameters of interest, indicator parameters, PCA axes and copper extracts (Tessier extraction), Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Hollow symbols indicate values < MDL.

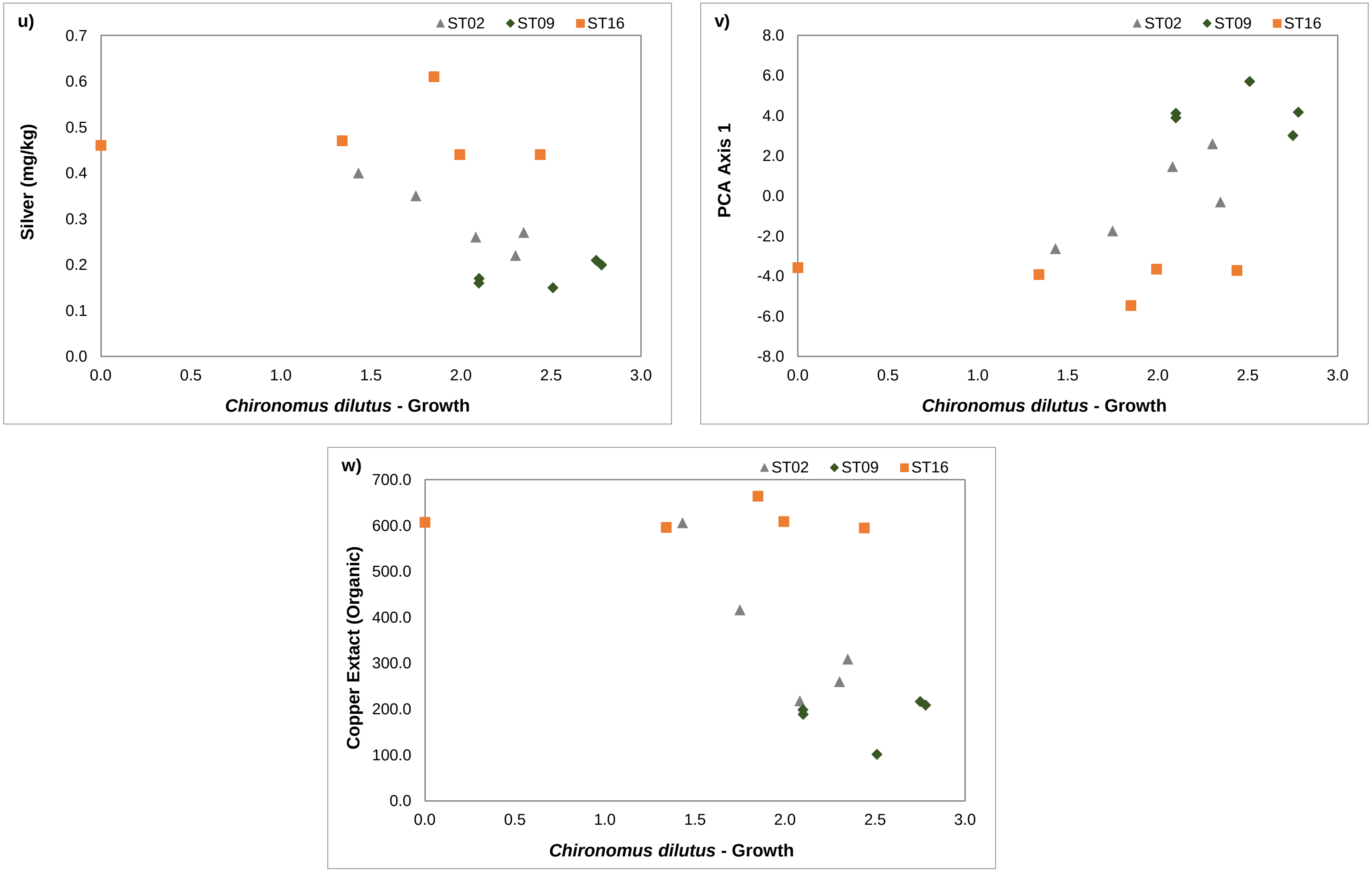


Figure I.2: Scatterplots of significant Spearman's correlation relationships ($p < 0.01$) between toxicity endpoints and physical endpoints, parameters of interest, indicator parameters, PCA axes and copper extracts (Tessier extraction), Hazeltine Creek sampling areas, Mount Polley Mine, 2014. Hollow symbols indicate values < MDL.

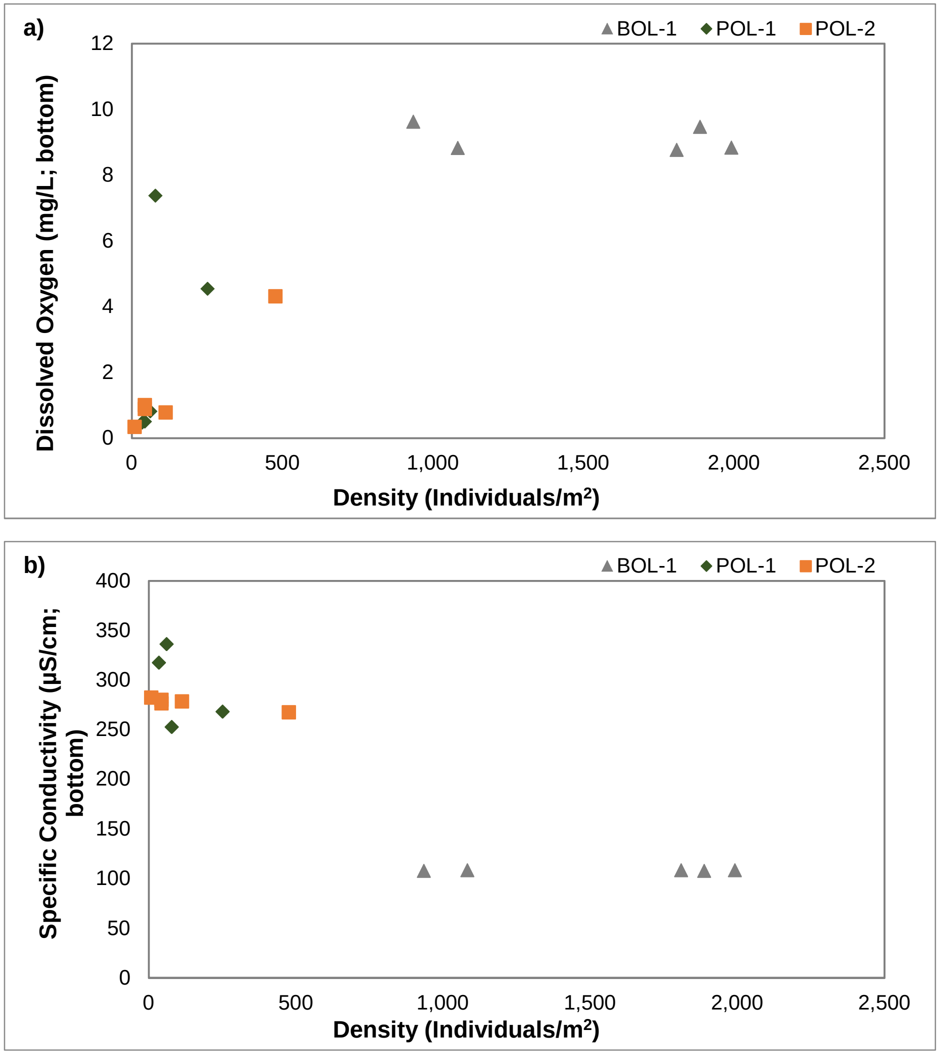


Figure I.3: Scatterplots of significant Spearman's correlation relationships ($p < 0.0001$) between benthic invertebrate community metrics and water in-situ measures, Mount Polley Mine, 2014. Polley and Bootjack Lake mid-depth sampling areas.

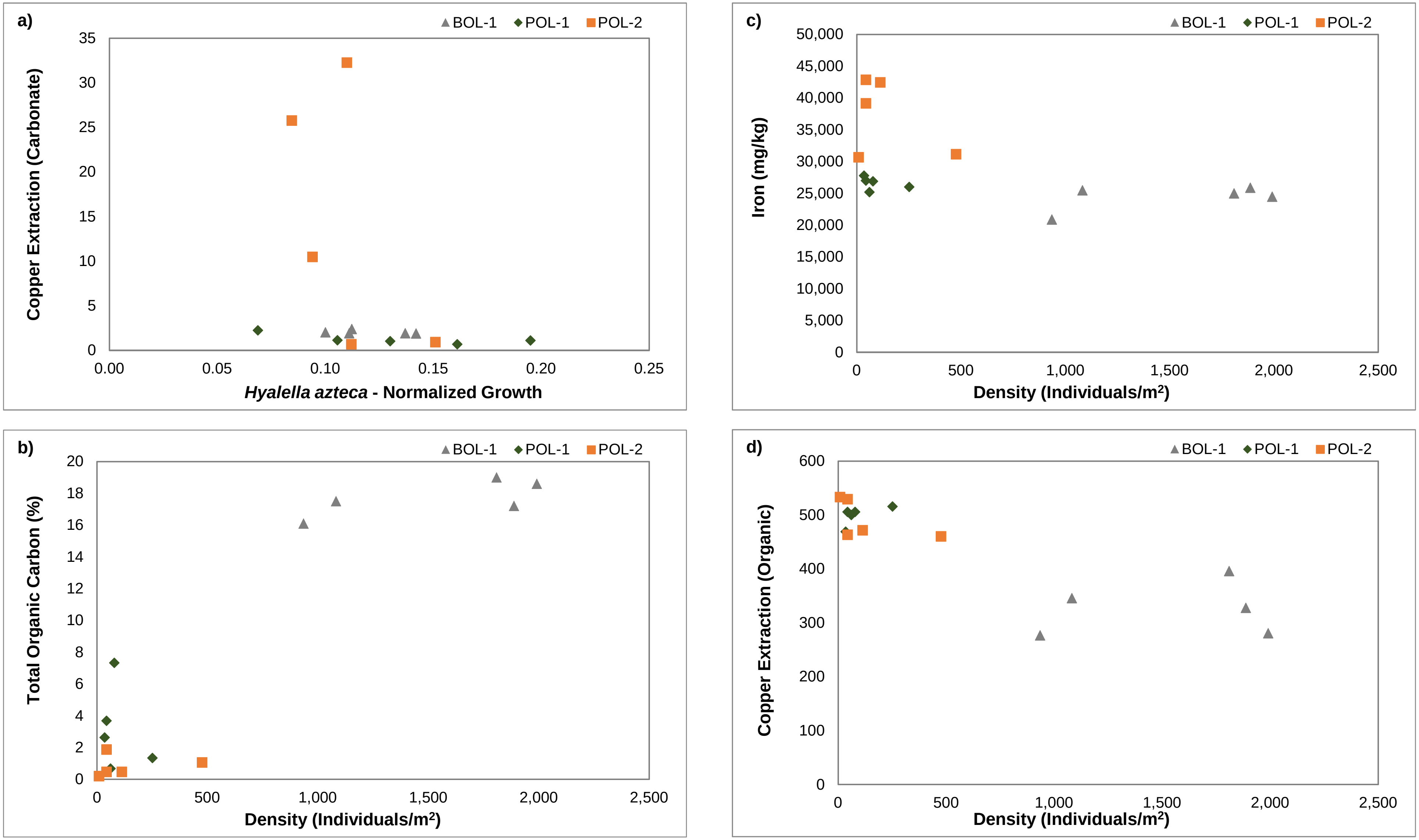


Figure I.4: Scatterplots of Spearman's correlation relationships ($p<0.01$) between toxicity endpoints, benthic invertebrate community metrics and physical endpoints, parameters of interest, indicator parameters, PCA axes and copper extracts (Tessier extraction), Mount Polley Mine, 2014. Polley and Bootjack Lake mid-depth sampling areas.

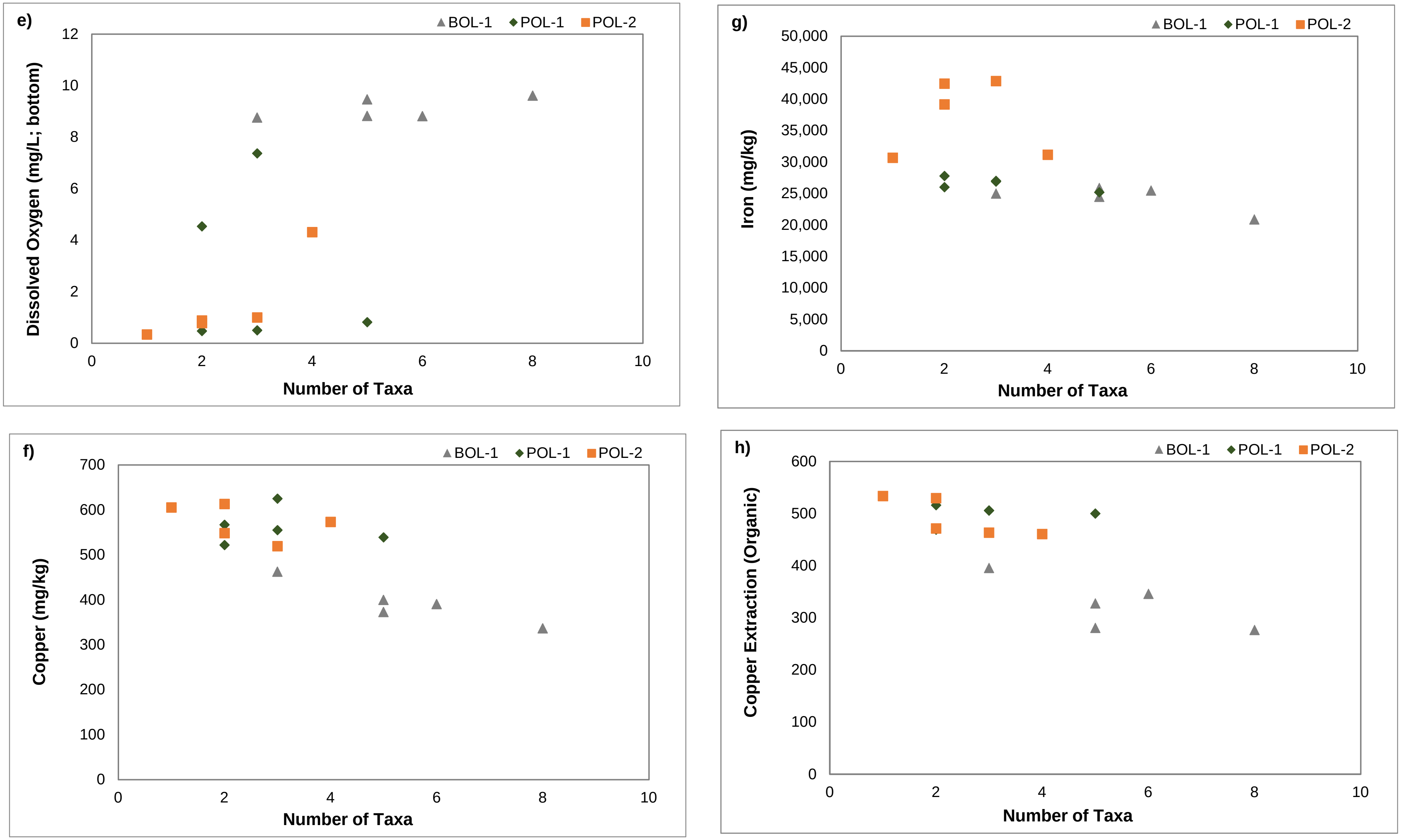
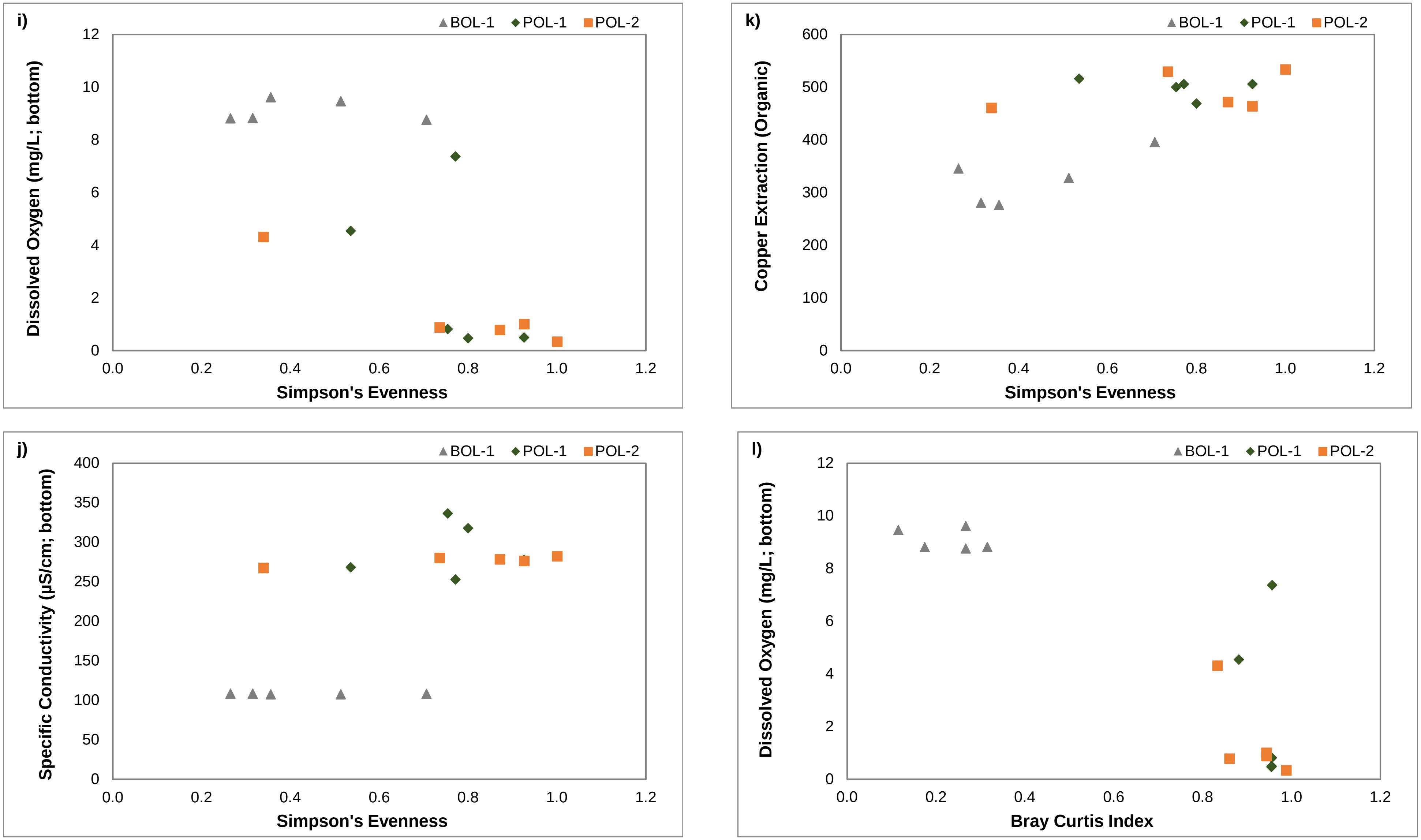


Figure I.4: Scatterplots of Spearman's correlation relationships (p<0.01) between toxicity endpoints, benthic invertebrate community metrics and physical endpoints, parameters of interest, indicator parameters, PCA axes and copper extracts (Tessier extraction), Mount Polley Mine, 2014. Polley and Bootjack Lake mid-depth sampling areas.



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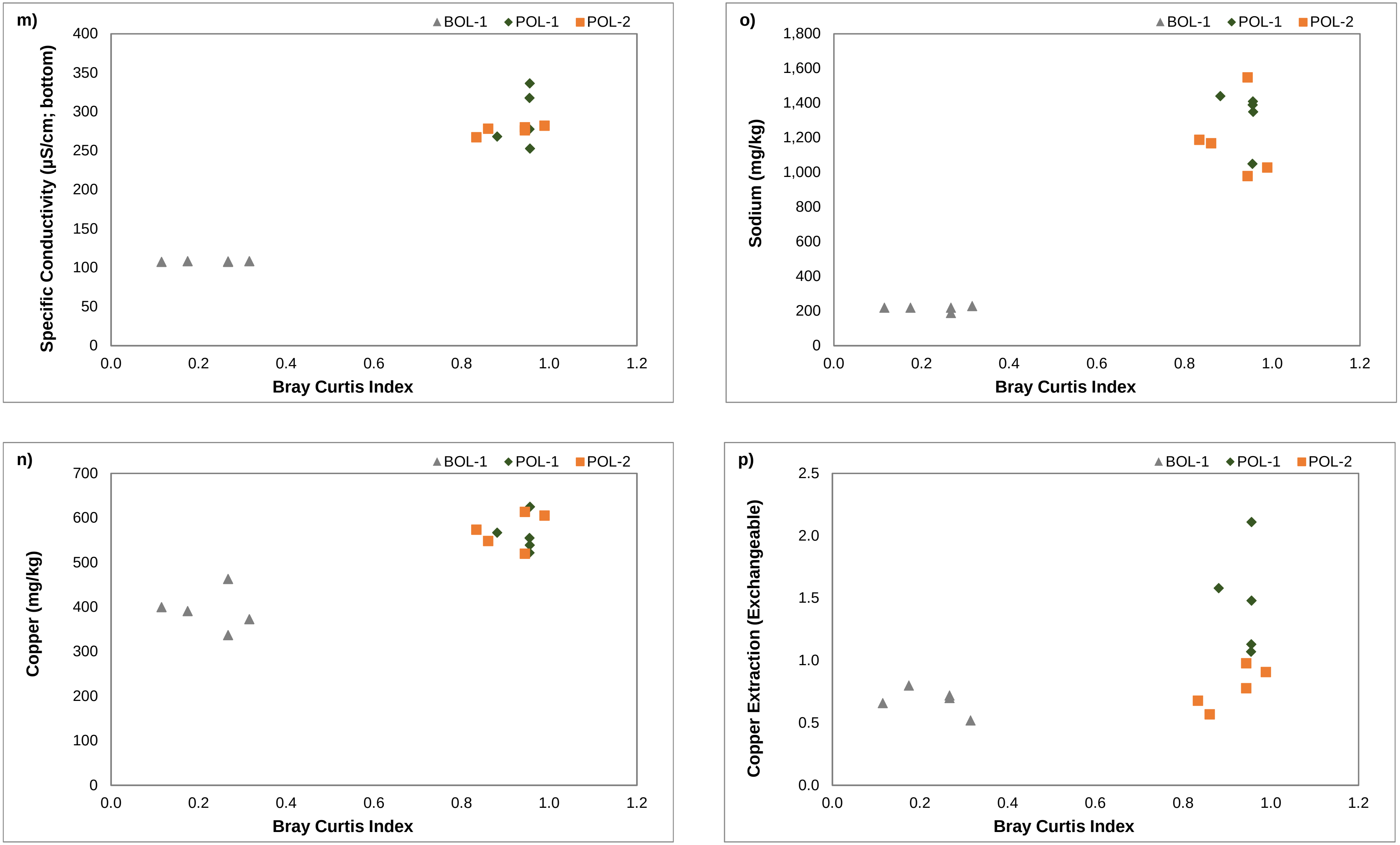

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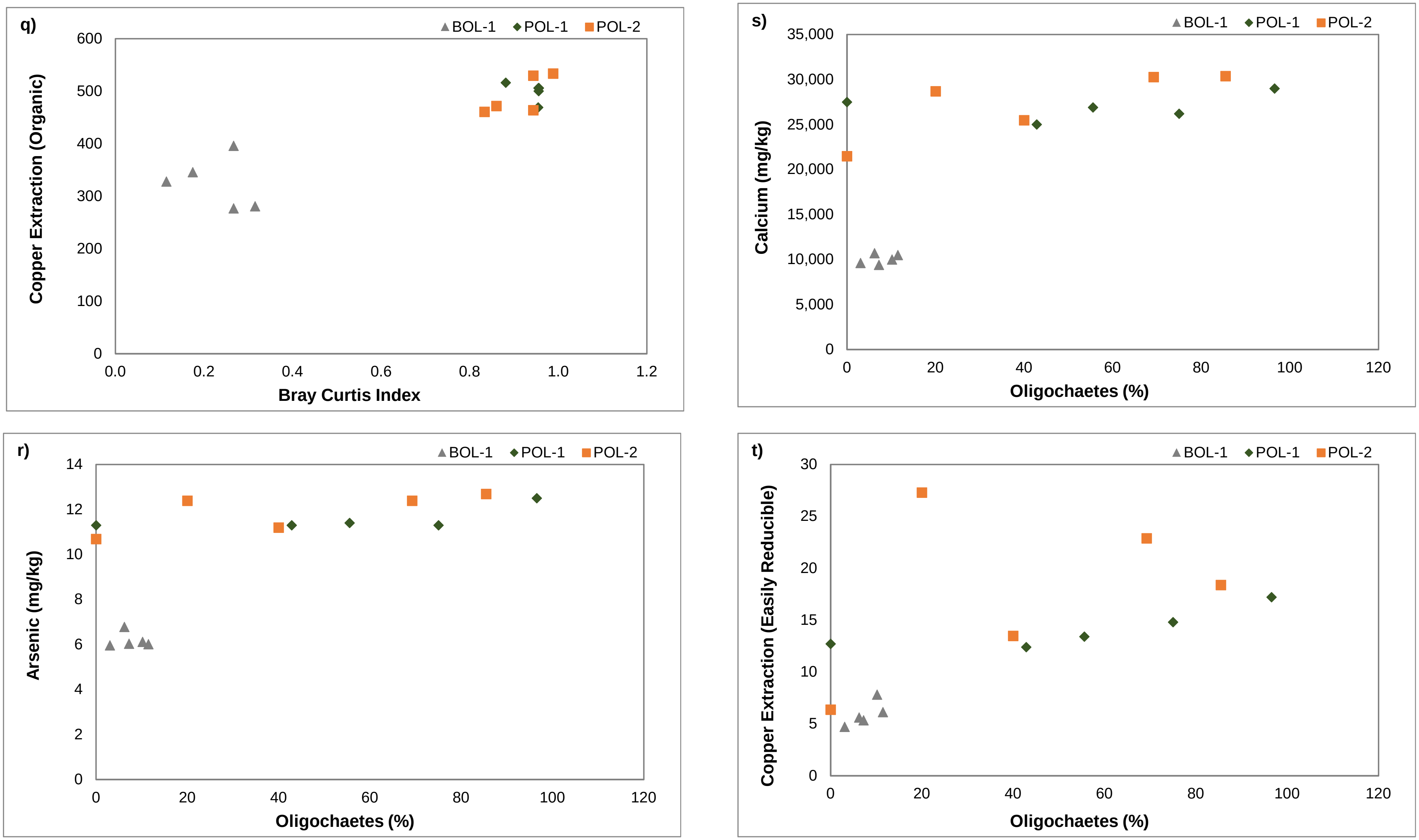

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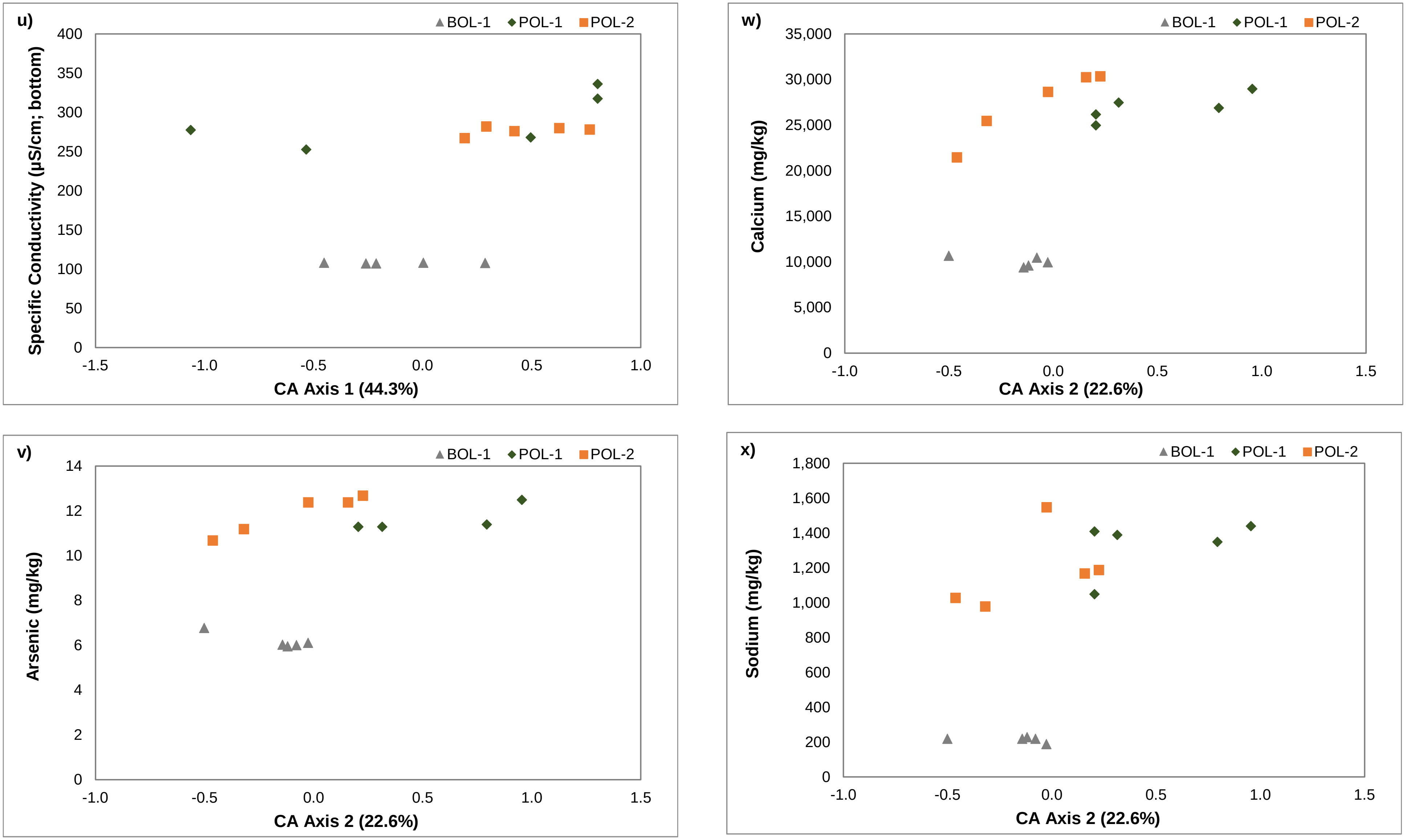

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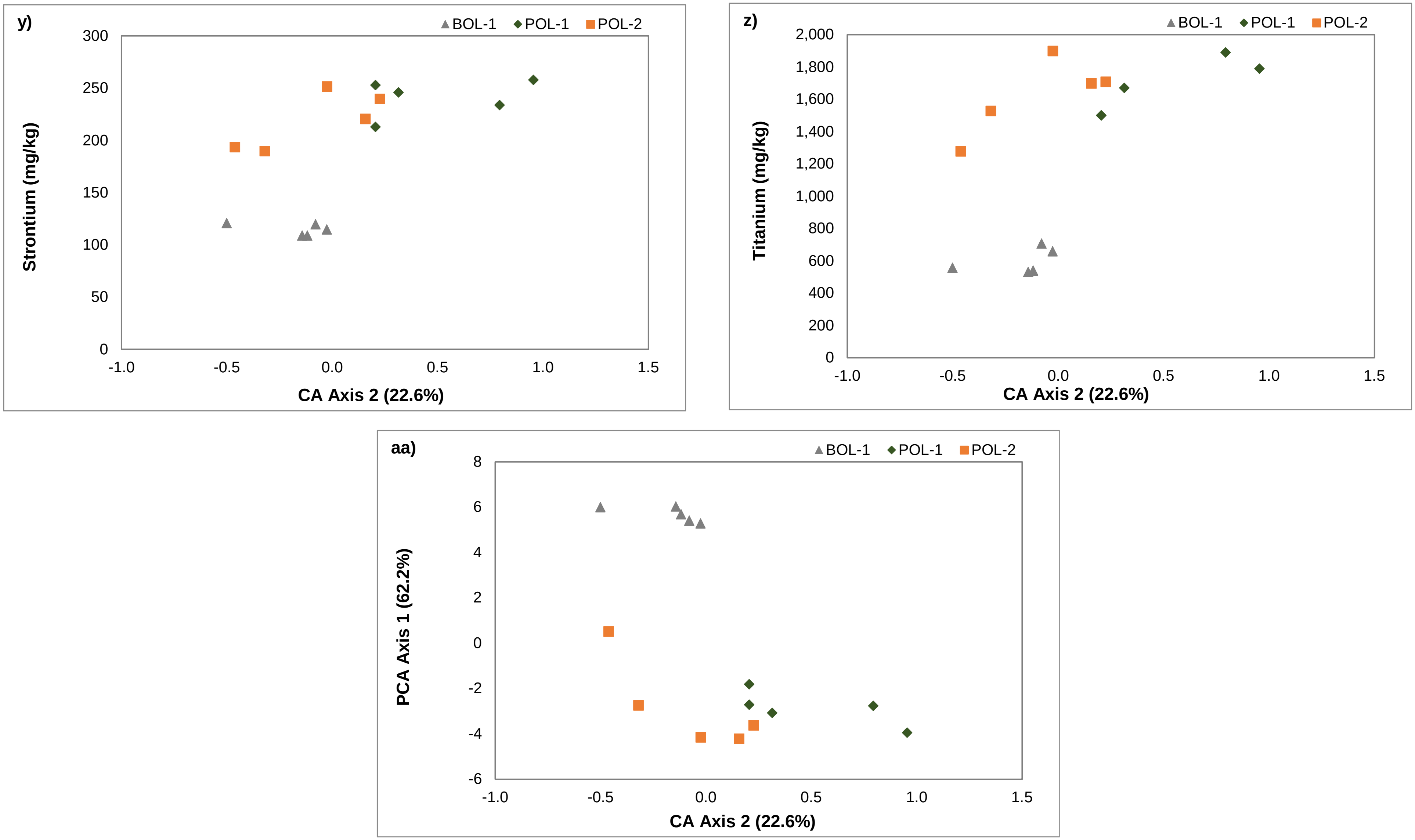

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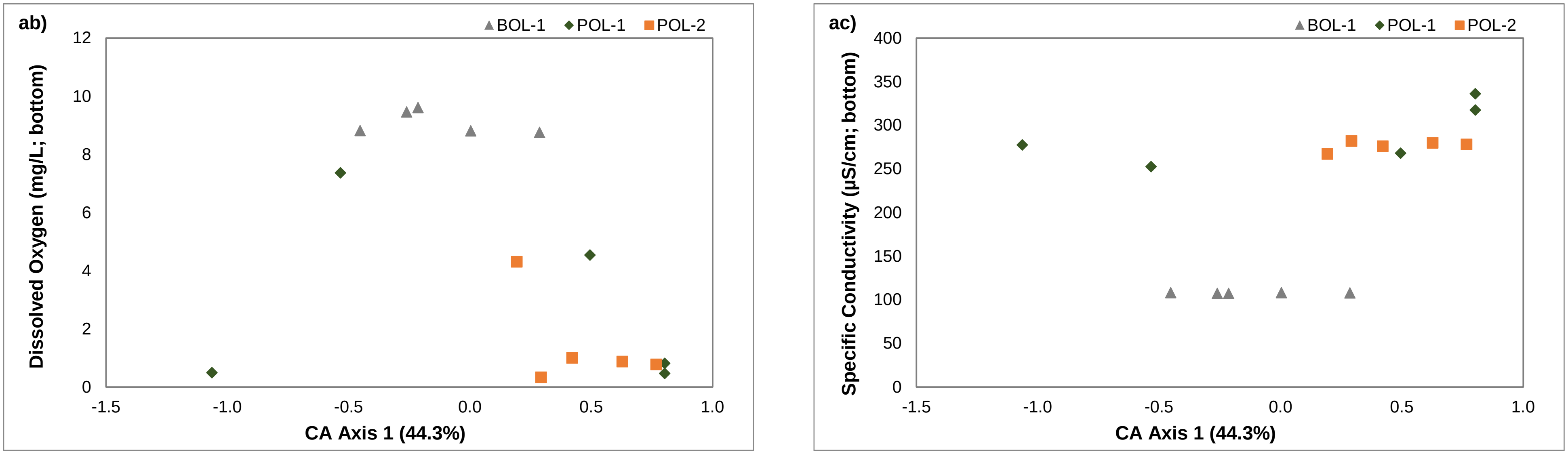

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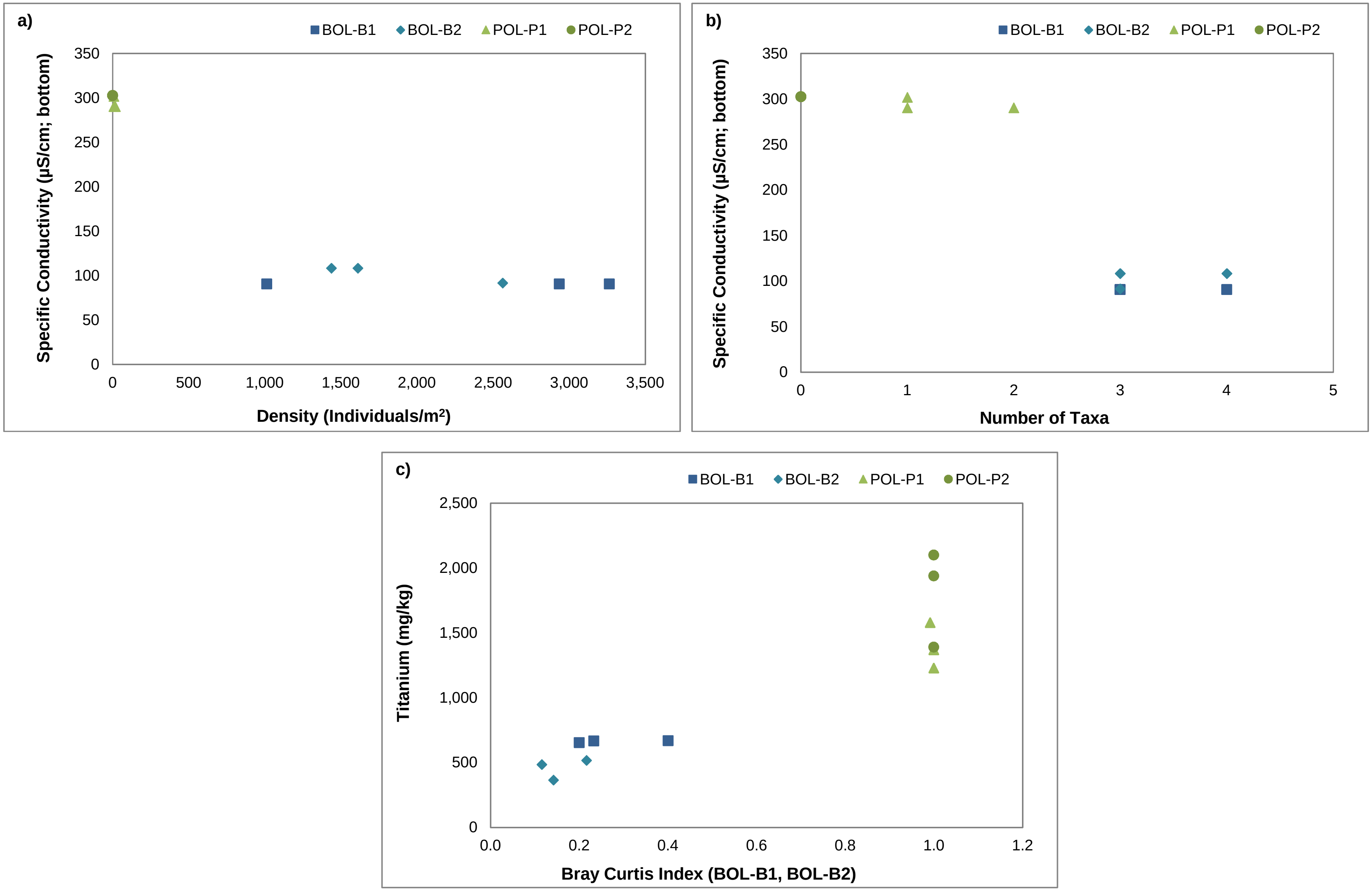
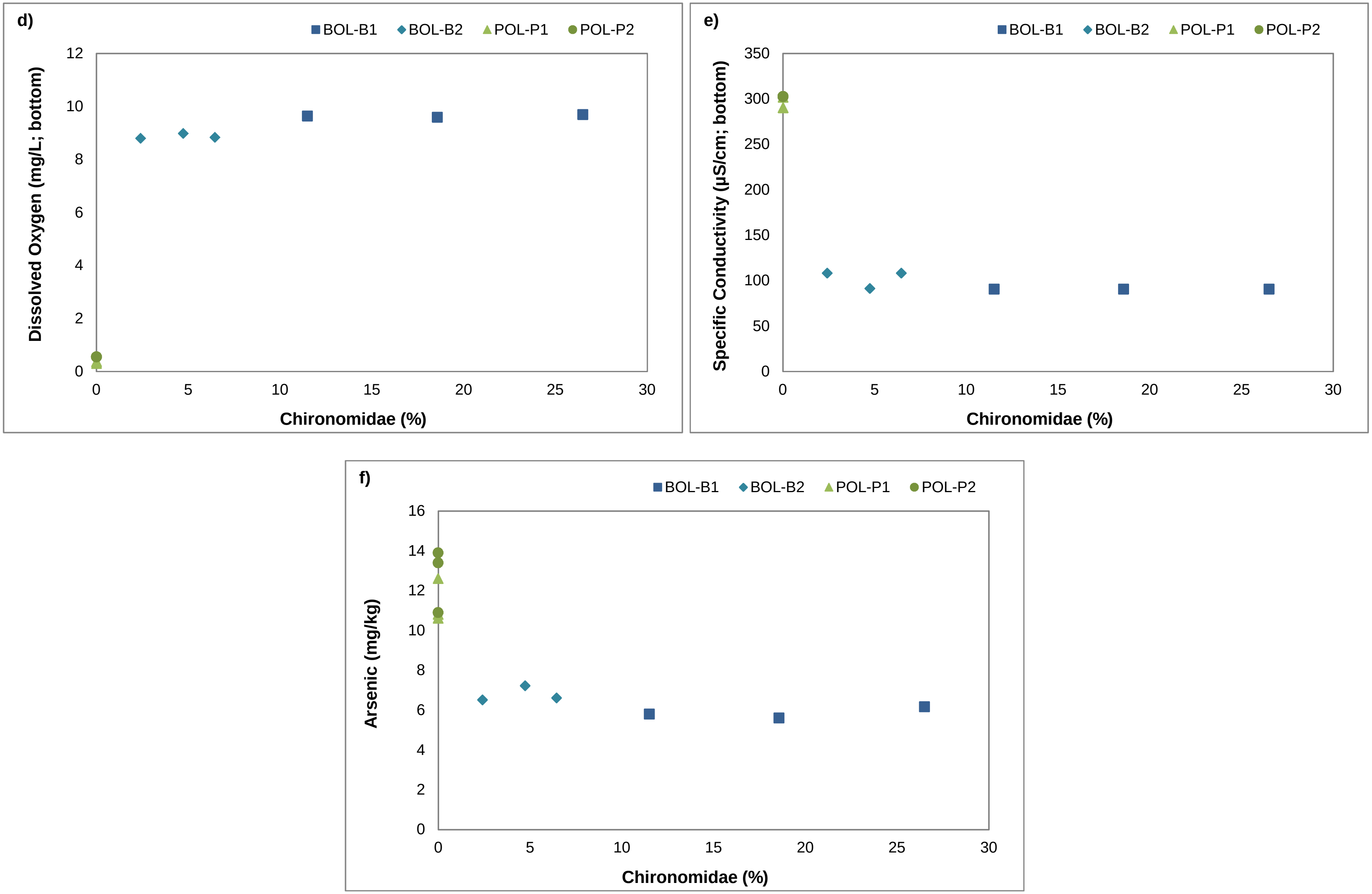


Figure I.5: Scatterplots of significant Spearman's correlation relationships ($p < 0.0001$) between toxicity endpoints, benthic invertebrate community metrics and physical endpoints, parameters of interest, indicator parameters, PCA axes and copper extracts (Tessier extraction), Mount Polley Mine, 2014. Polley and Bootjack Lake deep sampling areas.



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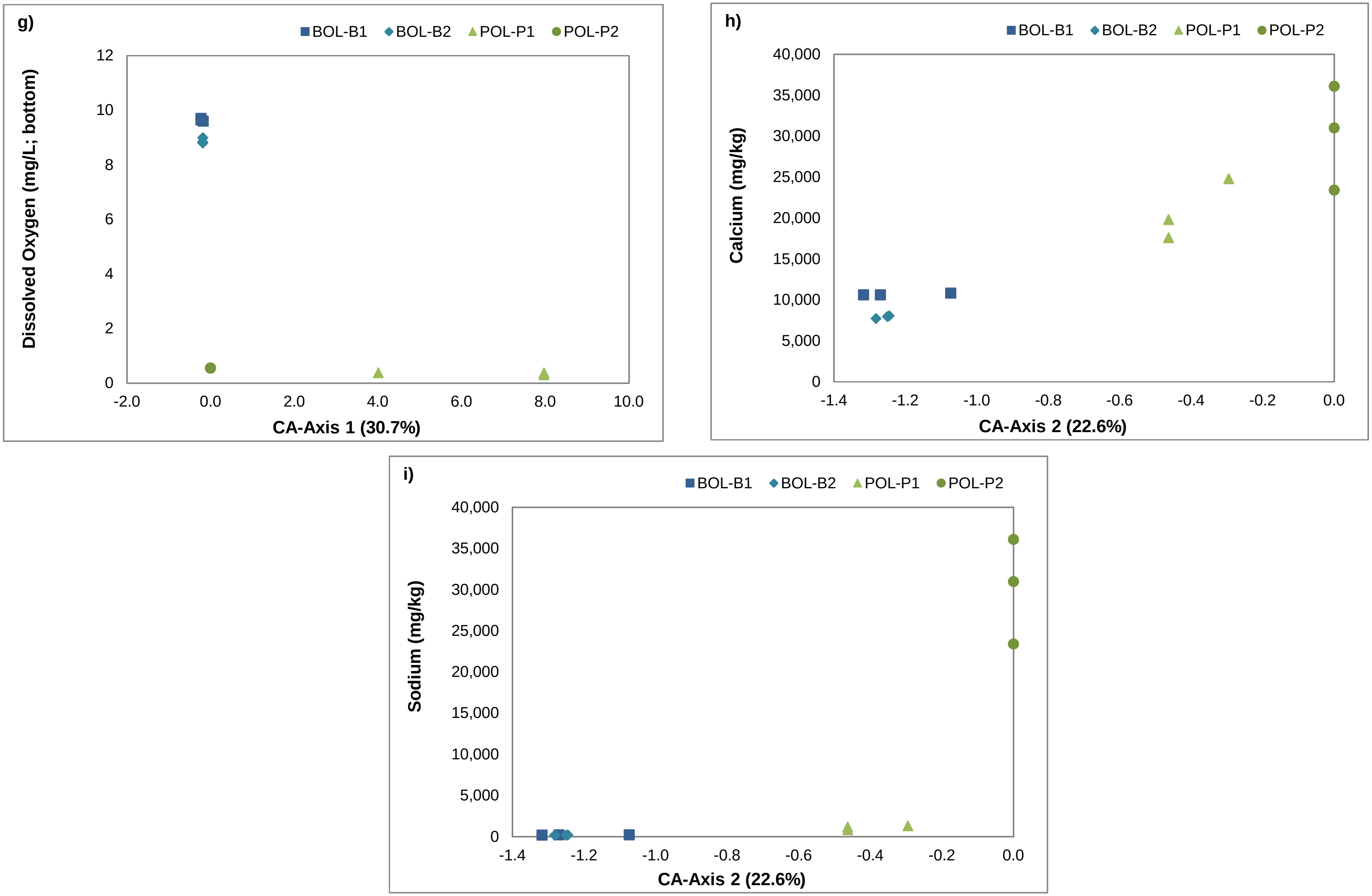

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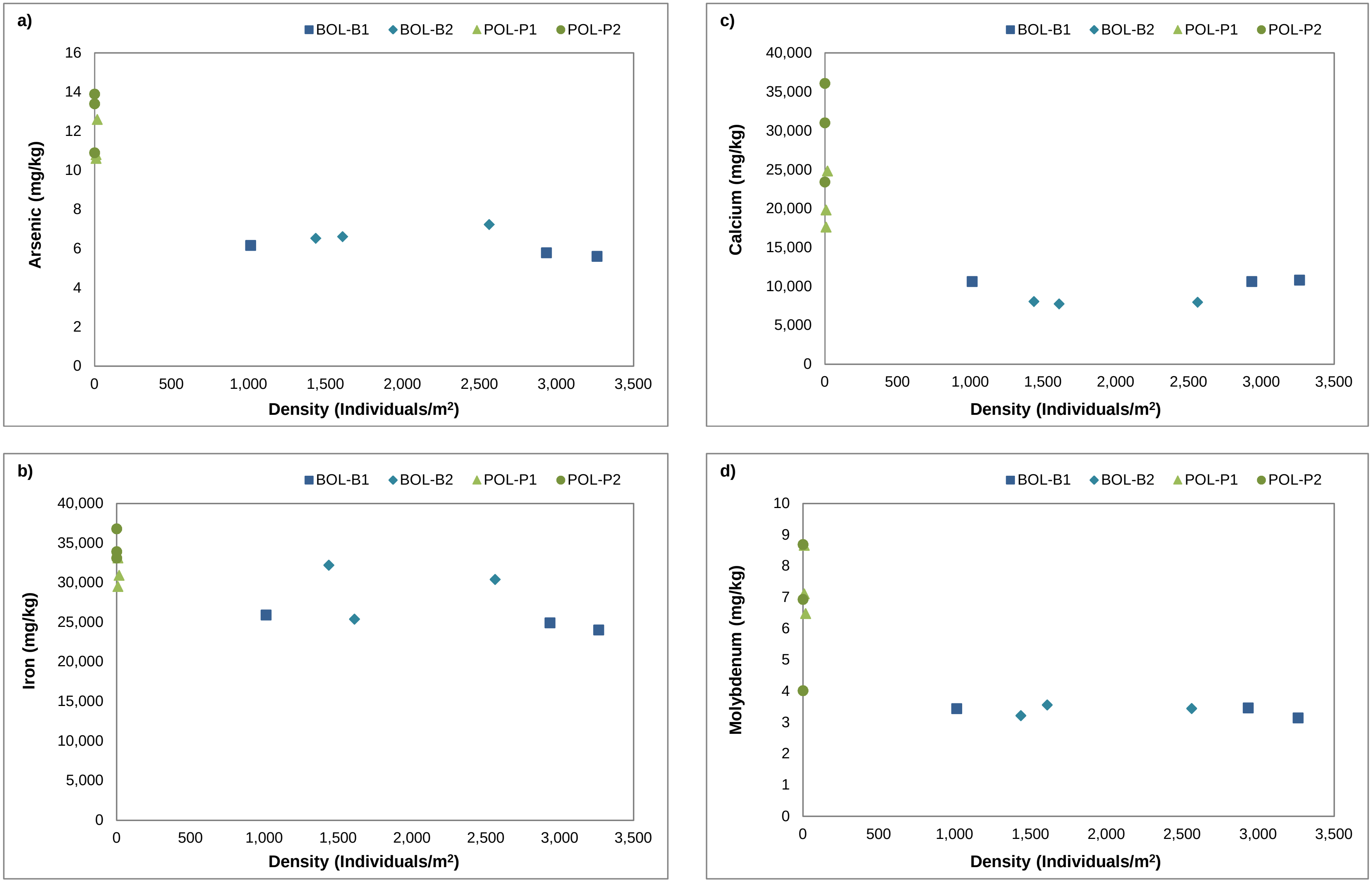
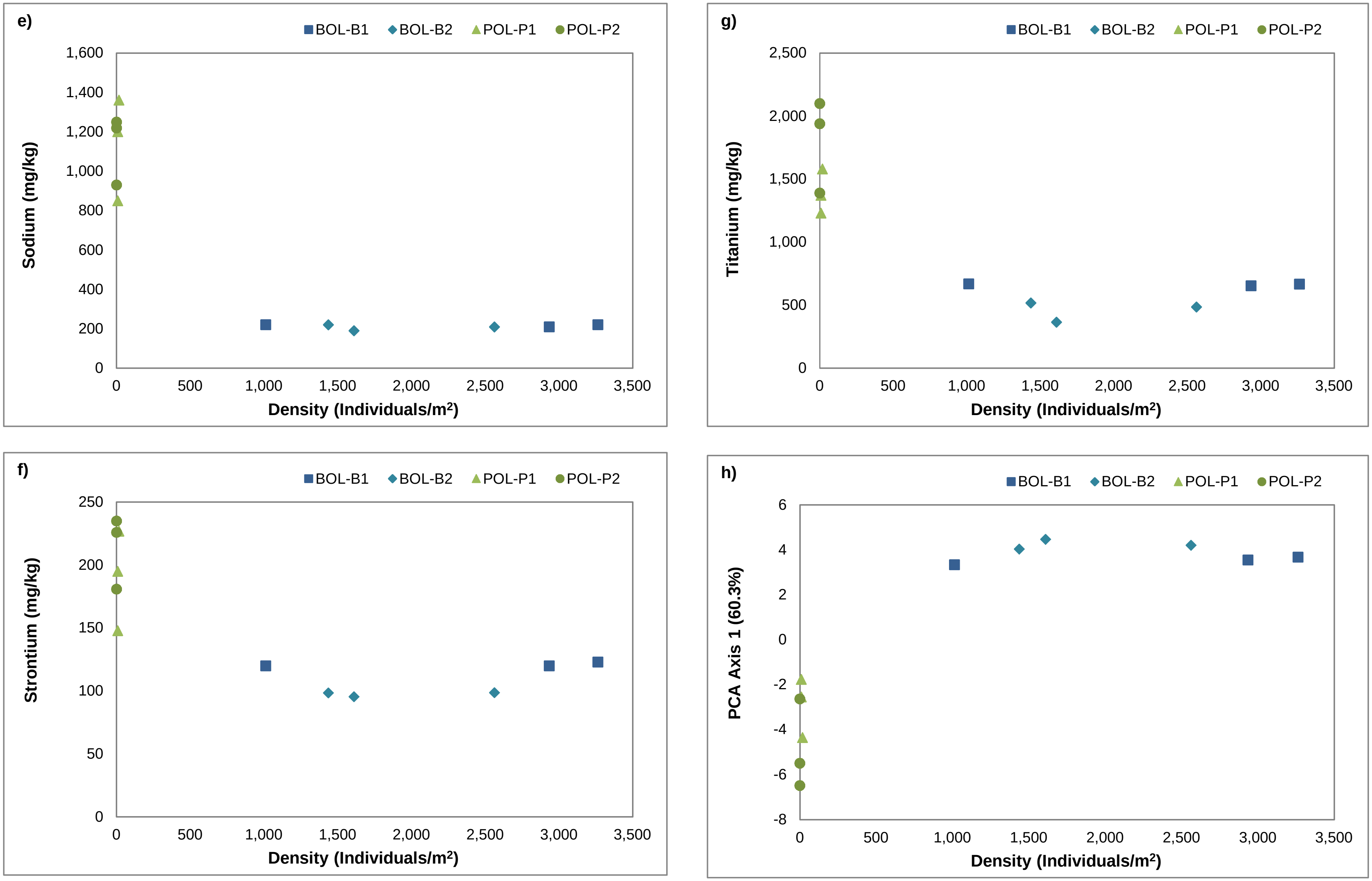


Figure I.6: Scatterplots of Spearman's correlation relationships ($p < 0.01$) between toxicity endpoints, benthic invertebrate community metrics and physical endpoints, parameters of interest, indicator parameters, PCA axes and copper extracts (Tessier extraction), Mount Polley Mine, 2014. Polley and Bootjack Lake deep sampling areas.



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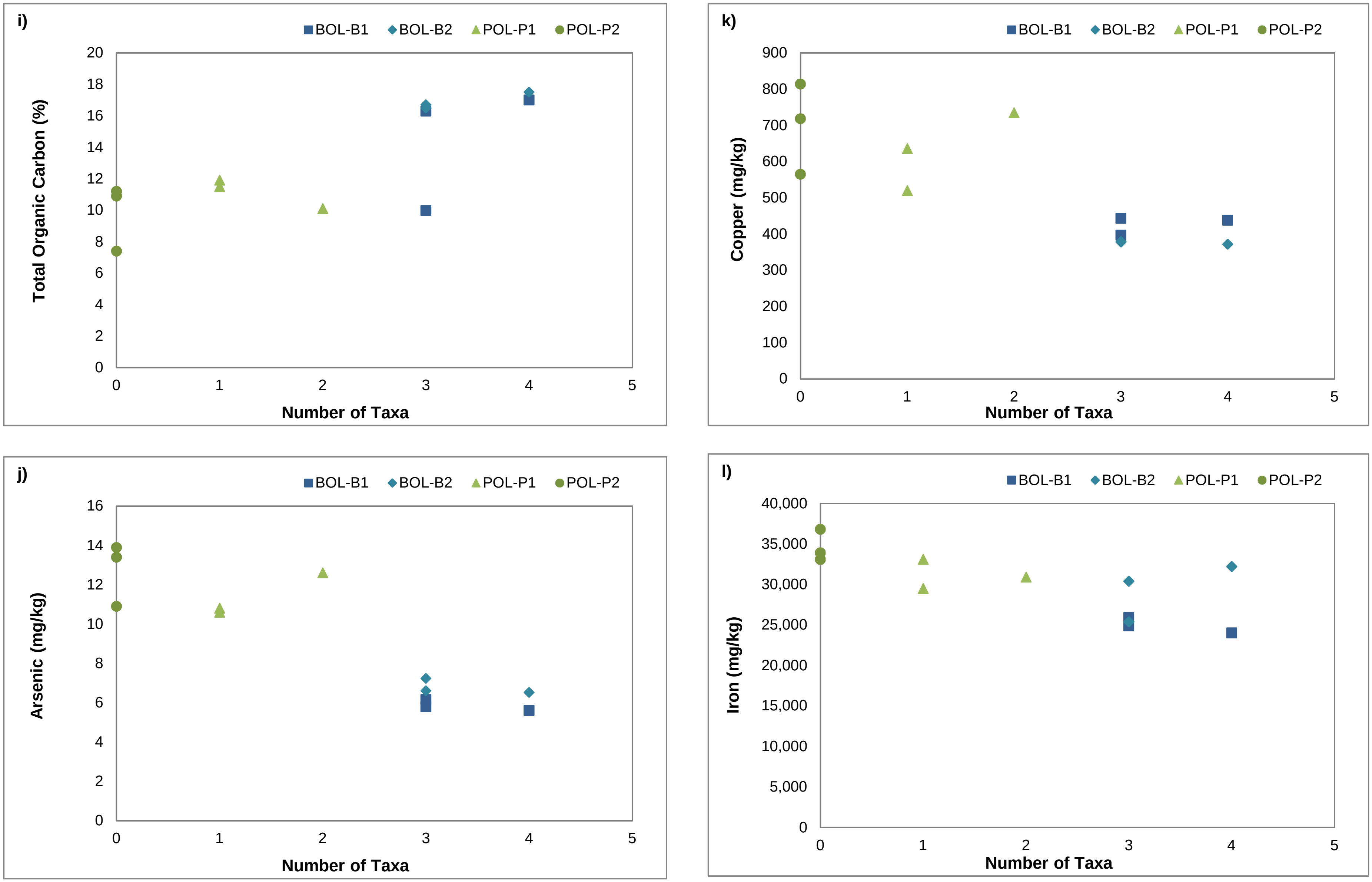

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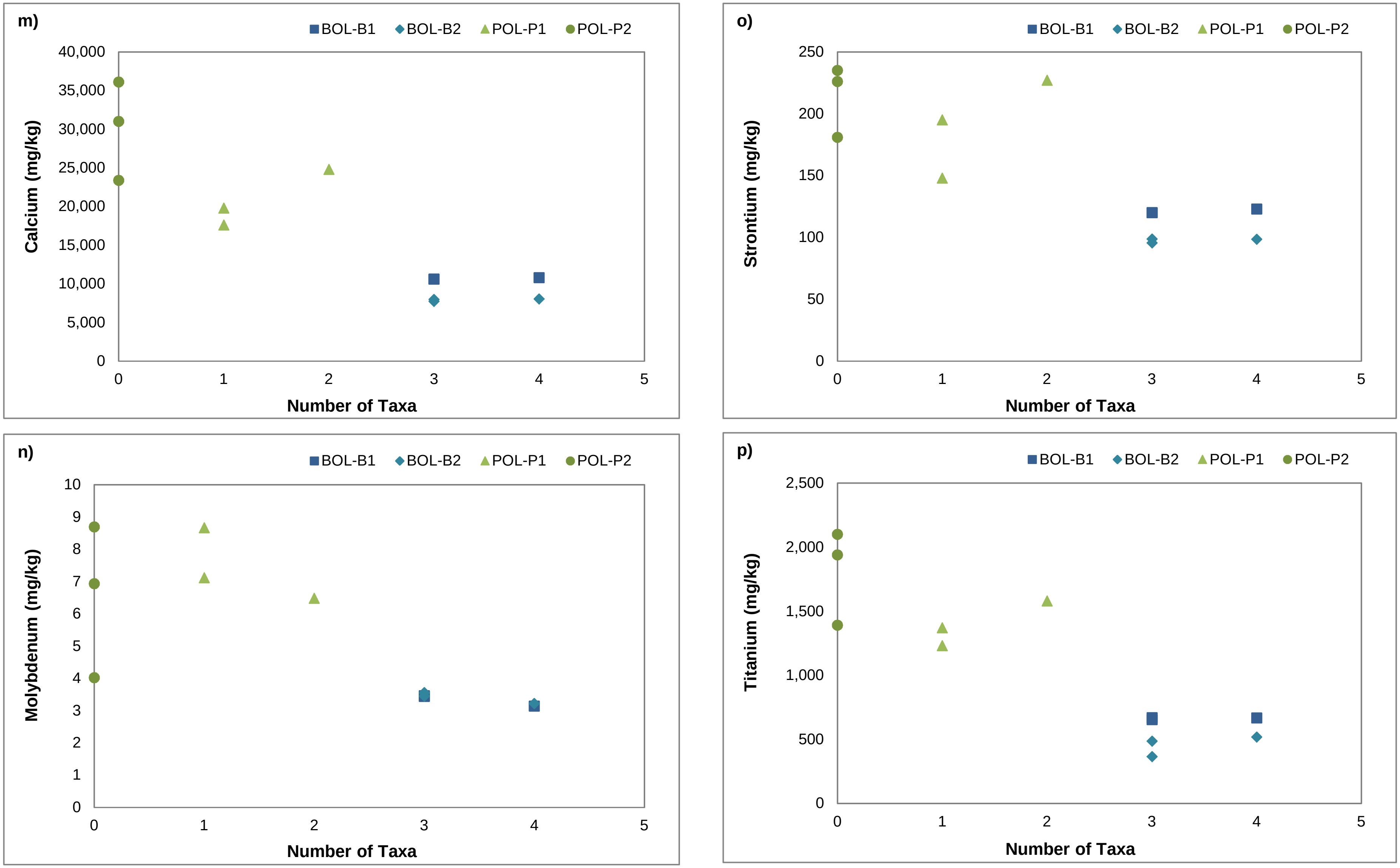

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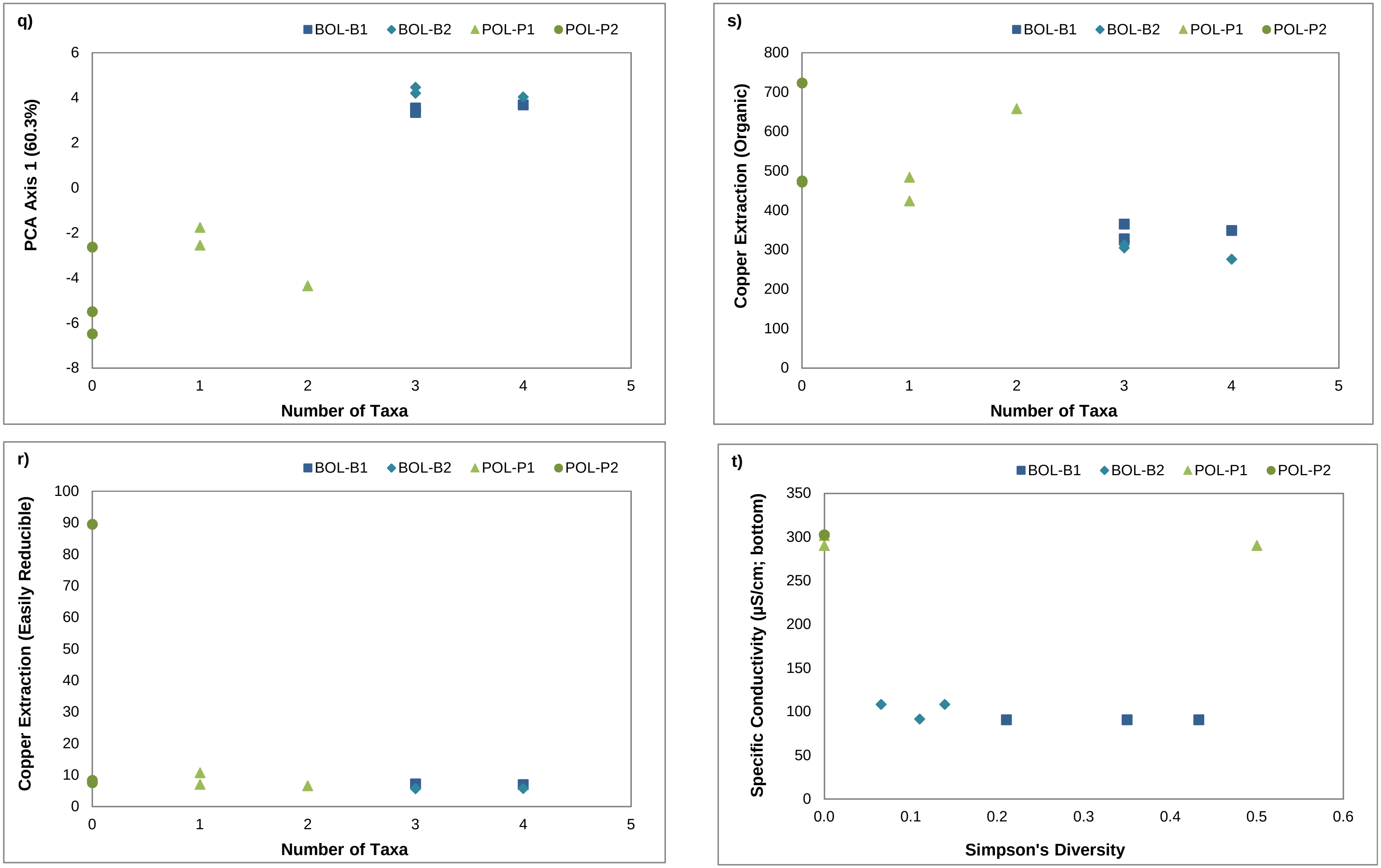

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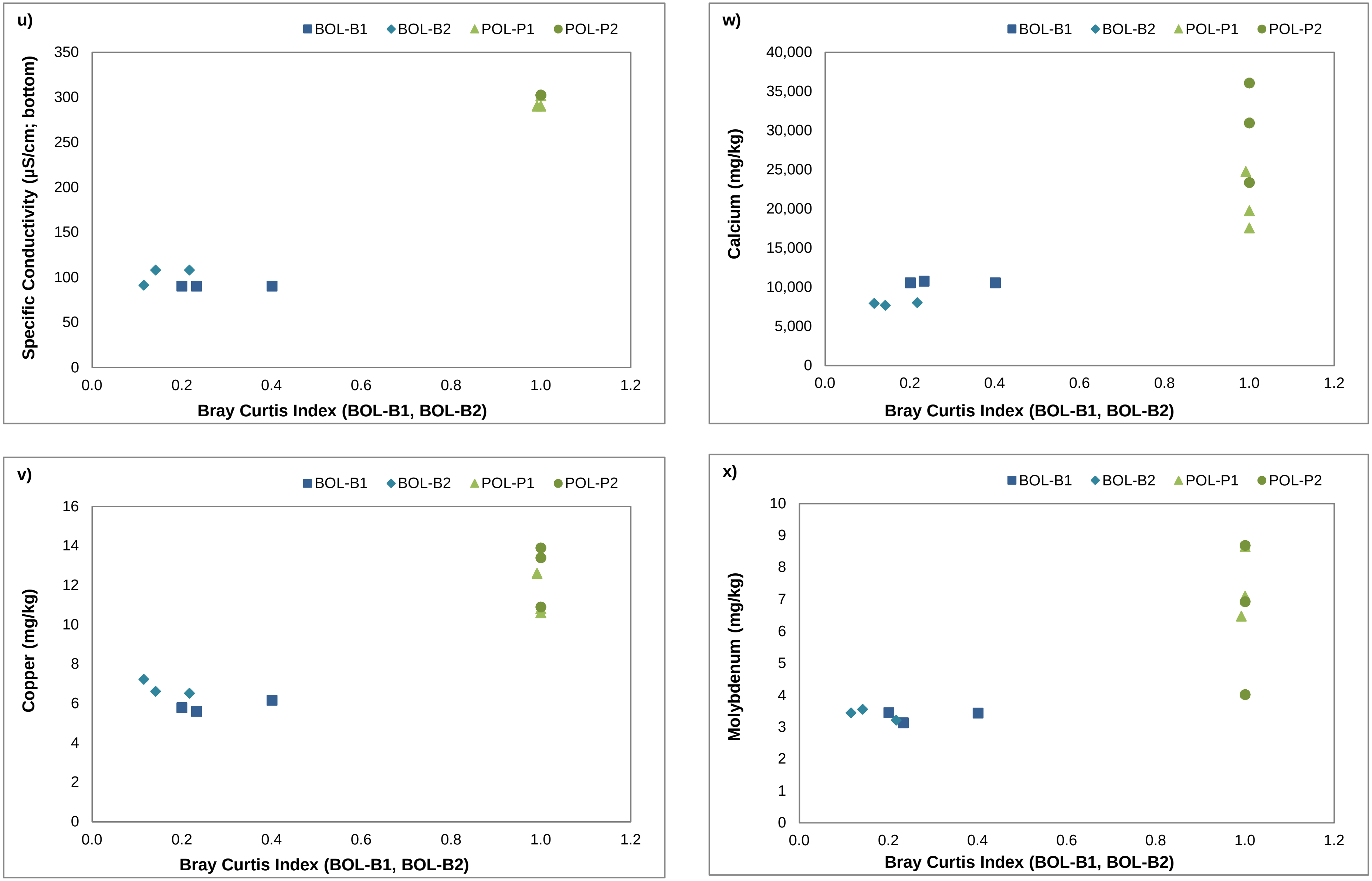

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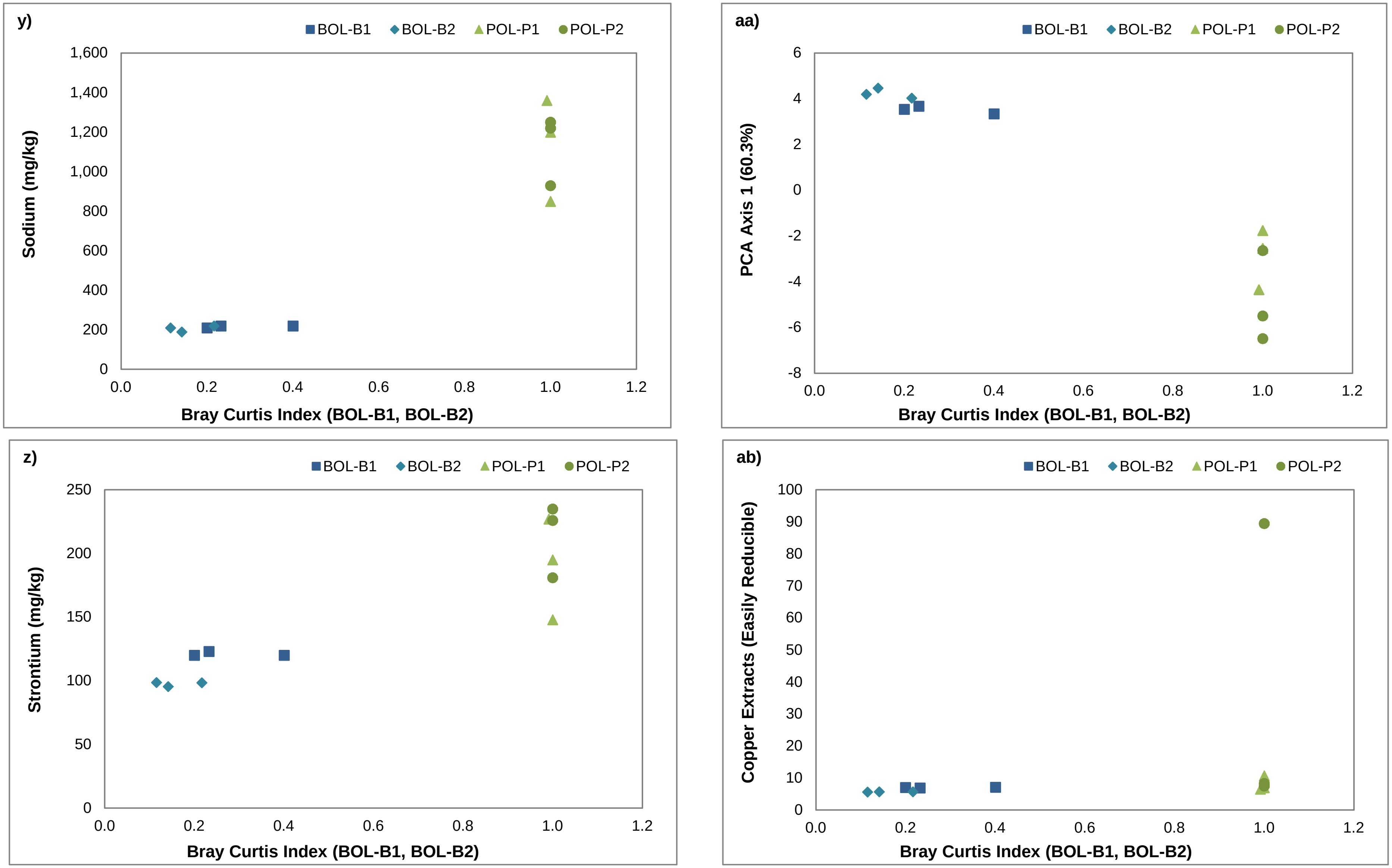

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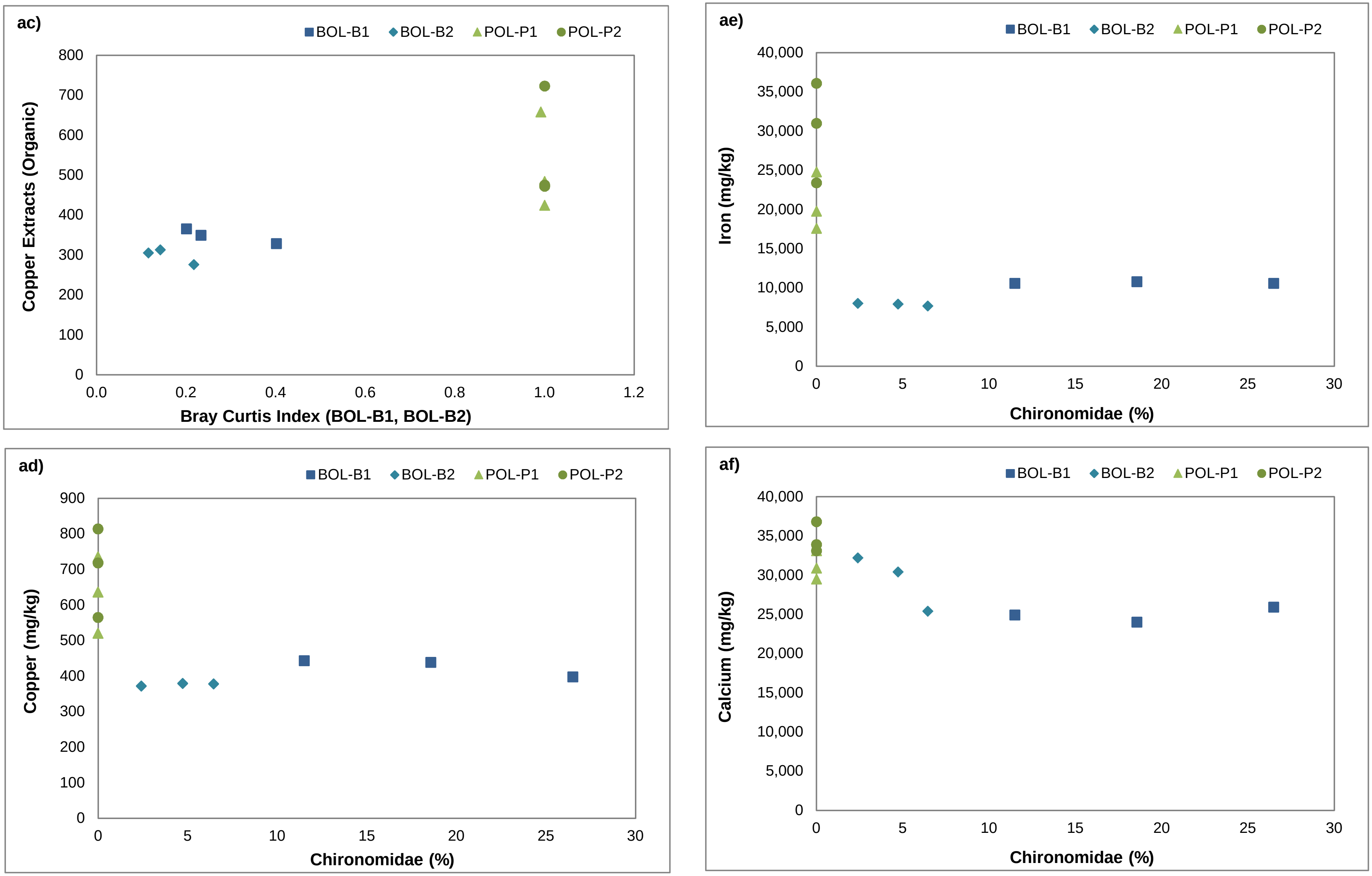

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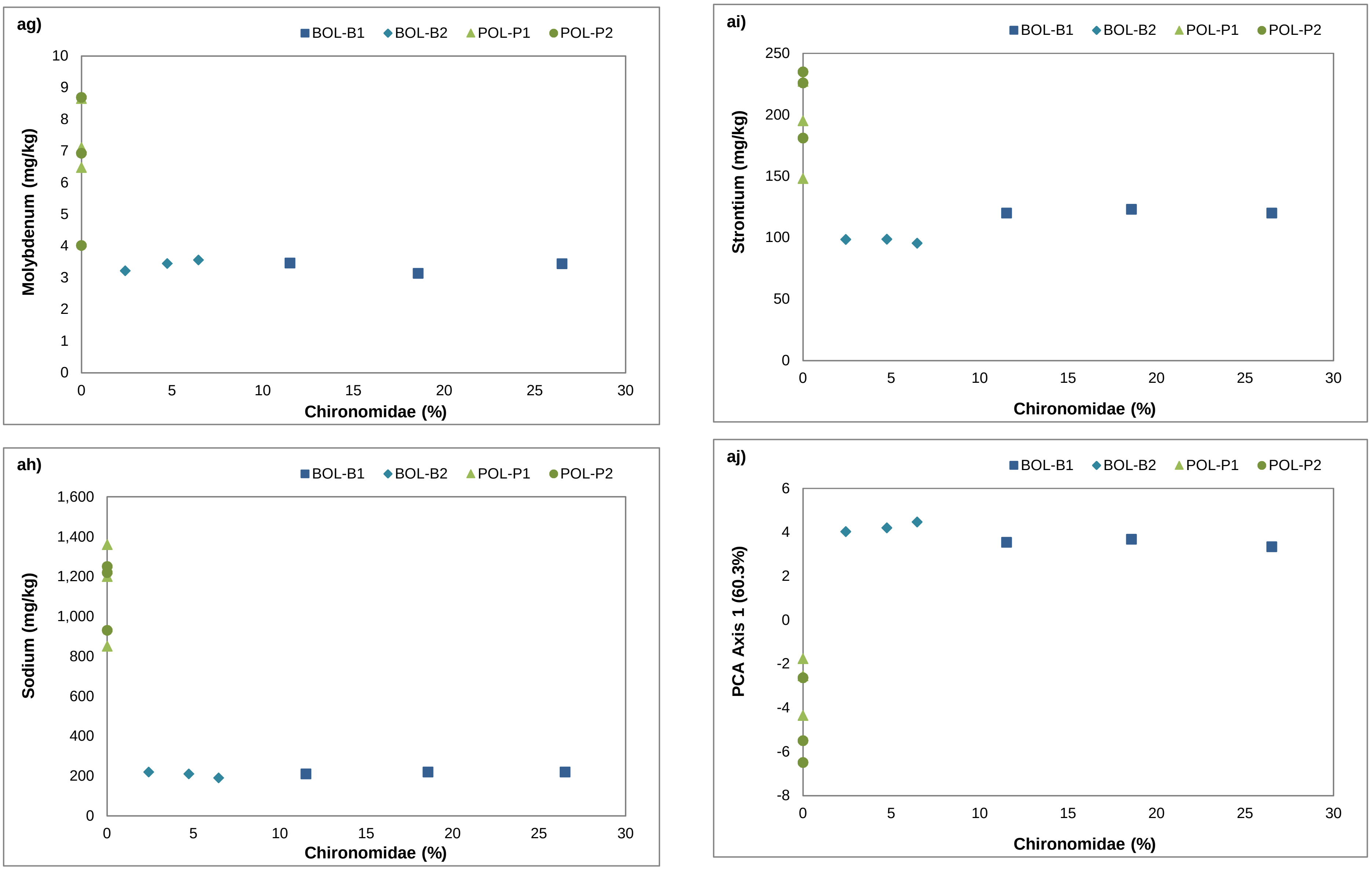

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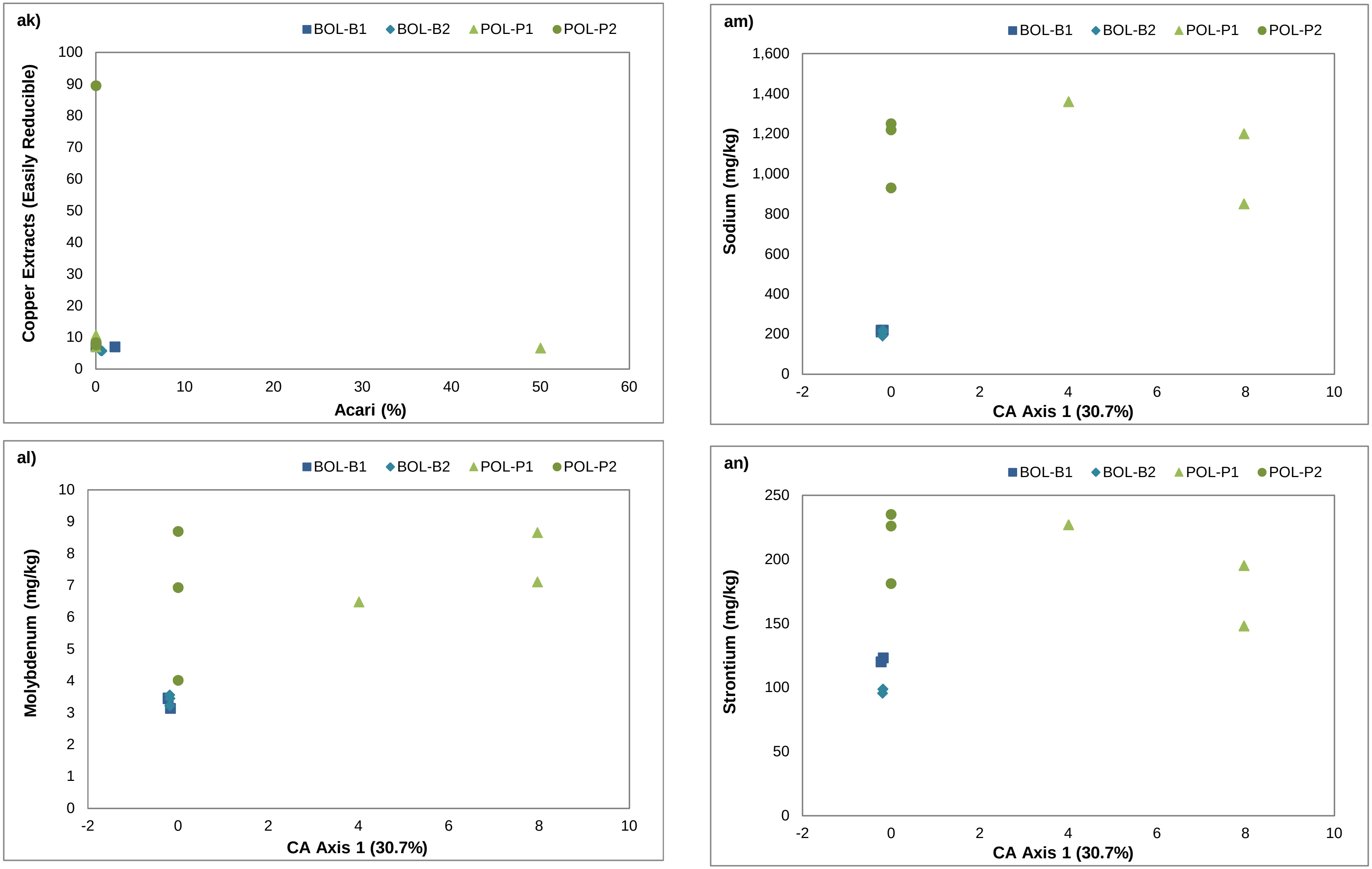

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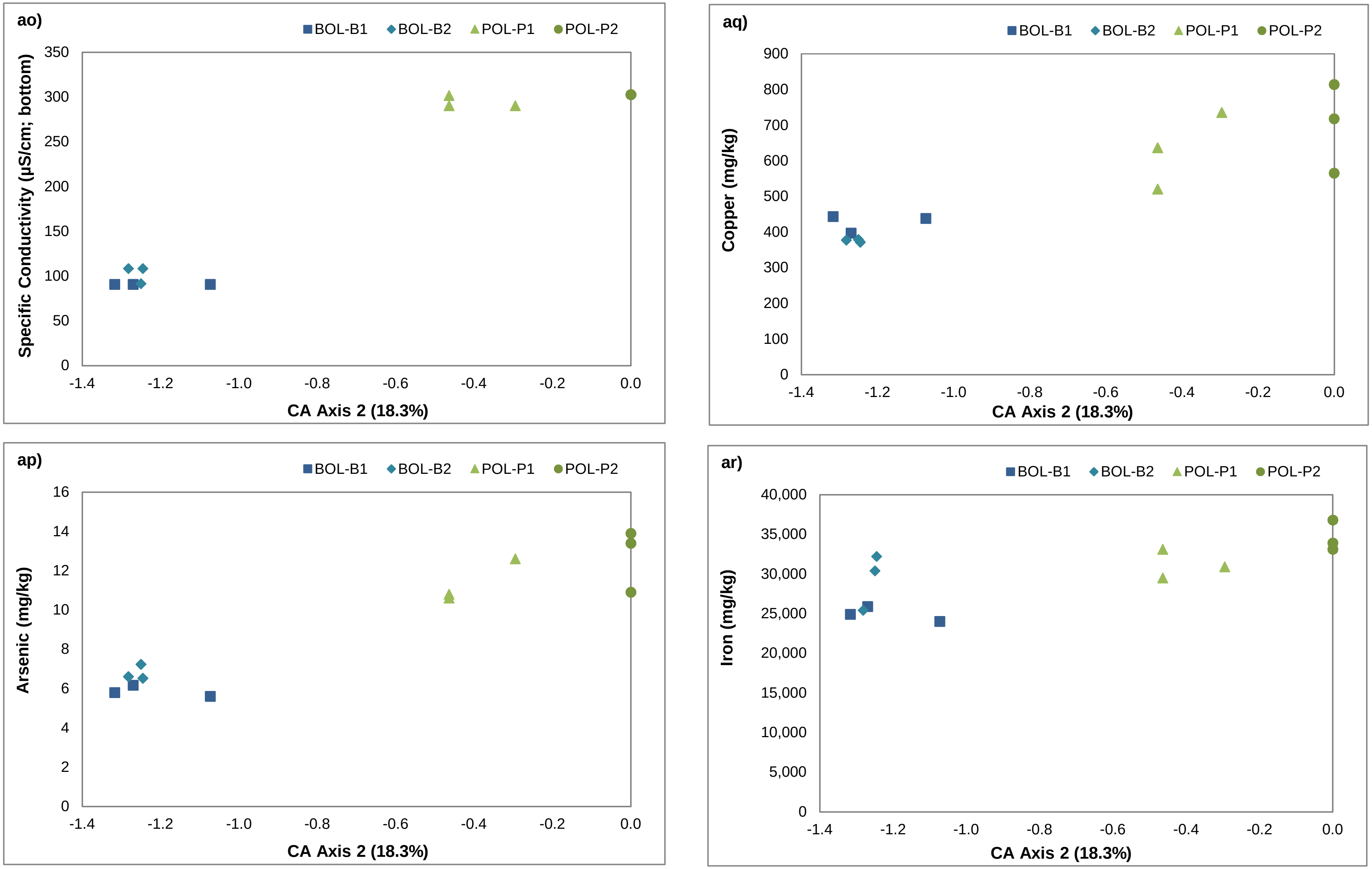

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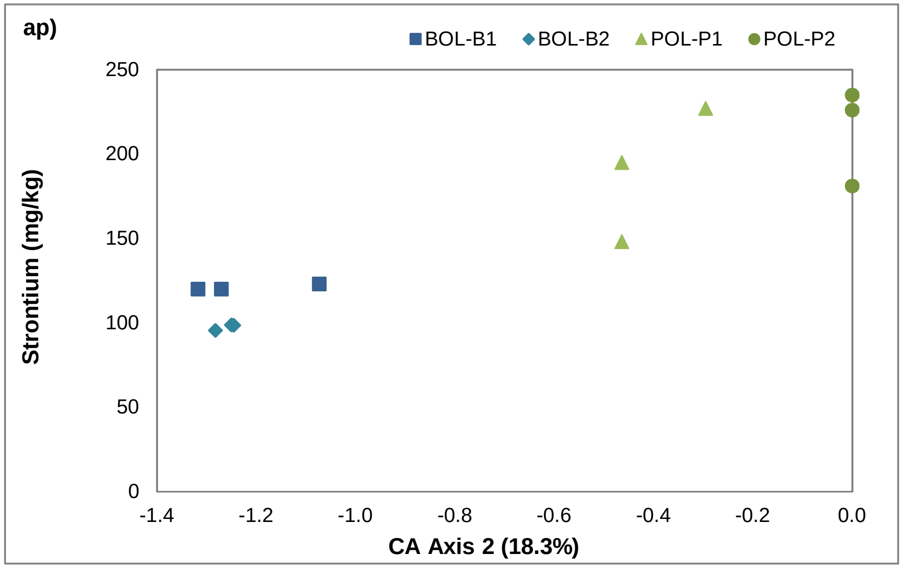

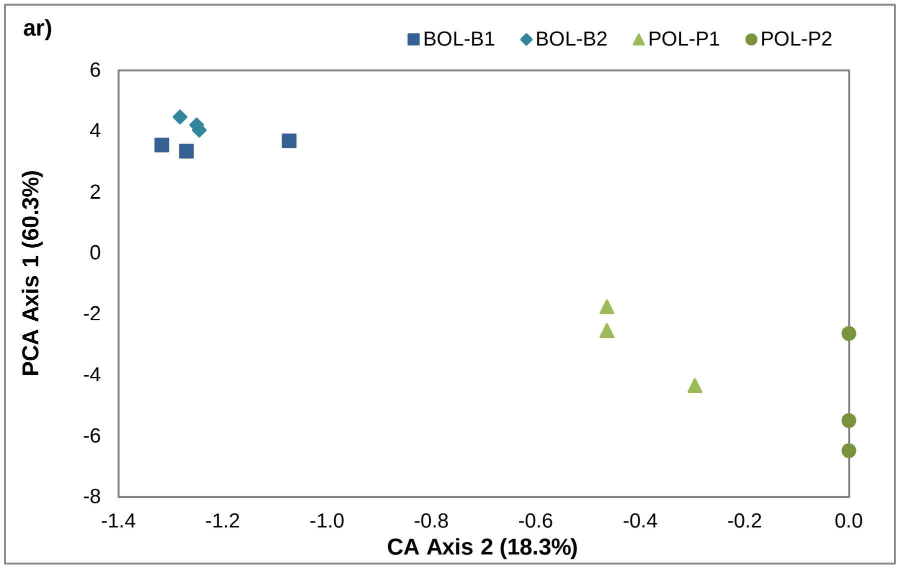

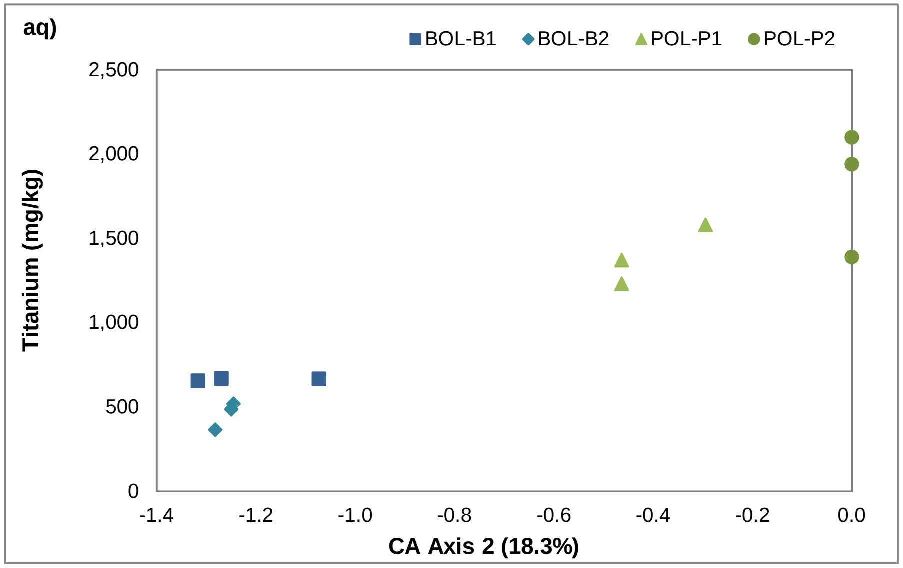

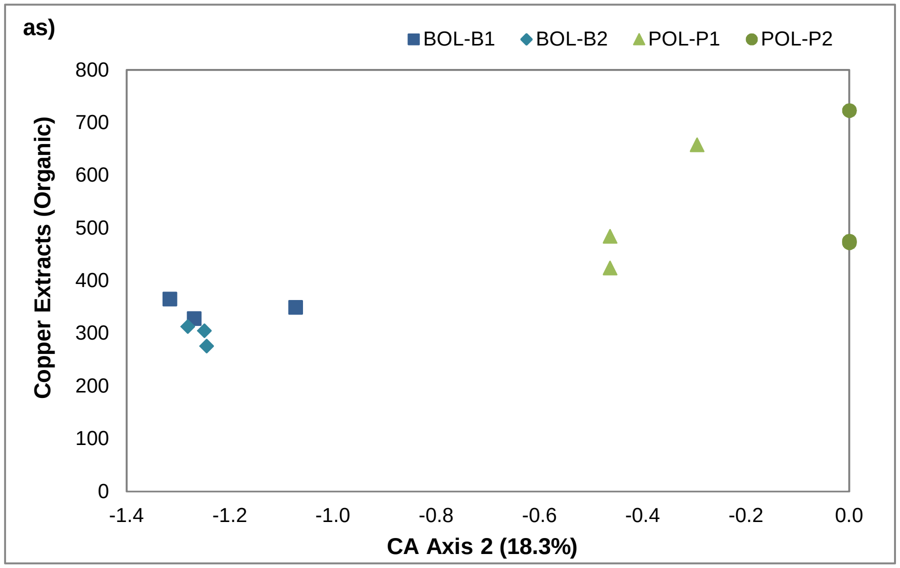

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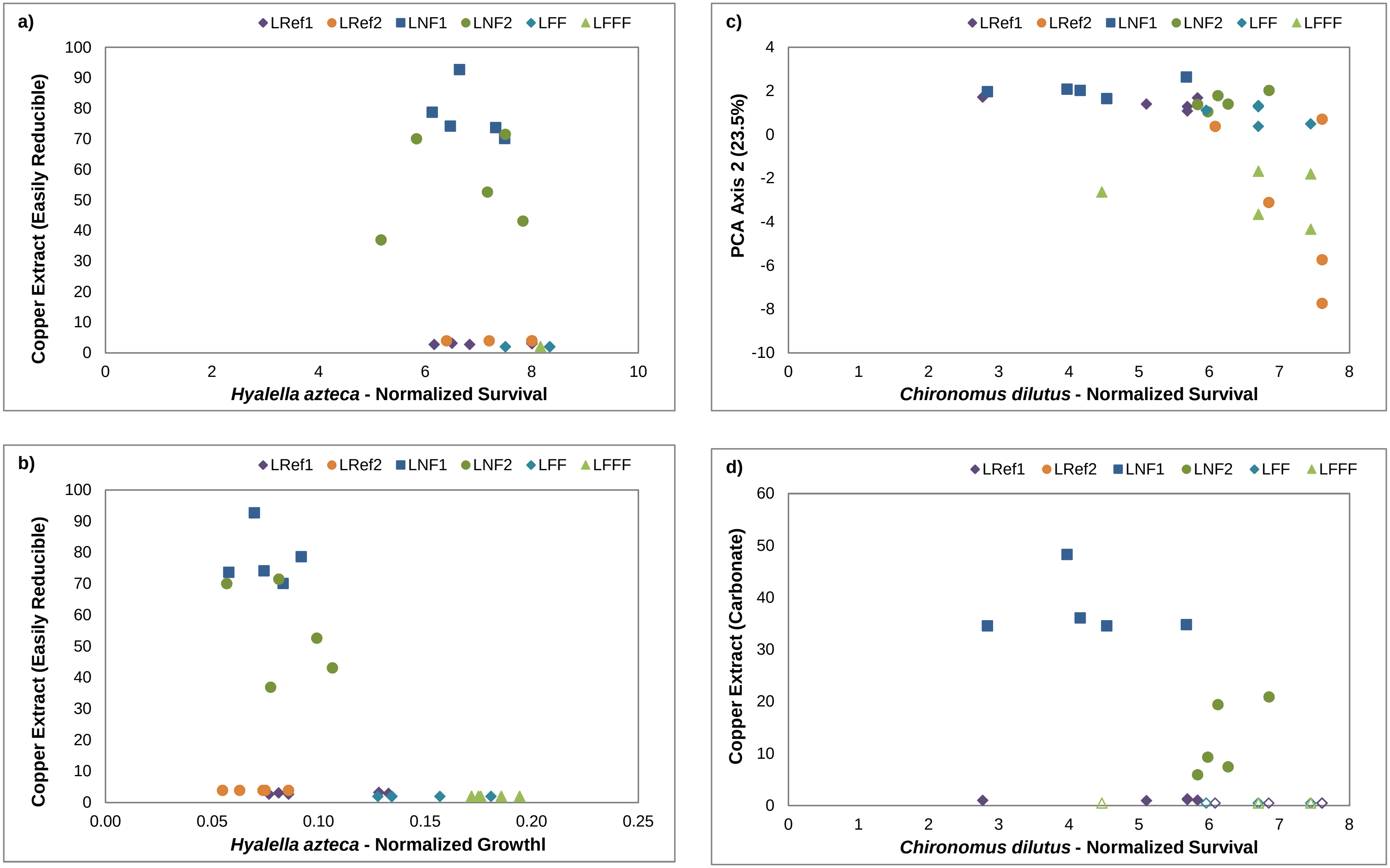
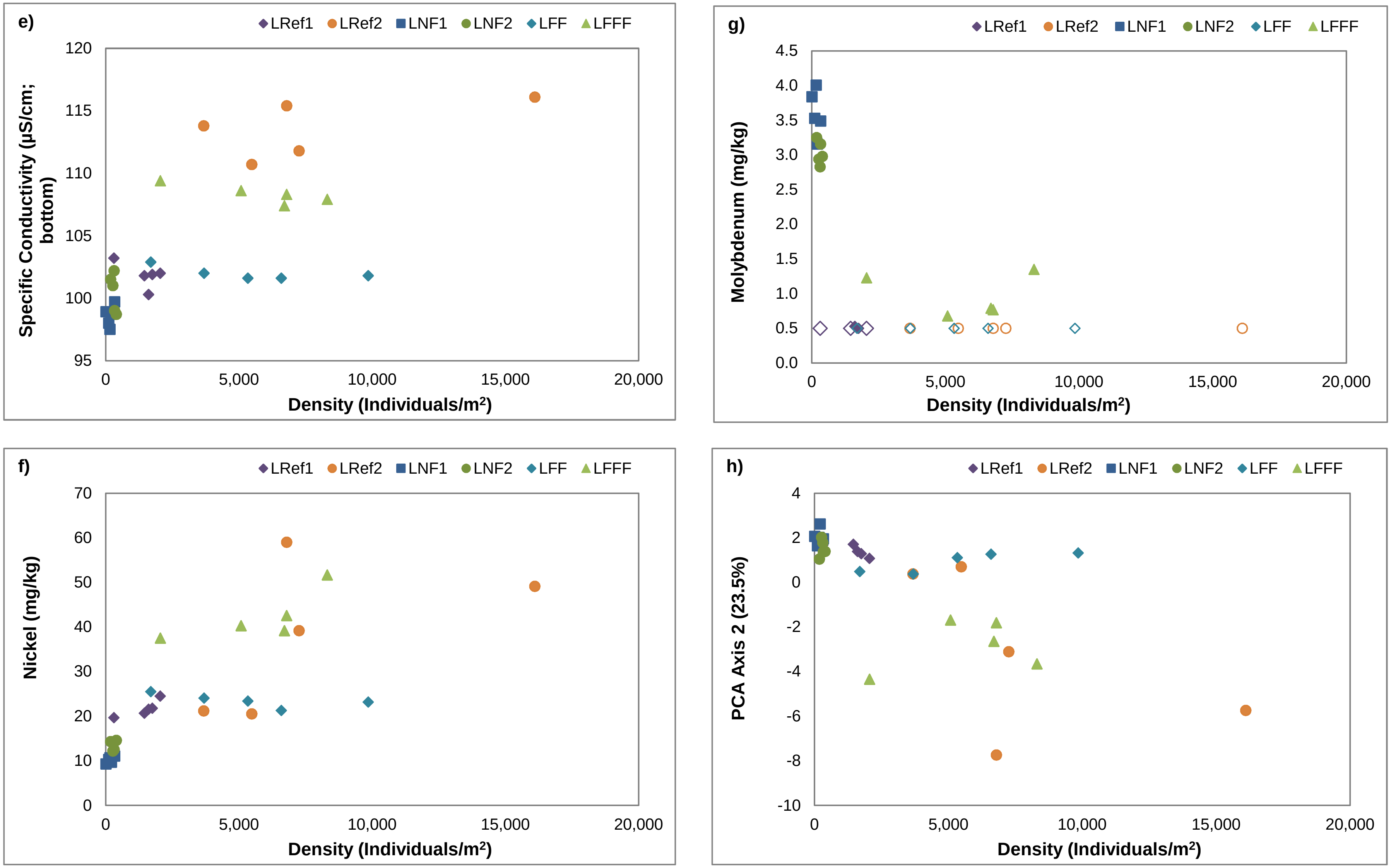


Figure I.7: Scatterplots of significant Spearman's correlation relationships ($p < 0.00009$) between toxicity endpoints, benthic invertebrate community metrics, sediment physical endpoints, parameters of interest, indicator parameters, PCA axes and copper extracts (Tessier extraction), Mount Polley Mine, 2014. Quesnel Lake littoral sampling areas. Hollow symbols indicate values < MDL.



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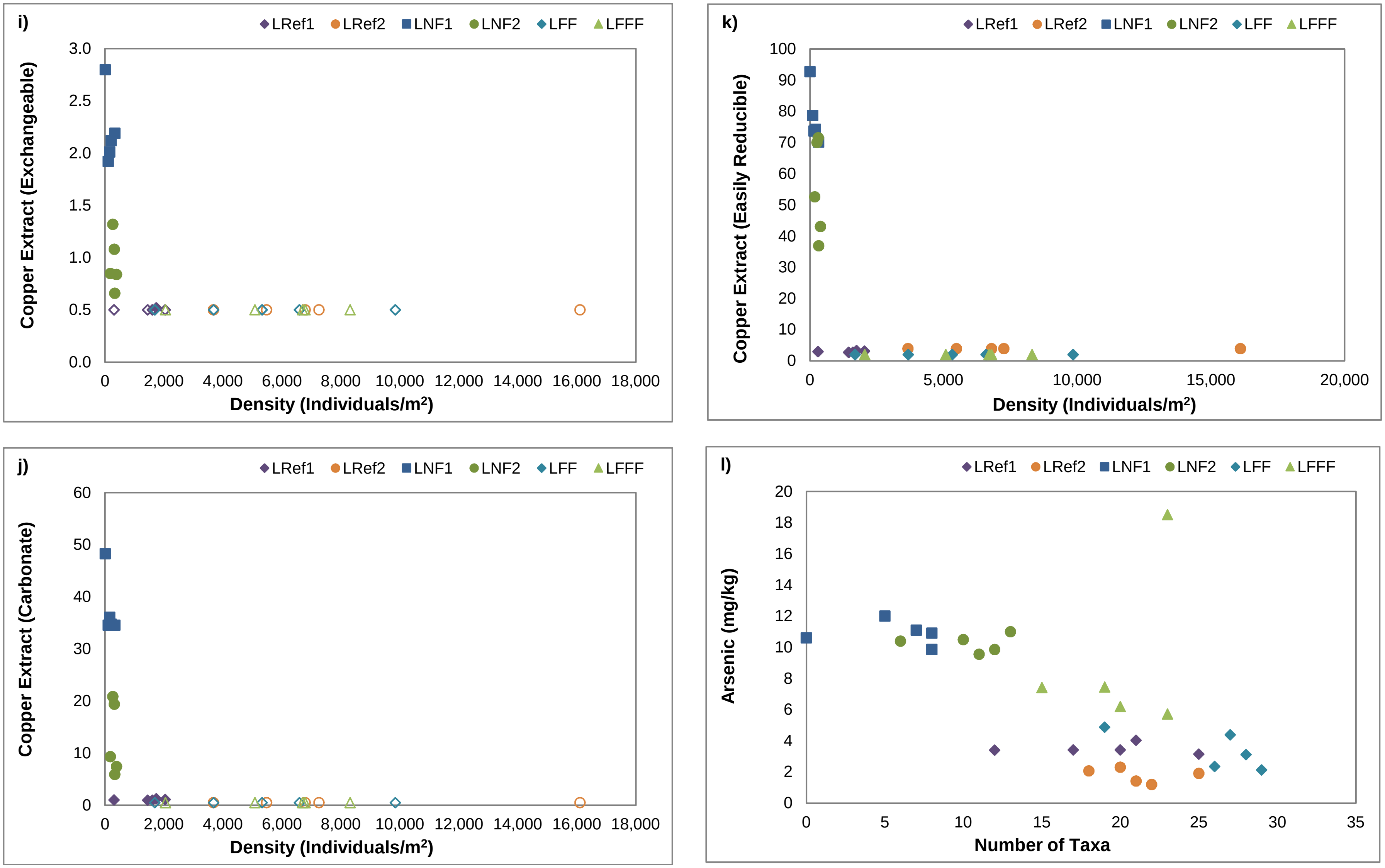

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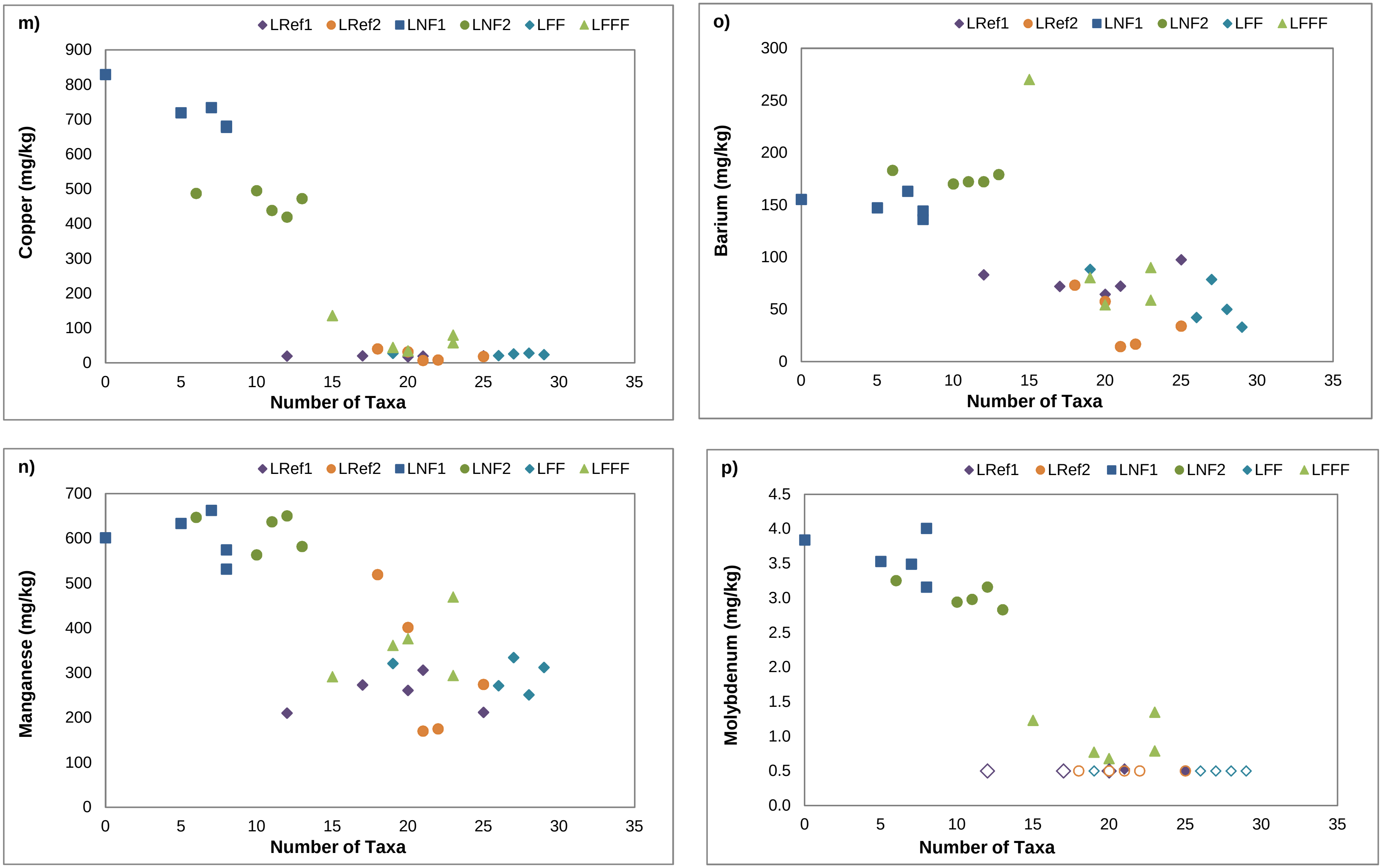

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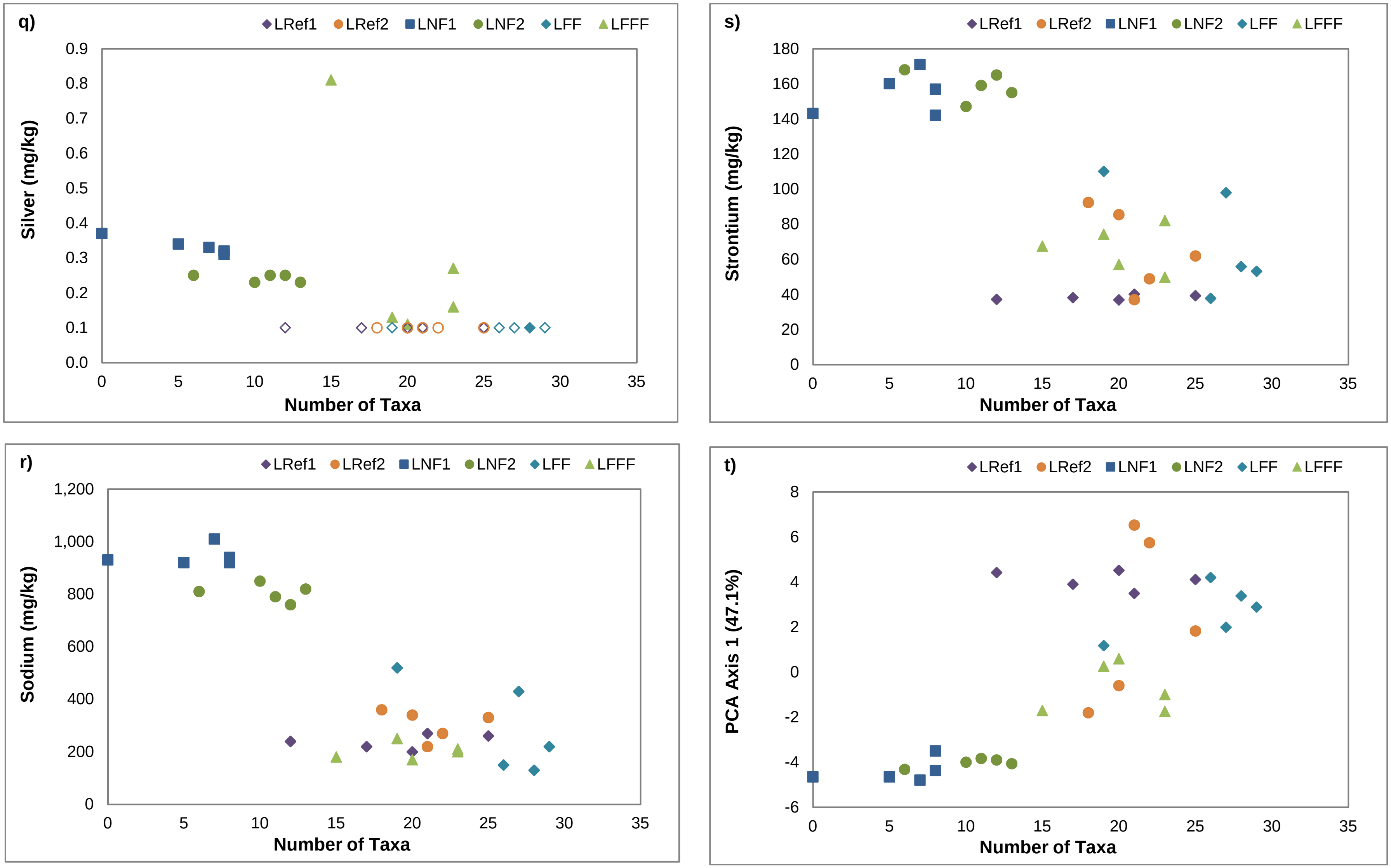

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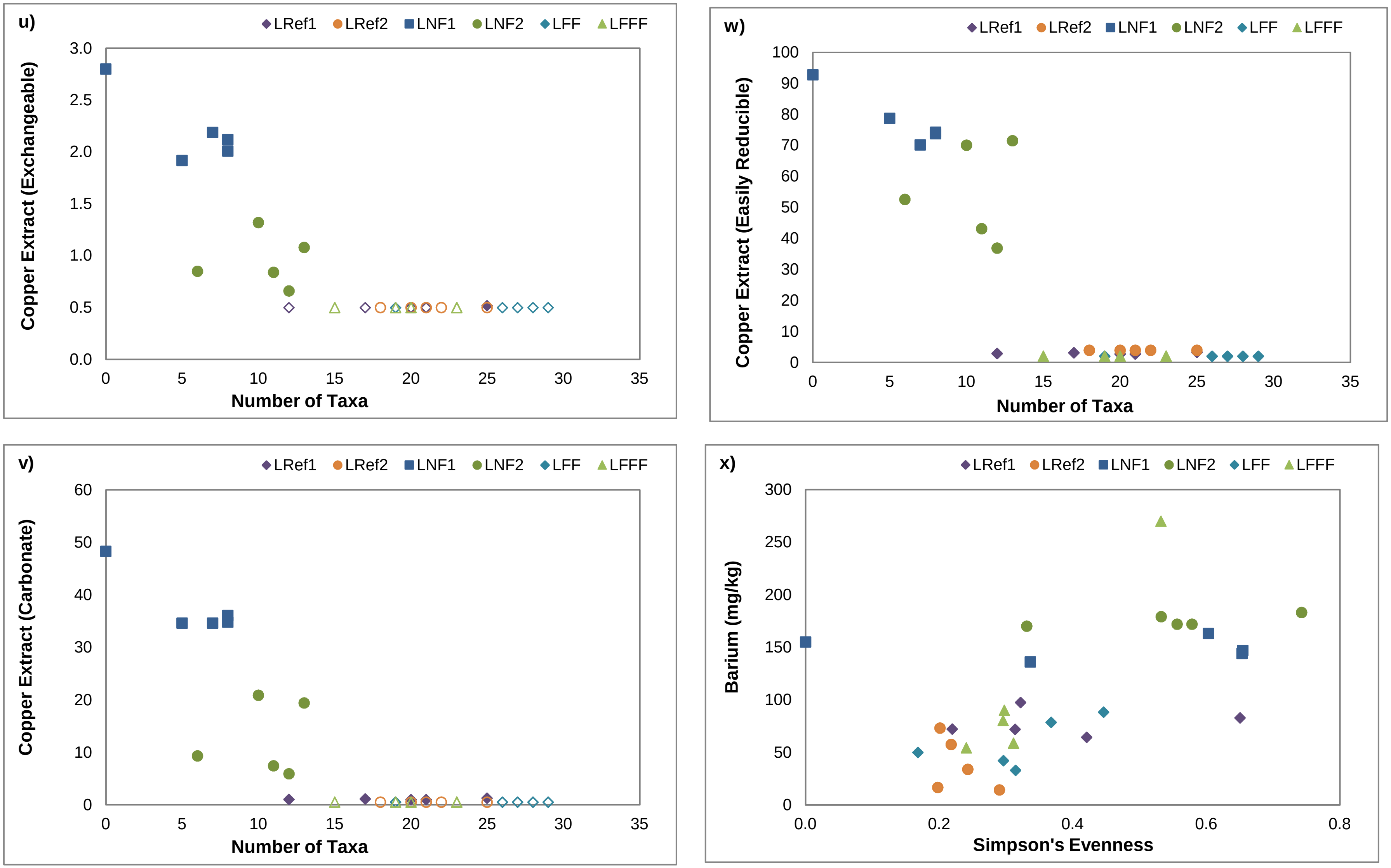

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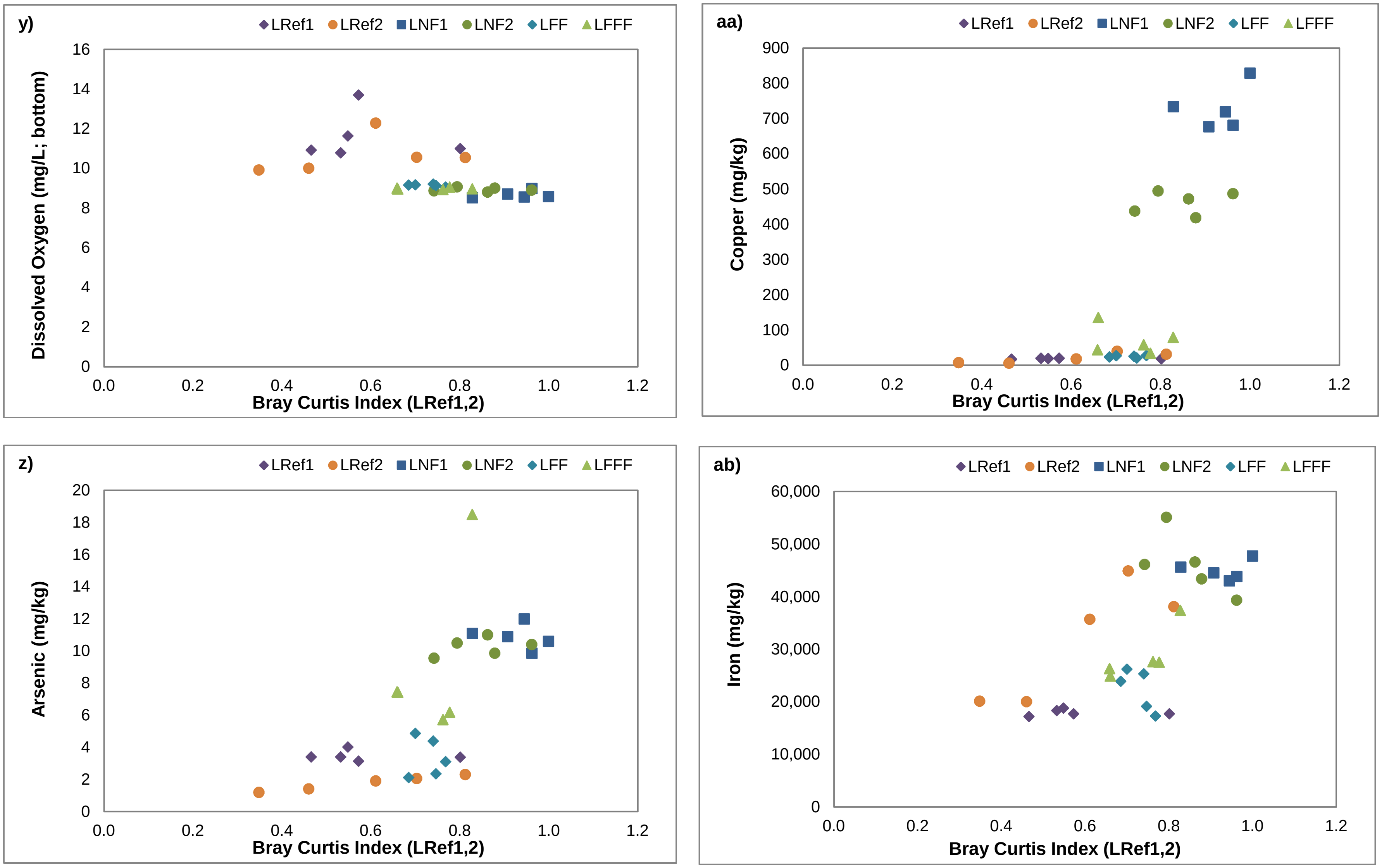

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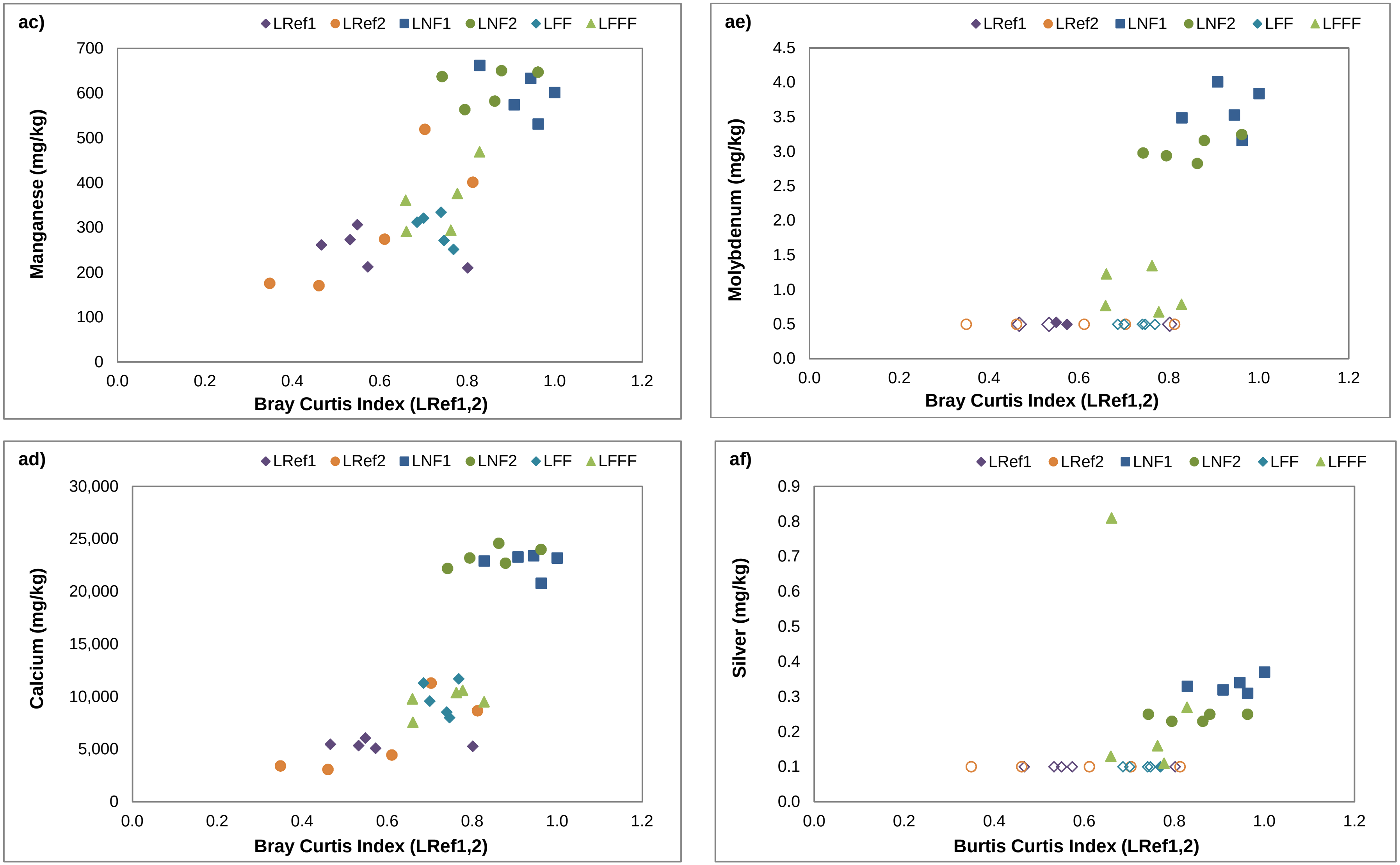

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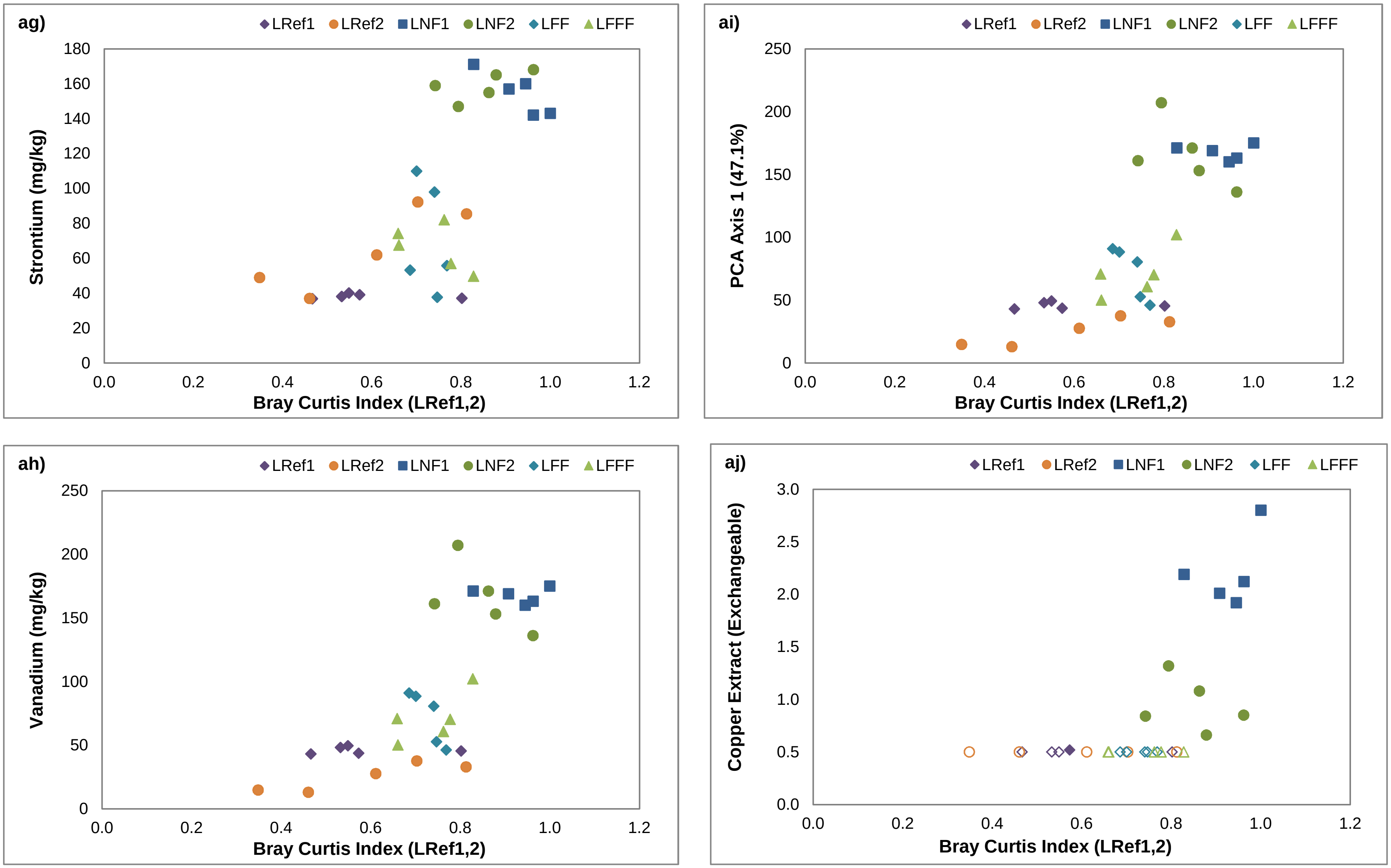

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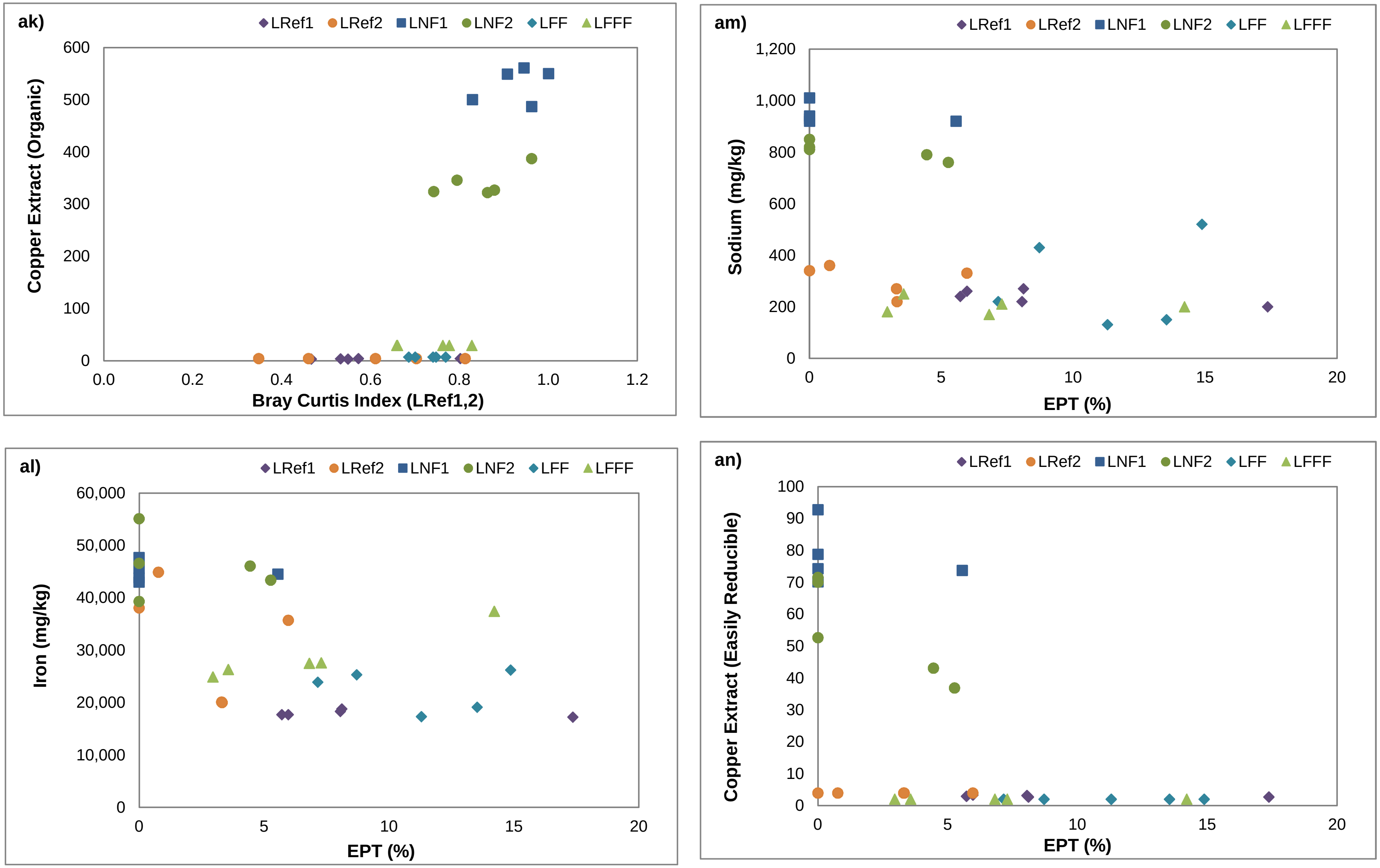

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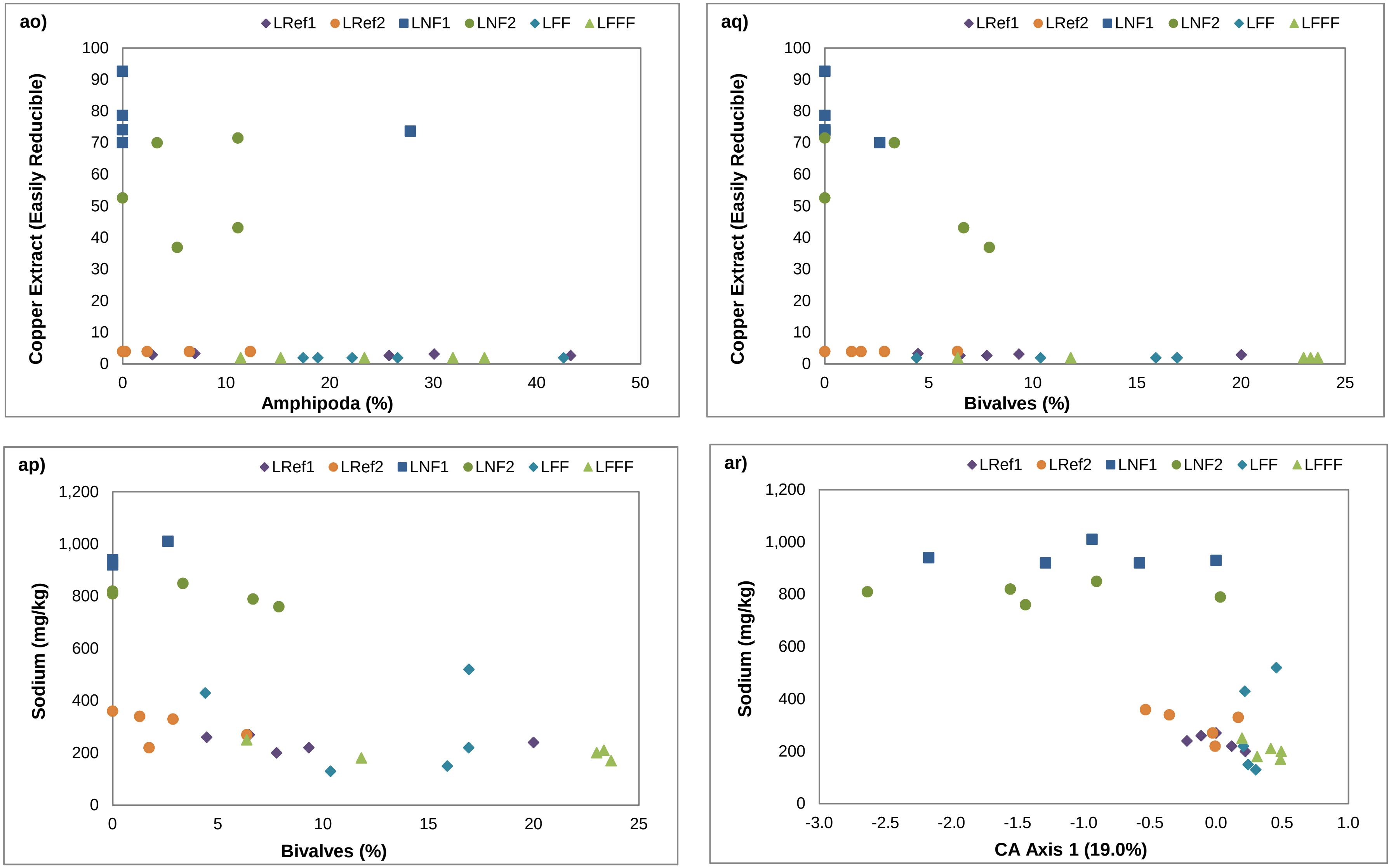

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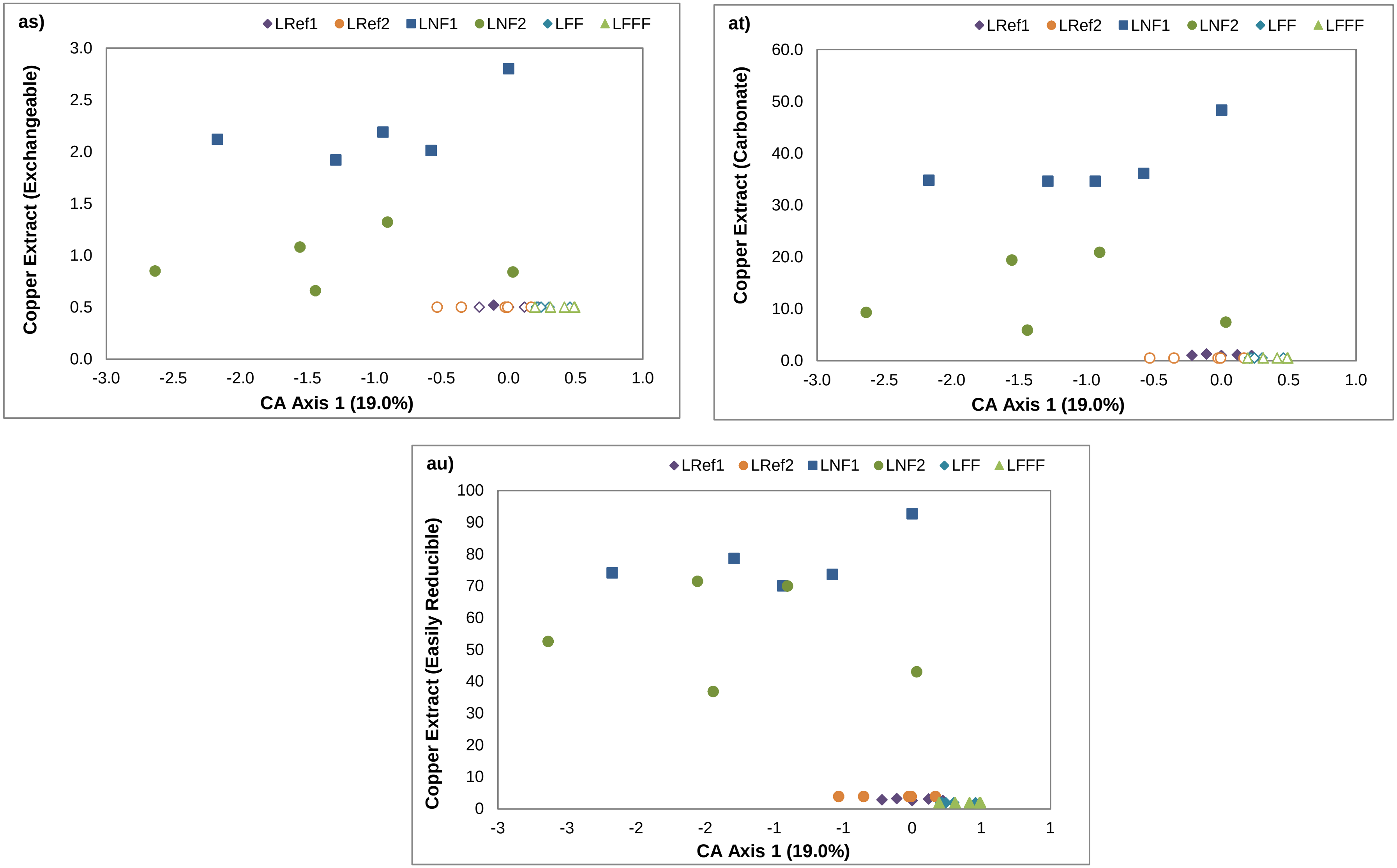

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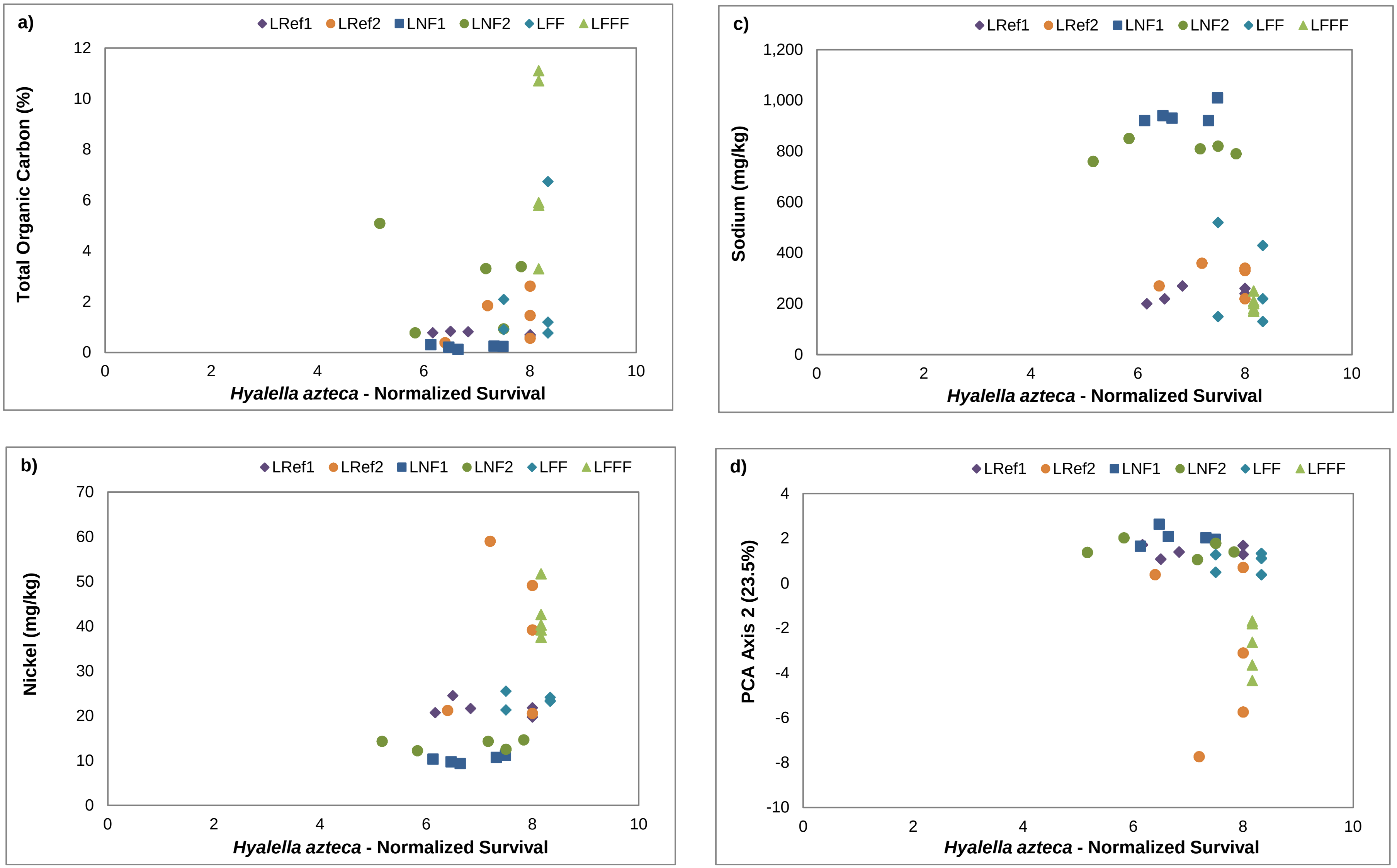
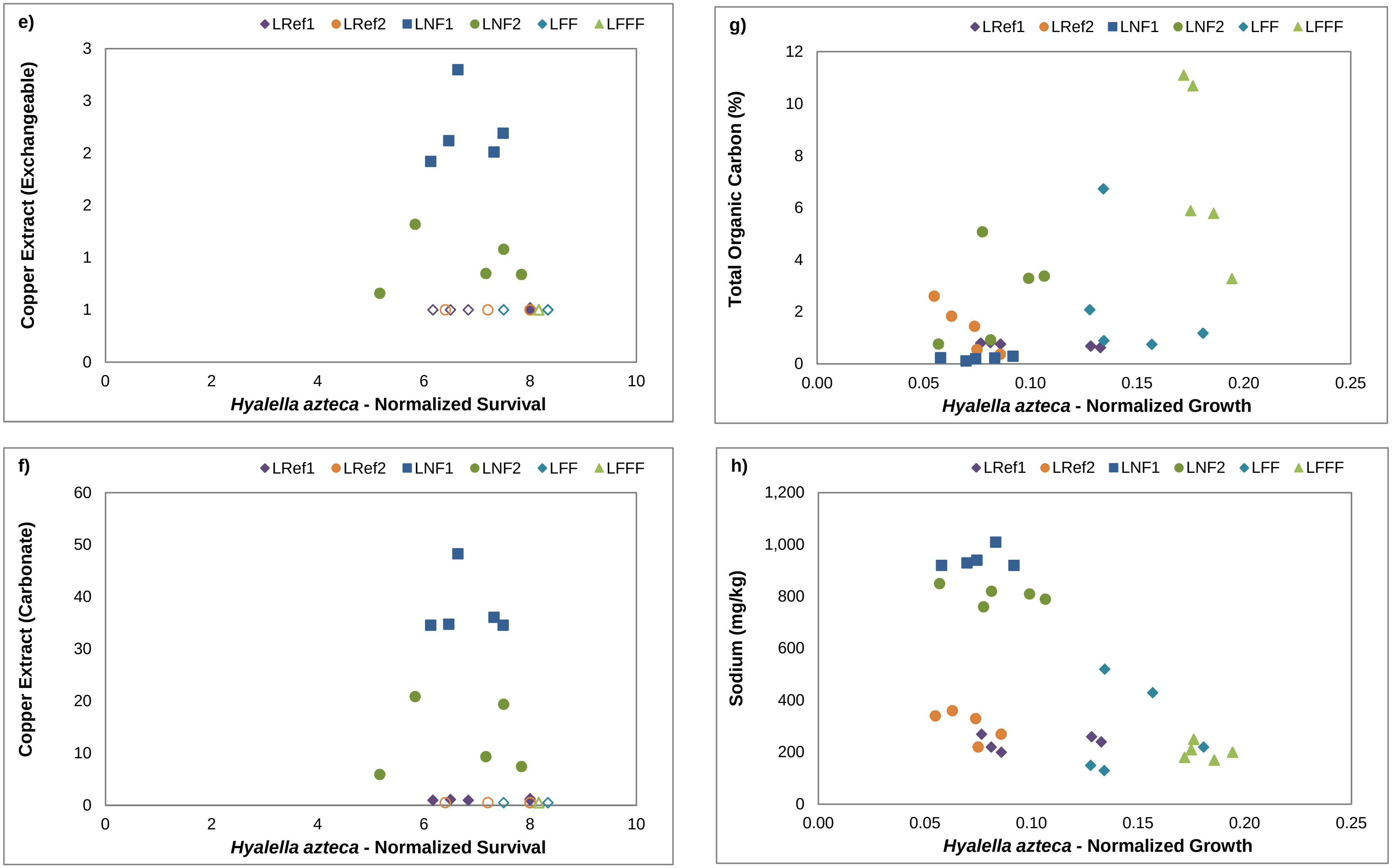


Figure I.8: Scatterplots of Spearman's correlation relationships ($p < 0.01$) between toxicity endpoints, benthic invertebrate community metrics and physical endpoints, parameters of interest, indicator parameters, PCA axes and copper extracts (Tessier extraction), Mount Polley Mine, 2014. Quesnel Lake Littoral sampling areas. Hollow symbols indicate values < MDL.



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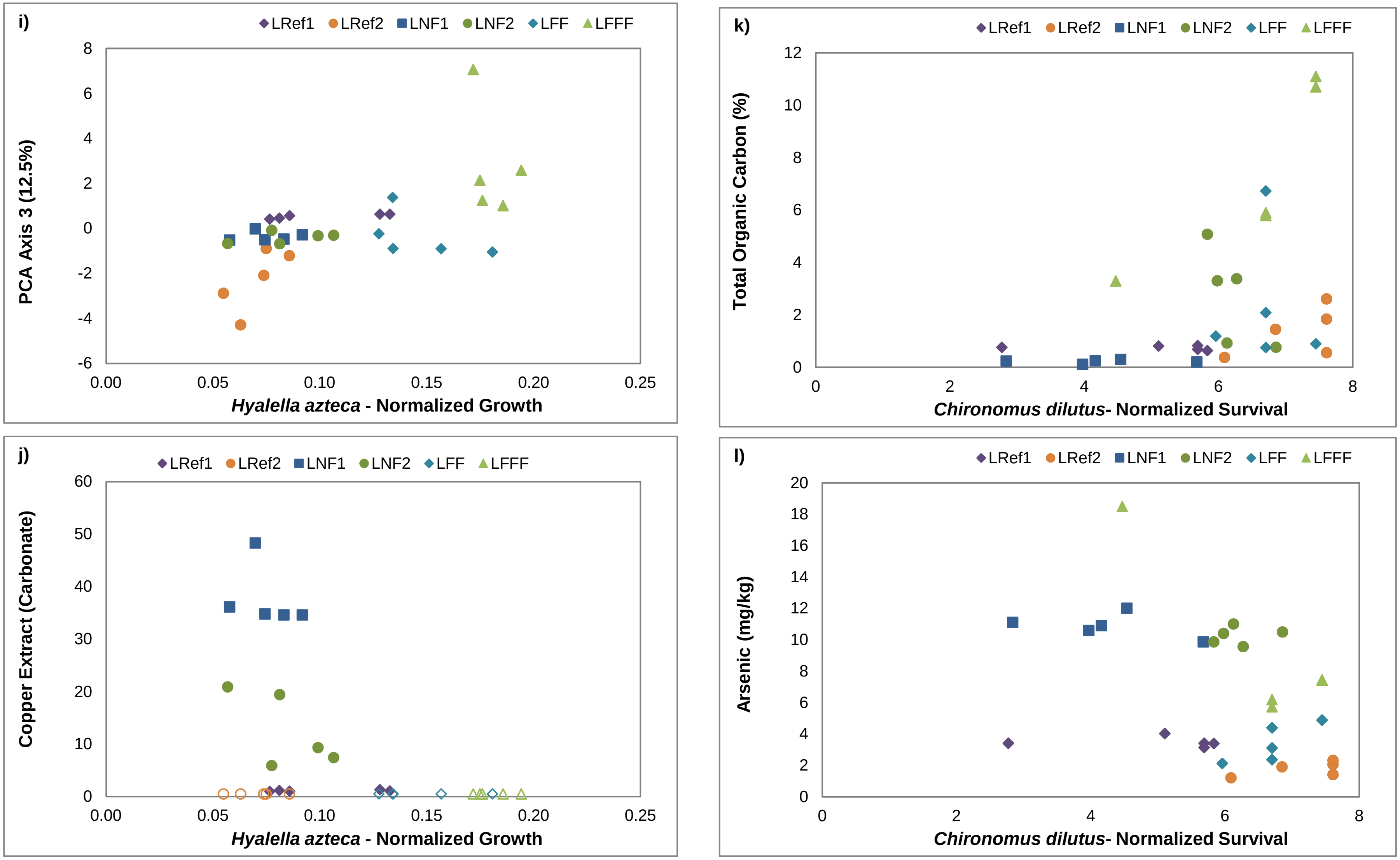

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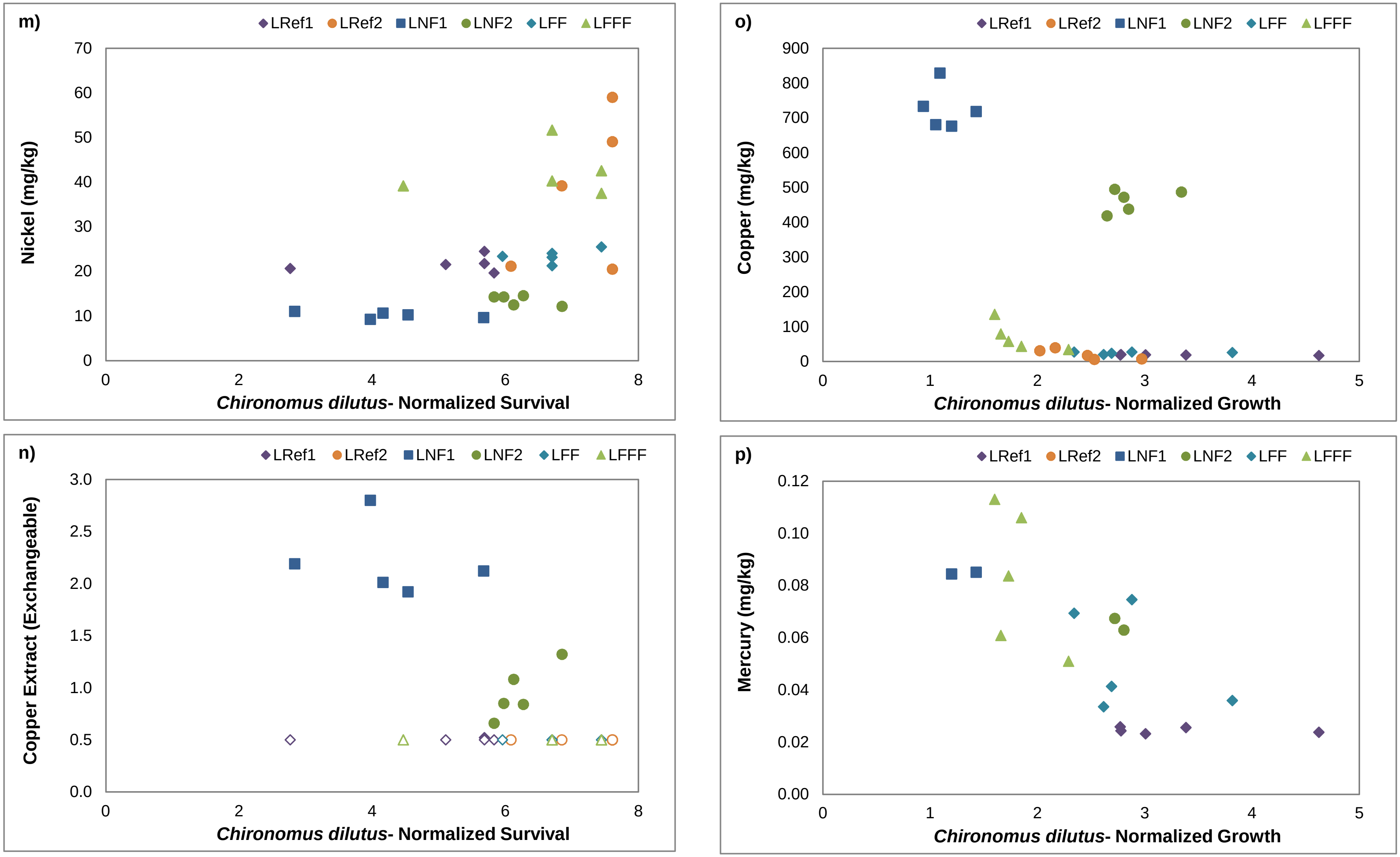

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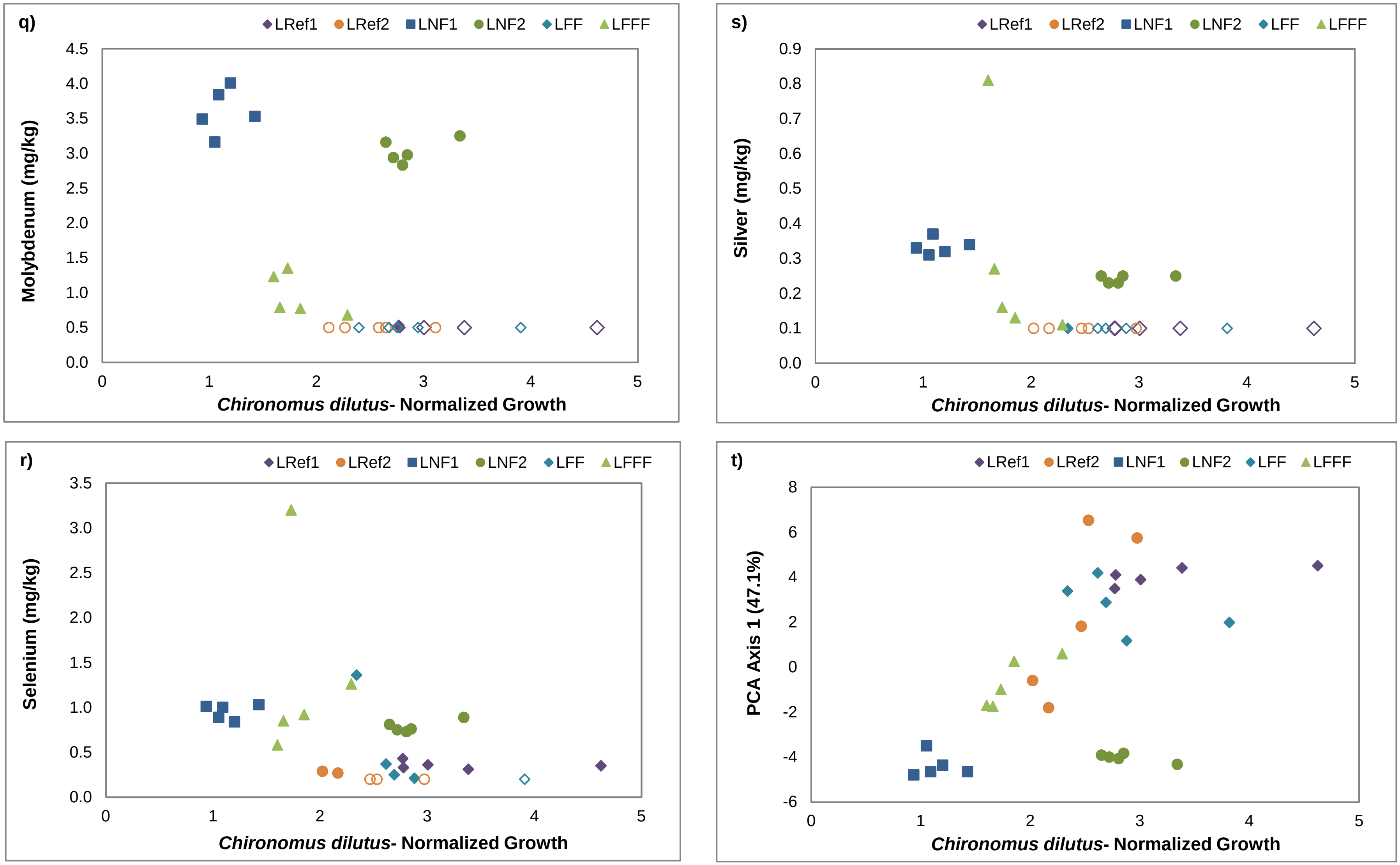

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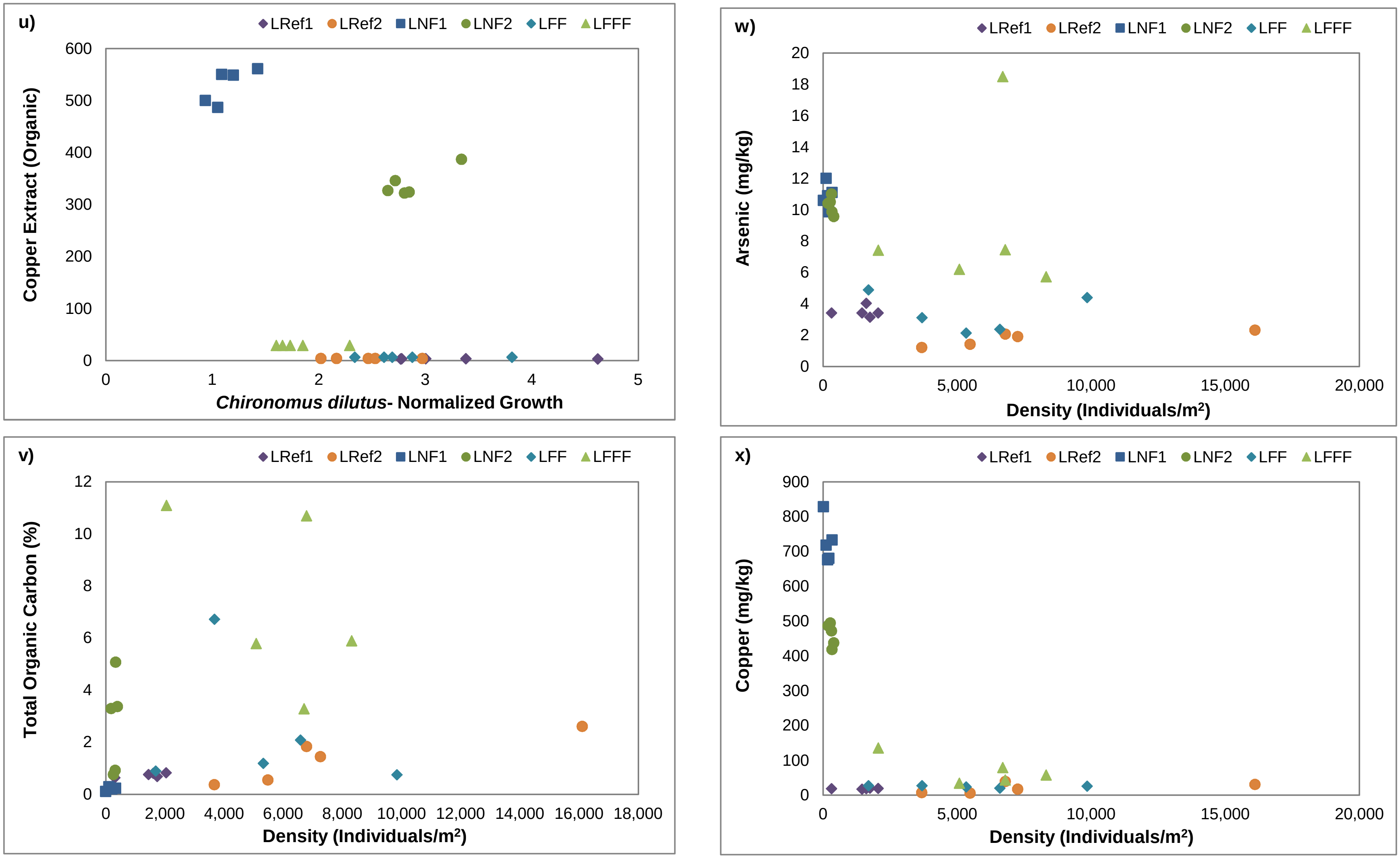

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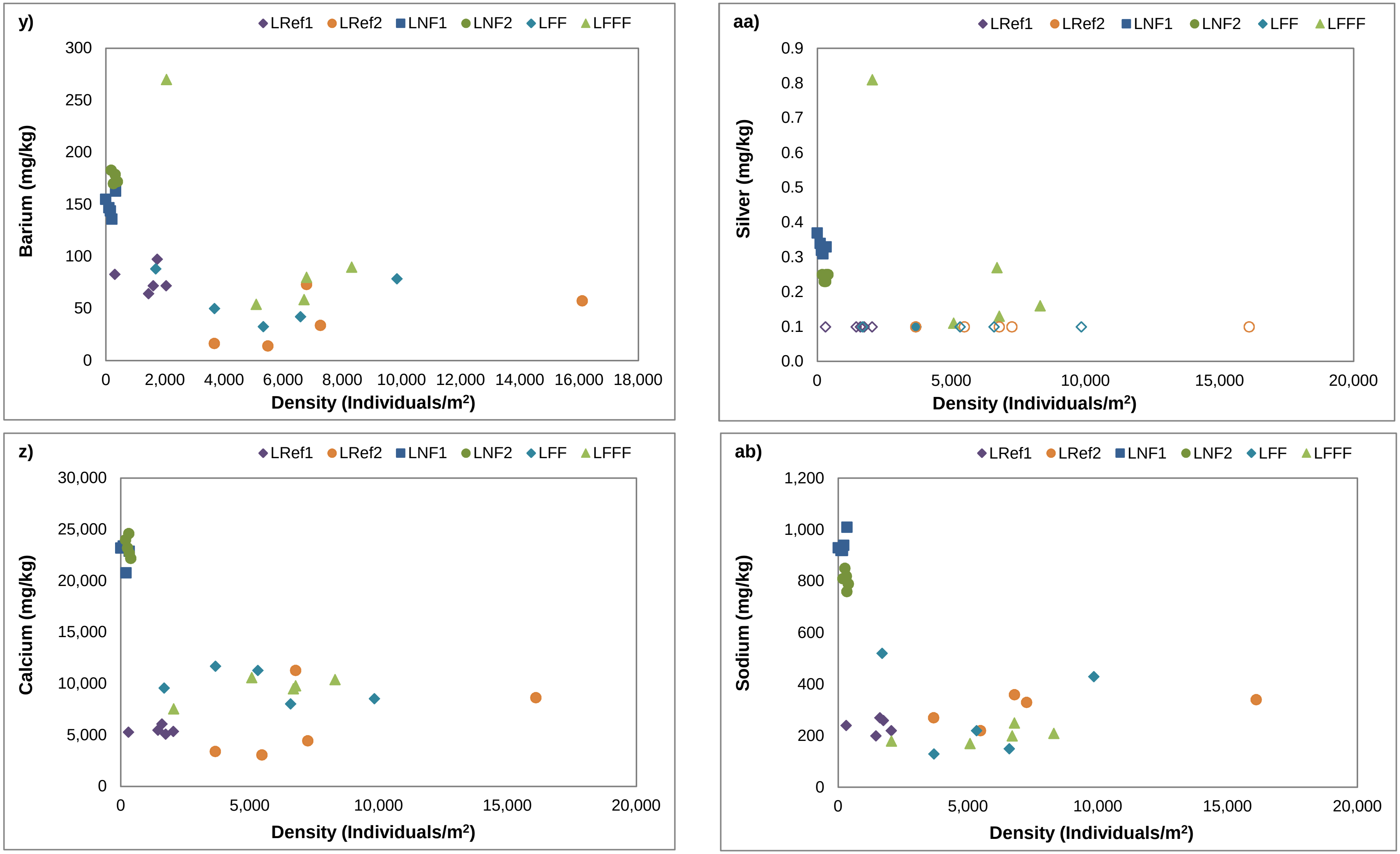

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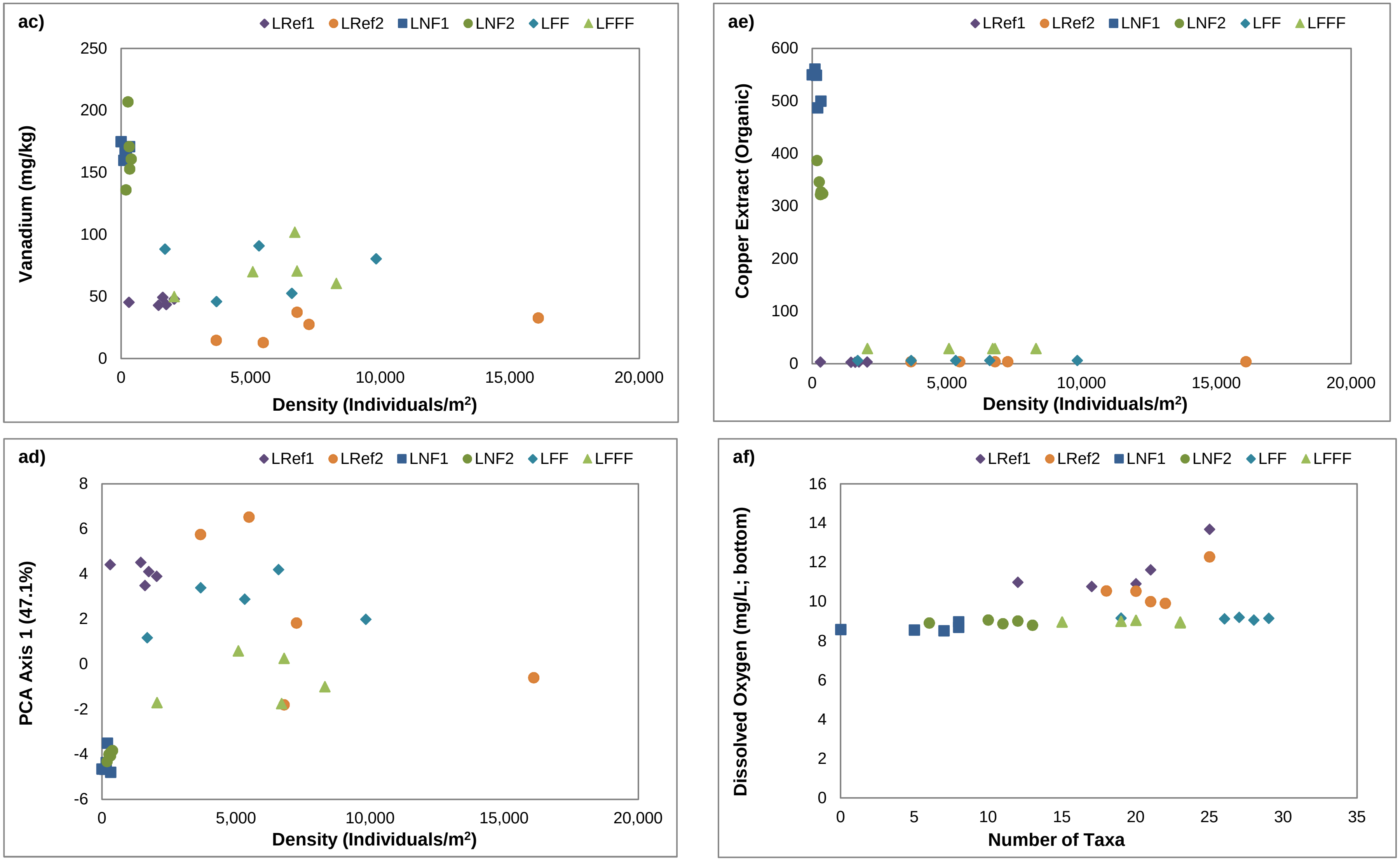

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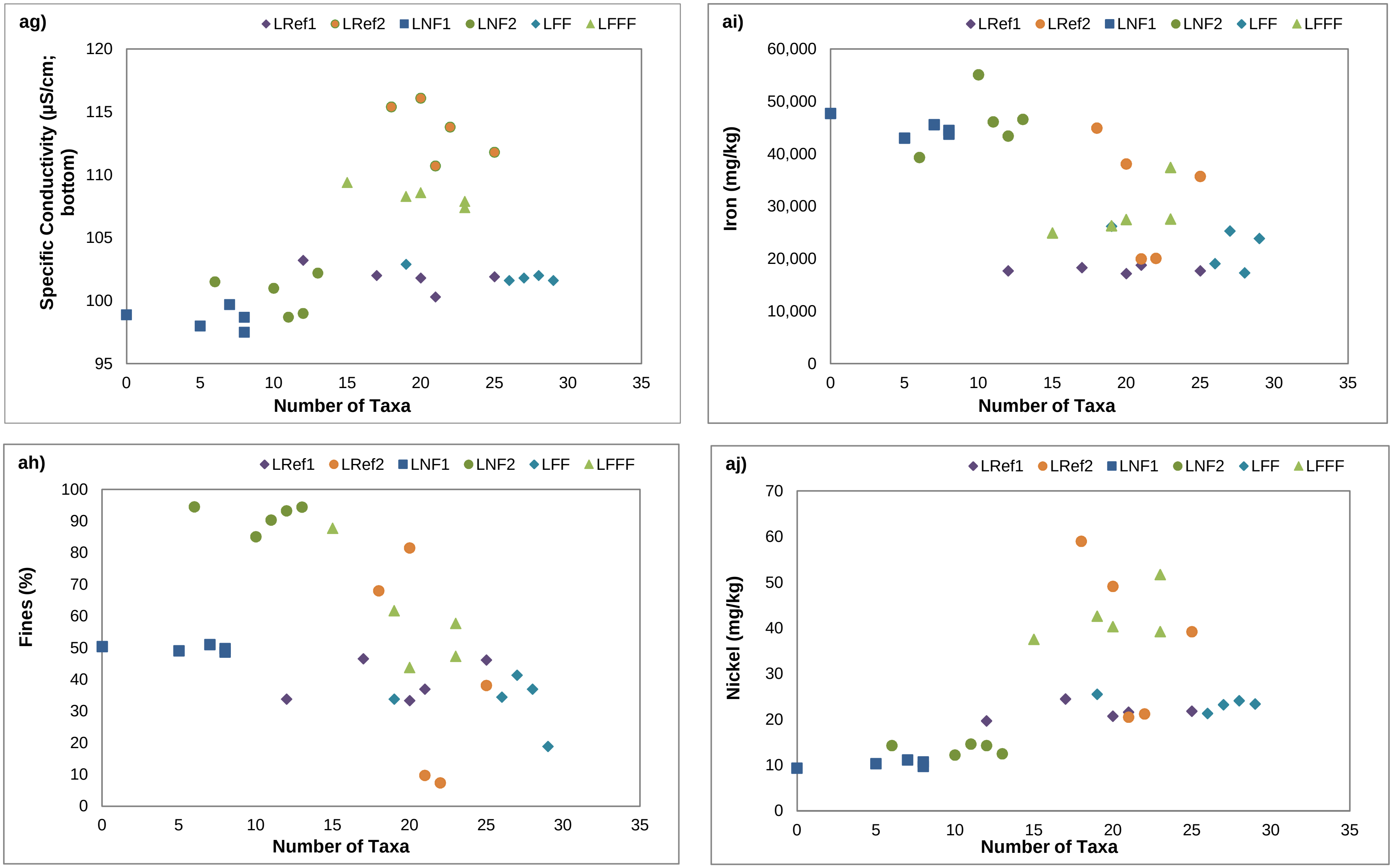

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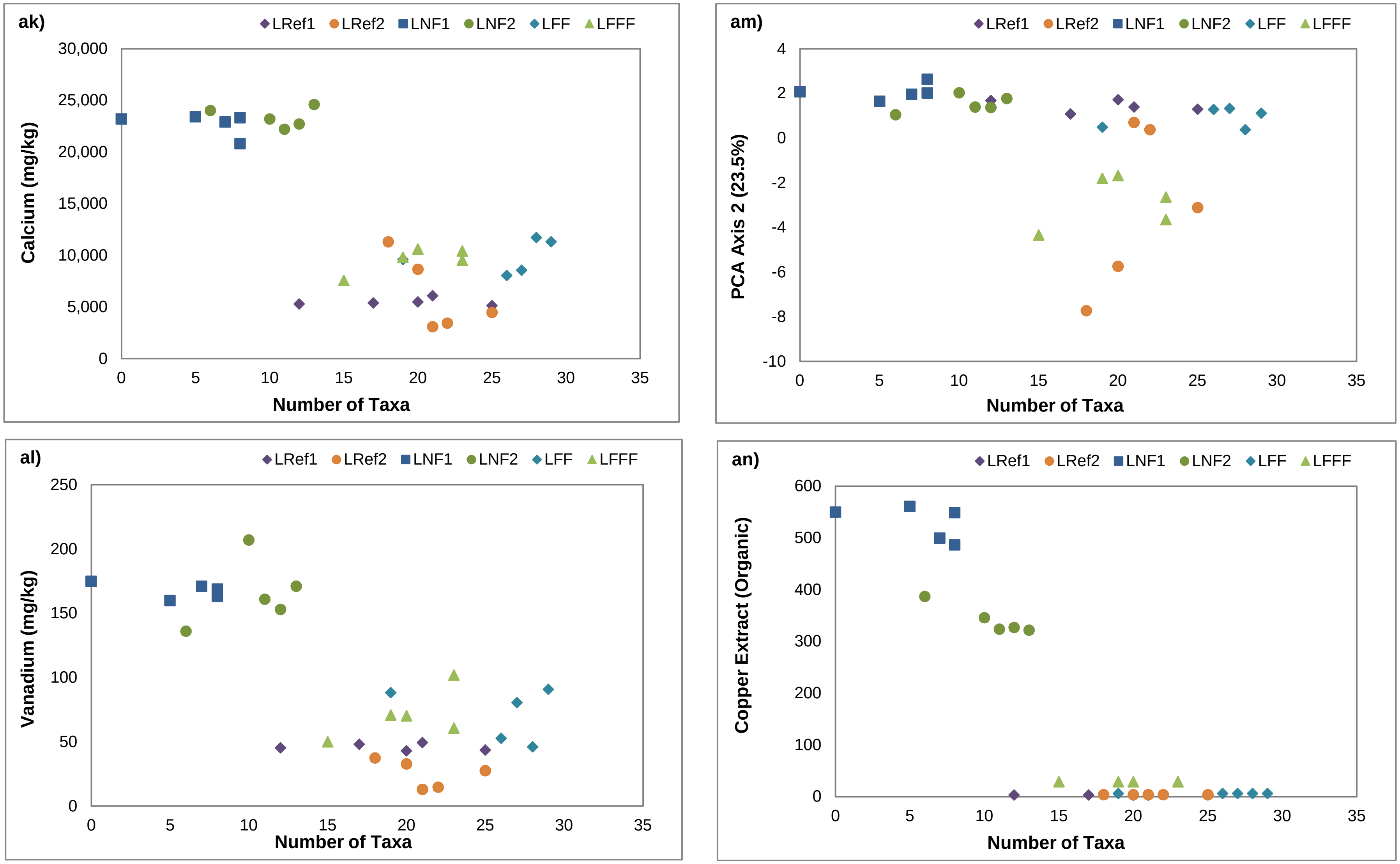

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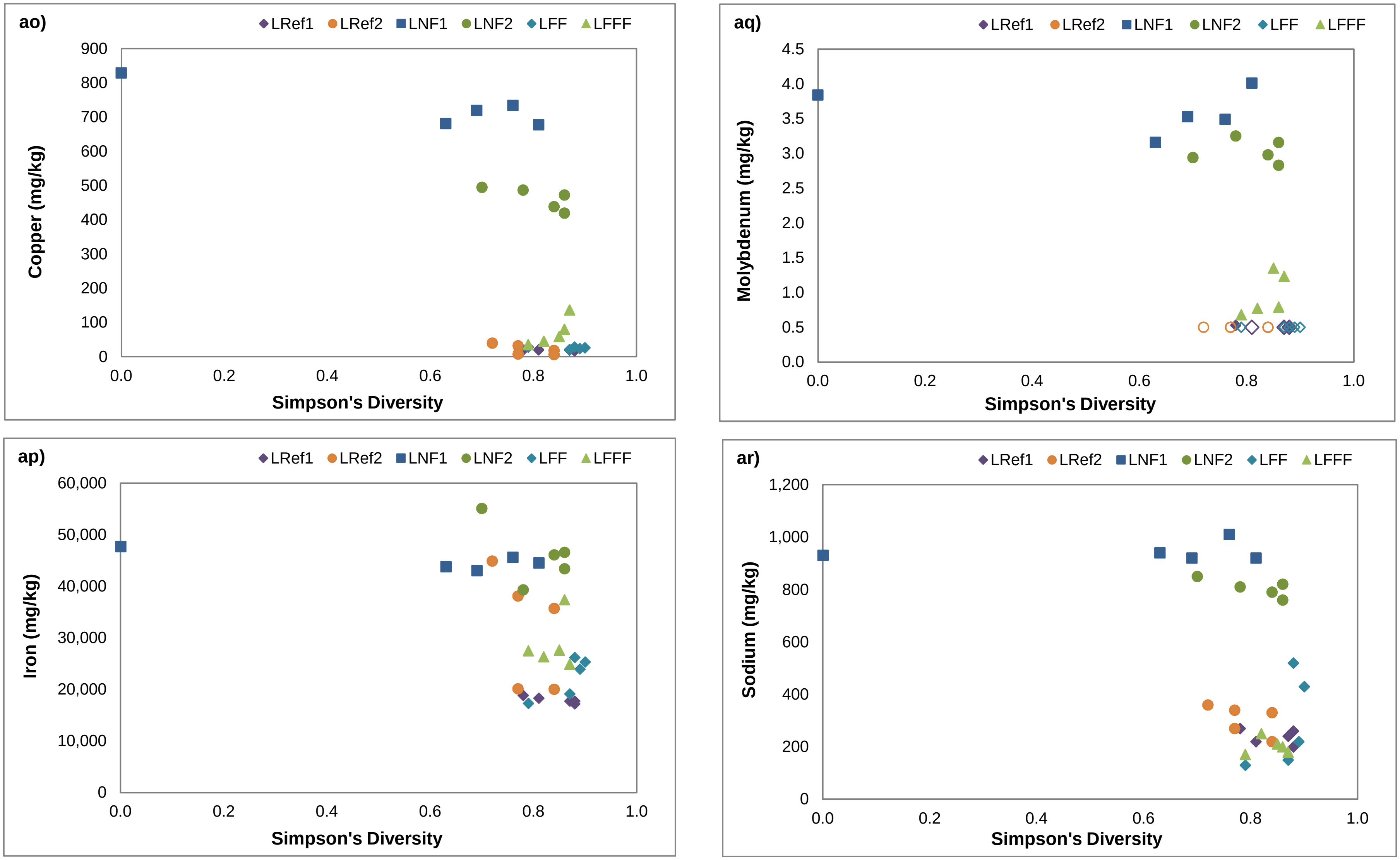

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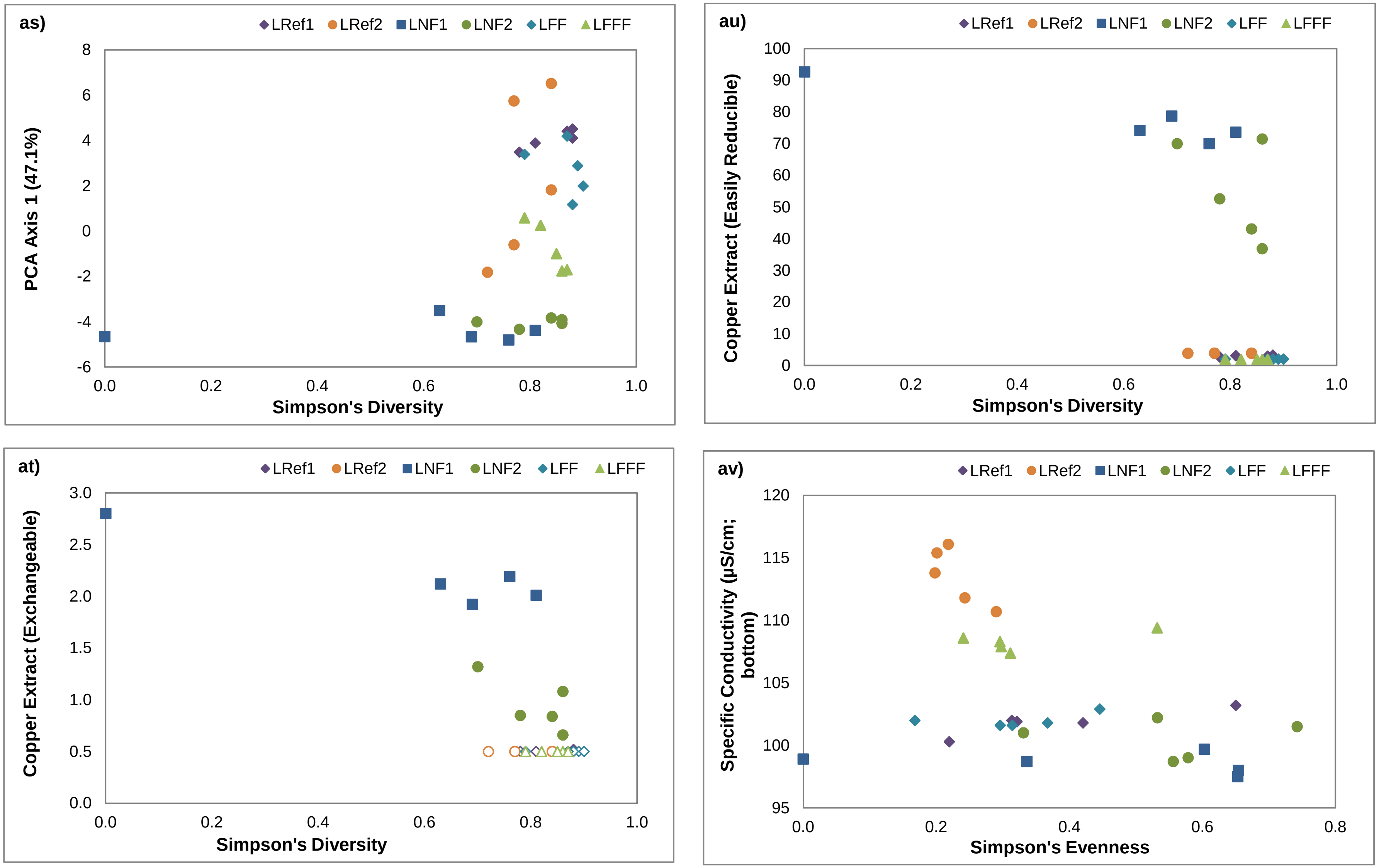

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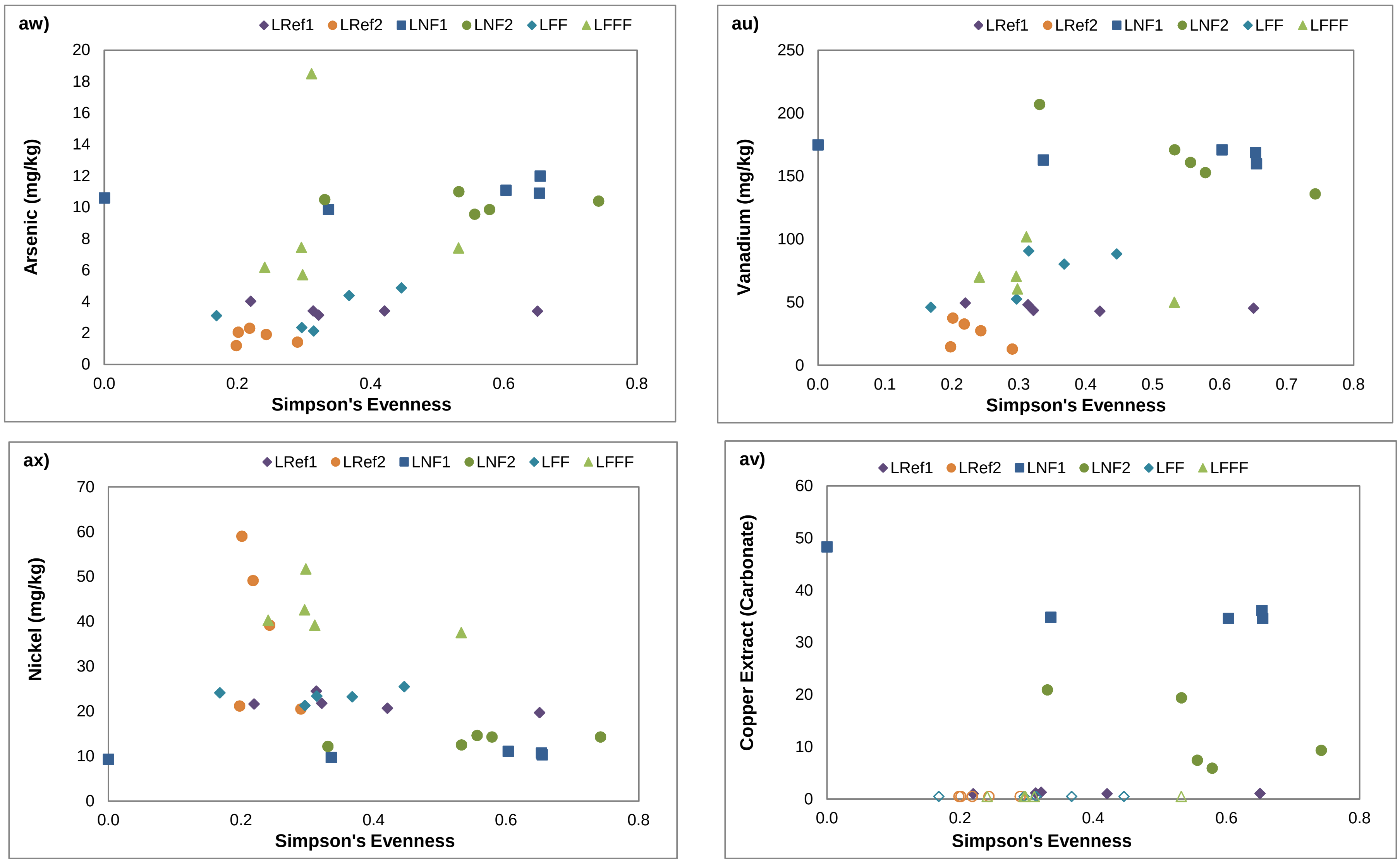

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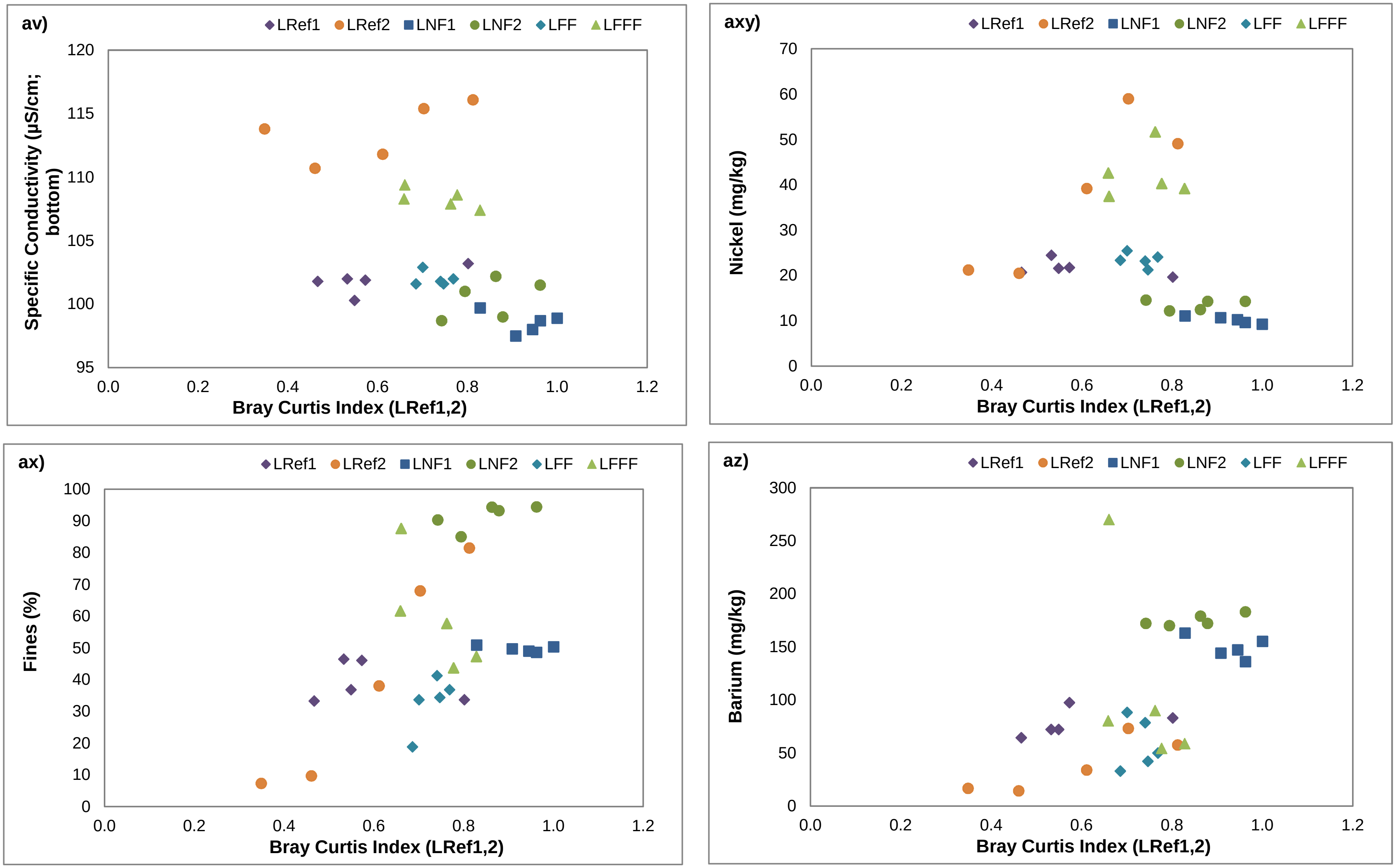

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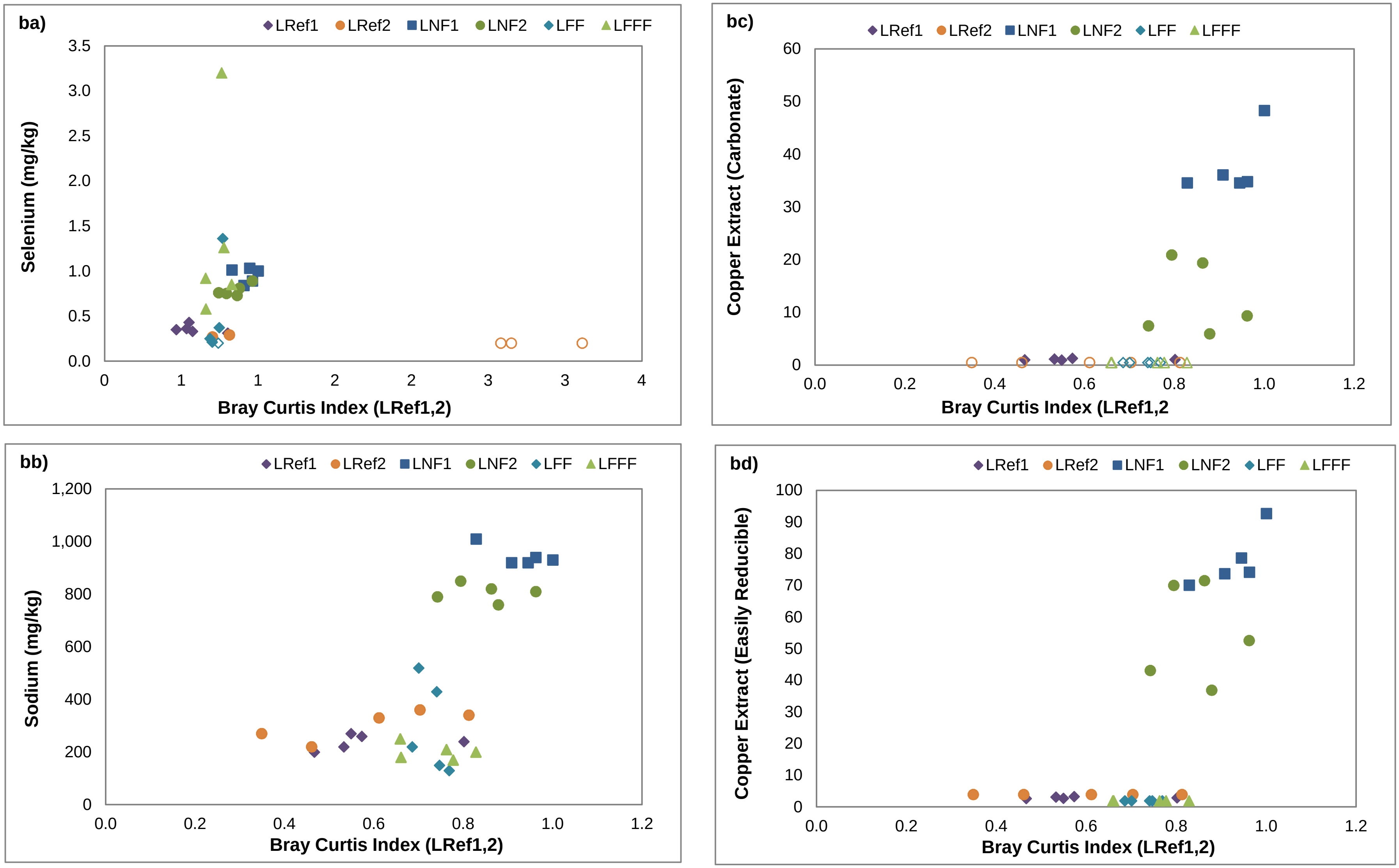

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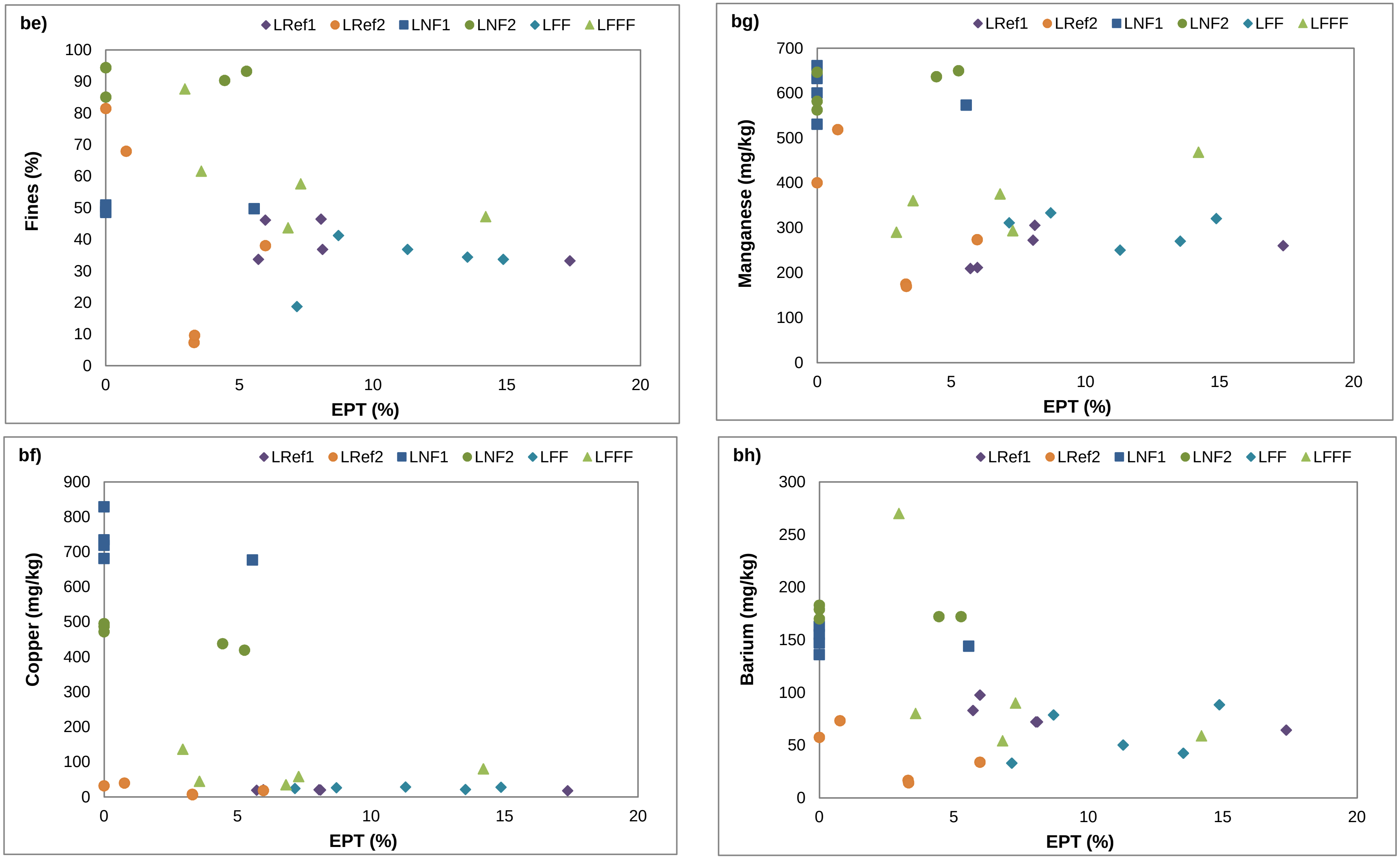

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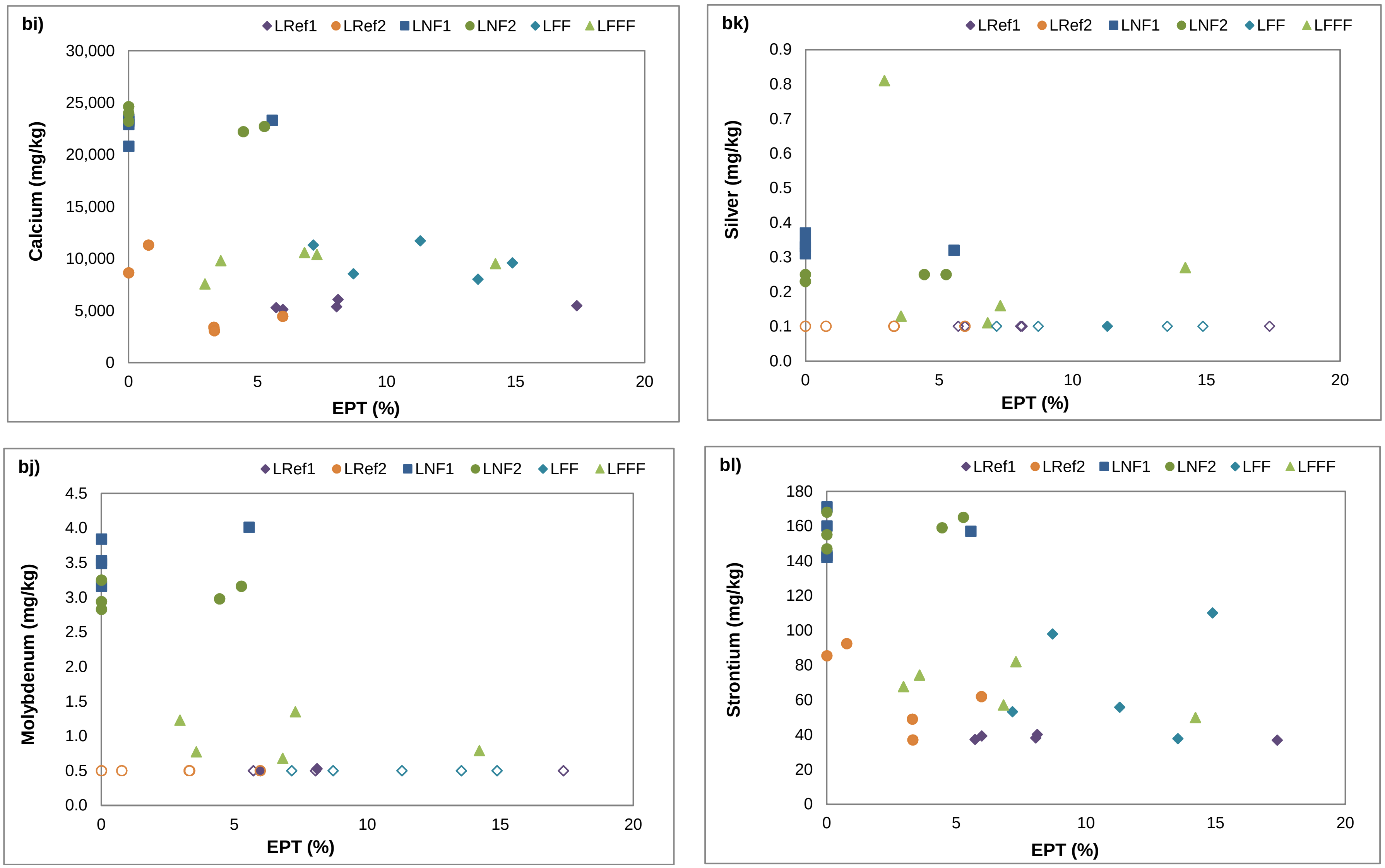

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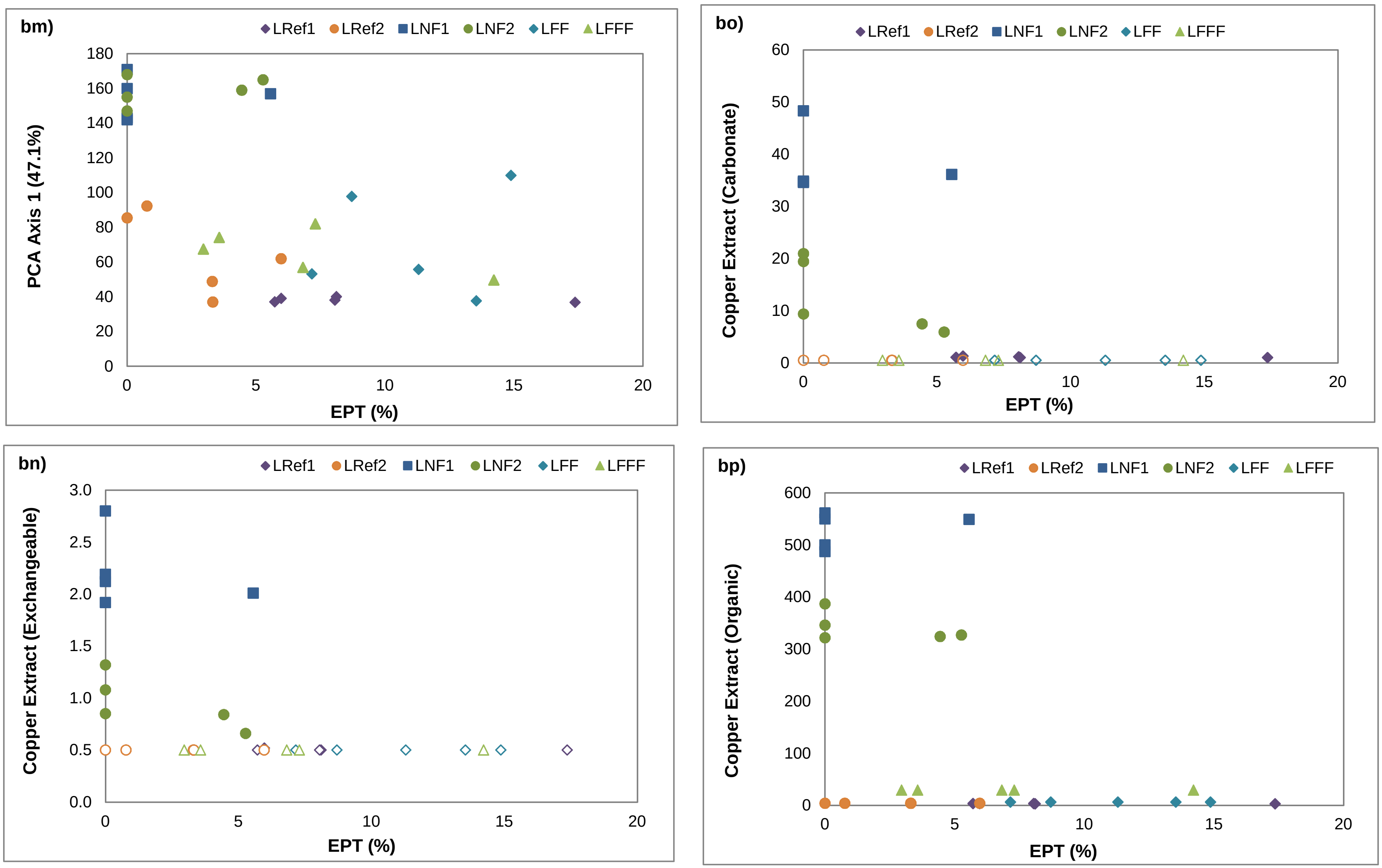

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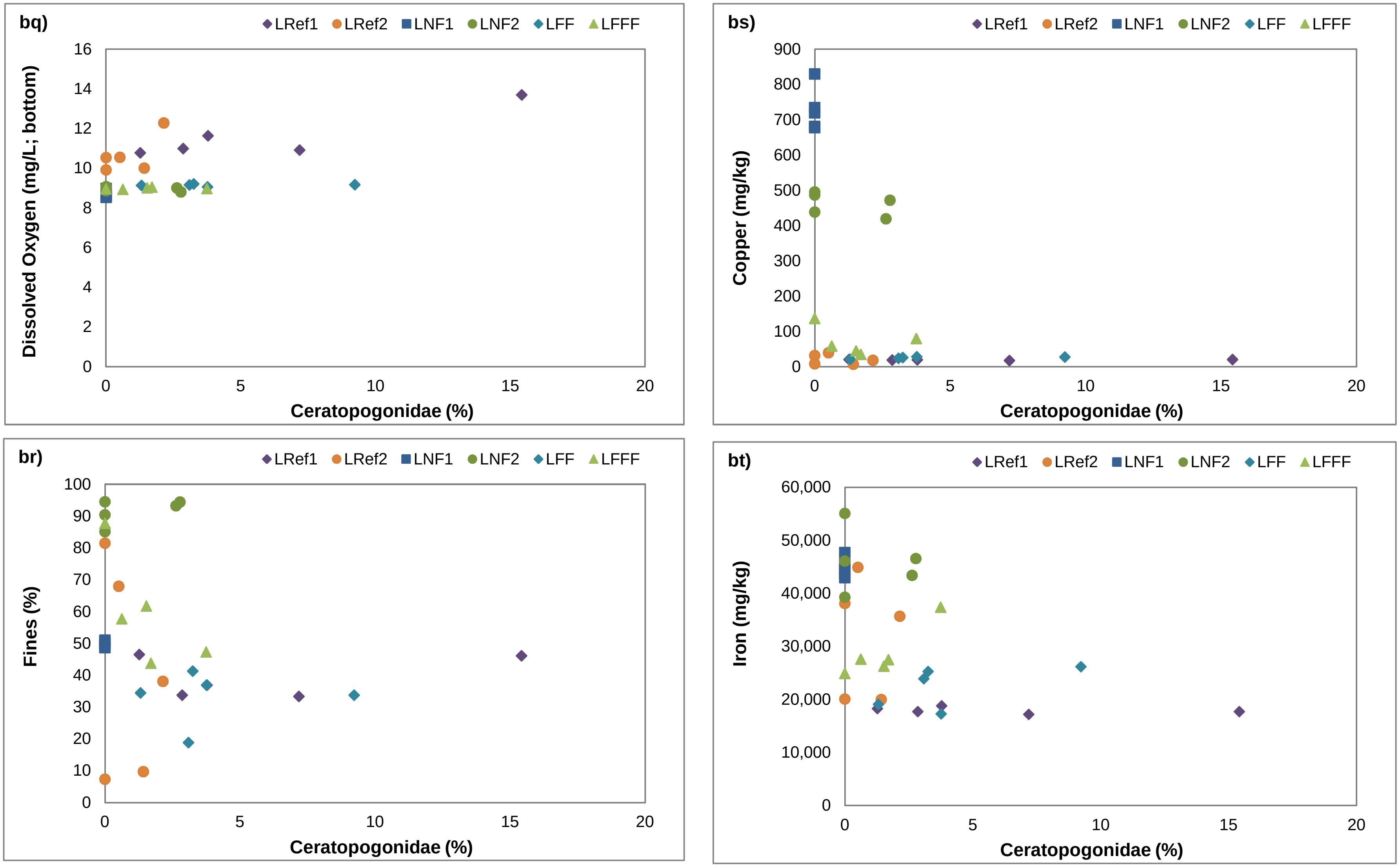

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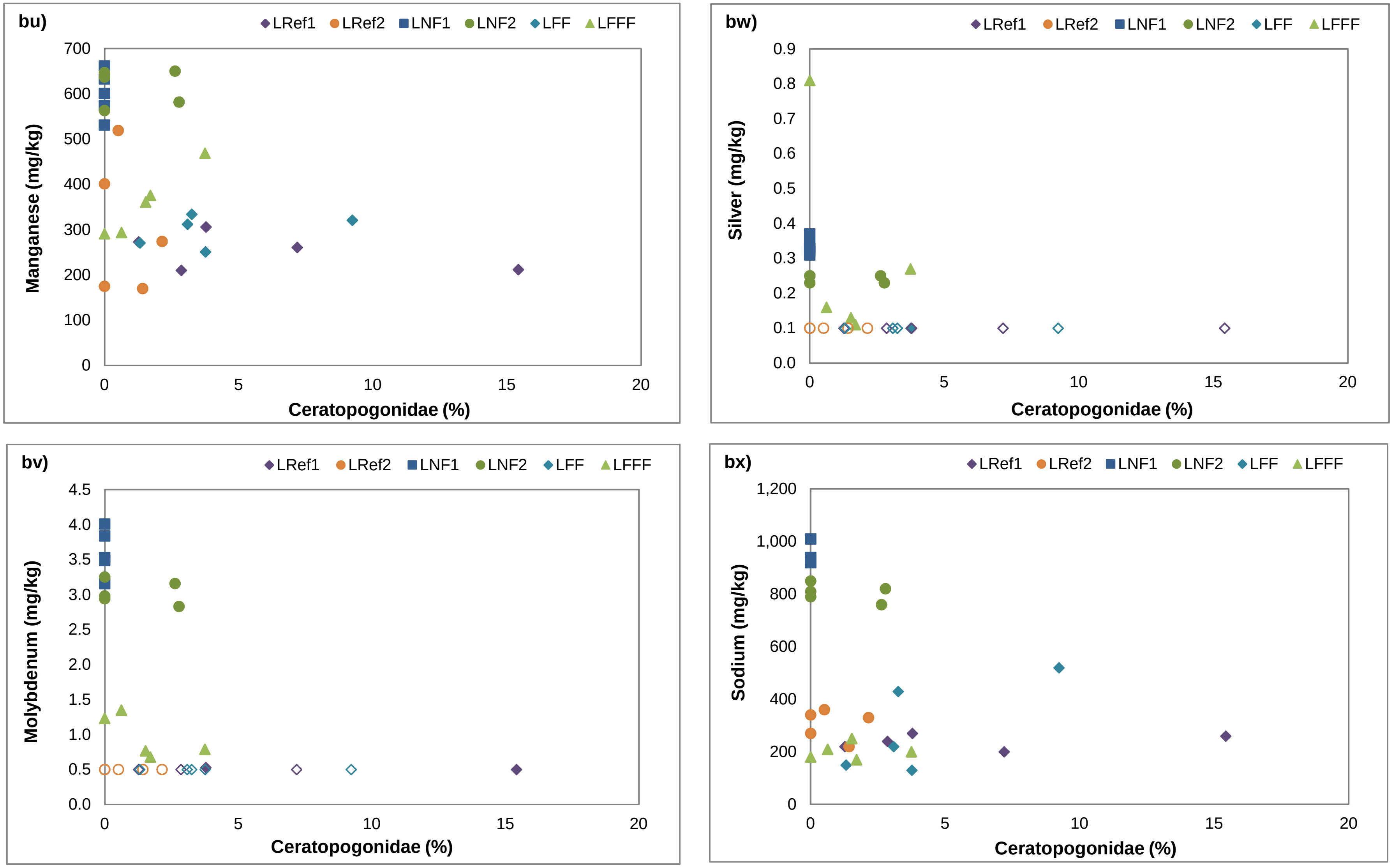

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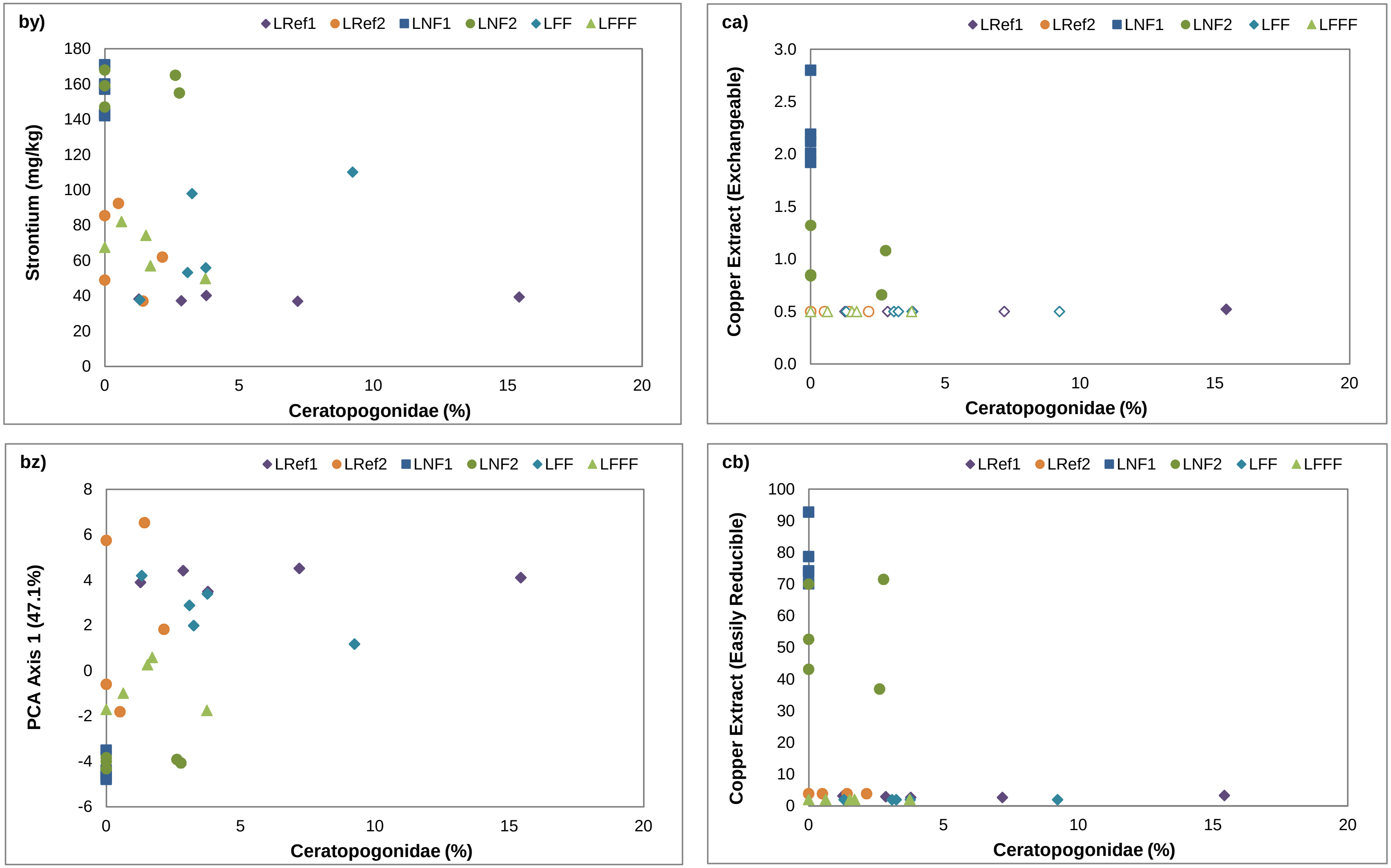

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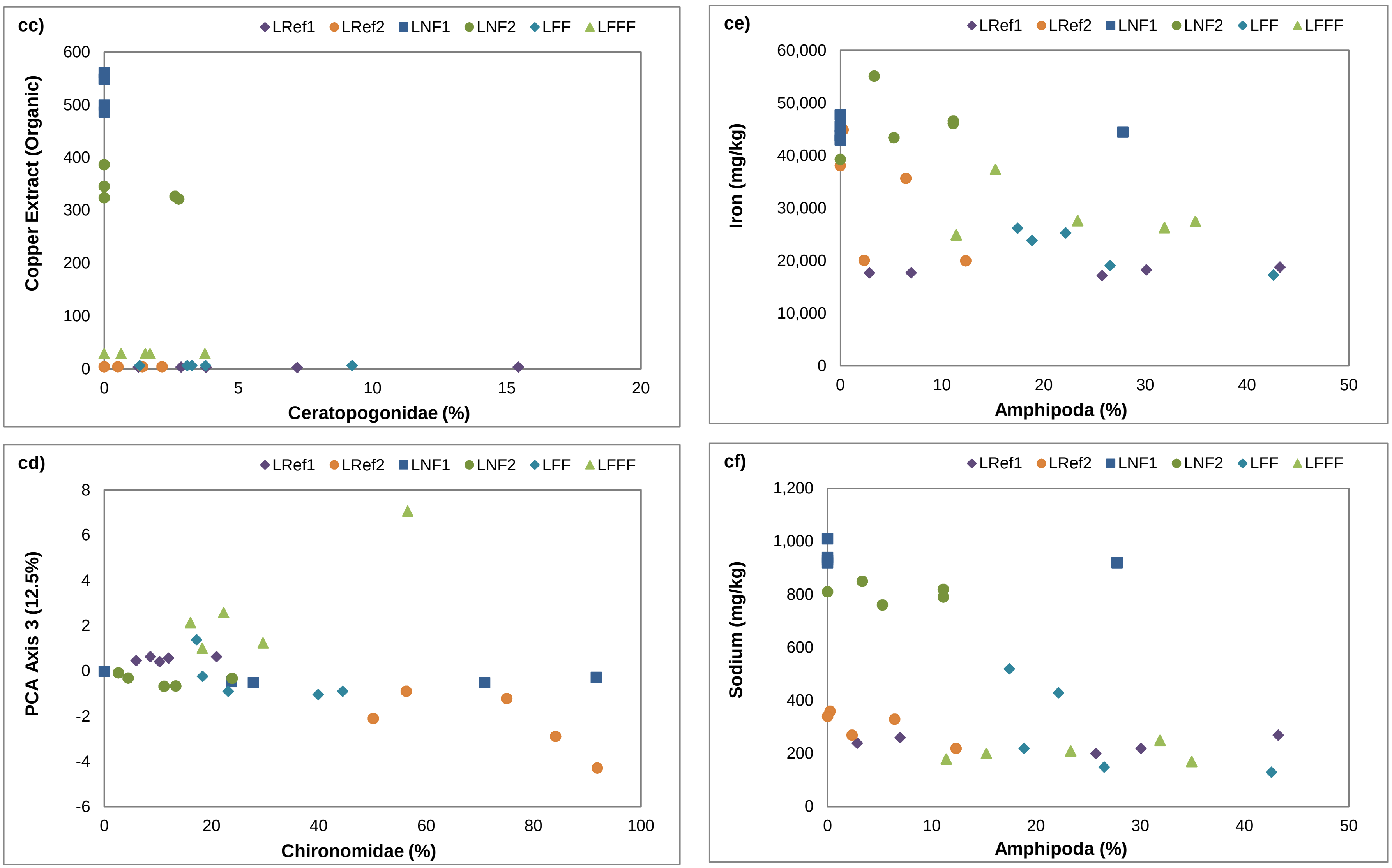

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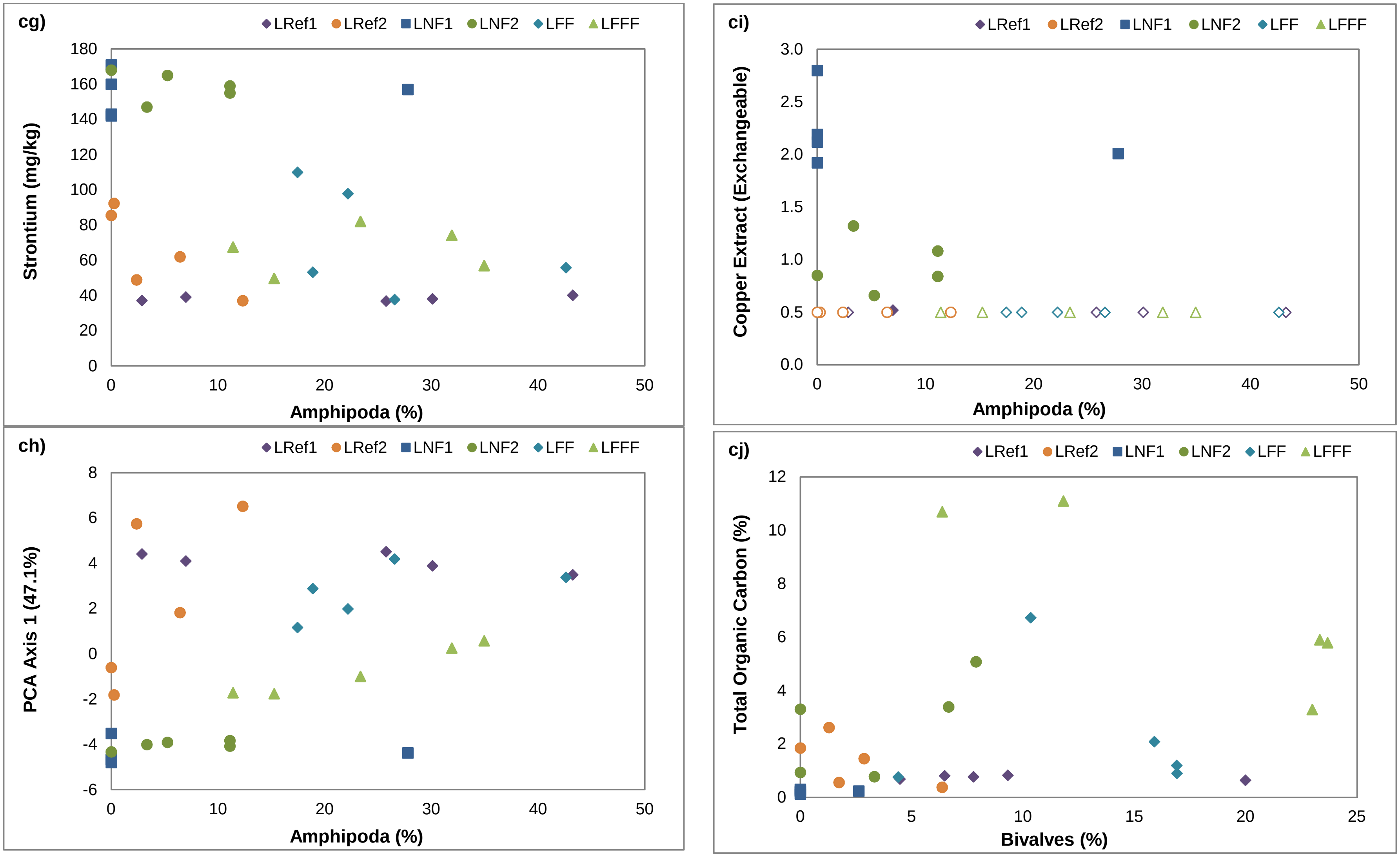

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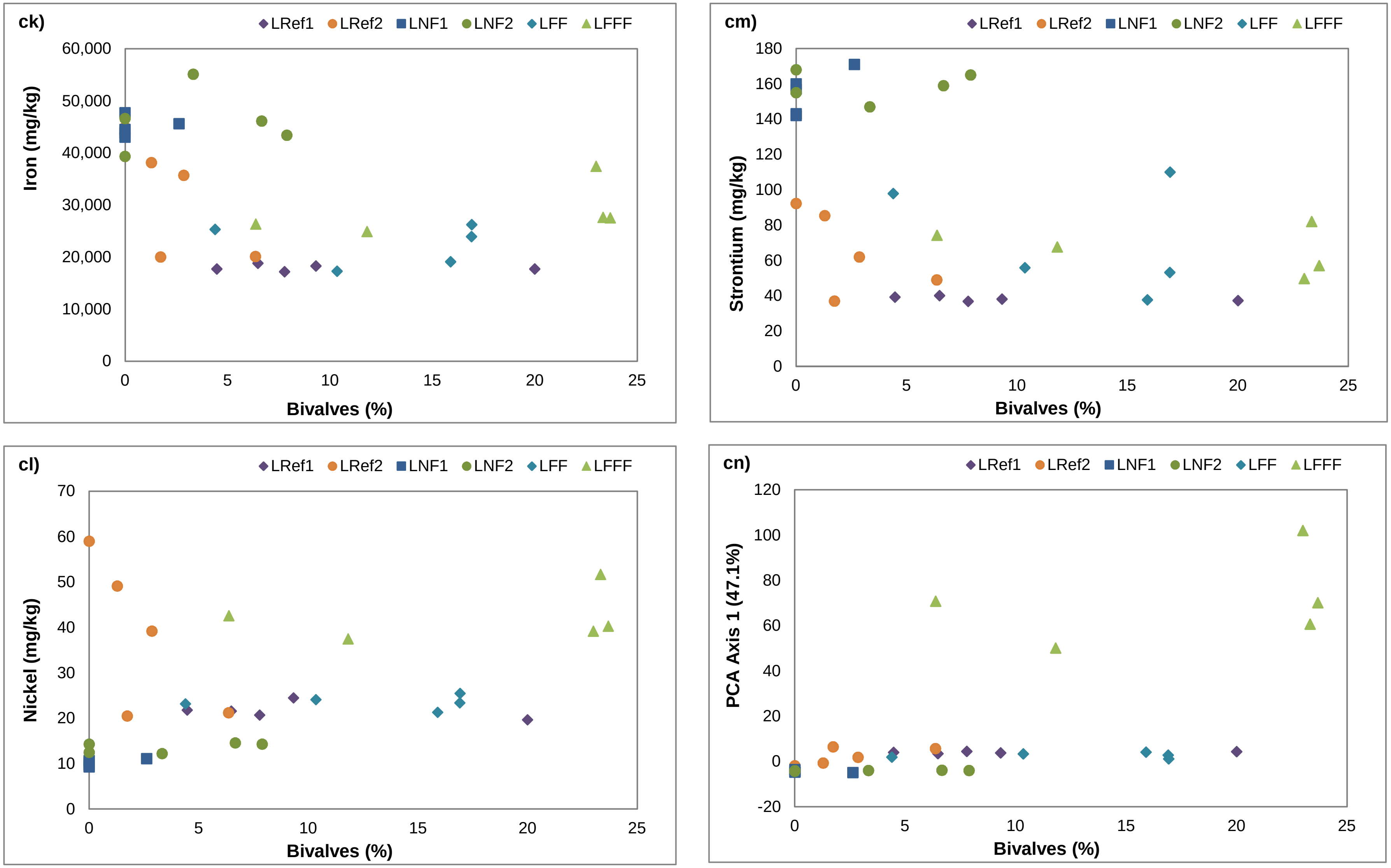

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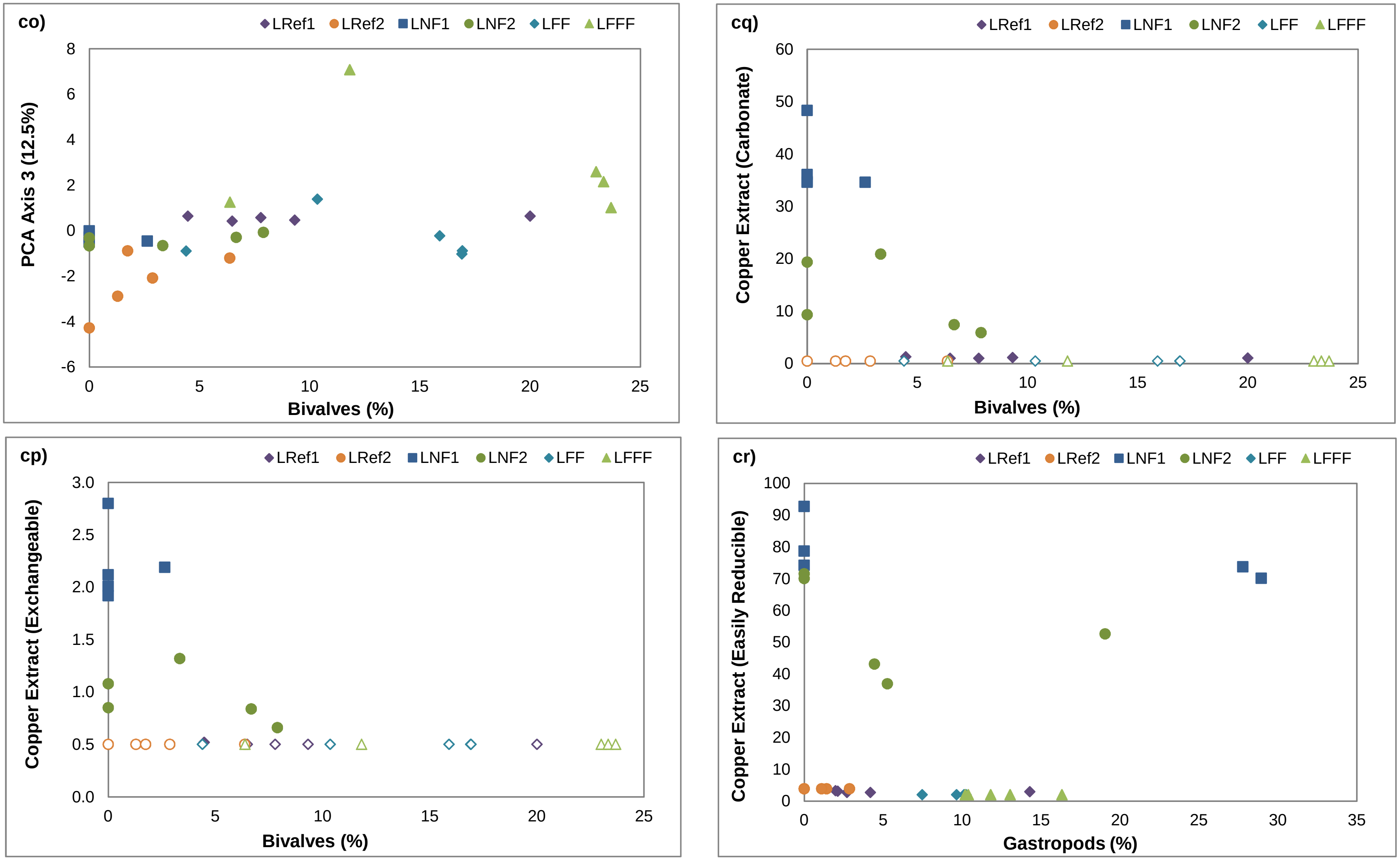

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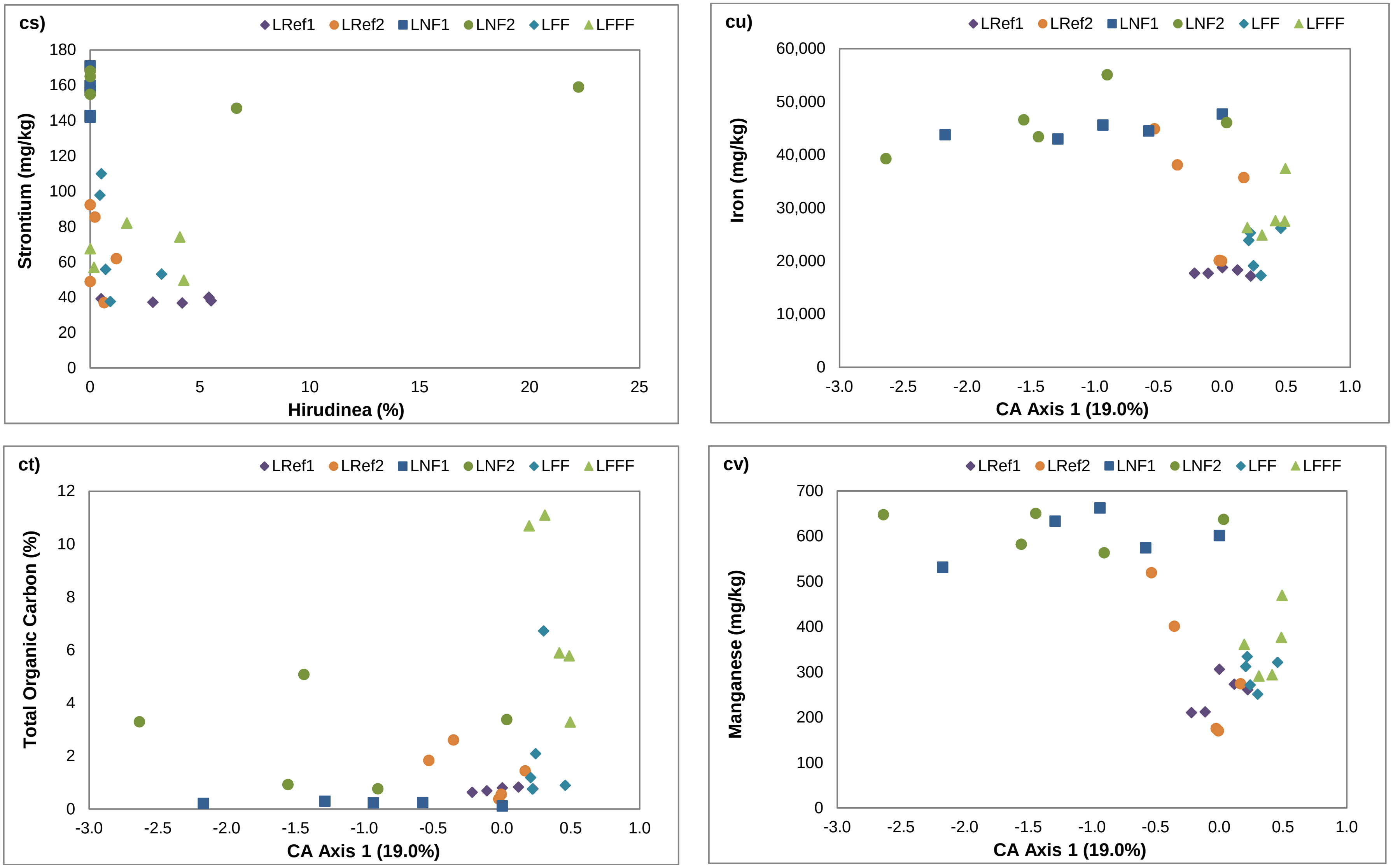

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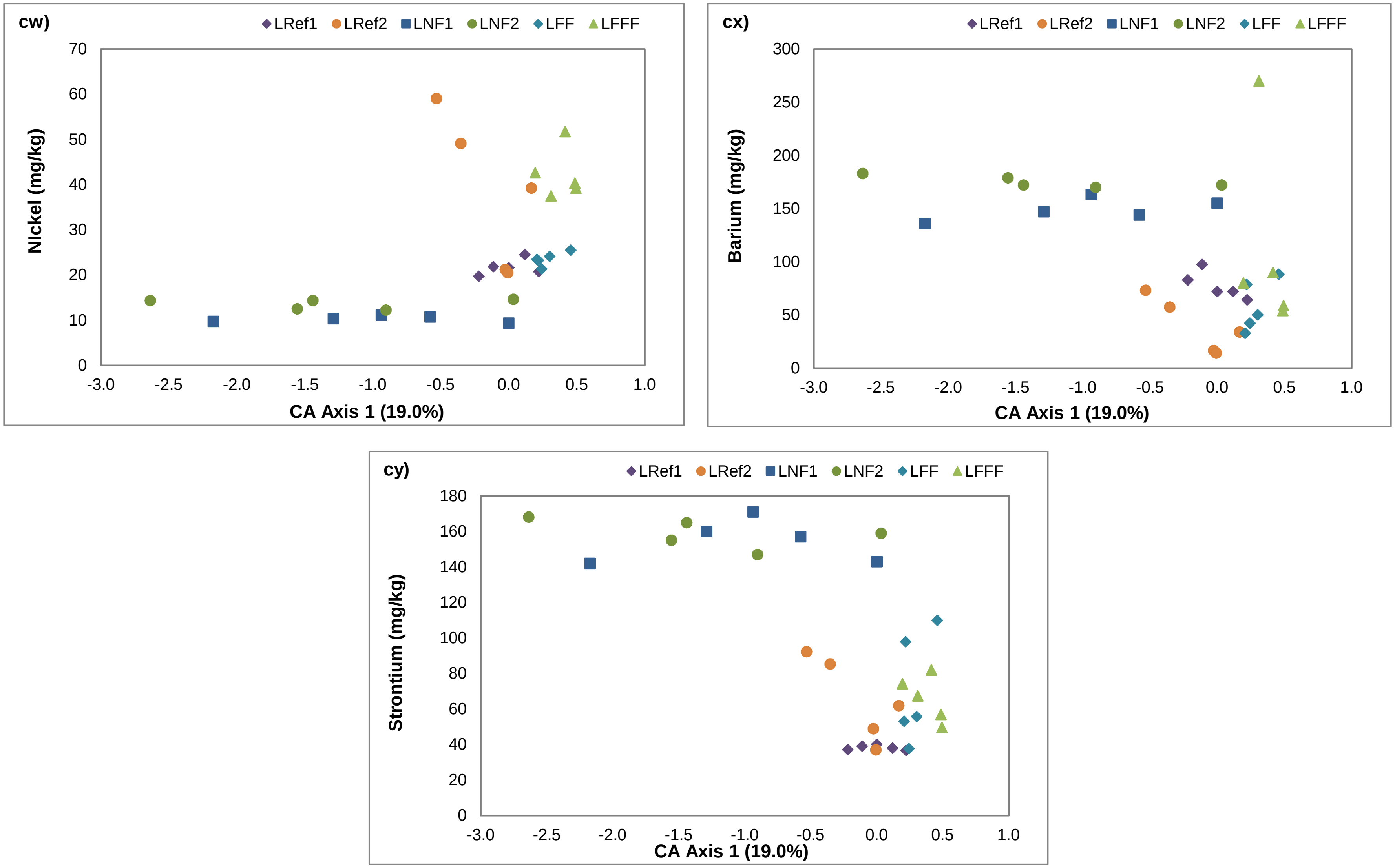

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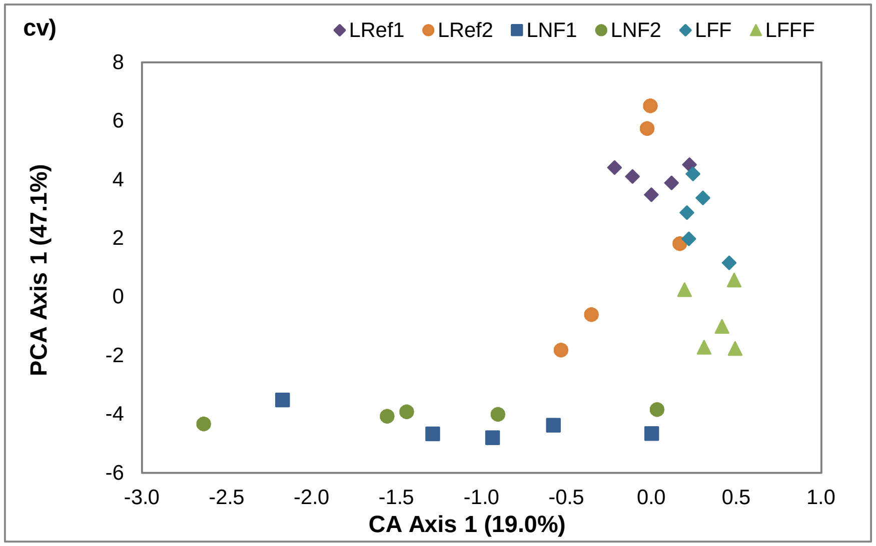

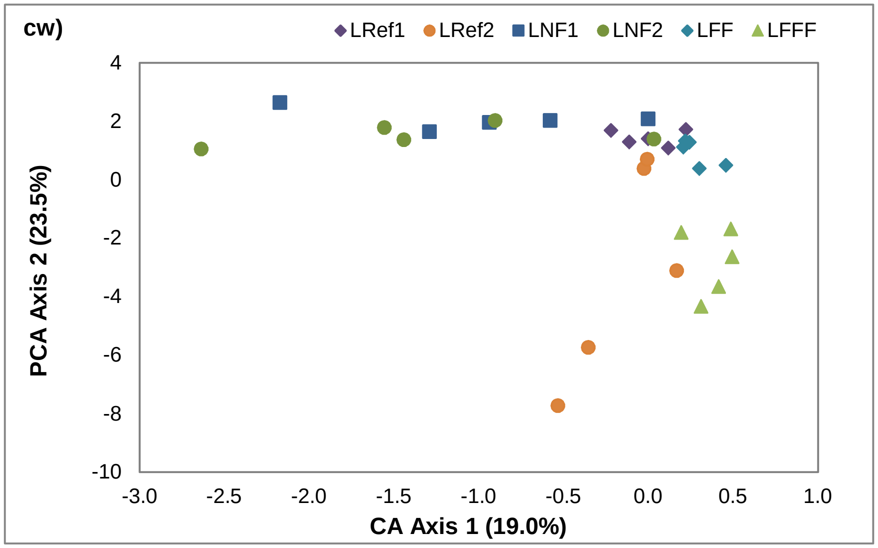

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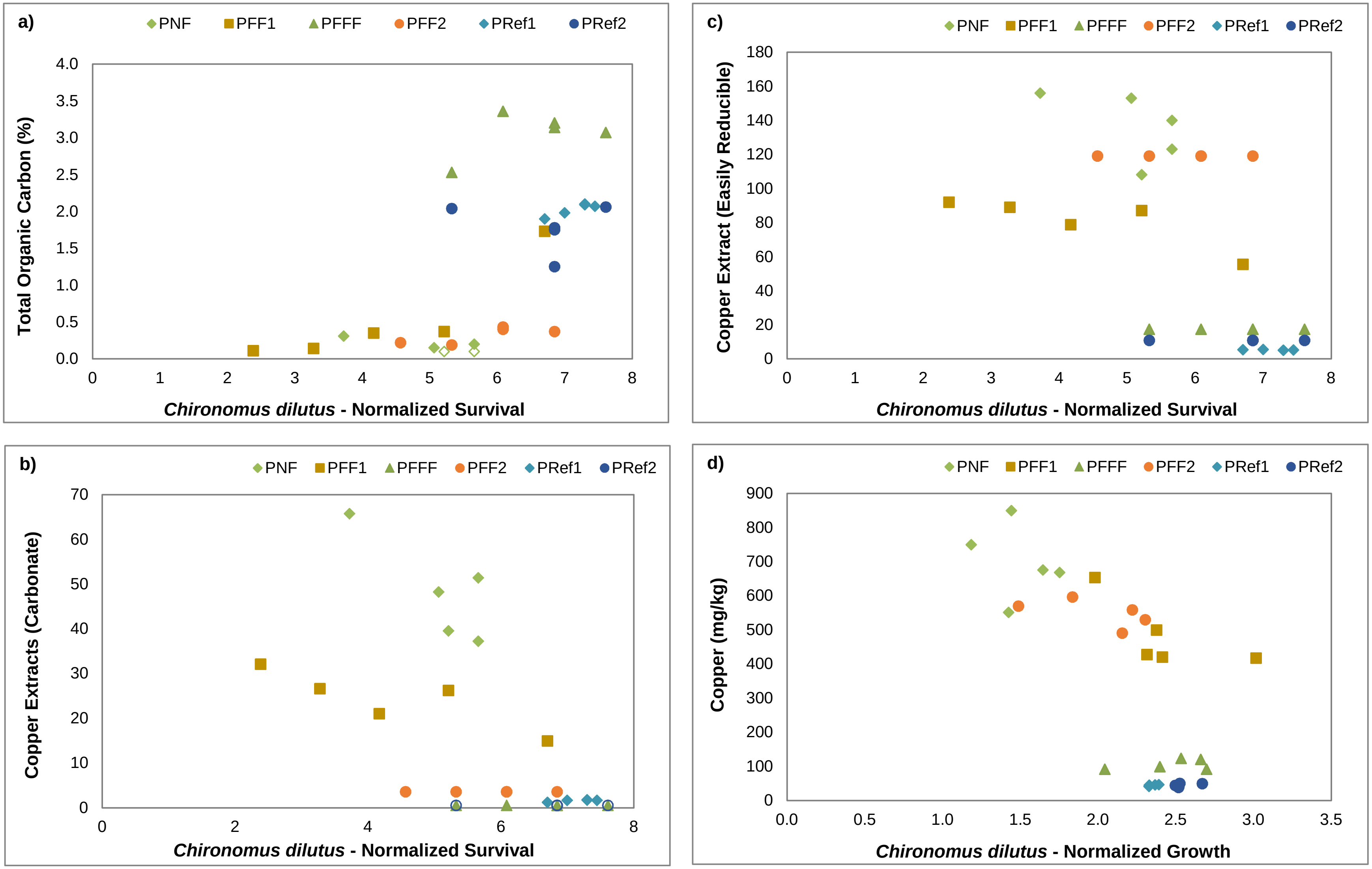
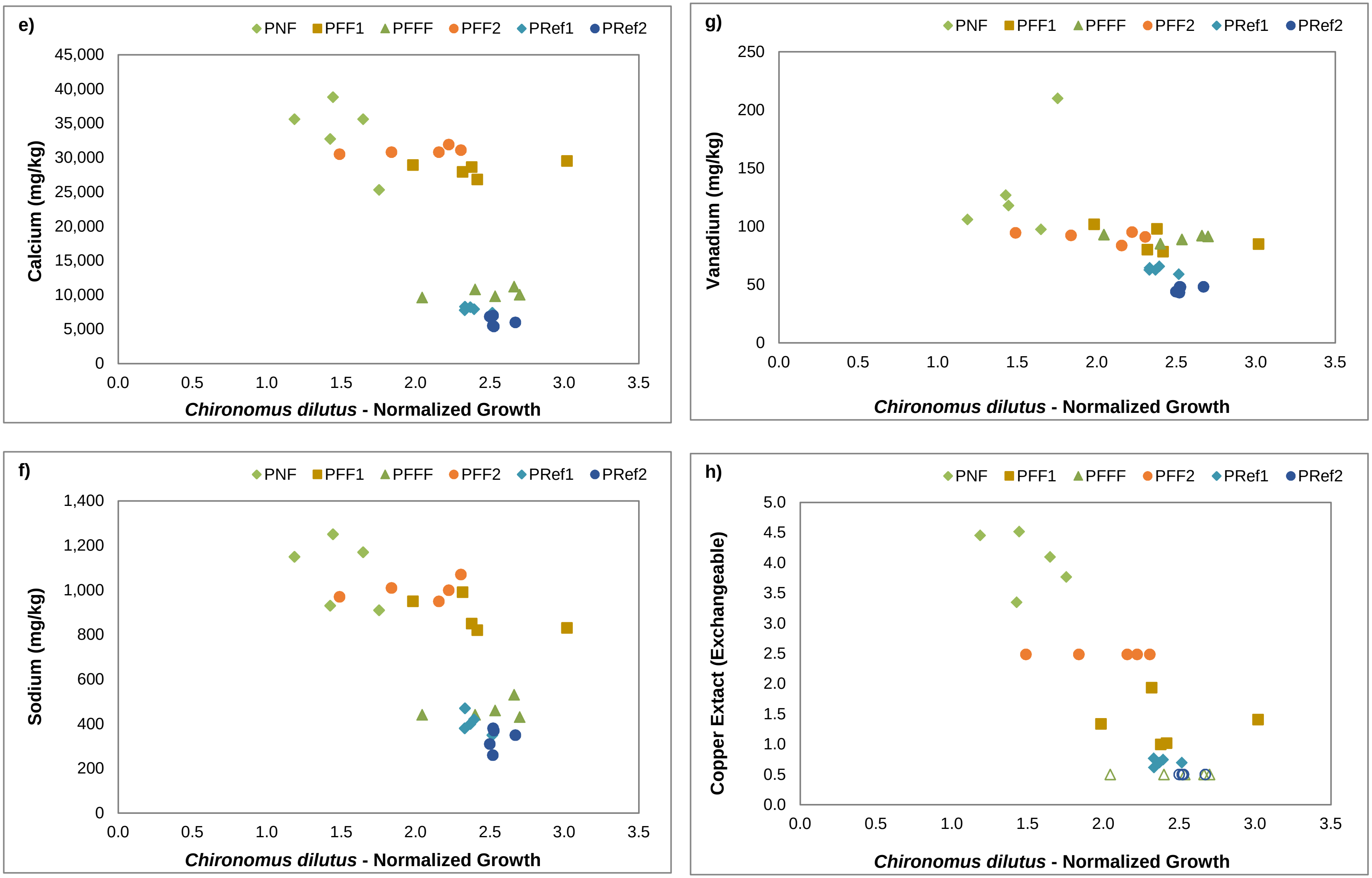


Figure I.9: Scatterplots of significant Spearman's correlation relationships (p < 0.0001) between toxicity endpoints, benthic invertebrate community metrics and physical endpoints, parameters of interest, indicator parameters, PCA axes and copper extracts (Tessier extraction), Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Hollow symbols indicate values < MDL.



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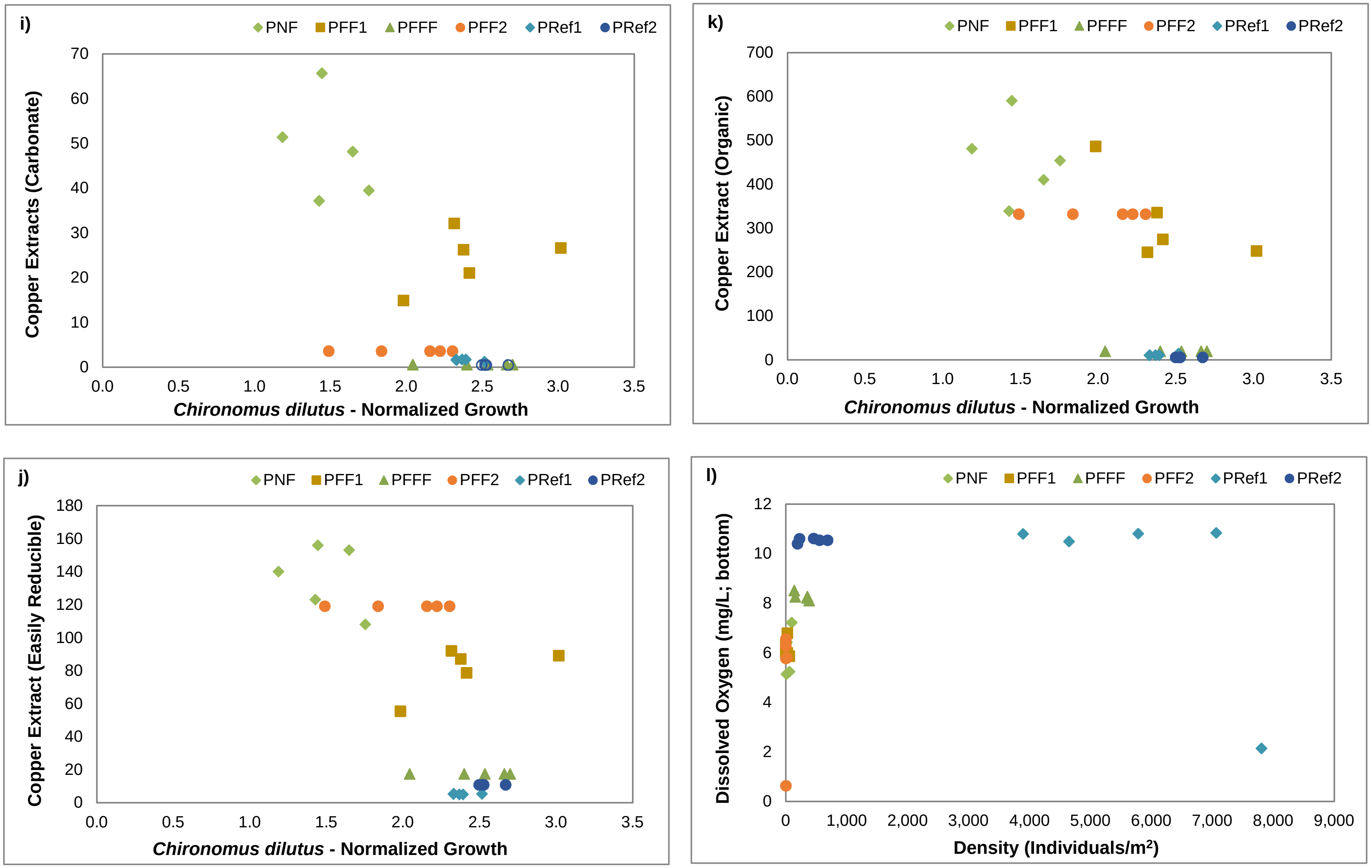

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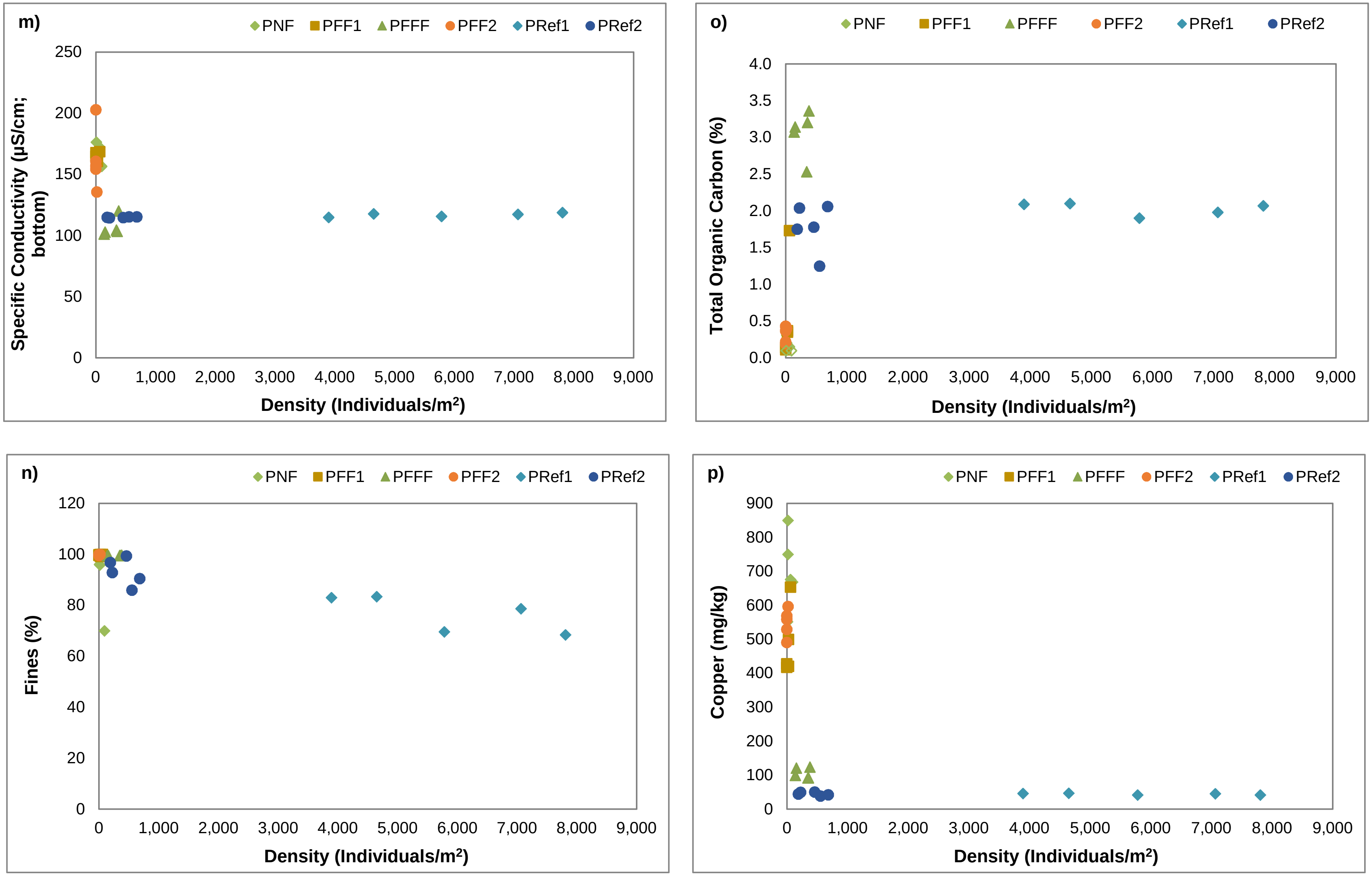

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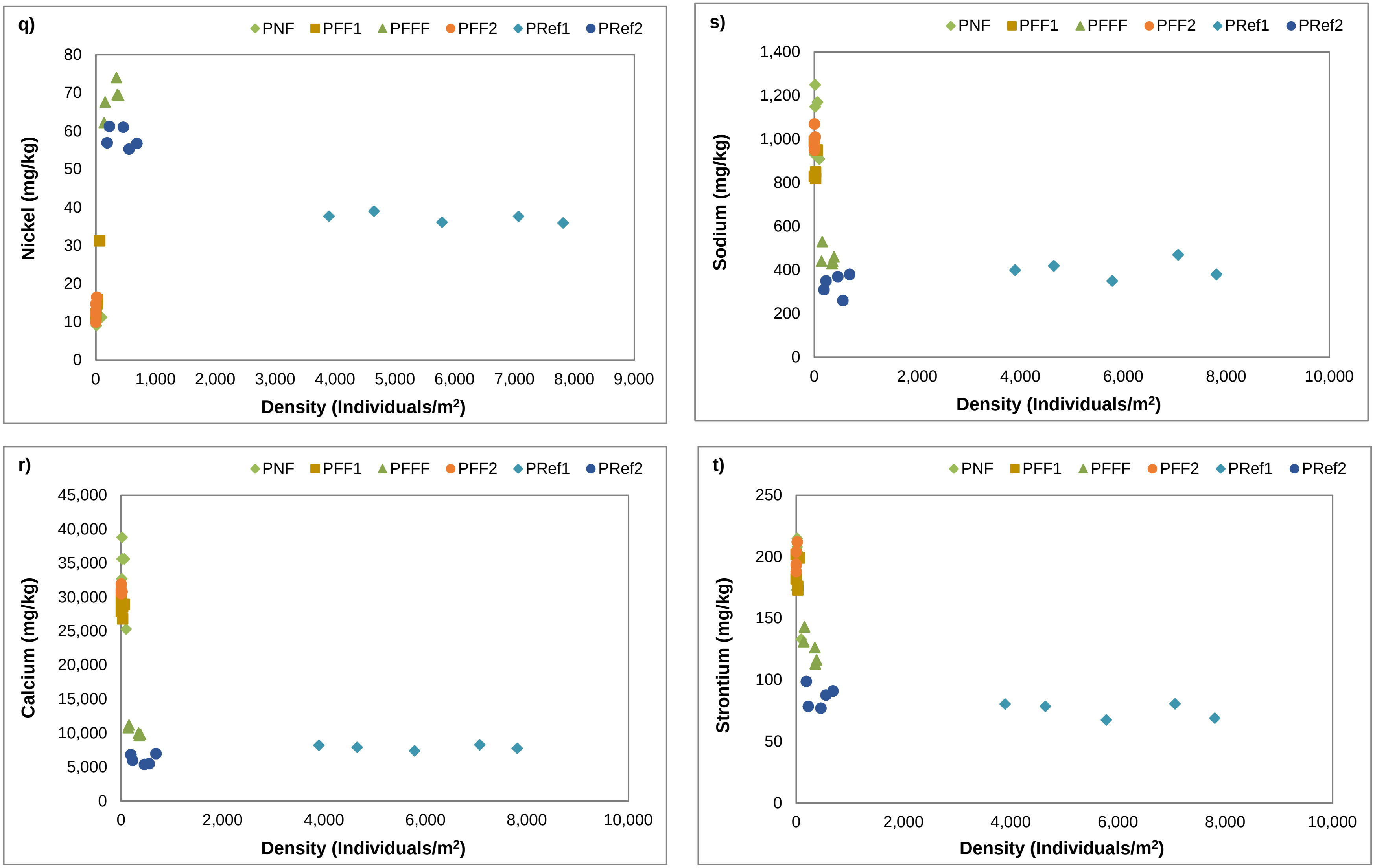

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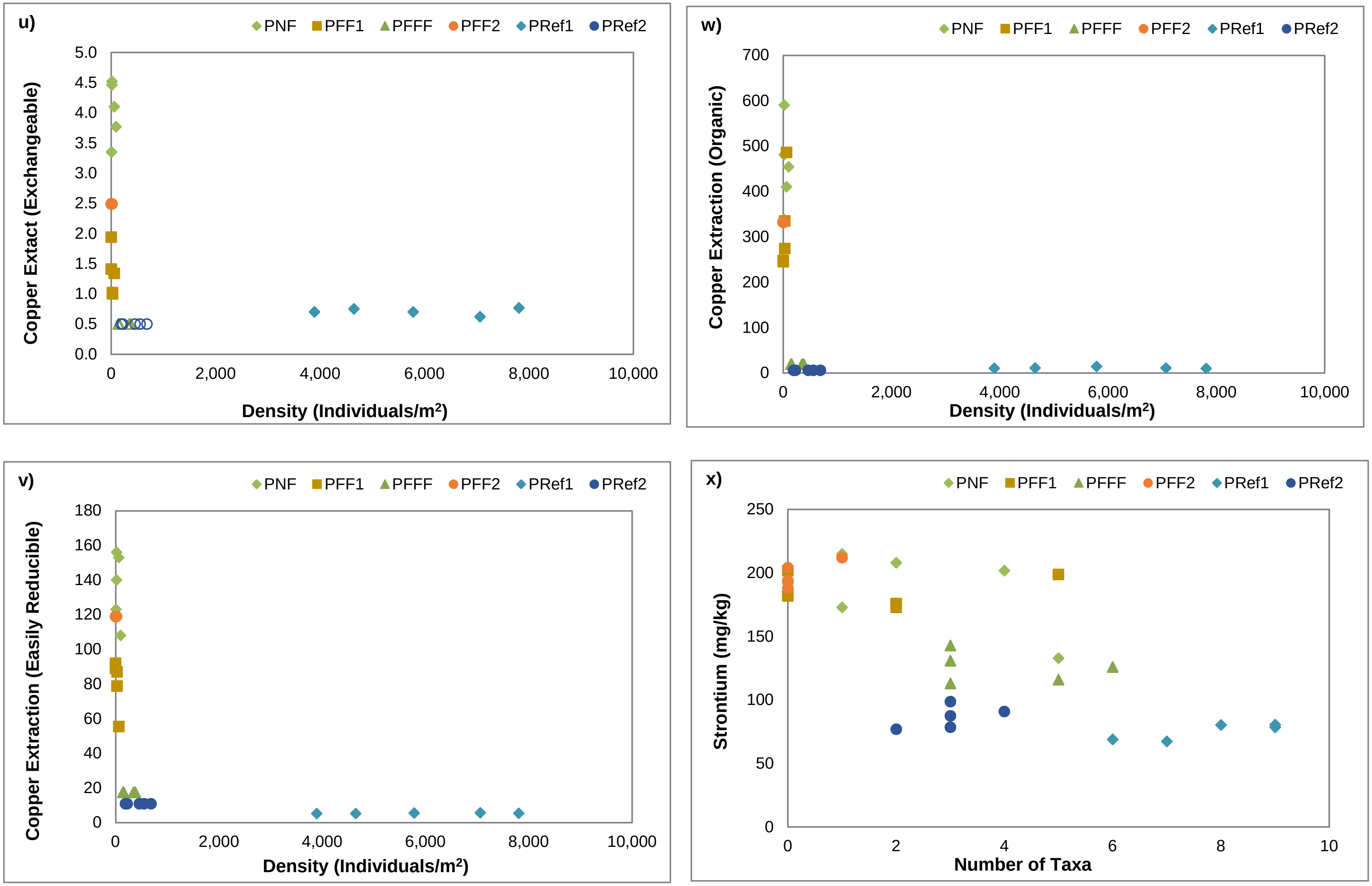

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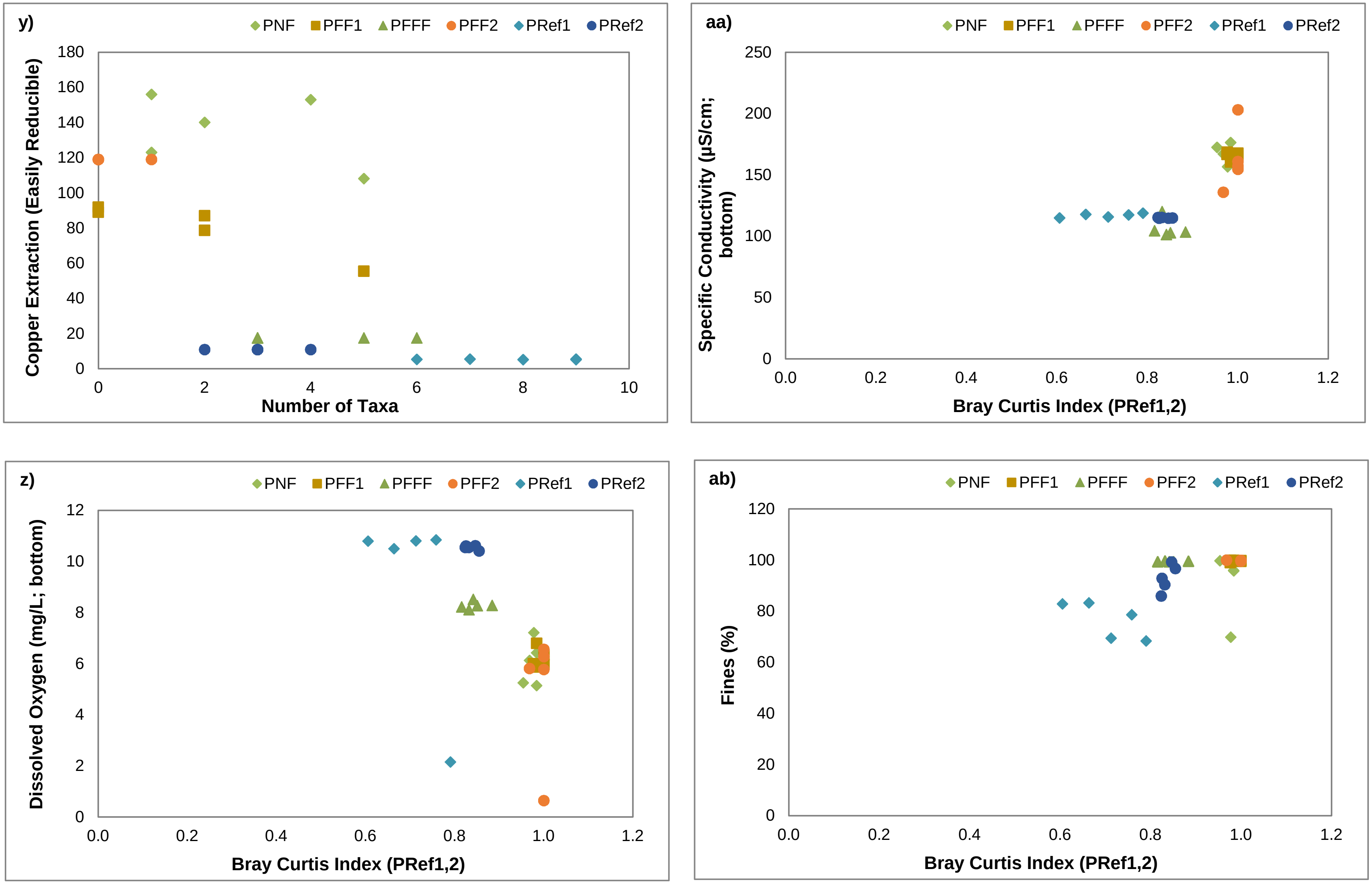

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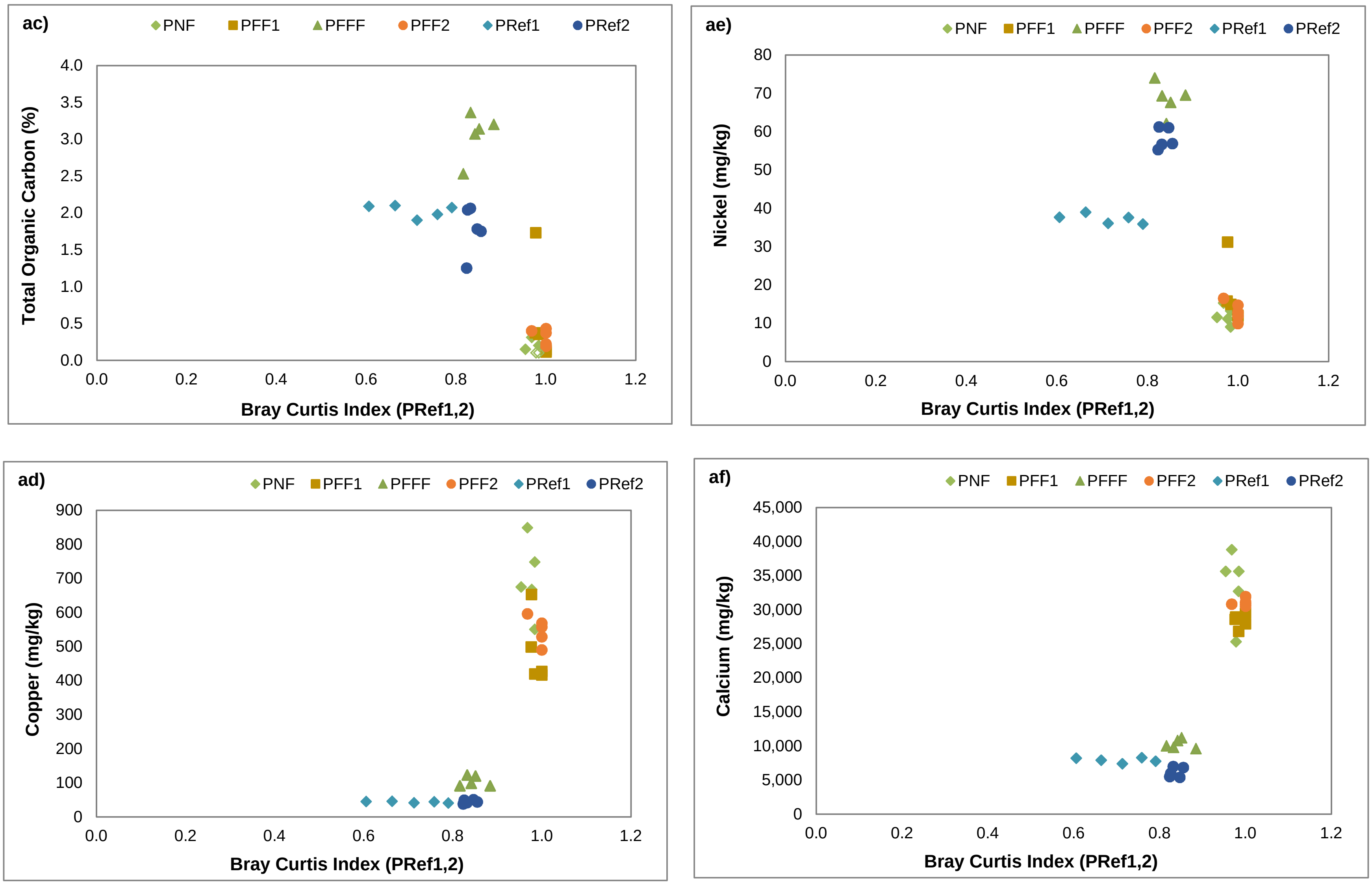

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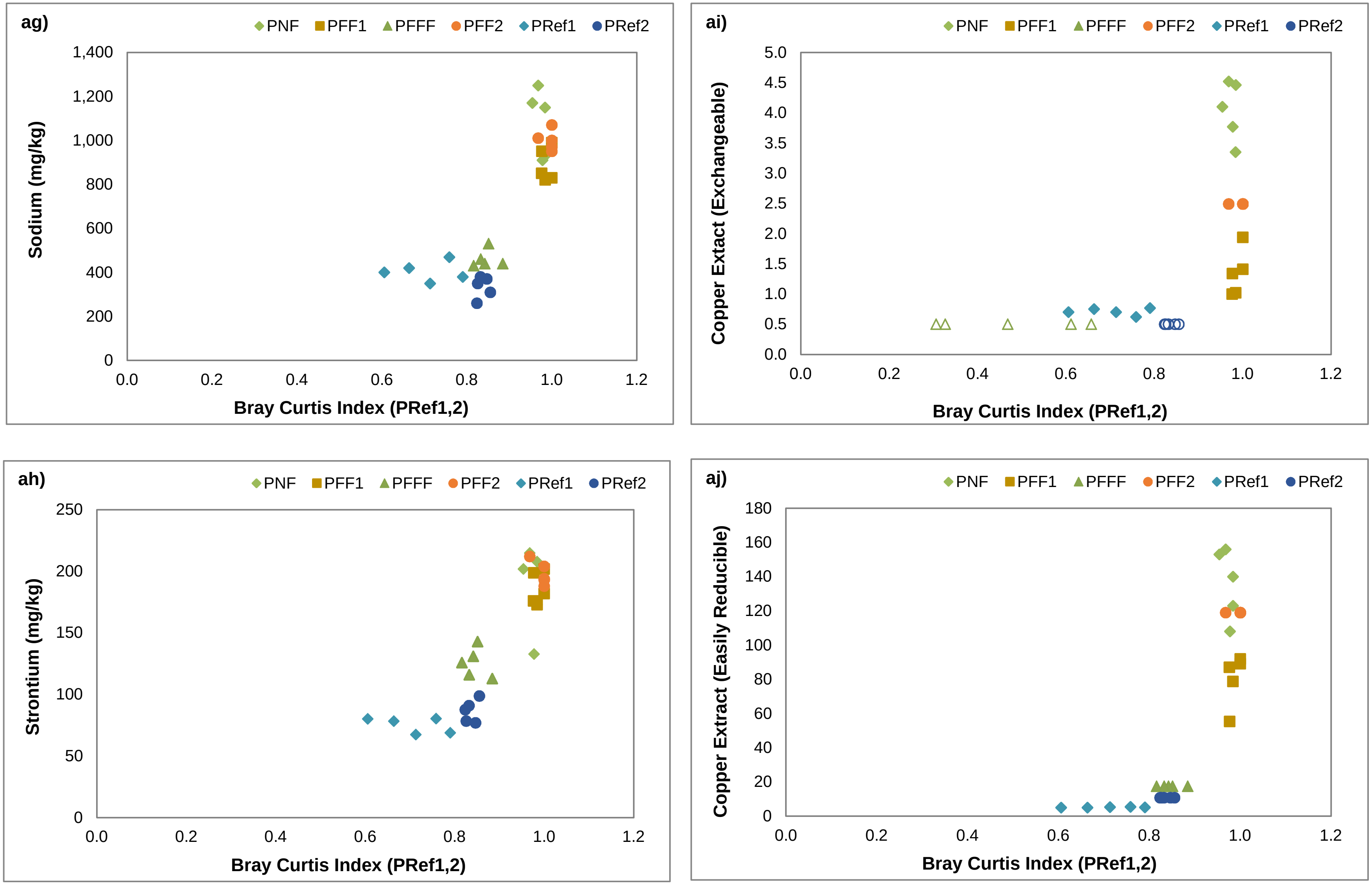

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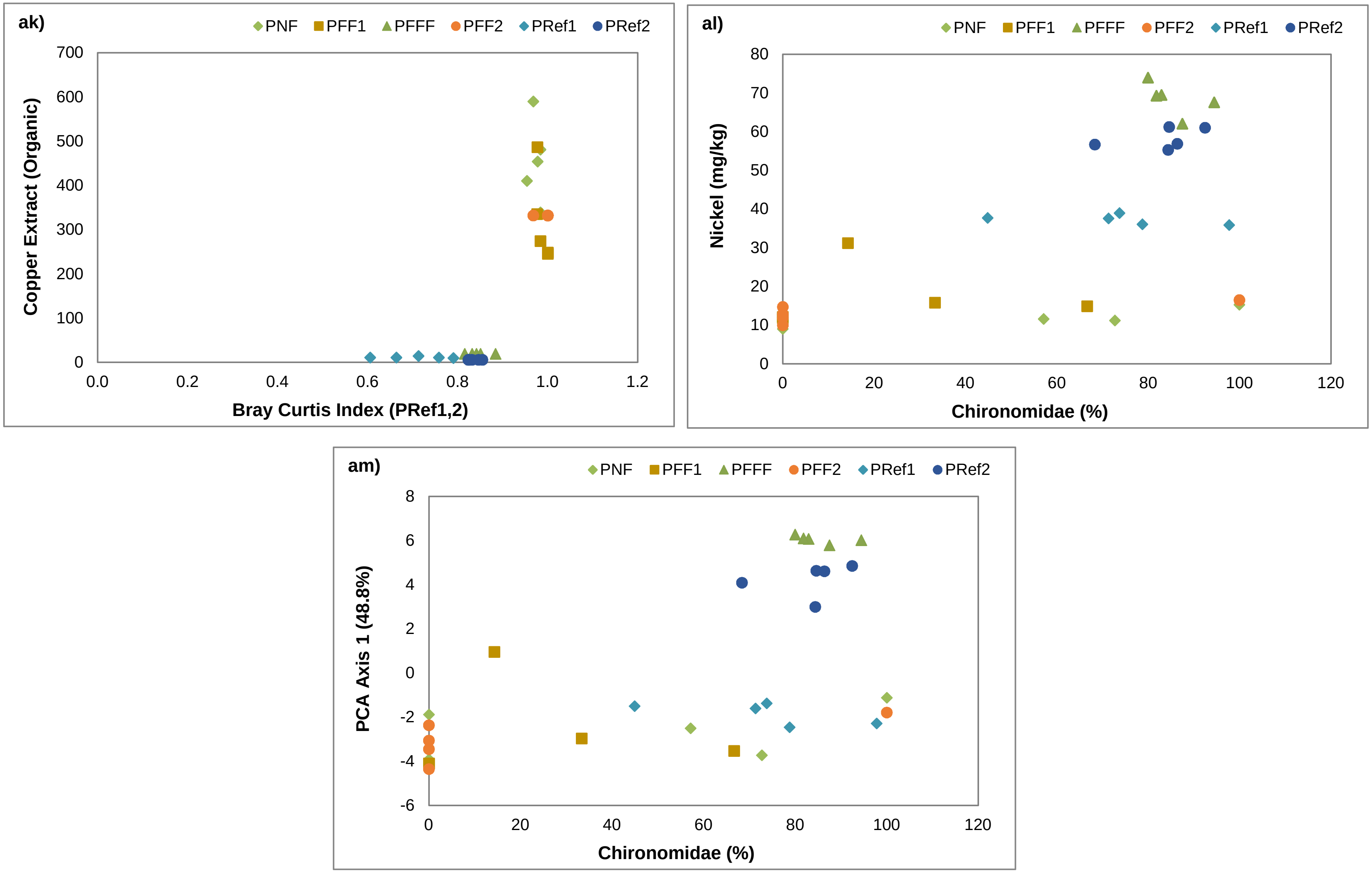

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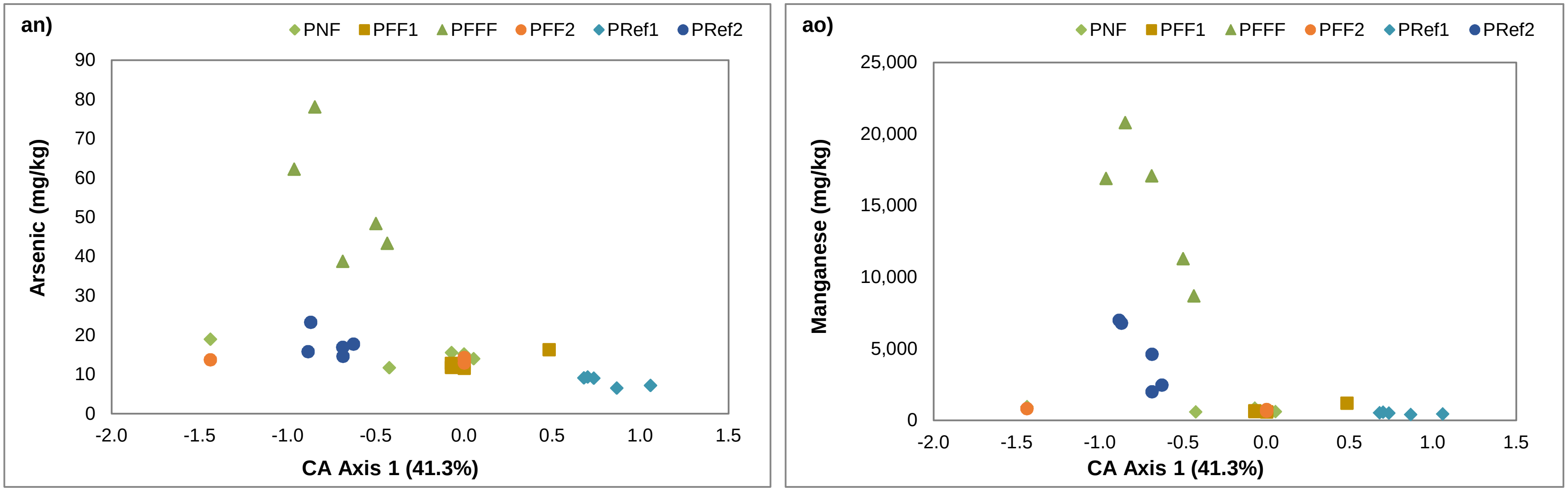

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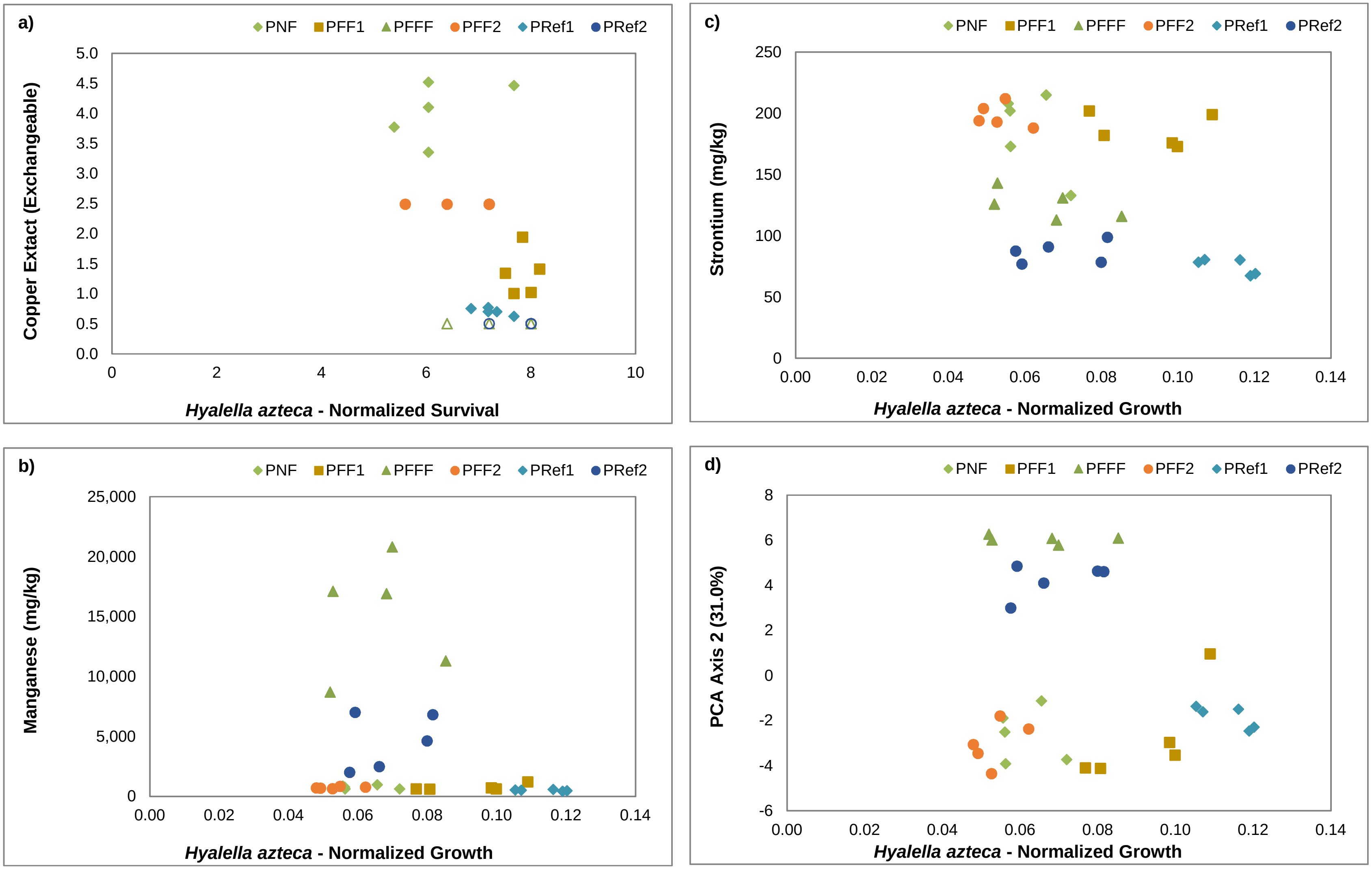
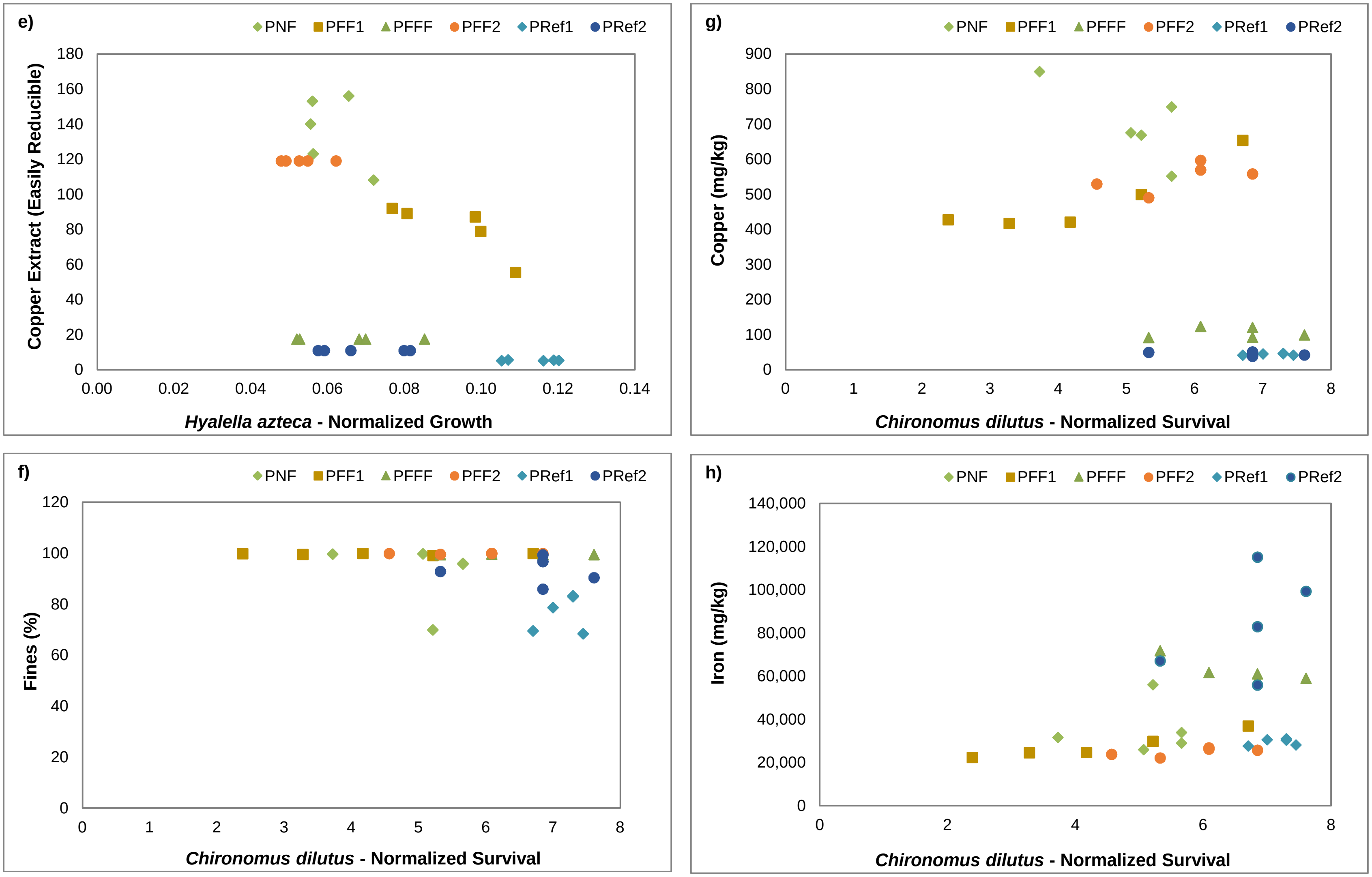


Figure I.10: Scatterplots of Spearman's correlation relationships (p < 0.01) between toxicity endpoints, benthic invertebrate community metrics and physical endpoints, parameters of interest, indicator parameters, PCA axes and copper extracts (Tessier extraction), Quesnel Lake profundal sampling areas, Mount Polley Mine, 2014. Hollow symbols indicate values < MDL.



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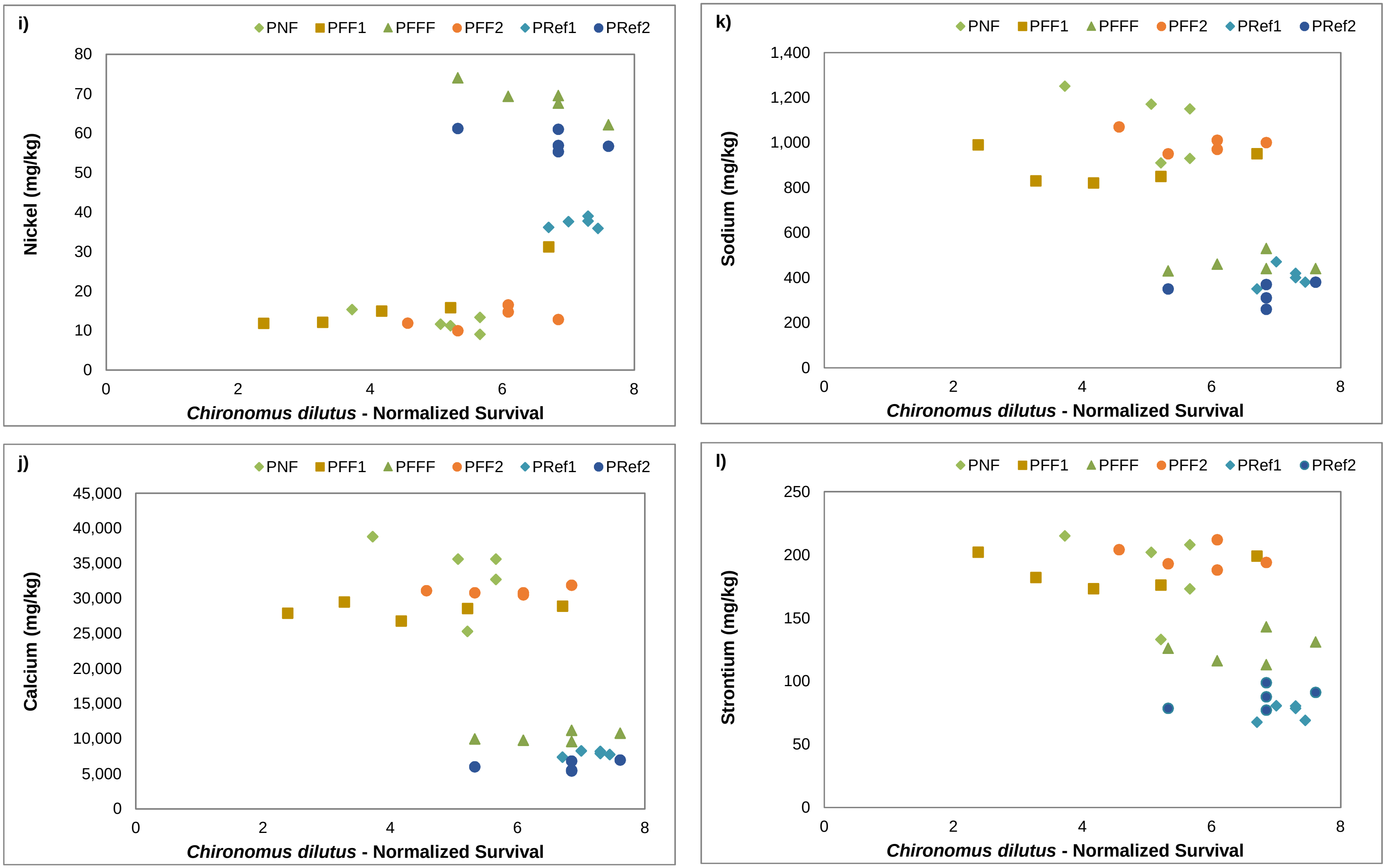

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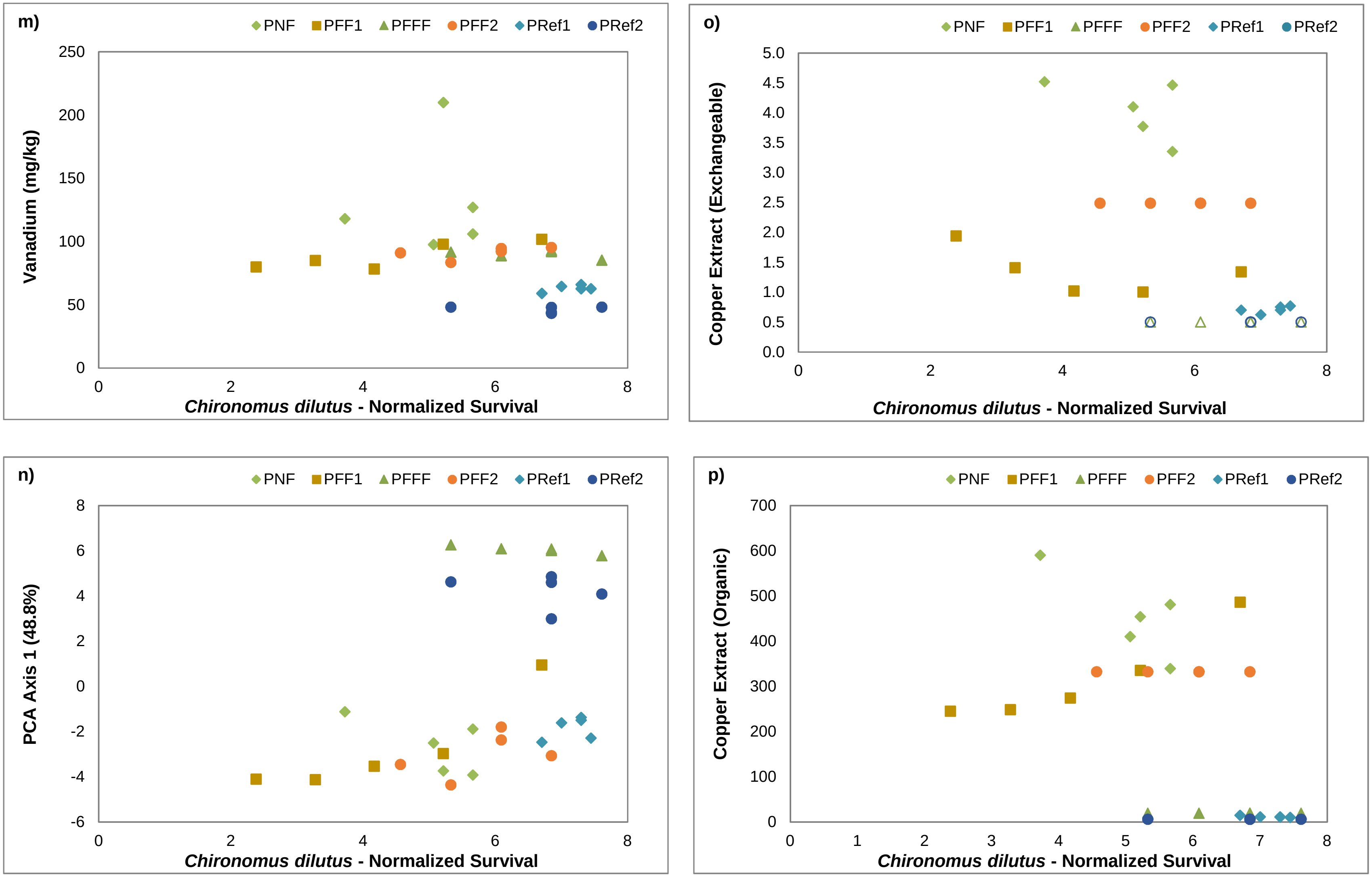

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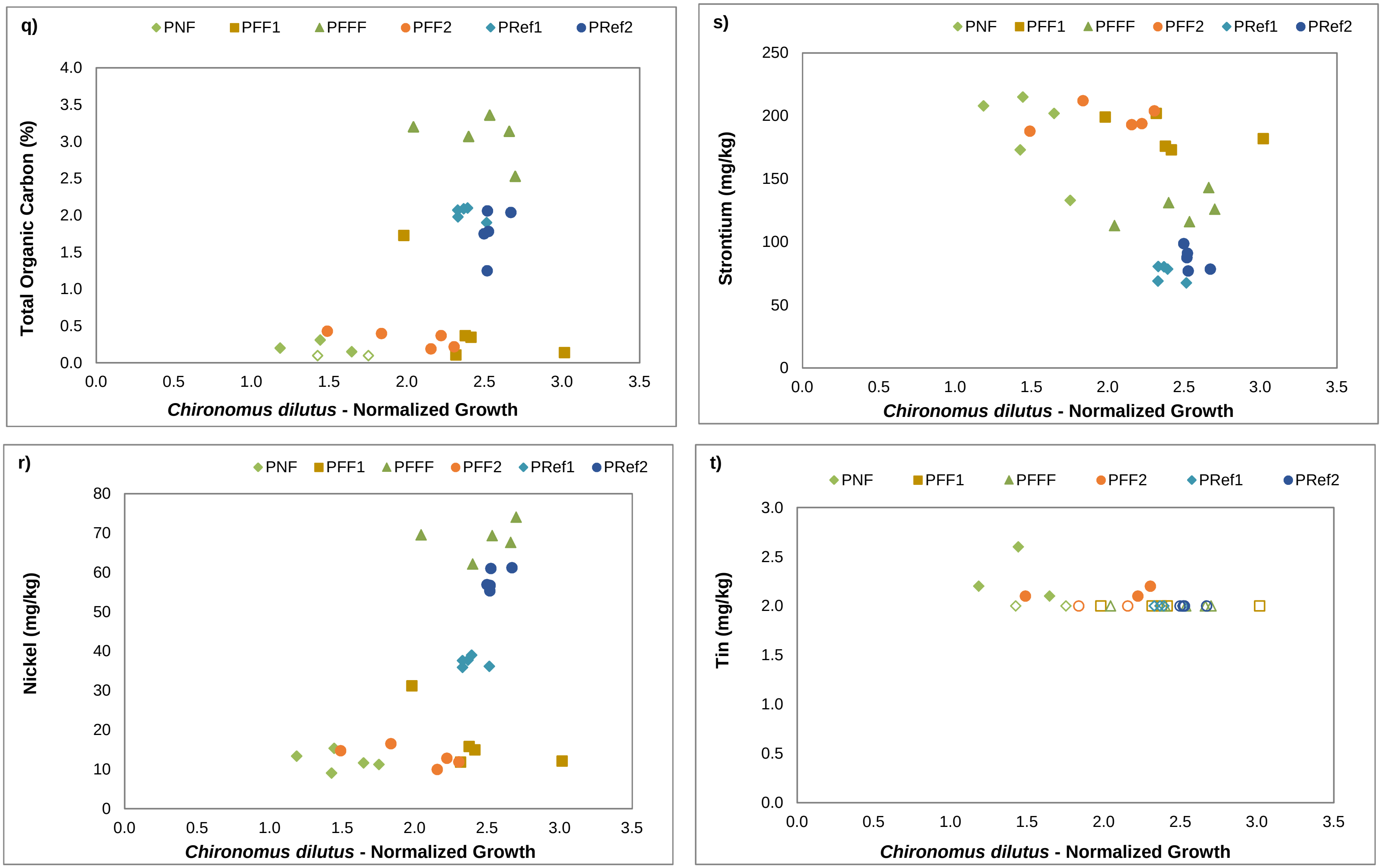

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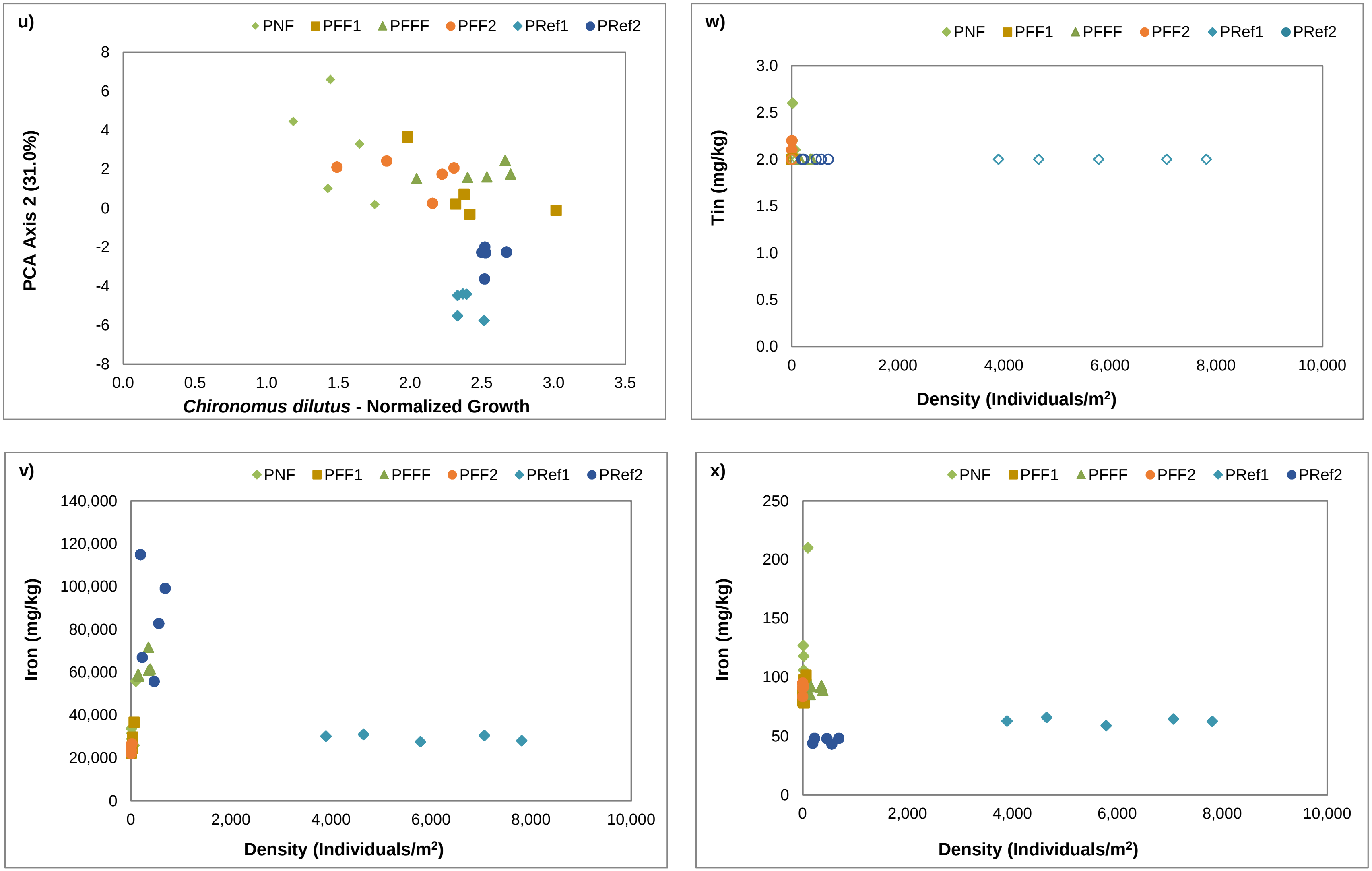

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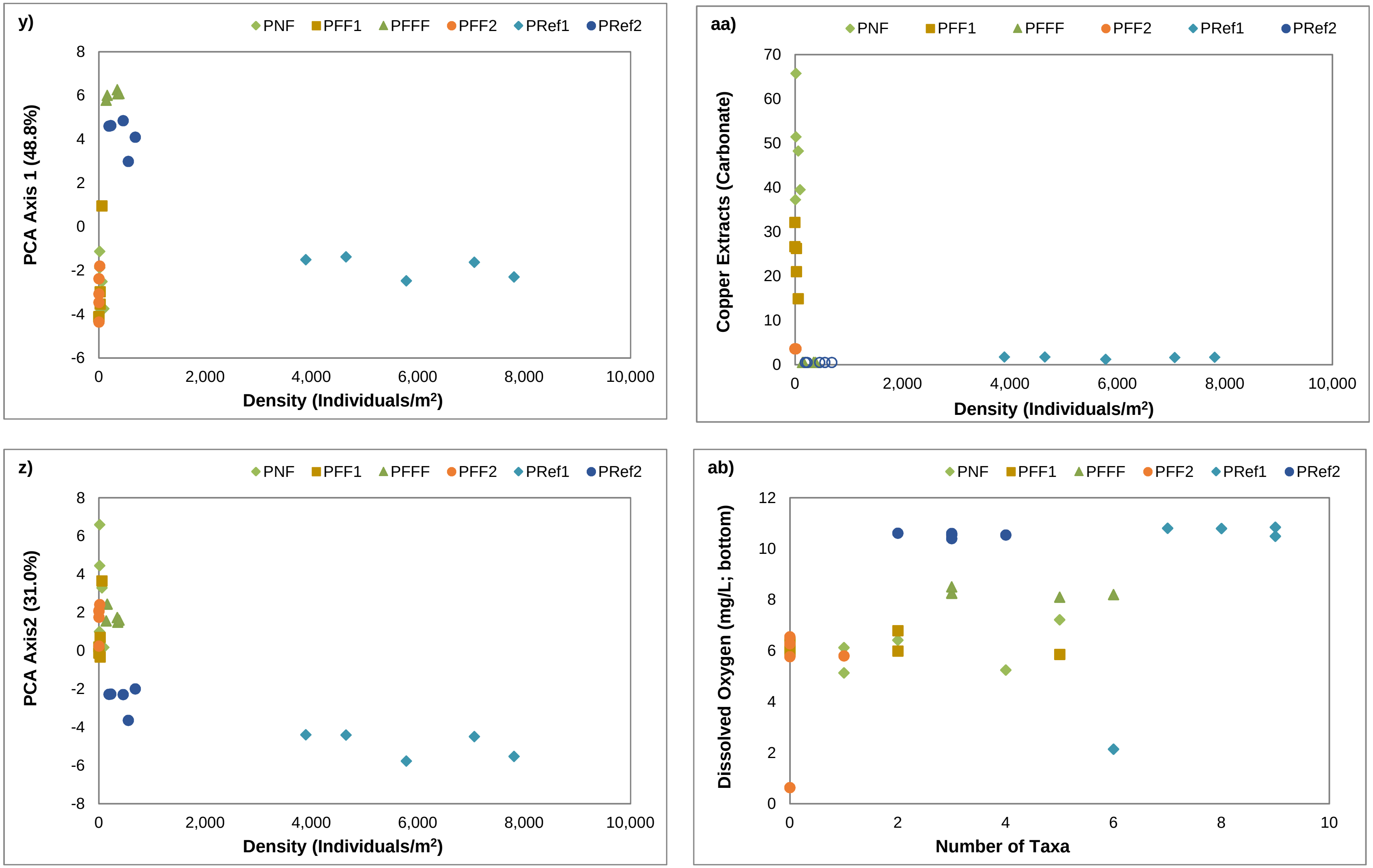

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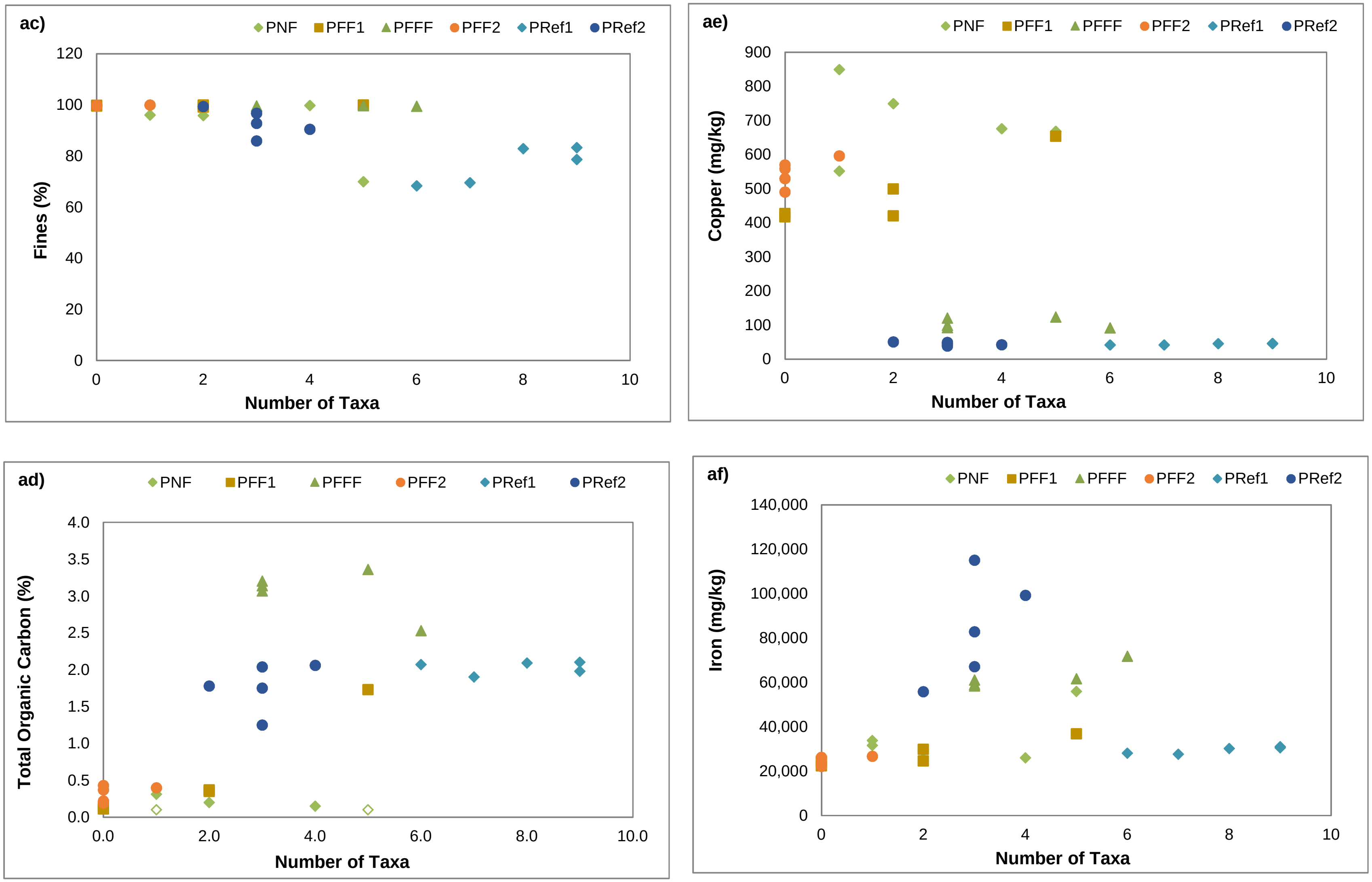

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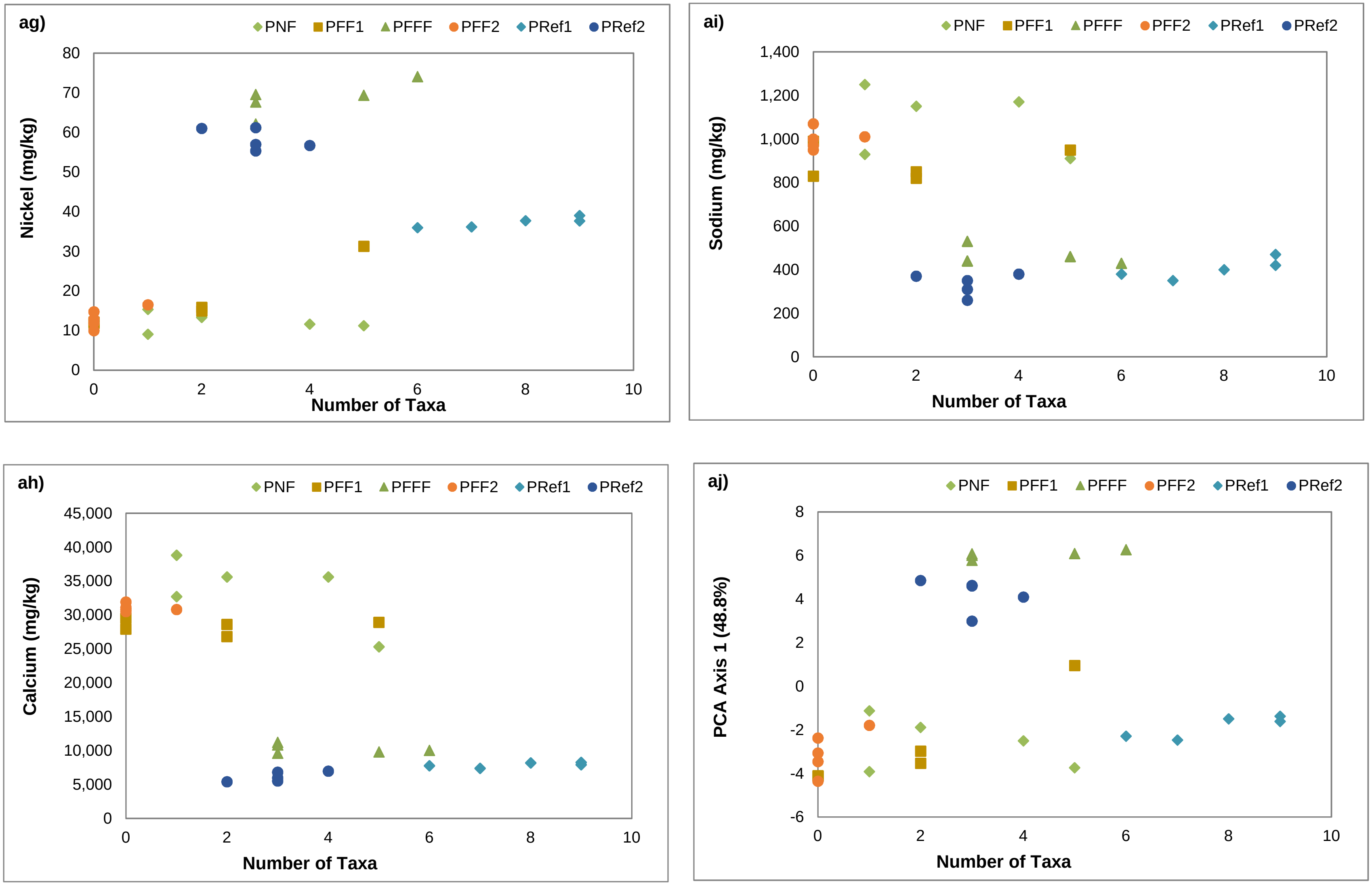

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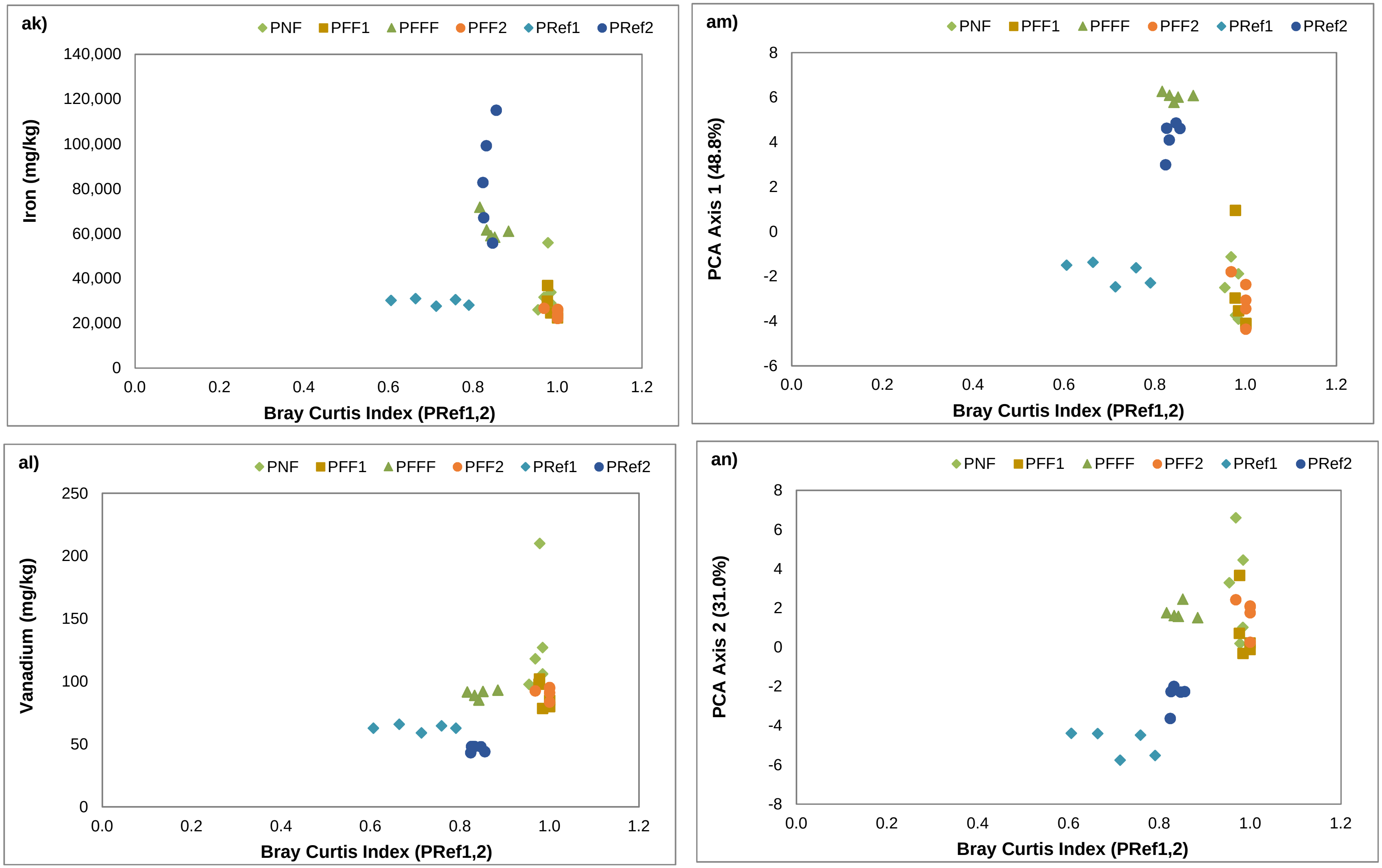

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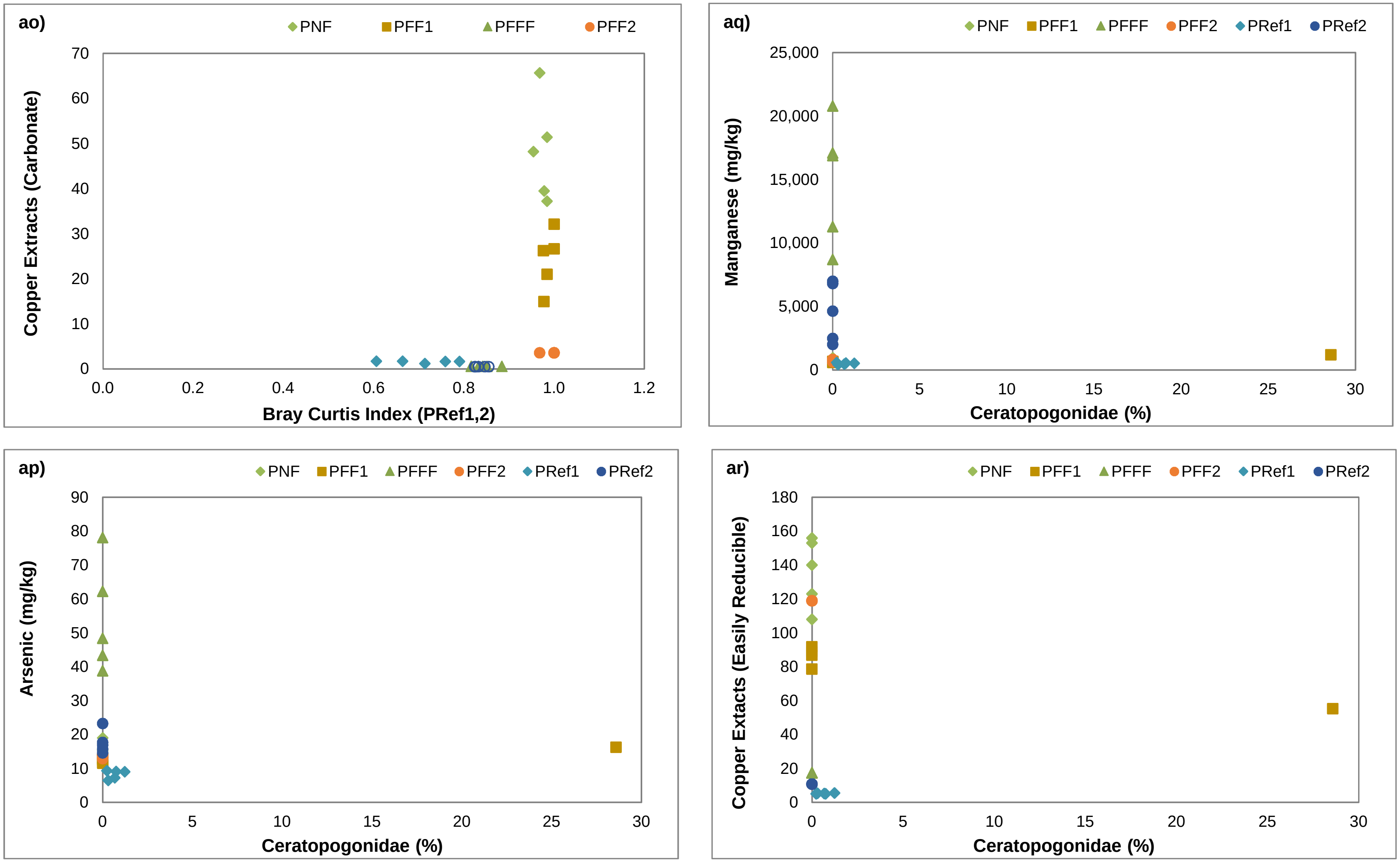

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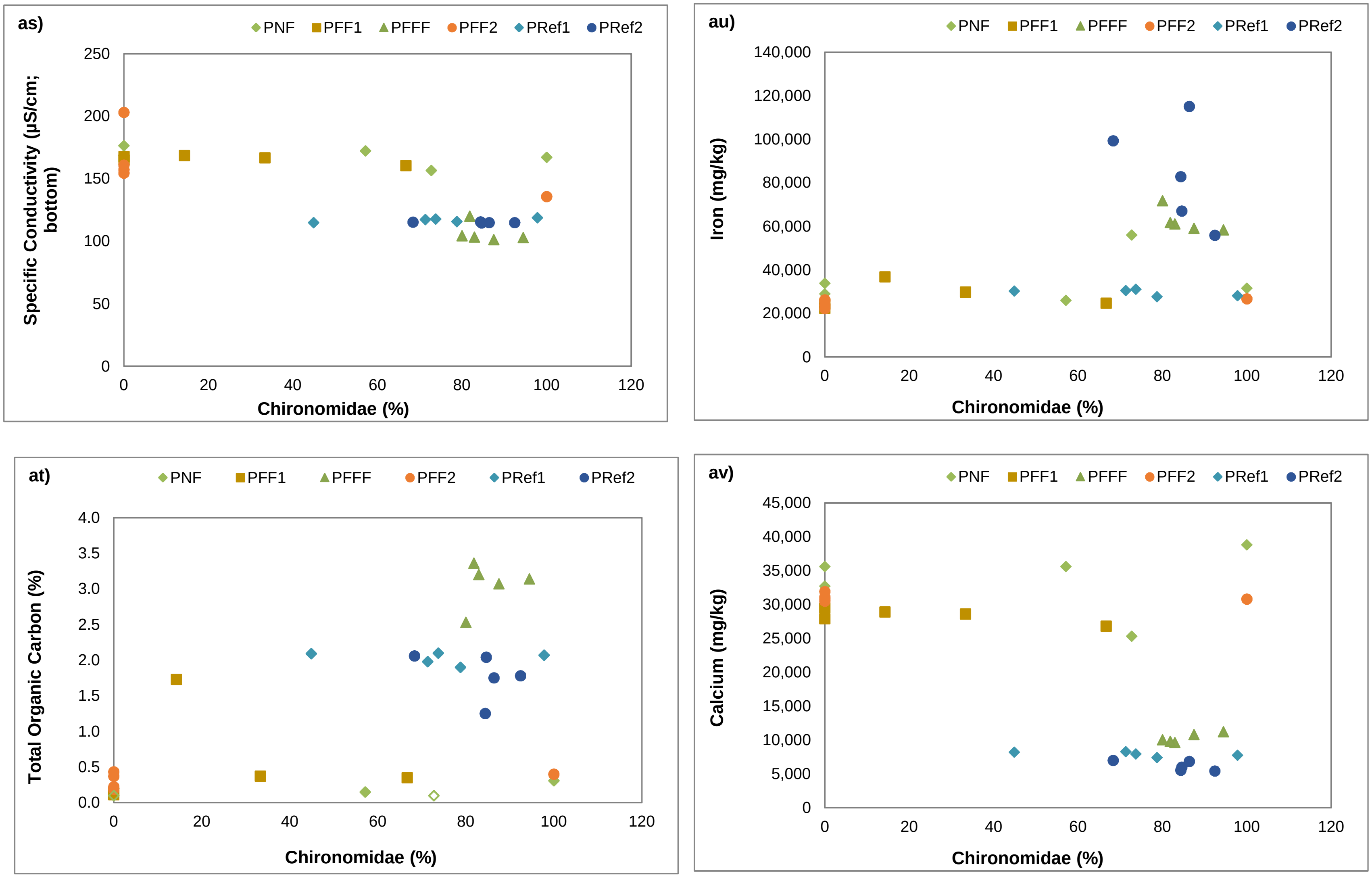

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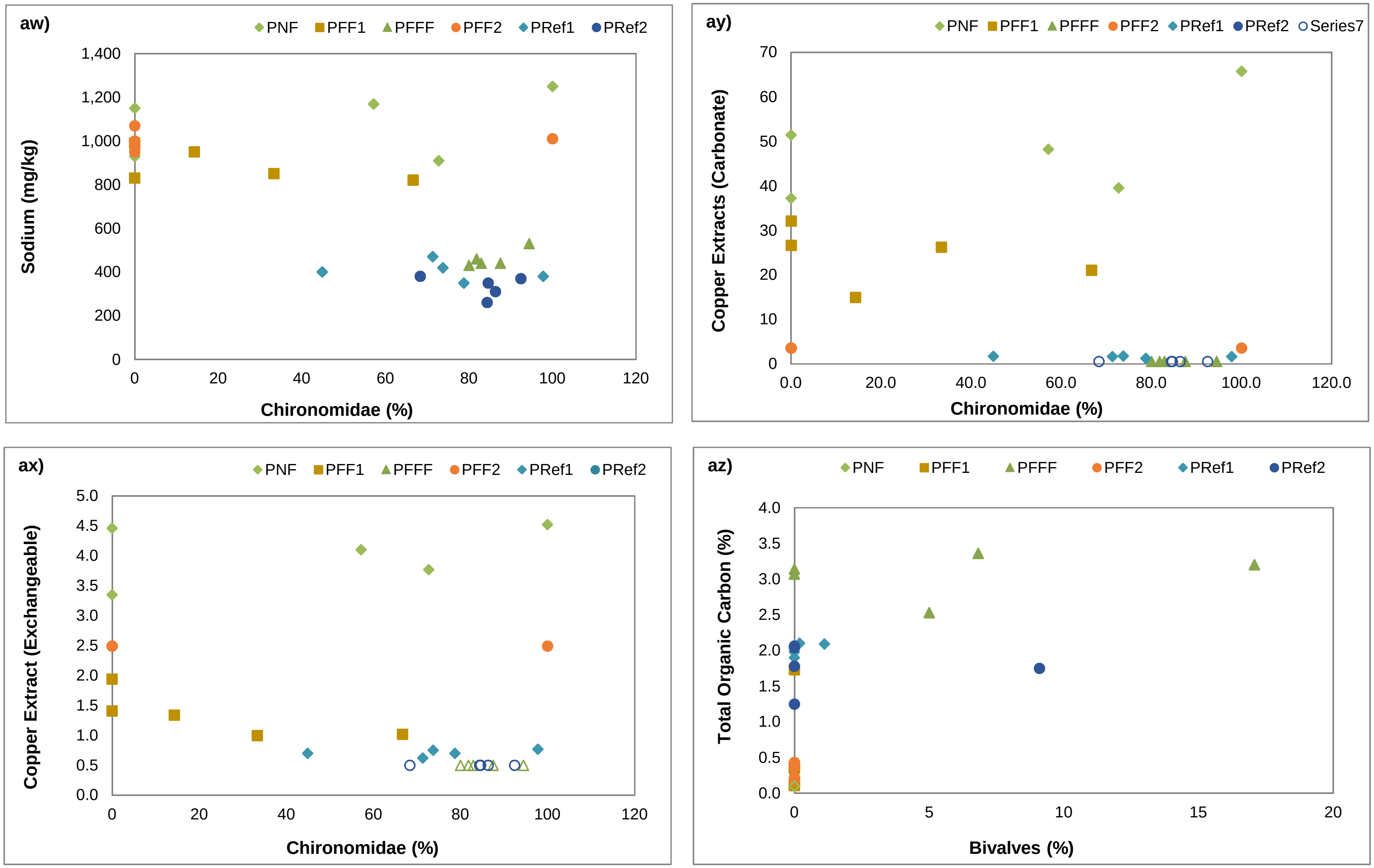

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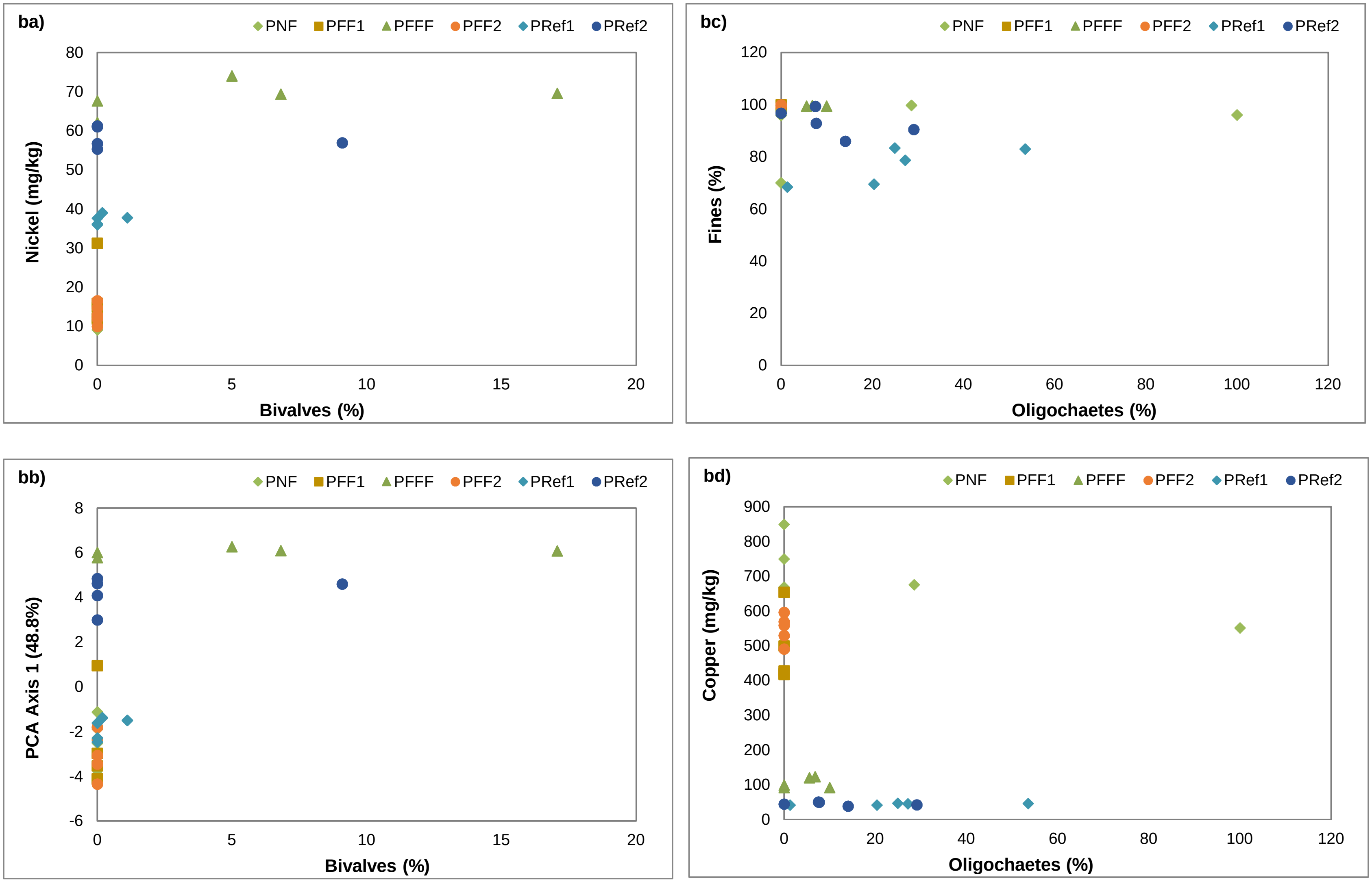

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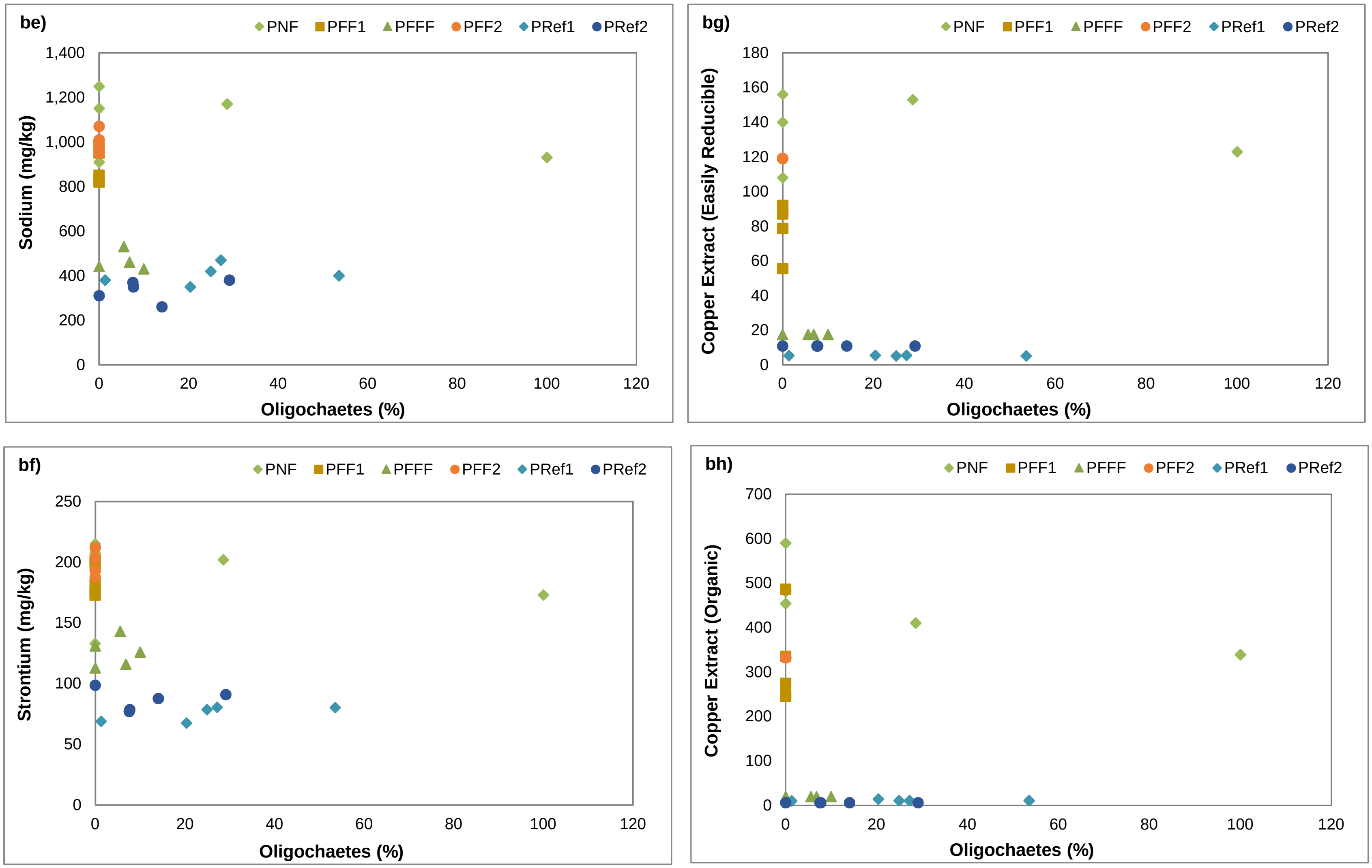

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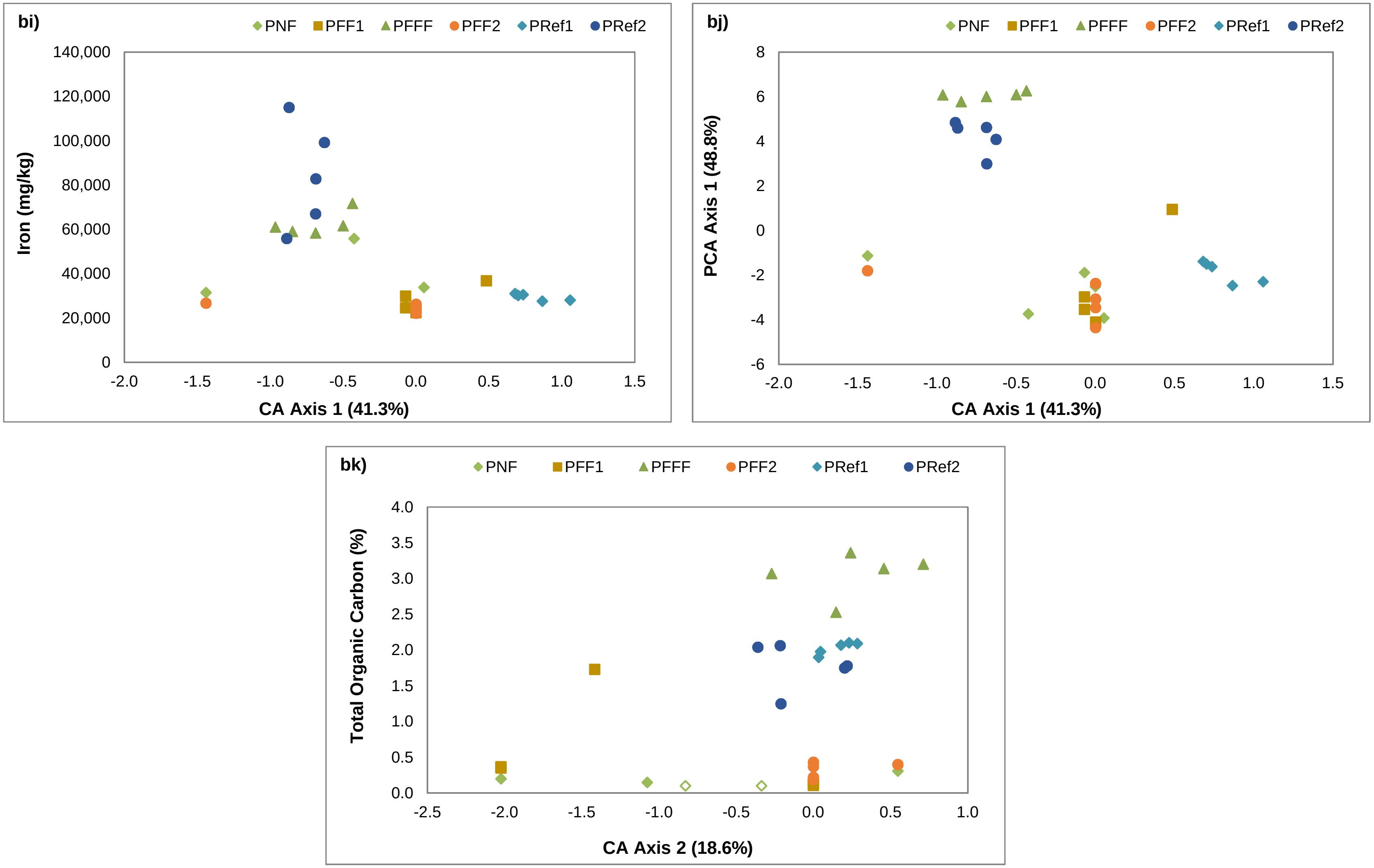

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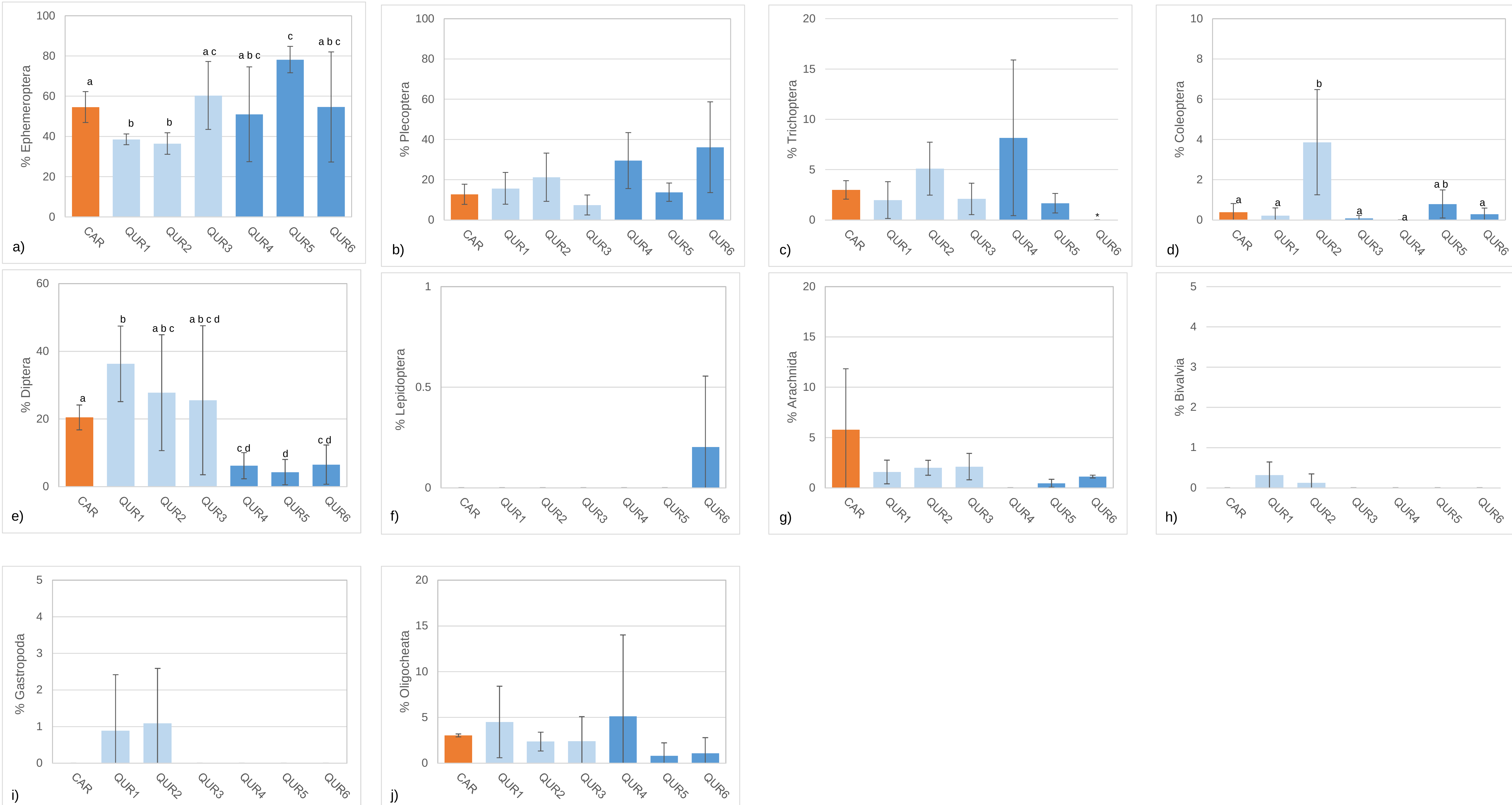


Figure I.11: **Bar charts of major groups for CAR reference (orange) and Quesnel River (blue) areas. Mean values ± one standard deviation are dispayed, letters above whiskers identify statistical difference (i.e. areas that do not share a common letter are statistically different, no letter indicates non-significant ANOVA). Light and dark blue colouring represents upper and lower reaches of the Quesnel River, respectively. Mount Polley Mine, 2014.**

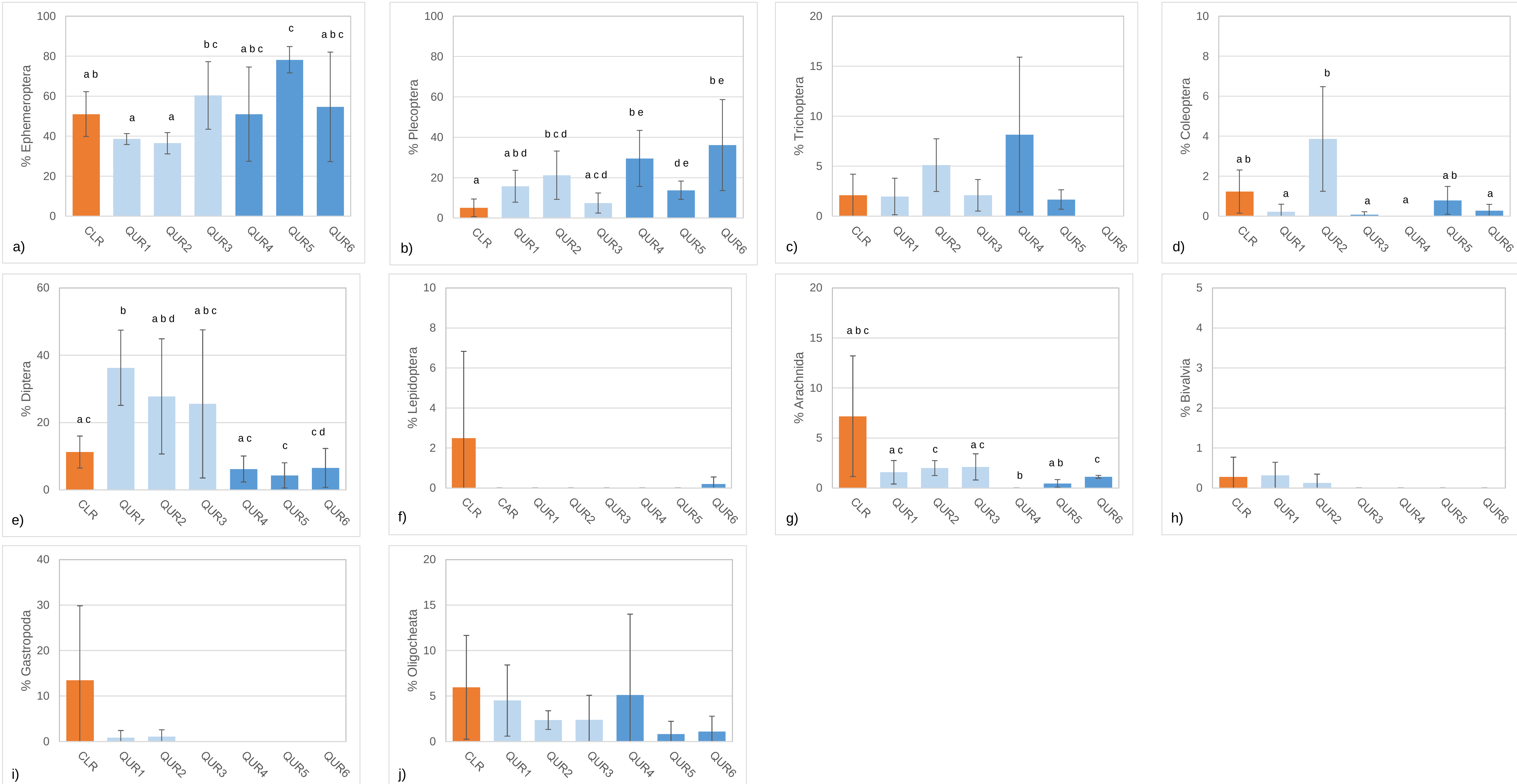


Figure I.12: Bar charts of major groups for CLR reference (orange) and Quesnel River (blue) areas. Mean values ± one standard deviation are dispayed, letters above whiskers identify statistical difference (i.e. areas that do not share a common letter are statistically different, no letter indicates non-significant ANOVA). Light and dark blue colouring represents upper and lower reaches of the Quesnel River, respectively. Mount Polley Mine, 2014.

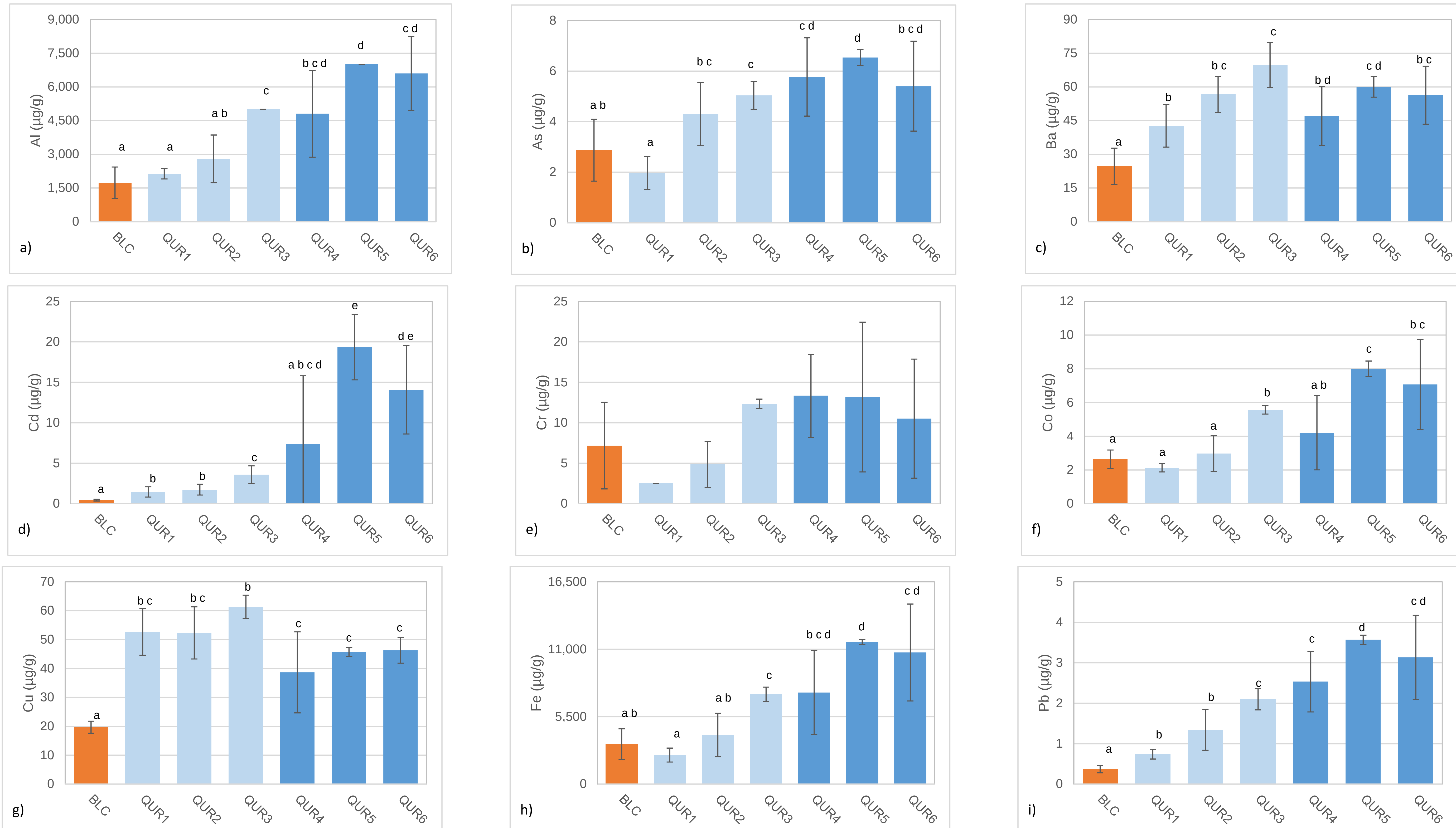
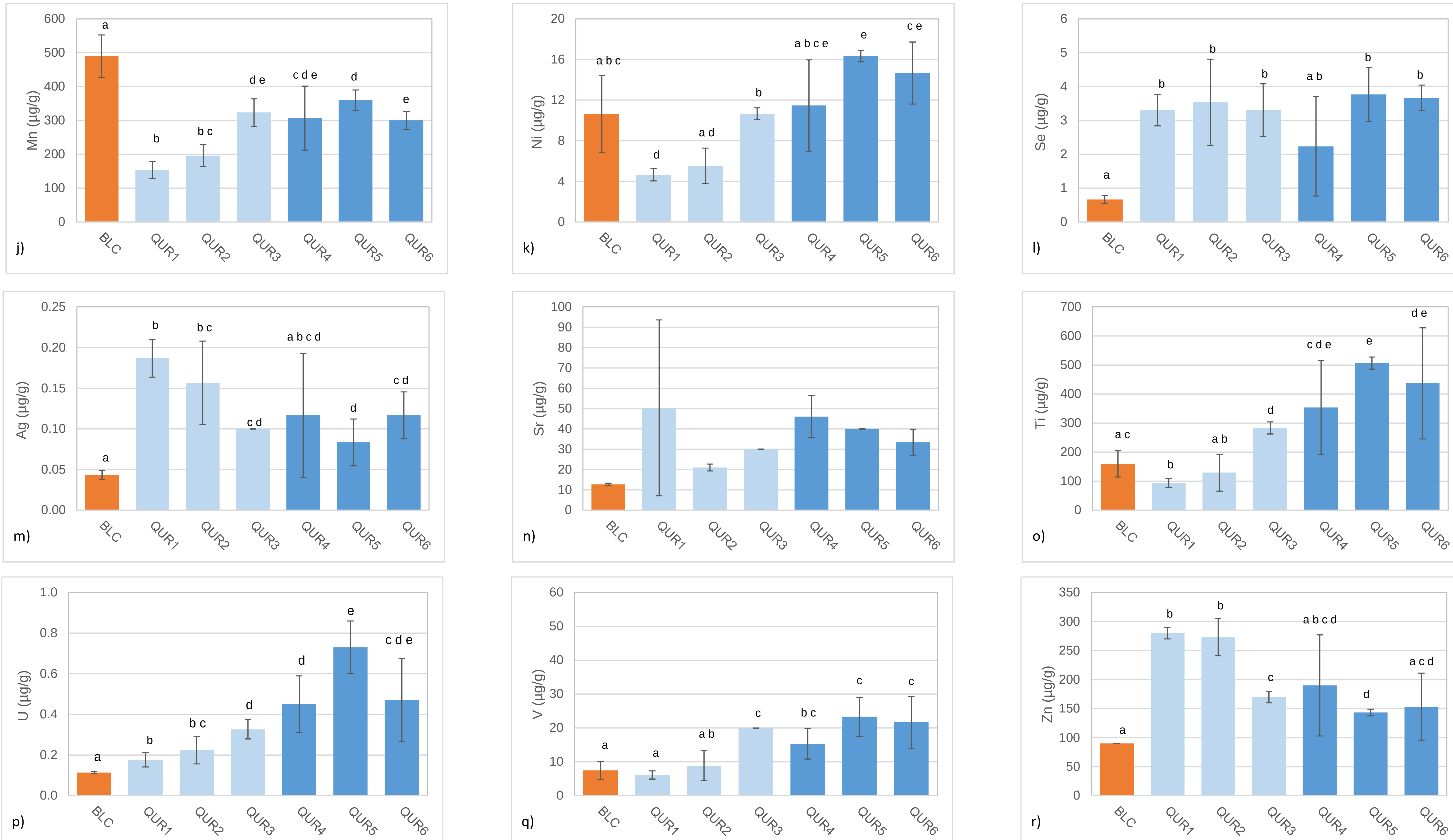


Figure I.13: Bar charts of metal and metalloid concentrations in community benthic invertebrate tissue samples for BLC reference (orange) and Quesnel River (blue) areas. Mean values ± one standard deviation are dispayed, letters above whiskers identify statistical difference (i.e. areas that do not share a common letter are statistically different, no letter indicates non-significant ANOVA). Light and dark blue colouring represents upper and lower reaches of the Quesnel River, respectively. Mount Polley Mine, 2014.



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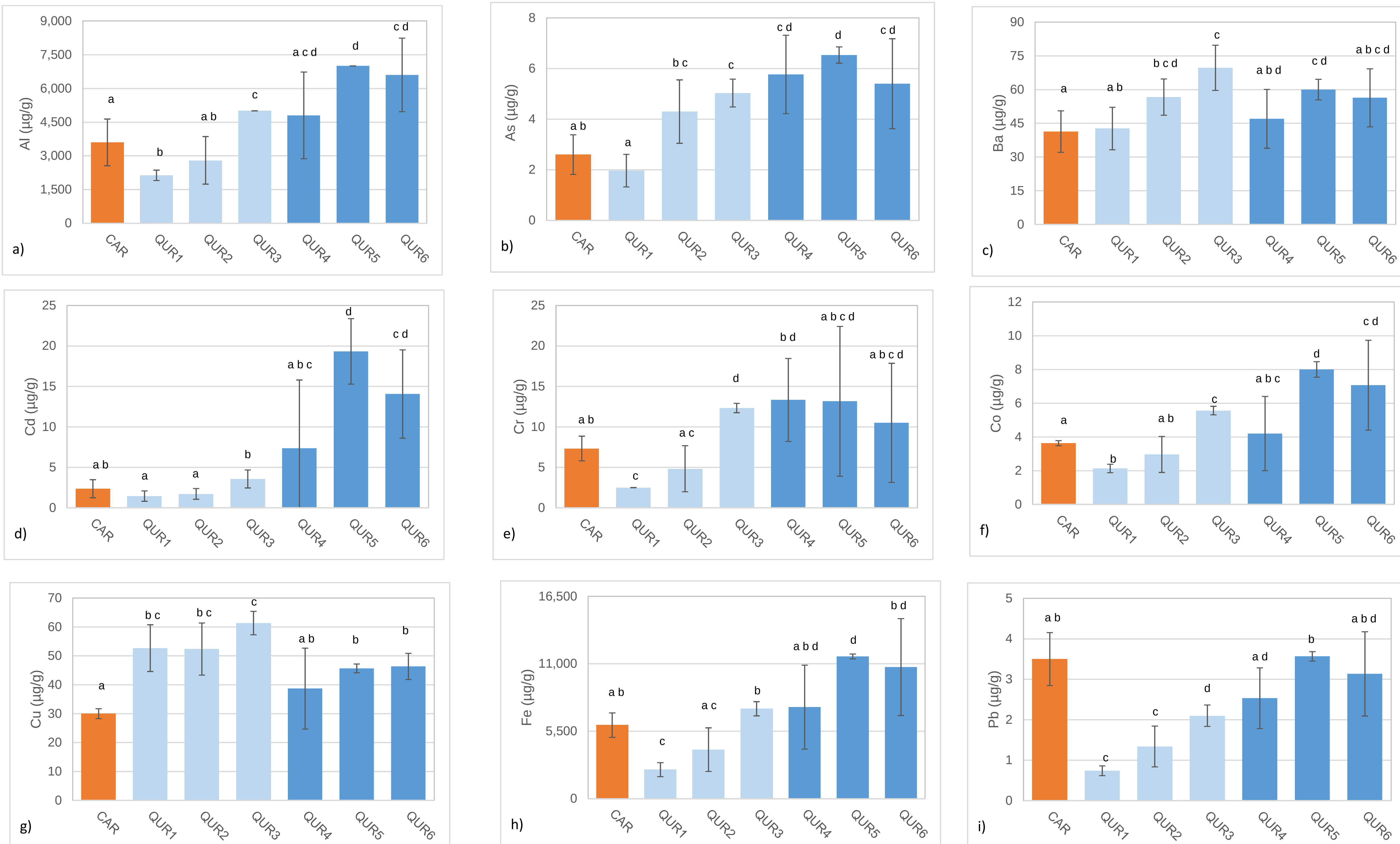
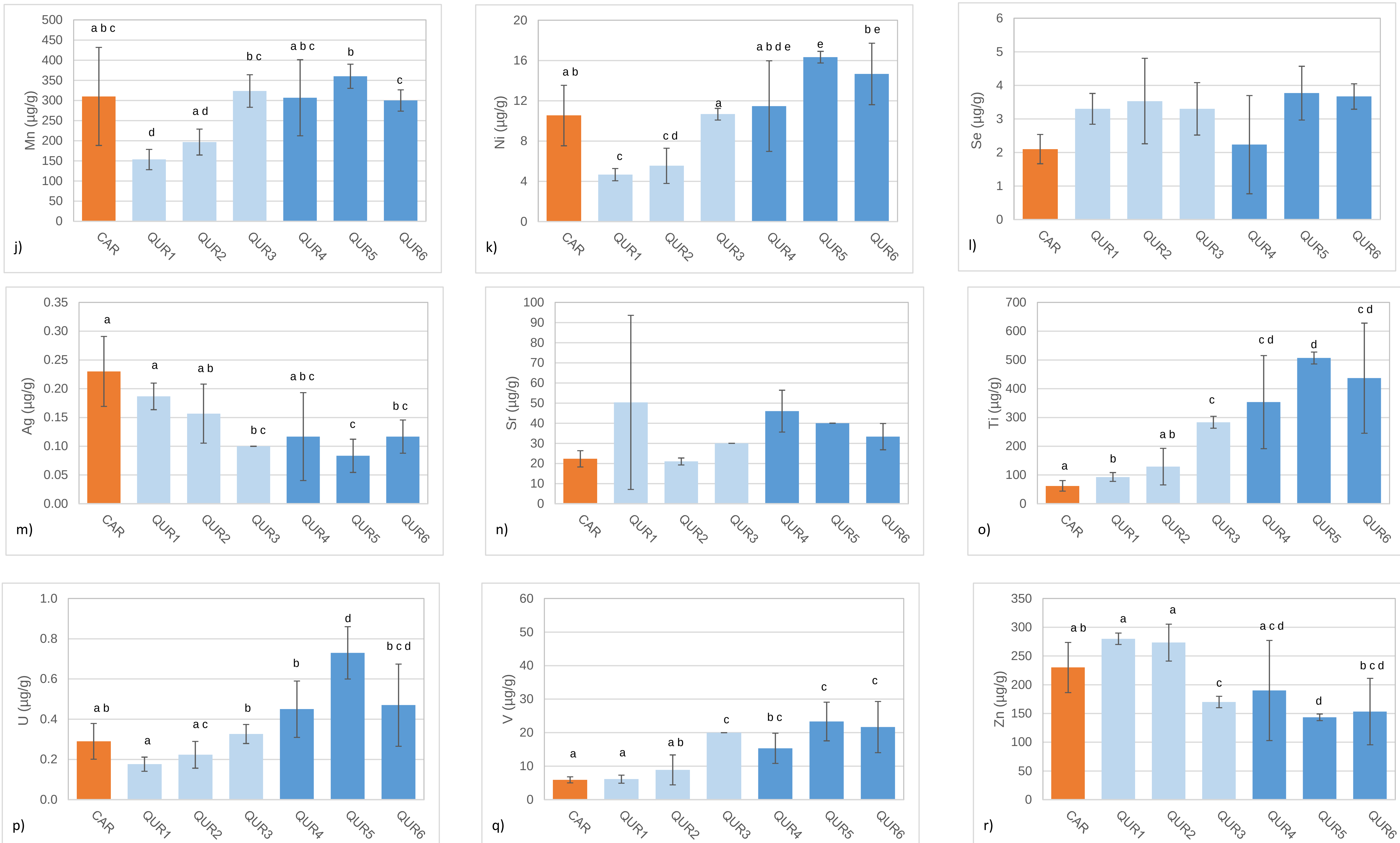


Figure I.14: Bar charts of metal and metalloid concentrations in community benthic invertebrate tissue samples for CAR reference (orange) and Quesnel River (blue) areas. Mean values ± one standard deviation are dispayed, letters above whiskers identify statistical difference (i.e. areas that do not share a common letter are statistically different, no letter indicates non-significant ANOVA). Light and dark blue colouring represents upper and lower reaches of the Quesnel River, respectively. Mount Polley Mine, 2014.



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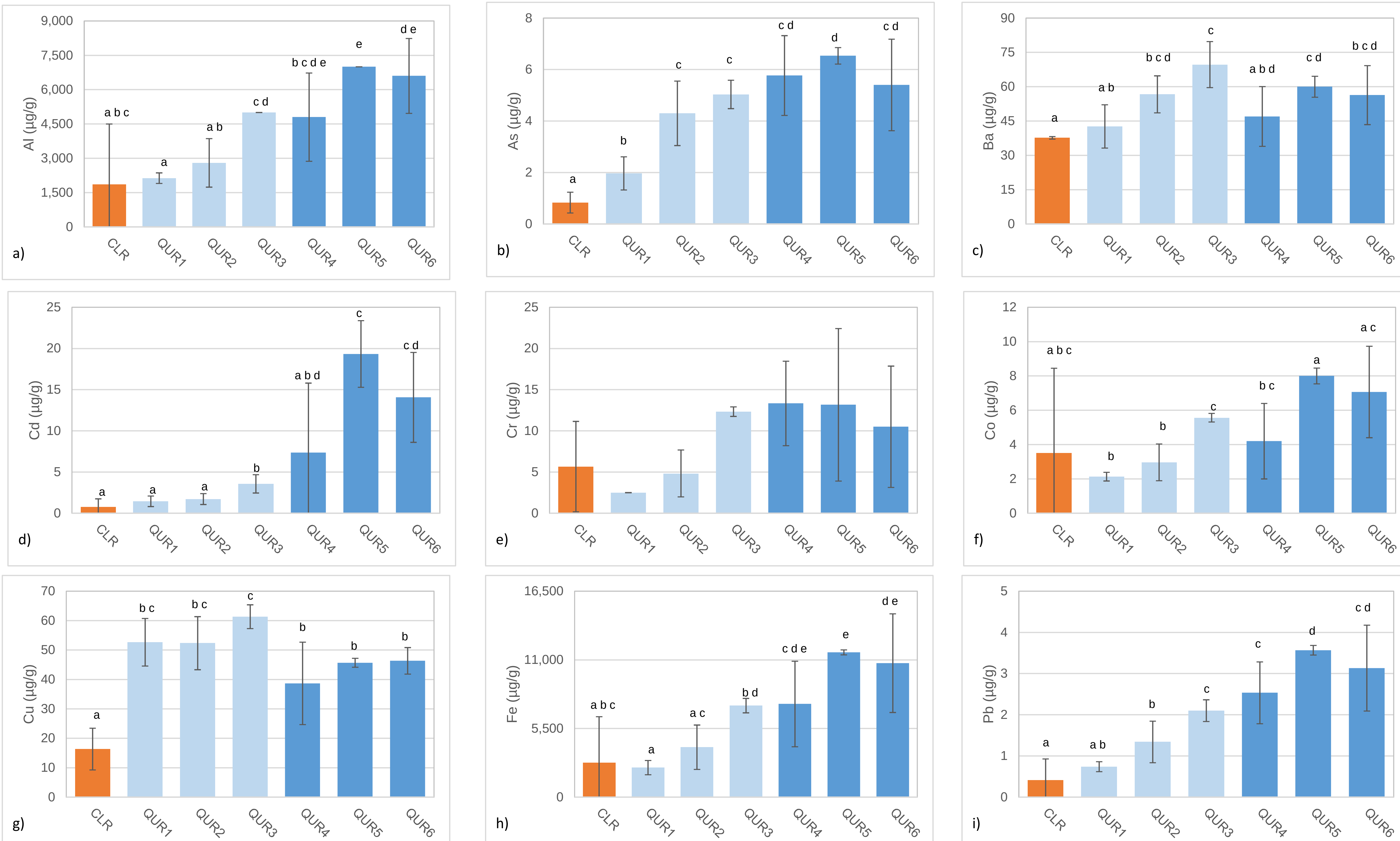


Figure I.15: Bar charts of metal and metalloid concentrations in community benthic invertebrate tissue samples for CLR reference (orange) and Quesnel River (blue) areas. Mean values ± one standard deviation are dispayed, letters above whiskers identify statistical difference (i.e. areas that do not share a common letter are statistically different, no letter indicates non-significant ANOVA). Light and dark blue colouring represents upper and lower reaches of the Quesnel River, respectively. Mount Polley Mine, 2014.

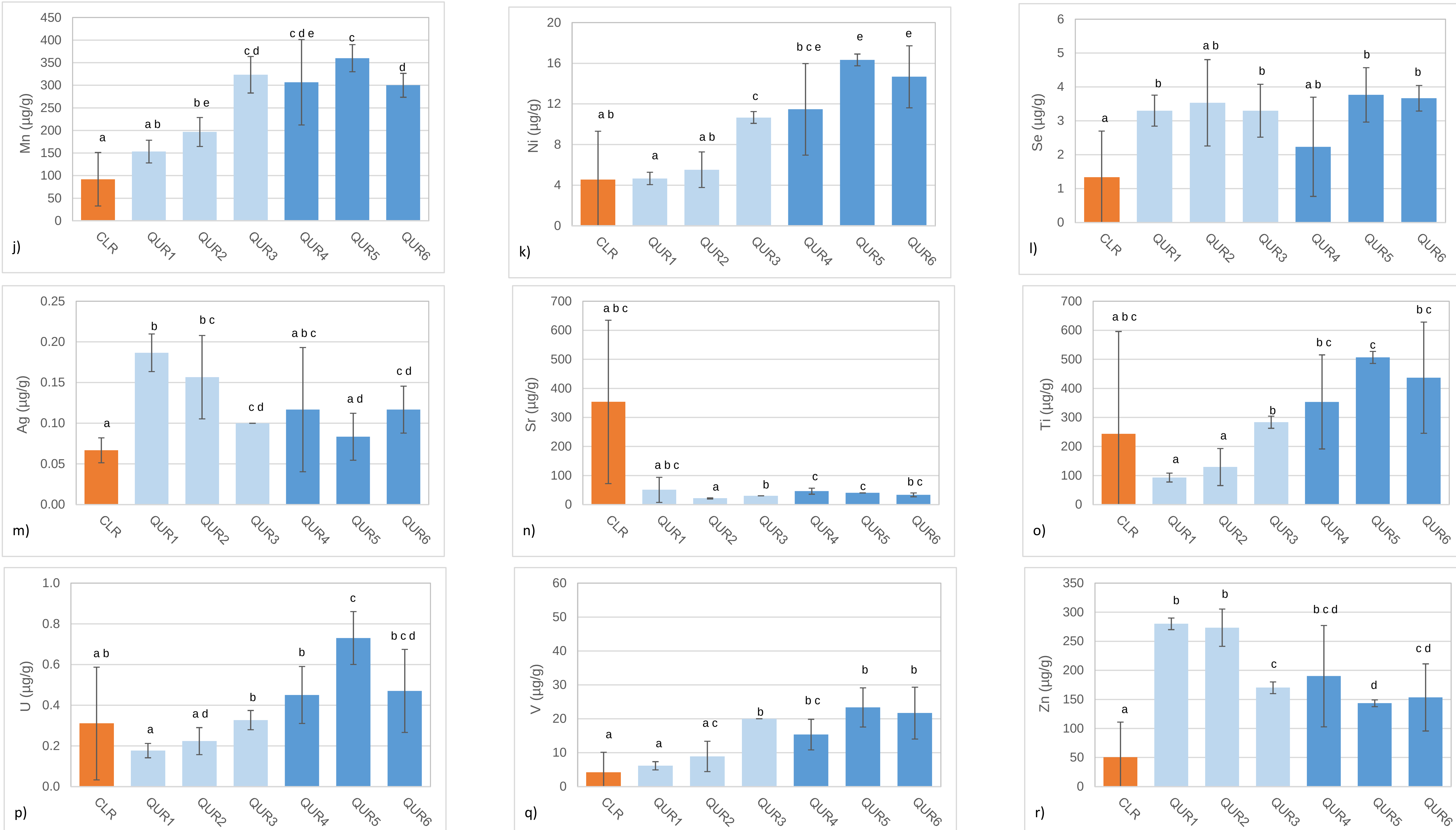


Figure I.15: Bar charts of metal and metalloid concentrations in community benthic invertebrate tissue samples for CLR reference (orange) and Quesnel River (blue) areas. Mean values ± one standard deviation are dispayed, letters above whiskers identify statistical difference (i.e. areas that do not share a common letter are statistically different, no letter indicates non-significant ANOVA). Light and dark blue colouring represents upper and lower reaches of the Quesnel River, respectively. Mount Polley Mine, 2014.

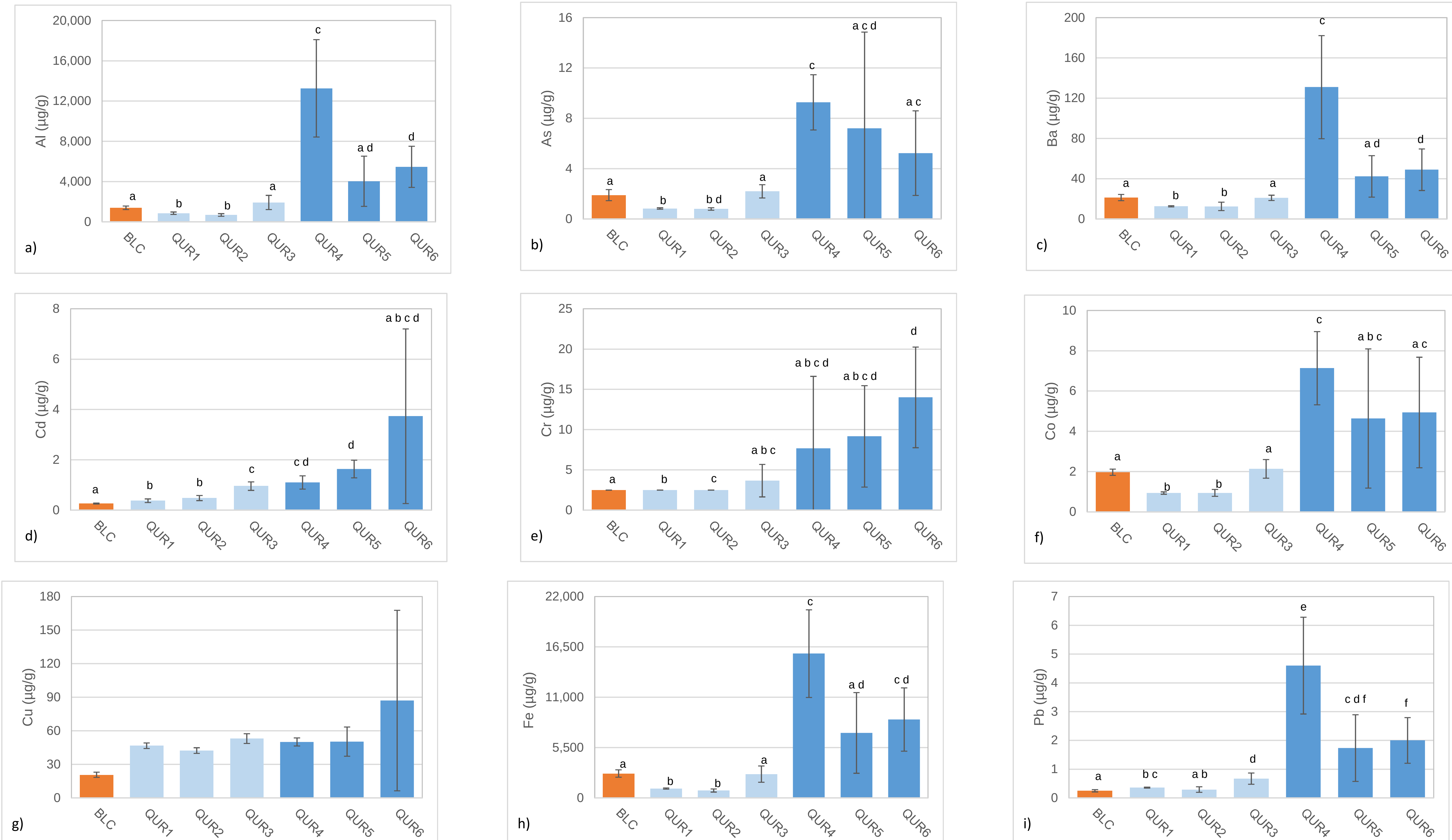
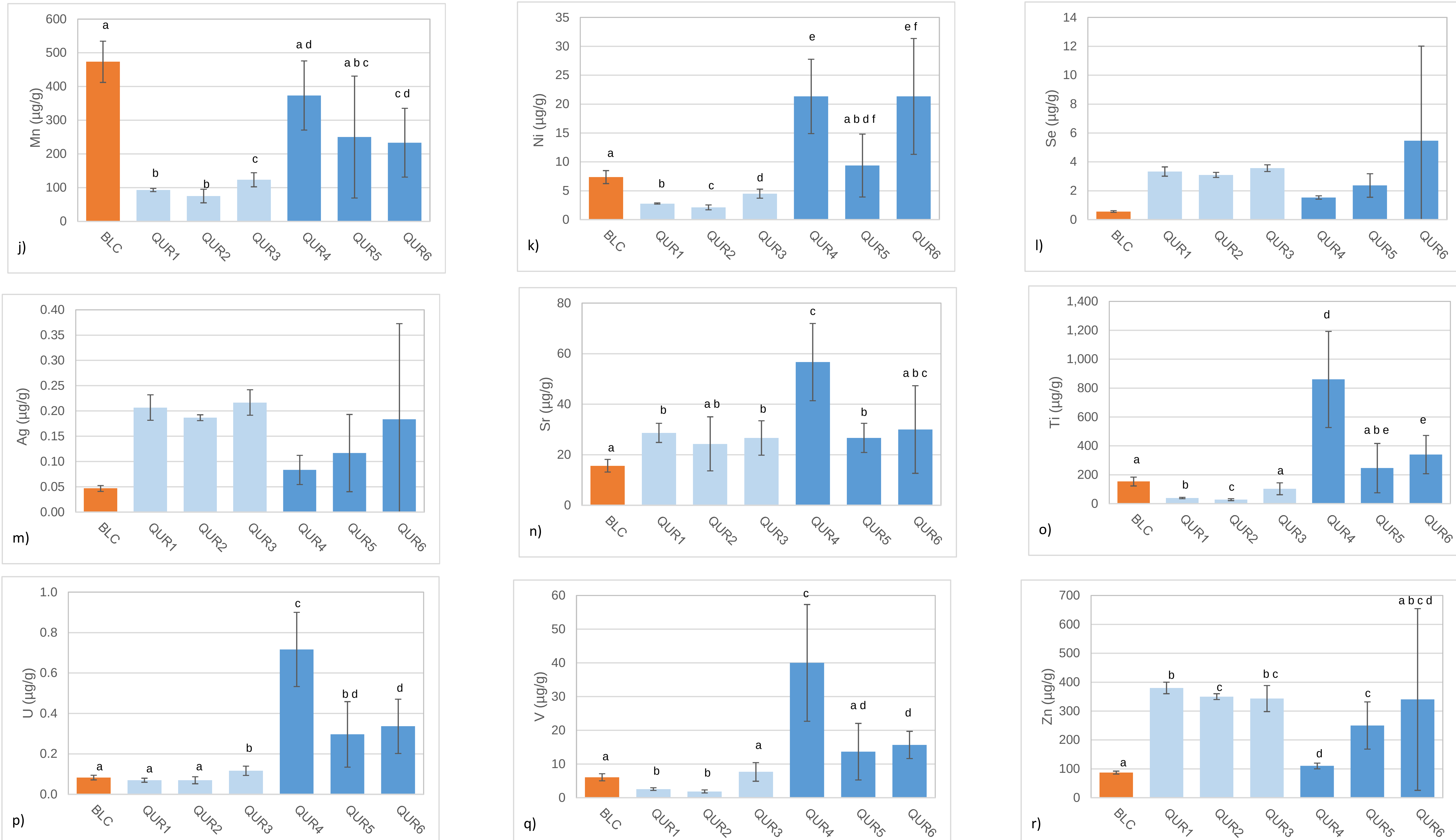


Figure I.16: Bar charts of metal and metalloid concentrations in perlidae tissue samples for BLC reference (orange) and Quesnel River (blue) areas. Mean values ± one standard deviation are dispayed, letters above whiskers identify statistical difference (i.e. areas that do not share a common letter are statistically different, no letter indicates non-significant ANOVA). Light and dark blue colouring represents upper and lower reaches of the Quesnel River, respectively. Mount Polley Mine, 2014.



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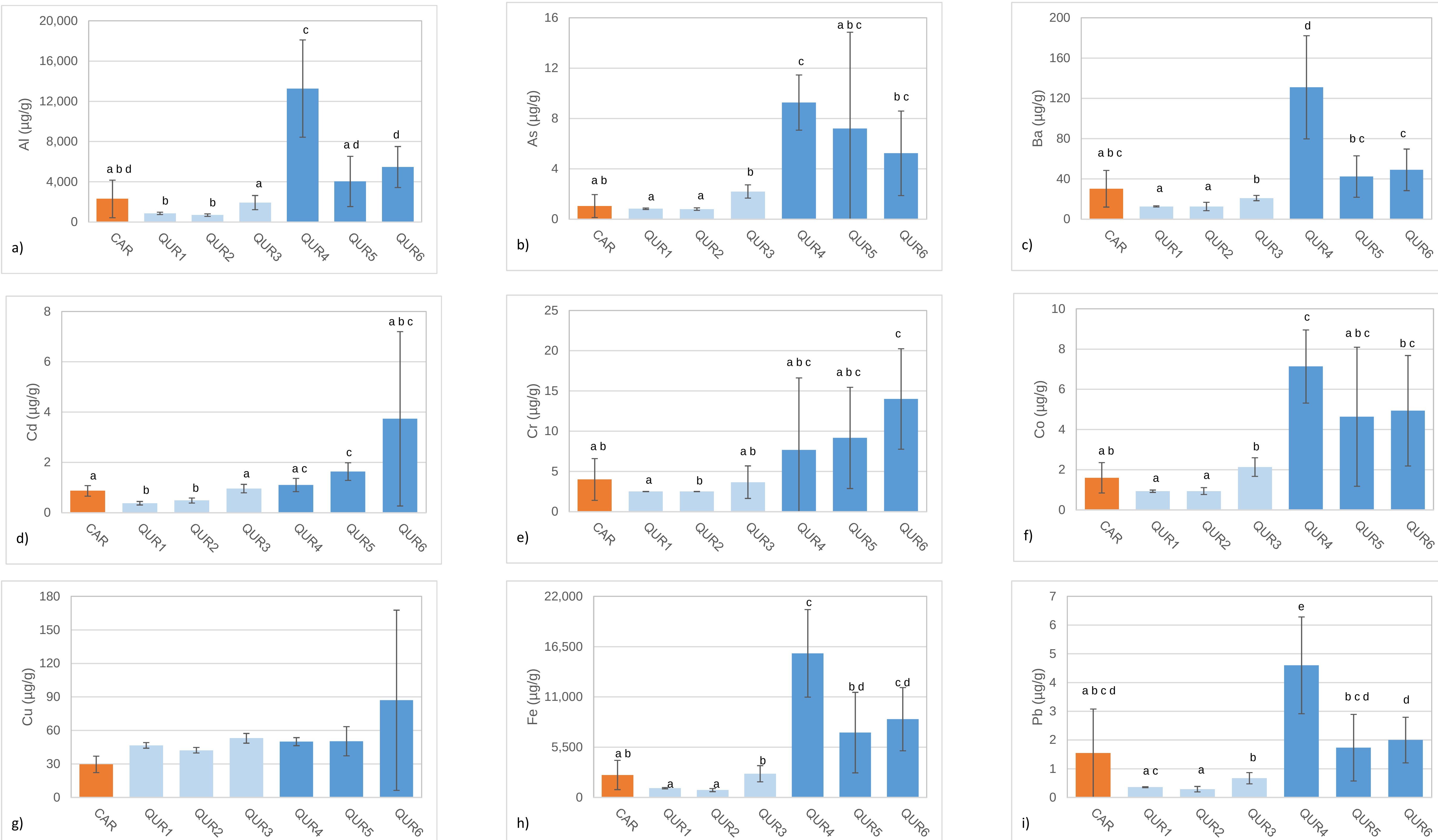

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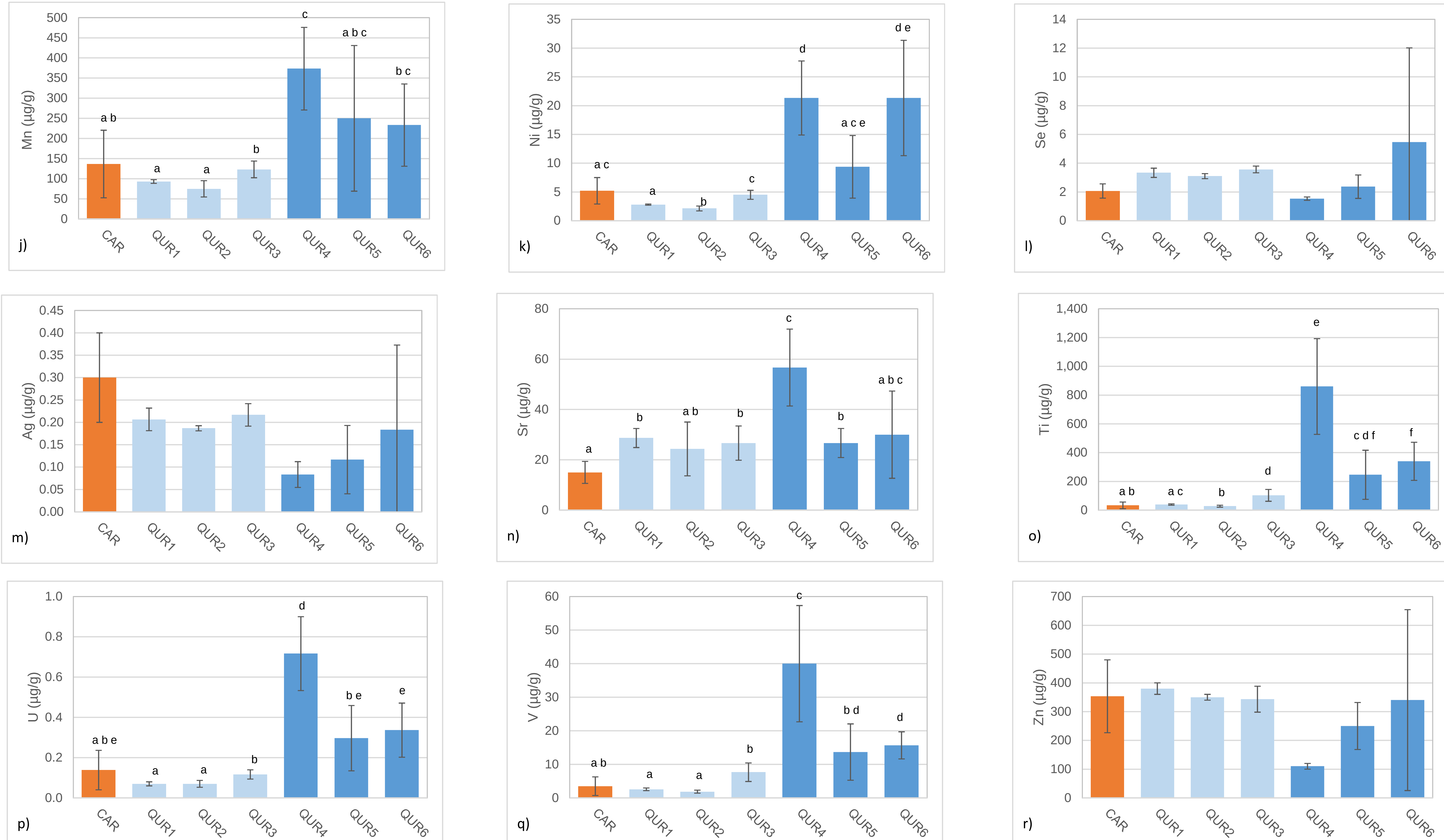

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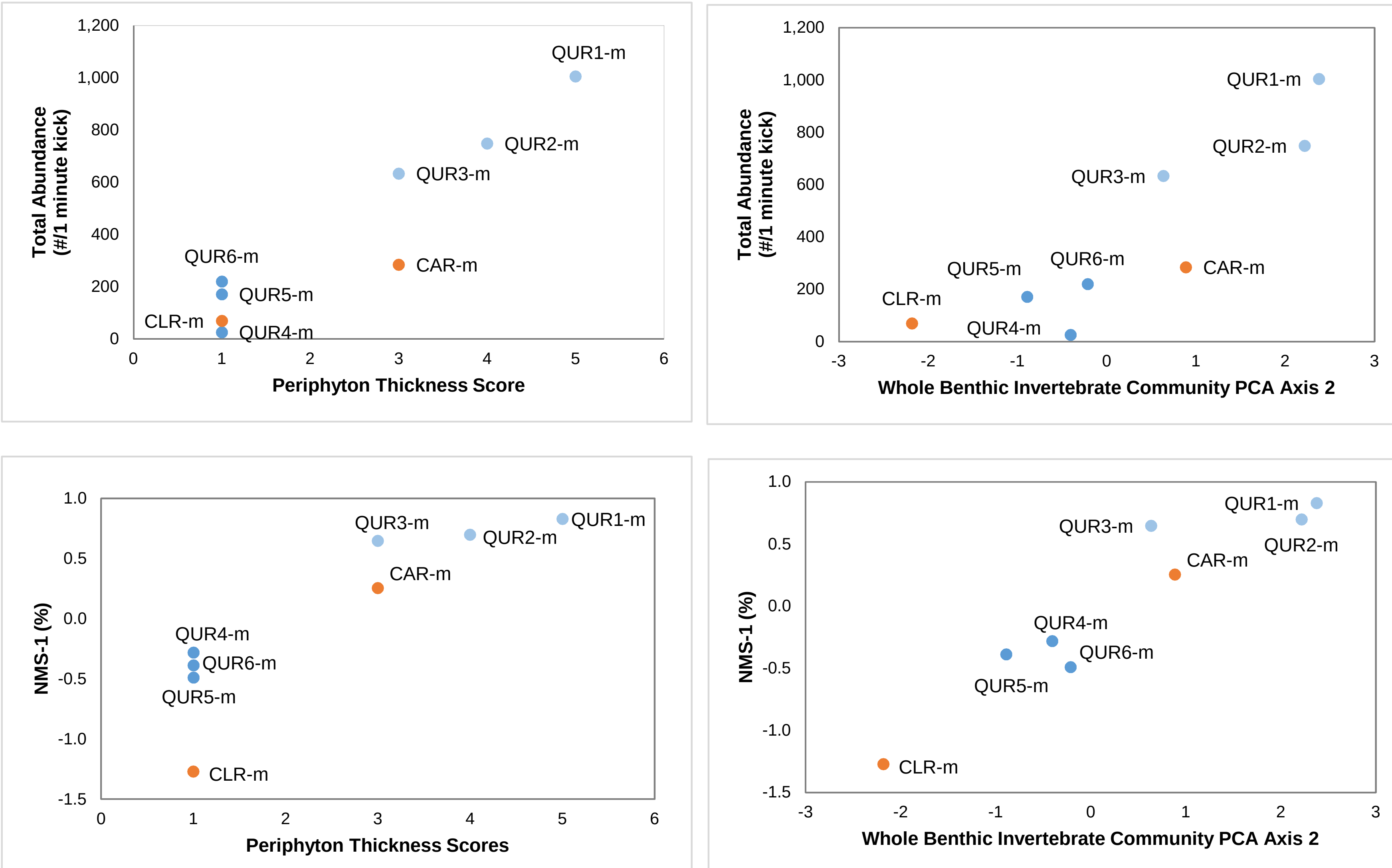
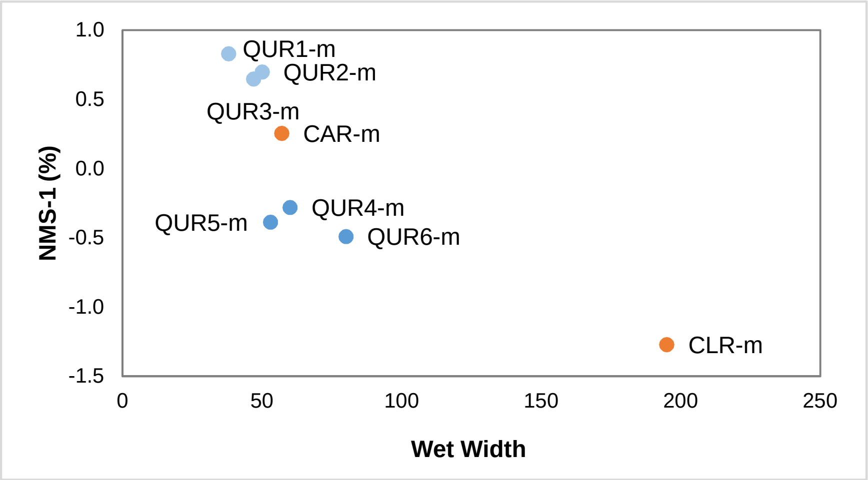


Figure I.18: Scatter plots of primary metrics with significant (Bonferroni p-value < 0.00208) Spearman's Rank correlation with environmental variables. Two reference areas and six Quesnel River areas are represented by orange and blue circles, respectively. Quesnel River areas are are futher distinguished with dark and light blue identifying upper and lower reaches, respectively. Mount Polley Mine, 2014.



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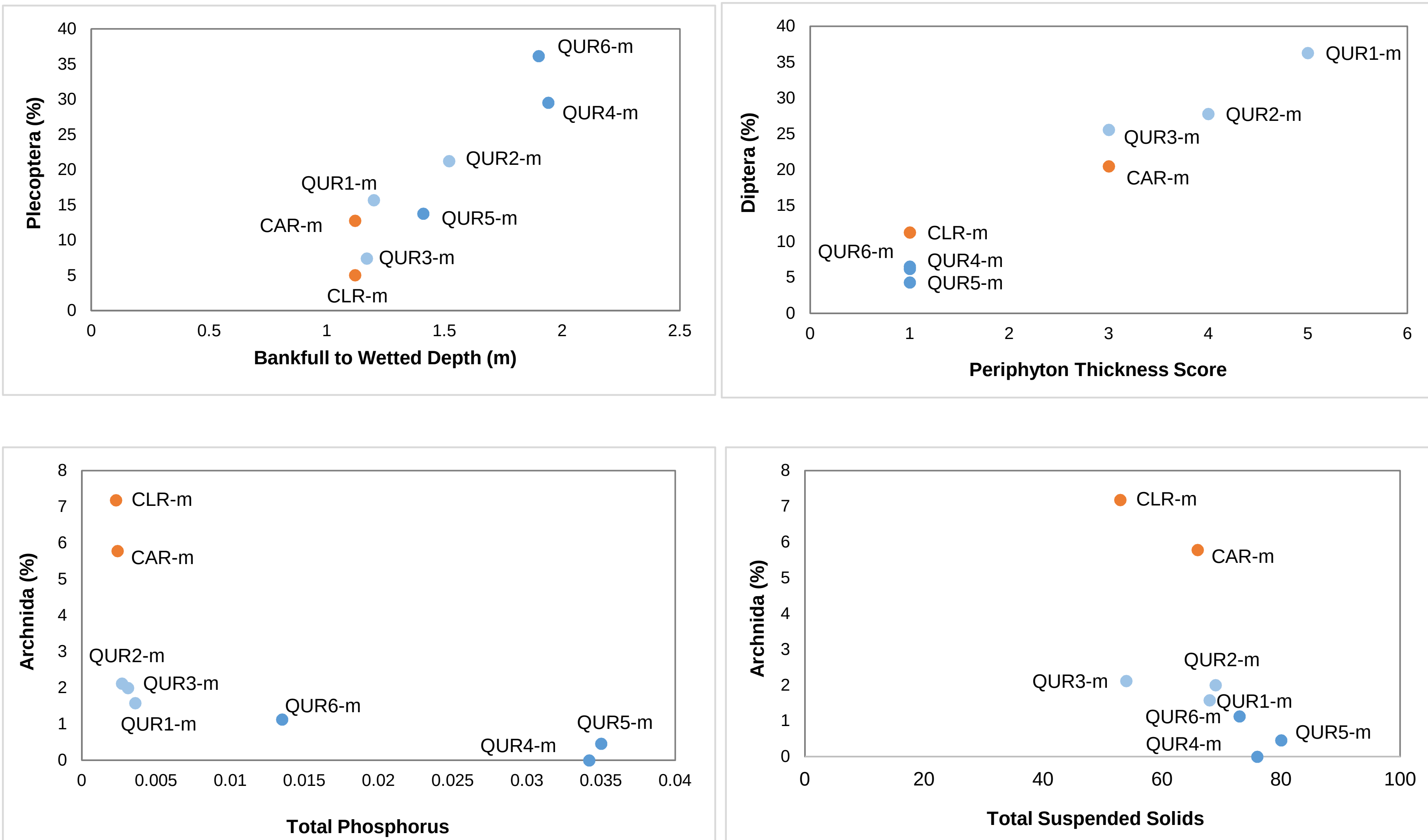
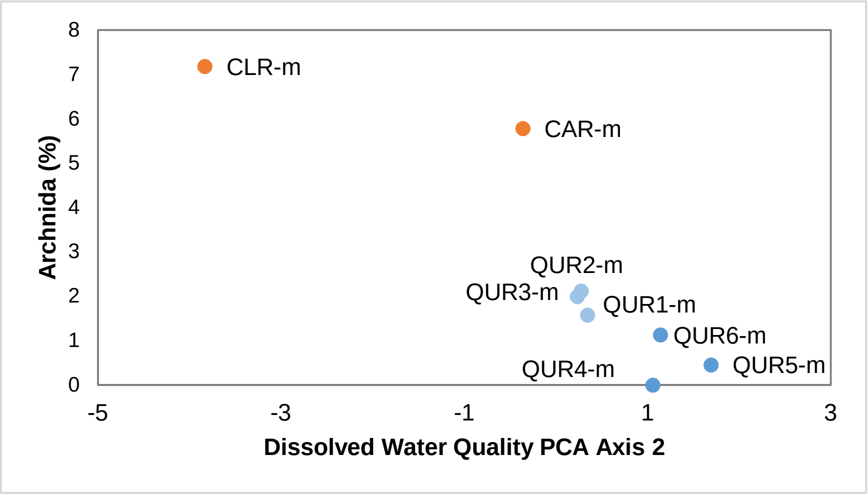


Figure I.19: Scatter plots of major groups with significant (Bonferroni p-value = 0.00208) Spearman's Rank correlation with environmental variables. Two reference areas and six Quesnel River areas are represented by orange and blue circles, respectively. Exposed areas are are futher distinguished with dark and light blue identifing upper and lower reaches, respectively. Mount Polley Mine, 2014.



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Provided on CD

Contents Of Appendix J: Lab Reports

Part 1AH: ALS Lab Report L1538597 (Finalized October 29, 2014)

Part 1AI: ALS Lab Report L1539051 (Finalized April 8, 2015)

Part 1AJ: ALS Lab Report L1539079 (Finalized April 6, 2015)

Part 1AK: ALS Lab Report L1570367 (Finalized January 27, 2015)

PART 2 Flett Research Dry Bulk Density and Porosity Report

PART 3 Nautilus Environmental Sediment Report

PART 4 SRC Analytical ICP Analyses

PART 5 SGS Semi-Quantitative X-Ray Diffraction

Provided on CD

APPENDIX F: MOUNT POLLEY TAILINGS DAM FAILURE – SURFACE WATER QUALITY IMPACT ASSESSMENT

Kerri Serben, M.Sc., Jordana van Geest, Ph.D. , Elaine Irving, Ph.D., R.P. Bio., P.Biol.
and Lee Nikl, M.Sc., R.P.Bio.

Golder Associates Ltd.

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June 5, 2015

Mount Polley Tailings Dam Failure - Surface Water Quality Impact Assessment

Submitted to:
Mount Polley Mining Corporation
Box 12
Likely, BC V0L 1N0

Report Number: 1411734-036-R-Rev0-10000

Distribution:

3 Copies - Mount Polley Mining Corporation
1 Copy - Ministry of Environment
1 Copy - Fisheries and Oceans Canada
2 Copies - Golder Associates Ltd.

REPORT

EXECUTIVE SUMMARY

The purpose of this surface Water Quality Impact Assessment (WQIA) was to characterize potential changes in downstream water quality, as a result of the August 4, 2014, tailings dam failure (the event) at the Mount Polley Mine. Changes in concentrations of contaminants identified by this report to be of potential concern following the event were evaluated in Hazeltine Creek and the downstream receiving environments Polley Lake, Quesnel Lake, and Quesnel River.

- Hazeltine Creek was directly impacted by the event. As a result of the large-scale physical impacts on this creek it was not considered to be fish habitat and thus was not defined as receiving environment for the assessment. Even though this creek is currently not considered to be an aquatic habitat, it was assessed based on comparisons to British Columbia Water Quality Guidelines (BC WQGs. Over the longer term, Mount Polley Mining Corporation (MPMC) intends to continue the restoration work of Hazeltine Creek, adding habitat features to support trout spawning and rearing in the upper reaches and spawning by sockeye and coho in the lower reaches.
- Receiving environments downstream of the tailings dam failure considered were Polley Lake, Quesnel Lake, and Quesnel River.

Changes in receiving environment water quality related to the event were evaluated based on a comparison to water quality guidelines and geochemical analysis of the waterborne and particulate material. The bioavailability of the copper in water was measured using aquatic toxicity tests with a variety of aquatic test species ranging from primary producers (plants), primary consumers (aquatic insects) to secondary consumers (fish). In general, immediately following the event, there were changes in water quality with concentrations of copper and turbidity exceeding water quality guidelines. However, the geochemical analysis indicated that the copper was tightly bound to particulate material indicating low potential for bioavailability. The low bioavailability of copper was confirmed by the results of the toxicity tests conducted during periods of higher turbidity as toxicity attributable to copper was not observed. Uncertainties in the assessment are documented for consideration in the development of water quality monitoring to support the Rehabilitation and Remediation Framework.

Hazeltine Creek

Creek water quality was influenced by the event and the subsequent erosion of exposed underlying native materials. Mitigation measures, such as construction of two sedimentation ponds in the lower creek and commissioned in December 2014, have reduced suspended particulate matter and concentrations of metals associated with suspended materials such, as aluminum and iron, in the water flowing out from Hazeltine Creek to Quesnel Lake. Post-event, total concentrations of these metals were higher than dissolved concentrations after the event, but total concentrations have now decreased such that total and dissolved concentrations are more similar. Total and dissolved copper concentrations decreased substantially over the post-event period from peak concentrations in August, but were still above BC WQGs in February 2015. More recently, stream erosion control works in Hazeltine Creek have concluded and Hazeltine Creek discharge turbidity is now typically in the single digits.

Receiving Environment

Suspended Particulate Matter

There were increased concentrations of suspended particulate matter in the waters of Polley Lake, Quesnel Lake, and Quesnel River due to the event. Over time, suspended particulates settled out in the receiving environment and the available data suggest that levels of particulate matter are no longer of concern. The larger suspended solids settled out more quickly following the event compared to the finer particulates measured by turbidity. The higher turbidity at depth in the lakes persisted until fall turnover. With turnover, turbidity at depth decreased, but increased in the near surface water. This relatively small change in surface turbidity resulted in a cloudy appearance within the West Basin. By early spring (March and April 2015), turbidity at surface and depth decreased to below BC WQGs for the protection of aquatic life except for some localised slightly elevated values close to the Hazeltine Creek mouth.

Observations of cloudy (turbid) water were recorded three times in late summer and early fall (late August, early September, early October) in Quesnel River. These cloudy-water events were the result of upwelling of deep, turbid water from Quesnel Lake at the outflow into Quesnel River as the lake responded to strong winds and currents (i.e., internal seiche). Turbidity in the river peaked in early December and declined to near baseline conditions by mid-February. As the turbidity in the main body of Quesnel Lake has returned to near baseline conditions, further cloudy water events in Quesnel River are not expected.

Phosphorus and Metals

An increase in the nutrient phosphorus was also observed in Polley and Quesnel Lakes due to the event. The potential impact of changes in phosphorus on aquatic life in Polley and Quesnel Lakes is discussed further elsewhere in the Quesnel and Polley Lakes Aquatic Productivity Impact Assessment.

Concentrations of metals immediately following the event through to April 2015, were not of potential concern with regards to drinking water sources or wildlife, with the exception of molybdenum in Polley Lake. The concentrations of molybdenum decreased over the winter and were no longer of potential concern by April. Although elevated immediately after the event with respect to BC WQGs for the protection of aquatic life, total concentrations of several metals decreased over the post-event period such that by April, only concentrations of total (but not dissolved) copper were above the water quality guideline for the protection of aquatic life in Quesnel Lake

The BC WQGs for the protection of aquatic life are a useful tool to identify chemicals in water that may cause adverse effects, but they are conservative in their derivation and should not be used for remediation purposes. Ideally, more direct measures of toxicity should be used that take into consideration the mixture of potential contaminants and other parameters in the water. The findings of toxicity testing with water samples collected throughout the post-event period, using three trophic levels of test species covering primary producers, primary consumers and secondary consumers, , together with the several geochemical lines of evidence, provided a more realistic assessment of potential impact of changes in water quality to aquatic life. These findings indicate that, although there were measured changes in water quality, the evidence available to date does not indicate that the constituents of the TSF materials resulted in toxicity in the water column. We note that this report is an interim report and that additional studies remain ongoing or are planned.

STATEMENT OF LIMITATIONS

This report was prepared for the exclusive use of MPMC. The inferences concerning the data, site and receiving environment conditions contained in this report are based on information obtained during investigations conducted at the site by Golder Associates Ltd. (Golder), other consultants and MPMC, and are based solely on the condition of the site at the time of the site studies and subsequent investigations and remediation and other information obtained by Golder, as described in this report. Soil, surface water and groundwater conditions may vary with location, depth, time, sampling methodology, analytical techniques and other factors.

In evaluating the subject site and water quality data, Golder has relied in good faith on information provided. The factual data, interpretations and recommendations pertain to a specific project as described in this report, based on the information obtained during the assessment by Golder on the dates cited in the report, and are not applicable to any other project or site location. Golder accepts no responsibility for any deficiency or inaccuracy contained in this report as a result of reliance on the aforementioned information.

The findings and conclusions documented in this report have been prepared for the specific application to this project, and have been developed in a manner consistent with that level of care normally exercised by environmental professionals currently practising under similar conditions in the jurisdiction. Golder makes no other warranty, expressed or implied and assumes no liability with respect to the use of the information contained in this report at the subject site, or any other site, for other than its intended purpose.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Golder accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or action based on this report. All third parties relying on this report do so at their own risk. Electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore no party can rely upon the electronic media versions of Golder’s report or other work product. Golder is not responsible for any unauthorized use or modifications of this report.

MPMC may rely on the information contained in this report subject to the above limitations.

Golder makes no other representation whatsoever, including those concerning the legal significance of its findings, or as to other legal matters touched on in this report, including, but not limited to, ownership of any property, or the application of any law to the facts set forth herein.

If new information is discovered during future work, including excavations, sampling, soil boring, predictive geochemistry or other investigations, Golder should be requested to re-evaluate the conclusions of this report and to provide amendments, as required, prior to any reliance upon the information presented herein. The validity of this report is affected by any change of site conditions, purpose, development plans or significant delay from the date of this report in initiating or completing the project.

Table of Contents

TABLES

FIGURES

APPENDICES

List of Abbreviations and Acronyms

+	Plus
-	Minus
>	greater than
<	less than
≤	less than or equal to
ADEC	Alaska Department of Environmental Conservation
BC	British Columbia
BC MoE	British Columbia Ministry of Environment
BC WQG	British Columbia Water Quality Guideline
$CaCO_3$	calcium carbonate
CCME	Canadian Council of Ministers of the Environment
COPC	Contaminant of Potential Concern
Cr (III)	trivalent chromium
Cr (VI)	hexavalent chromium
CRA	Commercial, Recreational and Aboriginal
Cu^{2+}	copper (free ion)
$CuOH^{+}$, $Cu(OH)_2$	copper hydroxides
$CuCO_3$, $Cu(CO_3)_2^{2-}$	copper carbonates
Cu-DOC	copper bound to dissolved organic carbon (DOC)
DO	dissolved oxygen
DOC	dissolved organic carbon
Golder	Golder Associates Ltd.
HAC	Hazeltine Creek
IDNR	Iowa Department of Natural Resources
LOEC	lowest observed effect concentration
MDL	Method Detection Limit
Minnow	Minnow Environmental Inc.
MPMC	Mount Polley Mining Corporation
N/A	not applicable
NWT	Northwest Territories
PEEIAR	Post-Event Environmental Impact Assessment Report
PHREEQC	pH REdox EQuilibrium (in C language)
POL	Polley Lake
QA/QC	quality assurance/quality control
QUL	Quesnel Lake

QUR	Quesnel River
Redox	reduction-oxidation
SD	standard deviation
SE	standard error
SNC-Lavalin	SNC-Lavalin Inc.
TDS	total dissolved solids
Tetra Tech	Tetra Tech EBA Inc.
TP	total phosphorus
TSF	tailings storage facility
TSS	total suspended solids
UBC	University of British Columbia
US EPA	United States Environmental Protection Agency
USA	United States of America
WLWB	Wek'èezhìi Land and Water Board
WQG	Water Quality Guideline
WQIA	Water Quality Impact Assessment

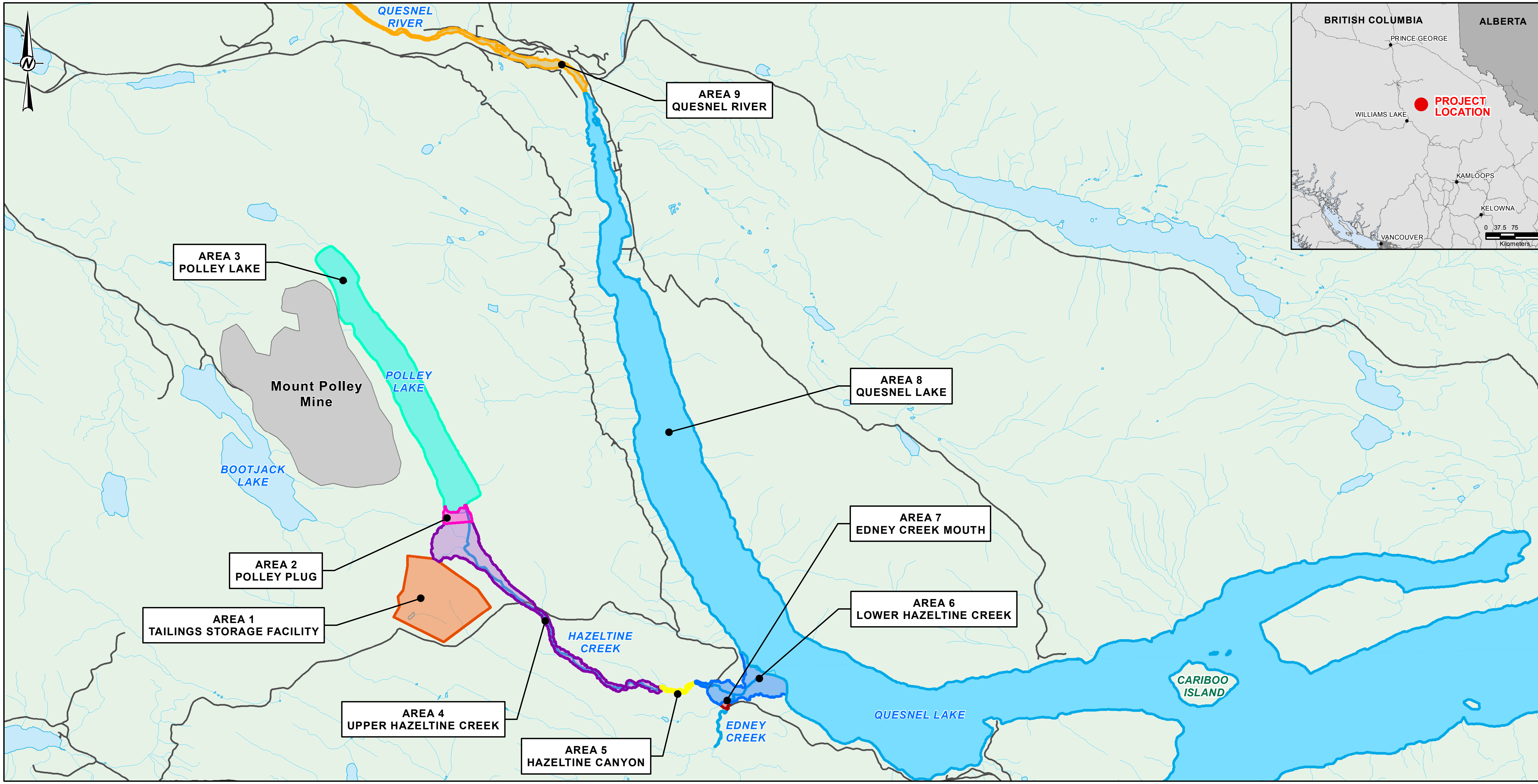
Units

%	percent
°C	degrees Celsius
µg/L	micrograms per litre
µm	micrometre
µS/cm	microsiemens per centimetre
d	day
h	hour
km	kilometre
km^2	square kilometre
m	metre
m^2	square metre
m^3	cubic metres
m^3/s	cubic metres per second
mg N/L	milligrams of nitrogen per litre
mg/L	milligrams per litre
NTU	nephelometric turbidity units

1.0 INTRODUCTION

On August 4, 2014, a failure of the Tailings Storage Facility (TSF) embankment and subsequent debris flow occurred at the Mount Polley Mine. The purpose of this Surface Water Quality Impact Assessment (WQIA) was to characterize potential changes in downstream water quality as a result of the Tailings Dam Failure (the event). Changes in water quality were assessed by comparing pre- and post-event water quality, where pre-impact data were available, and by evaluating post-event data in the context of applicable water quality guidelines (WQGs) with consideration of site-specific conditions. The WQIA scope focussed on an evaluation of water quality data available for surface waters located within seven study areas defined for the Post-Event Environmental Impact Assessment Report (PEEIAR) in (Golder 2015a) and shown on Figure 1.

To characterize potential event-related changes in downstream water quality, the WQIA evaluated changes in contaminants of potential concern (COPCs) during the post-event assessment period. The WQIA first defines spatial and temporal boundaries in Section 2. The assessment approach is described in Section 3, along with specific methods used to evaluate water quality changes that may have occurred as a result of the event. The impact assessment presented in Section 4 focusses on the evaluation of COPCs over the post event period in Hazeltine Creek and the receiving environment (i.e., Polley Lake, Quesnel Lake and Quesnel River). Changes in receiving environment water quality related to the event in terms of COPC guideline comparisons are discussed, as well as the findings of site-specific studies to evaluate contaminant bioavailability. Interim findings based on this assessment are presented in Section 5. Uncertainties in the impact assessment are discussed in Section 6 for consideration in the development of water quality monitoring to support the Rehabilitation and Remediation Framework.



LEGEND

REMEDIATION AREA

- 1 - TAILINGS STORAGE FACILITY
- 2 - POLLEY PLUG
- 3 - POLLEY LAKE
- 4 - UPPER HAZELTINE CREEK
- 5 - HAZELTINE CANYON
- 6 - LOWER HAZELTINE CREEK
- 7 - EDNEY CREEK MOUTH
- 8 - QUESNEL LAKE
- 9 - QUESNEL RIVER

- MOUNT POLLEY MINE SITE
- ROAD
- WATERCOURSE
- WATERBODY

0 2 4

1:80,000 KILOMETRES

REFERENCES

1. WATERCOURSE, LAKE, ROAD, CITY AND PROVINCE DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
2. PROJECTION: NAD 1983 UTM ZONE 10

CLIENT

IMPERIAL METALS
MOUNT POLLEY MINING CORPORATION

PROJECT

MOUNT POLLEY MINE
WATER QUALITY IMPACT ASSESSMENT

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-03-31
DESIGNED	JVG
PREPARED	RH
REVIEWED	LN
APPROVED	LN

TITLE

POST-EVENT ENVIRONMENTAL IMPACT ASSESSMENT STUDY AREAS

PROJECT NO.	CONTROL	REV.	FIGURE
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2.0 ASSESSMENT BOUNDARIES

2.1 Study Areas

The PEEIAR provides a description of the event, including estimates of the volumes of water, tailings, and Hazeltine debris flow scour sediments that were released. It also provides a description of the evolution of the event, areas of impact and the spatial boundary of the PEEIAR study area.

The WQIA focussed on surface water quality changes in six of the seven areas downstream of TSF and the Polley Lake "plug" identified by Golder (2015a)[1] (Figure 1), which are as follows:

- Upper Hazeltine Creek (Area 4);
- Lower Hazeltine Creek (Areas 6 and 7);
- Polley Lake (Area 3);
- Quesnel Lake (Area 8); and,
- Quesnel River (Area 9).

The spatial boundaries of the WQIA covered Hazeltine Creek located immediately downstream of the tailings dam failure and the area most directly impacted by event. As a result of the physical impacts on Hazeltine Creek, the creek was not considered to be fish habitat during the post event period and thus was not defined as a receiving environment. Receiving environments located downstream of the tailings dam failure were determined to be Polley Lake, Quesnel Lake, and Quesnel River. While the mouth of Edney Creek was impacted by the physical effects of the debris flow, Edney Creek water quality is determined by a watershed that was not influenced by the event and thus an impact assessment of Edney Creek water quality was not undertaken.

A brief description of Hazeltine Creek and each receiving environment with respect to pre-event surface water quality is presented below.

2.1.1 Hazeltine Creek

Hazeltine Creek flows from Polley Lake into the West Basin of Quesnel Lake, a distance of approximately 9.2 km. Minnow Environmental Inc. (Minnow 2014) provides summaries of surface water quality in upper Hazeltine Creek during three time periods: baseline (pre-1997), post-baseline operations (1997 to 2008), and recent operations prior to the event (2009 to 2013). Based on the most recent pre-event summary, surface waters in Hazeltine Creek were generally characterized as clear (median turbidity of 1.4 nephelometric turbidity units [NTU], range 0.28 to 16 NTU), alkaline (median pH of 7.9, range 6.7 to 9.1) and moderately soft in hardness (median hardness of 80 milligrams per litre [mg/L] as $CaCO_3$, range 39 to 820 mg/L). Based on median concentrations, total phosphorus (TP) and copper were higher than British Columbia water quality guidelines (BC WQGs)[2], but other parameters were less than BC WQGs (Minnow 2014). Upper concentration limits (defined by 95th percentile concentrations) ofllr total suspended solids (TSS), turbidity, nitrate, nitrite, aluminum, and copper were higher than BC WQGs.

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[1] Post-event water quality data were not available for Hazeltine Canyon [Area 5] but the water quality in the canyon is considered to be sufficiently represented by water quality upstream and downstream of the canyon.

[2] In this document, reference to BC WQG is intended to mean the water quality guidelines for freshwater aquatic life, except where specifically stated to the contrary.

2.1.2 Receiving Environment

2.1.2.1 Polley Lake

Polley Lake is a long (6.17 kilometre [km]) narrow (0.65 km) lake situated adjacent to the Mount Polley Mine within a watershed area of 17.1 square kilometres (km^2). Minnow (2014) estimated the hydraulic residence time of the lake as approximately 16.2 years. The lake has a mean depth of 18 metres (m) and maximum depths of 35 m in the southeast basin and 33 m in the northwest basin. The main inflow to the lake is from the Frypan Lake sub-watershed situated to the north. The present configuration of Polley Lake is not its natural form. Polley Lake was dammed and its drainage modified to provide water to hydraulic mining activities that occurred in the region during the early 1900's.

Polley Lake is a dimictic lake that mixes from the surface to the lake bottom twice each year. Thermal stratification occurs in summer; a thermocline typically forms at a depth between 5 and 15 m (Minnow 2014). Hypoxic conditions generally occur at depths greater than 20 m, with dissolved oxygen (DO) concentrations less than 5 mg/L (Minnow 2014). Trophic status of the lake changed from oligotrophic/mesotrophic prior to mine development to mesotrophic/eutrophic in 2012 (Minnow 2014).

Minnow (2014) summarized a sub-set of water quality data collected prior to the event (2009 to 2013) at two stations (P1 and P2) and two depths (surface and bottom) in Polley Lake. Based on this summary, water in Polley Lake is characterized as clear (median turbidity of 1.1 NTU), slightly alkaline (median pH 8.9 at surface and 7.7 at bottom), moderately soft in hardness (median hardness of 104 mg/L as $CaCO_3$) based on the scale described by McNeely et al. (1979), with low sensitivity to acid inputs (median total alkalinity of 79 mg/L as $CaCO_3$) based on the scale of acid sensitivity for lakes by Saffran and Trew (1996). Median concentrations of total dissolved solids (TDS) at surface and bottom ranged from 132 to 135 mg/L. Pre-event, median concentrations of chloride, sulphate, nitrate, nitrite, and ammonia were less than applicable BC WQGs as were median concentrations of metals[3] (Minnow 2014).

2.1.2.2 Quesnel Lake

Quesnel Lake is a large, deep fjord lake with a surface area of 266 km^2; the lake is comprised of East, West and North Arms. It is the deepest fjord-type lake in the world with a maximum depth of 511 m in the East Arm (Laval et al. 2008). The West Basin is a shallower (113 m maximum depth) portion of the West Arm that is separated from the rest of the lake by a shallow sill that is approximately 35 m deep, near Cariboo Island, and is considered the area between Cariboo Island and the Quesnel River (Laval et al. 2008). The West Basin has vertical mixing that is typical of temperate lakes, with thermal stratification for most of the year interrupted by brief turnover periods in the spring and the fall when vertical density gradients are lowest. In the deeper portions of the lake, seasonal turnover events only occur in the upper 100-200 m of the water column due to changes in temperature-density relationships with increased pressure at greater depths. The key drivers of circulation patterns in Quesnel Lake have been studied in detail (see James 2004; Laval et al. 2008; Laval et al. 2012; Potts 2004) and are most recently described in TetraTech EBA Inc. (Tetra Tech 2015).

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[3] The term "metal" is used in this report to encompass metals, metalloids (e.g., arsenic) and non-metal elements (e.g., selenium).

Limnological data were collected between 1985 to 1988 and in 1990 by Nidle et al. (1994). These data provided mean values for thermocline depth (12.4 m), epilimnetic temperature (12.4 degrees Celcius [°C]), and euphotic zone depth (15.5 m) (Shortreed et al. 2001). Mount Polley Mine is located near the West Basin of Quesnel Lake, which received inputs from the event via water and debris flows from Hazeltine Creek.

Nidle et al. (1994) also collected water chemistry data related to lake productivity, specifically, nutrients, pH, alkalinity, and TDS. At the time of sampling, mean annual lake-wide concentrations of TP (0.0027 mg/L), nitrate (0.104 milligrams of nitrogen per litre [mg N/L]), and total chlorophyll (1.03 micrograms per litre [µg/L]) were within the range for oligotrophic lakes (Shortreed et al. 2001). Annual lake-wide summaries indicated that the lake was slightly alkaline (average pH 7.2 to 7.8), low in TDS (59 to 66 mg/L), with low sensitivity to acid inputs (total alkalinity from 44 to 50 mg/L as $CaCO_3$) (Nidle et al. 1994).

More recent nutrient data obtained from the British Columbia Ministry of the Environment (BC MoE) suggests that Quesnel Lake has maintained its oligotrophic status (Appendix A). In water samples collected between August 2004 and September 2006, TP concentrations were within the range for oligotrophic lakes according to the Canadian Council of Ministers of the Environment (CCME 2004) trophic status classification for lakes. Total nitrogen concentrations (median of 0.17 mg/L) were similar to concentrations of nitrate measured previously by Nidle et al. (1994).

Limited pre-event water chemistry data are available for Quesnel Lake, with no available turbidity or metals data (Appendix A). Concentrations of ammonia, nitrate, and nitrite were less than their corresponding BC WQGs.

2.1.2.3 Quesnel River

Quesnel River is a major tributary of the Fraser River located in the Cariboo District of central British Columbia. From its outflow at Quesnel Lake, near the town of Likely, it flows 100 km to the northwest, descending 2500 m, to its confluence with the Fraser River at the town of Quesnel. The river is situated in a basin with an area of approximately 11,500 km^2 and has a mean discharge rate of 230 cubic metres per second (m^3/s) (Reynoldson et al. 2010).

Limited historical water quality data for Quesnel River were obtained from the BC MoE and are mostly restricted to the Likely Bridge near the town of Likely (Appendix A). During the sampling period (1972 to 1987) the surface water at Likely was well-oxygenated (DO from 8.5 to 13.4 mg/L), clear (turbidity from 0.2 to 1.4 NTU) and characterized as soft in hardness (46 to 56 mg/L as $CaCO_3$). A pH range of 6.5 to 8.1 was identified for this river with all measurements within the BC WQG pH range. Median concentrations of chloride, ammonia, nitrate, nitrite, and sulphate were less than their corresponding BC WQGs. Metals data were limited for Quesnel River; however, data for aluminum, chromium, copper, iron, lead, manganese, and zinc indicated that concentrations for these metals were less than BC WQGs. At the Gravelle Ferry Bridge, 50 km downstream of Likely, during the sampling period (2011 to July 2014), DO ranged from 9.3 to 10.5 mg/L, pH ranged from 7.8 to 8.0, and hardness ranged from 51 to 63 mg/L. Turbidity ranged from 0.18 to 47 NTU. Data for total phosphorus, total chromium, total copper, total iron, total zinc, and dissolved aluminum indicated that 95th percentile concentrations exceeded BC WQGs. These exceedances indicate that inputs of particulate bound metals to the river exist downstream of Likely.

2.2 Temporal Boundaries

The WQIA focussed on an evaluation of water quality changes after the event. Water quality monitoring is ongoing; however, for the purposes of this report, a data time period cutoff had to be set. For the purposes of initial identification of COPCs, the post-event time period was defined as August 2014 to February 2015, which was the time period for which water quality data were available,. For the evaluation of chemical COPCs in the receiving environment this assessment period was extended from February to April 2015 as new data became available. The assessment period was extended for these parameters because data collected after lake turn over were limited by a cessation of sample collection at the majority of lake stations during winter due to safety and logistical concerns. Consideration of March and April data expanded the post lake turnover dataset for these stations.

The pre-event time period represented the period of record for which water quality data were available for each of the study areas identified in Section 2.1. The compilation of pre-event water quality data is described further in Section 3.1, but data were available for Polley Lake (1995 to 2014), Hazeltine Creek (1990 to 2014), Quesnel Lake (2004 to 2006) and Quesnel River (1972 to 1987 and 2011 to 2014).

3.0 IMPACT ASSESSMENT APPROACH AND METHODS

3.1 Pre-Event Surface Water Quality

3.1.1 Data Compilation

Pre-event surface water quality data were compiled to provide context for the post-event WQIA. Data search efforts are detailed in Appendix A with an overview provided below.

The data search focused on surface water quality data collected in the spatial areas described in Section 2.1; i.e., Polley Lake, Hazeltine Creek, Quesnel Lake and Quesnel River. MPMC has a large baseline and pre-event water quality data set that includes water chemistry data related to the TSF supernatant, Polley Lake, Hazeltine Creek, and the mouth of Edney Creek (Table 3-1). These data were considered to be sufficiently comprehensive to enable a background characterization for those areas, such that only a search for Quesnel Lake and Quesnel River pre-event data was undertaken.

Representatives of the following agencies and groups were contacted to identify pre-event data in their possession or if they had knowledge of other data sources for Quesnel Lake and Quesnel River:

- BC MoE;
- BC Ministry of Forests, Lands and Natural Resource Operations;
- Fisheries and Oceans Canada;
- Environment Canada;
- BC Interior Health;
- local consultants who have worked in the Likely and Quesnel Lake area; and,
- regional researchers at the University of British Columbia (UBC) and University of Northern British Columbia.

Based on the results of this inquiry, a more limited pre-event data set was compiled for Quesnel Lake and Quesnel River (BC MoE data) compared to the pre-event data available for Polley Lake and Hazeltine Creek (MPMC data). Data for Quesnel River at the town of Likely included water samples analysed for a sub-set of chemical parameters including metals, nutrients, and major ions, with the most recent pre-event sample collected more than 25 years ago. Sampling at the Likely Bridge was re-commenced post-event. Data for Quesnel River 50 km downstream of Likely at the Gravelle Ferry Bridge was limited to six samples collected between June 2011 and July 2014. Water samples were analysed for a sub-set of parameters including turbidity, metals, nutrients, and major ions; TSS was not measured.

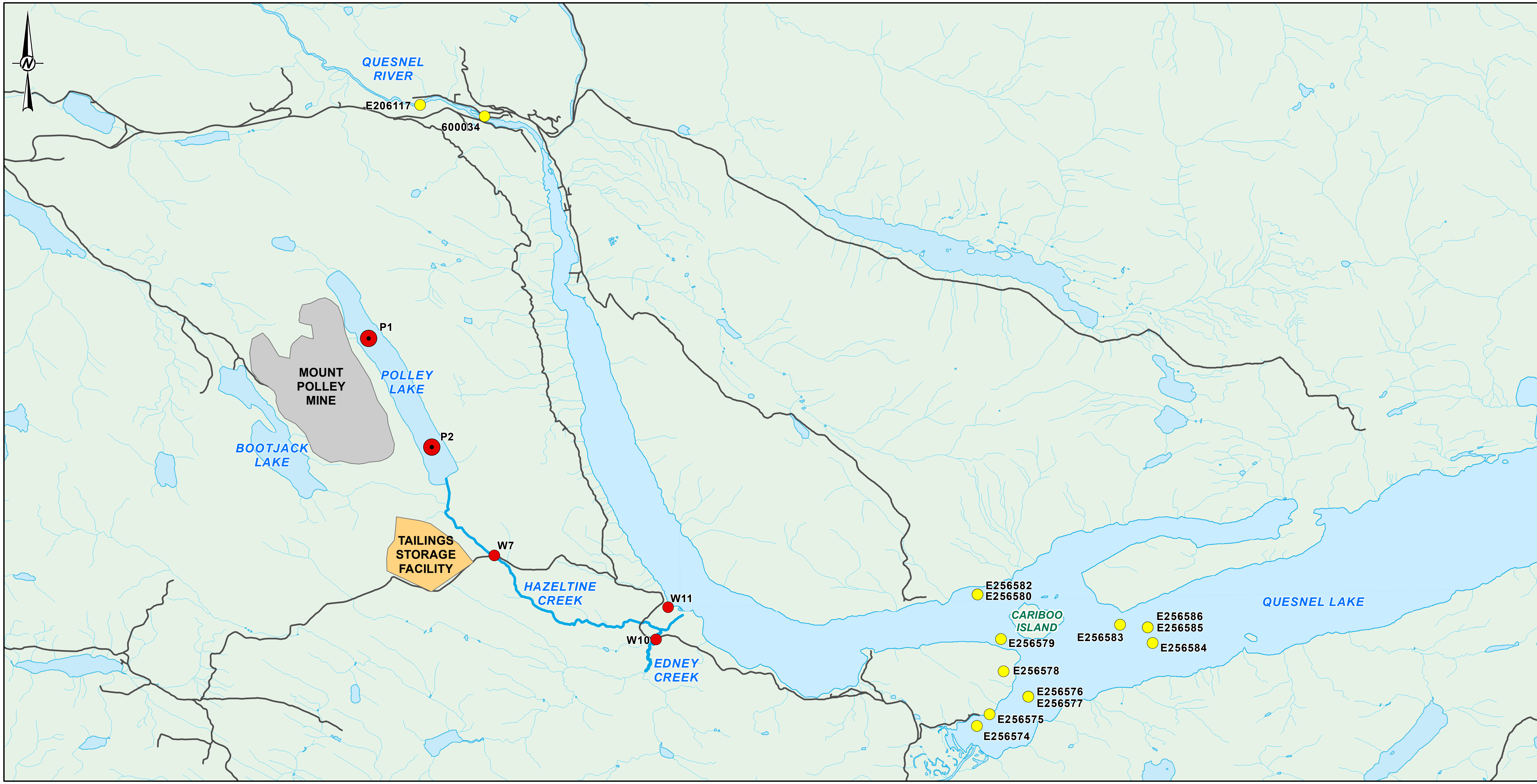
The Quesnel Lake dataset was comprised of data from nutrient-related monitoring surveys that were primarily focused around Horsefly Bay just east of Cariboo Island. Quesnel Lake data collected in 2003 (UBC and BC MoE data) and reported previously by MPMC (2009), were not included because sample location coordinates and documented quality assurance and quality control (QA/QC) procedures were not available, only total metals were reported without dissolved metal concentrations, and method detection limits for most metals were elevated above BC WQGs.

The surface water quality stations identified to define pre-event water quality conditions are listed in Table 3-1 and illustrated in Figure 2.

Table 3-1: Summary of Surface Water Quality Stations Identified to Define Pre-Event Conditions

Area	Monitoring Station	Station Description	Number of Samples	Date Range	Data Source
Polley Lake	P1	North end of Polley Lake	84 (and 40 depth profiles)	1995 to 2014	MPMC
	P2	South end of Polley Lake	82 (and 42 depth profiles)	1995 to 2014	
Hazeltine Creek	W7	Upper Hazeltine Creek	266	1990 to 2014	MPMC
Edney Creek	W11	Downstream of confluence with Hazeltine Creek	67	1995 to 2014	MPMC
Quesnel Lake	E256574	Horsefly Bay	28	2004 to 2006	BC MoE
	E256575	Horsefly Bay	37		
	E256576	Horsefly Bay	37		
	E256577	Horsefly Bay	36		
	E256578	Horsefly Bay	36		
	E256579	Near Cariboo Island	35		
	E256580	West of Cariboo Island	33		
	E256582	West of Cariboo Island	34		
	E256583	East of Cariboo Island	33		
	E256584	East of Cariboo Island	4		
	E256585	East of Cariboo Island	4		
	E256586	East of Cariboo Island	34		
Quesnel River - near lake outlet	600034	At town of Likely	35	1972 to 1988	BC MoE
	E206117	Downstream of Likely	8	1985 to 1987	
Quesnel River -downstream	Gravelle Ferry Bridge	50 km downstream of Likely, towards Fraser River	6	2011 to 2014	BC MoE

Notes:
MPMC = Mount Polley Mine Corporation; BC MoE = British Columbia Ministry of Environment.



LEGEND

PRE-EVENT MONITORING STATIONS

- ROUTINE - GRAB (MPMC)
- ROUTINE - GRAB + PROFILE (MPMC)
- ROUTINE - GRAB (MOE)
- TAILINGS STORAGE FACILITY
- MOUNT POLLEY MINE SITE
- ROAD
- WATERCOURSE
- WATERBODY

0 2.5 5

1:100,000 KILOMETRES

REFERENCES

1. WATER MONITORING STATIONS OBTAINED FROM MOUNT POLLEY MINING CORPORATION.
2. WATERCOURSE AND LAKE DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
3. PROJECTION: NAD 1983 UTM ZONE 10

CLIENT
IMPERIAL METALS
MOUNT POLLEY MINING CORPORATION

PROJECT
MOUNT POLLEY MINE
WATER QUALITY IMPACT ASSESSMENT

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-05-26
DESIGNED	JVG
PREPARED	RH
REVIEWED	LN
APPROVED	LN

TITLE
PRE-EVENT WATER QUALITY MONITORING STATIONS

PROJECT NO.	CONTROL	REV.	FIGURE
1411734	10000	A	2

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25mm

3.1.2 Data Analysis

Pre-event water quality data received from MPMC and BC MoE were summarized and used in the screening approach to identify COPCs for the WQIA. The data were grouped into four areas: Hazeltine Creek, Polley Lake, Quesnel Lake, and Quesnel River. The data were received from sources with established QA/QC programs and were considered reliable for the purpose of defining baseline conditions for the impact assessment. Field quality control samples (e.g., field duplicates) were removed from the dataset and the following summary statistics were calculated for each area:

- total number of samples;
- number and percentage of samples with values below the method detection limit (MDL); and,
- minimum, maximum, median, mean, standard deviation (SD), standard error (SE), and 95th percentile concentrations.

For values that were reported as less than the MDL, one-half the MDL was substituted for calculation of mean, SD, SE, and 95th percentile. For parameters with greater than 50% non-detect values, mean, SD, and SE were not calculated. For parameters with greater than 95% non-detect values, 95th percentile was not calculated.

The summary statistics for each study area are presented in Appendix A. The 95th percentile was used to define baseline conditions in the post-event COPC screening (Section 3.3).

3.2 Post-Event Surface Water Quality

3.2.1 Data Collection

After the event, MPMC[4] initiated a water quality monitoring program in Polley Lake, Hazeltine Creek, Edney Creek, Quesnel Lake, and Quesnel River. The program was adapted based on factors that included, but were not limited to: monitoring results, safety and logistical constraints, recommendations from BC MoE, and seasonal conditions (e.g., lake turnover, onset of winter). A summary of the monitoring program, locations of all sampling stations, and reports on the field methods, data management, and data quality review are presented in Appendix B. An overview of the program, as it occurred from August 6, 2014, to February 28, 2015, is presented below.

The monitoring program had several components, including the following:

- delineation and tracking of the suspended solids plume in Quesnel Lake;
- monitoring at key locations in Polley Lake, Hazeltine Creek, Quesnel Lake, and Quesnel River;
- monitoring associated with movement of Polley Lake water around the “plug” at the south end of Polley Lake and into Hazeltine Creek;
- residential drinking water monitoring; and,
- sampling for an acute and chronic toxicity testing program.

[4] The post-evetn water quality monitoring program was developed by a team at MPMC that included a water quality specialist and environmental scientist.

Water quality monitoring was undertaken at a large number of stations at varying frequencies (Table 3-2 and Table 3-3; Figure 3). In the lakes, samples were collected at surface and throughout the water column. Stations sampled more than four times between August and February were termed 'routine stations' for the purpose of the WQIA and reflect stations where monitoring was undertaken at an implied frequency. Following the event, sampling was undertaken daily or every two days at first with a transition to approximately weekly in the months that followed[5] (Table 3-2; Figure 3). A number of other stations were sampled between one and four times from August to February, largely in Quesnel Lake, for the purposes of tracking the suspended solids plume and monitoring of residential drinking water quality. These stations were termed 'investigative stations' for the purpose of the WQIA because monitoring was undertaken infrequently for a specific purpose that did not require frequent sampling at one location (Table 3-3; Figure 3).

Water samples were analysed for a broad suite of parameters, including total and dissolved metals (limited dataset for mercury), anions, nutrients, and other water quality parameters[6]. Depth profiles of field parameters (i.e., pH, temperature, specific conductivity, DO, and turbidity) were conducted throughout the water column at stations in Polley Lake and Quesnel Lake. At some stations in Hazeltine Creek and Quesnel River, continuous data loggers were installed to record field parameter measurements (Table 3-2).

Seven routine stations were sampled in Polley Lake. Immediately after the event, boat access to Polley Lake was not permitted for safety reasons and sampling was limited to shoreline stations (POL-2, POL-3, and POL-4). In early September, sampling began at four stations located down the midline of the lake (P1, P2, POL-5, and POL-6) and continued until mid-November. Sampling was reduced going into winter because of limited safe access to the lake. Unseasonably warm winter conditions did not allow typical formation of ice on the lake, and as a result planned under-ice sampling was not carried out.

For safety reasons, monitoring of Hazeltine Creek did not commence until late August, when Polley Lake water levels were reduced to a safe level (in accordance with potential geotechnical risks associated with the "plug") and a safety protocol was in place for accessing the creek. One routine station was sampled in upper Hazeltine Creek (HAC-05) and two routine stations were sampled in lower Hazeltine Creek (HAC-01, HAC-08). Samples collected at HAC-01, HAC-01a, HAC-01b in lower Hazeltine Creek have contiguous sampling periods and are considered to represent the same location, as the sample point was moved slightly to adapt to changes in the creek channel due to rehabilitation activities and construction of sedimentation ponds. Continuous data loggers were deployed at two stations in Hazeltine Creek and removed according to winter conditions. Two routine monitoring stations were established in Edney Creek in February 2015 once its flow was diverted from the sedimentation ponds into a reconstructed lower Edney Creek channel. A data logger was deployed again in lower Hazeltine Creek in January 2015.

There were a total of 27 routine stations in Quesnel Lake. Immediately after the event, routine monitoring at key near-field and downstream stations commenced in addition to investigative monitoring for plume delineation. By late August, a routine monitoring program was implemented for the West Basin. Stations were added east of Cariboo Island in mid-September as the plume migrated east towards the main body of the lake during seiche events. As the onset of winter conditions made safe boat access to stations less reliable, the monitoring program was modified in late October in an effort to maintain spatial coverage and frequent monitoring of key locations for fall turnover. The program was maintained through turnover until mid-December 2014.

[5] Winter water quality sampling frequency also considered safety and accessibility related to weather or ice cover.

[6] Conductivity, turbidity, hardness, TDS, TSS, temperature, dissolved oxygen, pH.

One routine station (QUR-1) was established on Quesnel River at the Quesnel River Research Centre near the town of Likely on August 6, 2014, and was monitored daily until December 23, 2014. This station was a key location to monitor water flowing out of Quesnel Lake to the downstream environments. In addition to daily grab samples, an automatic sampler was installed that collected water three times per day for analysis of metals, anions, and turbidity. Removal of the automatic sampler was necessary with the onset of winter conditions. A sonde instrument was also installed to measure field parameters (i.e., pH, temperature, specific conductivity, DO, and turbidity) every 15 minutes. This instrument remains in place to the present day.

Investigative stations were located in most study areas (Table 3-3), and were sampled less frequently for specific purposes (e.g., delineation of the suspended solids plume). A residential drinking water monitoring program was initiated in response to source water concerns for residents that draw drinking water from Quesnel Lake and Quesnel River and included sampling near residential water intakes.

Table 3-2: Post-Event Routine Water Quality Monitoring Stations (August 2014 to February 2015)

Area	Station Name	Number of Surface Samples	Number of Samples at Depth	Sample Depth Range	Number of Profiles	Date Range (mm/dd/yyyy)
Polley Lake	P1	11	11	Not specified	11	09/09/2014 - 11/18/2014
	P2	12	11	Not specified	11	09/09/2014 - 01/06/2015
	POL-2 shore	17	N/A	N/A	N/A	08/07/2014 - 12/15/2014
	POL-3 shore	19	N/A	N/A	N/A	08/08/2014 - 09/16/2014
	POL-4 shore	20	N/A	N/A	N/A	08/08/2014 - 12/16/2014
	POL-5	9	9	9-12 m	9	09/08/2014 - 11/18/2014
	POL-6	9	9	11-14 m	9	09/09/2014 - 11/18/2014
Upper Hazeltine	HAC-05	22	N/A	N/A	N/A	08/28/2014 - 02/02/2015
		continuous data logger				11/05/2014 - 11/26/2014
Lower Hazeltine	HAC-01	23	N/A	N/A	N/A	08/24/2014 -09/25/2014
	HAC-01a	61	N/A	N/A	N/A	09/27/2014 - 12/12/2014
	HAC-01b	11	N/A	N/A	N/A	12/16/2014 - 02/24/2015
		continuous data logger				01/19/2015 - 02/28/2015
	HAC-08	5	N/A	N/A	N/A	01/27/2015 - 02/24/2015
		continuous data logger				11/06/2014 - 11/26/2014
Edney Creek	EDC-01	2	N/A	N/A	N/A	02/17/2015 - 02/24/2015
	EDC-02	1	N/A	N/A	N/A	02/24/2015
Quesnel Lake	QUL-2	22	32	8-50 m	21	08/06/2014 - 11/18/2014
	QUL-2a	9	17	40-60 m	10	09/25/2014 - 11/14/2014
	QUL-3	13	3	10-37 m	2	08/06/2014 - 09/04/2014
	QUL-9	12	N/A	N/A	N/A	08/06/2014 - 08/24/2014
	QUL-17	9	N/A	N/A	N/A	08/08/2014 - 08/17/2014
	QUL-18	49	33	8-100 m	19	08/08/2014 - 12/16/2014
	QUL-19	14	2	35-55 m	2	08/08/2014 - 08/27/2014
	QUL-20	50	2	10-20 m	34	08/08/2014 - 11/06/2014
	QUL-21	30	41	6-47 m	22	08/08/2014 - 11/06/2014
	QUL-21a	10	20	40-65 m	11	09/25/2014 - 11/19/2014
	QUL-22	35	21	4-25 m	21	08/08/2014 - 10/24/2014
	QUL-23	30	N/A	N/A	N/A	08/24/2014 - 10/15/2014

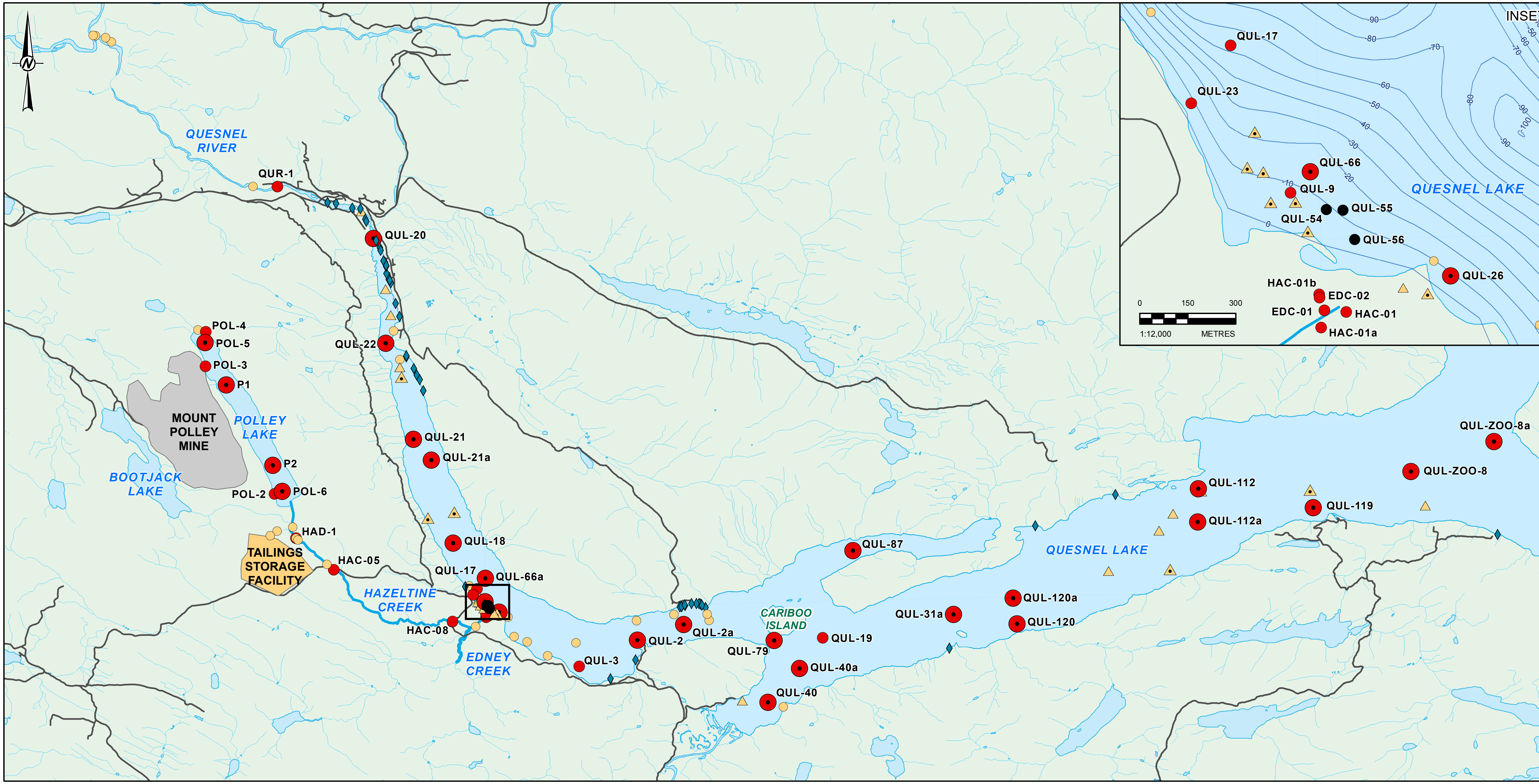
Area	Station Name	Number of Surface Samples	Number of Samples at Depth	Sample Depth Range	Number of Profiles	Date Range (mm/dd/yyyy)
Quesnel Lake	QUL-26	9	8	10-27 m	5	08/11/2014 - 08/21/2014
	QUL-31a	5	14	40-170 m	5	09/27/2014 - 11/18/2014
	QUL-40	7	14	40-100 m	9	09/19/2014 - 10/27/2014
	QUL-40a	7	21	40-140 m	8	09/27/2014 - 11/17/2014
	QUL-66	25	51	10-85 m	28	08/24/2014 - 01/15/2015
	QUL-66a	14	25	40-105 m	13	09/25/2014 - 12/16/2014
	QUL-79	32	65	8-79 m	36	08/25/2014 - 12/16/2014
	QUL-87	11	23	13-57 m	12	08/25/2014 - 11/18/2014
	QUL-112	11	23	30-120 m	11	09/20/2014 - 12/04/2014
	QUL-112a	2	8	40-230 m	2	11/13/2014 - 12/11/2014
	QUL-119	6	12	20-98 m	6	09/21/2014 - 09/11/2014
	QUL-120	8	16	35-88 m	8	09/21/2014 - 12/04/2014
	QUL-120a	4	16	40-200 m	4	10/11/2014 - 12/11/2014
	QUL-ZOO-8	4	15	40-240 m	4	10/05/2014 - 11/13/2014
	QUL-ZOO-8a	2	6	40-240 m	2	10/09/2014 - 10/26/2014
Quesnel River	QUR-1	293	N/A	N/A	N/A	08/06/2014 - 02/23/2014
		continuous data logger				08/12/2014 - 02/28/2015

Notes:
N/A = not applicable.

Table 3-3: Post-Event Investigative Water Quality Monitoring Stations (August 2014 to February 2015).

Area	Number of Stations	Number of Samples/Station	Date Range (mm/dd/yyyy)
Polley Lake	1	1	08/07/2014
Hazeltine Creek	6	1 to 2	08/27/2014 - 01/19/2015
Quesnel Lake - surface and depth	37[a]	1 to 3	08/06/2014 - 10/12/2014
Quesnel Lake - profiles	23	1	08/07/2014 - 10/12/2014
Quesnel Lake - residential	44	1 to 4	08/06/2014 - 12/01/2014
Quesnel River	10[b]	1	08/27/2014 - 11/19/2014

Notes:
(a) 5 stations with field parameters only.
(b) 3 stations with field parameters only.



LEGEND

POST-EVENT MONITORING STATIONS

- ROUTINE - GRAB
- ROUTINE - GRAB + PROFILE
- INVESTIGATION - GRAB
- INVESTIGATION - PROFILE
- INVESTIGATION - GRAB + PROFILE
- RESIDENTIAL INTAKE
- SUPPLEMENTARY STATION MARCH TO APRIL 2015
- TAILINGS STORAGE FACILITY
- MOUNT POLLEY MINE SITE

- BATHYMETRY
- ROAD
- WATERCOURSE
- WATERBODY

0 3 6

1:120,000 KILOMETRES

REFERENCES

1. WATER MONITORING STATIONS OBTAINED FROM MOUNT POLLEY MINING CORPORATION.
2. WATERCOURSE AND LAKE DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
3. PROJECTION: NAD 1983 UTM ZONE 10

CLIENT
IMPERIAL METALS
MOUNT POLLEY MINING CORPORATION

PROJECT
MOUNT POLLEY MINE
WATER QUALITY IMPACT ASSESSMENT

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-05-26
DESIGNED	JVG
PREPARED	RH
REVIEWED	LN
APPROVED	LN

TITLE
POST-EVENT WATER QUALITY MONITORING STATIONS

PROJECT NO.	CONTROL	REV.	FIGURE
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3.2.2 Data Compilation and Analysis

SNC-Lavalin Inc. (SNC-Lavalin) was retained by MPMC to assist with the development and implementation of a QA/QC program for the water quality monitoring program implemented immediately after the event. On December 20, 2014, program oversight and data management for the water quality monitoring program transitioned to MPMC from SNC-Lavalin. A summary of the program and relevant reports on the field methods, data management, and data quality review are presented in Appendix B.

The water quality monitoring data were evaluated by SNC-Lavalin and MPMC for quality and usefulness in accordance with the BC Field Sampling Manual (BC MWLAP 2003). Analytical and field monitoring data that were verified to be reliable, as well as station location information, were uploaded by MPMC to their water quality database. MPMC provided outputs of the data from August 2014 to February 2015 in an electronic format for this WQIA. The data were used as received and considered reliable for the purposes of the impact assessment because there was a process of sample continuity and data quality verification. The data were grouped into four areas, corresponding to samples that represent water quality conditions within Polley Lake, Hazeltine Creek, Quesnel Lake, and Quesnel River. For the purpose of the impact assessment, all remediation areas along Hazeltine Creek were combined and evaluated as one area.

Post-event water quality data compiled for all stations within an area were evaluated as one dataset for COPC screening (Section 3.3). Subsequent data analysis of COPC temporal trends focused on representative stations selected for each area. Substitutions were not made for values that were reported as less than the MDL and these values were set equal to the MDL for purposes of plotting data, calculating 30-day (d) averages, and correlation analysis. For field parameters, daily averages were calculated from continuous data loggers and averages at 1-m depth intervals were calculated for high-resolution depth profiles. Data from stations HAC-01, HAC-01a, HAC-01b were combined for station-specific water quality analyses as the data were considered to represent one sample location because of their close proximity and contiguous datasets.

3.3 Identification of COPCs: Hazeltine Creek and Receiving Environment

The total number of parameters or substances considered in the WQIA was 76, including physical parameters (specific conductivity, DO, hardness, pH, total dissolved solids, total suspended solids, turbidity, and water temperature), major ions (alkalinity, chloride, fluoride, sulphate), nutrients (ammonia, nitrate, nitrite, total nitrogen, total phosphorus), and total and dissolved metals (Appendix C, Table C-1). The purpose of the COPC screening process outlined below is to focus the post-event assessment on those substances that might be of consequence, thereby carrying out a more focused and detailed evaluation of post-event impact on water quality.

COPCs were identified from the post-event dataset for further characterization of post-event water quality at representative monitoring stations in Hazeltine Creek and the receiving environment. Substances were identified as COPCs if they were greater than pre-event concentrations and applicable BC WQGs based on the most sensitive receiving environment water use.

3.3.1 Receiving Environment Water Uses

Known environmental uses on Quesnel Lake, particularly with respect to the West Basin, were identified to determine the most sensitive water use for the receiving environment. The following environmental uses were identified for Quesnel Lake:

- Commercial, recreational, and aboriginal (CRA) fisheries;

- Recreational uses such as scenery and wildlife viewing, swimming, boating, kayaking, canoeing, waterskiing/tubing/wakeboarding, and in the winter snowmobiling and ice fishing when ice conditions allow; and,
- Drinking and residential water use for domestic purposes[7].

Although agriculture, especially cattle ranching, is an economic driver in the local area (Cariboo Envirotech 2009), there are no water licenses (current or pending) for stock watering or irrigation use for Quesnel Lake (BC MoE 2015b).

Water quality guidelines have been developed by BC MoE to be protective of different water uses, including aquatic life, wildlife, drinking water sources, recreational contact, and agriculture. Based on the above uses identified for Quesnel Lake, guidelines protective of aquatic life, wildlife, drinking water sources and recreational contact are applicable to the receiving environment in Quesnel Lake.

With the exception of molybdenum, total aluminum, and pH, the most sensitive receiving environment use was the protection of aquatic life. For molybdenum, the most conservative 30-d BC WQG value was adopted (i.e., irrigation assuming the copper: molybdenum ratio is less than 2:1 *in lieu* of a 30-d value for wildlife). For total aluminum, the most conservative maximum BC WQG was adopted (i.e., water for wildlife) because aquatic life guidelines are based only on dissolved aluminum. Recreational guidelines are not shown in Table 3-4; they are similar to, but in some cases less stringent than, drinking water guidelines and are thus implicitly considered in the analysis; however, recreational use is clearly a relevant receiving environment use. For pH, the drinking water guideline range of 6.5-8.5 was adopted that is slightly narrower than that specified for aquatic life.

Table 3-4: BC Water Quality Guidelines for Receiving Environment Uses Relevant to the Water Quality Impact Assessment

Parameter	Units	Maximum BC Water Quality Guidelines			Chronic BC Water Quality Guidelines	
		Aquatic Life	Drinking Water	Wildlife Water	Aquatic Life	Wildlife Water
Physical Parameters						
Dissolved Oxygen	mg/L	Min 5 – 9	-	-	**Min 8-11**	-
Total Suspended Solids	mg/L	+25 mg/L from background	-	+20 mg/L from background	**+5 mg/L from background**	-
Turbidity	NTU	+8 NTU from background	**+1 NTU change from background (untreated water)**	+10 NTU change from background	+2 NTU change from background	-
Water Temp	°C	**±1°C change from background**	15	±1°C change from background	-	-
pH (field)	pH Unit	6.5 - 9.0	**6.5 - 8.5**	-	6.5 - 9.0	-
Major Ions						
Calcium	mg/L	-	-	-	see note[(a)]	-
Chloride	mg/L	600	250	600	**150**	-
Sulphate	mg/L	-	500	-	**218[(b)]**	-

[7] Domestic purposes as defined in the BC *Water Act* means the use of water for household requirements, sanitation and fire prevention, the watering of domestic animals and poultry and the irrigation of a garden not exceeding 1012 m^2 adjoining and occupied with a dwelling house.

Parameter	Units	Maximum BC Water Quality Guidelines			Chronic BC Water Quality Guidelines	
		Aquatic Life	Drinking Water	Wildlife Water	Aquatic Life	Wildlife Water
Nutrients						
Ammonia	mg/L (as N)	20.5(c)	-	-	**1.84(c)**	-
Nitrate	mg/L (as N)	32.8	10	100	**3**	-
Nitrite	mg/L (as N)	0.060(d)	1	10	**0.02(d)**	-
Total Phosphorus	mg/L	-	0.01	-	**0.005-0.015 in lakes**	-
Total Metals						
Aluminum	mg/L	-	-	**5**	-	-
Antimony	mg/L	-	-	-	**0.009W**	-
Arsenic	mg/L	**0.005**	0.025M	0.025M	-	-
Boron	mg/L	**1.2**	5	5	-	-
Chromium	mg/L	-	-	-	**0.001W(e)**	0.05W(e)
Cobalt	mg/L	0.11	-	-	**0.004**	-
Copper	mg/L	0.0067(f)	0.5	0.3	**0.002(f)**	-
Iron	mg/L	**1**	-	-	-	-
Manganese	mg/L	1.09(g)	-	-	**0.83(g)**	-
Molybdenum	mg/L	2	0.25	0.05	1	**0.01(h)**
Selenium	mg/L	-	0.01	-	**0.002**	0.002
Silver	mg/L	0.0001(i)	-	-	**0.00005(i)**	-
Zinc	mg/L	0.03(j)	5	-	**0.0075(j)**	-
Dissolved Metals						
Aluminum	mg/L	0.1(k)	0.2	-	**0.05(k)**	-
Antimony	mg/L	-	-	-	-	-
Cadmium	mg/L	0.000288(l)	-	-	**0.000127(l)**	-
Iron	mg/L	**0.35**	-	-	-	-

Notes:
Values are taken from the approved guidelines unless otherwise noted
W = working guideline; M = interim guideline, Min = Minimum concentration requirement based on life stage
Hardness dependent guidelines are based on hardness of 50 mg/L, considered representative of average conditions in the receiving environment
Bold Indicates most conservative WQG
(a) up to 4 - highly sensitive to acid inputs; 4 to 8 - moderately sensitive; over 8 - low sensitivity
(b) hardness dependent sulphate guideline: BC 30-d WQG (mg/L) = 128 at hardness <30 mg/L, at hardness 31-75 mg/L = 218, at hardness 76-180 mg/L = 309, at hardness 181-250 mg/L = 429, at hardness >250 mg/L determine base on site water
(c) pH and temperature dependent ammonia guideline: values selected from Table 3 (maximum WQG) and Table 4 (30-d WQG) in BC WQG based on a temperature of 10°C and 7.0 pH, considered representative of average conditions in the receiving environment
(d) chloride dependent nitrite guideline: BC Max WQG (mg/L) = 0.06 at Cl <2 mg/L, at Cl 2-4 mg/L = 0.12, at Cl 4-6 mg/L = 0.18, at Cl 6-8 mg/L = 0.24, at Cl 8-10 = 0.30, at Cl >10 = 0.6; BC 30-d WQG (mg/L) = 0.02 mg/L at Cl <2 mg/L, at Cl 2-4 mg/l = 0.04, at Cl 4-6 mg/L = 0.06, at Cl 6-8 mg/L = 0.08, at Cl 8-10 mg/L = 0.1, at Cl >10 = 0.2, determined based on Cl <2 mg/L considered representative of average conditions in the receiving environment
(e) guideline is for chromium VI (Cr(VI))
(f) hardness dependent copper guideline: BC Max WQG (mg/L) = (0.094(hardness)+2)/1000; BC 30-d WQG (mg/L) = 0.002 at hardness ≤50 mg/L , at hardness >50 mg/L = 0.04*hardness/1000
(g) hardness dependent manganese guideline: BC Max WQG (mg/L) = 0.01102*(hardness)+0.54; BC 30-d WQG (mg/L) = 0.0044*hardness+0.605
(h) BC 30-d WQG for irrigation water for forage crops (most sensitive WQG) substituted due to concern for ruminants and no 30-d WQG proposed for wildlife water supply
(i) hardness dependent silver guideline: BC Max WQG (mg/L) = 0.0001 at hardness ≤100 mg/L, at hardness >100 mg/L = 0.003; BC 30-d WQG (mg/L) = 0.00005 at hardness ≤100 mg/L, at hardness > 100 mg/L = 0.0015
(j) hardness dependent zinc guideline: BC Max WQG (mg/L) = (33+0.75(hardness-90))/1000; BC 30-d WQG (mg/L) = (7.5+0.75(hardness-90))/1000
(k) pH dependent dissolved aluminum guideline: BC Max WQG (mg/L) = 0.1 at pH ≥6.5, at pH <6.5 = exp(1.209-2.426*(pH)+0.286*(pH^2)); BC 30-d WQG (mg/L) = 0.05 at pH ≥6.5, at pH <6.5 = exp(1.6-3.327*(median pH)+0.402*(median pH^2), determined based on 7.0 pH
(l) hardness dependent dissolved cadmium guideline: BC MaxWQG (mg/L) = (exp(1.03*ln(hardness)-5.274))/1000; BC 30-d WQG (mg/L) = (exp(0.736*ln(hardness)-4.943))/1000

3.3.2 COPC Identification

Post-event maximum and 95th percentile parameter concentrations calculated for Hazeltine Creek and each receiving environment area were compared to BC WQGs for the most sensitive water use identified in Table 3-4. Maximum and 95th percentile concentrations represented upper limit concentrations in the post-event water quality dataset. Water quality parameters were not identified as COPCs for Hazeltine Creek or the receiving environment areas if post-event upper limit concentrations were below the applicable guideline. BC WQGs are conservative environmental quality benchmarks with built-in safety factors that represent concentrations where adverse impacts on water quality are not expected. A parameter was identified to be of concern if maximum and 95th percentile concentrations were above the lowest applicable BC WQG. The potential for adverse effects on aquatic life and other receiving environment uses was evaluated in the impact assessment for parameters identified as COPCs.

With respect to parameters that do not have applicable BC WQGs, these parameters were identified to be of concern if post-event upper-limit concentrations were more than 20% higher than comparable pre-event concentrations. A difference of less than or equal to 20% between comparable post-event concentrations and pre-event concentrations was not considered to be distinguishable from the background conditions and therefore not considered to represent a potential effect to water quality in the receiving environment. This assessment criterion is consistent with BC MoE (2013) where a relative percent difference less than 20% between two duplicate water quality values is not considered to indicate a distinguishable difference between the two values.

Parameters that did not have a BC WQG and where a pre-event condition could not be defined (i.e., Quesnel Lake), were conservatively identified as COPCs.

Additional considerations in the identification of COPCs are listed below.

- Alkalinity, hardness, calcium, magnesium, potassium and sodium are components of TDS mixtures and so were not evaluated individually. Instead TDS was identified as a COPC because predicted concentrations were higher than baseline (+20%) and so were distinguishable from the baseline conditions. However, TDS benchmarks have been established in Northwest Territories (Diavik Diamond Mine), Alaska and Iowa (from 500 to 1000 mg/L) (ADEC 2009, IDNR 2009, WLWB 2013). Post-event 95th percentile TDS concentrations for Hazeltine Creek (460 mg/L), Quesnel Lake (101 mg/L) and Polley Lake (219 mg/L) were below these TDS benchmarks. Furthermore, upper bound concentrations in TDS constituents, sulphate and chloride, were below the BC WQG for the protection of aquatic life in Hazeltine Creek and the receiving environment areas.
- Tin was not identified as a COPC because it is the organic form of tin that is toxicologically relevant, not the inorganic form.
- Strontium was not identified as a COPC because 95th percentile concentrations in Hazeltine Creek and the receiving environment were substantially below the strontium chronic effects benchmark of 10.7 mg/L recently proposed by McPherson et al. (2014) for freshwater environments.
- Pre-event upper-limit concentrations of total chromium and zinc in Quesnel River were above the applicable BC WQG and post-event concentrations were indistinguishable from comparable pre-event concentrations (less than a 20% difference). Total chromium and zinc were therefore not identified as COPCs for Quesnel River.Mercury was not identified as a COPC in the receiving environment because measured values above the BC WQG were rarely reported. Detection limits in some cases (<0.00001, <0.00005) were equal to or

greater than the WQG and this uncertainty should be addressed by future monitoring of waterborne mercury in the receiving environment at detection limits below the BC WQG. Measurement of mercury in water is a relatively poor indicator of mercury toxicity. As a bioaccumulative constituent, the toxic effects of mercury are best evaluated through a comparison of aquatic organism tissues to tissue-based toxicological benchmarks or guidelines. With respect to Quesnel Lake, mercury concentrations in fish tissues sampled after the event will be addressed in the future Human Health Ecological Risk Assessment.

- Vanadium was not identified as a COPC in the receiving environment because concentrations were below the lowest chronic toxicity value documented by Environment Canada and Health Canada (2010) (0.1 mg/L).
- Total phosphorus was retained as a COPC for Polley Lake and Quesnel Lake because the BC WQG directly applies to lake environments. In Quesnel River close to Likely, the upper bound post-event concentration was lower than the corresponding concentration before the event, indicating no contribution from the event. Further downstream at the Gravelle Ferry Bridge post-event concentrations in Quesnel River are also lower than concentrations measured prior to the event. A post-event assessment of total phosphorus was only relevant for the receiving environment, not Hazeltine Creek because the creek does not currently support substantial instream habitat including plants and algae whose growth could be affected by phosphorus concentrations in the water.

3.4 Impact Assessment Approach

3.4.1 Hazeltine Creek

3.4.1.1 COPC Assessment

At Station HAC-05[8] in the upper creek and Station HAC-01[9] in the lower creek, instantaneous measurements and rolling 30-d average values for each COPC were compared against the following applicable ambient BC WQGs to assess changes in water quality as a result of the event. Data collected between August 2014 and February 2015 were used in the assessment.

- Instantaneous measurements were compared against the short-term maximum BC WQGs (where available) for the most sensitive water use, to evaluate intermittent or transient impacts on water quality (BC MoE 2015a).
- Rolling 30-d average values were calculated and compared against long-term average BC WQGs. The 30-d mean guidelines are intended to be applied to mean concentrations of a minimum of five samples collected over a 30-d time period (BC MoE 2015a).

Temporal and spatial trends in the concentrations of each COPC were discussed with a focus on changes in concentrations related to the event.

[8] Station HAC-05 in upper Hazeltine Creek is downstream of the TSF at the Gavin Lake Road bridge.

[9] Station HAC-01 in lower Hazeltine Creek is at the outlet of Hazeltine and Edney creeks into Quesnel Lake. This station was moved to HAC-01a, then HAC-01b during construction of the sedimentation ponds just upstream of this location.

3.4.1.2 Supporting Environmental Parameters

Turbidity, DO, specific conductivity, and temperature data collected from August 2014 to February 2015 from station HAC-05 (upper Hazeltine Creek) and station HAC-01 (lower Hazeltine Creek) were plotted.

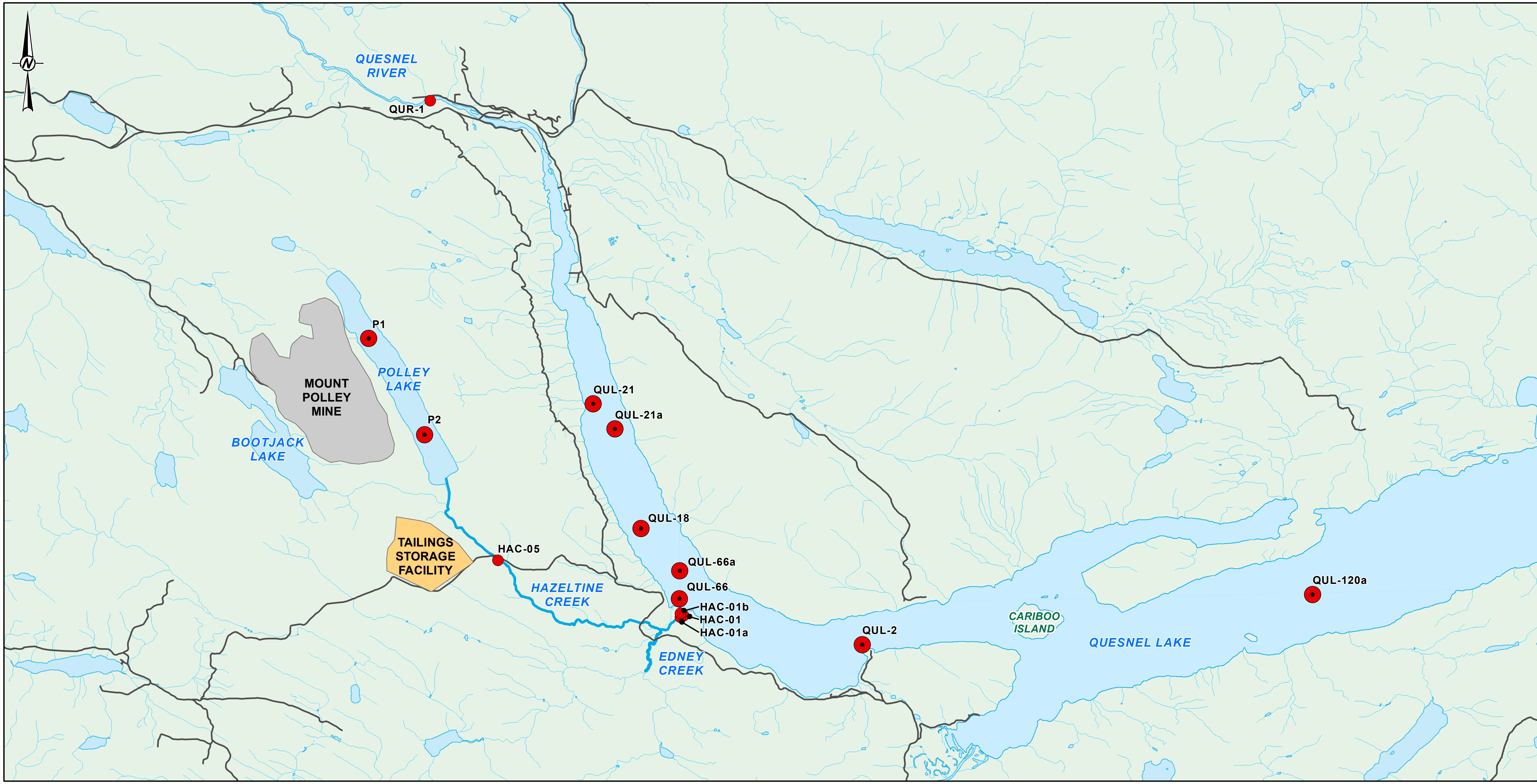
3.4.2 Receiving Environment

3.4.2.1 Selection of Representative Stations

Parameters identified as COPCs were evaluated further by examining temporal trends at representative monitoring stations in each of the three receiving environment areas (Figure 4 and Table 3-5). The time period for the evaluation of trends of metal and nutrient COPCs at these representative stations was extended to April 2015 as discussed in Section 2.2. The rationale for station selection is provided in the summaries by water body provided below.

Table 3-5: Summary of Representative Water Quality Stations for the Receiving Environment

Water Quality Study Area	Area #	Water Quality Monitoring Stations Selected as Representative Stations
Polley Lake	Area 3	P1, P2
Quesnel Lake	Area 8	QUL-2, QUL-66, QUL-66a, QUL-18, QUL-21
Quesnel Lake (turbidity only)	Area 8	QUL-120a, QUL-21a
Quesnel River	Area 9	QUR-1, Gravelle Ferry Bridge



LEGEND

POST-EVENT MONITORING STATIONS

- ROUTINE - GRAB
- ROUTINE - GRAB + PROFILE
- TAILINGS STORAGE FACILITY
- MOUNT POLLEY MINE SITE
- ROAD
- WATERCOURSE
- WATERBODY

0 2.5 5

1:100,000 KILOMETRES

REFERENCES
1. WATER MONITORING STATIONS OBTAINED FROM MOUNT POLLEY MINING CORPORATION.
2. WATERCOURSE AND LAKE DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
3. PROJECTION: NAD 1983 UTM ZONE 10

CLIENT
IMPERIAL METALS
MOUNT POLLEY MINING CORPORATION

PROJECT
MOUNT POLLEY MINE
WATER QUALITY IMPACT ASSESSMENT

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-03-31
DESIGNED	JVG
PREPARED	RH
REVIEWED	LN
APPROVED	LN

TITLE
POST-EVENT REPRESENTATIVE WATER QUALITY STATIONS

PROJECT NO.	CONTROL	REV.	FIGURE
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Polley Lake

Two stations that represented the deepest areas of the lake, provided geographical coverage, and with the largest number of post-event water quality data, were selected from a possible seven routine stations sampled on Polley Lake:

- **Station P1** along the midline, at the north end of the lake.
- **Station P2** along the midline, at the south end of the lake.

Quesnel Lake

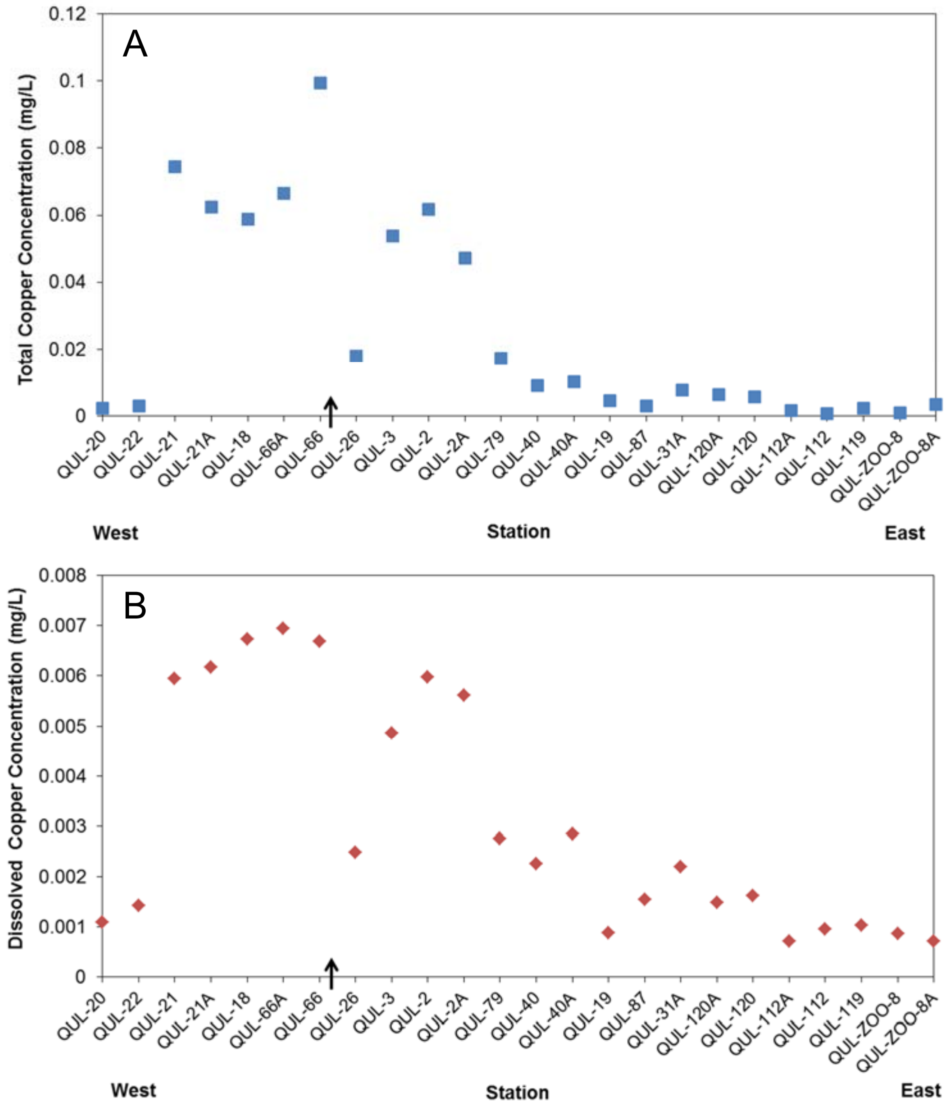
Five stations on Quesnel Lake were selected from a possible 27 routine stations sampled, to provide spatial representation across the West Basin relevant to the event, based on the following considerations:

- The location of the monitoring stations relative to event-related inputs via Hazeltine Creek. Stations representative of near-field (close to Hazeltine Creek), mid-field (some distance from Hazeltine Creek) and far-field areas (located closer to Likely [west] and Cariboo Island [east]) were targeted for assessment.
- Specific stations were selected from examination of post-event 95^{th} percentile values calculated for copper and turbidity at depth (below 20 m) at 24 routine stations on Quesnel Lake (Figure 5 and Figure 6). Copper data at depth were used to select representative stations because it was the only metal where both total and dissolved forms were identified as COPCs in Quesnel Lake and concentrations were higher at depth (see Section 4.2). Stations with higher reported copper concentrations and turbidity levels for that area of the lake (as indicated by 95^{th} percentile values) were typically selected to represent a conservative assessment of water quality over time.
- The number of measurements available for each station relative to the other routine stations.

The locations of each representative station selected for assessment are described as follows:

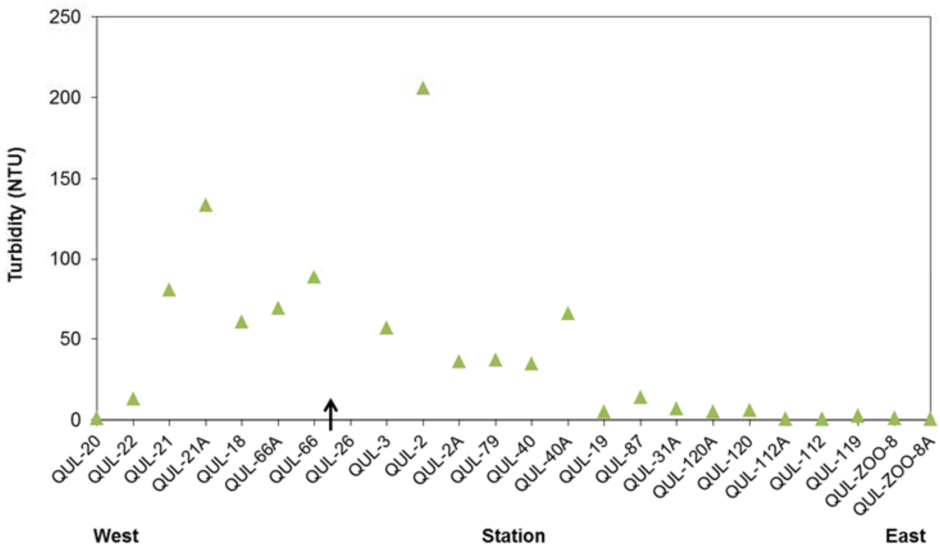
- **Station QUL-66** is located near the mouth of Hazeltine Creek where the debris flow entered the lake. Stations QUL-54, -55, and -56 replaced Station QUL-66 in March 2015 to adapt to the new outlet location of Hazeltine Creek into Quesnel Lake, downstream of the sedimentation ponds.
- **Station QUL-66a** is a deep station north of QUL-66, but still close to the mouth of Hazeltine Creek.
- **Station QUL-18** is located northwest towards Quesnel River between QUL-66 and QUL-21, and represents one of the deepest points in the West Basin. It was assessed with regards to chemical COPCs because monitoring at this station extended to April 2015.
- **Station QUL-21** is located further northwest towards Quesnel River. QUL-21a is the corresponding deep station south of QUL-21 and was only assessed with regards to turbidity measures of the plume in 2014.
- **Station QUL-2** is located east of the mouth of Hazeltine Creek towards Cariboo Island. Data were pooled with Station QUL-2a (a nearby deep station) with regards to time series for turbidity and chemical COPCs because monitoring at this latter station extended to April 2015.

- **Station QUL-120a** is a deep far-field station located east of Cariboo Island towards the main body of the lake and was assessed with regards to turbidity measures of the plume. Data were pooled with Station QUL-120 with regards to time series of phosphorus to provide a more comprehensive dataset.



Note: Arrow represents the inflow from Hazeltine Creek and Tailings Dam Failure event-related inputs to the West Basin of Quesnel Lake.

Figure 5: Total (A) and Dissolved (B) Copper Concentrations (95th Percentile) at Depth (below 20 m) at 24 Routine Stations on Quesnel Lake (data from August 2014 to February 2015). The highest concentrations were typically measured at depth.



Note: Arrow represents the inflow from Hazeltine Creek and Tailings Dam Failure event related inputs to the West Basin of Quesnel Lake

Figure 6: Turbidity Levels (95th Percentile) at Depth (below 20 m) at 24 Routine Stations on Quesnel Lake (data from August 2014 to February 2015). The highest concentrations were typically measured at depth.

Quesnel River

Two stations on Quesnel River were selected as representative stations; one station close to the outlet of Quesnel Lake and one station 50 km downstream of Likely:

- **Station QUR-1** is located at the Quesnel River Research Centre near the town of Likely and reflects water quality at the outflow of Quesnel Lake. This station was routinely monitored by MPMC during the post-event period.
- **A station at the Gravelle Ferry Bridge**, which is more than 50 km downstream of Likely, was monitored by BC MoE prior to the event (June 2011, 2012, and 2014 and July 2014) and more frequently post-event (August 2014 to March 2015). Approximately 50 water samples were collected in the post-event period for metals concentrations, major ions, nutrients, turbidity, and general physical parameters. Measurement of TSS and TDS were limited to six sampling events. Water quality data from this location were not used for the identification of COPCs for Quesnel River, but were relied upon for discussion of downstream water quality because of the limited number of samples collected from the Quesnel River between the Gravelle Ferry Bridge and Station QUR-1 at Likely.

3.4.2.2 COPC Assessment

Instantaneous measurements and rolling 30-d average values for each COPC were compared against the following applicable ambient BC WQGs to assess changes in water quality as a result of the event.

- Instantaneous measurements were compared against the short-term maximum BC WQGs (where available) for the most sensitive water use to evaluate intermittent or transient impacts on aquatic life.

- Rolling 30-d average values were calculated and compared against long-term average BC WQGs that are intended to prevent sub-lethal and lethal effects on the most sensitive species and life stage for an indefinite time period. The 30-d mean guidelines are intended to be applied to mean concentrations of a minimum of five samples collected over a 30-d time period (BC MoE 2015a).

Temporal and spatial trends in the concentrations of each COPC were discussed with a focus on changes in concentrations related to the event.

3.4.2.3 Supporting Environmental Parameters

Water quality profiles of turbidity, DO, specific conductivity, and temperature were plotted for representative stations in Quesnel Lake and Polley Lake. Water quality measurements taken at Station QUR-1 on the Quesnel River were plotted.

4.0 IMPACT ASSESSMENT

4.1 Hazeltine Creek

Hazeltine Creek located directly downstream of the TSF was the study area most directly impacted by the event. As a result of the physical impacts on Hazeltine Creek, the creek was not considered to be fish habitat during the post-event assessment study period. Even though this creek is currently not significantly utilized by aquatic organisms, aquatic habitat use is an intended future use in the longer term; therefore, water quality was assessed based on comparisons to WQGs that imply an aquatic habitat use.

Post-event TSS and turbidity levels in Hazeltine Creek were elevated and varied widely by one to three orders of magnitude (Section 4.1.2 and Appendices D and E). Turbid and high suspended sediment conditions inevitably meant that 21 metals in total form were identified as COPCs (Table 4-1). Six of these 22 metals were also identified as COPCs in their dissolved forms.

Table 4-1: Contaminants of Potential Concern Identified in Hazeltine Creek

Study Area	Non-Chemical Substances	Total Metals	Dissolved Metals
Hazeltine Creek (#4-7)	**particulate matter (turbidity, TSS)**	**aluminum**, arsenic, barium, beryllium, cadmium, **chromium**, cobalt, **copper**, **iron**, lead, lithium, manganese, mercury, **molybdenum**, nickel, **selenium**, silver, thallium, titanium, vanadium, zinc	**aluminum, chromium, copper, iron, molybdenum, selenium**

Notes:
TSS = total suspended solids; TP = total phosphorus; TDS = total dissolved solids
Bolded COPCs were evaluated in the Water Quality Impact Assessment
Dissolved oxygen was above the minimum requirements for aquatic life
In-situ pH was within the BC WQG range of 6.5 to 9.0 for aquatic life

Changes in water quality described here in the WQIA relate to the COPCs aluminum, chromium, copper, iron, molybdenum, and selenium. Both total and dissolved forms of these COPCs were elevated in Hazeltine Creek following the event. Post-event concentrations of the other 15 metals were identified as COPCs based on total metal concentrations that were associated with elevated loads of suspended sediment and particulates rapidly transported downstream to Quesnel Lake in the weeks immediately following the event. An assessment of the potential impact of the downstream transport of particulate metals on aquatic life in Quesnel Lake is addressed in Section 4.2.2.3 of this WQIA as well as in the Quesnel and Polley Lakes Aquatic Productivity Impact Assessment (Golder 2015d).

- *WQIA Section 4.2.2.3:* Total and dissolved metal concentrations measured post-event in the Quesnel Lake and Quesnel River receiving environments were evaluated based on comparison to WQGs and pre-event concentrations.
- *Quesnel and Polley Lakes Aquatic Productivity Impact Assessment*: Both aqueous and dietary exposure routes for metal COPCs identified in the WQIA were evaluated further with respect to potential impacts on aquatic life.

4.1.1 Field Measured Environmental Parameters

Post-event temperature changes in Hazeltine Creek reflected typical seasonal patterns and DO was above the minimum requirements for aquatic life during all sampling events from August 2014 through February 2015 (Appendix D, Section 2.0). Turbidity is discussed with suspended particulate matter in Section 4.1.2.

4.1.2 Suspended Particulate Matter

In both upper and lower Hazeltine Creek, turbidity fluctuated by two- to three orders of magnitude, respectively, with no apparent temporal trends. Ongoing, active erosion of exposed banks has been noted in parts of the creek and examples are highlighted in Figure 7. Additionally, construction activities related to bank stabilization, erosion control, and rehabilitation have been undertaken in various parts of the creek. Sedimentation ponds constructed in lower Hazeltine Creek and commissioned on December 12, 2014, have reduced turbidity in the outflow to Quesnel Lake; however, these ponds are not capable of removing very fine particulate material (MPMC unpublished data). Golder investigated the possibility of using flocculants to enhance particulate removal efficiency of the sedimentation ponds (Golder 2015b), but it was determined that while flocculants are a proven technology in closed, engineered systems, they would be of limited efficacy in that specific application. Further details are provided in Golder (2015b).

Figure 7: Photographs of erosion along Hazeltine Creek post-event.

Available post-event data indicate that TSS and turbidity in both upper and lower Hazeltine Creek did increase as a result of the event, and that post-event concentrations were above BC WQGs. The magnitude of observed exceedances was more prominent in the lower creek compared to the upper creek prior to sedimentation pond commissioning in December 2014. Since then, the magnitude of guideline exceedance in the lower creek has been smaller than the upper creek.

- In upper Hazeltine Creek (HAC-05), TSS and turbidity varied by two or more orders of magnitude during the post-event period and were higher than the corresponding 24-h BC WQGs, at times considerably so. The 30-d average concentrations of these parameters were consistently above the 30-d BC WQG, with turbidity and TSS showing different patterns over time (Appendix D: Section 2.0, Appendix E: Section 2.1).
- In lower Hazeltine Creek (HAC-01), both TSS and turbidity were above the 24-h and 30-d average BC WQGs (Appendix D: Section 2.0, Appendix E: Section 2.1). Both parameters decreased over time, although turbidity was more variable. Concentrations of both turbidity and TSS were reduced by approximately two orders of magnitude after the sedimentation ponds in this lower section were commissioned in December 2014.

TSS and turbidity in Hazeltine Creek are expected to improve as the creek channel erosion control work is extended to the canyon. The data included in this report extend to February; however, considerable water quality improvements have been more recently observed as the channel was extended to the canyon and Hazeltine Creek water clarity being visibly improved (Figure 8). Detailed results from March 2015 onward will be provided in subsequent reports.

Figure 8. Hazeltine Creek turbidity has decreased since erosion control works, part of Hazeltine Creek channel rehabilitation, was completed on May 11, 2015.

4.1.3 Metals

Copper

Total copper concentrations in Hazeltine Creek were above BC WQGs for the protection of aquatic life following the event and post-event concentrations remained above BC WQGs in February 2015 (Appendix E: Section 2.2). The frequency and magnitude of exceedance was more prominent in the lower section of the creek compared to the upper creek.

The progressive decrease in total copper from peak concentrations in August was particularly evident in lower Hazeltine Creek. Concentrations decreased from several orders of magnitude above the BC WQG in the first three to four months following the event, to concentrations closer to the guideline after December 2014. Dissolved concentrations in lower Hazeltine Creek were more stable over the post-event period, with 30-d average concentrations consistently above the 30-d guideline and periodic exceedances of the maximum WQG (Appendix E: Section 2.2).

Aluminum

Total aluminum concentrations in upper and lower Hazeltine Creek were elevated by one to two orders of magnitude above the BC maximum wildlife WQG after the event, but decreased to below the guideline by December 2014 when the sediment ponds became operational (Appendix E: Section 2.3).

Dissolved concentrations were typically below BC WQGs for the protection of aquatic life in the upper creek and were above these guidelines in the lower creek (Appendix E: Section 2.3). In the lower creek dissolved concentrations periodically exceeded the maximum BC WQG throughout the post-event period, though a decrease in concentrations was evident in December through February when concentrations were lower than or approximated the maximum WQG (Appendix E: Section 2.3). Thirty-day rolling average concentrations calculated for the lower creek remained above the 30-d BC WQG for the duration of the post-event period until February 2015 (Appendix E: Section 2.3).

Chromium

Chromium is most commonly found in trivalent Cr(III) and hexavalent Cr(VI) states in freshwater environments. Cr(III) oxidizes slowly to Cr(VI), although Cr(VI) is more soluble (United States Environmental Protection Agency [US EPA] 1984). As such, Cr(III) dominates in reducing environments such as sediments and wetlands, whereas Cr(VI) is the primary species found in surface waters (CCME 1999). The hexavalent form is more toxic to aquatic life than the trivalent form, and thus is typically addressed separately in water quality guideline derivations. The 30-d working BC WQGs for chromium are 0.001 mg/L for Cr(VI) and 0.0089 mg/L for Cr(III) adopted from the federal chromium water quality guideline (CCME 1999).

Post-event, 30-d average total concentrations in Hazeltine Creek were above both Cr(VI) and Cr(III) guidelines, until January 2015, when total concentrations decreased below the Cr(III) WQG, but remained above the Cr(VI) WQG (Appendix E: Section 2.4). Dissolved 30-d average concentrations were typically below the lowest guideline. Speciation data available for lower Hazeltine Creek indicate a small proportion of the dissolved chromium was likely present in the more toxic Cr(VI) form. The Cr(III) WQG is therefore more applicable to the lower section of this creek (Appendix C, Table C-7). In January and February total concentrations were below the Cr(III) BC WQG.

Iron

Total iron concentrations in Hazeltine Creek were elevated by two to three orders of magnitude above the BC maximum WQG for the protection of aquatic life after the event, but decreased to below the guideline by December 2014 when the sediment ponds became operational (Appendix E: Section 2.5). In February total concentrations were above the BC WQG, but were within an order of magnitude of the guideline. Total iron concentrations are expected to reflect elevated suspended sediment conditions in the creek that are influenced by ongoing bank erosion because iron has a propensity to preferentially adsorb to particulates.

Dissolved concentrations in February were below the dissolved BC WQG in Hazeltine Creek. Between August and December 2014 the majority of dissolved iron concentrations were below the dissolved BC WQG with periodic guideline exceedances in the lower creek (Appendix E: Section 2.5).

Molybdenum

Total and dissolved molybdenum concentrations were below the most conservative maximum WQG for wildlife, but 30-d rolling average concentrations were above the most sensitive long term average WQG conservatively applied to address potential exposure to sensitive ruminant wildlife (Appendix E: Section 2.6). The most relevant exposure route for molybdenum uptake by wildlife ruminants, such as deer and moose, is through their plant-based diet rather than directly via drinking water (Swain 1986). Hazeltine Creek does not currently support within-stream vegetation, and riparian vegetation is presently limited; planting has only recently started. Thus, since the event, there has been no or limited potential for the uptake of molybdenum by ruminant wildlife. Sampling of vegetation in impacted areas is planned for the near future, as part of the risk assessment studies.

Selenium

Thirty-day rolling average concentrations of total selenium calculated for upper Hazeltine Creek from September to February were below the 30-d BC WQG. Corresponding average concentrations in the lower creek were above this guideline for a few weeks following the event (Appendix E: Section 2.7). By mid-October, total concentrations had decreased below the guideline and this decrease continued throughout the post-event period. The initial transient peak in total selenium lasted a few weeks and was not accompanied by dissolved concentrations that exceeded the BC WQG. The potential for selenium uptake by lower trophic levels following the event would have been further limited by the altered creek environment. After the event the creek had limited aquatic habitat to support lower trophic levels, no fish presence and a lack of breeding habitat for aquatic feeding birds.

4.1.4 Summary

Water quality in Hazeltine Creek has been influenced by the event, ongoing active erosion of exposed banks, and remediation activities in the creek. Sedimentation ponds constructed in lower Hazeltine Creek and commissioned December 12, 2014, had reduced suspended particulate matter in the lower creek. However, following termination of discharge from the TSF, completion of erosion control works was the primary strategy for addressing turbid water outflows from Hazeltine Creek (see photo Figure 8). Concentrations of metals associated with suspended materials, such as aluminum and iron, have also decreased substantially from peak concentrations in August. Dissolved concentrations of iron and aluminum were substantially lower than total concentrations. By the end of February, dissolved iron had decreased below the BC WQG, but dissolved aluminum was still above the 30-d WQG. Total and dissolved copper concentrations decreased substantially over the post-event period from peak concentrations in August, but were still above BC WQGs in February.

4.2 Receiving Environment

Polley Lake received direct inputs of TSF supernatant, tailings, and potentially some dam construction material from the event whereas Quesnel Lake received event-related inputs via Hazeltine Creek which included the above, as well as material eroded from the Hazeltine channel. Quesnel River represented the far-field receiving environment downstream from Quesnel Lake. Based on the COPC screening process described in Section 3.3, COPCs were identified for Polley Lake, Quesnel Lake, and Quesnel River (QUR-1; Table 4-2).

Table 4-2: Contaminants of Potential Concern Identified in the Receiving Environment

Study Area	Non-Chemical Substances	Total Metals	Dissolved Metals	Non-Metal Substances
Polley Lake (#3)	particulate matter (turbidity, TSS)	copper, molybdenum	molybdenum	TP
Quesnel Lake (#8)	particulate matter (turbidity, TSS)	chromium, copper, iron	copper	TP
Quesnel River (#9)	particulate matter (turbidity)	copper	copper	*no substances*

1) Notes:
2) TSS = total suspended solids; TP = total phosphorus; TDS = total dissolved solids.
3) Dissolved oxygen was above the minimum requirements for aquatic life in all areas except Polley Lake; this will be discussed under Section 4.2.2.1 – Supporting Environmental Parameters.
4) In-situ pH was within the BC WQG range of 6.5 to 8.5 (drinking water) with the exception of: 39% of samples in Polley Lake and <1% of samples in Quensel Lake and Quesnel River that exceeded WQG upper limit of 8.5
5) In-situ pH was within the BC WQG range of 6.5 to 9.0 (aquatic life) with the exception of 4% of samples in Polley Lake and <1% of samples in Quesnel River that exceeded WQG upper limit of 9.0.
6) Nitrite concentrations were below the maximum and 30-day BC WQGs at representative stations P1 (North) and P2 (South). Nitrate exceedances occurred in samples collected in September from POL-5 and POL-6. Subsequent samples collected from this station were below the BC WQG.

4.2.1 Relationship between Receiving Environment and Source Water Quality

A comparison of baseline water quality in the near-field receiving environment (i.e., Polley Lake and Quesnel Lake) to the pre-event TSF supernatant or source water was completed to identify which parameters could be expected to be elevated in the receiving environment as a result of the event and to corroborate the identification of COPCs.

Receiving environment water quality was represented by pre-event baseline data for Polley Lake (Appendix A, Table A-1) and post-event data from Quesnel Lake monitoring stations located east of Cariboo Island collected between August 2014 and February 2015. This Quesnel Lake dataset was used to represent baseline conditions because pre-event data from the West Basin and West Arm were insufficient to do so (i.e., no metals data). Samples with turbidity values above 1 NTU were excluded from this dataset as these could reflect flow of the turbid plume, trapped below the thermocline, that was transported eastward over the sill during seiche events in late summer 2014 (Tetra Tech 2015; Petticrew et al. 2015). Source water quality was based on data reported by SNC-Lavalin (2014) for the period from 2009 to 2014, where available, or from MPMC site monitoring. An enrichment factor, calculated as the ratio between a chemical concentration in source water and the receiving environment, was determined for chemical parameters identified as COPCs in Polley Lake and Quesnel Lake (Table 4-2), based on respective mean and maximum concentrations. An enrichment factor greater than 1 is therefore indicative of high concentrations in TSF water, relative to receiving waters. The enrichment factor is used here to indicate the relative potential for increases to the concentration of the receiving environment from the TSF supernatant; however, it does not indicate a numeric multiple of predicted concentration which would depend on a number of factors such as the size of the receiving environment. It also does not provide insight into potential for increased concentrations from eroded Hazeltine Creek material.

Enrichment factors for COPCs in TSF water compared to receiving waters are presented in Table 4-3 for Polley Lake and Quesnel Lake. These ratios range from less than 1, indicating that concentrations are lower in the TSF compared to the receiving environment (e.g., phosphorus in Polley Lake), to approximately 600 for dissolved copper (in Quesnel Lake). Enrichment factors for phosphorus and chromium are low, indicating that the TSF supernatant was not likely to be a major source of these COPCs. Pre-event conditions in Hazeltine Creek regularly exceeded BC WQGs for chromium. Copper, iron, and molybdenum have high enrichment factors, indicating that these COPCs may be mine related (i.e., from the TSF).

Table 4-3: Enrichment Factors of Contaminants of Potential Concern in Pre-event TSF Supernatant Relative to Polley Lake (Pre-event) and Quesnel Lake (Post-event) Water Quality

Parameter	Concentration (mg/L)						Enrichment Factor[b]			
	Polley Lake Pre-event (1995 - July 2014)		Quesnel Lake Post-event[a] (August 2014 - February 2015)		TSF supernatant (2009 - 2014)		Supernatant / Polley Lake		Supernatant / Quesnel Lake	
	Mean	Maximum	Mean	Maximum	Mean	Maximum	Based on Mean	Based on Maximum	Based on Mean	Based on Maximum
Total Phosphorus	0.041	0.34	<0.002	0.029	0.024	0.085	0.6	0.3	12	3.0
Total Chromium	<0.0005	<0.001	<0.0005	0.006	0.00054	0.0021	n/c	n/c	1.1	0.3
Total Copper	0.0023	0.032	<0.001	0.0042	0.014	0.064	7.2	6.0	14	15
Dissolved Copper	0.0018	0.010	0.00051	0.001	0.022	0.6	n/c	n/c	42	601
Total Iron	<0.03	0.13	<0.03	0.052	0.27	1.7	n/c	n/c	8.9	33
Total Molybdenum	0.0016	0.0025	0.0003	0.0018	0.21	0.2	128	84	n/c	n/c
Dissolved Molybdenum	0.0015	0.0023	0.0003	0.00048	0.13	0.28	86	122	n/c	n/c

Notes:
n/c: Enrichment factor not calculated for parameters not identified as contaminants of potential concern in a receiving environment.

(a) Based on post-event data from monitoring stations east of Cariboo Island with turbidity ≤1 NTU (i.e., to exclude samples possibly influenced by the turbidity plume)

(b) Enrichment factor = concentration in TSF supernatant / receiving environment

4.2.2 Changes in Receiving Environment Water Quality

In this section changes in suspended particulate matter, metals, and phosphorus are evaluated for representative stations within each study area. Temporal and spatial changes throughout the post-event period from August 2014 to April 2015 are discussed in relation to applicable BC WQGs.

4.2.2.1 Field Measured Environmental Parameters

Field water column profile measurements of DO, water temperature, turbidity, and specific conductivity in Polley Lake, Quesnel Lake, and Quesnel River are shown in Appendix D. This section summarizes changes in field profiles resulting from the event with a focus on changes in turbidity.

Polley Lake

In July 2014, prior to the event, Polley Lake was thermally stratified and the thermocline was located at a depth of 5 to 10 m, as is normal for Polley Lake. Surface water above the thermocline was well oxygenated (greater than [>] 9 mg/L) and DO decreased with depth to less than 5 mg/L at approximately 25 m deep. Specific conductivity was uniform throughout the water column. Thermal stratification of the lake was less pronounced post-event in that surface water was cooler post-event than pre-event, and deep water was warmer (i.e., the difference between surface and deep temperature was less post-event than pre-event). Dissolved oxygen was reduced to less than the minimum BC WQG of 5 mg/L at depths below 10 m. Turbidity and specific conductivity were elevated below 7 m, indicative of the suspended materials and TDS deposited in the lake from the event.

Turbidity at depth decreased over the late summer as particulate matter settled (Figure 9 and Figure 10). Specific conductivity remained unchanged during late summer. In mid-October, lake surface water began to cool further and mix with the deeper water and by late October temperature, DO, turbidity, and specific conductivity were uniform throughout the water column. By mid-November, DO increased to between 5 and 7 mg/L and turbidity decreased to less than 1 NTU. Sampling was discontinued from November 18 through to April 2015 (with the exception of one sample) due to the inability to safely access off-shore stations because of thin ice cover.

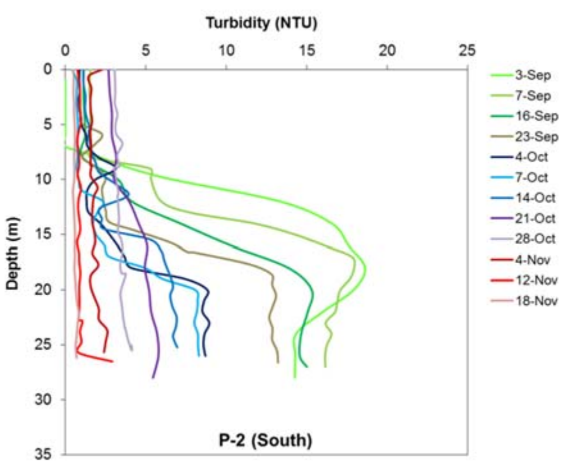
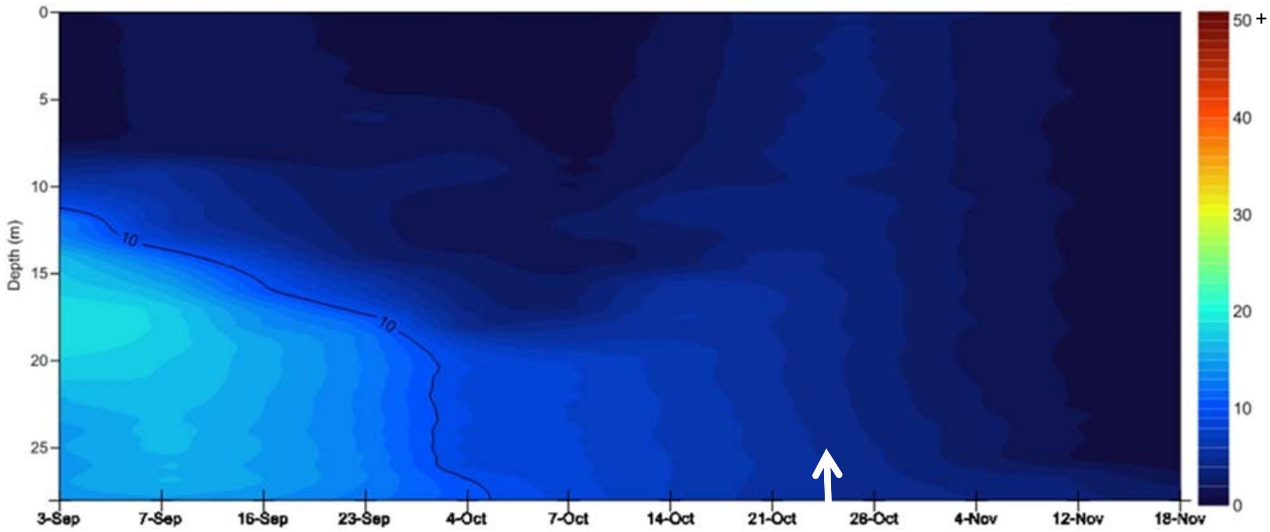


Figure 9: Post-event Depth Profiles of In-situ Measured Turbidity at Station P2, Polley Lake.



Note: The white arrow represents the approximate timing of late-October turnover in Polley Lake.

Figure 10: Post-event Contours of In-situ Measured Turbidity at Station P2, Polley Lake. Turbidity (NTU) shown on right hand axis.

Quesnel Lake

Post-event monitoring in the West Basin showed the lake to be thermally stratified with a thermocline located at depth between 10 to 25 m. Turbidity and conductivity were elevated below 30 m, indicative of the plume of suspended and dissolved materials deposited in the lake from the event that was trapped below the thermocline. Small peaks in turbidity between 20 and 50 m depths and to the east of Cariboo Island (e.g., QUL-120a, Appendix D; Section 3.0) reflect movement of deep turbid water over the sill (35 m depth) into the deeper main body of the lake. A decrease in turbidity at depth as particulate matter settled over the late summer was noted for some stations (e.g., QUL-66 close to Hazeltine Creek and QUL-18 in the West Basin towards the Quesnel River outflow; Figure 11 to Figure 13).

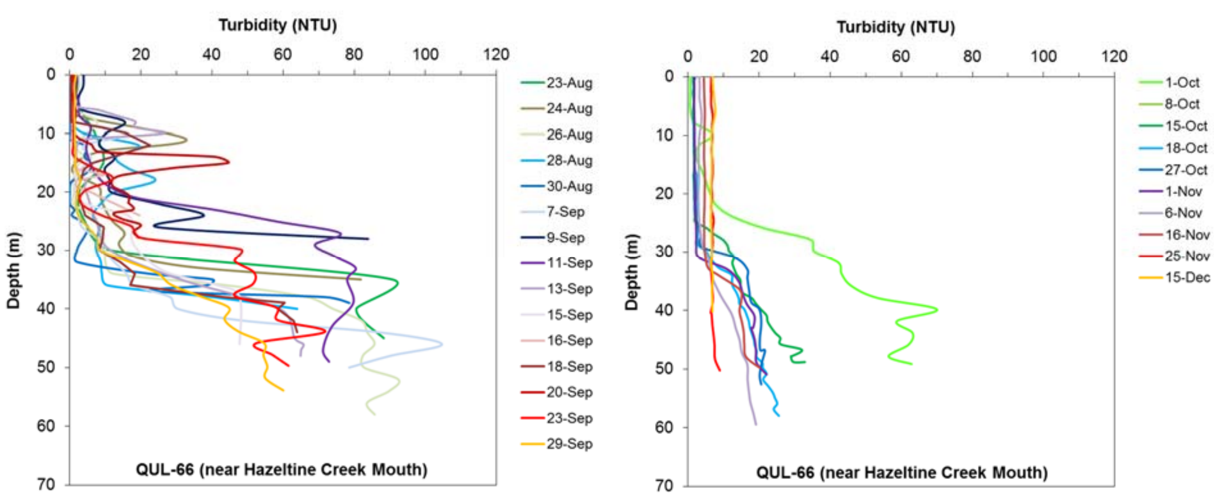
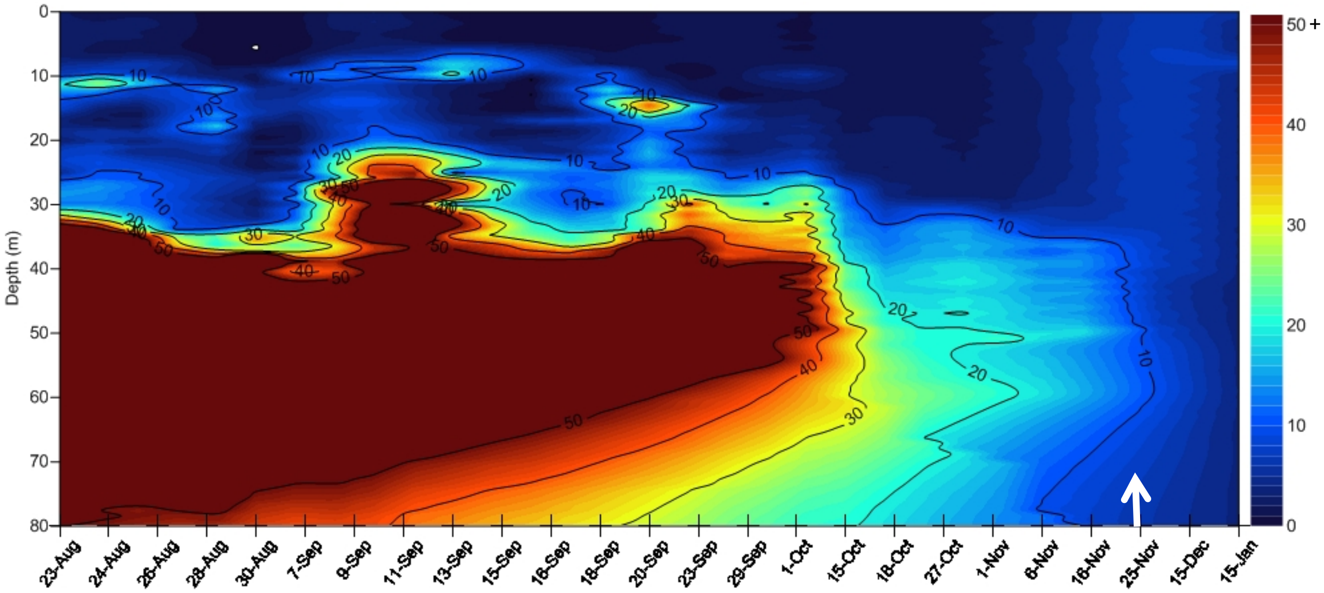
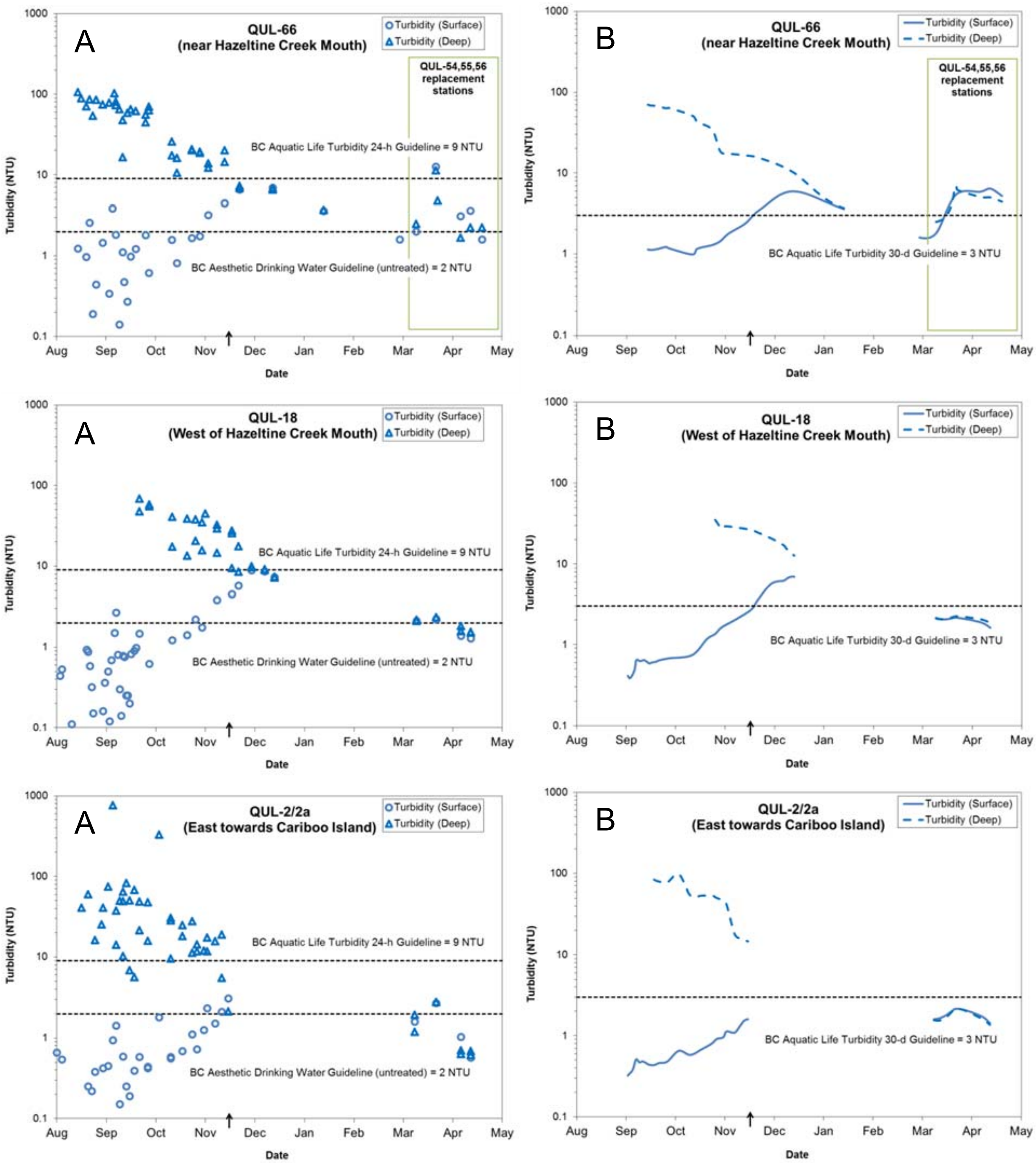


Figure 11: Post-event Depth Profiles of In-situ Measured Turbidity at Station QUL-66, Quesnel Lake.



Note: The white arrow represents the approximate timing of mid-November turnover in Quesnel Lake.

Figure 12: Post-event Contours of In-situ Measured Turbidity at Station QUL-66, Quesnel Lake. Turbidity (NTU) shown on right hand axis.



Note: Arrow represents the approximate timing of mid-November turnover in Quesnel Lake. Gaps represent >30 d between sampling. Baseline assumed ≤1 NTU with respect to BC WQG values.

Figure 13: Post-event Instantaneous (A) and Rolling 30-day Average (B) Concentrations of Turbidity at stations QUL-66, QUL-18, and QUl-2/2a, Quesnel Lake.

In mid- to late October, surface water began to cool and mix due to the lake turnover event. By mid-November measurements of temperature, turbidity, and specific conductivity were uniform throughout most of the water column. Turbidity at depth decreased to less than 10 NTU, which corresponded with an increase in turbidity in surface waters (Figure 13). This relatively small change in turbidity at the surface compared to deeper waters resulted in a cloudy appearance within the West Basin of the lake throughout the late fall and winter. By early spring (March and April 2015), turbidity at surface and depth decreased and was below 24-h and 30-d BC aquatic life WQGs (Figure 13). The exception to this was a few samples collected near the mouth of Hazeltine Creek (QUL-66) with slightly elevated turbidity that reflects localized input of particulate matter from Hazeltine Creek before erosion control works progressed to their current state. At stations further afield in both directions (QUL-18 towards Quesnel River and QUL-2/2a [pooled stations] towards Cariboo Island), turbidity remained low. Most recent samples show that turbidity is close to the maximum BC aesthetic drinking water guideline for untreated water (+1 NTU above baseline, when background is ≤5 NTU).

Dissolved oxygen was above the minimum requirements for aquatic life during all sampling events from August 2014 through February 2015. Sampling was discontinued from December 16 through to February 2015 at most stations in Quesnel Lake due to the inability to safely access off-shore stations.

Separate observations and data of Quesnel Lake water quality were recently published (Petticrew at al. 2015). The description of data obtained by these authors closely aligns with the findings of MPMC's team as provided here and in TetraTech (2015) as well as findings of BC MoE (2015c).

Quesnel River

Temperature changes in Quesnel River post-event reflected typical seasonal patterns as well as patterns reflective of transient "seiche" events. Dissolved oxygen was above the minimum requirements for aquatic life during all sampling events from August 2014 through February 2015. Specific conductivity in Quesnel River increased from 92 µS/cm until mid-December and has since remained relatively stable at approximately 140 µS/cm.

As discussed in the context of suspended particulate matter in Section 4.2.2.2 and shown in Figure 17 episodic peaks in turbidity concentrations were recorded three times in late summer and early fall (late August, early September, early October) and corresponded to observations of cloudy river water over several days. These "cloudy-water" events were the result of internal seiches in Quesnel Lake during the late summer and early fall and the upwelling of deep turbid water (see Figure 12) at the outflow of the lake into Quesnel River (as described by Tetra Tech 2015). Beginning in early November, turbidity increased more substantially and continually in the river as fall turnover in the lake caused the deep turbid water to be mixed throughout the water column. Turbidity in the river peaked in early December and declined to less than 2 NTU by mid-February. Turbidity in Quesnel River at the Likely Bridge is now less than 1 NTU.

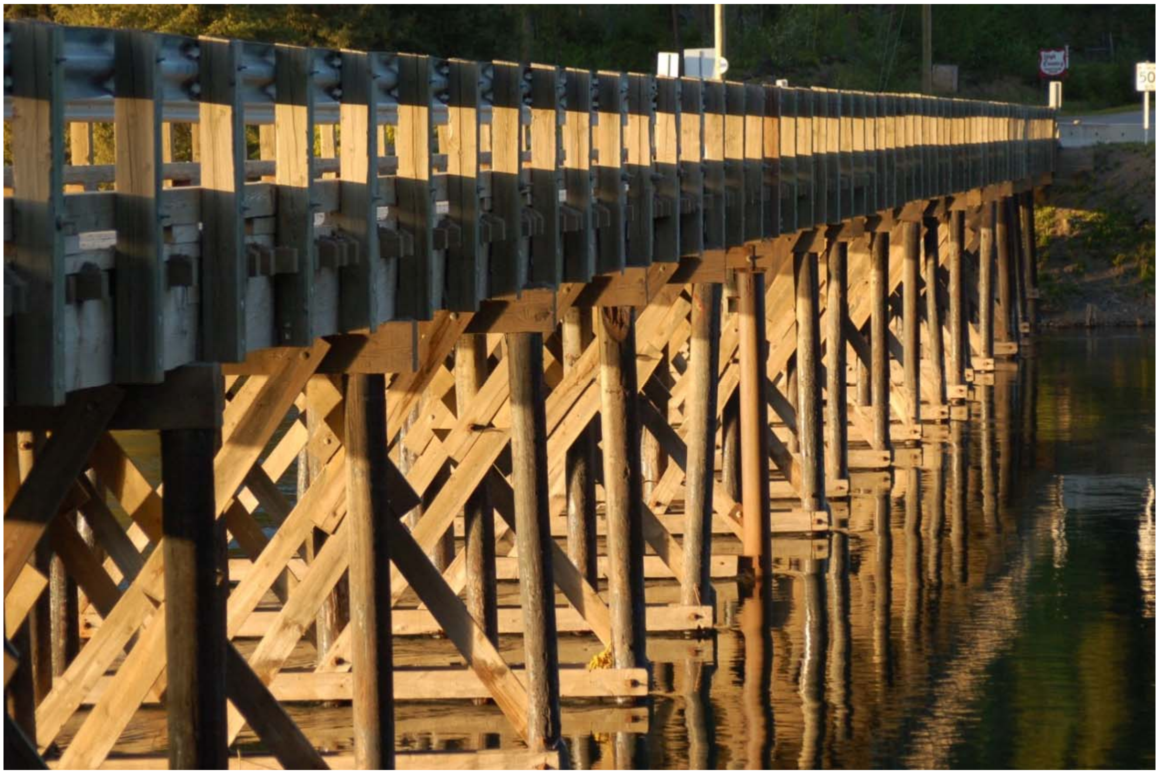


Figure 14. The turbidity of the Quesnel River at the Likely Bridge has decreased to less than 1 NTU. May 12, 2015 photo.

4.2.2.2 Suspended Particulate Matter

Background

Suspended particulate matter consists of suspended substrate particles (e.g., clay and silt), organic matter (e.g., detritus), planktonic organisms, and bacteria. It can be measured optically as turbidity or gravimetrically as TSS. Turbidity is a measure of water's cloudiness or haziness as determined by how much light can be transmitted or scattered through a sample; TSS is measured as the amount, by weight, of suspended particulate matter (solids) retained on a glass fiber filter. The relationship between turbidity and TSS depends on site-specific conditions, including particle size, colour, and reflective properties.

Turbidity and TSS data may be influenced by anthropogenic activities that affect waterbodies and watercourses, as well as natural, temporal (i.e., seasonal), and spatial phenomena (Caux et al. 1997). Under most natural conditions, soil erosion and weathering are the greatest contributors to turbidity, such as runoff during the spring freshet. Biological activity, such as the proliferation of planktonic organisms during warm summer months, may also have a seasonal effect on turbidity and TSS measurements (Chapman 1992).

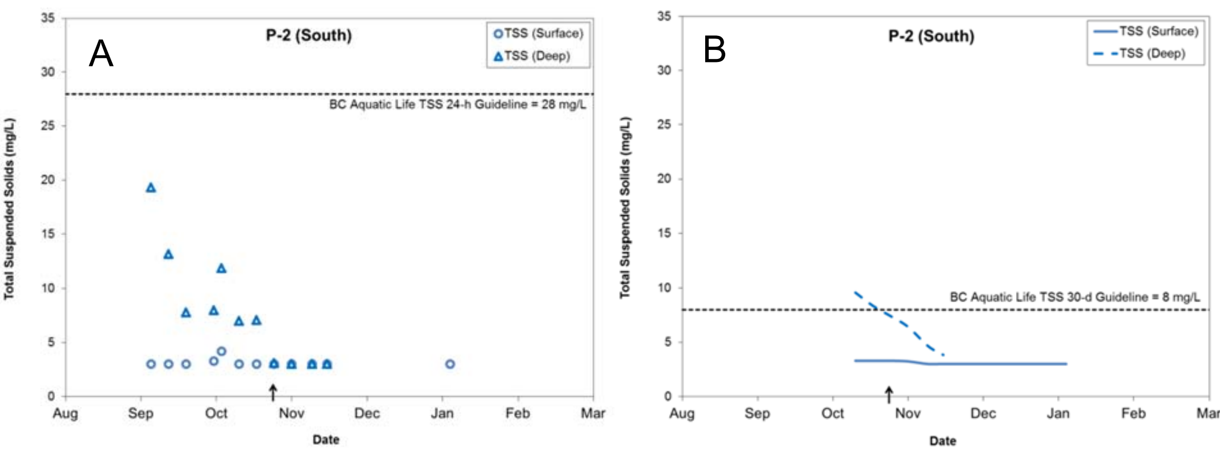
Elevated turbidity and TSS can have negative implications for drinking water quality and for aquatic life. Turbidity may affect drinking water quality by reducing the aesthetic appeal of water and/or reducing the effectiveness of water treatment methods. Turbidity and suspended solids affect light penetration, which, in turn, may affect photosynthetic organisms such as algae (Birtwell et al. 2008). As suspended sediments settle out of the water column, they can fill the interstitial spaces within aquatic substrate, thereby reducing the quantity and quality of cover and habitat available to macroinvertebrates, fish eggs, and fish fry. Elevated concentrations of suspended solids may affect fish health and survival by abrading or clogging the gills, altering behaviour (e.g., migration), and reducing the foraging efficiency of sight-feeding species (CCME 2002; Newcombe and Jensen 1996; Robertson et al. 2006). However, the potential for water quality impacts from suspended particulate matter and the extent of those impacts will depend on site-specific factors such as water velocity, particle size, and angularity, habitat characteristics, season, and other factors. Quantification of those effects is relevant to determining whether or not there is an impact.

Appendix F provides additional information on the measurement of turbidity and TSS, their occurrence and variability in the aquatic environment under natural conditions, and the BC MoE guidelines for protection of aquatic life and for drinking water quality

Polley Lake

TSS measurements over time recorded during the post event period at Station P2 are shown in Figure 15. Corresponding figures for Station P1 are provided in Appendix D: Section 1.0 and Appendix E: Section 1.1.

Concentrations of TSS at depth decreased to below detection by early November; concentrations in surface waters were rarely above detection (MDL = 3.0 mg/L). The same decreasing trend in concentrations at depth was observed for turbidity (Section 4.2.2.1); however, increased turbidity in surface waters following lake turnover was not reflected in changes to surface TSS. Instantaneous and 30-d average concentrations of TSS were lower than the 24-hour (h) and 30-d average BC WQGs. However, turbidity at depth was above the 24-h and 30-d average BC WQGs until lake turnover (Figure 9 and Figure 10).



Note: Arrow represents the approximate timing of late-October turnover in Polley Lake. Baseline assumed equal to MDL of 3.0 mg/L.

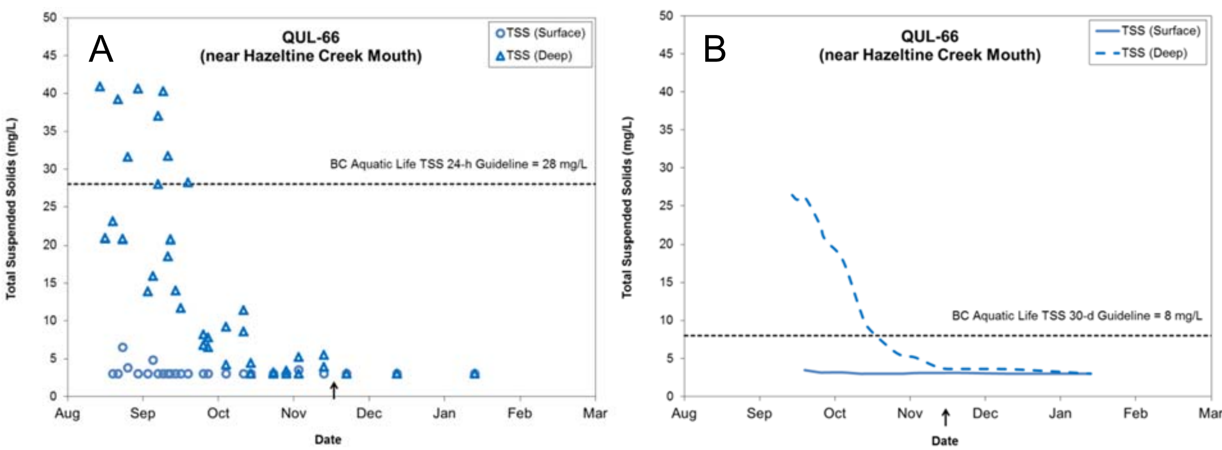
Figure 15: Post-event Instantaneous (A) and Rolling 30-day Average (B) Concentrations of Total Suspended Solids at Station P2, Polley Lake.

Quesnel Lake

Trends in TSS and turbidity were assessed at the five stations selected as representative stations in Section 3.4.2.1; i.e., QUL-66 (near the mouth of Hazeltine Creek), QUL-66a (north of QUL-66), and three stations further afield in the lake (stations QUL-21 northwest towards Quesnel River; QUL-2 east towards Cariboo Island; and QUL-120a located further east towards the main body of the lake). TSS measurements over time for Station QUL-66 are shown in Figure 16. Corresponding figures for the other stations are provided in Appendix E: Section 3.1.

At these stations, concentrations of TSS at depth decreased to near detection limits (3.0 mg/L) by mid-October, while turbidity remained elevated at depth (Section 4.2.2.1). The observed difference between the two measurements of particulate matter is likely the result of settling of larger particles (>1.5 µm measured as TSS) while smaller particles remained in suspension and were detected in turbidity measurements.

In surface waters, TSS was rarely detected before turnover and did not reflect increased turbidity in surface waters with lake turnover. Concentrations of TSS in most individual samples collected at surface and at depth were less than the 24-h BC WQGs.



Note: Arrow represents the approximate timing of mid-November turnover in Quesnel Lake. Baseline assumed equal to MDL of 3.0 mg/L.

Figure 16: Post-event Instantaneous (A) and Rolling 30-day Average (B) Concentrations of Total Suspended Solids at Station QUL-66, Quesnel Lake.

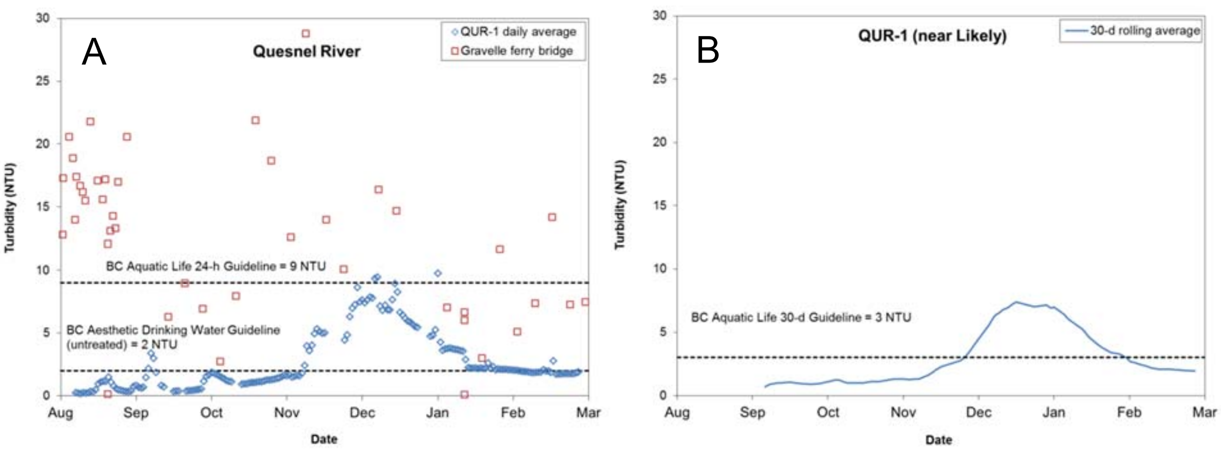
Trends in 30-d average TSS concentrations were more pronounced at Station QUL-66 close to the mouth of Hazeltine Creek, compared to other stations in the West Basin that are further away from the creek mouth to the west and the east. Close to the mouth of Hazeltine Creek 30-d average TSS concentrations were above the 30-d BC WQG until mid-October (Figure 16). At Station QUL-21 located towards the outflow to Quesnel River, 30-d average concentrations declined below the guideline by late September (Appendix E; Section 3.1). The 30-d BC WQG was not exceeded at the other three Quesnel Lake stations.

Available post-event data indicate that TSS concentrations and turbidity levels in Quesnel Lake did increase as a result of the event, particularly at depth, and post-event concentrations and levels were above BC WQGs. By September, TSS concentrations had decreased below the BC WQG, but turbidity remained elevated until early 2015.

Quesnel River

At Station QUR-1 located downstream of the lake outflow at Likely, at the Quesnel River Research Centre, concentrations of TSS were below BC WQGs and rarely detected post-event. TSS concentrations did not reflect the increases in turbidity that occurred following fall turnover in Quesnel Lake, but there was an increase in turbidity in the river from November to January with peak concentrations recorded in December (Figure 17). Turbidity concentrations were typically less than the 24-h BC WQG, but 30-d average turbidity levels were above the 30-d BC WQG from mid-November to early February. The observed difference between the two measurements of particulate matter likely reflects both the detection limit of TSS (3.0 mg/L) as well as the small particle size of suspended particles that would have passed through the glass fibre filter (1.5 µm).

At the Gravelle Ferry Bridge, which is more than 50 km downstream of Likely, BC MoE (2015d) reported that turbidity and TSS are commonly higher as compared to those measured near Likely. TSS concentrations ranged from 6.7 to 40 mg/L in samples collected between December 2014 and March 2015 at this downstream station. Turbidity at Gravelle Ferry Bridge was variable over time. Immediately after the event turbidity was as high as 15 to 20 NTU compared to less than 2 NTU at QUR-1 and at the time that turbidity peaked at Station QUR-1 in December, turbidity at Gravelle Ferry Bridge was almost twice as high (Figure 17) as it was at QUR-1. This suggests that sources of turbidity not related to the event influences water quality in the Quesnel River downstream of the town of Likely.



Quesnel River at Likely baseline turbidity assumed ≤1 NTU with respect to BC WQG values.

Figure 17: Post-event Instantaneous (A) and Rolling 30-day Average (B) Concentrations of Turbidity at Station QUR-1, Quesnel River. Turbidity measured at Gravelle Ferry Bridge also shown (BC MoE post-event data).

4.2.2.3 Metals

Background

Metals occur naturally in the environment as geochemical components of sediments, soils, and rocks. They can exist in dissolved form, adhered to particulates, as part of organic and/or inorganic complexes, and in various oxidation states (Campbell et al. 2006). Measures of total metal concentrations encompass all of these forms and do not necessarily reflect the bioavailable concentration of a metal that might be directly taken up by aquatic organisms potentially resulting in adverse effects (Chapman and Wang 2000; Chapman 2008; Singleton 1987). Metal accumulation and toxicity is dependent on metal bioavailability, which is influenced by exposure and toxicity modifying factors that include environmental exposure conditions as well as physiological and biological characteristics of aquatic organisms. Environmental exposure conditions that can influence metal toxicity and accumulation include pH, water hardness, and dissolved organic carbon (Campbell et al. 2006). For example, elevated concentrations of organic carbon can protect against metals toxicity (Wood et al. 2011; Meyer et al. 2012).

Metals adsorbed to or sequestered by particles are less bioavailable for direct uptake from the water by aquatic organisms than dissolved metals in the water column (Chapman et al. 1998; Luoma and Rainbow 2008). Total metals concentrations reflect both the proportion of metals associated with particles and that dissolved in the water column. Dissolved concentrations tend to provide a more realistic indication of the bioavailable concentration for direct uptake from the water, particularly in turbid receiving environments (Chapman and Wang 2000). However, the measure of “dissolved” metals is an operational definition based on whether the metal passes through a small (0.45 µm) filter (BC MWLAP 2013). Where particles are smaller than this size – which some of the particulates in Quesnel Lake were, metals that are associated with particulates will be measured as “dissolved” metals. Water quality guidelines for the protection of aquatic life are generally applied to total concentrations, but are derived from laboratory-based toxicity tests. In these tests, exposure concentrations are based on metals in solution from metal salts and the laboratory test water has a low level of suspended matter (typically clear water). Typically, these tests, while reporting in total metals, are based on dissolved and thus bioavailable metals. The application of WQGs to total concentrations measured in the environment can therefore be conservative, especially when those metals are part of the mineral matrix that makes up the particle.

Some metals are essential for the normal growth, development, and reproduction of organisms. Copper, chromium, and iron are essential metals, whereas aluminium is not. For example, copper is a co-factor in the function of important proteins and enzymes such as cytochrome, ascorbate oxidase, and plastocyanin (Chapman and Wang 2000). Organisms will tend to regulate their internal concentrations of essential metals within an optimal range; outside this small range deficiency occurs (insufficient metal) and toxicity (excess metal) (Chapman and Wang 2000, Campbell et al. 2006).

Aquatic organisms can take up metals from diet or water (e.g., across gills in fish). Bioconcentration (accumulation from water) and bioaccumulation (accumulation from water and diet) are relative to the concentrations in the environment: bioconcentration factors (BCFs) and bioaccumulation factors (BAFs) can be higher at low media concentrations than at higher media concentrations (i.e., BCFs and BAFs are inversely related to exposure concentrations) (Grosell 2012, Wood 2012). This pattern is likely because metals are taken up by facilitated transport (ion exchangers or channels), which can be saturated and are also physiologically regulated (Grosell 2012, Wood 2012). For example, when aqueous concentrations of copper are elevated, aquatic organisms such as plankton and fish will typically have higher body burdens of copper. However, the ratio of the concentration of copper in the tissue to the concentration in water can be lower than in environments with lower water concentrations, because in the low-concentration environment, the aquatic organism will selectively uptake the copper to meet its physiological needs.

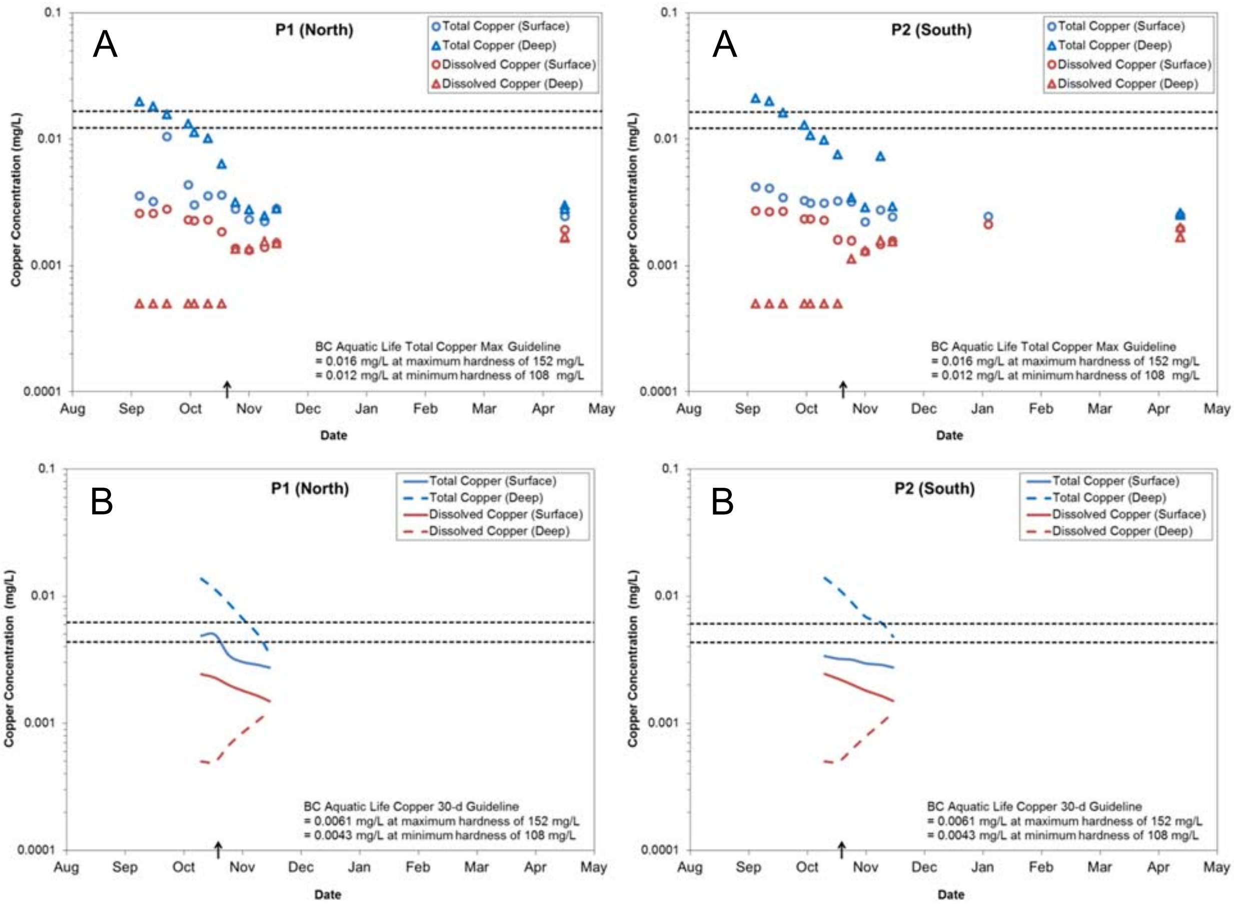
Bioaccumulation of essential metals will occur, but bioaccumulation does not necessarily indicate adverse effects, as metals in biota can be sequestered or excreted by various mechanisms (Fairbrother et al. 2007; Chapman 2008). Metallothioneins (in animals and bacteria) and phytochelatins (in algae, plants, and some fungi) are involved in both the regulation of essential metals and the detoxification of non-essential metals (Chapman and Wang 2000). These proteins and peptides are induced by the exposure to elevated metals, and will protect the aquatic organisms from metal toxicity by binding excess metals. Other detoxification strategies include sequestering metals in granules within the tissue, creating insoluble metal precipitates, or excreting (e.g., accumulating metals in the exoskeleton that can be shed during moulting) (Chapman and Wang 2000). Thus, metals in tissues of biota are divided into metabolically available metal and stored detoxified metal; toxicity does not depend on total accumulated metal concentration, but rather on a threshold concentration of internal metabolically available metal (Rainbow 2007; Luoma and Rainbow 2008).

Inorganic metals such as copper, aluminum, iron, and chromium do not biomagnify; only mercury and selenium can biomagnify, and only in their organic forms (Chapman and Wang 2000; Campbell et al. 2006; USEPA 2007; Chapman 2008). Biomagnification is defined as increasing concentrations of a substance solely via uptake from food up three or more trophic levels. Organic forms of mercury (methylmercury) and selenium (organoselenium) can biomagnify because biological uptake of these methylated forms of metals is efficient, yet elimination (excretion) is slow (e.g., Wiener et al. 2000, Stewart et al. 2010). Thus tissue concentrations of methylmercury and organoselenium are higher in successively higher trophic level organisms (e.g., predatory fish, fish-eating birds, humans) then would be expected based on concentrations in water or diet alone. Selenium is an essential element and is present in mineral supplements; however, mercury is not an essential element.

Copper

Polley Lake

Although initially elevated after the event, total copper concentrations decreased over time at the lake surface and at depth to concentrations below the maximum and the 30-d BC WQGs, and similar to median pre-event concentration (i.e., 0.002 mg/L, Appendix A, Table A-1). Instantaneous and 30-d average dissolved concentrations reported during the post-event period were lower than the maximum and 30-d average BC WQGs (Figure 18). Copper increases were not observed over the eight months following the event.



Note: Arrow represents the approximate timing of late-October turnover in Polley Lake.

Figure 18: Post-event Instantaneous (A) and Rolling 30-day Average (B) Total and Dissolved Copper Concentrations at Stations P1 and P2, Polley Lake.

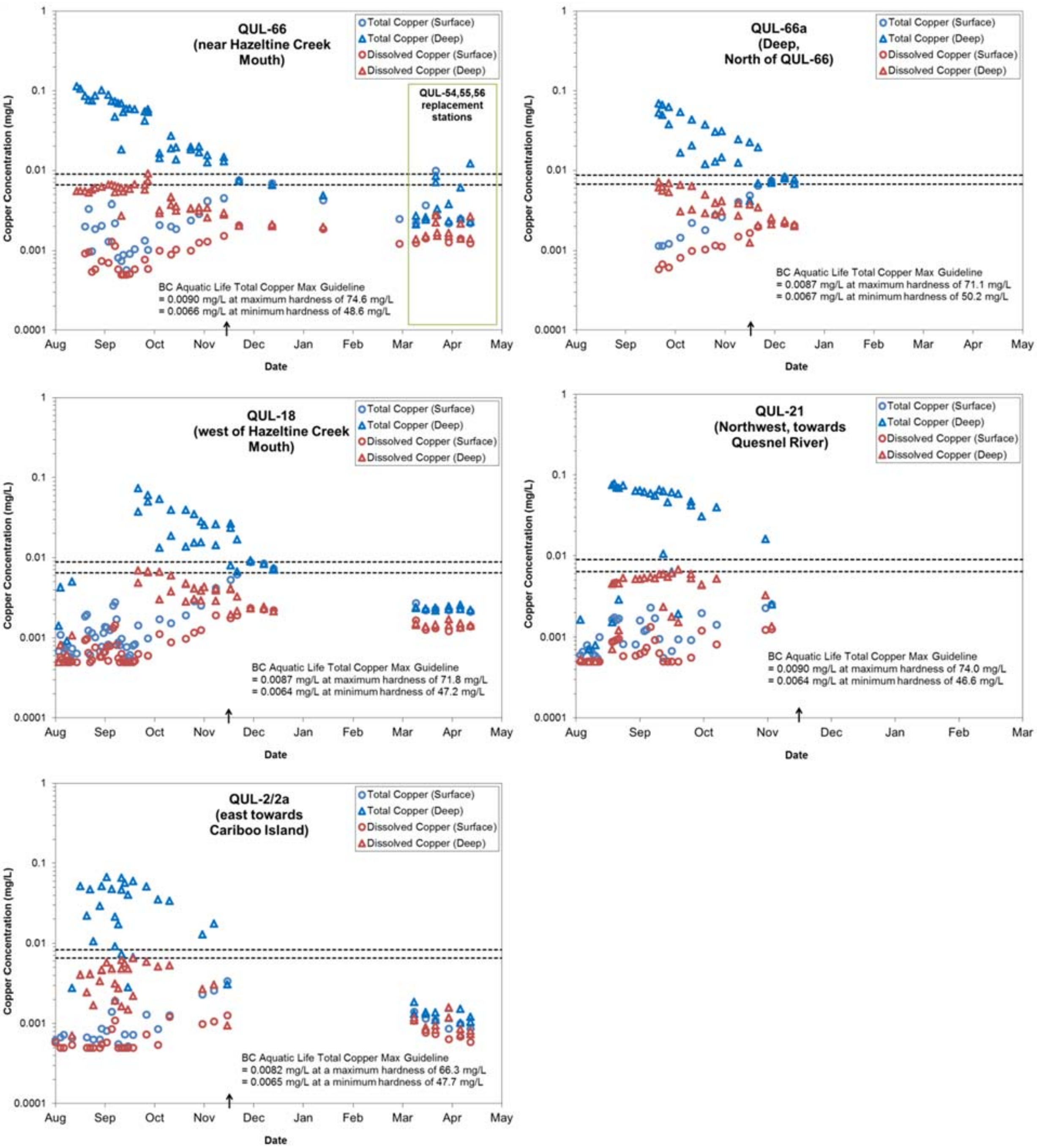
Quesnel Lake

Total and dissolved copper concentrations were assessed at the five stations selected as representative stations in Section 3.4.2.1; i.e., QUL-66 (near the mouth of Hazeltine Creek[10]), QUK-66a (a deeper station north of Station QUL-66), QUL-18 (west of Hazeltine Creek mouth), and two stations further afield in the lake in both directions (Station QUL-21 northwest towards Quesnel River and Station QUL-2/2a [pooled stations] east towards Cariboo Island).

At these stations, total concentrations at depth were higher than the maximum BC WQG, but the majority of total concentrations at surface were less than the guideline (Figure 19). Dissolved concentrations measured in most individual samples collected at surface and at depth were less than the maximum BC WQG, calculated using the lowest measured hardness. In the most recent samples collected in March and April, 2015, total and dissolved concentrations were less than maximum BC WQG at stations QUL-18 and QUL-2/2a. These results indicate that

[10] Monitoring at QUL-66 ceased at the end of February; to show changes in copper concentrations at this general location since March, data from replacement near-field stations QUL-54, QUL-55, QUL-56 were used.

concentrations were initially elevated due to the event, but declined over the sampling period to concentrations below the BC WQG in 2015. An exception to this general observation was four total copper measurements near the mouth of Hazetline Creek that approximated or were above the guideline in March and April. The corresponding dissolved copper concentrations for these measurements were below the BC WQG as were the other total measurements. Turbid waters in Hazeltine Creek flow may have resulted in more variable total measurements in March and April; however, erosion control works completed since have reduced turbid water in Hazeltine Creek.

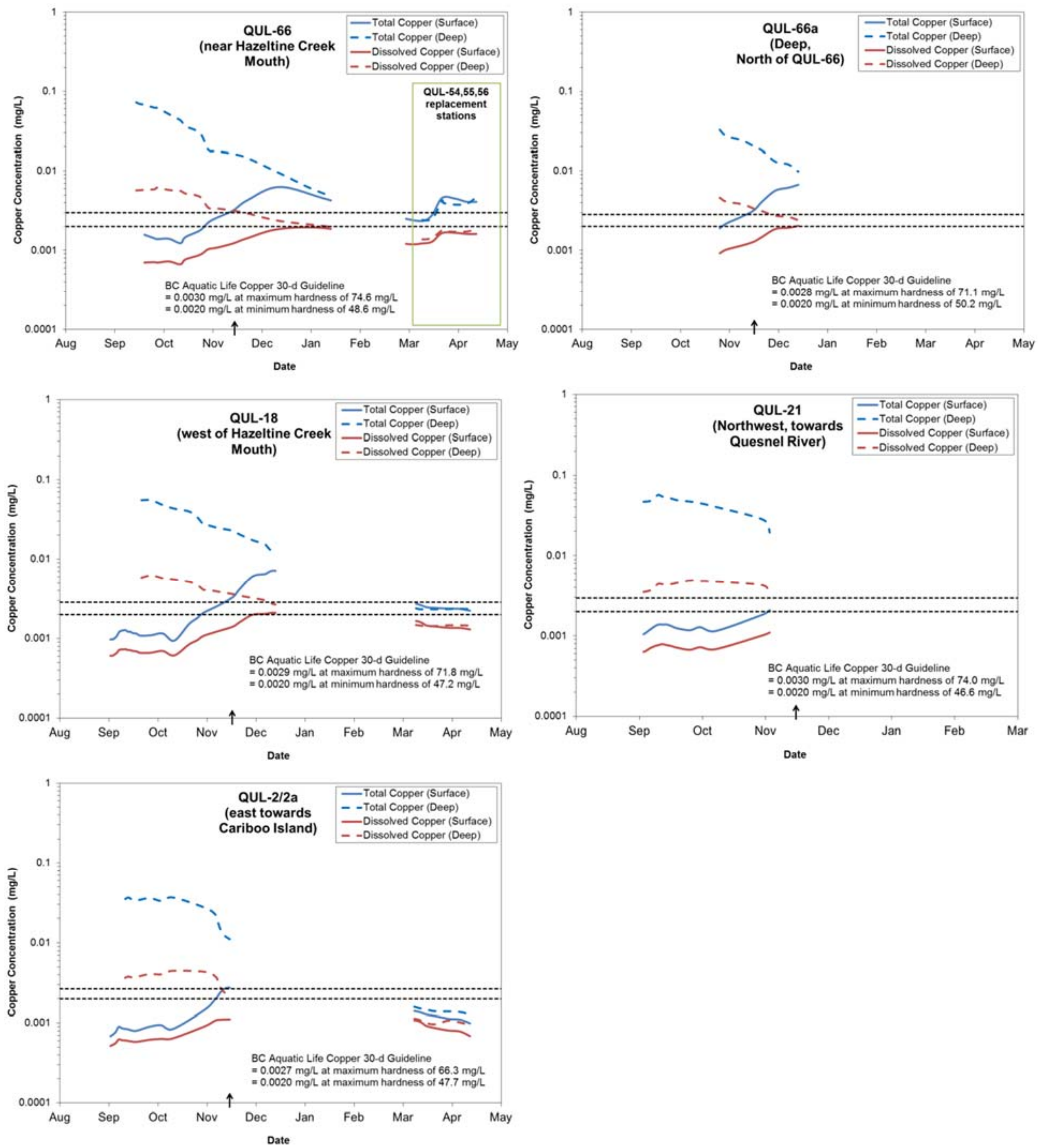


Note: Arrow represents the approximate timing of mid-November turnover in Quesnel Lake.

Figure 19: Post-event Instantaneous Total and Dissolved Copper Concentrations at Stations QUL-66, QUL-66a, QUL-18, QUL-21, and QUL-2/2a, Quesnel Lake.

The rolling 30-d average concentrations showed similar trends prior to lake turnover at each of the representative stations: 30-d average total and dissolved concentrations were higher at depth than at surface, and concentrations at depth were above the 30-d average BC WQG (Figure 20).

Trends in 30-d average concentrations were more pronounced at stations closer to the mouth of Hazeltine Creek (stations QUL-66, QUL-66a, and QUL-18) relative to stations further afield in Quesnel Lake (Station QUL-21 northwest towards Quesnel River and Station QUL-2/2a to the east towards Cariboo Island). At stations QUL-66 and QUL-18, 30-d average total and dissolved concentrations at depth declined, particularly after the lake turnover in November, such that 30-d average dissolved concentrations at these stations were below the 30-d average BC WQG based on minimum hardness by March (Figure 20). Total concentrations remained above the guideline. Simultaneously, the 30-d average total and dissolved concentrations at surface increased and were the same as the concentrations at depth within a couple of months after lake turnover. The trends suggest that the lake waters were mixed after lake turnover, such that there was less of a difference between total and dissolved concentrations at surface and at depth and that concentrations were declining over time. Further afield in Quesnel Lake at Station QUL-2/2a, total and dissolved concentrations were below 30-d average BC WQG by March.



Note: Arrow represents the approximate timing of mid-November turnover in Quesnel Lake. Gaps represent >30 d between sampling.

Figure 20: Post-event Rolling 30-day Average Total and Dissolved Copper Concentrations at Stations QUL-66, QUL-18, QUL-21, and QUL-2/2a, Quesnel Lake.

Quesnel River

Instantaneous and 30-d average total copper concentrations in grab samples collected in Quesnel River near the town of Likely (QUR-1) were higher than maximum and 30-d average BC WQGs; the highest total copper concentrations were measured at the beginning of December (Figure 21). Rolling 30-d average total copper concentrations declined from a peak in January to the 30-d average BC WQG in mid-April.

In comparison, dissolved copper concentrations in grab samples were substantially lower than the maximum BC WQG throughout the sampling period (Figure 21). Rolling 30-d average dissolved concentrations were higher than the 30-d average BC WQG for a short time between December and mid-January (Figure 21). However, this 30-d average BC WQG was conservatively calculated using the minimum measured hardness for all individual samples analyzed during the post-event period. When calculated using the 30-d average hardness associated with these samples, the 30-d average dissolved concentrations were less than the applicable BC WQGs.

BC MoE reports on water samples collected from two locations on the Quesnel River: at the Likely Bridge, which is upstream of Station QUR-1, and the Gravelle Ferry Bridge, which is more than 50 km downstream of Likely. Post-event water quality results at Likely Bridge have been consistent with MPMC samples collected at Station QUR-1. BC MoE (2015d) reported that pre-event water samples collected at the Gravelle Ferry Bridge exceeded BC WQGs for total copper as well as total chromium and dissolved aluminum. BC MoE (2015d) noted that the Quesnel River at the Gravelle Ferry Bridge receives inputs from several smaller tributaries and one large river (Cariboo River) and that the observed water quality is influenced by factors other than just Quesnel Lake. Prior to and immediately after the event, total copper concentrations at Gravelle Ferry Bridge were more than four times higher than measured at Likely (Figure 21), indicating that there are sources of particulate bound metals entering the river system between these locations. Therefore, there is the potential for sources of turbidity not related to the event to influence water quality downstream of Likely (as discussed in Section 4.2.2.2).

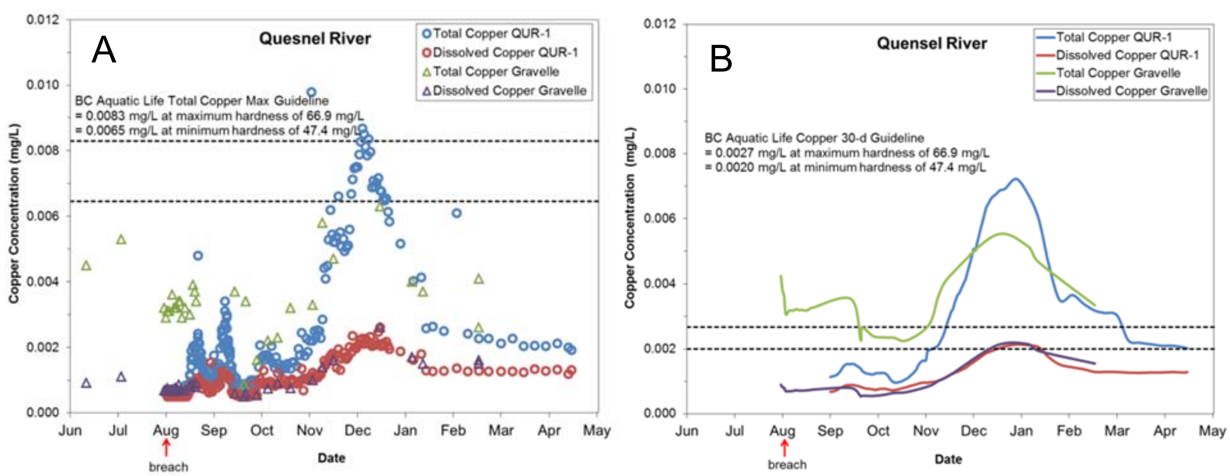
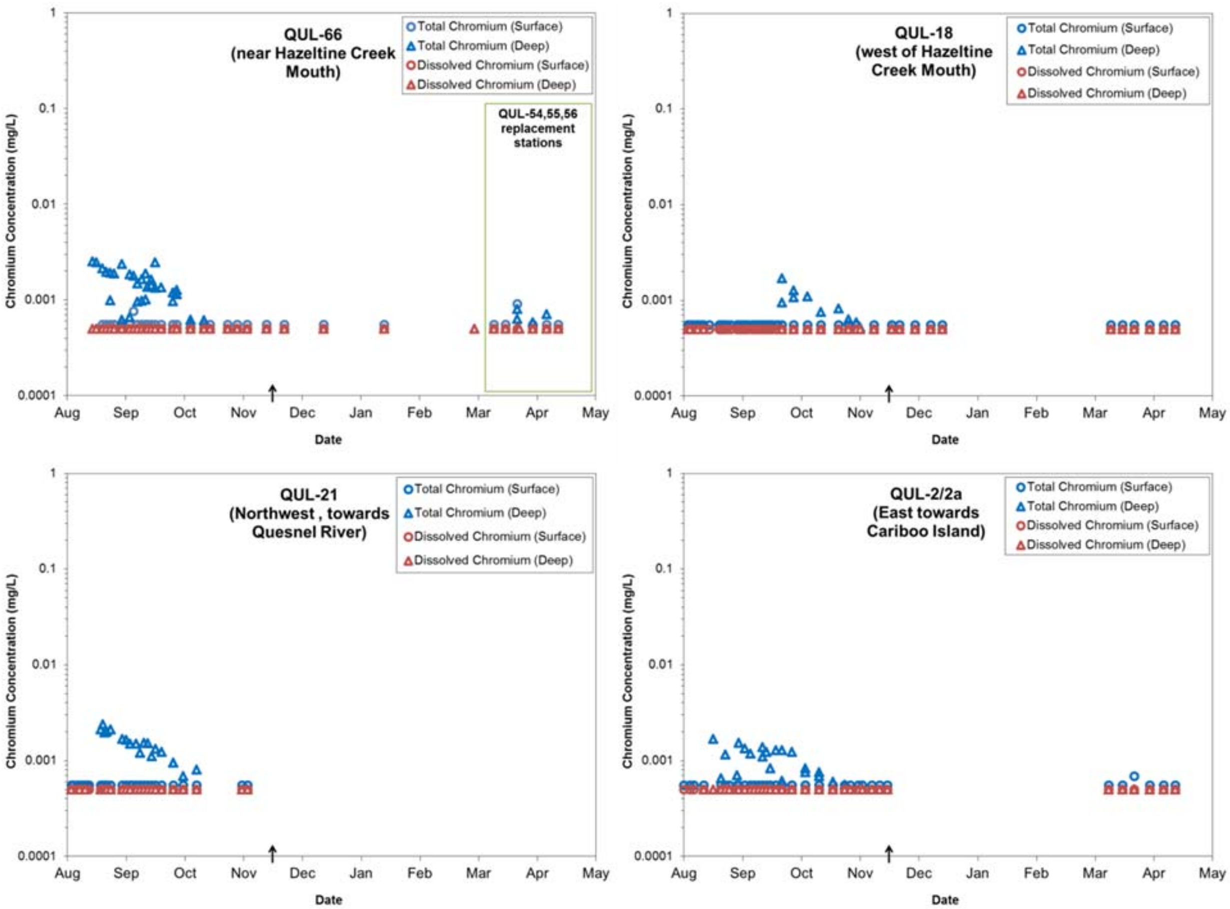


Figure 21: Post-event Instantaneous (A) and Rolling 30-day Average (B) Total and Dissolved Copper Concentrations at Station QUR-1 near Likely and at the Gravelle Ferry Bridge, Quesnel River.

Chromium

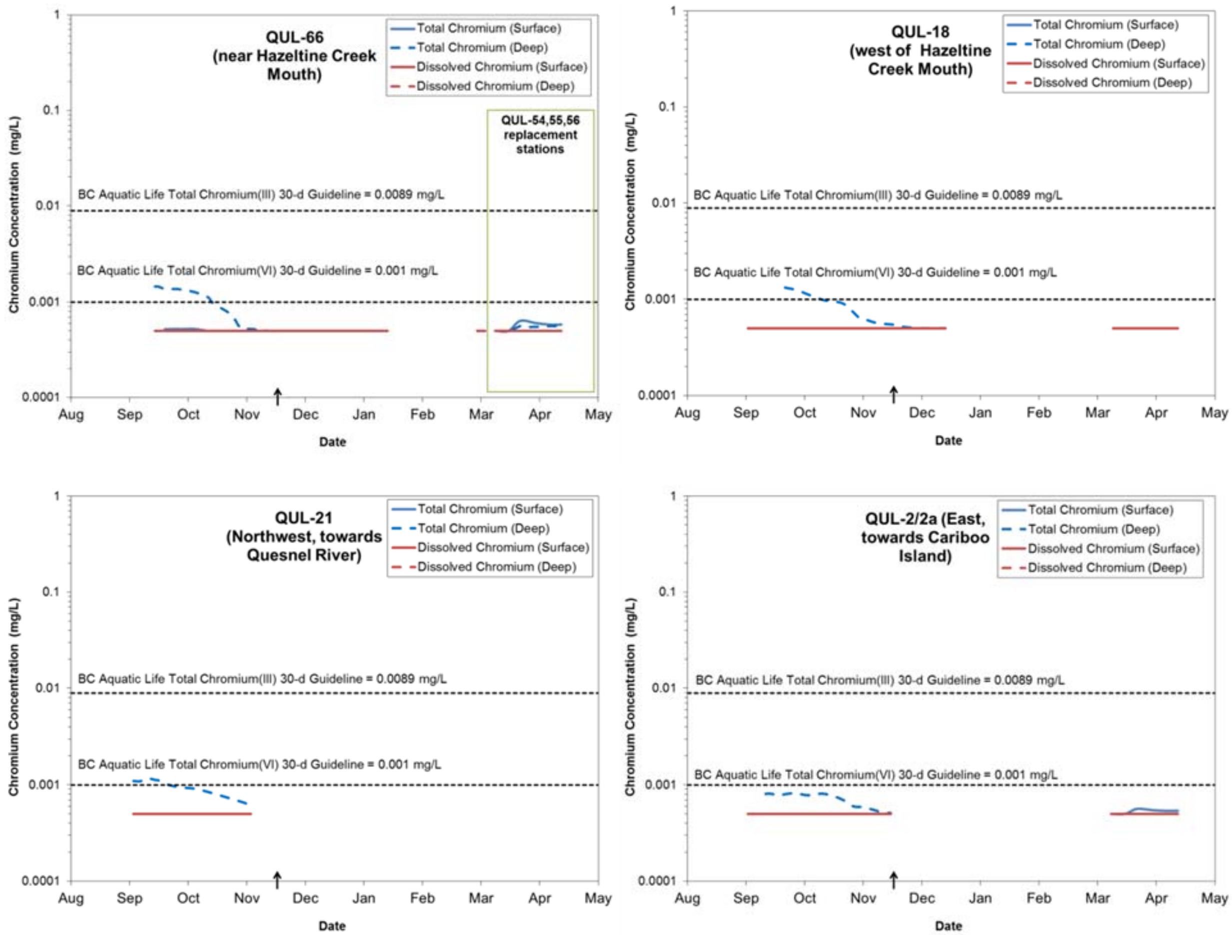
Quesnel Lake

Total chromium concentrations at depth were higher than the 30-d BC WQG after the event at near-field stations close to the mouth of Hazeltine Creek, but declined to below the most conservative guideline in October (Figure 22 and Figure 23). Total concentrations at surface were always less than the guideline and several results were reported as less than the detection limit. Dissolved chromium was not detected in samples collected at surface and at depth. These results indicate that concentrations were initially elevated due to the event, but declined over the sampling period.



Note: Arrow represents the approximate timing of mid-November turnover in Quesnel Lake.

Figure 22: Post-event Instantaneous Total and Dissolved Chromium Concentrations at Stations QUL-66, QUL-18, QUL-21, and QUL-2/2a, Quesnel Lake.



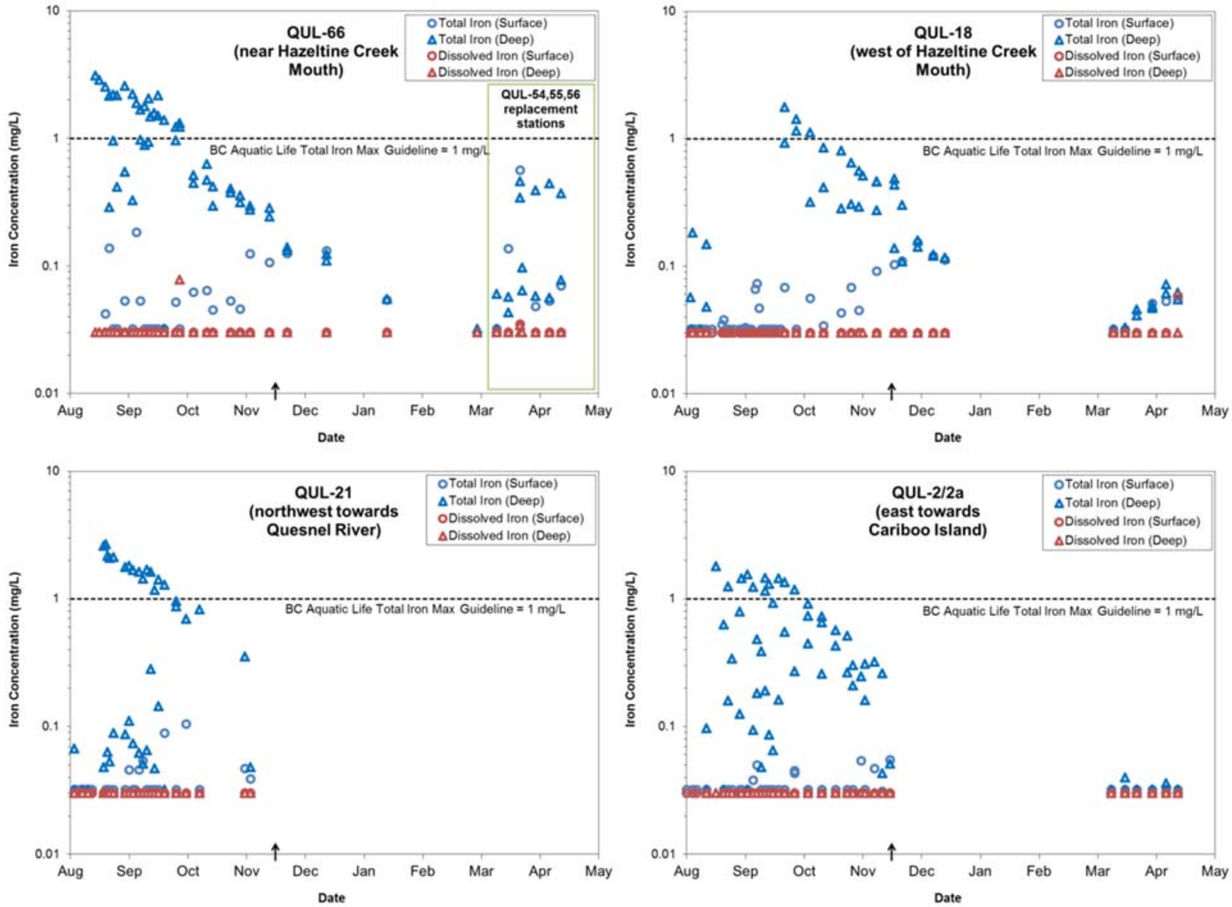
Note: Arrow represents the approximate timing of mid-November turnover in Quesnel Lake. Gaps represent >30 d between sampling.

Figure 23: Post-event Rolling 30-day Average Total and Dissolved Chromium Concentrations at Stations QUL-66, QUL-18, QUL-21, and QUL-2/2a, Quesnel Lake.

Iron

Quesnel Lake

Total iron concentrations at depth were higher than the maximum BC WQG immediately after the event, and declined below the guideline by October (Figure 24). There was no obvious temporal or spatial trend in total concentrations at surface; values were always below the maximum BC WQG. Dissolved iron was typically not detected in individual samples collected at surface or at depth. These results indicate that total iron concentrations at depth were initially elevated due to the event, likely in association with suspended particulate matter, but declined over the sampling period.



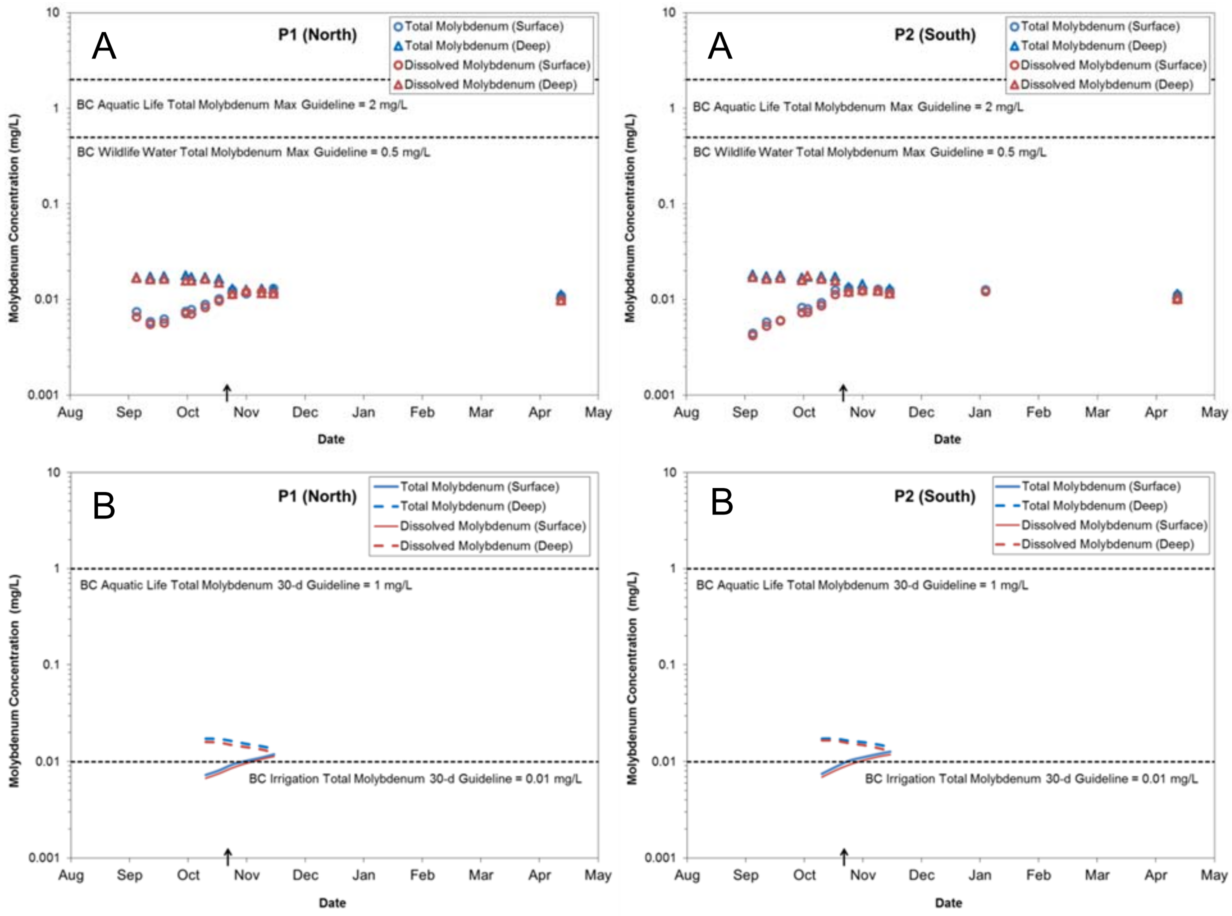
Note: Arrow represents the approximate timing of mid-November turnover in Quesnel Lake.

Figure 24: Post-event Instantaneous Total and Dissolved Iron Concentrations at Stations QUL-66, QUL-18, QUL-21, and QUL-2/2a, Quesnel Lake.

Molybdenum

Polley Lake

Total and dissolved molybdenum concentrations were below the most conservative maximum BC WQG for wildlife (Figure 25). Thirty-day rolling average concentrations calculated were above the most sensitive long-term average BC WQG at depth before and after turnover and after turnover close to the lake surface (Figure 25). Discrete samples taken at surface and at depth in January and April were below or approximated this 30-d guideline conservatively applied to address exposure to potentially sensitive ruminant wildlife. Swain (1986) suggested that wildlife would be less susceptible to molybdenosis than domesticated ungulates because wildlife are not confined to one area and will forage from a variety of food sources. Harmful effects due to moose and deer that may have foraged on plants adjacent to or within Polley Lake are considered unlikely based on the low proportion of the diet of moose or deer these plants would be expected to represent. Furthermore, although toxicity data for wildlife ruminants are limited, available data for deer suggests they are more tolerant than sheep or cattle (Swain 1986).



Note: Arrow represents the approximate timing of late-October turnover in Polley Lake.

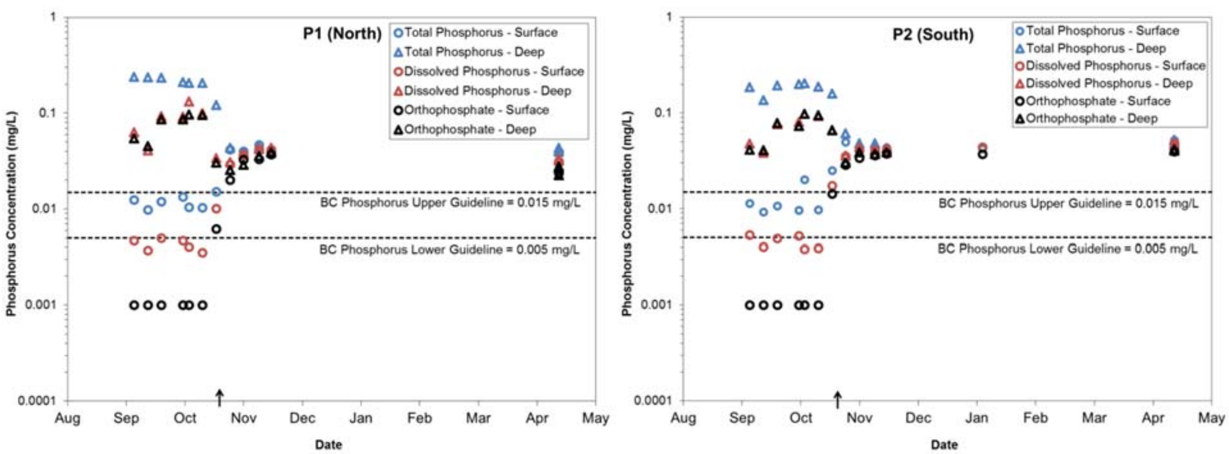
Figure 25: Post-event Instantaneous (A) and Rolling 30-day Average (B) Total and Dissolved Molybdenum Concentrations at Stations P1 and P2, Polley Lake.

4.2.2.4 Total Phosphorus

Unlike some of the nitrogen forms (ammonia, nitrite), phosphorus is not toxic to aquatic biota. However, given that primary productivity in freshwater lake environments tends to be limited by phosphorus, relative changes in lake phosphorus concentrations due to the event were evaluated (Environment Canada 2004). The BC WQG for TP in lakes is intended to be applied to the spring turnover concentration or the mean epilimnetic growing season concentration (e.g., May to September). Although post-event data were collected in the latter portion of the summer and into the fall, TP concentrations at surface and depth in Polley and Quesnel lakes were compared to the BC WQG range for lakes (i.e., 0.005 to 0.015 mg/L; BC MoE 2015a).

Polley Lake

Prior to the event, Minnow (2014) described a progressive increase in phosphorus concentrations in Polley Lake that resulted in a change in trophic status from oligotrophic/mesotrophic during the baseline (1989 to 1996) to mesotrophic/eutrophic in 2012 (Appendix A: Table A-1). After the event, concentrations of TP at the surface were within the 2009 to 2013 pre-event range reported by Minnow (2014). At depth, TP concentrations were substantially higher and were elevated above pre-event concentrations (Appendix A, Table A-1 and Minnow 2014) and above the upper limit of the BC WQG (Figure 26). Dissolved phosphorus and orthophosphate were also elevated at depth. Relatively lower concentrations of dissolved compared to total phosphorus suggested that a proportion of the TP was bound to or part of the mineral matrix of particulates present at depth. A common geologic source of phosphorus is the mineral apatite, which was part of the mineral matrix of the tailings particles. In deep samples, concentrations of dissolved phosphorus and orthophosphate were similar, indicating that most of the dissolved phosphorus would have been available for uptake by plants. In contrast, the surface samples contained orthophosphate concentrations near or below the detection limit. During fall turnover, concentrations of total and dissolved phosphorus, and orthophosphate from both surface and deep samples converged to median pre-event concentrations (i.e., 0.02 to 0.03 mg/L; Appendix A, Table A-1) and remained above the upper limit of the BC WQG in subsequent samples (Figure 26).



Note: Arrow represents the approximate timing of late-October turnover in Polley Lake.

Figure 26: Post-event Instantaneous Total and Dissolved Phosphorus and Orthophosphate at Stations P1 and P2, Polley Lake.

Quesnel Lake

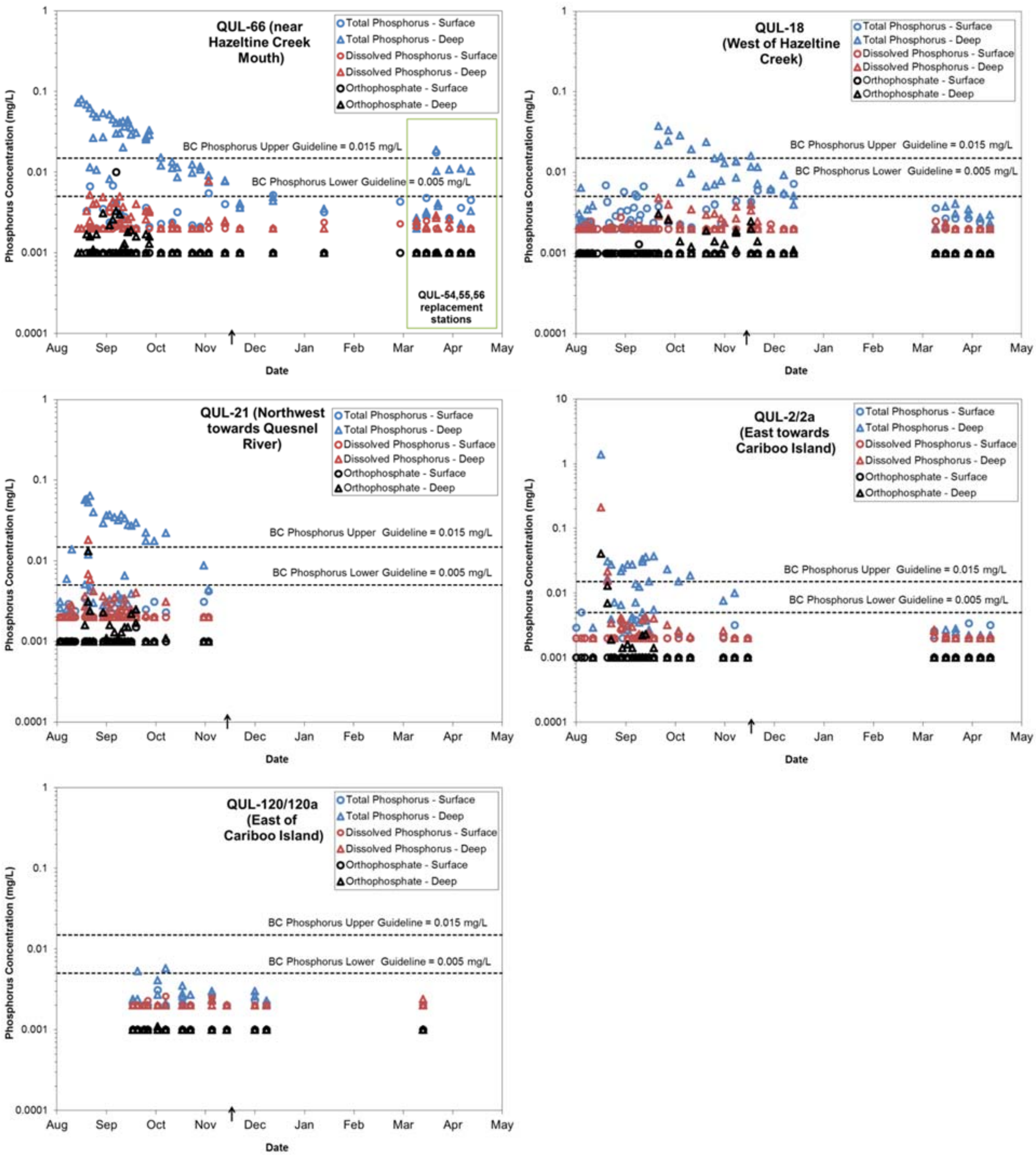
Similar to Polley Lake, total and dissolved phosphorus and orthophosphate were higher in deep water samples than surface waters.

Total and dissolved phosphorous concentrations were assessed at the five stations selected as representative stations in Section 3.4.2.1; i.e., QUL-66 (near the mouth of Hazeltine Creek[11]), QUL-66a (a deeper station north of Station QUL-66), QUL-18 (west of Hazeltine Creek mouth), and two stations further afield in the lake in both directions (Station QUL-21 northwest towards Quesnel River and Station QUL-2/2a east towards Cariboo Island).

[11] Monitoring at QUL-66 ceased at the end of February; to show changes in copper concentrations at this general location since March, data from near-by stations QUL-54, QUL-55, QUL-56 were used.

After the event, TP concentrations at depth were elevated above pre-event concentrations (Appendix A, Table A-1), concentrations measured outside of the West Basin (i.e., QUL-120/120a), and the upper limit of the BC WQG (Figure 27). At the surface, where suspended particulate concentrations were low, TP was not elevated above pre-event concentrations or guidelines. A comparison of total and dissolved phosphorus concentrations at depth suggests that a large proportion of the TP was bound to particulates, because mean dissolved concentrations were much lower. The association of TP with the presence of particulate material may be a reflection of the phosphate mineral apatite or inputs of soil and organic debris associated with the debris that flowed down Hazeltine Creek to Quesnel Lake as a result of the event.

Concentrations of TP at depth decreased over time, such that concentrations measured after fall turnover were below guidelines and similar to surface water concentrations (Figure 27). The observed increase in TP concentrations in the spring at depth at Station QUL-66 likely reflects input of particulate matter from Hazeltine Creek. Post-event, dissolved phosphorus and orthophosphate concentrations at surface and depth were typically below the median pre-event concentration (i.e., 0.003 mg/L; Appendix A, Table A-1), changed little over time, and in surface water samples were frequently near or below detection limits. The potential impact of changes in phosphorus concentrations on aquatic life in Quesnel Lake is discussed further in Golder (2015d).



Note: Arrow represents the approximate timing of mid-November turnover in Quesnel Lake.

Figure 27: Post-event Instantaneous Total and Dissolved Phosphorus and Orthophosphate at Near Field Stations QUL-66, QUL-18, QUL-21, QUL-2/2a and Far Field Station QUL-120/120a, Quesnel Lake.

4.2.3 Evaluation of Copper Bioavailability

Of the metal COPCs evaluated in the receiving environment, copper was the COPC of primary interest because total and dissolved forms reported to be above BC WQGs during the post-event period (Section 4.2.2.3). The following evaluation of copper bioavailability in the receiving environment considers the relationship between turbidity and copper in addition to geochemical speciation modelling undertaken for Quesnel Lake and Quesnel River.

4.2.3.1 Relationship between Turbidity and Copper

Measures of total metal concentrations in water include metals adsorbed to particulate matter, thus there is often a correlation between total metal concentration and turbidity or total metal concentration and TSS. In contrast, concentrations of metals in truly dissolved forms have no correlation with particulate matter. Due to the amount of materials, including fine clays and organic materials, which were deposited into the downstream environment after the event, as well as the subsequent periods of turbid conditions, the correlation between turbidity and total and dissolved copper was examined for the receiving environment.

Correlation analysis was conducted on log-transformed values of in-situ measured turbidity and concentrations of both total and dissolved copper to determine Spearman's correlation coefficients and p-values. Correlation was considered significant at p-values less than or equal to (≤) 0.05; plots and statistics are shown for the representative stations in Polley Lake, Quesnel Lake, and Quesnel River in Appendix G.

For each of the representative stations, there was a significant positive correlation between total copper concentration and turbidity. In Polley Lake, there was a significant negative correlation between dissolved copper concentration and turbidity; dissolved copper concentrations were below method detection limits in samples with the highest turbidity (Figure 28 and Appendix G). At each of the Quesnel Lake stations and the one station in Quesnel River, there was a significant positive correlation between dissolved copper concentration and turbidity (Figure 28 and Appendix G). These relationships suggest that measures of dissolved concentrations may have included fine particulate matter that passed through the 0.45-μm filter, particularly in Quesnel Lake. Laser diffraction particle size analysis of water samples collected at surface and depth from stations QUL-66 and QUL-18 in November 2014 showed that particles less than 0.45 μm comprised up to 6% (v/v) of the particle size distribution (MPMC unpublished data). Therefore, the reported dissolved metals concentrations may have overestimated the metal concentration that would have been bioavailable for direct uptake from the water by aquatic biota. Copper adsorbed to or sequestered by particulates could have potentially been taken up by aquatic organisms via dietary exposure, but as discussed in Section 4.2.3.2 fish have been shown to regulate and internally compartmentalize dietary copper, thus maintaining homeostasis. The potential for copper accumulation in aquatic organisms in Quesnel Lake due to waterborne and dietary exposure routes is addressed in Golder (2015d).

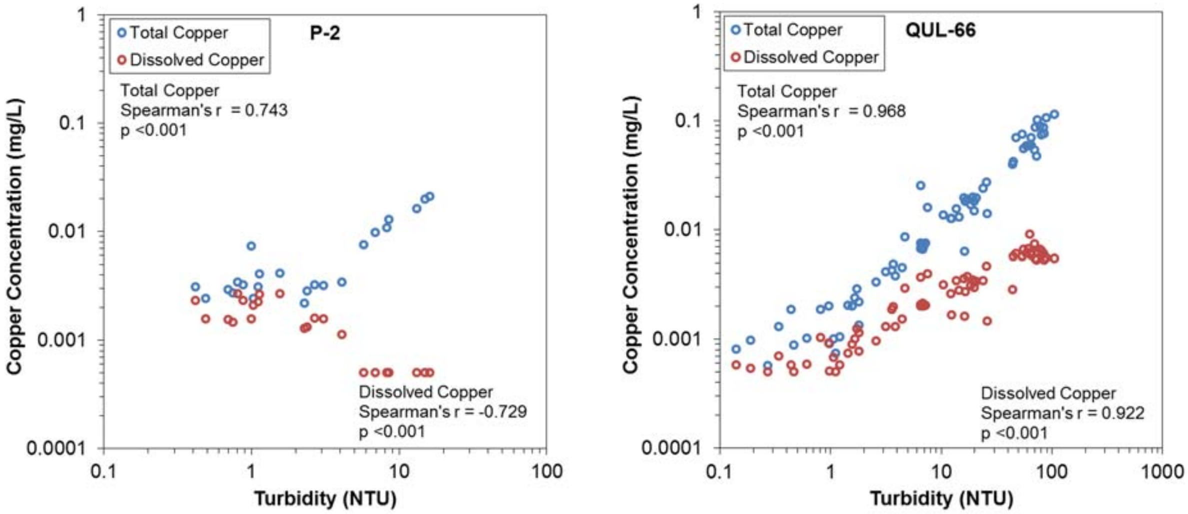


Figure 28: Correlation between turbidity and total and dissolved copper at Station P-2 in Polley Lake and Station QUL-66in Quesnel Lake post-event.

4.2.3.2 Copper Speciation Modelling

Copper occurs in surface waters in several forms or "species", depending on exposure conditions in the receiving environment, such as pH, alkalinity, hardness, salinity, and dissolved organic matter (Campbell et al. 2006). Dissolved copper species include free ionic copper (Cu^{2+}), copper hydroxides ($CuOH^{+}$ and $Cu(OH)_2$), copper carbonates ($CuCO_3$, $Cu(CO_3)_2^{2-}$), and copper bound to dissolved organic carbon (Cu-DOC). An understanding of the speciation of the "dissolved" metal fraction (per operational definition of <0.45 µm-filter) provides a truer measure of the bioavailability because scientific knowledge indicates it is the free metal species that is typically bioavailable for uptake from the water, with the potential to illicit adverse effects (Campbell 1995; Campbell et al. 2006). The particulate fraction also included in the measurement of total copper can potentially also be taken up by aquatic organisms through the dietary exposure route. Dietary copper uptake by fish has been shown to be regulated by the liver before being discharged via bile excretion and the kidneys, thus maintaining homeostasis (Miller et al. 1992, 1993). The potential for copper accumulation in aquatic organisms in Quesnel Lake due to waterborne and dietary exposure routes is addressed in Golder (2015d).

With respect to waterborne exposure addressed here in the WQIA, free ionic Cu^{2+} is the most bioavailable form and so has the greatest potential for toxicity to aquatic life, although copper-hydroxide complexes can also be bioavailable to a lesser extent and can thus also contribute to toxicity (Grosell 2012). Copper tends to be more bioavailable, and thus more toxic to aquatic life in surface waters having high dissolved copper concentrations, low ionic strength, low pH, and low DOC, as the copper will be predominantly present as the free ionic Cu^{2+} under such conditions (Grosell 2012). In freshwaters characterized by alkaline pH, copper-carbonate complexes tend to dominate.

Speciation modelling reported in Golder (2015c; Appendix H) estimated copper speciation at the representative stations assessed in Quesnel Lake and Quesnel River using the pH Redox Equilibrium in C language (PHREEQC) computer geochemical equilibrium modeling program (Parkhurst and Appelo 1999). The model output made it possible to estimate the proportion of copper bioavailable under site-specific water chemistry conditions at the representative Quesnel Lake stations. The PHREEQC program computes metal species and their concentrations based on inputs of water metal concentration and water chemistry parameters known to affect the speciation of the metal in question.

The speciation modelling suggested that the bioavailable fractions of the reported dissolved copper concentrations for Quesnel Lake (Figure 19 and Figure 20) and Quesnel River (Figure 21) would likely have been present at concentrations substantially lower than 30-d BC WQG. The modelling results indicate that copper was mainly present as copper carbonate ($CuCO_3$) (generally greater than 80% of the dissolved concentration), with minor percentages of copper hydroxide ($CuOH^+$ and $Cu(OH)_2$) and free ionic copper (Cu^{2+}) present.

Given the copper species most bioavailable to aquatic life are free ionic copper and copper hydroxides, the speciation modelling suggested that only a small percentage of dissolved copper concentrations would have been bioavailable for direct uptake from the water by organism in Quesnel lake and Quesnel River. The majority of dissolved copper, as represented by the fraction passing a 0.45-µm filter, would have been present as copper carbonate that is less bioavailable for direct uptake compared to free ionic copper.

4.2.4 Post-Event Toxicity Testing Program

The evaluation of water quality impacts in the receiving environment discussed in Section 4.2.2focussed on changes in water chemistry and exceedance of BC WQGs based on an examination of individual COPCs; however, in reality these substances exist in a complex mixture. Although the most common form of interaction among contaminants is additive, it is possible that more-than-additive (synergistic) or less-than additive (antagonistic) interactions are operable. In addition to monitoring water quality following the event, MPMC also initiated a toxicity testing program where water samples taken from the receiving environment were subject to a battery of standard laboratory acute and sub-lethal tests using sensitive plant, invertebrate, and fish test species. The program provides the strongest evaluation of the bioavailable fraction as it is a direct measure of effect using water from the site and sensitive test species representing primary producers, primary consumers, and secondary consumers.

4.2.4.1 Initial Toxicity Testing (August to September 2014)

Minnow (2015) reported on a total of 53 toxicity tests using six different species that were carried out on water samples collected in August and September 2014 from Polley Lake (POL-2, POL-6), Quesnel Lake (QUL-66), and the Quesnel River (QUR-1). These tests also included testing of the discharge from Polley Lake to Hazeltine Creek (HAD-1, HAD-2). Quesnel Lake water samples were taken from the monitoring station closest to the source of event-related inputs at the mouth of Hazeltine Creek.

The following standard toxicity tests were included in the post-event toxicity testing program:

- 96-h acute lethality to rainbow trout (*Oncorhynchus mykiss*);
- 48-h acute lethality to *Daphnia magna*;
- 7-d survival and growth of fathead minnow (*Pimephales promelas*);
- 7-d survival and reproduction of *Ceriodaphnia dubia*;
- 7-d growth inhibition in the aquatic plant *Lemna minor;* and,
- 72-h growth inhibition in the alga *Pseudokirchneriella subcapitata*.

Overall, the results of this testing in the weeks following the event indicated no toxicity that could be attributed to the elevated concentrations reported for some metals. This finding supports the chemistry results of the water quality monitoring program that consistently reported lower concentrations of dissolved metals compared to total metals, as well as the copper speciation described above. As discussed in Section 4.2.2.3 dissolved forms are understood to be more bioavailable for direct uptake from water by aquatic organisms compared to particulate metals.

In a relatively small number of tests (9 of 53 tests) some responses were noted. These were typically observations of impaired reproduction in *C. dubia* exposed to turbid deep water samples from Quesnel Lake. The observed effects were not considered to be related to metal concentrations; however, recommendations were made by Minnow (2015) to undertake confirmatory resampling and retesting to verify the observed responses and examine potential causes.

4.2.4.2 Follow Up Toxicity Testing (November 2014 to February 2015)

Subsequent water samples collected from November 2014 to February 2015 were subject to the following sub-lethal toxicity tests:

- 7-d survival and reproduction of *C. dubia* on filtered (0.45 µm) and unfiltered samples to examine the influence of suspended solids.
- 7-d survival and growth of rainbow trout; and,
- 7-d survival and growth of fathead minnow.

Fish Toxicity Testing

No impacts on survival and growth of fathead minnows and rainbow trout were observed for water samples collected from Polley Lake (P2 surface, POL-4), Quesnel Lake (QUR-66 surface and depth), and Quesnel River (QUR-1; Table 4-4).

An early life stage test (embryo-alevin) with rainbow trout was carried out using water samples regularly collected from the Quesnel River (QUR-1) between November 25 and December 22, 2014. The water samples were collected to coincide with egg availability which also coincided with the period of greatest turbidity in Quesnel River. There were no reported adverse effects on the survival or normal development of rainbow trout eggs exposed to the water through to hatching of the alevin stage (MPMC 2015). Similar results were observed when the test was repeated with water samples collected from December 10, 2014 to January 7, 2015 (MPMC unpublished data). These results suggest that the increase in turbidity in the Quesnel River after turnover of Quesnel Lake was unlikely to have an effect on incubating salmonid eggs in the river.

Invertebrate Toxicity Testing

No impacts on *C. dubia* survival were observed in water samples collected from Polley Lake (P2 surface, POL-4), Quesnel Lake (QUR-66 surface and deep), and Quesnel River (QUR-1; Table 4-4). Likewise no impacts on *C. dubia* reproduction were observed in samples from Polley Lake (P2 surface, POL-4), Quesnel River in January and February 2015, and from filtered samples from Quesnel Lake.

Reproductive effects were reported for unfiltered samples, taken mainly at depth from Quesnel Lake close to the Hazeltine Creek mouth, but no effects were observed for the corresponding filtered samples suggesting that exposure to suspended particulate matter in the samples may have resulted in a reproductive test response in this sensitive invertebrate. Two unfiltered samples taken from Quesnel River in November and December 2014 also showed a reproductive test response (Table 4-4) that coincided with rising turbidity at the station sampled (QUR-1).

Table 4-4: Summary of Post-event Surface Water Toxicity Testing (November 2014 to February 2015) (unpublished MPMC data)

Test Type	Station	Sample Date	LC50 (% v/v)[a] (Median Lethal Concentration)	IC25 (% v/v)[a] (25th Percentile Inhibitory Concentration)	IC50 (% v/v)[a] (Median Inhibitory Concentration)
7-d fathead minnow survival and growth	P2-surface	January 6, 2015	>100	>100	>100
	QUL-66-0m	January 15, 2015	>100	83.2 (46.7-100)	>100
	QUL-66-85m		>100	95.6 (25.4-100)	>100
	QUR-1	January 7, 2015	>100	>100	>100
	QUR-1	February 10, 2015	>100	>100	>100
7-d rainbow trout survival and growth	P2-surface	January 6, 2015	>100	>100	>100
	QUL-66-0m	January 15, 2015	>100	>100	>100
	QUL-66-85m		>100	>100	>100
	QUR-1	January 7, 2015	>100	>100	>100
7-d *C. dubia* survival and reproduction	POL-4	December 16, 2014	>100	>100	>100
	P2-surface	January 6, 2015	>100	>100	>100
	QUL-66-0m	November 25, 2014	>100	29.3 (10.9-4.02)	>100
	QUL-66-0m (Filtered)		>100	>100	>100
	QUL-66-20m		>100	6.2 (3.0-32.5)	>100
	QUL-66-20m (Filtered)		>100	>100	>100
	QUL-66-45m		>100	22.1 (5.4-57.7)	>100
	QUL-66-45m (Filtered)		>100	92.5	>100
	QUL-66-0m	January 15, 2015	>100	11.1 (7.2-29.1)	>100
	QUL-66-0m (Filtered)		>100	>100	>100
	QUL-66-85m		>100	8.3 (2.3-23.0)	>100
	QUL-66-85m (Filtered)		>100	>100	>100
	QUR-1	November 25, 2014	>100	8.2 (2.1-34.4)	>100
	QUR-1	December 16, 2014	>100	50.6 (37.6-60.4)	>100
	QUR-1	January 7, 2015	>100	>100	>100
	QUR-1 (Filtered)		>100	>100	>100
	QUR-1	February 10, 2015	>100	>100	>100

a. Effect concentration; in instances where an effect was observed, 95% confidence limits are also provided (where calculable).

4.2.5 Summary

Observed Changes in Water Quality

Following initial screening of water quality using BC WQGs, including total and dissolved forms of relevant parameters, COPCs were identified for the receiving environment (Table 4-2). Changes in concentrations of COPCs (i.e., suspended particulate matter, metals, and phosphorus) were evaluated for stations selected to be representative of Polley Lake, Quesnel Lake, and Quesnel River. Temporal and spatial changes throughout the post-event period from August 2014 to April 2015 were examined in relation to applicable BC WQGs.

Post-event changes in COPCs over time are summarized in Table 4-5. Post-event concentrations of COPCs were typically only elevated at depth until the beginning of lake turnover. Following turnover when the lakes were mixed, concentrations of some COPCs at depth decreased, but increased near the surface as a result of the mixing throughout the water column. The most recent sampling (up to April 2015) indicates that concentrations of all identified COPCs have decreased to below BC WQGs or are within the range of pre-event conditions, with the exception of total copper in Quesnel Lake. Although total copper concentrations showed a substantial decreasing trend over the post-event period, concentrations in one or more samples from at least one of the representative stations in Quesnel Lake remain elevated above BC WQGs for the protection of aquatic life. Concentrations of total copper and the other COPCs measured following the event, from August 2014 to April 2015, were below BC WQGs for other relevant uses; i.e., wildlife, and drinking water sources[12].

[12] Molybdenum concentrations at the representative stations were below BC WQGs for the protection of aquatic life and drinking water

Table 4-5: Summary of Post-Event Changes of Identified Contaminants of Potential Concern in the Receiving Environment over Time at Representative Stations

Study Area	Contaminant of Potential Concern	Event to Lake Turnover (August 2014 to November 2014)		Lake Turnover to Last Sampling Event (November 2014 to April 2015)		Last Sampling Event (up to April 2015)	
		Surface	Deep	Surface	Deep	Surface	Deep
Polley Lake	Turbidity	● (green)	● (orange)	● (green)	● (green)	● (green)	● (green)
	TSS	● (green)	● (orange)	● (green)	● (green)	● (green)	● (green)
	Total Copper	● (orange)	● (orange)	● (green)	● (orange)	● (green)	● (green)
	Dissolved Copper[a]	● (green)	● (green)	● (green)	● (green)	● (green)	● (green)
	Total Molybdenum	● (green)	● (orange)	● (orange)	● (orange)	● (green)	● (green)
	Dissolved Molybdenum	● (green)	● (orange)	● (orange)	● (orange)	● (green)	● (green)
	Total Phosphorus	● (green)[b]	● (orange)	● (green)[b]	● (green)[b]	● (green)[b]	● (green)[b]
Quesnel Lake	Turbidity	● (green)	● (orange)	● (green)	● (orange)	● (green)	● (green)
	TSS	● (green)	● (orange)	● (green)	● (green)	● (green)	● (green)
	Total Chromium	● (green)	● (orange)	● (green)	● (green)	● (green)	● (green)
	Dissolved Chromium[a]	● (green)	● (green)	● (green)	● (green)	● (green)	● (green)
	Total Copper	● (green)[c]	● (orange)	● (orange)	● (orange)	● (orange)	● (orange)
	Dissolved Copper	● (green)	● (orange)	● (orange)	● (orange)	● (green)	● (green)
	Total Iron	● (green)	● (orange)	● (green)	● (green)	● (green)	● (green)
	Dissolved Iron[a]	● (green)	● (green)	● (green)	● (green)	● (green)	● (green)
	Total Phosphorus	● (green)	● (orange)	● (green)	● (green)	● (green)	● (green)
Quesnel River	Turbidity	● (green)	n/a	● (orange)	n/a	● (green)	n/a
	Total Copper	● (green)		● (orange)		● (green)	
	Dissolved Copper	● (green)		● (orange)		● (green)	

Notes:
n/a: Not applicable; only surface water samples were collected from Quesnel River.
(a) Dissolved metal form shown, but results are summarized because the total metal form was identified as a COPC.
(b) Concentrations exceed the BC WQG, but are comparable to pre-event conditions (Section 4.2.2).
(c) Concentrations began to increase above the 30-d BC WQG range (based on the range of hardness) in October 2014.
● (green) = Concentrations are below BC WQG(s) at representative stations
● (orange) = Concentrations exceed the maximum and/or 30-day BC WQG in one or more samples from at least one representative station.

Evaluation of Copper Bioavailability

Based on comparison to BC WQGs for the protection of aquatic life and pre-dam failure conditions, total copper concentrations in Quesnel Lake have increased and exceed the BC WQGs (Table 4-5). The BC WQGs for the protection of aquatic life are a useful tool to identify chemicals in water that may cause adverse effects, but they are conservative in their derivation and should not be used for making remedial decisions. Ideally, more direct measures of toxicity should be used that take into consideration the mixture of contaminants and other parameters in the water. The findings of toxicity testing with water samples using three trophic levels of test species covering primary producers, primary consumers and secondary consumers sampled throughout the post-event period together with the several geochemical lines of evidence provided a more realistic assessment of potential impact of changes in water quality to aquatic life.

Observed changes in metal concentrations in the receiving environment due to the event were unlikely to have resulted in adverse effects on aquatic organisms in consideration of the following lines of evidence.

- A toxicity testing program initiated immediately after the event and carried through the post-event period indicated that receiving environment waters were not acutely toxic to sensitive plant, fish, and invertebrate species. Sub-lethal, long-term effects were not reported for sensitive plant, fish, and invertebrate species, with the exception of a reproductive test response in some samples related to suspended matter in the samples and not water chemistry.
- Although total metals concentrations were elevated above provincial guidelines for the protection of aquatic life for some metals, dissolved concentrations were substantially lower and generally did not exceed provincial guidelines, or decreased to below guideline in the period following the event (with the exception of copper). These guidelines are derived from laboratory-based toxicity tests where exposure concentrations are measured in solutions characterized by low levels of suspended matter and total and dissolved concentrations are similar. The application of WQGs to total concentrations under turbid conditions prevalent during the post-event period is therefore conservative.
- Dissolved forms of copper in Quesnel Lake and Quesnel River would likely have been dominated by copper carbonates with a minor proportion of copper present in the free ion form (Cu^{2+}) that is readily bioavailable for direct uptake from the water by organisms. Copper carbonates by comparison are not readily bioavailable for uptake.

The WQIA relied on comparisons to provincial water quality guidelines, waterborne toxicity testing and water quality speciation modelling. These lines of evidence have limited consideration of metal uptake via the dietary exposure route[13], but tend to be focussed on direct waterborne exposure. The potential for metal uptake via waterborne and dietary exposure routes by aquatic organisms in the receiving environment after the event is evaluated in Golder (2015d).

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[13] With the exception of selenium and molybdenum water quality guidelines.

5.0 INTERIM FINDINGS – WATER QUALITY

This section provides interim conclusions based on the data contained in this report. They are interim because the post-event environmental studies are still in progress.

Changes in water quality observed in Polley Lake, Quesnel Lake, and Quesnel River due to the event mainly related to elevated levels of particulate matter suspended in the water column. Over time the suspended particulates settled out in the receiving environment and the available data suggest that levels of particulate matter are no longer of concern in the receiving environment. Suspended solids settled out more quickly following the event compared to the finer particulates measured by turbidity that remained elevated at depth in Quesnel Lake until lake turnover in November.

Concentrations of metals measured in the receiving environment immediately following the event through to April 2015, were not of potential concern with regards to drinking water sources or wildlife, with the exception of molybdenum in Polley Lake that was no longer of potential concern by April 2015 and unlikely to have posed a risk to wildlife based on considerations provided in Swain (1986). Although elevated immediately after the event in Polley and Quesnel Lakes with respect to BC WQGs for the protection of aquatic life, total concentrations of several metals decreased over the post-event period such that by April 2015, only total copper was elevated in Quesnel Lake. Post-event water quality monitoring continues.

Based on comparison to the BC WQG for the protection of aquatic life and pre-dam failure conditions, total copper concentrations in Quesnel Lake increased following the event. The BC WQGs for the protection of aquatic life are a useful tool to identify chemicals in water that may cause adverse effects, but they are conservative in their derivation and should not be used for remediation purposes. Ideally, more direct measures of toxicity should be used that take into consideration the mixture of contaminants and other parameters in the water. The findings of toxicity testing with water samples using three trophic levels of test species covering primary producers, primary consumers, and secondary consumers sampled throughout the post-event period, together with the several geochemical lines of evidence, provided a more realistic assessment of potential impact of changes in water quality to aquatic life. These findings indicate that, although there were measured changes in water quality, the evidence available to date does not indicate that the event resulted in toxicity in the water column. We note that this report is an interim report and that additional studies remain ongoing or are planned.

6.0 UNCERTAINTY ASSESSMENT

The impact assessment involved the compilation and assessment of pre- and post-event water quality data to evaluate changes in water quality in the study areas as a result of the event. It is appropriate to identify areas of uncertainty for the ongoing development of water quality monitoring downstream of the Mount Polley mine.

The main uncertainties are summarized and discussed below in Table 6-1.

Table 6-1: Uncertainty Assessment for the Water Quality Impact Assessment

Uncertainty Source / Assumption	Degree of Uncertainty	Under/ Over Estimate of Impact	Rationale
Assessment stations selected in each study area were representative of the water quality in that area.	Low	Neutral	Routinely monitored stations in each study area were targeted. Reasonable spatial coverage was targeted in Quesnel Lake including two stations located close to the mouth of Hazeltine Creek and the source of breach-related inputs to Quesnel Lake.
Post-event monitoring during the winter months at some stations was limited due to logistical and safety concerns. The available data are assumed to provide a reasonable characterization of conditions at and following fall turnover in Quesnel Lake and downstream in Quesnel River.	Moderate	Neutral	The coverage of assessment stations per area was such that winter monitoring data were available within each study area during the lake turnover events and from December to February, although at a reduced frequency.
Evaluation of metal parameters was primarily based on the comparison of dissolved metal concentrations to BC WQGs.	Low	Neutral	As discussed in Section 3.3 (Identification of COPCs), this assumption is supported by the available science that shows that dissolved concentrations are bioavailable for uptake by aquatic biota. An evaluation based on the total concentration, especially under turbid conditions, would over-estimate the potential for adverse effects and not provide useful or realistic input to the Restoration and Remediation Strategy.
Dissolved metal concentrations in their entirety were bioavailable to aquatic biota.	Moderate	Over Estimate	The identification of relationships between dissolved copper and turbidity and suggestions by Tetra Tech (2015) that laboratory-measured TSS is missing some fine-grained material, suggests that the dissolved samples may contain some fine particulates. Metals associated with those particulates may not be bioavailable for uptake and so the potential for toxicity may be over-estimated.
Post-event mercury data were limited after early September 2014. Mercury was frequently reported below method detection limits that are above the BC WQG.	Low	Neutral	Mercury was monitored for approximately one month following the event when concentrations would have been the highest. Limited data collected after September support the expectation that mercury concentrations decreased over time. Further monitoring would confirm this expectation.
Background metals data were not available for Quesnel Lake and limited data were available for Quesnel River.	Low	Neutral	The identification of metal COPCs for Quesnel Lake and Quesnel River generally relied on a comparison to BC WQGs that are conservative and intended to be applied province-wide.

Uncertainty Source / Assumption	Degree of Uncertainty	Under/ Over Estimate of Impact	Rationale
Pre-event surface water quality data were used as received from the source (i.e., MPMC or BC MoE).	Low	Neutral	Reported values were assumed to be accurate and representative of the study areas given known data quality assurance/quality control programs.
Pre-event surface water quality data were characterized by a range of method detection limits, based on data availability.	Low	Neutral	COPC identification primarily focus on screening to BC WQGs for the protection of aquatic life, using upper-limit (maximum and 95^{th} percentile) post-event concentrations. This was considered to be a conservative screening approach that would not have been heavily influenced by a pre-event condition defined by method detection limits.
Interaction of contaminant mixtures will not result in effects greater than estimated through the use of BC WQGs.	Low	Neutral	The assessment evaluated water quality parameters individually; however, in reality they exist in a mixture in each study area environment. Although the most common form of interaction among contaminants is additive, it is possible that more-than-additive (synergistic) or less-than additive (antagonistic) interactions are operable. Toxicity testing of water samples collected from the study areas addresses uncertainty related to mixture effects, as discussed in Section 4.2.4.

Notes:
MPMC = Mount Polley Mining Corporation; BC MoE = British Columbia Ministry of Environment; COPC = Contaminant of Potential Concern; BC WQG = British Columbia Water Quality Guideline; RRS = Rehabilitation and Remediation Strategy; TSS = total suspended solids.

7.0 CLOSURE

We trust that this report provides sufficient information for your present needs. If you have any questions, please do not hesitate to contact the undersigned at 604-296-4200.

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9.0 GLOSSARY

Term	Definition
95th Percentile	The number in a distribution such that 95% of the values in the distribution are less than or equal to the number and 5% of the values are greater than the number.
Abrading	The action by which suspended solids wear away or erode fish tissues.
Acute	A stimulus severe enough to rapidly induce an effect; in aquatic toxicity tests, an effect observed in 96 hours or less is typically considered acute. When referring to aquatic toxicology or human health, an acute effect is not always measured in terms of lethality.
Additive	When two or more substances acting in combination produce a total effect that is equivalent to the sum total of the individual effects of each substance.
Adsorbed	Refers to atoms, ions or molecules that are adhered or bonded to a surface.
Adverse effect	An effect that results in a negative impact or is considered undesirable.
Alkalinity	A measurement (expressed in mg/L of calcium carbonate) of the capacity of water to neutralize acids. The concentration is measured based on the presence of naturally available bicarbonate, carbonate, and hydroxide ions.
Antagonistic	Refers to an effect resulting from the opposing effects of two substances or actions.
Anthropogenic	Human-related, often referring to an activity, development or disturbance on the landscape.
Bioaccumulation	The accumulation of a substance in the tissues of an aquatic organism through exposure to water and diet.
Bioaccumulation factor	The ratio of the concentration of a substance in tissue to its concentration in water or the diet, when the organism could have accumulated the substance through either media.
Bioavailability	The portion of a substance or chemical that is immediately available for uptake by organisms. Bioavailability of different substances can change over time.
Bioconcentration	The accumulation of a substance in the tissues of an aquatic organism through exposure to water only (does not include dietary uptake).
Bioconcentration factor	The ratio of the concentration of a substance in tissue to its concentration in water.
Biomagnification	Increasing tissue concentrations of a substance solely through uptake from food such that the tissue concentrations increase at each trophic level in the food web.
Biomass	Refers to the mass of biological material, including plants, animals and decaying organic matter, present within a particular habitat, area or ecosystem at any one time.
Biota	Plant and animal life found in a region, watercourse or waterbody.
Chlorophyll *a*	A photosynthetic pigment found in plants responsible for the conversion of inorganic carbon and water into organic carbon. The concentration of chlorophyll *a* is an indicator of algal concentration.
Chronic	The development of adverse effects after extended exposure to a given substance. In chronic toxicity tests, the measurement of a chronic effect can be reduced growth, reduced reproduction or other non-lethal effects, in addition to lethality. Chronic should be considered a relative term depending on the life span of the organism.

Term	Definition
Conductivity	A measure of the ability of water to carry an electrical current. This measurement is directly related to the amount of positively (cations) and negatively (anions) charged ions in the water and can be correlated with the concentration of total dissolved solids.
Confluence	Refers to the location at which two watercourses join and become one stream or river.
Constituent	An individual chemical, property, or measurement in water (e.g., aluminum, chloride, total dissolved solids)
Contaminant of Potential Concern (COPC)	A chemical that is emitted or released into the environment and poses a potential risk of exposure to humans or ecological receptors.
Contiguous	Refers to two items or entities that are touching or side-by-side.
Creek	Branch of or small tributary to a river.
Detritus	Small particles of organic matter produced by the breakdown and decay of plant and animal matter.
Diatom	A type of planktonic algae. Diatoms are generally unicellular and have cell walls that contain silica.
Dimictic	Refers to lakes that mix from top to bottom twice a year; mixing occurs in spring and fall.
Discharge	The volumetric rate of flow of water in a watercourse at a specified point, expressed in units of m^3/s or equivalent.
Dissolved organic carbon (DOC)	The dissolved portion of organic carbon in water. It is comprised of humic substances and partly degraded plant and animal materials.
Dissolved oxygen (DO)	The amount of free oxygen dissolved in water, usually expressed in milligrams per litre (mg/L), parts per million (ppm), or percent of saturation (%). Adequate concentrations of dissolved oxygen are required by fish and other aquatic organisms.
Downstream	Away from the source of a river or stream.
Dyke	A long wall or embankment built to prevent flooding.
Epilimnetic	Refers to the upper layer of water within lakes that develop a thermocline.
Erosion	The wearing away of the land surface by running water, wind, ice, or other geological agents.
Euphotic zone	In an aquatic environment, it is the uppermost layer of water that receives sufficient sunlight to promote photosynthesis.
Eutrophic	Excessive growth of algae or other primary producers in a stream, lake, or wetlands as a result of large amounts of nutrient ions, especially phosphate or nitrate.
Far-field	An area far removed from the zone of influence.
Field duplicate	A second water sample that is collected at the same place and time as the original water sample.
Fjord lake	A lake formed by the action of receding glacial ice.
Freshet	Flow conditions resulting from the melting of snow and ice in spring.
Fry	A young, newly hatched fish that has used up its yolk sac and has started active feeding.

Term	Definition
Geochemistry	The chemistry of the composition and alterations of solid matter such as sediments or soil.
Habitat	The physical space within which an organism lives, and the abiotic and biotic entities (e.g., resources) it uses and selects in that space.
Hardness	A measure of the mineral content of a water sample; magnesium- and calcium-containing compounds contribute to water hardness. Water samples with high and low mineral contents are referred to either hard or soft, respectively.
Humic	Describes substances that contribute to the natural organic matter found in water.
Hydraulic residence time	Time required for a volume of water equivalent to the lake volume to be discharged from a lake (lake volume divided by daily river discharge).
Hypoxic	Refers to a watercourse, waterbody or water sample that has low levels of dissolved oxygen. Generally this refers to water conditions where dissolved oxygen is less than 5 mg/L or in the range of 1 to 30% saturation.
In situ	In place, i.e., measured in the field.
Ion	A molecule or atom that has a net positive or negative electric charge due to an uneven number of electrons and protons.
Ionic strength	An expression of the ionic charge in a sample of water. The greater the concentration of ions in a sample, the greater the ionic strength.
Lethality	Refers to the ability of a toxicant or action to cause death.
Limnological	Pertaining to the study of open fresh and more rarely saline waterbodies, specifically lakes and ponds (both natural and manmade), including their physical, chemical, and biological properties.
Lowest Observed Effect Concentration (LOEC)	Refers to the lowest concentration of a substance that is found to cause an adverse effect to the growth, development or lifespan of a test organism.
Macroinvertebrates	A group of animals that lack a spinal cord and are large enough to be seen with the naked human eye.
Mean	Arithmetic average value in a distribution.
Median	A single statistical value used to characterize a series of data values. Half of the data values are larger than the median value, and half of the data values are less than the median value.
Mesotrophic	Describes the trophic status of a watercourse or waterbody with moderate nutrient enrichment; total phosphorus concentrations are generally between 10 and 20 micrograms per litre.
Metals	Any of a class of substances (including many chemical elements) which are in general lustrous, malleable, fusible, ductile solids and good conductors of heat and electricity.
Metalloids	Any element intermediate in properties between metals and non-metals. A metalloid element has the form or appearance of a metal.
Method detection limit	Refers to the lowest concentration of a substance (e.g., metal, nutrient) that can be measured with 99% confidence that the measured concentration is not equal to zero (i.e., the substance is present in the sample media).
Mid-field	An area located a moderate distance from the zone of influence.

Term	Definition
Mitigation	The elimination, reduction or control of the adverse environmental effects of a project, including restitution for any damage to the environment caused by such effects through replacement, reclamation, compensation, or any other means.
Near-field	An area located within or near the zone of influence.
Nutrients	Elements or chemicals essential to growth or repair of organic bodies, including carbon, oxygen, nitrogen, phosphorus, and silica.
Oligotrophic	Trophic state classification for lakes characterized by low productivity and low nutrient inputs (particularly total phosphorus).
Ore	A type of mineral or rock that contains relatively large concentrations of metals or other economically valuable substances.
Orthophosphate	A phosphate-containing salt or ester.
Parameter	A particular physical, chemical, or biological property that is being measured.
pH	The negative log of the concentration of the hydronium ion. It is a measure of the acidity or alkalinity of all materials dissolved in water, expressed on a scale from zero (0) to 14, where seven (7) is neutral, values below seven are acidic and values over seven are alkaline.
Plankton	Microscopic aquatic organisms (tiny plants [phytoplankton] and animals [zooplankton]) free-floating and suspended in the water column.
Plume	Describes a discharge in terms of its shape, size and/or direction of movement within the receiving environment, namely surface water.
Productivity	A measure of the biomass produced by an aquatic system.
Redox	Refers to reduction and oxidation reactions in which electrons are transferred between atoms.
Remediation	The process of removing, reducing or neutralizing the adverse effects a hazardous material has on the environment.
Risk assessment	Process that evaluates the probability of adverse effects that may occur, or are occurring on target organism(s) as a result of exposure to one or more stressors.
Sediment	Solid material that is transported by, suspended in, or deposited from water. It originates mostly from disintegrated rocks; it also includes chemical and biochemical precipitates and decomposed organic material, such as humus. The quantity, characteristics and cause of the occurrence of sediment in streams are influenced by environmental factors. Some major factors are degree of slope, length of slope soil characteristics, land usage and quantity and intensity of precipitation.
Significant	A term used in statistics to describe the likelihood that a given outcome of a tested difference or similarity is in fact due to some relationship, rather than chance.
Seiche	A type of long-wavelength wave that occurs as a result of some disturbance within waterbody that is relatively closed-off from the outside environment. Long waves resonate outward to the boundaries of the waterbody, and then resonate back inward.
Silica	A tough, hard substance found in the cell walls of diatoms.
speciation (metal)	The form of a metal occurring in water.
Sonde instrument	An instrument used to measure water quality (e.g., dissolved oxygen, pH, conductivity, temperature) in situ.

Term	Definition
Specific conductivity	Represents the ability of a water sample to conduct an electrical current. Waters with higher concentrations of dissolved salts will have a greater specific conductance. The measurement is corrected based on temperature.
Standard deviation	An expression of the spread or variation of a collection of data values or measurements.
Standard error	The standard deviation of a calculated statistic.
Sub-watershed	A smaller portion of a watershed containing a drainage area, which is connected to the larger portion by a single channel.
Supernatant	A liquid layer overlying a more solid layer.
Synergistic	When two or more substances acting in combination produce a total effect that is greater than the sum total of the individual effects of each substance.
Tailings	The substances and materials remaining after metals and/or other economically valuable substances are removed from ore.
Temporal	Occurring over time.
Thermal stratification	Refers to the process by which layers of water having different temperatures form within a waterbody.
Thermocline	In thermally stratified waterbodies, the thermocline is the transitional zone between the upper layer of warmer water and the lower layer of cooler water.
Total dissolved solids (TDS)	The dissolved matter found in water that is comprised of mineral salts and small amounts of other inorganic and organic substances.
Total phosphorus	A measurement of particulate and dissolved phosphorus and phosphate molecules in water.
Total suspended solids (TSS)	The amount of suspended substances in a water sample. Biotic (e.g., plankton) and abiotic (e.g., silt) solids that can be removed from a water sample by filtration.
Toxic	Refers to a substance, dose, or concentration that is harmful to a living organism.
Toxicant	A substance that elicits a toxic, harmful effect in a living organism.
Toxicity	The inherent potential or capacity of a material to cause adverse effects in a living organism.
Turbidity	The degree of clarity in the water column or in a water sample; turbidity can be used as a surrogate measure of the amount of suspended particulate matter in a waterbody.
Turnover	A seasonal process that involves the mixing of upper and lower layers of water within a lake; mixiing of water masses is depended on water temperature and density.
Uptake	The process by which a chemical crosses an absorption barrier and is absorbed into the body.
Water quality	A measure of concentrations of contaminants, or naturally occurring minerals, in water. Lower concentrations of a particular contaminant generally lead to better water quality.
Watershed	The area drained by a river or stream.

APPENDIX A

Pre-Event Surface Water Quality

Mount Polley Mining Corporation

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MEMORANDUM

March 26, 2014

TO: Jordana van Geest, Golder Associates Ltd.

FROM: Katie McMahen, Mount Polley Mining Corporation

RE: Baseline/Background Water Chemistry Data Search for the MPMC PEEIAR

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1 INTRODUCTION

As per the letter sent to Dale Reimer, General Manager of Mount Polley Mining Corporation (MPMC) by the British Columbia Ministry of Environment (BC MoE) on February 20, 2015, the Post-Event Impact Assessment Report (PEEIAR) for the Mount Polley Tailings Storage Facility (TSF) breach of August 4, 2014 is to "incorporate all available baseline/background data and compared to monitoring data results".

This summary document provides an overview of available baseline/background water chemistry data that has been sourced for the water quality section of the PEEIAR.

2 BASELINE/BACKGROUND WATER CHEMISTRY DATA PURSUED

Baseline/background (herein referred to as "pre-event") water chemistry data for the following sub-areas of the area impacted by the breach were sourced to be incorporated into the PEEIAR:

- The Mount Polley TSF;
- Polley Lake;
- Hazeltine Creek ;
- Edney Creek Mouth;
- Quesnel Lake; and
- Quesnel River.

3 SUMMARY OF SOURCES CONTACTED AND DATA OBTAINED

3.1 Mount Polley Mining Corporation

MPMC has a large dataset of baseline and pre-event data available, as follows:

- TSF supernatant (site E1, 1997 – 2014);
- Polley Lake (sites P1 and P2, 2001 – 2014, and 1995 – 2014 for select parameters);
- Hazeltine Creek (site W7, 1990 – 2014); and
- Edney Creek downstream of the confluence with Hazeltine Creek (1995 – 2014).

The water chemistry of these locations was also characterized in detail in the *Technical Assessment Report Mount Polley Mine Discharge of Treated Water to Polley Lake* and accompanying *Aquatic Environmental Description* (Minnow, 2014).

Based on the long data records and regular sample collection frequencies by MPMC staff, this data is considered to be sufficiently comprehensive for these areas that only a search for Quesnel Lake and Quesnel River pre-event data was further pursued.

MPMC also has a single sample from Quesnel Lake at the end of the North Arm that was taken on May 14, 2012. This sample location is spatially very distant from the West Arm where the post-event sampling program took place. Given that the water chemistry in the North Arm potentially has different influencing sources and factors; based on this, and that it is a single sample, these results will not be incorporated as pre-event data.

3.1 Local Consultants

A number of local consultants who have worked in the Likely and Quesnel Lake area were contacted to inquire whether they had any pre-event data or if they could recommend other sources of pre-event data.

3.1.1 Richard Holmes, RPBio

Richard Holmes of Cariboo Envirotech Limited was contacted by email on December 11, 2014, to inquire if he was aware of any available Quesnel Lake or Quesnel River water chemistry data. In his response on December 12, 2014, Mr. Holmes indicated that Fisheries and Oceans Canada (DFO) had a water sampling program at the Quesnel River Research Centre (then called the Quesnel River Hatchery) during its years of operation (1981 – 1995). The Hatchery did some water quality monitoring at that time as part of an effluent discharge permit from the MoE. His other recommendation was to contact other local consultants Norm Zirnhelt and Rob Dolighan.

3.1.2 Norm Zirnhelt, RPBio

Norm Zirnhelt of Environmental Quality Consulting was contacted by email on December 11, 2014, to inquire if he was aware of any available Quesnel Lake or Quesnel River water chemistry data. In his response on December 11, 2015, Mr. Zirnhelt indicated that MoE did a study of Horsefly Bay in Quesnel Lake and recommended contacting Chris Swan and Kym Keogh of MoE. He also recommended contacting Rob Dolighan, another local consultant who previously worked for the DFO.

3.1.3 Rob Dolighan, RP Bio

Rob Dolighan was contacted by email on December 11, 2014, to inquire if he was aware of any available Quesnel Lake or Quesnel River water chemistry data. In his response on December 12, 2014, Mr. Dolighan reiterated Mr. Zirnhelt's comment that MoE had collected water quality data related to a study of nutrient loading from the Horsefly River. He also mentioned that the Institute of Ocean Sciences had collected some chemistry and physical limnology data and suggested Svien Vagle as a contact with this organization. His final recommendation was that majority of historic data would be with the DFO research group at Cultus Lake who have collected limnological data from Quesnel Lake since 1985. Daniel Selbie was provided as a DFO contact.

3.2 Regulatory Agencies

3.2.1 BC Ministry of Environment

Chris Swan (MoE Environmental Impact Assessment Biologist), Kym Keogh (MoE Environmental Impact Assessment Biologist) and Gabriele Matscha (MoE Environmental Impact Assessment Section Head) were all contacted by email on December 11, 2014, to inquire if they had any historic Quesnel Lake or Quesnel River water chemistry data. On February 5, 2015, Kym Keogh provided available data. For Quesnel Lake, this dataset is large (approximately 650 samples from the West Arm of Quesnel Lake primarily focused around Horsefly Bay), but consists only of nutrient data. For Quesnel River, this dataset consists of 43 samples taken at Likely between 1972 and 1988, which were analysed for nutrients and several other parameters, but not representing what is considered a typical “full suite” sample in current times; limited metals data is available (for example, 13 dissolved copper and two total copper results).

Results from 12 samples taken in Quesnel Lake by the University of British Columbia (UBC) Oceanography Department on September 9, 2003 were previously sourced from MoE by Minnow Environmental Ltd. (Minnow) for inclusion in the document *Mount Polley Mine Technical Assessment for a Proposed Discharge of Mine Effluent* (MPMC, 2009). Neither Minnow nor MoE were able to provide further details on these samples, such as sample location coordinates and data quality information, in response to requests from MPMC in 2015. The data also does not include dissolved metals, and method detection limits exceeded the BC Water Quality Guidelines for a number of parameters, including arsenic, boron, cadmium, chromium, cobalt, copper, lead, selenium and silver. Given this, and the lack of data quality and location information, the data was not selected for use as baseline/background data in the PEEIAR.

Due to the apparent lack of baseline data for Quesnel Lake and Quesnel River, an additional request was sent to BC MoE (Chris Swan and Kym Keogh via email) on March 9-10, 2015, for available reference data from any creeks or rivers flowing into Quesnel Lake. Results for select parameters from samples of Horsefly River were provided on March 16, 2015, for 352 samples taken from 2006 to 2014. This data was not recommended for use in baseline comparison, because it reflects a different catchment area with different land uses and environmental conditions.

On March 10, 2015, at the request of MPMC, Leigh-Ann Fenwick (MoE Mount Polley Environmental Project Manager) send a request for available data to the Environmental Working Group, a group composed of relevant agencies, First Nations, and stakeholders that was assembled to provide feedback to MPMC on breach response measures and monitoring. One response was received from David Weir (BC Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) Water Section Head), indicating that he had some data.

3.2.1 BC Ministry of Forests, Lands and Natural Resource Operations

On March 13, 2015, Dave Weir reviewed MFLNRO files on Polley Lake and Hazeltine Creek with Katie McMahen (MPMC). All available data were related to hydrology, and no water chemistry data were found.

3.2.2 Fisheries and Oceans Canada

Dr. Dan Selbie, Head of the Lakes Research Program, Science Branch, Salmon and Freshwater Ecosystems was contacted on December 11, 2014, to inquire if he was aware of any available Quesnel Lake or Quesnel River water chemistry data. In his response on December 15, 2014, Dr. Selbie provided a paper on limnological data from the 1985-1990 study of Quesnel Lake (Nidle et al., 1994) which provides the only comprehensive information DFO has on the West Arm of Quesnel Lake, to the best of his knowledge. He also recommended that there may be some water quality monitoring data associated with the Quesnel River Hatchery Facility when it was in operation. The abstract of the Nidel et al. (2004) study is as follows:

> "Results of a limnological investigation of Quesnel Lake are presented. Ten stations were sampled for a variety of physical, chemical and biological variables. Stations were sampled six or seven times each year during 1985-1988 and 1990. Summarized data for each station and date are presented along with selected vertical profiles of *in vivo* fluorescence and temperature."

This paper provides background nutrient and physical data for Quesnel Lake; however, data for metals and certain physical parameters including turbidity, specific conductance and dissolved oxygen, are not available as part of this data set. This data was not used as baseline data because more recent nutrient data was available from BC MoE.

Svein Vagle from the Institute of Ocean Sciences was contacted via email on December 15, 2014, to inquire if he was aware of any available Quesnel Lake or Quesnel River water chemistry data. In his response on December 18, 2014, he indicated that he was only aware of some unarchived nutrient data that would take some time to review. This nutrient data was not pursued, as relatively comprehensive nutrient data for Quesnel Lake was provided by Dr. Selbie.

A search of the Waves Database on January 22, 2015, for the search terms "Quesnel Lake" and "Quesnel River" yielded 24 and 58 results, respectively; however, no water chemistry data was found in these documents.

3.2.3 Interior Health

Rob Birtles of Interior Health was contacted by email on December 11, 2014, to inquire if he was aware of any available Quesnel Lake or Quesnel River water chemistry data. Mr. Birtles indicated that we was not aware of any Interior Health recreational water quality data for Quesnel Lake, and said he would search for any historic raw (pre-treatment) drinking water data. In an email sent March 9, 2015, Mr. Birtles confirmed that no historic data was available.

3.2.4 Environment Canada

Elaine Irving, Senior Environmental Scientist with Golder Associates had a phone conversation on March 6, 2015, with Jessica Ingram, Water Quality Monitoring and Surveillance, Pacific and Yukon, Environment Canada regarding federal water quality data for Quesnel Lake and Quesnel River from the last 15 years. Ms. Ingram indicated that according to the Canada-British Columbia Water Quality Monitoring Agreement signed in 1985, Environment Canada does not have any water quality data additional to those data provided by the province of BC.

3.3 Regional Researchers

3.3.1 University of British Columbia

Dr. Bernard Laval of UBC was contacted on December 11, 2014, to inquire if he was aware of any available Quesnel Lake or Quesnel River water chemistry data, as he has been actively researching flow patterns and physical limnology of Quesnel Lake for more than a decade. In his response on December 19, 2014, Dr. Laval provided references to some of his students' Master's theses:

- The Heat Budget of Quesnel Lake (Potts, 2002); and
- Mixing processes from CTD profiles using a lake-specific equation of state: Quesnel Lake (James, 2001).

Two of Dr. Laval's publications were also sourced:

- Wind-driven Summertime Upwelling in a Fjord-type Lake and its Impact on Downstream River Conditions: Quesnel Lake and River, British Columbia, Canada (Laval et al., 2008); and
- The joint effects of riverine, thermal, and wind forcing on a temperature fjord lake: Quesnel Lake, Canada (Laval et al., 2012).

These papers provide valuable pre-event data on flow patterns and physical parameters, but do not include water chemistry data beyond physical parameters (temperature and specific conductance); for this reason the data is not being used in the PEEIAR water quality section.

3.3.1 University of Northern British Columbia

Sam Albers, Facility Manager of the University of Northern British Columbia (UNBC) Quesnel River Research Centre (QRRC) was contacted by email on January 8, 2015, to inquire if he was aware of any available Quesnel Lake or Quesnel River water chemistry data. In his response on January 8, 2015, Mr. Albers provided the QRRC publication list and a list of literature that the QRRC has compiled relevant to the area. In reviewing the documents listed in these resources, and in a review of papers, books, and documents in the QRRC "library" on January 22, 2015, no relevant water chemistry data was encountered.

An online search of the UNBC library was also completed using the key words "Quesnel Lake" and "Quesnel River" and 49 and 35 results were found, respectively; however, no water chemistry information that had not previously been obtained through other search avenues was found.

4 SUMMARY OF DATA SOURCED

MPMC has an extensive pre-event water chemistry data set for the TSF supernatant, Polley Lake, Hazeltine Creek, and the mouth of Edney Creek. This data will constitute pre-event (baseline/background) data used in the PEEIAR for these locations.

After contacting known local environmental consultants, relevant regulatory agencies, and regional research groups, minimal pre-event water chemistry data was found for Quesnel Lake and Quesnel River. Available pre-event data sourced that will be incorporated into the water quality section of the PEEIAR is:

- 43 samples from the Quesnel River at Likely analysed for limited parameters, with the most recent sample being greater than 25 years ago (MoE).
- Nutrient data for the West Arm of Quesnel Lake from 352 samples taken from 2004 to 2006, primarily focused around Horsefly Bay, just east of Cariboo Island (MoE).

Table 1 provides a summary of the search for pre-event water chemistry data for use in the PEEIAR and Table 2 provides a detailed summary of the pre-event data that was considered for use in the PEEIAR.

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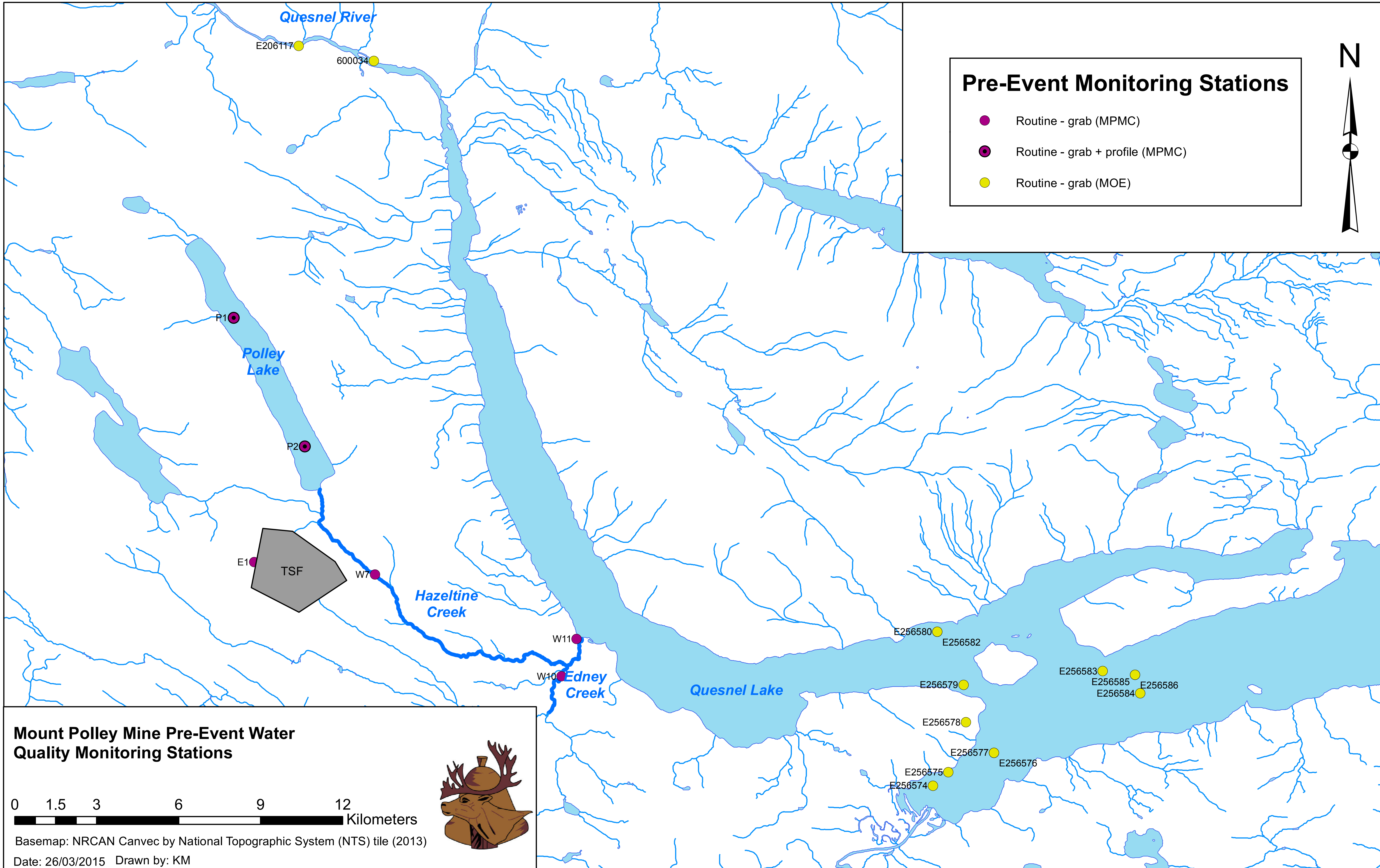
Table 1. Summary of the information obtained in a search for pre-event (baseline/background) water chemistry data for use in the MPMC TSF breach PEEIAR (✓= data available, ✗ = no data available)

Source	TSF	Hazeltine Creek	Polley Lake	Quesnel River	Quesnel Lake	Comments
MPMC	✓	✓	✓	✗	✓	- Includes data collected by Minnow Environmental Inc. - Extensive data for TSF, Hazeltine Creek, and Polley Lake - Only a single sample from Quesnel Lake (end of North Arm)
MoE	Did not search for data beyond MPMC dataset (considered sufficient to characterize pre-breach conditions for these areas)			✓	✓	- Nutrient data only for Quensel Lake - Data also provided for Horsefly River (Quesnel Lake inflow) - Limited metal data and the most recent sample was >25 years ago
MFLNRO				✗	✗	- Hydrology data only
DFO				✗	✓	- Quesnel Lake data is from 1985 - 1990 and includes only nutrient and general chemical data (no metal data). - Search of DFO Waves data base yielded no results with water chemistry data.
Institute of Ocean Sciences				✗	✗	Some unarchived nutrient data available, but not pursued.
Environment Canada				✗	✗	Do not collect data since the Canada-British Columbia Water Quality Monitoring Agreement was signed in 1985.
Interior Health				✗	✗	
Norm Zirnhelt				✗	✗	Recommended contacting MOE and Rob Dolighan.
Rob Dolighan				✗	✗	Recommended contacting MOE, DFO, and the Institute of Ocean Sciences.
Richard Holmes				✗	✗	Recommended contacting MOE, Norm Zirnhelt and Rob Dolighan.
UNBC				✗	✗	Search of UNBC library yielded no results with water chemistry data (that had not already been found from other sources).
UBC				✗	✓	- Physical parameters (CTD cast data). - Water quality data without sample location or data quality information. No total metals data and poor method detection limits (above BC Water Quality Guidelines) for multiple parameters.

Table 2. Summary of pre-event water chemistry data considered for use in the water quality section of the MPMC TSF breach PEEIAR

				Samples - Surface		Samples - Depth		Profiles	
Area	**Station Name**	**Sample Location Type**	**Data Source**	**Number of Samples**	**Date Range (mm/dd/yyyy)**	**Number of Samples**	**Samples - Depth (mm/dd/yyyy))**	**Number of Profiles**	**Date Range (mm/dd/yyyy)**
Horsefly River	E266622	Baseline	MOE	244	05/11/2006 - 04/22/2014	N/A	N/A	N/A	N/A
TSF	E1	Baseline	MPMC	190	08/26/1997 - 05/01/2014	-	-	-	-
Polley Lake	P1	Baseline	MPMC	35	05/01/1995 - 11/18/2014	5m - 1 6m - 1 10m - 4 15m - 2 18m - 2 20m - 4 25m - 1 bottom - 34	06/13/2001 08/21/2013 06/13/2001 - 05/20/2014 05/01/1995 - 06/13/2001 05/09/1996 - 08/21/2013 08/26/2009 - 05/20/2014 06/13/2001 05/01/1995 - 11/18/2014	40	05/01/1995 - 11/18/2014
	P2	Baseline	MPMC	35	05/01/1995 - 11/18/2014	5m - 1 6m - 1 10m - 4 13m - 1 15m - 2 18m - 1 20m - 4 22m - 5 bottom - 28	06/14/2001 08/21/2013 06/14/2001 - 05/20/2014 05/09/1996 05/01/1995 - 06/14/2001 08/21/2013 06/14/2001 - 05/20/2014 06/14/2001 - 08/26/2009 05/09/1996 - 11/18/2014	42	05/01/1995 - 11/18/2014
Upper Hazeltine	W7	Baseline	MPMC	266	03/17/1990 - 07/29/2014	N/A	N/A	N/A	N/A
	HD1-US	Baseline	MPMC	23	09/24/2013 - 07/29/2014	N/A	N/A	N/A	N/A
Edney Creek	W10	Baseline	MPMC	34	03/21/1995 - 02/28/2015	N/A	N/A	N/A	N/A
	W11	Baseline	MPMC	67	03/21/1995 - 07/08/2014	N/A	N/A	N/A	N/A
Quesnel River	EMS# 600034	Baseline	MOE	35 1 - field parameters only	07/12/1972 - 11/24/1988	N/A	N/A	N/A	N/A
	EMS# E206117	Baseline	MOE	8	03/12/85 - 03/05/1987	N/A	N/A	N/A	N/A
Quesnel Lake	End of North Arm	Baseline	MPMC	1	05/14/2012	-	-	-	-
	EMS# E256574	Baseline	MOE	28	08/09/2004 - 09/25/2006	-	-	-	-
	EMS# E256575	Baseline	MOE	37	08/09/2004 - 09/25/2006	-	-	-	-
	EMS# E256576	Baseline	MOE	37	08/09/2004 - 09/25/2006	-	-	-	-
	EMS# E256577	Baseline	MOE	36	08/09/2004 - 09/25/2006	-	-	-	-
	EMS# E256578	Baseline	MOE	36	08/09/2004 - 09/25/2006	-	-	-	-
	EMS# E256579	Baseline	MOE	35	08/10/2004 - 09/26/2006	-	-	-	-
	EMS# E256580	Baseline	MOE	33	08/10/2004 - 09/26/2006	-	-	-	-
	EMS# E256582	Baseline	MOE	34	08/09/2004 - 09/26/2006	-	-	-	-
	EMS# E256583	Baseline	MOE	33	08/09/2004 - 09/26/2006				
	EMS# E256584	Baseline	MOE	4	09/08/2004				
	EMS# E256585	Baseline	MOE	4	08/10/2004 - 08/10/2006	-	-	-	-
	EMS# E256586	Baseline	MOE	34	08/10/2004 - 09/26/2006				
	Unknown	Baseline	UBC/MOE	12	09/09/2003	-	-	-	-



Pre-Event Monitoring Stations
Routine - grab (MPMC)
Routine - grab + profile (MPMC)
Routine - grab (MOE)
N
Quesnel River
E206117
600034
P1
Polley Lake
P2
E1
TSF
W7
Hazeltine Creek
W11
W10
Edney Creek
Quesnel Lake
E256580
E256582
E256583
E256585
E256586
E256584
E256579
E256578
E256577
E256576
E256575
E256574
Mount Polley Mine Pre-Event Water Quality Monitoring Stations
0 1.5 3 6 9 12 Kilometers
Basemap: NRCAN Canvec by National Topographic System (NTS) tile (2013)
Date: 26/03/2015 Drawn by: KM

Parameter	Units	Minimum	Median	Mean	Standard Deviation	Standard Error	95th Percentile	Maximum	Number of Samples	Number of Samples < MDL	% Samples <MDL
Conductivity (in situ)	µS/cm	64.0	198	185	34.2	2.66	220	350	165	0	0
Dissolved Oxygen (in situ)	%	10	56	62	44	18	116	120	6.0	0	0
Dissolved Oxygen (in situ)	mg/L	6.0	6.7	6.7	0.73	0.52	7.1	7.2	2.0	0	0
pH (in situ)	-	6.9	8.2	8.8	9	7.8	9.4	9.6	172	0	0
Temperature (in situ)	°C	0.200	11.4	11.6	6.06	0.490	21.0	22.8	153	0	0
Conductivity (lab)	µS/cm	122	202	188	32.4	4.26	211	215	58	0	0
pH (lab)	-	7.3	8.0	8.2	8.5	7.6	8.9	9.2	58	0	0
Alkalinity	mg/L (as $CaCO_3$)	57	76	75	8.9	0.82	84	128	119	0	0
Hardness	mg/L (as $CaCO_3$)	56	99	92	17	1.6	111	139	111	0	0
Total Dissolved Solids	mg/L	2.00	129	118	26.4	2.56	141	187	106	2	1.9
Total Suspended Solids	mg/L	1.0	<3.0	nc	nc	nc	5.1	139	119	88	73.9
Turbidity (lab)	NTU	0.35	1.1	1.3	0.78	0.071	2.7	4.8	119	0	0
Major Ions											
Calcium (Total)	mg/L	17.9	31.5	29.7	5.69	0.538	36.3	48.8	112	0	0
Calcium (Dissolved)	mg/L	17.7	32.0	29.6	5.57	0.605	35.9	43.7	85	0	0
Chloride	mg/L	0.20	<0.50	nc	nc	nc	nc	0.5	72	69	95.8
Fluoride	mg/L	0.04	0.06	0.06	0.01	0.001	0.06	0.07	44	0	0
Magnesium (Total)	mg/L	2.72	4.63	4.33	0.790	0.0740	5.17	6.99	112	0	0
Magnesium (Dissolved)	mg/L	2.73	4.44	4.32	0.784	0.0850	5.05	7.18	85	0	0
Potassium (Dissolved)	mg/L	0.29	0.40	0.42	0.14	0.015	0.68	<2.0	85	4	4.7
Sodium (Total)	mg/L	3.52	4.22	4.21	0.460	0.0460	4.61	7.46	100	0	0
Sodium (Dissolved)	mg/L	2.7	4.1	4.1	0.48	0.052	4.5	7.3	85	0	0
Sulphate	mg/L	2.8	25	20	10	0.93	29	32	119	0	0
Nutrients											
Ammonia	mg/L (as N)	0.0025	0.0072	0.010	0.012	0.0011	0.031	0.079	119	53	44.5
Nitrate	mg/L (as N)	0.0025	0.043	0.067	0.080	0.0070	0.21	0.33	106	33	31.1
Nitrite	mg/L (as N)	0.0005	<0.001	nc	nc	nc	0.004	0.009	106	76	71.7
Total Nitrogen	mg/L	<0.12	0.32	0.30	0.14	0.014	0.53	0.79	107	10	9.3
Orthophosphate (Dissolved)	mg/L (as P)	<0.001	0.02	0.03	0.04	0.003	0.08	0.3	119	15	12.6
Total Dissolved Phosphorus	mg/L	<0.002	0.02	0.03	0.04	0.003	0.08	0.3	121	2	1.7
Total Phosphorus	mg/L	0.0046	0.030	0.041	0.040	0.0040	0.094	0.34	116	0	0
Dissolved Organic Carbon	mg/L	4.25	5.30	6.45	3.25	0.314	16.3	17.8	107	0	0
Total Metals											
Aluminum	mg/L	0.0020	0.012	0.016	0.010	0.0010	0.031	0.11	112	10	8.9
Antimony	mg/L	<0.00005	<0.0001	nc	nc	nc	0.00005 (a)	0.0002	112	106	94.6
Arsenic	mg/L	0.0001	0.0004	0.0005	0.0002	0.00001	0.0007	0.001	112	0	0
Barium	mg/L	0.0039	0.0070	0.0066	0.0012	0.00011	0.0081	0.011	112	12	10.7
Beryllium	mg/L	<0.00005	0.0005	nc	nc	nc	nc	<0.005	112	111	99.1
Bismuth	mg/L	<0.00005	0.0005	nc	nc	nc	nc	<0.1	112	107	95.5
Boron	mg/L	0.011	0.022	0.023	0.010	0.0010	0.050 (a)	<0.1	106	12	11.3
Cadmium	mg/L	0.000005	<0.00002	nc	nc	nc	0.0001 (a)	<0.0002	112	106	94.6
Chromium	mg/L	<0.0002	<0.0005	nc	nc	nc	nc	<0.001	112	111	99.1
Cobalt	mg/L	<0.00002	<0.0001	nc	nc	nc	nc	<0.001	112	109	97.3
Copper	mg/L	0.001	0.002	0.002	0.003	0.0003	0.003	0.03	112	0	0
Iron	mg/L	0.009	<0.03	nc	nc	nc	0.08	0.1	112	70	62.5
Lead	mg/L	0.00002	<0.00005	nc	nc	nc	0.0005 (a)	0.002	112	94	83.9
Lithium	mg/L	<0.0002	<0.005	nc	nc	nc	nc	<0.005	100	98	98
Manganese	mg/L	0.0005	0.03	0.06	0.1	0.01	0.2	1	112	0	0
Mercury	mg/L	0.000005	<0.00001	nc	nc	nc	0.00003	0.00005	18	17	94.4
Molybdenum	mg/L	0.0005	0.002	0.002	0.0007	0.00007	0.002	0.002	112	12	10.7
Nickel	mg/L	0.0003	0.0005	nc	nc	nc	nc	0.0006	106	102	96.2
Selenium	mg/L	<0.0005	0.0008	0.0007	0.0003	0.00003	0.001	0.002	106	38	35.8
Silicon	mg/L	2.78	3.63	3.72	0.560	0.0540	4.58	6.50	106	0	0
Silver	mg/L	0.000005	<0.00001	nc	nc	nc	0.00004	<0.0001	106	95	89.6
Strontium	mg/L	0.087	0.22	0.19	0.060	0.0060	0.24	0.26	106	0	0
Tellurium	mg/L	<0.00005	<0.00005	nc	nc	nc	nc	<0.00005	6	6	100
Thallium	mg/L	0.00001	<0.0001	nc	nc	nc	nc	<0.0001	100	99	99
Tin	mg/L	0.00005	<0.0001	nc	nc	nc	0.00009	0.001	100	93	93
Titanium	mg/L	0.0002	<0.01	nc	nc	nc	0.005 (a)	<0.01	106	99	93.4
Uranium	mg/L	0.00003	0.0001	0.0001	0.00002	0.000002	0.0001	0.0001	106	0	0
Vanadium	mg/L	0.0005	<0.001	nc	nc	nc	0.01	<0.03	106	83	78.3
Zinc	mg/L	<0.001	<0.003	nc	nc	nc	0.004	0.06	106	80	75.5
Dissolved Metals											
Aluminum	mg/L	0.0005	0.002	nc	nc	nc	0.005	0.007	85	43	50.6
Antimony	mg/L	<0.00005	0.0001	nc	nc	nc	nc	0.00019	85	81	95.3
Arsenic	mg/L	0.0003	0.0004	0.0004	0.0001	0.00001	0.0006	0.00075	85	0	0
Barium	mg/L	0.0038	0.0066	0.0062	0.0011	0.00012	0.0075	0.0104	85	6	7.1
Beryllium	mg/L	<0.00005	0.0005	nc	nc	nc	nc	<0.005	85	84	98.8
Bismuth	mg/L	<0.00005	0.0005	nc	nc	nc	nc	<0.1	85	83	97.6
Boron	mg/L	0.011	0.021	0.021	0.0093	0.0011	0.050 (a)	<0.1	79	6	7.6
Cadmium	mg/L	0.0000085	<0.000017	nc	nc	nc	nc	<0.0002	85	81	95.3
Chromium	mg/L	<0.0002	<0.0005	nc	nc	nc	nc	<0.001	85	84	98.8
Cobalt	mg/L	<0.00002	0.0001	nc	nc	nc	nc	<0.001	85	83	97.6
Copper	mg/L	0.0008	0.002	0.002	0.001	0.0001	0.003	0.0101	85	0	0
Iron	mg/L	<0.005	<0.03	nc	nc	nc	nc	<0.03	85	83	97.6
Lead	mg/L	0.000025	<0.000050	nc	nc	nc	0.00050 (a)	<0.001	85	75	88.2
Lithium	mg/L	<0.0002	<0.005	nc	nc	nc	0.003 (a)	<0.005	79	75	94.9
Manganese	mg/L	0.0001	0.0005	0.007	0.03	0.003	0.02	0.236	85	3	3.5
Mercury	mg/L	<0.00005	<0.00005	nc	nc	nc	0.00006	0.00006	6	4	66.7
Molybdenum	mg/L	0.00060	0.0018	0.0015	0.00069	0.000070	0.0022	0.00232	85	6	7.1
Nickel	mg/L	0.0003	<0.0005	nc	nc	nc	nc	<0.001	85	83	97.6
Selenium	mg/L	<0.0005	0.001	0.0007	0.0003	0.00004	0.001	0.0016	85	35	41.2
Silicon	mg/L	2.74	3.67	3.75	0.565	0.0613	4.78	6.05	85	0	0
Silver	mg/L	0.000005	<0.00001	nc	nc	nc	nc	<0.0001	85	83	97.6
Strontium	mg/L	0.086	0.19	0.17	0.059	0.0065	0.24	0.253	85	0	0
Tellurium	mg/L	<0.00005	<0.00005	nc	nc	nc	nc	<0.00005	6	6	100
Thallium	mg/L	<0.00001	<0.0001	nc	nc	nc	nc	<0.0001	79	78	98.7
Tin	mg/L	0.0001	0.0001	nc	nc	nc	0.00009	0.00035	79	72	91.1
Titanium	mg/L	0.0003	<0.01	nc	nc	nc	0.005 (a)	<0.01	85	78	91.8
Uranium	mg/L	0.00003	0.0001	0.0001	0.00002	0.000002	0.00009	0.000104	85	0	0
Vanadium	mg/L	0.0005	<0.001	nc	nc	nc	0.02 (a)	<0.03	85	77	90.6
Zinc	mg/L	0.00050	0.0016	nc	nc	nc	0.0030	0.0432	85	64	75.3

Source: MPMC

Notes:

Summary statistics were calculated and presented as follows:

- Minimum, Maximum, and Median were calculated using absolute values; that is, when the summary statistic corresponded to a non-detect (ND) value in the dataset, then the method detection limit (MDL) was reported.
- Mean, Standard Deviation (SD), Standard Error (SE), and 95th percentile were calculated by substituting 0.5*MDL for any ND values. Therefore, it is possible that 95th percentile was equal to 0.5*MDL.
- Mean, SD, and SE were not calculated for parameters with greater than 50% non-detect values.
- 95th percentile was not calculated for parameters with greater than 95% non-detect values.

(a) Calculated values are equal to the highest method detection limit.

< = less than; MDL = method detection limit; % = percent; µS/cm = microSiemens per centrimetre; mg/L = milligrams per litre; °C = degrees Celcius; $CaCO_3$ = calcium carbonate; nc = not calculated; NTU = nephelometric turbidity units; N = nitrogen; P = phosphorus.

Parameter	Units	Minimum	Median	Mean	Standard Deviation	Standard Error	95th Percentile	Maximum	Number of Samples	Number of Samples < MDL	% Samples <MDL
Conductivity (in situ)	µS/cm	0.505	167	179	66.0	3.43	310	349	369	0	0
Dissolved Oxygen (in situ)	%	105.4	105.4	nc	nc	nc	105.4	105.4	1	0	0
Dissolved Oxygen (in situ)	mg/L	8.59	8.59	nc	nc	nc	8.59	8.59	1	0	0
pH (in situ)	-	2.61	7.89	7.99	0.486	0.0254	8.36	9.14	367	0	0
Temperature (in situ)	°C	-1.10	5.50	7.10	6.03	0.300	17.5	22.1	338	0	0
Conductivity (lab)	µS/cm	96.5	222	221	55.4	5.70	314	340	96	0	0
pH (lab)	-	6.96	8.09	8.06	0.230	0.0230	8.24	8.39	96	0	0
Alkalinity	mg/L (as $CaCO_3$)	<0.500	72.9	74.1	32.7	1.80	140	195	325	18	5.5
Hardness	mg/L (as $CaCO_3$)	39.4	80.0	90.4	51.7	2.90	151	820	318	0	0
Total Dissolved Solids	mg/L	3.00	122	123	76.5	4.70	194	1110	267	14	5.2
Total Suspended Solids	mg/L	<1	<4	nc	nc	nc	9	197	311	197	63.3
Turbidity (in situ)	NTU	0.20	1.4	2.0	1.4	0.20	4.4	5.2	48	0	0
Turbidity (lab)	NTU	0.28	1.4	1.8	1.8	0.10	4.6	16	330	1	0.3
Major Ions											
Calcium (Total)	mg/L	12.0	24.4	27.0	9.29	0.500	44.3	54.6	318	0	0
Calcium (Dissolved)	mg/L	11.9	25.0	27.5	9.36	0.547	44.3	54.9	293	0	0
Chloride	mg/L	<0.50	0.68	0.90	0.79	0.10	2.6	<10	147	65	44.2
Fluoride	mg/L	0.03	0.1	0.1	0.03	0.00	0.1	0.2	91	6	6.6
Magnesium (Total)	mg/L	2.15	4.40	5.10	2.21	0.100	9.97	12.8	318	0	0
Magnesium (Dissolved)	mg/L	2.26	4.59	5.14	2.20	0.128	9.92	12.6	293	0	0
Potassium (Dissolved)	mg/L	0.27	0.51	0.57	0.22	0.013	0.97	2.1	292	0	0
Sodium (Total)	mg/L	0.000700	4.06	4.50	1.82	0.100	8.47	15.5	293	0	0
Sodium (Dissolved)	mg/L	1.81	4.11	4.50	1.77	0.104	8.19	14.5	292	0	0
Sulphate	mg/L	<1.00	8.60	13.8	12.2	0.700	33.0	77.9	322	7	2.2
Nutrients											
Ammonia	mg/L (as N)	0.00070	0.0053	0.0086	0.010	0.00059	0.026	0.13	319	147	46.1
Nitrate	mg/L (as N)	0.0030	0.044	0.10	0.34	0.025	0.55	3.8	190	11	5.8
Nitrite	mg/L (as N)	<0.001	0.002	nc	nc	nc	0.007	0.2	273	138	50.5
Total Nitrogen	mg/L	0.150	0.384	0.500	0.690	0.100	1.13	6.44	154	0	0
Orthophosphate (Dissolved)	mg/L (as P)	<0.0010	0.0060	0.0095	0.010	0.00060	0.028	0.084	321	50	15.6
Total Dissolved Phosphorus	mg/L	0.0020	0.014	0.017	0.010	0.00081	0.043	0.063	208	3	1.4
Total Phosphorus	mg/L	<0.00050	0.020	0.024	0.010	0.00090	0.054	0.069	274	12	4.4
Total Organic Carbon	mg/L	5.8	17	15	4.9	1.1	20	21	20	0	0
Dissolved Organic Carbon	mg/L	1.3	7.0	9.1	5.7	0.40	19	62	252	0	0
Total Metals											
Aluminum	mg/L	0.0059	0.075	0.10	0.12	0.0060	0.35	0.63	322	0	0
Antimony	mg/L	<0.00005	<0.0001	nc	nc	nc	0.00009	0.0003	305	251	82.3
Arsenic	mg/L	0.00008	0.0005	0.0006	0.002	0.00009	0.0009	0.03	325	7	2.2
Barium	mg/L	0.0040	0.0080	0.0085	0.0038	0.00022	0.016	0.025	305	17	5.6
Beryllium	mg/L	<0.00005	<0.0001	nc	nc	nc	nc	<0.005	305	304	99.7
Bismuth	mg/L	<0.00005	<0.0005	nc	nc	nc	0.05 (a)	<0.1	305	287	94.1
Boron	mg/L	0.008	0.02	0.02	0.01	0.0009	0.05 (a)	<0.1	188	31	16.5
Cadmium	mg/L	<0.000010	0.000010	nc	nc	nc	0.00010 (a)	0.00075	305	247	81
Chromium	mg/L	<0.000020	<0.00050	nc	nc	nc	0.0013	0.0051	305	195	63.9
Cobalt	mg/L	<0.000010	<0.00010	nc	nc	nc	0.00050 (a)	0.0052	305	165	54.1
Copper	mg/L	0.00080	0.0025	0.0031	0.0045	0.00025	0.0061	0.077	325	7	2.2
Iron	mg/L	0.0040	0.14	0.20	0.14	0.0079	0.45	1.0	325	3	0.9
Lead	mg/L	<0.00002	0.00005	nc	nc	nc	0.0005 (a)	0.02	324	164	50.6
Lithium	mg/L	<0.0002	0.0005	nc	nc	nc	0.003 (a)	<0.005	258	153	59.3
Manganese	mg/L	0.00196	0.0153	0.0201	0.0157	0.000880	0.0491	0.155	318	0	0
Mercury	mg/L	<0.000010	<0.000050	nc	nc	nc	0.000029	0.00096	126	115	91.3
Molybdenum	mg/L	<0.000010	0.00098	0.0015	0.0022	0.00012	0.0025	0.023	318	31	9.7
Nickel	mg/L	<0.00005	<0.0005	nc	nc	nc	0.001	0.01	318	190	59.7
Selenium	mg/L	<0.0001	<0.0005	nc	nc	nc	0.001	0.001	313	220	70.3
Silicon	mg/L	1.3	3.9	4.0	0.89	0.050	5.4	8.4	318	0	0
Silver	mg/L	<0.00001	<0.00001	nc	nc	nc	0.00005 (a)	0.0001	305	262	85.9
Strontium	mg/L	0.0646	0.133	0.200	0.0700	0.00420	0.291	0.442	316	0	0
Tellurium	mg/L	<0.000050	<0.000050	nc	nc	nc	nc	0.00038	102	100	98
Thallium	mg/L	<0.00005	<0.00005	nc	nc	nc	nc	<0.0001	265	265	100
Tin	mg/L	<0.0001	<0.0001	nc	nc	nc	0.0002	0.002	265	209	78.9
Titanium	mg/L	<0.010	<0.010	nc	nc	nc	0.011	0.18	305	158	51.8
Uranium	mg/L	0.00003	0.00009	0.0001	0.00009	0.000005	0.0003	0.0007	290	0	0
Vanadium	mg/L	<0.000050	0.0010	0.0021	0.0039	0.00022	0.020 (a)	<0.030	305	122	40
Zinc	mg/L	<0.000050	<0.0030	nc	nc	nc	0.0049	0.094	325	179	55.1
Dissolved Metals											
Aluminum	mg/L	0.0023	0.018	0.048	0.070	0.0041	0.19	0.61	296	17	5.7
Antimony	mg/L	<0.00005	<0.0001	nc	nc	nc	0.00007	0.0002	292	254	87
Arsenic	mg/L	<0.0001	0.0005	0.0005	0.0002	0.00001	0.0008	0.001	299	5	1.7
Barium	mg/L	0.0037	0.0073	0.0079	0.0036	0.00021	0.015	0.024	292	19	6.5
Beryllium	mg/L	<0.00005	<0.0001	nc	nc	nc	nc	<0.005	292	292	100
Bismuth	mg/L	<0.00005	<0.0005	nc	nc	nc	nc	<0.1	292	282	96.6
Boron	mg/L	<0.008	0.02	0.02	0.01	0.0009	0.05 (a)	<0.1	186	32	17.2
Cadmium	mg/L	<0.000010	0.00001	nc	nc	nc	0.0001 (a)	0.0005	292	246	84.2
Chromium	mg/L	<0.00020	<0.00050	nc	nc	nc	0.0011	0.0041	292	225	77.1
Cobalt	mg/L	<0.000010	<0.00010	nc	nc	nc	0.00050 (a)	0.00064	292	209	71.6
Copper	mg/L	0.00063	0.0022	0.0027	0.0045	0.00025	0.0051	0.079	320	8	2.5
Iron	mg/L	<0.0050	0.052	0.084	0.080	0.0046	0.25	0.39	299	74	24.7
Lead	mg/L	<0.00002	<0.00005	nc	nc	nc	0.0005 (a)	0.001	299	204	68.2
Lithium	mg/L	<0.0002	0.0005	nc	nc	nc	0.003 (a)	<0.005	256	171	66.8
Manganese	mg/L	0.000155	0.00700	0.00923	0.00962	0.000560	0.0246	0.0785	292	7	2.4
Mercury	mg/L	<0.000050	<0.00005	nc	nc	nc	nc	0.0001	109	106	97.2
Molybdenum	mg/L	0.00028	0.0010	0.0015	0.0022	0.00012	0.0027	0.021	313	25	8
Nickel	mg/L	0.0001	<0.0005	nc	nc	nc	0.0009	0.009	292	221	75.7
Selenium	mg/L	<0.0001	<0.0005	nc	nc	nc	0.001	0.002	292	208	71.2
Silicon	mg/L	2.2	3.8	3.9	0.77	0.045	5.2	8.3	292	0	0
Silver	mg/L	0.000005	<0.00001	nc	nc	nc	nc	0.0001	292	281	96.2
Strontium	mg/L	0.0641	0.136	0.160	0.0728	0.00426	0.285	0.443	292	1	0.3
Tellurium	mg/L	<0.000050	<0.000050	nc	nc	nc	nc	0.000070	102	101	99
Thallium	mg/L	<0.00001	<0.00005	nc	nc	nc	nc	<0.0001	263	263	100
Tin	mg/L	<0.000005	<0.0001	nc	nc	nc	0.0002	0.0009	263	200	76
Titanium	mg/L	<0.000050	<0.010	nc	nc	nc	0.0050 (a)	0.18	292	197	67.5
Uranium	mg/L	0.00002	0.00008	0.0001	0.00009	0.00001	0.0003	0.0007	288	1	0.3
Vanadium	mg/L	<0.000050	0.0010	nc	nc	nc	0.015 (a)	<0.030	292	156	53.4
Zinc	mg/L	<0.00050	0.0017	nc	nc	nc	0.0025 (a)	0.044	299	184	61.5

Source: MPMC

Notes:

Summary statistics were calculated and presented as follows:

- Minimum, Maximum, and Median were calculated using absolute values; that is, when the summary statistic corresponded to a non-detect (ND) value in the dataset, then the method detection limit (MDL) was reported.
- Mean, Standard Deviation (SD), Standard Error (SE), and 95th percentile were calculated by substituting 0.5*MDL for any ND values. Therefore, it is possible that 95th percentile was equal to 0.5*MDL.
- Mean, SD, and SE were not calculated for parameters with greater than 50% non-detect values.
- 95th percentile was not calculated for parameters with greater than 95% non-detect values.

(a) Calculated values are equal to the highest method detection limit.

< = less than; MDL = method detection limit; % = percent; µS/cm = microSiemens per centimetre; mg/L = milligrams per litre; °C = degrees Celcius; $CaCO_3$ = calcium carbonate; nc = not calculated; NTU = nephelometric turbidity units; N = nitrogen; P = phosphorus.

Table A-3: Pre-event Water Quality in Quesnel Lake, August 9, 2004 to September 26, 2006

Parameter	Units	Minimum	Median	Mean	Standard Deviation	Standard Error	95th Percentile	Maximum	Number of Samples	Number of Samples < MDL	% Samples <MDL
Nutrients											
Ammonia	mg/L (as N)	<0.0050	0.0070	nc	nc	nc	0.011	0.13	352	274	77.8
Nitrate (Dissolved)	mg/L (as NO_3)	<0.020	<0.081	0.063	0.034	0.0018	0.13	0.15	352	160	45.5
Nitrite (Dissolved)	mg/L (as N)	<0.002	<0.002	nc	nc	nc	0.003	0.009	352	213	60.5
Total Organic Nitrogen	mg/L	<0.02	0.08	0.08	0.03	0.002	0.1	0.2	298	2	0.7
Total Nitrogen	mg/L	0.10	0.17	0.16	0.031	0.0016	0.21	0.29	352	0	0
Total Dissolved Nitrogen	mg/L	0.0990	0.175	0.167	0.0300	0.00200	0.207	0.288	298	0	0
Orthophosphate (Dissolved)	mg/L (as P)	<0.001	0.003	0.003	0.001	0.00008	0.005	0.007	352	62	17.6
Total Dissolved Phosphorus	mg/L	<0.002	0.003	nc	nc	nc	0.004	0.01	352	247	70.2
Total Phosphorus	mg/L	<0.002	0.004	nc	nc	nc	0.008	0.02	352	211	59.9
Total Organic Carbon	mg/L	0.70	1.7	2.0	1.1	0.10	3.9	9.3	297	0	0
Dissolved Organic Carbon	mg/L	<0.50	1.7	2.0	1.4	0.10	3.8	12	297	4	1.3
Total Inorganic Carbon	mg/L	7.60	11.1	11.1	1.60	0.100	13.6	17.5	297	0	0
Total Carbon	mg/L	9.3	13	13	1.5	0.10	15	21	297	0	0
Silica (Dissolved)	mg/L	2.9	3.1	3.1	0.14	0.020	3.2	3.6	54	0	0

Source: BC MoE

Notes:

Summary statistics were calculated and presented as follows:

- Minimum, Maximum, and Median were calculated using absolute values; that is, when the summary statistic corresponded to a non-detect (ND) value in the dataset, then the method detection limit (MDL) was reported.
- Mean, Standard Deviation (SD), Standard Error (SE), and 95th percentile were calculated by substituting 0.5*MDL for any ND values. Therefore, it is possible that 95th percentile was equal to 0.5*MDL.
- Mean, SD, and SE were not calculated for parameters with greater than 50% non-detect values.
- 95th percentile was not calculated for parameters with greater than 95% non-detect values.

< = less than; MDL = method detection limit; % = percent; mg/L = milligrams per litre; N = nitrogen; nc = not calculated; NO_3 = nitrate; P = phosphorus.

Table A-4: Pre-event Water Quality in Quesnel River, July 12, 1972 to March 5, 1987

Parameter	Units	Minimum	Median	Mean	Standard Deviation	Standard Error	95th Percentile	Maximum	Number of Samples	Number of Samples < MDL	% Samples <MDL
Specific Conductance	µS/cm	98.0	110	111	9.82	1.48	119	160	44	0	0
Dissolved Oxygen	mg/L	8.50	10.2	10.5	1.50	0.416	12.6	13.4	13	0	0
pH	-	6.5	7.8	7.8	0.32	0.049	8.0	8.1	43	0	0
Temperature	°C	0	7	7	5	1	14	16	22	0	0
Total Alkalinity	mg/L (as $CaCO_3$)	43.0	46.9	47.1	2.88	0.614	51.5	53.8	22	0	0
Hardness	mg/L (as $CaCO_3$)	45.9	49.3	50.0	2.86	0.675	54.6	55.8	18	0	0
Biological Oxygen Demand	mg/L	<10	<10	nc	nc	nc	nc	<10	8	8	100
Turbidity	NTU	0.20	0.50	0.60	0.28	0.063	1.0	1.4	20	0	0
Total Dissolved Solids	mg/L	54	62	63	4.7	1.0	70	70	21	0	0
Total Suspended Solids	mg/L	<1.0	1.5	1.5	0.74	0.19	2.3	3.0	16	3	19
Major Ions											
Calcium (Dissolved)	mg/L	15.4	16.9	16.9	0.940	0.243	18.2	18.5	15	0	0
Chloride (Dissolved)	mg/L	<0.30	<0.50	nc	nc	nc	1.0	1.5	11	6	55
Magnesium (Total)	mg/L	1.6	1.8	1.8	0.15	0.052	2.0	2.0	8	0	0
Magnesium (Dissolved)	mg/L	1.74	1.90	1.92	0.14	0.039	2.1	2.2	12	0	0
Potassium (Dissolved)	mg/L	0.5	0.5	0.5	0.0	0.0	0.5	0.5	3	0	0
Sodium (Dissolved)	mg/L	0.80	1.0	0.96	0.090	0.028	1.1	1.1	11	0	0
Sulphate (Dissolved)	mg/L	<5.0	6.0	5.9	0.99	0.23	6.9	7.1	19	1	5
Nutrients											
Ammonia (Dissolved)	mg/L	<0.0050	0.0050	0.0060	0.004	0.001	0.01	0.02	27	12	44
Nitrate (Total)	mg/L (as N)	0.070	0.11	0.10	0.020	0.0080	0.12	0.12	6	0	0
Nitrate (Dissolved)	mg/L (as N)	0.060	0.10	0.099	0.020	0.0060	0.13	0.15	15	0	0
Nitrite (Dissolved)	mg/L (as N)	<0.005	<0.005	nc	nc	nc	nc	<0.005	34	34	100
Total Organic Nitrogen	mg/L	<0.010	0.070	0.073	0.050	0.015	0.14	0.15	12	1	8
Total Nitrogen	mg/L	0.10	0.18	0.18	0.050	0.010	0.27	0.28	26	0	0
Orthophosphate (Dissolved)	mg/L (as P)	<0.003	<0.003	nc	nc	nc	nc	<0.003	24	24	100
Total Dissolved Phosphorus	mg/L	<0.003	<0.003	nc	nc	nc	0.004	0.005	23	12	52
Total Phosphorus	mg/L	<0.003	0.005	0.02	0.08	0.01	0.01	0.5	36	6	17
Total Metals											
Aluminum	mg/L	0.02	0.02	0.02	nc	nc	0.02	0.02	2	0	0
Chromium	mg/L	<0.005	<0.005	nc	nc	nc	nc	<0.005	1	1	100
Copper	mg/L	<0.0010	<0.0010	nc	nc	nc	0.0047	0.0070	8	7	88
Iron	mg/L	<0.10	<0.15	0.13	0.11	0.075	0.19	0.20	2	1	50
Lead	mg/L	0.001	0.001	0.02	0.04	0.01	0.08	0.1	8	4	50
Manganese	mg/L	<0.01	<0.01	nc	nc	nc	0.02	0.02	8	5	63
Zinc	mg/L	<0.005	<0.005	nc	nc	nc	0.02	0.03	8	6	75
Dissolved Metals											
Chromium	mg/L	<0.005	0.007	0.007	0.003	0.001	0.009	0.01	8	2	25
Copper	mg/L	0.0010	0.0030	0.0050	0.010	0.0020	0.014	0.020	13	4	31
Iron	mg/L	<0.10	<0.10	nc	nc	nc	0.10	0.10	13	11	85
Lead	mg/L	0.001	0.001	nc	nc	nc	0.003	0.005	13	7	54
Manganese	mg/L	<0.01	<0.02	nc	nc	nc	0.03	0.06	13	12	92
Zinc	mg/L	0.005	0.006	0.009	0.01	0.002	0.02	0.02	12	0	0

Source: BC MoE

Notes:

Summary statistics were calculated and presented as follows:

- Minimum, Maximum, and Median were calculated using absolute values; that is, when the summary statistic corresponded to a non-detect (ND) value in the dataset, then the method detection limit (MDL) was reported.
- Mean, Standard Deviation (SD), Standard Error (SE), and 95th percentile were calculated by substituting 0.5*MDL for any ND values. Therefore, it is possible that 95th percentile was equal to 0.5*MDL.
- Mean, SD, and SE were not calculated for parameters with greater than 50% non-detect values.
- 95th percentile was not calculated for parameters with greater than 95% non-detect values.

< = less than; MDL = method detection limit; % = percent; µS/cm = microSiemens per centrimetre; mg/L = milligrams per litre; °C = degrees Celcius; $CaCO_3$ = calcium carbonate; nc = not calculated; NTU = nephelometric turbidity units; N = nitrogen; P = phosphorus.

APPENDIX B

Post-Event Surface Water Quality Monitoring Program

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MEMORANDUM

March 26, 2014

TO: Jordana van Geest, Golder Associates Ltd.

FROM: Katie McMahen, Mount Polley Mining Corporation

RE: MPMC Post-Event Water Quality Monitoring Program Summary

TABLE OF CONTENTS

1 INTRODUCTION

In response to the Mount Polley Tailings Storage Facility (TSF) breach, which occurred on August 4, 2014, Mount Polley Mining Corporation (MPMC) initiated a water quality monitoring program in the downstream environments of Polley Lake, Hazeltine Creek, Edney Creek, Quesnel Lake, and Quesnel River. This memorandum summarizes the post-event water quality monitoring program and discusses the program's objectives, key changes to program elements, and the changing environmental, safety, and logistical considerations which influenced the program.

The monitoring program was initially developed and managed by representatives from Imperial Metals Corporation (Jack Love, R.P.Bio) and Minnow Environmental Inc. (Pierre Stecko, R.P.Bio), with support from MPMC (Colleen Hughes, EP and Katie McMahen, P.Ag) and Cariboo Environmental Quality Consulting (Norm Zirnhelt, P.P.Bio). SNC Lavalin Inc. (Trevor McConkey, P.Ag, Erik Jancicka, P.Chem, and Cliff Robinson, R.P.Bio) transitioned into managing the program in mid-August, with support from MPMC and Golder Associates Ltd. (Lee Nikl, R.P.Bio). Starting on December 20, 2014, full program management transitioned to MPMC.

This program was continually adapted based on factors including, but not limited to, monitoring results, recommendations for additional sampling from the British Columbia Ministry of Environment (BC MoE), and seasonal conditions, such as lake turnover. Weekly summaries of the water quality monitoring program were submitted to BC MoE and published on the Imperial Metals Mount Polley Updates website. These weekly reports included:

- Water quality monitoring planned and completed;
- Deviations from the program (such as supplemental monitoring or stations missed due to unsafe boating conditions); and
- Changes to the monitoring program, and rationale for any changes.

The subsequent sections summarize the development and evolution of the post-event water quality monitoring program from August 6, 2014 to February 28, 2015.

2 INITIAL RESPONSE AND PROGRAM DEVELOPMENT

Immediately following the TSF breach, the initial response included four main components as described below. These evolved into key elements of the water quality monitoring program. Samples were shipped to ALS Laboratory daily with emergency (less than one day) turnaround time until August 12, 2014, when it was adjusted to priority (24 hour) turnaround time. Additional details on sampling methods, sample handling, and Quality Assurance/Quality Control measures are referenced in separate documents from SNC Lavalin Inc. and MPMC (SNC, 2015; MPMC, 2015).

Unless otherwise specified, samples were analysed for a full suite of parameters, which includes total and dissolved metals (except mercury), anions, nutrients, and dissolved organic carbon. Supplemental monitoring of other parameters is discussed in Section 8.

2.1 Plume Delineation

On August 6, 2014, water quality monitoring in Quesnel Lake commenced to track the extent and movement of the plume of suspended solids that entered the lake as a result of the debris flow from the TSF. On the first day of sampling, this consisted of monitoring at the surface only to allow samplers to cover a larger area. Subsequently field parameter profiles and samples throughout the water column were taken, as it was discovered that the plume was at depth (contained within the hypolimnion). Profiles could only be conducted to 30 metres in depth and did not include turbidity initially until equipment could be rented or bought from Hoskin Scientific; these orders were rushed.

The limitations of these monitoring methods were recognized, and EBA-Tetra Tech were contracted to carry out larger scale transects of conductivity, temperature, and turbidity profiles, as well as conduct limnological and hydrodynamic investigations.

2.2 Implementation of Routine Monitoring at Key Locations

2.2.1 Hazeltine Creek and Polley Lake

Initially, due to geotechnical concerns over the stability of the “plug” at the outflow of Polley Lake, access to Hazeltine Creek and boating on Polley Lake were not permitted under the safe work procedures developed by MPMC under guidance from the BC Ministry of Mines. For this reason, Hazeltine Creek was not initially included in the monitoring plan, and monitoring of Polley Lake was limited to shoreline samples around the perimeter (three sites were monitored daily from August 8 -21, 2014, at which point sample frequency was reduced to weekly).

2.2.2 Quesnel Lake

In the first ten days after the breach, routine monitoring at key near-field and downstream stations commenced in addition to investigative plume delineation monitoring. Approximately daily surface monitoring was carried out at QUL-20 and QUL-22, and approximately daily profiles and samples throughout the water column were carried out at QUL-18 and QUL-26. By late August, while some supplemental sampling to monitor the plume was still ongoing, a routine monitoring program was implemented for Quesnel Lake from Cariboo Island to the Quesnel River (Table 1). Water quality monitoring stations are shown in the map included as Attachment 1.

Table 1 Initial Quesnel Lake routine monitoring program

Monitoring Type	Frequency	Stations
Surface	Daily/every two days	QUL-20*, QUL-18, QUL-23**
Surface + depth	Every two days	QUL-2, QUL-21, QUL-22, QUL-66, QUL-79

*surface only (profile done to confirm lake was fully mixed)

**shallow station (profile or depth samples not possible)

2.2.3 Quesnel River

The start of Quesnel River at the outlet of Quesnel Lake in Likely, BC was identified as a key location to monitor water passing out of Quesnel Lake to the downstream environments. Station QUR-1 was established at the Quesnel River Research Centre on August 6, 2014, and was monitored daily until December 23, 2014. On August 12, 2014, an ISCO automatic sampler was installed at QUR-1, and it sampled three times per 24 hours on evenly spaced intervals. The ISCO samples were only analysed for total metals, dissolved metals, anions, and turbidity, but daily full suite grab sampling continued through this period. A YSI EXO sonde was also installed at QUR-1 on August 12, 2014; this instrument was deployed to measure field parameters (including pH, temperature, specific conductance, dissolved oxygen, and turbidity) every 15 minutes, and is still in place. Data is downloaded weekly, at minimum.

2.3 Monitoring of Residential Drinking Water Quality

A number of residents on Quesnel Lake and upper Quesnel River draw drinking water from the lake or river. On August 7, 2014, water quality monitoring was initiated to respond to human health concerns regarding consumption of the water. Initially this program involved surface samples in residential areas, including Likely, Winkley Creek, Mitchell Bay, and near the junction of Quesnel Lake's east and north arms. By mid-August, the program expanded to include samples near residential water intakes (at depth off docks or from a boat) and tap samples at individual houses, as requested by residents. The majority of requests were met by the end of August, but sampling continued into October and included re-visiting some residents when requested. Sample results were shared with residents.

2.4 Implementation of Water Toxicity Testing Program

A water toxicity testing program was implemented to assess potential acute or chronic toxicity conditions in areas downstream of the TSF. Testing at Quesnel River (QUR-1), Polley Lake, and Quesnel Lake (near the Hazeltine Creek mouth) commenced August 6, 9, and 21, 2014, respectively. Phase 1 of this program included ongoing monitoring at these stations until September 30, 2015. When all of the toxicity test results were available, they were reviewed by Pierre Stecko, R.P. Bio (Minnow Environmental Inc.), and MPMC began carrying out recommendations for Phase 2 of monitoring at these same locations on November 19, 2015. It is anticipated that this second phase of testing will be completed by the end of April 2015. A more detailed summary of this program is provided in the memorandum from Minnow Environmental Inc. to MPMC entitled "Summary and Interpretation of Water Toxicity Tests" and dated January 9, 2015.

3 PUMPING OF POLLEY LAKE

To manage accumulation of water behind the “plug” at the south end of Polley Lake (which prevented water from flowing into Hazeltine Creek) and to address geotechnical concerns regarding the stability of the “plug”, pumps were installed at the south end of Polley Lake to transfer water around the “plug” into Hazeltine Creek. This system was commissioned on August 10, 2014, and water at the pipe outlet (station HAD-1) was sampled daily from August 10, 2014, until September 2, 2014. Sampling frequency was reduced to weekly until the pumps were removed at the end of November. A second pipeline was commissioned at the end of August, and the outflow (station HAD-2) was sampled four times to confirm consistency with HAD-1. After September 3, 2014, field parameters were taken from HAD-1 and HAD-2 for comparison and if readings were consistent (within 10%), only HAD-1 was sampled to avoid redundancy.

4 IMPROVED ACCESS

At the end of August, further geotechnical investigations and drawing down of Polley Lake water levels through pumping allowed MPMC to amend the Hazeltine Creek safe work procedure to allow restricted access to Hazeltine Creek and boating on Polley Lake. The resulting changes in the monitoring program are outlined in the subsequent sections.

4.1 Polley Lake

On September 9, 2014, weekly monitoring of sites around the perimeter of Polley Lake was replaced with weekly monitoring at four stations (including two stations which were monitored prior to the event) located along the midline of the lake This included field parameter profiles and samples throughout the water column.

4.2 Hazeltine Creek

Investigative monitoring was carried out along the length of Hazeltine Creek starting on August 24, 2014, and routine stations were established at:

- HAC-01 at the outlet of Hazeltine/Edney Creek into Quesnel Lake. This site was sampled daily, (when conditions allowed safe access) until September 25, 2015, when the daily sampling station was moved to station HAC-01a to adjust for lateral channel movement; and
- HAC-05 in Upper Hazeltine Creek at the Gavin Lake Road bridge. This station was sampled weekly until early February when sampling was discontinued due to active rehabilitation and sediment and erosion control work taking place in the area.

Four samples of the water flowing from the TSF breach location to the Hazeltine Creek channel were taken between August 23 and September 11, 2014. Sampling was discontinued because flow from this source was captured into Mount Polley's contact water collection system, which went online on September 4, 2014.

Access to Hazeltine Creek further improved with the construction of new bridges at the Gavin Lake Road and Ditch Road crossings, and as part of post-event hydrology and geomorphology investigations, Manta Eureka 2 continuous monitoring sensors were installed at the Gavin Lake Bridge (HAC-05) and Ditch Road Bridge (HAC-08). From November 5/6-26, 2014, these sensors logged turbidity, temperature, and specific conductance measurements every 30 minutes.

5 PLUME MIGRATION

In mid-September, as the plume migrated east of Cariboo Island in Quesnel Lake, increased monitoring of this area resulted in gradual adjustments to the routine monitoring program. During this period, preliminary findings from EBA-Tetra Tech's monitoring program also became available to help guide the water quality monitoring program. Refinements to the monitoring program included:

- Increased monitoring of the East Basin (east of Cariboo Island).
- Stations were spatially adjusted to monitor the deepest locations in Quesnel Lake (station names for the adjusted locations had an "a" added to them); and
- A sample location was added (QUL-zoo-8), which is the zooplankton monitoring station of the University of Northern British Columbia Quesnel River Research Centre. This station is located at the junction of the east and north arms of Quesnel Lake.

The Quesnel Lake routine monitoring program as of late September is shown in Table 2.

Table 2 Quesnel Lake routine monitoring program, as of late September 2014

Monitoring Type	Frequency	Stations
Surface	Weekly	QUL-20*
Surface + depth	Weekly	QUL-2, QUL-2a, QUL-21, QUL-21a, QUL-22, QUL-18, QUL-31a, QUL-40a, QUL-66, QUL-66a, QUL-119, QUL-Zoo-8
	Twice per week	QUL-40, QUL-79, QUL-87, QUL-120, QUL-112

*surface only (profile done to confirm lake was fully mixed)

6 ONSET OF WINTER CONDITIONS

As winter approached, monitoring of lake turnover in Polley and Quesnel Lakes took place, and was followed by reduction in sampling frequencies to account for unsafe boating conditions, freeze up, and low flow conditions. These adjustments are outlined below. In addition, some equipment that had previously been installed and is not designed to withstand winter conditions was removed, including removal of the ISCO sampler at QUR-1 on October 1, 2014, and removal of the Manata Eureka 2 continuous monitoring sondes from Upper and Lower Hazeltine Creek on November 26, 2014.

6.1 Polley Lake

Polley Lake continued to be monitored through fall turnover (when the thermal stratification of a lake breaks down and the lake becomes fully mixed). Turnover occurred in early November and sampling ended on November 18, 2014. Surface samples were taken at stations POL-4 in December and P2 in January in association with samples collected for toxicity testing. Unseasonably warm winter conditions did not allow typical formation of ice on the lake, and as a result planned under-ice sampling was not completed.

Requested sample turnaround time at the laboratory was adjusted to “regular” status (approximately ten days) in November after the lake had turned over.

6.2 Hazeltine Creek

As more water chemistry data for Hazeltine Creek became available and creek flow rates slowed due to freezing conditions in late November, sampling frequency at HAC-01a was reduced to weekly and the requested laboratory turnaround time was reduced to “regular” status.

6.3 Quesnel Lake

Based on predictions of a Quesnel Lake hydrodynamic model developed by EBA-Tetra Tech, mixing of the turbidity contained in the hypolimnion throughout the entire water column was anticipated as thermal stratification of the lake broke down and fall turnover occurred. As winter conditions made safe boat access to Quesnel Lake monitoring stations less reliable, the monitoring program in late October was streamlined (Table 3) and efforts were made to maintain spatial coverage and frequent monitoring of key locations for fall overturn. Note that stations QUL-120, QUL-112, and QUL-zoo-8 had deeper or shallower alternatives, which were monitored in depending on weather conditions.

Table 3 Quesnel Lake routine monitoring program, as of late October

Monitoring Type	Frequency	Stations
Surface + depth	Weekly	QUL-2a, QUL-18, QUL-21a, QUL-40a, QUL-66, QUL-66a, QUL-112/QUL-112a, QUL-120/QUL-120a, QUL-zoo-8/QUL-zoo-8a
	Twice per week	QUL-79
Time/weather permitting		QUL-2, QUL-20*, QUL-21, QUL-22, QUL-31a, QUL-87, QUL-119

*surface only (profile done to confirm lake was fully mixed)

On October 23-24, 2014, Justin Rogers of EBA-Tetra Tech conducted a site visit to help MPMC develop a procedure for carrying out “casts” instead of manually logging lake profiles, to improve monitoring efficiencies. Implementation of this new procedure in late November allowed for increased data collection in a shorter time period (ideal for winter weather conditions). This resulted in further adjustments to the routine monitoring program, as shown in Table 4.

Table 4 Quesnel Lake routine monitoring program, as of late November

Monitoring Type	Frequency	Stations
Surface + depth	Weekly	QUL-18, QUL-66a, QUL-79, QUL-112/QUL-112a
Profiles only	Weekly	QUL-22, QUL-21a, QUL-18, QUL-66a, QUL-66, QUL-2a, QUL-79, QUL-40a, QUL-120/QUL-120a

This program was maintained through turnover, which occurred in late November in the West Basin and early December in the East Basin. Sampling was discontinued for winter on December 17, 2014. No additional residential monitoring was completed during the turnover period because the lake was fully mixed at turnover, and samples taken in the routine sampling program were expected to be representative of water near residential intakes. MPMC has also been supplying residents who draw water out of the lake with drinking water since the TSF breach occurred.

Supplemental monitoring was completed during unseasonably warm weather in January, with sampling and a profile taken along with planned toxicity testing samples at QUL-66 on January 15, 2015. Profiles were also completed at stations QUL-18, QUL-40a, and QUL-79 on January 22, 2015. Requested sample turnaround time at the laboratory for Quesnel Lake was adjusted to “regular” status in January 2015.

6.4 Quesnel River

Requested laboratory sample turnaround time for Quesnel River was adjusted to “regular” status at the end of December after the lake had turned over, and the sampling frequency was reduced to weekly.

7 LOWER HAZELTINE SEDIMENT AND EROSION CONTROL WORKS

On December 12, 2014, construction of sedimentation ponds in Lower Hazeltine Creek, just upstream of Quesnel Lake, was completed and the ponds were commissioned. Further changes in the monitoring program resulted as follows:

- Station HAC-01a was moved to station HAC-01b, the new outflow channel of Hazeltine and Edney Creek (downstream of the sedimentation ponds and upstream of Quesnel Lake).
- Weekly monitoring of stations upstream of the sedimentation ponds commenced, for comparison with HAC-01b (originally at HAC-09 at the pond inflow, then moved upstream to HAC-08 to avoid influence of Edney Creek, which was also flowing into the sedimentation ponds).
- A YSI EXO sonde was deployed at HAC-01b on January 19, 2015 and continuously monitors field parameters (pH, specific conductance, ORP, temperature, dissolved oxygen, and turbidity), logging data every fifteen minutes.
- On February 15, 2015, Edney Creek flow was diverted from the sedimentation ponds into the reconstructed Lower Edney Creek channel, which joins Hazeltine Creek downstream of the sedimentation ponds. Two new weekly monitoring stations were established: EDC-01 (Edney Creek upstream of the confluence with Hazeltine Creek); and EDC-02 (Edney Creek downstream of the confluence with Hazeltine Creek, upstream of Quesnel Lake).

8 MONITORING OF SPECIFIC PARAMETERS

8.1 Bacteriology

Bacteriology samples for analysis of total coliform bacteria and *E. coli* were taken between August 7, 2014, and August 8, 2014, because sewage from the mine facilities was discharged to the TSF prior to the breach. This monitoring was discontinued when some results from the ambient receiving environment were found to exceed pre-event levels in the TSF, and appeared to be in the typical range for lakes in the region.

8.2 Mercury

Based on historic monitoring and geochemistry of the tailings and rock at the Mount Polley site, mercury was not anticipated to be an issue. However, due to public concern, water sampling for analysis of mercury was conducted until early September. It was discontinued based on results consistently being below ALS Laboratory’s method detection limit.

8.3 Processing Reagents

From October 8-15, 2014, sampling for volatile organic compounds related to mine processing reagents was completed at near-field monitoring stations in Polley Lake, Hazeltine Creek, and Quesnel Lake. This sampling was not continued because results were low level or below laboratory method detection limits. This decision was further supported by results from the Soil Quality Impact Assessment, which indicated that concentrations of related parameters were less than laboratory detection limits in the soil samples targeted for analysis.

8.4 Speciated Chromium

Water sampling for analysis of speciated chromium was initiated the week of October 17, 2014, at stations where chromium exceedances of BC water quality guidelines were observed. This specialized analysis was used to quantify the relative composition of different chromium species in order to apply the species-specific MoE BC water quality guideline for aquatic life.

8.5 Particle Size

To improve understanding of the physical characteristics of the fine particles suspended in Quesnel Lake, advanced particle size analysis was carried out using a Mastersizer at the University of Western Ontario. Samples taken on November 20, 2014, from HAC-01, and QUL-66 (surface and depth), and on November 25, 2014, from QUL-18 (surface and depth) were analysed.

8.6 Chlorophyll *a*

Chlorophyll *a* sampling was conducted at surface monitoring locations on Quesnel Lake September 3-20, 2014. Monitoring was carried out to verify that turbidity of the plume was not associated with algae or other phytoplankton, and to monitor surface chlorophyll *a* levels in areas downstream of the breach to evaluate the impact of the event on algae and phytoplankton. This monitoring did not continue into winter conditions, when these organisms are typically less active.

9 SUMMARY

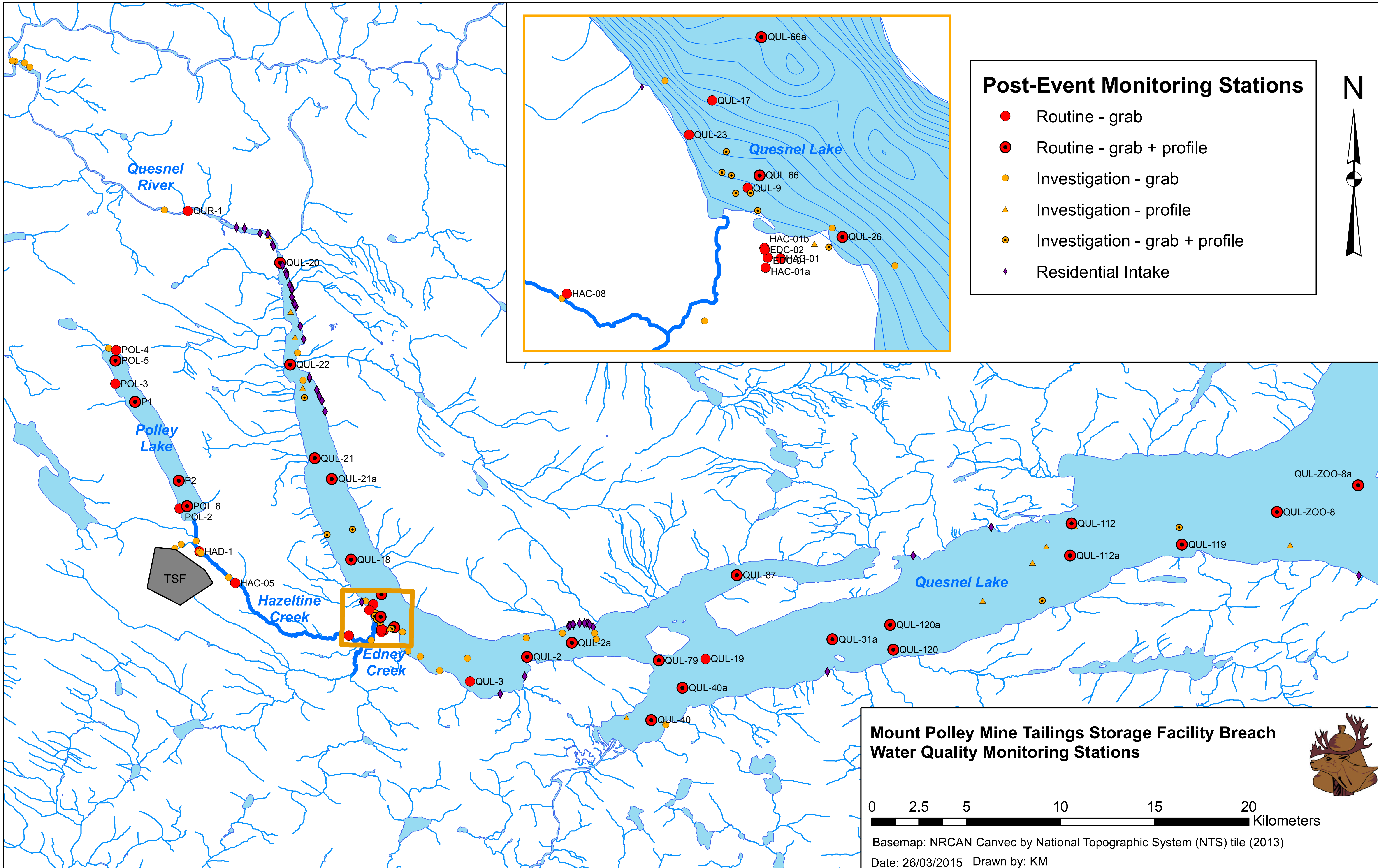
A map of these stations is included as Attachment 1 (Mount Polley Mine Tailings Storage Facility Breach Water Quality Monitoring Stations). A summary of water quality monitoring completed, including number of samples at surface and depth, number of lake profiles taken, and associated sampling periods is provided in Attachment 2.

10 REFERENCES

Minnow Environmental Inc. 2015. Summary and Interpretation of Water Toxicity Tests . January 9, 2015.

MPMC. 2015. Mount Polley Post-Event Water Quality Monitoring Program Data Quality Report. March 26, 2015.

SNC Lavalin Inc. 2015. Summary of Data Quality Assurance / Quality Control and Field Methods for the Mount Polley Water Quality Monitoring and Sampling Program. Memorandum. March 30, 2015.


Post-Event Monitoring Stations
Routine - grab
Routine - grab + profile
Investigation - grab
Investigation - profile
Investigation - grab + profile
Residential Intake
N
Quesnel River
QUR-1
QUL-20
QUL-22
QUL-21
QUL-21a
QUL-18
POL-4
POL-5
POL-3
P1
Polley Lake
P2
POL-6
POL-2
HAD-1
TSF
HAC-05
Hazeltine Creek
Edney Creek
QUL-3
QUL-2
QUL-2a
QUL-79
QUL-19
QUL-40a
QUL-40
QUL-87
QUL-31a
QUL-120a
QUL-120
Quesnel Lake
QUL-112
QUL-112a
QUL-119
QUL-ZOO-8
QUL-ZOO-8a
QUL-66a
QUL-17
QUL-23
QUL-66
QUL-9
QUL-26
HAC-01b
EDC-02
HAC-01
HAC-01a
HAC-08
Mount Polley Mine Tailings Storage Facility Breach
Water Quality Monitoring Stations
0
2.5
5
10
15
20
Kilometers
Basemap: NRCAN Canvec by National Topographic System (NTS) tile (2013)
Date: 26/03/2015
Drawn by: KM

			Samples - Surface			Samples - Depth			Profiles			
Area	**Station Name**	**Sample Location Type**	**Number of Samples**	**Duplicate Samples**	**Date Range (mm/dd/yyyy)**	**Number of Samples**	**Duplicate Samples**	**Samples - Depth (mm/dd/yyyy))**	**Number of Profiles**	**Date Range (mm/dd/yyyy)**	**Continuous Logger Data**	**Comments**
TSF	Breach-1	Investigation	4	0	08/23/2014 - 09/11/2014	N/A	N/A	N/A	N/A	N/A	-	
Polley Lake	P1	Routine	11	2	09/09/2014 - 11/18/2014	P1-B - 11	1	09/09/2014 - 11/18/2014	11	09/09/2014 - 11/18/2014	-	
	P2	Routine	12	3	09/09/2014 - 01/06/2015	P2-B - 11	1	09/09/2014 - 11/18/2014	11	09/09/2014 - 11/18/2014	-	
	POL-1	Investigation	1	0	08/07/2014	N/A	N/A	N/A	N/A	N/A	-	
	POL-2	Routine	17	1	08/07/2014 - 12/15/2014	N/A	N/A	N/A	N/A	N/A	-	
	POL-3	Routine	19	2	08/08/2014 - 09/16/2014	N/A	N/A	N/A	N/A	N/A	-	
	POL-4	Routine	20	1	08/08/2014 - 12/16/2014	N/A	N/A	N/A	N/A	N/A	-	
	POL-5	Routine	9	1	09/08/2014 - 11/18/2014	9m - 2 10m - 2 11m - 3 12m - 2	11m - 2	08/09/2014 - 18/11/14	9	09/08/2014 - 11/18/2014	-	
	POL-6	Routine	9	0	09/09/2014 - 11/18/2014	11m - 2 12m - 2 13m - 2 14m - 3	0	09/09/14 - 18/11/2014	9	09/09/14 - 11/18/2014	-	
Discharge from pumping Polley Lake	HAD-1	Routine	32	2	08/10/2014 - 11/26/2014	N/A	N/A	N/A	N/A	N/A	-	Data consistent between sample points - can use as "one" station
	HAD-2	Routine	4	0	08/30/2014 - 09/03/2014	N/A	N/A	N/A	N/A	N/A	-	
Upper Hazeltine	HAC-02	Investigation	1	0	08/27/2014	N/A	N/A	N/A	N/A	N/A	-	
	HAC-03	Investigation	2	0	08/27/2014 - 09/24/2014	N/A	N/A	N/A	N/A	N/A	-	
	HAC-04	Investigation	1	0	08/27/2014	N/A	N/A	N/A	N/A	N/A	-	
	HAC-05	Routine	22	2	08/28/2014 - 02/02/2015	N/A	N/A	N/A	N/A	N/A	11/05/2014 - 11/26/2014	Continuous monitoring: turbidity, sp. conductance, and temperature only
	HAC-07	Investigation	1	0	09/24/2014	N/A	N/A	N/A	N/A	N/A	-	
Lower Hazeltine	HAC-01	Routine	23	5	08/24/2014 -09/ 25/2014	N/A	N/A	N/A	N/A	N/A	-	HAC-01 and HAC-01a are more or less the same sample point, just move slightly to adapt to changes in the creek channel.
	HAC-01a	Routine	61	4	09/27/2014 - 12/12/2014	N/A	N/A	N/A	N/A	N/A	-	
	HAC-01b	Routine	11	1	12/16/2014 - 02/ 24/2015	N/A	N/A	N/A	N/A	N/A	01/19/15 - 02/28/2015	
	HAC-06	Investigation	1	0	08/28/2014	N/A	N/A	N/A	N/A	N/A	-	
	HAC-08	Routine	5	1	01/27/2015 - 02/24/2015	N/A	N/A	N/A	N/A	N/A	11/06/2014 - 11/26/2014	Continuous monitoring: turbidity, sp. conductance, and temperature only
	HAC-09	Investigation	2	0	01/12/2015 - 01/19/2015	N/A	N/A	N/A	N/A	N/A	-	
Edney Creek	EDC-01	Routine	2	0	02/17/2015 - 02/24/2015	N/A	N/A	N/A	N/A	N/A	-	Continuous monitoring: (temperature only) implemented 05/03/2015
	EDC-02	Routine	1	0	02/24/2015	N/A	N/A	N/A	N/A	N/A	-	Downstream of confluence with Hazeltine Creek
Quesnel River	QUR-1	Routine	293	15	08/06/2014 - 02/23/2014	N/A	N/A	N/A	N/A	N/A	08/12/14 - 02/28/2015	Includes ISCO samples (anions, metals, and turbidity only)
	QUR-2	Investigation	1	1	10/16/2014	N/A	N/A	N/A	N/A	N/A	-	
	QUR-3	Investigation	1	0	10/17/2014	N/A	N/A	N/A	N/A	N/A	-	
	QUR-4	Investigation	1	0	10/26/2014	N/A	N/A	N/A	N/A	N/A	-	
	QUR-5	Investigation	1	0	10/26/2014	N/A	N/A	N/A	N/A	N/A	-	
	QUR-6	Investigation	1	0	10/19/2014	N/A	N/A	N/A	N/A	N/A	-	
	QUR-7	Investigation	1	0	11/19/2014	N/A	N/A	N/A	N/A	N/A	-	
	QUR-8	Investigation	1	0	08/27/2014	N/A	N/A	N/A	N/A	N/A	-	
	QUR-10	Investigation	1 - field parameters only	0	11/15/2014	N/A	N/A	N/A	N/A	N/A	-	
	QUR-11	Investigation	1 - field parameters only	0	11/15/2014	N/A	N/A	N/A	N/A	N/A	-	
	CONF-01	Investigation	1 - field parameters only	0	11/15/2014	N/A	N/A	N/A	N/A	N/A	-	
Quesnel Lake	QUL-1	Investigation	1	0	08/06/2014	-	-	-	-	-	-	
	QUL-2	Routine	22	5	08/06/2014 - 11/18/2014	8m - 1 9m - 1 10m - 1 13m - 1 14m - 1 15m - 1 16m - 1 22m - 1 25m - 3 30m - 1 37m - 1 38m - 1 40m - 8 42m - 1 43m - 1 44m - 1 47m - 4 48m - 1 49m - 1 50m - 1	13m - 1 25m - 1 40m - 3 43m - 1 48m - 1	08/16/2014 - 11/18/2014	21	08/16/2014 - 11/18/2014	-	
	QUL-2a	Routine	9	1	09/25/2014 - 11/14/2014	40m - 9 60m - 8	40m - 1 60m - 1	09/25/2014 - 11/14/2014	10	09/25/2014 - 01/22/2015	-	
	QUL-3	Routine	13	2	08/06/2014 - 09/04/2014	10m - 1 33m - 1 37m - 1	0	09/04/2014	2	08/22/2014 - 09/04/2014	-	
	QUL-4	Investigation	1	0	08/06/2014	-	-	-	-	-	-	
	QUL-5	Investigation	1	0	08/06/2014	-	-	-	-	-	-	
	QUL-6	Investigation	1	0	08/06/2014	-	-	-	-	-	-	
	QUL-7	Investigation	1	0	08/06/2014	-	-	-	-	-	-	
	QUL-8	Investigation	1	0	08/06/2014	-	-	-	-	-	-	
	QUL-9	Routine	12	2	08/06/2014 - 08/24/2014	-		-	-	-	-	
	QUL-10	Investigation	1	0	08/06/2014	-	-	-	-	-	-	
	QUL-11	Investigation	1	0	08/07/2014	5m - 1 10m - 1 15m - 1 20m - 1 24 m - 1	-	08/07/2014	1	08/07/2014	-	
	QUL-12	Investigation	1	0	08/07/2014	5m - 1 10m - 1 15m - 1 20m - 1	-	08/07/2014	1	08/07/2014	-	

			Samples - Surface			Samples - Depth			Profiles			
Area	Station Name	Sample Location Type	Number of Samples	Duplicate Samples	Date Range (mm/dd/yyyy)	Number of Samples	Duplicate Samples	Samples - Depth (mm/dd/yyyy))	Number of Profiles	Date Range (mm/dd/yyyy)	Continuous Logger Data	Comments
	QUL-13	Investigation	1	0	08/07/2014	5m - 1 10m - 1 15m - 1 20m - 1	-	08/07/2014	1	08/07/2014	-	
	QUL-14	Investigation	1	0	08/07/2014	3m - 1	-	08/07/2014	1	08/07/2014	-	
	QUL-15	Investigation	1	0	08/07/2014	4.5m - 1	-	08/07/2014	1	08/07/2014	-	
	QUL-16	Investigation	1	0	08/07/2014	4.5m - 1	-	08/07/2014	1	08/07/2014	-	
	QUL-17	Routine	9	1	08/08/2014 - 08/17/2014	-		-	-	-	-	
	QUL-18	Routine	49	3	08/08/2014 - 12/16/2014	8m - 2 10m - 1 16m - 1 40m - 13 80m - 12 100m - 4	0	08/08/2014 - 12/16/2014	19	08/08/14 - 01/22/2015	-	
	QUL-19	Routine	14	1	08/08/2014 - 08/27/2014	35m - 1 55m - 1	0	08/27/2014	2	08/11/2014 - 08/27/2014	-	
	QUL-20	Routine	50	7	08/08/2014 - 11/06/2014	10m - 1 20m - 1	0	08/23/2014	34	08/22/2014 - 11/06/2014	-	
	QUL-21	Routine	30	3	08/08/2014 - 11/06/2014	6m - 1 7m - 1 8m - 1 9m - 1 10m - 2 11m - 1 12m - 1 15m - 1 16m - 1 18m - 2 20m - 2 21m -1 30m - 5 40m - 5 45m - 4 46m - 8 47m - 4	40m - 1 47m - 1	08/08/14 - 11/06/2014	22	08/08/14 - 11/06/2014	-	
	QUL-21a	Routine	10	1	09/25/2014 - 11/19/2014	40m - 10 55m - 3 60m - 6 65m - 1	40m - 1 55m - 1 60m - 2	09/25/2014 - 11/19/2014	11	09/25/2014 - 12/17/2014	-	
	QUL-22	Routine	35	5	08/08/2014 - 10/24/2014	4m - 2 5m - 2 6m - 2 7m - 2 8m - 2 9m - 8 25m - 3	7m - 1 25m - 1	08/24/2014 - 09/23/2014	21	08/08/2014 - 12/17/2014	-	
	QUL-23	Routine	30	3	08/24/2014 - 10/15/2014	-	-	-	-	-	-	
	QUL-26	Routine	9	0	08/11/2014 - 08/21/2014	10m - 1 12m - 2 13m - 1 20m -1 24m - 1 26m - 1 27m - 1	0	08/11/2014 -08/ 19/2014	5	08/11/2014 - 08/21/2014	-	
	QUL-28	Investigation	3	0	08/11/2014 - 08/13/2014	-	-	-	1	08/11/2014	-	
	QUL-30	Residential	1	0	08/07/2014	-	-	-	-	-	-	
	QUL-31	Residential	1	0	08/07/2014	-	-	-	-	-	-	
	QUL-31a	Routine	5	0	09/27/2014 - 11/18/2014	40m - 5 80m - 4 100m - 1 120m - 2 170m - 2	40m - 1 80m - 1	09/27/2014 - 11/18/2014	5	09/27/2014 - 11/18/2014	-	
	QUL-32	Residential	1	0	08/06/2014	-	-	-	-	-	-	
	QUL-33	Residential	1	0	08/06/2014	-	-	-	-	-	-	
	QUL-34	Residential	-	-	-	1	0	08/13/2014	-	-	-	
	QUL-35	Residential	2	0	08/14/2014 - 10/28/2014	1	0	08/14/2014	-	-	-	
	QUL-36	Residential	1	0	10/28/2014	3m - 1 8m - 1	-	08/14/2014 - 10/10/2014	-	-	-	
	QUL-37	Residential	2	0	08/15/2014 - 08/24/2014	7m - 1	0	08/15/2014	-	-	-	
	QUL-38	Residential	3	1	08/18/2014 - 10/03/2014	2m - 1	0	08/26/2014	-	-	-	
	QUL-39	Residential	1	0	08/18/2014	-	-	-	-	-	-	
	QUL-40	Routine	7	0	09/19/2014 - 10/27/2014	40m - 5 45m - 1 50m - 1 80m - 5 98m - 1 100m - 1	0	09/19/2014 - 10/27/2014	9	09/19/2014 - 10/27/2014	-	
	QUL-40a	Routine	7	1	09/27/2014 - 11/17/2014	40m - 7 80m - 5 100m - 1 120 m - 5 140m - 3	40m - 1	09/27/2014 - 11/17/2014	8	09/27/2014 - 01/22/2015	-	
	QUL-41	Investigation	1 - field parameters only	-	08/11/2014	-	-	-	-	-	-	

			Samples - Surface			Samples - Depth			Profiles			
Area	Station Name	Sample Location Type	Number of Samples	Duplicate Samples	Date Range (mm/dd/yyyy)	Number of Samples	Duplicate Samples	Samples - Depth (mm/dd/yyyy))	Number of Profiles	Date Range (mm/dd/yyyy)	Continuous Logger Data	Comments
	QUL-44	Investigation	1 - field parameters only	-	08/11/2014	-	-	-	-	-	-	
	QUL-60	Residential	2	0	08/18/2014 - 08/24/2014	3m - 1	0	08/26/2014	-	-	-	
	QUL-61	Residential	1	0	08/18/2014	2m - 1	0	08/26/2014	-	-	-	
	QUL-62	Residential	1	0	08/18/2014	-	-	-	-	-	-	
	QUL-63	Residential	1	0	08/18/2014	-	-	-	-	-	-	
	QUL-64	Residential	1	0	08/18/2014	2m - 2	0	08/27/2014 - 12/01/2014	-	-	-	
	QUL-65	Investigation	1 - field parameters only	-	08/19/2014	45m - 1	0	08/19/2014	1	08/19/2014	-	
	QUL-66	Routine	25	2	08/24/2014 - 01/15/2015	10m - 3 14m - 1 15m - 3 16m - 1 18m - 1 20m - 2 24m - 1 34m - 1 39m - 1 40m - 16 45m - 4 46m -1 48m - 4 50m - 8 55m - 2 58m - 1 85m - 1	40m - 3 45m - 1 50m - 2	08/24/2014 - 01/15/2015	28	08/24/2014 - 01/15/2015	-	Monitoring in 2015 may be moved to a more appropriate near field monitoring location, as the outlet of Hazeltine/Edney Creek has moved into the newly constructed channel
	QUL-66a	Routine	14	2	09/25/2014 - 12/16/2014	40m - 11 80m - 9 85m - 1 95m - 1 100m - 2 105m - 1	40m - 1 100m - 1	09/25/2014 - 12/16/2014	13	09/25/2014 - 12/17/2014	-	
	QUL-67	Investigation	1 - field parameters only	-	08/20/2014	34m - 1	0	08/20/2014	1	08/20/2014	-	
	QUL-68	Investigation	-	-	-	40m - 1	0	08/21/2014	1	08/21/2014	-	
	QUL-69	Investigation	-	-	-	32m - 1	0	08/21/2014	-	-	-	
	QUL-70	Investigation	-	-	-	-	-	-	1	08/22/2014	-	
	QUL-71	Investigation	-	-	-	-	-	-	1	08/22/2014	-	
	QUL-72	Investigation	-	-	-	-	-	-	1	08/22/2014	-	
	QUL-73	Investigation	-	-	-	-	-	-	1	08/22/2014	-	
	QUL-74	Investigation	-	-	-	46m - 1	0	08/21/2014	-	-	-	
	QUL-75	Investigation	-	-	-	40m - 1	0	08/21/2014	-	-	-	
	QUL-76	Investigation	-	-	-	-	-	-	1	08/22/2014	-	
	QUL-77	Residential	3	0	08/22/2014 - 10/28/2014	-	-	-	-	-	-	
	QUL-79	Routine	32	1	08/25/2014 - 12/16/2014	8m - 1 10m -1 12m - 1 14m - 1 15m - 1 20m - 1 25m - 1 26m - 1 27m - 1 30m - 2 32m - 1 38m -1 40m - 20 43m - 2 45m - 1 50m - 13 55m - 9 58m - 2 60m - 4 79m - 1	50m - 1	08/25/2014 - 12/16/2014	36	08/25/2014 - 01/22/2015	-	
	QUL-80	Investigation	-	-	-	-	-	-	1	08/23/2014	-	
	QUL-81	Residential	3	0	08/24/2014 - 10/19/2014	-	-	-	-	-	-	
	QUL-82	Residential	-	-	-	1	0	08/25/2014	-	-	-	
	QUL-83	Residential	-	-	-	1	0	08/25/2014	-	-	-	
	QUL-84	Residential	-	-	-	1	0	08/25/2014	-	-	-	
	QUL-85	Residential	-	-	-	1	0	08/25/2014	-	-	-	
	QUL-86	Residential	-	-	-	1	0	08/25/2014	-	-	-	
	QUL-87	Routine	11	3	08/25/2014 - 11/18/2014	13m - 1 20m - 1 25m - 2 40m - 8 50m - 7 53m - 1 55m - 2 57m - 1	25m - 1 40m - 1	08/25/2014 - 11/18/2014	12	08/25/2014 - 11/18/2014	-	
	QUL-88	Residential	-	-	-	2m - 1	0	08/26/2014	-	-	-	
	QUL-89	Residential	-	-	-	1m - 1	0	08/27/2014	-	-	-	
	QUL-90	Residential	1	0	08/27/2014	-	-	-	-	-	-	
	QUL-91	Residential	1	0	08/28/2014	-	-	-	-	-	-	
	QUL-92	Residential	1	0	08/28/2014	-	-	-	-	-	-	
	QUL-94	Residential	4	0	08/28/2014 - 10/28/2014	-	-	-	-	-	-	
	QUL-96	Investigation	1	0	09/03/2014	77m - 1	0	09/03/2014	-	-	-	
	QUL-101	Residential	-	-	-	1	0	09/01/2014	-	-	-	

			Samples - Surface			Samples - Depth			Profiles			
Area	Station Name	Sample Location Type	Number of Samples	Duplicate Samples	Date Range (mm/dd/yyyy)	Number of Samples	Duplicate Samples	Samples - Depth (mm/dd/yyyy))	Number of Profiles	Date Range (mm/dd/yyyy)	Continuous Logger Data	Comments
	QUL-102	Residential	-	-	-	1	0	09/04/2014	-	-	-	
	QUL-103	Residential	1	0	10/11/2014	1	0	09/04/2014	-	-	-	
	QUL-104	Residential	1	0	09/10/2014	-	-	-	-	-	-	
	QUL-105	Residential	2	1	09/11/2014 - 09/22/2014	-	-	-	-	-	-	
	QUL-106	Investigation	-	-	-	-	-	-	1	09/14/2015	-	
	QUL-107	Residential	-	-	-	2m - 2	2m - 1	09/15/2014 - 10/10/2014	-	-	-	
	QUL-108	Residential	-	-	-	1	0	09/15/2014	-	-	-	
	QUL-109	Residential	-	-	-	1	0	09/15/2014	-	-	-	
	QUL-110	Investigation	1	0	09/20/2014	-	-	-	1	09/13/2014	-	
	QUL-111	Residential	1	0	09/19/2014	-	-	-	-	-	-	
	QUL-112	Routine	11	0	09/20/2014 - 12/04/2014	30m - 1 40m - 10 80m - 11 120m - 1	30m - 1 40m - 1 80m - 1	09/20/2014 - 12/04/2014	11	09/20/2014 - 12/04/2014	-	Alternate to QUL-112a
	QUL-112a	Routine	2	0	11/13/2014 - 12/11/2014	40m - 2 80m - 2 120m - 2 230m - 2	230m - 1	11/13/2014 - 12/11/2014	2	11/13/2014 - 12/12/2014	-	Alternate to QUL-112a
	QUL-113	Residential	1	0	09/20/2014	2m - 3	-	09/20/2014 - 10/10//2014	-	-	-	
	QUL-114	Residential	1	0	09/20/2014	-	-	-	-	-	-	
	QUL-115	Residential	1	0	09/20/2014	-	-	-	-	-	-	
	QUL-116	Residential	1	0	09/20/2014	-	-	-	-	-	-	
	QUL-117	Residential	1	0	09/20/2014	-	-	-	-	-	-	
	QUL-119	Routine	6	2	09/21/2014 - 09/11/2014	20m - 1 40m - 5 80m - 5 98m - 1	0	09/21/2014 - 11/09/2014	6	09/21/2014 - 11/09/2014	-	
	QUL-120	Routine	8	1	09/21/2014 - 12/04/2014	35m - 1 40m - 7 80m - 7 88m - 1	40m - 1	09/21/2014 - 12/04/2014	8	21/09/2014 - 12/04/2014	-	Alternate to QUL-120a
	QUL-120a	Routine	4	0	10/11/2014 - 12/11/2014	40m - 4 80m - 4 120m - 4 160m - 1 190m - 2 200m -1	160m - 1 190m - 1	10/11/2014 - 12/11/2014	4	10/11/2014 - 12/17/2014	-	Alternate to QUL-120
	QUL-121	Investigation	-	-	-	16m - 1	0	09/21/2014	-	-	-	
	QUL-124	Residential	1	1	09/21/2014	-	-	-	-	-	-	
	QUL-131	Investigation	1	0	10/09/2014	30m - 1 80m - 2	-	10/09/2014	1	10/09/2014	-	
	QUL-132	Investigation	-	-	-	-	-	-	1	10/08/2014	-	
	QUL-133	Investigation	-	-	-	-	-	-	1	10/08/2014	-	
	QUL-134	Investigation	-	-	-	-	-	-	1	10/08/2014	-	
	QUL-136	Investigation	1	0	10/12/2014	40m - 1 80m - 1	-	10/12/2014	1	10/12/2014	-	
	QUL-138	Residential	-	-	-	2m - 1	0	12/01/2014	-	-	-	
	QUL-ZOO-8	Routine	4	0	10/05/2014 - 11/13/2014	40m -4 80m - 4 120m - 3 160m - 1 200m - 1 240m - 2	80m - 1	10/05/2014 - 11/13/2014	4	10/05/2014 - 11/13/2014	-	Alternate to QUL-ZOO-8a
	QUL-ZOO-8a	Routine	2	0	10/09/2014 - 10/26/2014	40m - 2 80m - 2 120m - 1 240m - 1	0	10/09/2014 - 10/26/2014	2	10/09/2014 -10/ 26/2014	-	Alternate to QUL-ZOO-8
	Raft Creek Rec Site	Investigation	1 - bacteriology only	0	08/07/2014	-	-	-	N/A	N/A	-	
Blackwater Creek	BLC	Reference	1	0	10/01/2014	N/A	N/A	N/A	N/A	N/A	-	
Cariboo River	CAR	Reference	1	0	10/01/2014	N/A	N/A	N/A	N/A	N/A	-	
	CAR-1	Reference	1	0	08/01/2014	N/A	N/A	N/A	N/A	N/A	-	
	CAR-01	Reference	1 - field parameters only	0	11/15/2014	N/A	N/A	N/A	N/A	N/A	-	
	CAR-02	Reference	1 - field parameters only	0	11/15/2014	N/A	N/A	N/A	N/A	N/A	-	
	CAR-03	Reference	1 - field parameters only	0	11/15/2014	N/A	N/A	N/A	N/A	N/A	-	
Clearwater River	CLR	Reference	1	0	10/01/2014	N/A	N/A	N/A	N/A	N/A	-	
Horsefly River	HOR	Reference	1	0	10/11/2014	N/A	N/A	N/A	N/A	N/A	-	

Notes:

1) Cells highlighted in blue are currently being monitored in the 2015 monitoring program.

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MEMORANDUM

TO:	Mount Polley Mining Corporation	**Date:**	June 5, 2015
C.C.:			
FROM:	Prepared by: J. Lu, M.Sc., Project Scientist L. McOrmond, B.Sc., Project Scientist Reviewed By: E. Jancicka, P.Chem., Project Manager C. Robinson, Ph.D., R.P.Bio.	**Ref.:**	621717
Subject:	Summary of Data Quality Assurance / Quality Control and Field Methods for the Mount Polley Water Quality Monitoring and Sampling Program		

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ATTACHMENTS

June 5, 2015
621717

1. INTRODUCTION

The objective of this memorandum is to document the field sampling methods and data quality assurance / quality control (QA/QC) measures implemented during the water quality monitoring and sampling program following the Mount Polley Mine (Mine) Tailings Storage Facility (TSF) breach. The following program components are summarized:

- A summary of the QA/QC methods and their implementation;
- A description of field methods used to collect water quality data;
- A summary of the data management systems used; and
- A summary of qualifications of water quality monitoring and sampling team members.

2. QUALITY ASSURANCE / QUALITY CONTROL

The Environment & Water Division of SNC-Lavalin Inc. (SNC-Lavalin) assisted Mount Polley Mining Corporation (MPMC) with the development and implementation of a QA/QC program during the water quality monitoring and sampling program following the TSF breach. SNC-Lavalin staff was directly involved in the field data collection program from August 22, 2014 to November 19, 2014, and with the data management and QA/QC review for sampling dates from August 4, 2014 to December 19, 2014. Quality assurance (QA) included management and technical practices designed to confirm that data were commensurate with the objectives of the water quality program and that data were scientifically tenable. The quality control (QC) included specific data quality objectives (DQOs), statistical assessment of data quality, and corrective measures taken whenever the DQOs were not met.

The following sections detail the QA/QC program implemented during the water quality monitoring and sampling program. The project-specific data integrity and management plan and QA/QC flow chat, Attachment 1, were used as guidance documents during the field sampling program.

2.1. Field Data Collection and Document Control

Water quality data were collected using a range of field sampling and monitoring equipment. Equipment was used in accordance with manufacturer's recommendations and MPMC Standard Operating Procedures and Work Methods, inspected daily, and maintained in good working condition. Calibration information including calibration results, standard solution information, and equipment comments or concerns was recorded on calibration logs for each piece of equipment used during the program. For full equipment methodologies and calibration details, refer to sections 3.1 through 3.3.

Field data related to the water quality program for the Mount Polley TSF breach were collected and tracked using multiple field forms developed or adapted for use on this project. Forms were used for field data collection, including water sample collection details, lake profile data collection, equipment calibration, and daily observations tracking. Field data and samples were collected by staff from SNC-Lavalin, MPMC, Minnow Environmental Inc., Cariboo Environmental Quality and Tetra Tech EBA. Field forms were reviewed by SNC-Lavalin staff daily to confirm that records were filled out in full, and were consistent with other information submitted. Field forms were filed and saved electronically according to date and area of interest. Individual samples were tracked using spreadsheets to record the locations of samples, frequency of sampling, duplicate and blank sample information, sample shipping information, laboratory correspondence, and QA/QC issues. Examples of field forms and tracking forms are included in Attachment 2. Details related to sample procurement and handling are summarized in section 3.5.

2.2. Analytical Laboratory

A Canadian Association for Laboratory Accreditation Inc. (CALA) accredited laboratory, ALS Environmental (ALS) of Burnaby, BC, was used to analyze the water samples. Water samples submitted were tracked for adherence to laboratory sampling and analysis protocols, including hold times, sample containers, preservatives, detection limits, and approved methodology. Details regarding laboratory protocols are available from ALS upon request.

The laboratory QA/QC program included the analysis of laboratory method blanks, laboratory sample duplicates, surrogate recovery, and chemical spikes. The laboratory method blank analysis was used to detect interferences or impurities introduced by laboratory equipment, reagents, or solvents. Surrogate recovery was analyzed by spiking samples with known quantities of surrogate chemicals that have similar chemical properties to the parameters being analyzed. The reported recovery provided an indication of the analytical method accuracy. Chemical spikes were conducted by adding known concentrations of the analyte of interest to a sample to evaluate the effects of the sample matrix on the analytical method. The analysis of selected samples in duplicate was used to evaluate the reproducibility of the analytical method.

Results of the laboratory's QC performance (standards, spike recoveries, etc) were requested to be included in the analytical results reports, and were reviewed to confirm results were within acceptable limits. Instances of non-conformity to laboratory QA limits required additional analysis to confirm the quality of the initial result.

Prior to sample submission, chain-of-custody (CoC) forms were prepared and checked by field staff to ensure sample IDs, sample time, hold time, preservative and sample storage temperatures were correctly entered. To avoid transcription errors that may be introduced during laboratory internal process, electronic CoC forms were used for samples collected after September 24, 2014.

A sample tracking sheet was used to record field and laboratory related information, including sample IDs and dates, sample shipped and received dates, laboratory report and sample IDs, and QA/QC notes in laboratory sample receipt confirmation (SRC) forms and lab reports.

Upon receipt of each SRC from the laboratory, details were compared against CoCs including sample IDs and dates, recording of all requested analyses, and sample integrity or hold time issues. Follow up correspondence and corrective actions were initiated in the case of any discrepancies.

Upon receipt of each certificate of analysis (COA) from the laboratory, analyses completed were checked against CoCs. A thorough review of the laboratory QA/QC notes was also completed to confirm that analytical results were reported within acceptable quality control limits. Re-analyses were requested if any results reported outside of the DQO were potentially due laboratory sample handling and procedures.

Laboratory method detection limits (MDLs) for all parameters analyzed, as well as counts of the number of samples for which each MDL was reported, are included in Attachment 3. Elevated MDLs were noted during data review and checked for consistency against the laboratory's comments on each COA. Elevated MDLs were primarily due to adjustments for required dilution as a result of sample turbidity. If a reported MDL exceeded a comparison criterion, the result was footnoted during data tabulation.

2.3. QA/QC Samples

Quality control samples collected during the water quality sampling program included blind field duplicate samples, equipment blanks, filter blanks, field blanks, deionized (DI) water blanks and trip blanks.

- Blind field duplicate samples were samples collected at the same location and time by the same sampler and using the same sampling procedure and equipment. Duplicate samples were used to check the reproducibility of field and laboratory procedures, and to indicate sample heterogeneity.
- Equipment blanks contained DI water that was transferred to the appropriate sample container after passing through the decontaminated field sampling equipment. Equipment blanks were used to assess whether sampling equipment was introducing a source of potential contamination.
- Filter blanks contained DI water that had passed through the filter used to collect samples for dissolved metals analysis. Filter blanks were used to assess whether the filters being used were introducing a source of potential contamination.
- Field blanks contained analyte-free water prepared in bottles by ALS that was exposed to the atmosphere and ambient conditions at a specific sampling location by opening the bottles. These blanks were used to quantify the potential exposure to contaminants from airborne or other sources potentially associated with ambient conditions at the sampling location.
- DI water blanks contained DI water transferred to the appropriate sample container. These blanks were used to determine the quality of the DI water and to confirm its suitability for use in decontamination procedures.
- Trip blanks contained analyte free water prepared in bottles by ALS that traveled to and from the site or sampling location without breaking the seal of the bottle. Trip blanks were used to assess the potential for contamination from sample handling, shipping, and laboratory analytical procedures.

The target frequencies of duplicate samples and blanks that were adopted for the QA/QC program are summarized in Table A below. As the sampling program proceeded, the observed quality and reproducibility of data as well as the size of the data set supported performance-based decisions to reduce the frequency of duplicate and blank samples. Initial and final target frequencies are indicated in Table A.

Table A: QA/QC Duplicate and Blank Target Frequencies

QA Sample Type	Initial Target Frequency	Final Target Frequency	Applicable Parameters
Blind Field Duplicates	Every 10 samples	Every 10 samples	All parameters
Equipment Blanks	Every 20 samples or per equipment	Weekly	All parameters
Filter Blanks	Weekly	Weekly	Dissolved Metals
Field Blanks	Every 20 samples	Weekly (rotate sample areas)	All organic parameters
DI Water Blanks	Weekly	Monthly	Total Metals
Trip Blanks	Weekly	Weekly (rotate sample areas)	Volatiles only

A summary of duplicate and blank frequencies achieved during the program is included in section 2.4.

2.3.1. Data Quality Objectives

In order to assess blind field duplicate results relative to DQOs, SNC-Lavalin calculated the practical quantitation limit (PQL) which was defined as five times the laboratory method detection limit (MDL). For analytes in blind field duplicate sets where concentrations were above the PQL, the relative percent difference (RPD) was calculated as described below. Because analytical error increases substantially when results approach the PQL, RPDs were not considered meaningful and were not calculated if one or both concentrations in a duplicate set were below the PQL.

RPD values were calculated using the following equation:

$$RPD\ (\%) = \frac{|X_x - X_y|}{\bar{X}} \times 100$$

Where X_x= the concentration of the original sample

X_y= the concentration of the blind field duplicate sample

The acceptance criteria for RPDs between blind duplicate samples for water parameters were defined as 1.5 times the laboratory RPD criteria for this program, as summarized in Table B below.

Table B: Duplicate Sample RPD Acceptance Criteria

Analyte Group	RPD Acceptance Criterion
Metals	30%
Inorganics	30%
Organics	45%
Other parameters	1.5 X Laboratory RPD

2.4. Summary of QA/QC Sample Results

A summary of frequencies and results for QA/QC samples collected during the program is provided below.

2.4.1. Duplicate and Blank Sample Frequencies

The frequencies of duplicate and blank samples that were collected during the water sampling program are indicated in Table C below.

Table C: QA/QC Duplicate and Blank Achieved Frequencies

QA Sample Type	Quesnel Lake	Polley Lake	Hazeltine Creek	Program Total
Regular Samples	1,354	128	154	1,636
Blind Field Duplicates	103 (7.6%)	14 (11%)	12 (7.8%)	129 (7.9%)
Equipment Blanks	29	3	0	32 (average 1.6 / week)
Filter Blanks	17	0	0	17 (average 0.9 / week)
Field Blanks	32	3	7	42 (average 2.1 / week)
DI Water Blanks	10	0	0	10 (average 2 / month)
Trip Blanks	9	2	6	17 (average 0.9 / week)

2.4.2. Relative Percent Differences

Blind duplicate sample sets for which RPD values exceeded the DQO are summarized in Attachment 4, and are separated by type of RPD issue and by sampling area.

As outlined in Attachment 4, RPD exceedances were generally attributable to the following causes:

- Laboratory related QA/QC issues;
- Potential contamination from field sampling equipment (i.e., high equipment blanks); and
- Poor repeatability between the field duplicate samples.

Once an RPD exceedance was identified, the associated results were subsequently compared to comparison guidelines, and the laboratory was contacted if one or both concentrations were greater than comparison guidelines. For RPD exceedances due to laboratory related issues, corrective action was initiated by reanalyzing the batch of affected samples.

2.4.3. Blank Sample Issues

Analytical results indicated that all filter blanks, field blanks, DI water blanks and trip blanks were within the specific DQOs.

Some equipment blank issues were identified during the sampling program, as listed in Attachment 4. These blanks contained concentrations of some analytes greater than the PQL, which was defined as the DQO for blank samples. Field samples collected on these days were flagged as potentially contaminated by sampling equipment. Some of the analytical results for these samples were also flagged as having RPD issues, as listed in Attachment 4. Equipment blank issues were subsequently resolved through review of methods (including more thorough equipment decontamination), field audits and discussions with field staff.

2.4.4. Laboratory QA Results

In addition to the RPD issues identified in Attachment 4, several samples were noted as having dissolved metals concentrations greater than total metals concentrations. SNC-Lavalin followed up with the lab on these results, but a root cause was not determined.

3. FIELD MONITORING AND SAMPLING METHODOLOGY

The sections below outline methodologies implemented for the collection of field data and samples during the water quality field program.

3.1. Monitoring and Sampling Locations

Station locations were navigated to and recorded in the field using a Garmin handheld GPS unit. Coordinates for each new station were recorded on field forms and saved in a tracking spreadsheet. Coordinates for new stations were programmed into other onsite field GPS units for future sampling visits. Coordinates were used to generate drawings showing station locations to date, which were subsequently verified by field staff. Station locations were uploaded into SNC-Lavalin’s database and associated with the relevant samples at each station.

Sample ID nomenclature used prefixes that were related to the subject study area from which the samples were collected. Sample prefixes for each area included: QUR (Quesnel River), QUL (Quesnel Lake), POL (Polley Lake), HAC (Hazeltine Creek), and HAD (Hazeltine Creek Discharge). The sample IDs were uploaded to the SNC-Lavalin database.

3.2. Water Quality Monitoring and Column Profiling

3.2.1. YSI EXO1 and YSI EXO2

YSI EXO sondes were used to collect water quality data which were stored on the sonde units themselves or the handheld, depending on the application, and then transferred to the EXO handheld unit, and/or transferred to an onsite MPMC computer. Data were collected using user-replaceable sensors which measured up to six different parameters at one time. The parameters measured are outlined in sections 3.2.1.1 through 3.2.1.9. A qualified representative from the YSI EXO vendor, Hoskin Scientific, was contracted to come to the Mine for a day to carry out a training workshop on calibration, use, care, and maintenance of this equipment.

The YSI EXO units can be used to collect data using multiple logging methods. During the course of the water quality monitoring program, data were collected in four different ways. Initially, water quality data were collected by recording information from the YSI EXO handheld unit directly onto field forms by hand.

After approximately one month, the water quality team switched to manual logging data on the handheld, which involved lowering the sonde to a desired depth and capturing the data point on the handheld unit. This generated a data set for a specific location at different depths which was subsequently uploaded to an onsite MPMC computer.

The casting method was also used to collect data, which involved adjusting the settings on the sonde to collect data at specific time intervals and lowering the sonde into the water at a rate of approximately 1 metre per second (m/s). During the water quality monitoring program, the sonde was programmed to collect data every 0.25 seconds. The procedure for this data collection method involved placing the boat approximately 50 m upwind of the desired station(to account for drift), determining the depth of the water using depth detectors, and lowering the sonde at a rate of 1 m/s, stopping 2 m above the bottom. The sonde was then retrieved at the same rate. Parameters were recorded during both the down-cast and the up-cast. Depth was monitored using a metered rope attached to the sonde. This procedure was completed twice, creating two sets of data which could then be compared for data variability and reliability. If the sonde made contact with the bottom during the first cast (because depth to bottom was too deep to be determined using a depth detector), it was cleaned by performing a surface water rinse and wiping the sonde with a Kimwipe®. During the casting process, boat operators attempted to hold the boat in position; however, if significant drift occurred during the cast, the operator slowly manoeuvred the boat until the line was less than 10 degrees from vertical. Drift was recorded on field sheets. Data collected using these methods were uploaded to an onsite MPMC computer at the end of each day.

The final logging method, continuous monitoring, involved permanently installing a YSI EXO sonde at a specific location within a body of water and programming it to record data at specific time intervals. This method was only used at one location, QUR-1, located in Quesnel River. Data was collected every 15 minutes for the duration of the water quality sampling program, and was downloaded to an onsite MPMC computer and reviewed approximately once per week. At this location, readings of temperature, specific conductivity, pH, dissolved oxygen (DO) and turbidity were also manually recorded onto field forms or captured on the YSI EXO handheld daily when samples were being taken. The continuous logging sonde was cleaned approximately monthly and data were compared to laboratory results, with sensors being calibrated as necessary based on the results of these comparisons.

3.2.1.1. Depth Measurements

The YSI EXO2 sonde and one of two YSI EXO1 sondes were used to measure water depth in metres (m) which was verified in the field manually by counting metre marks along the length of the deployment cord. The other YSI EXO1 sonde did not have depth capabilities, and depth was measured manually when using this sonde. When performing the manual logging method using the YSI EXO1, depth measurements were recorded on the field forms and then added to the electronic data set by hand, and subsequently checked for QA/QC.

3.2.1.2. Temperature

The YSI EXO1 and YSI EXO2 units were fitted with temperature sensors which recorded the temperature of the water in degrees Celsius (^{o}C). According to the manufacturer, temperature sensors do not require calibration or maintenance.

3.2.1.3. Specific Conductivity

Specific conductivity is a measure of a solution's ability to conduct electricity, adjusted for the temperature. Measuring the specific conductivity gives an indication of the ionic content in a solution and is closely linked to the total dissolved solids within a solution. The YSI EXO units were fitted with specific conductivity sensors which measured in units of micro-Siemens per centimetre (µS/cm). Checks of the sensors were conducted at the start and end of each day using a standard solution of 1,413 µS/cm. Specific conductivity sensors were calibrated weekly, as per manufacturer's recommendations, or when necessary based on the results of the daily checks. Calibration and daily check information including date, time, temperature, cell constant value, YSI QC score, and user initials were recorded on calibration forms for each YSI EXO unit.

3.2.1.4. pH

The pH of water is a measure of how acidic or basic it is and ranges from 0 (acidic) to 14 (basic). pH is a measure of the relative amount of free hydrogen and hydroxyl ions in the water. The YSI EXO units were fitted with pH sensors which were calibrated daily using standard solutions of pH 4, pH 7 and pH 10 as per manufacturer's recommendations. End of day checks were also conducted to document drift over the course of a day. Calibration and daily check information including date, time, temperature, YSI QC score, standard solutions used, and user initials were recorded on calibration forms for each YSI EXO unit.

3.2.1.5. Dissolved Oxygen

DO is a measure of the total free, non-compound oxygen present in water and is an indicator of water quality which can affect aquatic life. The YSI EXO units were fitted with dissolved oxygen sensors which measured the concentration of dissolved oxygen in water in units of milligrams per litre (mg/L) and percent air saturation.

Sensors were calibrated daily in the field at the sample area to account for changes in barometric pressure. Calibration information including date, time, temperature, pre and post percent saturation, and user initials were recorded on calibration forms for each YSI EXO unit or in the field notes.

3.2.1.6. Oxidation-Reduction Potential

Oxidation-reduction potential (ORP) can affect the chemical (ionic) form of elements and compounds, which may influence their behaviour in the environment. ORP levels are measured in millivolts (mV), and range from -2,000 mV to +2,000 mV. The YSI EXO units were fitted with ORP sensors which estimated ORP based on the total dissolved oxygen concentrations in the water.

ORP sensors were checked and calibrated approximately monthly, using a standard solution of 240 mV. Calibration and check information including date, time, temperature, standard solution, pre and post ORP values, QC score, and user initials were recorded on calibration forms for each YSI EXO unit.

3.2.1.7. Turbidity

Turbidity is a measure of the clarity of water. YSI EXO units were fitted with turbidity sensors which measured the turbidity of water by measuring the amount of light that is scattered by suspended particles in the water column. Turbidity readings were recorded in Formazin turbidity units (FNU) or Nephelometric Turbidity Unit (NTU).

Checks were conducted on the sensors at the start and end of each day using standard solutions of 0 FNU, 12.4 FNU and/or 124 FNU, or comparisons with a calibrated La Motte turbidity meter. Turbidity sensors were calibrated as necessary, when the results of the daily checks indicated instrument drift. Calibration and daily check information including date, time, temperature, standard used, pre and post standards values, and user initials were recorded on calibration forms for each YSI EXO unit.

3.2.1.8. Total Algae and Chlorophyll

Total algae concentration is a measure of the total algal biomass within a unit of water, including planktonic algae and cyanobacteria. Algae concentrations can affect water quality and ecosystem function by reducing nitrogen and carbon concentrations and by depleting dissolved oxygen. The YSI EXO units were fitted with total algae sensors which measured both chlorophyll a and levels of blue-green algae using optical sensors.

Calibration was conducted by using DI water to zero the sensor and using the factory default calibration slope. This method of calibration provided relative data only; algae results were used as a guide to measure fluctuations in algal concentration throughout the water column, rather than as definitive values.

3.2.2. LaMotte 2010 and 2020 Portable Turbidity Meters

The LaMotte turbidity meters are portable devices used to measure the turbidity of water, in units of FNU or NTU. The LaMotte meters can measure turbidity ranging from 0 to 4,000 FNU/NTU by measuring the amount of light that is scattered from suspended particles in the water column. Calibration of LaMotte units was conducted daily, at a minimum, according to manufacturer's recommendations, using standard solutions of 0 NTU, 1 NTU, and 10 NTU.

During the course of the water quality sampling program, the calibrated LaMotte turbidity meters were periodically used as a reference measurement to confirm the validity of the YSI EXO turbidity values. Values were recorded manually onto field forms for each sample location, as well as in the calibration logs for each YSI EXO unit.

3.2.3. WTW Portable Handheld Meter

A WTW portable handheld meter (WTW) was used to measure the conductivity, pH, and DO in water. The WTW was used during the course of the water quality sampling program to collect data from Polley Lake surface, Hazeltine Creek and the Hazeltine Creek Discharge area. Readings were recorded manually onto field forms for each sample location.

Calibration of the WTW pH probes was conducted daily using solutions of pH 7 and pH 10 for pH calibration, and post check were completed at the end of the day. Conductivity probes were calibrated weekly using a 1,413 µs/cm standard. Calibration information including date, time, temperature, standard solution information, calibration results, and user initials were recorded on calibration forms for each WTW unit.

3.2.4. Secchi Disk

A Secchi disk is a 20 cm diameter disk with alternating black and white quadrants which is used to measure the clarity of water. Secchi disks at the end of a rope marked in meters were lowered into the water on the shady side of the boat. Depths were recorded when the disk was no longer visible, and again when the disk reappeared. The average of these two readings was recorded as the "Secchi depth" at each location, and was considered a relative measure of water clarity. Secchi depths were recorded at each non-shoreline station on Quesnel Lake and Polley Lake during each monitoring and sampling event. Surface conditions which may have affected visibility were recorded at each station, including ripples, wind conditions, and relative brightness of the sun. A dedicated observer was responsible for collecting Secchi depths each day, in order to minimize the variability in readings between stations.

3.3. Water Sampling

The following sections outline the methods implemented for the collection of water samples and submission for laboratory analysis. Sampling methods were based on MPMC Standard Operating Procedures and Work Methods and SNC-Lavalin Preferred Operating Procedures, which are generally based on the BC Field Sampling Manual.

For the specific water sample collection methods outlined below, general procedures were implemented, including but not limited to:

- Wearing clean nitrile gloves when collecting samples and switching gloves between each sample.
- The use of clean and decontaminated sampling equipment. Equipment was cleaned daily performing a DI water rinse and by rinsing with surface water at each location between samples.
- The use of laboratory approved bottles for each specific parameter. Bottles were certified clean, supplied by ALS, and shipped to MPMC upon request.
- Performing a triple rinse, using sample water, of laboratory supplied 1 liter plastic sample bottles.
- The use of laboratory approved preservatives for parameters that required field preservation. Preservatives were measured by ALS Laboratory for correct volume, labeled, and supplied to MPMC upon request.

- The use of laboratory approved syringes and 0.45 µm filter disks when collecting samples which required field filtering (dissolved metals). Syringes and filter disks were certified clean, supplied by ALS Laboratory, and shipped to MPMC upon request. Field filtering involved removing the plunger portion of the syringe, attaching the filter disk to the tip, and collecting water in the chamber of the syringe. The plunger was then used to push water through the filter disk and into the sample bottle. A new syringe and filter was used for each sample collected.

- Ensuring proper labeling of each sample bottle including sample ID, client, date, parameter, and preservative was complete and accurate.

- Maintaining sample temperatures below 4^{o}C by storing samples in coolers with ice packs while in the field and during shipping and in refrigerators overnight.

3.3.1. Manual Grab Sampling

Manual grab sampling was used to collect samples of surface water, and involved manually filling laboratory approved bottles for each sampling parameter at the surface of the water, using extension tools to hold the bottles as required.

3.3.2. Kemmerer and Van Dorn Samplers

Kemmerer and Van Dorn water bottle samplers were used to collect water samples from discrete depths below the surface. Although slightly different in shape and size, both water bottle samplers were made from similar materials (acrylic tube with silicone seals on either end), and were operated using the same general principles. Both water bottle samplers were attached to a marked rope. The seals were propped open and the unit was lowered into the water, allowing the water to flow in and out of the tube at either end. Once the unit was at the desired depth, a metal messenger weight was wrapped around the rope and slid down the length of the rope. As the messenger contacted the Kemmerer or Van Dorn sampler, the end seals were released and the tube snapped shut, capturing the water at that specific depth. The water sample was then retrieved to the boat and water was released into the appropriate sample containers through a small spout on the side of the unit. Both units were decontaminated daily using DI water, and were rinsed with surface water at each station prior to sampling.

3.3.3. Teledyne ISCO 6712 Full Size Portable Sampler

The automated ISCO sampler was used to collect water samples from a specific location at programmed time intervals. The unit consisted of a plastic sampling tube, which was placed into the water at the desired sample location and depth. The tube was connected to the sampling unit, a hard plastic shell containing a digital controller, sampling arm, and 24 – 1 litre (L) plastic bottles. Sampling intervals were programmed into the digital recorder, which instructed the unit to intake water through the tube and the sampling arm to fill one of the 1 L bottles at each desired sampling time. Samples were kept below 4^{o} C by placing ice packs next to the 1 L bottles inside of the unit.

The ISCO sampler was used at QUR-1 in the Quesnel River from August 12, 2014 through October 1, 2014 during the water quality sampling program. The sampling tube was suspended beneath the surface of the water by attaching it to metal bars which were driven into the riverbed. The tube was inspected daily to assess that the water level had not dropped below the tube, and that the tube had not shifted deeper into the water column. The sampling frequency was set to one sample every 8 hours (three samples per day). The samples were retrieved from the ISCO sampler daily, at which time the ice packs were replaced, the samples were transferred into bottles for laboratory analysis, and the 1 L bottles were rinsed with DI water.

3.4. Residential Water Quality Sampling

3.4.1. Residential Intake Sampling

Water samples for the residential water quality sampling program were collected from residential properties on Quesnel Lake. At each property visited, water samples were collected using a Kemmerer or Van Dorn samplers. Depending on the location of water intakes, samples were collected either from the sampling boat at a point approximately 1 m above the water intake point, or from the residents' dock. Details regarding Kemmerer and Van Dorn sampler methodologies are noted in section 3.3.2.

3.5. Sample Procurement and Handling

Water samples for specific parameters were collected using the methodologies, sampling bottles and preservatives listed in Table D below. Samples were placed into ice-chilled coolers and shipped to ALS for analysis under chain-of-custody documentation. Samples were shipped approximately daily (generally on weekdays, with limited weekend shipping as required), on a sufficient frequency to meet parameter hold times as listed in Table D below.

Table D: Parameter-Specific Sampling Methods

Parameter	Methodology	Bottles	Preservation	Hold Time
Dissolved Metals	Use a syringe and 0.45 µm filter disks	1 x 250 mL Plastic	HNO_3	6 months
Total Metals	Typical grab sampling techniques	1 x 250 ml Plastic	HNO_3	6 months
Total Mercury	Typical grab sampling techniques	1 x 40 ml Glass Vial	HCl	28 days
Anions (Cl, SO4, F)	Triple rinse container with sample water before collection	1 x 1L Plastic	N/A	28 days
Total Alkalinity*	Triple rinse container with sample water before collection	1 x 1L Plastic	N/A	14 days
Nitrate/Nitrite*	Triple rinse container with sample water before collection	1 x 1L Plastic	N/A	72 hours
Phosphorus *(dissolved)	Triple rinse container with sample water before collection	1 x 1L Plastic	N/A	72 hours
Phosphorus *(total reactive, ortho-PO4)	Triple rinse container with sample water before collection	1 x 1L Plastic	N/A	72 hours
Total Nitrogen, Ammonia, Total Phosphorous	Typical grab sampling techniques	1 x 250 ml Amber Glass	H_2SO_4	28 days
Dissolved Organic Carbon	Typical grab sampling techniques	1 x 120 ml Amber Glass	H_2SO_4-after filtration	28 days
Speciated Chromium	Typical grab sampling techniques	1 x 125 ml Plastic	NaOH	30 days
Coliforms & E.Coli	Typical grab sampling techniques	1 x 250 ml Plastic	$Na_2S_2O_3$	24-48 hours
EPH	Typical grab sampling techniques	2 x 500 ml Amber Glass	$NaHSO_4$	14 days
Glycols	Typical grab sampling techniques	2 x 40 ml Glass Vial	N/A	7 days

Table D (Cont'd): Parameter-Specific Sampling Methods

Parameter	Methodology	Bottles	Preservation	Hold Time
Non-anionic surfactants	Typical grab sampling techniques	1 x 500 ml Amber Glass	N/A	2 days
Total xanthates	Typical grab sampling techniques	2 x 125 ml Amber Glass	N/A	No standard hold time
Floatation Agents**	Typical grab sampling techniques	2 x 40 ml Glass Vial	$NaHSO_4$	14 days
Chlorophyll-a	Immediately wrap entire sample bottle in tinfoil to prevent light from entering. Not field filtered (filtered in lab)	1 x 250mL Plastic	N/A	48 hours for filtration in lab

* Sampled as part of the Nutrient package.
** Includes acetone, carbon disulfide, heptanes, 2-hexanone, methyl ethyl ketone, methyl isobutyl ketone, 4-methyl-2-pentanol, octane, pentane, 1,2,3-trimethylbenzene

4. DATA MANAGEMENT

For the Mount Polley project, analytical and field data, including station location information, were uploaded to SNC-Lavalin's proprietary environmental management information system, known as esMECI.

esMECI consolidates monitoring and analytical data into a central database for ease of management, analysis and reporting. Data are imported into the system directly from the digital Excel files received from the laboratories, which minimizes the potential for manual keying errors. esMECI also incorporates numerous quality control features to further enhance data confidence.

During the course of the project, information uploaded into esMECI included the following:

- Station location coordinates;
- Sample identification information (e.g., Sample ID, date, depth, duplicate coding);
- Field measurements (i.e., temperature and pH); and
- ALS laboratory analytical results.

Water quality analytical data and field measurements were exported from esMECI into Excel tables on a weekly basis for presentation to MPMC. Tabulated analytical data were compared to selected regulatory comparison guidelines for reference purposes and weekly reporting to third parties. RPDs for blind field duplicate samples were calculated by esMECI during table generation. Results tables were then reviewed manually and compared to the laboratory analytical reports and field notes as a QA/QC measure.

Water column profile field data were entered onto Excel tables manually from field notes, or from YSI EXO files without processing, through esMECI.

5. STAFF QUALIFICATIONS

A summary of qualifications for staff directly involved in water quality data generation and management (SNC-Lavalin, MPMC and other companies) is included in Attachment 5.

6. ACRONYMS AND DEFINITIONS

CALA – Canadian Association for Laboratory Accreditation Inc.

CCME – Canadian Council of Ministers of the Environment

DI – deionized

DO – dissolved oxygen

DQO – data quality objectives

MDL – method detection limit

MPMC – Mount Polley Mining Corporation

ORP – Oxidation-reduction potential

PAH – polycyclic aromatic hydrocarbons

PQL – practical quantitation limit

pH – a measure of the alkalinity or acidity of water, measured on a scale of 1 to 14, with 7 being neutral, less than 7 acidic, and greater than 7 alkaline or basic

QA/QC – quality assurance / quality control

RPD – relative percent difference

TSF – tailings storage facility

7. REFERENCES

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ATTACHMENT 1

Data Integrity and Management Plan and QA/QC Flow Chart

DATA INTEGRITY AND MANAGEMENT FRAMEWORK
MT POLLEY CEIA, AUGUST 15, 2014

The data integrity and management framework (DIMF) will be implemented to track field monitoring data, field documentation, laboratory submissions, the receipt of analytical results, and to verify the quality of those analytical results. All field staff will review and implement the DIMF and relevant Preferred / Standard Operating Procedures (P/SOPs), or document instances where the DIMF cannot be implemented. Field staff will also review and implement relevant provincial guidance documents regarding sampling protocols and P/SOPs, which will be made available on a secure Sharepoint Site. A file sharing protocol is in development and will be integrated into the DIMF at a later time. The following principles make up the DIMF.

1. Work plans will be prepared for all phases of project work and will be executed by trained and qualified personnel.

2. Sample procurement and monitoring will be in accordance with P/SOPs (MPMC, SNC-Lavalin, Minnow, SRK, etc.) and, as applicable, with provincial and/or federal guidance and protocols as referenced in Pollution Abatement Order 107461.

3. Discipline leads will be responsible for ensuring the adequacy of the work plans and that P/SOPs are in place.

4. Field duplicate samples will be collected at an approximate 1 in 10 frequency (10%) for all key laboratory analytical parameters. Field blanks and equipment blanks will be collected at an approximate 5% frequency (1 in 20 samples) or every other day for continuous and similar sampling programs (i.e., water quality monitoring on Quesnel and Polley Lake). De-ionized water blanks and filter blanks are being tested by the batch on an approximate monthly basis. Laboratory soil duplicates (splitting in the lab) will be carried out.

5. A daily record of events will be maintained in bound field books including purpose, time, date, crew members, location, temperature, weather, and any changing ambient conditions that could affect sample integrity (i.e., rain, dust, etc.).

6. Potentially relevant observations regarding biological, geotechnical, or other environmental concerns will be documented and reported to the project coordinator on a daily basis for inclusion in the weekly report to the Project Management team and regulators. Photographs will be taken to support observations and also to provide representative documentation of each field program. All photographs will be saved according to the file sharing protocol, with key photographs labeled.

7. Sampling records will be filled out in full at the field at time of sample collection.

8. GPS waypoints will be recorded at all locations using equipment of suitable accuracy for the purposes of the studies being undertaken. In the event this is not possible, locations will be described in writing (i.e., address) or using a map of appropriate scale and use of identifiable landmarks.

9. Samples will be handled, stored, and transported in accordance with P/SOPs. This includes proper sample preservation including use of ice charged coolers (as required), protecting sample vessels as necessary, shipping within hold times, and use of Chain of Custody documentation. Caution will be taken shipping over weekends or near statutory holidays and should be generally avoided if possible.

10. Chain of Custody (COC) documentation will be filled out in full and submitted to the Data Coordinator at the end of each day along with photographs, field notes, sampling records, and any other relevant field documentation. Files will be stored in appropriate folders as per the file sharing protocol.

11. On a daily basis, the Data Coordinator will update a Sample Tracking Spreadsheet (STS) with sample information shown on submitted COCs including date and time of sampling, sample ID, media type (soil, sediment, water, biological parameters or tissues, etc.). To ensure ease of data management and cross referencing, the STS will be structured to allow data to be sorted by media, sample ID, and laboratory report number.

12. Using the STS, the data coordinator will track sample receipt confirmations and will follow up with the receiving laboratory if sample receipt confirmations (SRCs) are not received. Any deficiencies will be reported to the Project Data Manager (i.e., sample ID discrepancies, missed hold times, elevated temperatures) and corrective action taken to avoid further deficiencies.

13. Analytical report turn-around-time (TAT) will be tracked by the data coordinator and date of report receipt tracked. The laboratory analytical reports will be saved to an appropriate file folder structure on a secure Sharepoint site accessible by appropriate mine and project staff.

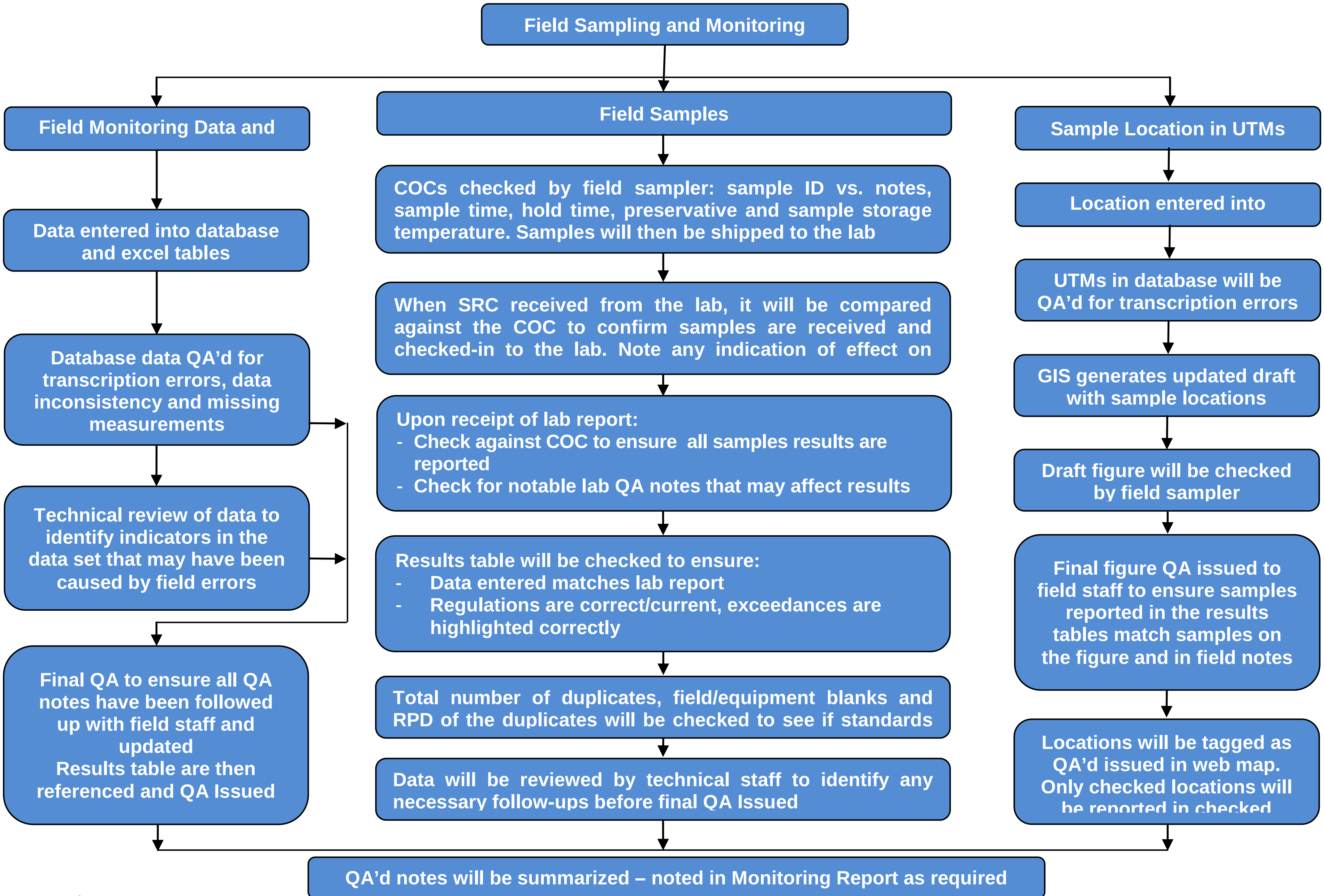
14. All analytical reports will be reviewed upon receipt for completeness, potentially anomalous data, and data quality waivers. This initial QA/QC screen will be tracked on the STS. Appropriate investigations will be initiated as issues are identified (i.e., laboratory re-checks, sample review, etc.).

15. A companion Data QA/QC spreadsheet will be maintained by the Data Coordinator documenting any recorded field or laboratory based QA/QC concerns.

16. The Data Coordinator will be responsible for the transcription of field notes into soil, sediment, or water sample logs as deemed necessary.

17. Relative percent differences (RPDs) for data sample sets will be calculated upon tabulation of the data and investigations initiated as necessary.

A field and desktop audit will be performed periodically to confirm adherence to P/SOPs and the effectiveness of the DIMF. Based on audit results, improvements will be made on a continuous basis.



Legend
COC – Chain of Custody
GIS – Geology Information System
ID – Identification number
QA – quality assured
RPD - Relative Percent Difference
SRC – Sample Receive Confirmation
UTM - Universal Transverse Mercator

ATTACHMENT 2

Example Field and Tracking Forms

Water Sampling	Mount Polley Mining Corporation

Client:__________________________________ **Field Crew:**__________________________________

Station Identifiers

Date/Time: __________________________________ Meter Model: __________________________________

Study Area: __________________________________ Map Datum (NAD): __________________________________

UTM E: __________________________________ UTM N: __________________________________

Water Depth: __________________________________ SECCHI: __________________________________

	IN SITU SURFACE FIELD MEASUREMENTS							PARAMETERS (BOTTLE, PRESERVATIVE)									
Sample ID	Sample Depth (m)	Water Depth (m)	Temperature (°C)	DO (mg/L)	DO (% sat)	Specific Conductivity (us/cm)	pH (pH units)	Turbidity	Nutrients-1 (1L PI)	Total Metals (250 mL PI, HNO_3)	Diss. Metals (250mL PI, HNO_3)	NH_3/TN (250mL AG, H_2SO_4)	DOC (120mL AG)	Total Mercury (40mL GL, HCl)	Coliforms E. Coli (250mL PI)		

Sample Description: ____

Comments: ____

minnow environmental inc.

Lake Physico-Chemical Profile Field Sheet

MINNOW ENVIRONMENTAL INCORPORATED

101 - 1025 Hillside Ave.
Victoria, BC V8R 3J2
Telephone: (250) 595 - 1627
Facsimilie: (250) 595 - 1625

Client: ______________ Project Name/Number: ______________
Date/Time: ______________ Field Crew: ______________
Lake: ______________ Station Identifier: ______________
Lat/Northing: ______________ Long/Easting: ______________
% Cloud Cover: ______________ Weather Notes: ______________

PHYSICAL/CHEMICAL CHARACTERISTICS

Depth (m): ______________

Secchi Depth (m): Disappear: ________ Reappear: ________ Average: ________

Depth	Temp	Dissolved Oxygen		pH	Sp. Cond	Turbidity	Other/Comments
(m)	(^{o}C)	(mg/L)	(% sat)	(pH units)	(uS/cm)	(NTU)	

Signature: ______________________

pH Calibration Form

Meter: ____
Acceptable Slope: ____________________________________

pH 4.0= 177mV
pH 7.0= 0 mV
pH 10.0= -177mV

Date	Time	Temp.	Battery Status	Slope (mV/pH)	pH 4 (mV)	pH 7 (mV)	pH10 (mV)	QC Score	Comments	Initials	Check				
											Date/Time	pH4	pH7	pH10	Initials

Calibration Frequency: Daily
End of Day Check Frequency: Daily

Mount Polley Mining Corporation
Likely, BC

Mount Polley Mining Corporation - Post Tailings Breach Monitoring Program

Daily observations tracking

Date:

Team Members:

New sites: (location)
Missed or dropped sites: (including rationale)
Wildlife/Habitat:
Lake Observations: (debris, white caps, fish, amphibians, etc)
Public interaction: (highlights of conversations or contact information)
Safety Concerns:

Mount Polley Water Quality Program
Sample Tracking Sheet

Lab ID	Date Sampled	Date Shipped	Date Received by Lab	Shipper's Initials	Samples within Report	Analytical Report Expected	Analytical Report Received?	SRC QA/QC	CofC #	Lab Report QA/QC	Cr Speciation	Lab SRC Notes	Lab report Notes on QA/QC	Lab follow up?	Final Report Issue Date

ATTACHMENT 3

Summary of Laboratory Method Detection Limits

Summary of Laboratory Method Detection Limits – Mount Polley Water Sampling

Dissolved Metals

Aluminum		Antimony		Arsenic		Barium		Beryllium		Bismuth		Boron		Cadmium	
mg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count
0.003	1,627	0.1	1,604	0.1	1,604	0.05	1,604	0.1	1,604	0.5	1,604	10	1,604	0.01	1,603
0.005	23	0.2	23	0.2	23	0.1	23	0.2	23	1	23	20	23	0.02	23
0.01	3	0.5	23	0.5	23	0.25	23	0.5	23	2.5	23	50	23	0.05	23
0.02	6	1	3	1	3	0.5	3	1	3	5	3	100	3	0.1	4
0.05	3	2	6	2	6	1	6	2	6	10	6	200	6	0.2	6
		5	3	5	3	2.5	3	5	3	25	3	500	3	0.5	3

Calcium		Chromium		Chromium (+3)		Cobalt		Copper		Iron		Lead		Lithium	
mg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count
0.05	1,654	0.5	1,650	5	19	0.1	1,604	0.5	1,627	30	1,654	0.05	1,604	0.5	1,604
0.1	3	1	3			0.2	23	1	23	60	3	0.1	23	1	23
0.15	2	2	6			0.5	23	2	3	90	2	0.25	23	2.5	23
0.25	3	5	3			1	3	4	6	150	3	0.5	3	5	3
						2	6	10	3			1	6	10	6
						5	3					2.5	3	25	3

Magnesium		Manganese		Mercury		Molybdenum		Nickel		Potassium		Selenium		Silicon	
mg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	mg/L	Count	µg/L	Count	µg/L	Count
0.1	1,654	0.05	1,603	0.05	21	0.05	1,604	0.5	1,604	0.05	1,604	0.5	1,650	50	1,654
0.2	3	0.1	23			0.1	23	1	23	0.1	23	1	3	100	3
0.3	2	0.25	23			0.25	23	2.5	23	0.25	23	2	6	150	2
0.5	3	0.5	3			0.5	3	5	3	0.5	3	5	3	250	3
		1	6			1	6	10	6	1	6				
		2.5	3			2.5	3	25	3	2.5	3				

Dissolved Metals

Silver		Sodium		Strontium		Thallium		Tin		Titanium		Uranium		Vanadium		Zinc	
µg/L	Count	mg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count
0.01	1,604	0.05	1,604	0.2	1,604	0.01	1,604	0.1	1,604	10	1,654	0.01	1,604	1	1,604	3	1,626
0.02	23	0.1	23	0.4	23	0.02	23	0.2	23	20	3	0.02	23	2	23	4	1
0.05	23	0.25	23	1	23	0.05	23	0.5	23	30	2	0.05	23	5	23	5	23
0.1	3	0.5	3	2	3	0.1	3	1	3	50	3	0.1	3	10	3	10	3
0.2	6	1	6	4	6	0.2	6	2	6			0.2	6	20	6	20	6
0.5	3	2.5	3	10	3	0.5	3	5	3			0.5	3	50	3	50	3

Total Metals

Aluminum		Antimony		Arsenic		Barium		Beryllium		Bismuth		Boron		Cadmium	
µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count
3	1,793	0.1	1,803	0.1	1,803	0.05	1,803	0.1	1,803	0.5	1,803	10	1,803	0.01	1,796
6	23	0.2	23	0.2	23	0.1	23	0.2	23	1	23	20	23	0.02	23
15	27	0.5	23	0.5	23	0.25	23	0.5	23	2.5	23	50	23	0.05	29
18	3	1	3	1	3	0.5	3	1	3	5	3	100	3	0.1	4
21	2	2	6	2	6	1	6	2	6	10	6	200	6	0.2	6
24	1	5	3	5	3	2.5	3	5	3	25	3	500	3	0.5	3
30	3														
60	6														
150	3														

Calcium		Chromium		Chromium (+6)		Cobalt		Copper		Iron		Lead		Lithium	
mg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count
50	1,853	0.5	1,849	1	19	0.1	1,803	0.5	1,786	30	1,853	0.05	1,797	0.5	1,803
100	3	1	3			0.2	23	1	35	60	3	0.1	26	1	23
150	2	2	6			0.5	23	1.5	1	90	2	0.15	1	2.5	23
250	3	5	3			1	3	2	1	150	3	0.25	24	5	3
						2	6	2.5	25			0.35	1	10	6
						5	3	3	1			0.5	3	25	3
								5	3			1	6		
								10	6			2.5	3		
								25	3						

Magnesium		Manganese		Mercury		Molybdenum		Nickel		Phosphorus		Potassium		Selenium	
µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count
100	1,853	0.05	1,803	0.01	150	0.05	1,803	0.5	1,803	2	1,570	50	1,803	0.5	1,849
200	3	0.1	23	0.05	193	0.1	23	1	23	20	61	100	23	1	3
300	2	0.25	23	0.1	5	0.25	23	2.5	23	200	59	250	23	2	6
500	3	0.5	3	0.5	7	0.5	3	5	3	2,000	20	500	3	5	3
		1	6	1	2	1	6	10	6			1,000	6		
		2.5	3			2.5	3	25	3			2,500	3		

Total Metals

Silicon		Silver		Sodium		Strontium		Thallium		Tin		Titanium		Uranium		Vanadium		Zinc	
µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count
50	1,853	0.01	1,802	50	1,803	0.2	1,803	0.01	1,802	0.1	1,803	10	1,853	0.01	1,803	1	1,803	3	1,803
100	3	0.02	23	100	23	0.4	23	0.02	22	0.2	23	20	3	0.02	23	2	23	6	23
150	2	0.04	1	250	23	1	23	0.05	23	0.5	23	30	2	0.05	23	5	23	15	23
250	3	0.05	23	500	3	2	3	0.1	3	1	3	50	3	0.1	3	10	3	30	3
		0.1	3	1,000	6	4	6	0.2	7	2	6			0.2	6	20	6	60	6
		0.2	6	2,500	3	10	3	0.25	1	5	3			0.5	3	50	3	150	3
		0.5	3					0.5	3										

General

Hardness		pH		Conductivity		Ammonia Nitrogen		Bromide		Chloride		DOC		Fluoride		Nitrate		Nitrite	
mg/L	Count	pH	Count	uS/cm	Count	µg/L	Count	mg/L	Count	mg/L	Count	mg/L	Count	µg/L	Count	µg/L	Count	µg/L	Count
0.5	1,837	0.1	1,835	2	1,835	5	1,689	0.05	21	0.5	1,843	0.5	1,646	20	1,840	5	1,843	1	1,835
0.86	3					13	6			1	1	1	34	40	1	10	1	2	1
1.3	2					25	15			2.5	1			100	1	25	1	5	9
2.2	3									5	8			200	8	50	8	10	8

Nitrate+ Nitrite		Ortho-phosphate		Sulphate		Total Alkalinity		TDS		TKN		Total Nitrogen (N)		Total Phosphorus		TSS		Turbidity	
µg/L	Count	mg/L	Count	mg/L	Count	mg/L	Count	mg/L	Count	mg/L	Count	mg/L	Count	mg/L	Count	mg/L	Count	NTU	Count
5.1	24	0.001	1,706	0.3	134	1	1,707	10	1,652	0.1	49	0.05	1,666	0.002	1,703	3	1,723	0.1	1,838
		0.01	4	0.5	1,709	3	3	13	52	0.1	2	0.1	19	0.02	6	5	21		
				1	1			20	6	0.5	2	0.11	2	0.2	1	6	1		
				2.5	1							0.25	8			9	18		
				5	8							0.4	1			15	7		
												0.5	8			23	20		
												1	7			45	11		

Glycols						Hydrocarbons				Microbiological Tests				Organics		Nitroaromatics & Nitroamines			
Diethylene glycol		Ethylene glycol		Propylene glycol		EPHw 10-19		EPHw 19-32		E. Coli		Total Coliform		Chlorophyll A		Heptane (C7)		Octane (C8)	
mg/L	Count	mg/L	Count	mg/L	Count	µg/L	Count	ug/L	Count	mpn/0.1L	Count	mpn/0.1L	Count	ug/L	Count	mg/L	Count	mg/L	Count
5	4	5	4	5	4	250	4	250	4	1	20	1	20	0.01	169	0.001	4	0.001	4

VOC															
Acetone		2-Hexanone		Carbon disulphide		Methyl ethyl ketone		Methyl isobutyl carbinol		Methyl isobutyl ketone		1,2,3-Trimethyl-benzene		n-Pentane	
ug/L	Count	ug/L	Count	ug/L	Count	ug/L	Count	ug/L	Count	ug/L	Count	ug/L	Count	ug/L	Count
10	2	1	4	5	4	10	4	10	4	1	4	1	4	10	4
20	2														

ATTACHMENT 4

Summary of DQO Exceedances

Summary of DQO Exceedances – Mount Polley Water Sampling

Sample Date	Sample ID(s)	Parameter(s) > DQO	Comment
RPD > DQO – Laboratory related QA/QC issues			
24-Sep-14	QUL-120-40m and QUL-120X-40m	T-Cu, T-Pb, T-Ni, T-Zn	Potential contamination during lab sample preparation.
RPD > DQO – Potential Field Sampling Equipment Contamination			
25-Aug-14	QUL-2-0m and QUL-2X-0m	Total P	May be due to high equipment blank noted on August 21, 2014. Data may be positively biased.
28-Aug-14	QUL-66 and QUL-66X	TSS	High equipment blank on KEM1B. Data may be positively biased.
28-Aug-14	QUL-66 and QUL-66X	Total P	High equipment blank on KEM1B. Data may be positively biased.
28-Aug-14	QUL-66 and QUL-66X	D-Al, T-Co, T-Fe, T-V	High equipment blank on KEM1B. Data may be positively biased.
26-Oct-14	QUL-120-40m and QUL-120X-40m	T-Pb	BLC blanks high on a few metals and T-P. Data may be positively biased.
12-Nov-14	QUL-79-50 and QUL-79x-50m	D-Mn, T-Pb	T-Pb exceeded MDL in KEM1B blank Nov 10 and 18th. No exceedences. Data may be positively biased.
RPD > DQO – No Regulatory Exceedances			
07-Aug-14	QUL-11-5m and QUL-11-5mx	Turbidity	No regulatory exceedences.
12-Aug-14	QUL-21 and QUL-21X	D-Mn, D-U	No comparison guidelines.
13-Aug-14	QUL-9 and QUL-9X	T-Al	No regulatory exceedances.
18-Aug-14	POL-3 and POL-3X	D-Mn	No comparison guidelines.
18-Sep-14	QUL-23 and QUL-23X	D-Mn	No comparison guidelines.
23-Sep-14	QUL-21-0m and QUL-21X-0m	T-Al,T-Mn	No regulatory exceedances.
23-Sep-14	QUL-23 and QUL-23X	D-Mn	No comparison guidelines.
25-Sep-14	QUL-66A-0m and QUL-66AX-0m	Chlorophyll A	No regulatory exceedances
28-Sep-14	QUL-87-0m and QUL-87X-0m	Chlorophyll A	No regulatory exceedances
10-Oct-14	HAD-1 and HAD-1X	Turbidity	No regulatory exceedances
25-Aug-14	QUL23 and QUL23X	Turbidity	Poor repeatability between the field duplicate samples.
11-Sep-14	QUL-66-50m and QUL-66X-50	Turbidity, T-Fe	Poor repeatability between the field duplicate samples.
01-Oct-14	QUL-66-40m and QUL-66x-40m	D-Al	Poor repeatability between the field duplicate samples.
14-Oct-14	QUL-2A-40m and QUL-2X-40m	Turbidity, sulphate, D-Mn, D-K, D-Na, D-Ba, D-Cu, D-Mo, D-U D-Al, T-Cu, T-Pb, T-Mn, T-Al, T-Ba, T-Fe, T-Mo, T-K, T-Si, T-Na, T-U	Poor repeatability between the field duplicate samples.

Summary of DQO Exceedances – Mount Polley Water Sampling (Cont'd)

Sample Date	Sample ID(s)	Parameter(s) > DQO	Comment
21-Oct-14	QUL-2A-40m and QUL-2AX-40m	T-Pb	Poor repeatability between the field duplicate samples.
11-Nov-14	QUL-66-55m and QUL-66X-55	T-P	Poor repeatability between the field duplicate samples.
12-Nov-14	QUL-79-50 and QUL-79x-50m	Turbidity	Poor repeatability between the field duplicate samples.
10-Oct-14	HAD-1 and HAD-1X	Turbidity	Poor repeatability between the field duplicate samples.
06-Sep-14	HAC-1 and HAC-1X	D-Al, D-Mn, D-Ba, D-Cu	Poor repeatability between the field duplicate samples.
19-Sep-14	HAC-1 and HAC-1X	D-Al,	Poor repeatability between the field duplicate samples.
1-Oct-14	HAC-05	T-P	Poor repeatability between the field duplicate samples.
26-Nov-14	HAC-01a	D-Al	Poor repeatability between the field duplicate samples.
12-Aug-14	POL-4 and POL-4X	Turbidity	Poor repeatability between the field duplicate samples.
14-Oct-14	POL-5-0m and POL-5X-0m	Nitrate nitrogen	Poor repeatability between the field duplicate samples
16-Sep-14	P1-0m and P1X-0m	Turbidity	Poor repeatability between the field duplicate samples
12-Nov-14	P1-0m and P1X-0m	Turbidity	Poor repeatability between the field duplicate samples
Equipment Blanks > DQO			
19-Aug-14	QUL equipment blank	T-Ba, T-Pb,T-Mn	Data may be positively biased.
21-Aug-14	QUL equipment blank	T-P, D-Na, T-Na	Data may be positively biased.
28-Aug-14	KEM1B blank	T-Al, T-As, T-Ba, T-Ca, T-Co, T-Cu, T-Fe, T-Pb, T-Mn, T-Si	Data may be positively biased.
10-Nov-14	KEM1B blank	T-Pb	Data may be positively biased.
18-Nov-14	KEM1B blank	T-Pb	Data may be positively biased.
26-Oct-14	BLC	T-P	Data may be positively biased.
27-Aug-14	ISCO	T-Al, T-Ba, T-Ca, T-Cu, T-Mn, T-Si	Data may be positively biased.
9-Sep-14	ISCO	T-Al, T-Ba, T-Ca, T-Mn, T-Si	Data may be positive biased.

T – total
D – dissolved
Al – aluminum
Ba – barium
Cd – cadmium
Co – cobalt
Cr – chromium
Cu – copper
Fe – iron
K – potassium
Mo – molybdenum
Na – sodium
Ni – nickel
P – phosphorous
Pb – lead
Si – silicon
Ti – titanium
U – uranium
V – vanadium
Zn – zinc
Mn – manganese
TSS – total suspended solids

ATTACHMENT 5

Summary of Staff Qualifications

Mount Polley Water Quality Program
Summary of Staff Qualifications

Name	Project Role	Description of Experience and Qualifications	Years of Experience	Professional Designation(s)
Field Monitoring and Sampling				
MPMC				
Colleen Hughes	Environmental Coordinator	Water and Soil Quality, Re-Vegetation, Project Coordination	12	EP
Jack Love	Environmental Manager	Project Management, Impact Assessment Biology	19	R.P.Bio
Katie McMahen	Project Coordination, Data Mgmt, Logistics	Reclamation, Hydrology, Water Management, Project Coordination	3.5	P. Ag
Gabriel Holmes	Project Coordination, Water Quality support, Field Sampler	Silviculture, field sampling	2.5	Certified Silvicultural Surveyor, Certified Danger and Wildlife Tree Assessor
Maclean Donohoe	Project Coordination, Water Quality support, Field Sampler	B.Sc in Geology, field sampling/assistance	<1	
Shauna Litke	Water Quality Support, Field Sampler, Data Mgmt	Metallurgy	<1	EIT
Sky Freeman	Water Quality Support, Field Sampler	Currently completing a B.Sc in Biology, field sampling/assistance	<1	
Ira Pierce	Assist with field data collection	Project-specific training for field data collection	<1	
Fernando John	Assist with field data collection	Project-specific training for field data collection	<1	
Gilbert Sellars	Assist with field data collection	Project-specific training for field data collection	<1	
Frank Abbott	Assist with field data collection	Project-specific training for field data collection	<1	
Everett Dan	Assist with field data collection	Project-specific training for field data collection	<1	
Cariboo Environmental Quality				
Norm Zirnhelt	Water Quality Support, Limnology Support, Fisheries Biology Support, EIA Support	Water Quality, Environmental Monitoring, Impact Assessment, Fisheries Technical/Field Assistance	>20	R.P.Bio
Candice Collier	Assist with field data collection	Water Quality, Benthic Monitoring, and Riparian Assessments	5	B.Sc.
Minnow				
Pierre Stecko	Lead - Sediment Impact Assessment, Water Quality Support, Field Sampler	Aquatic toxicology and sediment geochemistry	19	M. Sc., RPBio, EP
Mike White	Sediment Support, Water Quality Support, Field Sampler	Benthic Ecology and Biostatistics, Field studies	6	Ph. D.
Katharina Batchelar	Sediment Support, Water Quality Support, Field Sampler	Sediment, Benthic Biology	1	M. Sc.
EBA Tetratech				
Justin Rogers	Data Collection & Interpretation	M.Sc., Geological Oceanography, three dimensional numerical modeling, Data Collection & Interpretation	8	American Geophysical Union, Association for the Sciences of Limnology and Oceanography, Candanian Meteorological and Oceanographic
SNC-Lavalin				
Laura McOrmond	QA/QC Officer, Onsite Coordination, Water Quality/Project Support, Field Sampler	Contaminated sites assessment and monitoring	2.5	
Doug Curley	Water Quality/Project Support, Field Sampler	Contaminated sites assessment and monitoring	<1	
Mike Schutten	Water Quality/Project Support, Field Sampler	Contaminated sites assessment and monitoring	<1	
Troy Lange	Water Quality/Project Support, Field Sampler	Contaminated sites assessment and monitoring	4	
Jeff Lomon	Water Quality Support, Field Sampler	Contaminated sites assessment and monitoring	3	
Tyler Anderson	Water Quality Support, Field Sampler	Contaminated sites assessment and monitoring	7	EP
Trevor McConkey	Lead - Soil Impact Assessment, PM Support and Coordination, Field Sampler and Auditor	Soil and Water Quality, Reclamation and Re-Vegetation	15	M.Sc., P.Ag.
Jenn Piquard	Health & Safety Support, Water Quality Support, Field sampler	H&S, QA/QC, Onsite Coordination	5	A.Sc.T.
August Whelan	Water Quality Support (field instrument readings)	Geotechnical Engineer-In-Training	1.5	
Sarah Jossul	Water Quality Support (field instrument readings)	Junior Environmental Professional	4.5	B.I.T.
Eve Edmonstone	Water Quality Support (field instrument readings)	Geoenvironmental Engineer-In-Training	3	EIT
Mia Sakelariou	Data Management & Tabulation	Data management, database administration, tabulation, regulatory standards	12	
Natalie Neufeld	Data Management & Tabulation	Data management, database administration, tabulation, regulatory standards	9	

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MOUNT POLLEY POST-EVENT WATER QUALITY MONITORING PROGRAM DATA QUALITY REPORT

TO: Golder Associates Ltd.

FROM: Mount Polley Mining Corporation

DATE: March 26, 2015

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1 INTRODUCTION

On December 20, 2014, program oversight and data management for the water quality monitoring program following the Mount Polley Tailings Storage Facility (TSF) breach transitioned to Mount Polley Mining Corporation (MPMC) from SNC-Lavalin Inc. (SNC-Lavalin). The following details any changes after the transition in the field sampling methods and data quality assurance / quality control (QA/QC) measures for the water quality monitoring and sampling program.

2 QUALITY ASSURANCE / QUALITY CONTROL

MPMC implemented a QA/QC program similar to the one developed by SNC-Lavalin during the water quality monitoring and sampling program. Refer to the Memorandum titled "Summary of Data Quality Assurance / Quality Control and Field Methods for the Mount Polley Water Quality Monitoring and Sampling Program" by SNC-Lavalin (herein referred to as "SNC-Lavalin Memorandum") for details. Report structure and key statements were transcribed from the SNC-Lavalin Memorandum for consistency. MPMC staff directed the field data collection program starting November 20, 2014 and managed the QAQC program starting December 20, 2014. The QA/QC program included:

- Quality assurance (QA): management and technical practices designed to confirm that data were consistent with the objectives of the water quality program and that data were scientifically tenable
- Quality control (QC): specific data quality objectives (DQOs), statistical assessment of data quality, and corrective measures taken whenever the DQOs were not met

The following sections detail the changes implemented to the QA/QC program for the water quality monitoring and sampling program after December 20, 2014.

2.1 Field Data Collection and Document Control

For full equipment methodologies and calibration details, refer to sections 3.1 through 3.3 in the SNC-Lavalin Memorandum.

After November 19, 2014, all field data and samples were collected by MPMC staff. Field data related to the water quality program for the Mount Polley TSF breach were collected and tracked using field notebooks specific to each area of interest. Water sample collection, field data collection not electronically logged, equipment calibration done in the field (e.g. dissolved oxygen (DO) calibration), photographic recordkeeping, and daily observations tracking were recorded in these notebooks. Field notebooks were reviewed daily to confirm that records were filled out in full, accurate, and consistent with other information submitted, and were scanned and saved electronically according to date and area of interest. Individual samples were tracked using a spreadsheet which recorded the locations of samples, along with the date, duplicate and blank sample information, sample shipping information, laboratory correspondence, analytical results and data integrity issues.

2.2 Analytical Laboratory

Samples continued to be shipped to ALS Environmental (ALS) in Burnaby, BC for analaysis. ALS is a Canadian Association for Laboratory Accreditation Inc. (CALA) accredited laboratory. Water samples submitted were tracked for adherence to laboratory sampling and analysis protocols, including hold times, sample containers, preservatives, detection limits, and approved methodology. Sample integrity issues when these protocols were not adhered to were recorded in the sample tracking sheet. Refer to Section 2.2 in the SNC-Lavalin Memorandum for details on the QA/QC program of ALS.

2.3 QA/QC Samples

Quality control samples collected during the water quality sampling program included blind field duplicate samples, equipment blanks, filter blanks, field blanks, deionized (DI) water blanks and trip blanks. For a description of each QC sample, refer to the SNC-Lavalin Memorandum.

The target frequencies of duplicate samples and blanks that were adopted for the QA/QC program are summarized in Table 2.1 below.

Table 2.1 QA/QC Duplicate and Blank Target Frequencies

QA Sample Type	Target Frequency	Applicable Parameters
Blind Field Duplicates	10 %	All parameters
Equipment Blanks	Bi-weekly when equipment in use	All parameters
Filter Blanks	Quarterly	Dissolved Metals
Field Blanks	Monthly	All organic parameters
DI Water Blanks	Quarterly	Total Metals
Trip Blanks	Monthly	Volatiles only

A summary of the duplicate and blank frequencies achieved is included in Section 2.4.1.

2.3.1 Data Quality Objectives

To assess blind field duplicate results relative to DQOs, MPMC followed the calculations set out by SNC-Lavalin described in Section 2.3.1 of the SNC-Lavalin Memorandum for all parameters except low-level results. The practical quantitation limit (PQL) which was defined as five times the laboratory method detection limit (MDL) was calculated. For analytes in blind field duplicate sets where concentrations were above the PQL, the relative percent difference (RPD) was calculated as described in Section 2.3.1 in the SNC-Lavalin Memorandum. For low-level results (when results were below the PQL), MPMC followed guidance provided by ALS; if the difference between the two samples was greater than twice the MDL, the results were flagged.

2.4 Summary of QA/QC Results

QA/QC procedures were followed throughout the program to determine if the analytical results were accurate. Chain-of-custody (COC) records were completed electronically to minimize transcription errors at ALS upon receiving samples. All Sample Receipt Confirmation (SRC) reports were reviewed by MPMC upon receipt from ALS for sample integrity issues, to verify samples IDs, dates and analyses were correct and hold times were met. Any sample integrity issues were documented in the sample tracking spreadsheet. When analytical results were received, the data were reviewed for laboratory data qualifiers and any data anomalies were investigated.

2.4.1 Duplicates and Blank Samples

The total duplicate and blank samples that were collected during the water sampling program from December 20, 2014 to February 28, 2015 are indicated in Table 2.2.

Table 2.2 Summary of Duplicate and Blank Samples From December 20, 2014 to February 28, 2015

QA Sample Type	Quesnel Lake	Quesnel River	Polley Lake	Hazeltine Creek	Program Total
Regular Samples	2	14	1	27	44
Field Duplicates	0	2 (14.3%)	0	2 (7.4%)	4 (9.1%)
Equipment Blanks	0	N/A	0	N/A	0
Filter Blanks	0	0	0	N/A	0
Field Blanks	0	1	0	1	2 (4.5%)*
DI Water Blanks	0	0	0	0	0
Trip Blanks	0	1	0	1	2 (4.5%)*

* Indicates target frequency of monthly was met

2.4.2 Relative Percent Differences

Blind duplicate sample sets for which RPD values exceeded the DQO are summarized in Table 2.3, and are separated by type of RPD issue.

Table 2.3 Summary of RPD Exceedances

Sample Date	Sample IDs	Parameter RPD > DQO	Comment
RPD > DQO, Regulatory Exceedances Identified			
27-Jan-15	HAC-05 and HAC-05x	Dissolved Al	Poor repeatability between the field duplicate samples
RPD > DQO, No Regulatory Exceedances			
12-Aug-14	HAC-08 and HAC-08x	Total P	No exceedances

Once an RPD exceedance was identified, the associated results were subsequently compared to relevant guidelines, and the laboratory was contacted if one or both concentrations were greater than guideline(s). For RPD exceedances due to laboratory related issues, corrective action was initiated by reanalyzing the batch of affected samples.

2.4.3 Blank Sample Issues

Only one blank, the Hazeltine trip blank taken February 2, 2015, was flagged with detectable total manganese (0.000006 mg/L above the MDL).

2.4.4 Laboratory QA Results

There were no dissolved metals concentrations greater than total metals concentrations in any samples.

3 FIELD MONITORING AND SAMPLING METHODOLOGY

The sections below outline the changes of the methodologies SNC-Lavalin implemented for the collection of field data and samples during the water quality field program.

3.1 Monitoring and Sampling Locations

Coordinates for each new station were recorded in field notebooks and uploaded into an EHS Data MP-5 Database and associated with the relevant samples at each station. Coordinates for new stations were programmed into other onsite field GPS units for future sampling visits. Coordinates were used to generate drawings showing station locations to date, which were subsequently verified by field staff.

Sample ID nomenclature was kept consistent with established IDs and naming systems, as described in Section 3.1 in the SNC-Lavalin Memorandum.

3.2 Water Quality Monitoring and Column Profiling

MPMC continued to use the procedures outlined in Section 3.2 of the SNC-Lavalin Memorandum for water quality monitoring and column profiling. The sonde deployed at QUR-1 continued to monitor the Quesnel Lake outflow on Quesnel River, logging every 15 minutes. Another sonde was deployed on January 19, 2015 at the outlet of the lower sedimentation pond (sample ID: HAC-01b) to monitor the outflow of Hazeltine Creek into Edney Creek and Quesnel Lake, which also logs every 15 minutes.

Two Manta Eureka 2 sondes, which monitor temperature, specific conductivity and turbidity every 30 minutes, were also deployed at two hydrology stations. One was near the Gavin Lake Bridge (sample ID: HAC-05), which was installed from November 5-26, 2014 and the other just upstream of the Ditch Road Bridge (near HAC-08), which was installed from November 6-26, 2014.

3.3 Water Sampling

Water sampling by MPMC was completed using the methods outlined in Section 3.3 of the SNC-Lavalin Memorandum for water sampling.

3.4 Residential Water Quality Sampling

No residential intake samples were requested or taken after December 20, 2014.

3.5 Sample Procurement and Handling

All sample procurement and handling was conducted as outlined in Section 3.5 of the SNC-Lavalin Memorandum for water sampling. Shipping frequency decreased to 2-3 times a week and depended on the number of samples. Samples were shipped additional days as needed to avoid hold time exceedances. For a summary of hold time exceedance periods, see Table D in Section 3.5 of SNC-Lavalin Memorandum.

4 DATA MANAGEMENT

Analytical and field data, including station location information, were uploaded to MPMC's established EHS Data MP-5 Water Quality Database (MP-5). MP-5 consolidates monitoring and analytical data for ease of management, analysis, relevant guideline exceedances (e.g. BC Water Quality Guidelines) and reporting.

4.1 Station Locations and Identification

Station location coordinates were saved in MP-5 and were mapped ad hoc to ensure correct coordinates. Sample IDs, along with sample depth and sample type, such as duplicate classification, were saved and sorted by location of interest in MP-5. Results from all blanks were also uploaded.

4.2 Analytical Data

Analytical data are imported into MP-5 directly from the comma-separated value (.csv) files generated by ALS, which minimizes the potential for manual keying errors. Physical minimums and maximums are also stored in MP-5 and the importer compares these to imported data. Any data point out of its physical range is flagged and is investigated.

4.3 Field Measurements

From December 2014 to January 2015, MPMC cross-referenced all raw field documents with analytical data in the MP-5 database from August 4, 2014 to date to ensure all data were correct and uploaded in the database, including any relevant comments by field staff. Any discrepancies found were investigated and corrected in the MP-5 database.

Field measurements uploaded were the following:

- In-situ temperature
- In-situ specific conductivity
- In-situ pH
- In-situ DO
- In-situ turbidity
- Secchi disc readings, including weather comments or lake observations

4.4 Lake Profiles

Lake profile data was exported from the EXO sondes to EXO handhelds and uploaded to and saved on the MPMC network. All raw data files were saved, and copies were used to compile or analyse data.

5 STAFF QUALIFICATIONS

A summary of qualifications for MPMC staff directly involved in water quality data generation and management is included in Table 5.1.

.

Table 5.1 MPMC Staff Qualifications

Name	Project Role	Description of Experience and Qualifications	Years of Experience	Professional Designation(s)
Colleen Hughes	Environmental Coordinator	Water and Soil Quality, Re-Vegetation, Project Coordination	12	EP
Katie McMahen	Project Coordination, Data Mgmt, Logistics	Reclamation, Hydrology, Water Management, Project Coordination	3.5	P. Ag
Gabriel Holmes	Project Coordination, Water Quality support, Field Sampler	Silviculture, field sampling	2.5 (>10 years silviculture experience)	Certified Silvicultural Surveyor, Certified Danger and Wildlife Tree Assessor (>10 years silvicuture experience)
Maclean Donohoe	Project Coordination, Water Quality support, Field Sampler	B.Sc in Geology, field sampling/assistance	<1	
Shauna Litke	Water Quality Support, Field Sampler, Data Mgmt	Metallurgy	<1	EIT (2 years metallurgical engineering experience)
Ira Pierce	Assist with field data collection		<1	
Fernando John	Assist with field data collection		<1	
Gilbert Sellars	Assist with field data collection		<1	
Frank Abbott	Assist with field data collection		<1	
Alethea Andy	Assist with field data collection		<1	

6 ACRONYMS

CALA – Canadian Association for Laboratory Accreditation Inc.

COC – Chain-of-custody

DI – deionized

DO – dissolved oxygen

DQO – data quality objectives

MDL – method detection limit

MPMC – Mount Polley Mining Corporation

PQL – practical quantitation limit

QA/QC – quality assurance / quality control

RPD – relative percent difference

TSF – Tailings Storage Facility

7 REFERENCES

MoE (BC Ministry of Environment). 1998 (updated in 2001). BC Approved Water Quality Guidelines for the Protection of Water Quality Guidelines. Available at: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html

Raw Data reported in Appendix I

APPENDIX C

Post-Event Surface Water Quality and Identification of Contaminants of Potential Concern

Parameter	Units	BC Water Quality Guidelines for the Protection of Freshwater Aquatic Life[a]				Polley Lake		Hazeltine Creek		Quesnel Lake		Quesnel River	
		Maximum	notes	30-Day Average	notes	Baseline	Maximum	Baseline	Maximum	Baseline	Maximum	Baseline	Maximum
Physical Parameters													
Conductivity (lab)	µs/cm	-	-	-	-	211	*342*	314	*1190*	nm	*164*	119	133
Dissolved Oxygen (in situ)	mg/L	5-9	A, Min	8-11	A, Min	7.1	**min 0.14**	8.6	min 8.43	nm	**min 2.05**	13	min 6.04
Hardness (Dissolved)	mg/L (as $CaCO_3$)	-	-	-	-	111	*155*	151	*501*	nm	*75*	55	*67*
pH (in situ)	pH Unit	6.5 - 8.5	A, DW	6.5 - 9.0	A	9.4	**6.9 - 9.1**	8.4	**7.6 - 8.8**	nm	**6.8 - 8.8**	8.0	**7.2 - 9.4**
Total Dissolved Solids	mg/L	-	-	-	-	141	*229*	194	*857*	nm	*127*	70	*89*
Total Suspended Solids	mg/L	+25 mg/L, +10 mg/L if background 25-100 mg/L	A	+5 mg/L, +10% if background >100 mg/L	A	5.1	19.3	8.5	**91800**	nm	**47**	3	**44**
Turbidity (lab)	NTU	+1 NTU if background ≤5 NTU (untreated)	DW	+2 NTU, +10% if background >50 NTU	A	2.7	**18.4**	4.6	**100000**	nm	**153**	1.0	**23**
Water Temp (in situ)	°C	-	A	-	A	21.0	23.5	18	19	nm	22	14	20
Major Ions													
Alkalinity, Total	mg/L (as $CaCO_3$)	see note			W, r	84	*114*	140	*293*	nm	*71*	51	*62*
Chloride	mg/L	600	A	150	A	0.25	2.12	2.6	18	nm	0.80	1	0.58
Fluoride	mg/L	1.05 - 1.97	A, d	-	-	0.06	0.12	0.11	0.94	nm	0.22	nm	0.058
Sulphate	mg/L	-	-	218 - 429	A, e	29	65	33	483	nm	22	6.9	9.8
Nutrients													
Ammonia	mg/L (as N)	4.5 - 7.1	A, f	0.61 - 1.36	A, f	0.03	1.08	0.026	0.49	0.011	0.064	0.014	0.0068
Nitrate	mg/L (as N)	33	A	3	A	0.21	0.74	0.55	13	0.13	0.25	0.13	0.21
Nitrite	mg/L (as N)	0.06 - 0.6	A, g	0.02 - 0.2	A, g	0.0040	**0.22**	0.007	0.14	0.003	0.021	0.0025	0.0017
Total Kjeldahl Nitrogen	mg/L (as N)	-			-	0.19	nm	0.7	nm	0.14	nm	0.17	nm
Total Phosphorus	mg/L	0.005-0.015 in lakes			A	0.094	**0.24**	0.054	**233**	0.008	**1.4**	0.012	**0.035**
Total Metals													
Aluminum	mg/L	5	A, WW	-	-	0.031	1.1	0.35	**952**	nm	**7.3**	0.02	1.3
Antimony	mg/L	-	-	0.009	W	0.00005	0.00034	0.00009	0.0017	nm	0.00057	nm	0.00064
Arsenic	mg/L	0.005	A	-	-	0.00068	0.0020	0.0009	**0.84**	nm	0.0028	nm	0.0011
Barium	mg/L	-	-	1	W	0.0081	0.047	0.016	15	nm	0.19	nm	0.022
Beryllium	mg/L	-	-	0.00013	W	0.0025	<0.0001	0.0025	0.047	nm	0.00016	nm	<0.0001
Boron	mg/L	1.2	A	-	-	0.05	0.037	0.05	0.9	nm	0.013	nm	<0.01
Cadmium	mg/L	no T-Cd WQG, see D-Cd WQG				0.0001	*0.00021*	0.0001	*0.0146*	nm	*0.00017*	nm	*0.00041*
Calcium	mg/L	no T-Ca WQG, see D-Ca WQG				36	*51*	44	*2980*	nm	*26*	nm	*22*
Chromium	mg/L	-	-	0.001	W, j	0.0005	0.0016	0.0013	0.59	nm	0.0060	0.0025	0.0029
Cobalt	mg/L	0.11	A	0.004	A	0.0005	0.00089	0.0005	**0.98**	nm	0.0025	nm	0.00095
Copper	mg/L	0.007 - 0.049	A, k	0.002 - 0.02	A, k	0.0033	**0.053**	0.0061	**78**	nm	**0.14**	0.0047	**0.0098**
Iron	mg/L	1	A	-	-	0.082	**1.3**	0.45	**1000**	nm	**3.1**	0.19	**2.0**
Lead	mg/L	0.043 - 0.63	A, l	0.005 - 0.028	A, l	0.0005	0.00041	0.0005	**0.78**	nm	0.0062	0.083	0.00073
Lithium	mg/L	-			-	0.0025	0.0014	0.0025	*1.0*	nm	*0.0038*	nm	*0.0022*
Magnesium	mg/L	-			-	5.2	*6.9*	10.0	*751*	nm	*4.4*	2	*3.18*
Manganese	mg/L	1.2 - 6.0	A, m	0.87 - 2.8	A, m	0.19	1.0	0.049	**50**	nm	0.20	0.02	0.042
Mercury	mg/L	-	-	0.00001	A, n	0.000029	<0.00005*	0.000029	0.015	nm	0.000011	nm	<0.00005*
Molybdenum	mg/L	0.5	A, WW	0.01	A, IR	0.0024	0.018	0.0025	0.19	nm	0.011	nm	0.0036
Nickel	mg/L	-	-	0.025 - 0.15	W, o	0.0005	0.0022	0.0011	0.68	nm	0.0027	nm	0.0031
Selenium	mg/L	-	-	0.002	A	0.0012	0.0020	0.00098	0.080	nm	0.00073	nm	0.00093
Silver	mg/L	0.0001 - 0.003	A, p	0.00005	A, p	0.000043	0.000030	0.00005	**0.033**	nm	0.000046	nm	0.000045
Sodium	mg/L	-			-	4.6	*13*	8.5	*147*	nm	*6.9*	nm	*2.1*
Strontium	mg/L	-			-	0.24	*0.42*	0.29	*13*	nm	*0.29*	nm	*0.17*
Thallium	mg/L	-	-	0.0008	W	0.00005	0.00001	0.00005	0.0017	nm	0.000027	nm	0.000013
Tin	mg/L	-			-	0.00009	<0.0001	0.00023	*0.0066*	nm	*0.00089*	nm	*0.0028*
Titanium	mg/L	-			-	0.0050	0.037	0.011	*19*	nm	*0.25*	nm	*0.065*
Uranium	mg/L	-	-	0.0085	W	0.00010	0.00047	0.00034	0.056	nm	0.00100	nm	0.00033
Vanadium	mg/L	-			-	0.012	0.0031	0.015	*2.7*	nm	*0.012*	nm	*0.0036*
Zinc	mg/L	0.03 - 0.34	A, q	0.0075 - 0.31	A, q	0.0042	0.0060	0.0049	**4.0**	nm	0.015	0.022	0.010
Dissolved Metals													
Aluminum	mg/L	0.1	A, h	0.05	A, h	0.005	**0.56**	0.19	**2.2**	nm	**0.23**	nm	0.016
Antimony	mg/L	-	-	0.009	W	0.00005	0.00033	0.00007	0.0020	nm	0.00048	nm	0.00013
Arsenic	mg/L	0.005	A	-	-	0.00061	0.0018	0.00080	**0.0061**	nm	0.0011	nm	0.00035
Barium	mg/L	-	-	1	W	0.0075	0.031	0.015	0.078	nm	0.021	nm	0.0087
Beryllium	mg/L	-	-	0.00013	W	0.0025	<0.0001	0.0025	0.00016	nm	<0.0001	nm	<0.0001
Boron	mg/L	1.2	A	-	-	0.050	0.034	0.05	0.12	nm	<0.01	nm	<0.01
Cadmium	mg/L	0.0003 - 0.001	A, i	0.0001 - 0.0003	A, i	0.00010	0.00002	0.0001	0.00016	nm	0.000086	nm	0.00024
Calcium	mg/L	see note			W, b	36	*51*	44	*162*	nm	*25*	18	*23*
Chromium	mg/L	-	-	0.001	W, j	0.0005	0.0016	0.0011	0.0036	nm	0.0027	0.0093	<0.0005
Cobalt	mg/L	0.11	A	0.004	A	0.0005	0.00056	0.0005	0.0063	nm	<0.0001	nm	<0.0001
Copper	mg/L	0.008 - 0.018	A, k	0.002 - 0.007	A, k	0.0029	**0.029**	0.0051	**0.086**	nm	**0.0091**	0.014	0.0026
Iron	mg/L	0.35	A	-	-	0.015	**0.78**	0.25	**3.3**	nm	0.078	0.1	<0.03
Lead	mg/L	0.03 - 0.17	A, l	0.005 - 0.01	A, l	0.0005	0.00017	0.0005	0.0047	nm	0.00049	0.0032	<0.00005
Lithium	mg/L	-			-	0.0025	0.0013	0.0025	*0.011*	nm	0.0016	nm	0.0012
Magnesium	mg/L	-			-	5.1	*7.0*	9.9	*24*	nm	*2.8*	2.1	*2.8*
Manganese	mg/L	1.2 - 4.2	A, m	0.9 - 2.1	A, m	0.022	1.0	0.025	1.6	nm	0.11	0.03	0.0041
Mercury	mg/L	-	-	0.00001	A, n	0.000058	<0.00005*	0.000025	nm	nm	<0.00005*	nm	<0.00005*
Molybdenum	mg/L	0.5	A, WW	0.01	A, IR	0.0022	0.018	0.0027	0.19	nm	0.011	nm	0.0022
Nickel	mg/L	-	-	0.025 - 0.15	W, o	0.0005	0.0018	0.00093	0.0086	nm	0.0028	nm	0.00051
Potassium	mg/L	196-227			W, c	0.68	2.1	0.97	15	nm	1.6	0.5	0.70
Selenium	mg/L	-	-	0.002	A	0.0012	0.0020	0.001	0.033	nm	0.00067	nm	<0.0005
Silver	mg/L	0.0001 - 0.003	A, p	0.0001 - 0.0015	A, p	0.00005	0.000022	0.00005	0.0001	nm	0.000018	nm	<0.00001
Sodium	mg/L	-			-	4.5	*13*	8.2	*68*	nm	*5.7*	1.1	*1.9*
Strontium	mg/L	-			-	0.24	*0.40*	0.29	*2.5*	nm	*0.20*	nm	*0.16*
Thallium	mg/L	-	-	0.0008	W	0.00005	0.000023	0.00005	0.000039	nm	0.000015	nm	<0.00001
Tin	mg/L	-			-	0.00009	<0.0001	0.00022	0.00024	nm	*0.00028*	nm	*<0.0001*
Titanium	mg/L	-			-	0.005	0.020	0.005	0.135	nm	0.010	nm	<0.01
Uranium	mg/L	-	-	0.0085	W	0.000093	0.00043	0.00033	0.0042	nm	0.00084	nm	0.00031
Vanadium	mg/L	-			-	0.015	0.0022	0.015	0.0087	nm	*0.0015*	nm	*<0.001*
Zinc	mg/L	0.033 - 0.097	A, q	0.0075 - 0.071	A, q	0.0030	0.0060	0.0025	0.015	nm	0.025	0.020	0.005

Notes:

A = approved guideline, W = working guideline, Min = Minimum concentration requirement based on life stage, IR = irrigation guideline, WW = wildlife water supply guidelines, DW = drinking water guidelines

a) BC Water Quality (BCWQ) guidelines for the protection of freshwater aquatic life except where noted (e.g., total aluminum, molybdenum, pH)

b) up to 4 - highly sensitive to acid inputs; 4 to 8 - moderately sensitive; over 8 - low sensitivity. Refer to alkalinity, the more restrictive of calcium or alkalinity applies.

c) based on threshold for Daphnia magna immobilization of 373-432 as KCl

d) hardness dependent F guideline: BC Max WQG (mg/L) = 0.4 at hardness of 10 mg/L, otherwise = (-51.73 + (92.57 *log(hardness)))*0.01

e) hardness dependent sulphate guideline: BC 30-d WQG (mg/L) = 128 at hardness <30 mg/L, at hardness 31-75 mg/L = 218, at hardness 76-180 mg/L = 309, at hardness 181-250 mg/L = 429, at hardness >250 mg/L determine base on site water

f) pH and temperature dependent ammonia guideline: values selected from Tables 3 and 4 in BC WQG based on maximum temperature of 20°C and pH 8.2

g) chloride dependent nitrite guideline: BC Max WQG (mg/L) = 0.06 at Cl <2 mg/L, at Cl 2-4 mg/L = 0.12, at Cl 4-6 mg/L = 0.18, at Cl 6-8 mg/L = 0.24, at Cl 8-10 = 0.30, at Cl >10 = 0.6
BC 30-d WQG (mg/L) = 0.02 mg/L at Cl <2 mg/L, at Cl 2-4 mg/l = 0.04, at Cl 4-6 mg/L = 0.06, at Cl 6-8 mg/L = 0.08, at Cl 8-10 mg/L = 0.1, at Cl >10 = 0.2

h) pH dependent dissolved Al guideline: BC Max WQG (mg/L) = 0.1 at pH≥6.5, at pH <6.5 = EXP(1.209-2.426*(pH)+0.286*(pH2)); BC 30-d WQG (mg/L) = 0.05 at pH ≥6.5, at pH <6.5 = EXP(1.6-3.327*(median pH)+0.402*(median pH2); minimum baseline surface water pH = 5.57

i) hardness dependent dissolved Cd guideline: max BC WQG (mg/L) = (exp(1.03*ln(hardness)-5.274))/1000 BC 30-d WQG (mg/L) = (exp(0.736*ln(hardness)-4.943))/1000

j) guideline is for Cr(VI)

k) hardness dependent Cu guideline: BC Max WQG (mg/L) = (0.094(hardness)+2)/1000; BC 30-d WQG (mg/L) = 0.002 at hardness≤50 mg/L , at hardness >50 mg/L = 0.04*hardness/1000

l) hardness dependent Pb guideline: BC Max WQG (mg/L) = 0.003 at hardness≤8 mg/L, at hardness >8 mg/L = (EXP((1.273*ln(hardness))-1.46))/1000; BC 30-d WQG (mg/L) = (3.31+EXP(1.273(ln(hardness))-4.704))/1000 at hardness >8 mg/L, no guideline at hardness≤8 mg/L

m) hardness dependent Mn guideline: BC Max WQG (mg/L) = 0.01102*(hardness)+0.54; BC 30-d WQG (mg/L) = 0.0044*hardness+0.605

n) BC 30-d WQG (mg/L) = 0.00002 when methylmercury (MeHg) is 0.5% of total Hg, = 0.00001 at 1% MeHg, = 0.00000125 at 8% MeHg; applied middle guideline

o) hardness dependent Ni guideline: BC 30-d WQG = 0.025 at hardness <60 mg/L, at hardness 60-120 mg/L =0.065, at hardness 120-180 mg/L = 0.11, at hardness >180 mg/L = 0.15

p) hardness dependent Ag guideline: BC Max WQG (mg/L) = 0.0001 at hardness≤100 mg/L, at hardness >100 mg/L = 0.003; BC 30-d WQG (mg/L) = 0.00005 at hardness ≤100 mg/L, at hardness > 100 mg/L = 0.0015

q) hardness dependent Zn guideline: BC Max WQG (mg/L) = (33+0.75(hardness-90))/1000; BC 30-d WQG (mg/L) = (7.5+0.75(hardness-90))/1000

r) up to 10 - highly sensitive to acid inputs; 10 to 20 - moderately sensitive; over 20 - low sensitivity. Refer to calcium regarding sensitivity to acid inputs, the more restrictive of calcium or alkalinity is applicable.

nm - not measured
< reported value is <MDL
* = MDLs that are >WQG

123	Indicates concentration exceeding the BC Max WQ Guideline
123	Indicates concentration exceeding the BC 30-d WQ Guideline
123	Indicates concentration exceeding >20% baseline (95th percentile) for parameters without BC WQGs, or parameters without BC WQGs and baseline

Table C-2: Post-event Water Quality in Polley Lake, August 2014 to February 2015

Parameter	Units	BC Water Quality Guidelines for the Protection of Freshwater Aquatic Life[a]				Baseline (95th percentile)	Number of samples	Minimum	Median	95th Percentile	Maximum	Exceedance factor (95th Percentile/ Maximum BC WQG)	Exceedance factor (95th Percentile/ 30-Day BC WQG)
		Maximum	notes	30-Day Average	notes								
Physical Parameters													
Dissolved Oxygen (in situ)	mg/L	5-9	A, Min	8-11	A, Min	7.1	85	**0.14**	7.4				
Hardness (Dissolved)	mg/L (as $CaCO_3$)	-	-	-	-	111	138	76	116	*148*	*155*		
pH (in situ)	pH Unit	6.5 - 8.5	A, DW	6.5 - 9.0	A	9.4	136	6.9	8.3	N/A	**9.1**		
Total Dissolved Solids	mg/L	-	-	-	-	141	138	90	157	*219*	*229*		
Total Suspended Solids	mg/L	+25 mg/L, +10 mg/L if background 25-100 mg/L	A	+5 mg/L, +10% if background >100 mg/L	A	5.1	138	<3	<3	11	19		2.1
Turbidity (lab)	NTU	+1 NTU if background ≤5 NTU (untreated)	DW	+2 NTU, +10% if background >50 NTU	A	2.7	99	0.36	1.3	**14**	**18**	1.8	7.2
Nutrients													
Nitrite	mg/L (as N)	0.06 - 0.12	A, b	0.02 - 0.04	A, b	0.0040	138	<0.001	0.0011	**0.070**[g]	**0.22**	1.2	3.5
Phosphorus (P) Total	mg/L	0.005-0.015 in lakes	-	-	A	0.094	138	0.0045	0.022	**0.20**	**0.24**	40	
Total Metals													
Cadmium	mg/L	-	-	-	-	0.0001	138	<0.000010	<0.00001	0.00001	*0.00021*		
Chromium	mg/L	-	-	0.001	W, d	0.0005	138	<0.0005	<0.0005	<0.0005	0.0016		
Copper	mg/L	0.009 - 0.017	A, e	0.003 - 0.006	A, e	0.0033	138	0.0021	0.0034[g]	**0.016**[g]	**0.053**	1.8	5.4
Iron	mg/L	1	A	-	-	0.082	138	<0.03	0.031	0.43	**1.3**		
Mercury	mg/L	-	-	0.00001	A, f	0.000029	30	<0.000010	<0.000050*	<0.000050*	<0.000050*		
Molybdenum	mg/L	0.5	A, WW	0.01	A, IR	0.0024	138	0.0022	0.0077	0.017	0.018		1.7
Strontium	mg/L	-			-	0.24	138	0.16	0.28	*0.40*	*0.42*		
Dissolved Metals													
Aluminum	mg/L	0 - 0.1	A, c	0 - 0.05	A, c	0.0050	138	<0.003	0.0063	0.013	**0.56**		
Chromium	mg/L	-	-	0.001	W, d	0.00050	138	<0.0005	<0.0005	<0.0005	0.0016		
Copper	mg/L	0.009 - 0.017	A, e	0.003 - 0.006	A, e	0.0029	138	<0.0005	0.0022	0.0029	**0.029**		
Iron	mg/L	0.35	A	-	-	0.015	138	<0.03	<0.03	0.25	**0.78**		
Mercury	mg/L	-	-	0.00001	A, f	0.000058	2	<0.000050*	<0.000050*	<0.000050*	<0.000050*		
Molybdenum	mg/L	0.5	A, WW	0.01	A, IR	0.0022	138	0.0021	0.0072	0.017	0.018		1.7
Strontium	mg/L	-			-	0.24	138	0.15	0.28	*0.38*	*0.40*		

Notes:

Exceedance factors were calculated by dividing the 95th percentile to the cooresponding BC WQG under the most conservative scenario

A = approved guideline, W = working guideline, Min = Minimum concentration requirement based on life stage, IR = irrigation guideline, WW = wildlife water supply guidelines, DW = drinking water guidelines

a) BC Water Quality (BCWQ) guidelines for the protection of freshwater aquatic life except where noted (e.g., molybdenum, pH)

b) chloride dependent nitrite guideline: BC Max WQG (mg/L) = 0.06 at Cl <2 mg/L, at Cl 2-4 mg/L = 0.12, at Cl 4-6 mg/L = 0.18, at Cl 6-8 mg/L = 0.24, at Cl 8-10 = 0.30, at Cl >10 = 0.6

BC 30-d WQG (mg/L) = 0.02 mg/L at Cl <2 mg/L, at Cl 2-4 mg/l = 0.04, at Cl 4-6 mg/L = 0.06, at Cl 6-8 mg/L = 0.08, at Cl 8-10 mg/L = 0.1, at Cl >10 = 0.2

c) pH dependent dissolved Al guideline: BC Max WQG (mg/L) = 0.1 at pH ≥6.5, at pH <6.5 = EXP(1.209-2.426*(pH)+0.286*(pH2)); BC 30-d WQG (mg/L) = 0.05 at pH ≥6.5, at pH <6.5 = EXP(1.6-3.327*(median pH)+0.402*(median pH2); minimum baseline surface water pH = 5.57

d) guideline is for Cr(VI)

e) hardness dependent Cu guideline: BC Max WQG (mg/L) = (0.094(hardness)+2)/1000; BC 30-d WQG (mg/L) = 0.002 at hardness ≤50 mg/L , at hardness >50 mg/L = 0.04*hardness/1000

f) BC 30-d WQG (mg/L) = 0.00002 when methylmercury (MeHg) is 0.5% of total Hg, = 0.00001 at 1% MeHg, = 0.00000125 at 8% MeHg; applied middle guideline

g) value exceeds the guideline under the most conservative scenario but not the least conservative scenario

< reported value is <MDL

* = MDLs that are >WQG

123	Indicates concentration exceeding the BC Max WQ Guideline
123	Indicates concentration exceeding the BC 30-d WQ Guideline
123	Indicates concentration exceeding >20% baseline (95th percentile) without BC WQG

Table C-3: Post-event Water Quality in Hazeltine Creek, August 2014 to February 2015

Parameter	Units	BC Water Quality Guidelines for the Protection of Freshwater Aquatic Life[a]				Baseline (95th percentile)	Number of samples	Minimum	Median	95th Percentile	Maximum	Exceedance factor (95th Percentile/ Maximum BC WQG)	Exceedance factor (95th Percentile/ 30-Day BC WQG)
		Maximum	notes	30-Day Average	notes								
Physical Parameters													
Hardness (Dissolved)	mg/L (as $CaCO_3$)	-	-	-	-	151	146	62	124	*342*	*501*		
pH (in situ)	pH Unit	6.5 - 8.5	A, DW	6.5 - 9.0	A	8.4	116	7.6	8.1	N/A	**8.8**		
Total Dissolved Solids	mg/L	-	-	-	-	194	146	107	191	*460*	*857*		
Total Suspended Solids	mg/L	+25 mg/L, +10 mg/L if background 25-100 mg/L	A	+5 mg/L, +10% if background >100 mg/L	A	8.5	146	<3	**827**	**27650**	**91800**	1106	5530
Turbidity (lab)	NTU	+1 NTU if background ≤5 NTU (untreated)	DW	+2 NTU, +10% if background >50 NTU	A	4.6	105	2.47	**146**	**3242**	**100000**	405	1621
Nutrients													
Nitrate	mg/L (as N)	33	A	3	A	0.55	146	<0.005	0.071	0.56	13		
Phosphorus (P) Total	mg/L	0.005-0.015 in lakes			A	0.054	146	**0.0071 (<0.20)**	**1.6**	**35**	**233**	6904	
Sulphate	mg/L	-	-	218 - 429	A, c	33	146	2.7	38	148	483		
Total Metals													
Aluminum	mg/L	5	A, WW	-	-	0.35	146	0.18	**14**	**350**	**952**	70	
Arsenic	mg/L	0.005	A	-	-	0.0009	146	0.00054	**0.0087**	**0.27**	**0.84**	53	
Barium	mg/L	-	-	1	W	0.016	146	0.011	0.17	4.9	15		4.9
Beryllium	mg/L	-	-	0.00013	W	0.0025	146	<0.0001	0.00048	0.015	0.047		115
Cadmium	mg/L	-	-	-	-	0.0001	146	<0.000010	*0.00024*	*0.0049*	*0.015*		
Chromium	mg/L	-	-	0.001	W, e	0.0013	146	<0.0005	0.025	0.29	0.59		286
Cobalt	mg/L	0.11	A	0.004	A	0.0005	146	0.00017	0.013	**0.37**	**0.98**	3.3	92
Copper	mg/L	0.008 - 0.049	A, f	0.002 - 0.02	A, f	0.0061	146	0.0048[b]	**0.23**	**21**	**78**	2740	8653
Iron	mg/L	1	A	-	-	0.45	146	0.32	**23**	**390**	**1000**	390	
Lead	mg/L	0.044 - 0.64	A, g	0.005 - 0.028	A, g	0.00050	146	0.000076	0.0082[b]	**0.27[b]**	**0.78**	6	53
Lithium	mg/L	-			-	0.0025	146	<0.0005	0.018	*0.42*	*1.0*		
Manganese	mg/L	1.2 - 6.1	A, h	0.88 - 2.8	A, h	0.049	146	0.011	0.84	**16**	**50**	13	18
Mercury	mg/L	-	-	0.00001	A, i	0.000029	28	<0.000010*	0.00044	0.0058	0.015		4621
Molybdenum	mg/L	0.5	A, WW	0.01	A, IR	0.0025	146	0.00035	0.0078	0.060	0.19		6
Nickel	mg/L	-	-	0.07 - 0.15	W, j	0.0011	146	<0.0005	0.030	0.32	0.68		5
Selenium	mg/L	-	-	0.002	A	0.00098	146	<0.0005	0.0011	0.021	0.080		11
Silver	mg/L	0.0001 - 0.003	A, k	0.0001 - 0.0015	A, k	0.00005	146	<0.00001	0.00013[b]	**0.0090**	**0.033**	90	180
Strontium	mg/L	-			-	0.29	146	0.1	*0.53*	*4.2*	*13*		
Thallium	mg/L	-	-	0.0008	W	0.00005	146	<0.00001	0.00010	0.00090	0.0017		1.1
Titanium	mg/L	-			-	0.011	146	0.012	0.67	*7.0*	*19*		
Uranium	mg/L	-	-	0.0085	W	0.00034	146	0.000086	0.0014	0.021	0.056		2.5
Vanadium	mg/L	-			-	0.015	146	0.0011	*0.044*	*1.2*	*2.7*		
Zinc	mg/L	0.03 - 0.34	A, l	0.008 - 0.32	A, l	0.0049	146	<0.003	0.057[b]	**1.4**	**4.0**	48	193
Dissolved Metals													
Aluminum	mg/L	0.1	A, d	0.05	A, d	0.19	146	0.003 (<0.20)	0.040	**0.73**	**2.2**	7.3	15
Arsenic	mg/L	0.005	A	-	-	0.0008	146	0.00045	0.0013	0.0029	**0.0061**		
Chromium	mg/L	-	-	0.001	W, e	0.0011	146	<0.0005	<0.0005	0.0016	0.0036		1.6
Cobalt	mg/L	0.11	A	0.004	A	0.0005	146	<0.0001	0.00021	0.0022	0.0063		
Copper	mg/L	0.008 - 0.049	A, f	0.002 - 0.02	A, f	0.0051	146	0.0035[b]	**0.016[b]**	**0.053**	**0.086**	6.8	21
Iron	mg/L	0.35	A	-	-	0.25	146	<0.03	0.065	**1.0**	**3.3**		
Mercury	mg/L	-	-	0.00001	A, i	0.000025	nm	nm	nm	nm	nm		
Molybdenum	mg/L	0.5	A, WW	0.01	A, IR	0.0027	146	0.00035	0.0081	0.049	0.19		4.9
Selenium	mg/L	-	-	0.002	A	0.001	146	<0.0005	0.00092	0.0038	0.033		1.9
Strontium	mg/L	-			-	0.29	146	0.097	0.31	*0.83*	*2.5*		

Notes:

Exceedance factors were calculated by dividing the 95th percentile to the cooresponding BC WQG under the most conservative scenario

A = approved guideline, W = working guideline, Min = Minimum concentration requirement based on life stage, IR = irrigation guideline, WW = wildlife water supply guidelines, DW = drinking water guidelines

a) BC Water Quality (BCWQ) guidelines for the protection of freshwater aquatic life except where noted (e.g., total aluminum, molybdenum, pH)

b) value exceeds the guideline at the most conservative scenario but not the least conservative scenario

c) hardness dependent sulphate guideline: BC 30-d WQG (mg/L) = 128 at hardness <30 mg/L, at hardness 31-75 mg/L = 218, at hardness 76-180 mg/L = 309, at hardness 181-250 mg/L = 429, at hardness >250 mg/L determine base on site water

d) pH dependent dissolved Al guideline: BC Max WQG (mg/L) = 0.1 at pH ≥6.5, at pH <6.5 = EXP(1.209-2.426*(pH)+0.286*(pH2)); BC 30-d WQG (mg/L) = 0.05 at pH ≥6.5, at pH <6.5 = EXP(1.6-3.327*(median pH)+0.402*(median pH2); minimum baseline surface water pH = 5.57

e) guideline is for Cr(VI)

f) hardness dependent Cu guideline: BC Max WQG (mg/L) = (0.094(hardness)+2)/1000; BC 30-d WQG (mg/L) = 0.002 at hardness ≤50 mg/L , at hardness >50 mg/L = 0.04*hardness/1000

g) hardness dependent Pb guideline: BC Max WQG (mg/L) = 0.003 at hardness ≤8 mg/L, at hardness >8 mg/L = (EXP((1.273*ln(hardness))-1.46))/1000; BC 30-d WQG (mg/L) = (3.31+EXP(1.273(ln(hardness))-4.704))/1000 at hardness >8 mg/L, no guideline at hardness ≤8 mg/L

h) hardness dependent Mn guideline: BC Max WQG (mg/L) = 0.01102*(hardness)+0.54; BC 30-d WQG (mg/L) = 0.0044*hardness+0.605

i) BC 30-d WQG (mg/L) = 0.00002 when methylmercury (MeHg) is 0.5% of total Hg, = 0.00001 at 1% MeHg, = 0.00000125 at 8% MeHg; applied middle guideline

j) hardness dependent Ni guideline: BC 30-d WQG = 0.025 at hardness <60 mg/L, at hardness 60-120 mg/L =0.065, at hardness 120-180 mg/L = 0.11, at hardness >180 mg/L = 0.15

k) hardness dependent Ag guideline: BC Max WQG (mg/L) = 0.0001 at hardness ≤100 mg/L, at hardness >100 mg/L = 0.003; BC 30-d WQG (mg/L) = 0.00005 at hardness ≤100 mg/L, at hardness > 100 mg/L = 0.0015

l) hardness dependent Zn guideline: BC Max WQG (mg/L) = (33+0.75(hardness-90))/1000; BC 30-d WQG (mg/L) = (7.5+0.75(hardness-90))/1000

nm - not measured

< reported value is <MDL

* = MDLs that are >WQG

123	Indicates concentration exceeding the BC Max WQ Guideline
123	Indicates concentration exceeding the BC 30-d WQ Guideline
123	Indicates concentration exceeding >20% baseline (95th percentile) without BC WQG

Table C-4: Post-event Water Quality in Quesnel Lake, August 2014 to February 2015

Parameter	Units	BC Water Quality Guidelines for the Protection of Freshwater Aquatic Life[a]				Baseline (95th percentile)	Number of samples	Minimum	Median	95th Percentile	Maximum	Exceedance factor (95th Percentile/ Maximum BC WQG)	Exceedance factor (95th Percentile/ 30-Day BC WQG)
		Maximum	notes	30-Day Average	notes								
Physical Parameters													
Dissolved Oxygen (in situ)	mg/L	5-9	A, Min	8-11	A, Min	nm	1019	**2.1**	9.6				
Hardness (Dissolved)	mg/L (as $CaCO_3$)	-	-	-	-	nm	1097	*42*	*52*	*66*	*75*		
pH (in situ)	pH Unit	6.5 - 8.5	A, DW	6.5 - 9.0	A	nm	1035	6.8	7.8	N/A	**8.8**		
Total Dissolved Solids	mg/L	-	-	-	-	nm	1097	*49*	*68*	*101*	*127*		
Total Suspended Solids	mg/L	+25 mg/L, +10 mg/L if background 25-100 mg/L	A	+5 mg/L, +10% if background >100 mg/L	A	nm	1097	<3.00	<3.00	11	**47**		2.1
Turbidity (lab)	NTU	+1 NTU if background ≤5 NTU (untreated)	DW	+2 NTU, +10% if background >50 NTU	A	nm	906	0.00	1.2	**61**	**153**	7.6	30
Nutrients													
Nitrite	mg/L (as N)	0.06	A, b	0.02	A, b	0.0030	1097	<0.001	<0.001	0.0023	0.021		
Phosphorus (P) Total	mg/L	0.005-0.015 in lakes			A	0.008	1097	<0.002	0.0027	**0.030**	**1.4**	6.0	
Total Metals													
Aluminum	mg/L	5	A, WW	-	-	nm	1097	0.0079 (<0.015)	0.049	2.7	**7.3**		
Beryllium	mg/L	-	-	0.00013	W	0.0025	146	<0.0001	<0.0001	<0.0001	0.00016		
Cadmium	mg/L	-	-	-	-	nm	1097	*<0.000010*	*0.000010*	*0.000018*	*0.00017*		
Chromium	mg/L	-	-	0.001	W, d	nm	1097	<0.0005	<0.0005	0.0012	0.0060		1.2
Copper	mg/L	0.006 - 0.009	A, e	0.002 - 0.003	A, e	nm	1097	<0.0005	0.0016	**0.052**	**0.14**	8.7	26
Iron	mg/L	1	A	-	-	nm	1097	<0.030	0.037	**1.3**	**3.1**	1.3	
Lead	mg/L	0.027 - 0.056	A, f	0.004 - 0.006	A, f	nm	1097	<0.00005	<0.00005	0.00095	0.0062		
Mercury	mg/L	-	-	0.00001	A, g	nm	242	<0.00001*	<0.00005*	<0.00005*	0.000011		
Molybdenum	mg/L	0.5	A, WW	0.01	A, IR	nm	1097	0.00022	0.00035	0.0056	0.011		
Strontium	mg/L	-			-	nm	1097	*0.10*	*0.13*	*0.20*	*0.29*		
Vanadium	mg/L	-			-	nm	1097	<0.001	<0.001	*0.0048*	*0.012*		
Zinc	mg/L	0.03	A, h	0.008	A, h	nm	1097	<0.003	<0.003	0.0053	0.015		
Dissolved Metals													
Aluminum	mg/L	0.1	A, c	0.05	A, c	nm	1097	0.0032	0.0089	0.014	**0.23**		
Chromium	mg/L	-	-	0.001	W, d	nm	1097	<0.0005	<0.0005	<0.0005	0.0027		
Copper	mg/L	0.006 - 0.009	A, e	0.002 - 0.003	A, e	nm	1097	<0.0005	0.00084	0.0053	**0.0091**	0.9	2.6
Mercury	mg/L	-	-	0.00001	A, g	nm	17	<0.000050*	<0.000050*	<0.000050*	<0.000050*		
Molybdenum	mg/L	0.5	A, WW	0.01	A, IR	nm	1097	0.00021	0.00032	0.0052	0.011		
Strontium	mg/L	-			-	nm	1097	*0.10*	*0.13*	*0.18*	*0.20*		
Zinc	mg/L	0.03	A, h	0.008	A, h	nm	1097	<0.003	<0.003	<0.003	0.025		

Notes:

Exceedance factors were calculated by dividing the 95th percentile to the cooresponding BC WQG under the most conservative scenario

A = approved guideline, W = working guideline, Min = Minimum concentration requirement based on life stage, IR = irrigation guideline, WW = wildlife water supply guidelines, DW = drinking water guidelines

a) BC Water Quality (BCWQ) guidelines for the protection of freshwater aquatic life except where noted (e.g., total aluminum, molybdenum, pH)

b) chloride dependent nitrite guideline: BC Max WQG (mg/L) = 0.06 at Cl <2 mg/L, at Cl 2-4 mg/L = 0.12, at Cl 4-6 mg/L = 0.18, at Cl 6-8 mg/L = 0.24, at Cl 8-10 = 0.30, at Cl >10 = 0.6
BC 30-d WQG (mg/L) = 0.02 mg/L at Cl <2 mg/L, at Cl 2-4 mg/l = 0.04, at Cl 4-6 mg/L = 0.06, at Cl 6-8 mg/L = 0.08, at Cl 8-10 mg/L = 0.1, at Cl >10 = 0.2

c) pH dependent dissolved Al guideline: BC Max WQG (mg/L) = 0.1 at pH≥6.5, at pH <6.5 = EXP(1.209-2.426*(pH)+0.286*(pH2)); BC 30-d WQG (mg/L) = 0.05 at pH ≥6.5, at pH <6.5 = EXP(1.6-3.327*(median pH)+0.402*(median pH2); minimum baseline surface water pH = 5.57

d) guideline is for Cr(VI)

e) hardness dependent Cu guideline: BC Max WQG (mg/L) = (0.094(hardness)+2)/1000; BC 30-d WQG (mg/L) = 0.002 at hardness≤50 mg/L , at hardness >50 mg/L = 0.04*hardness/1000

f) hardness dependent Pb guideline: BC Max WQG (mg/L) = 0.003 at hardness≤8 mg/L, at hardness >8 mg/L = (EXP((1.273*ln(hardness))-1.46))/1000; BC 30-d WQG (mg/L) = (3.31+EXP(1.273(ln(hardness))-4.704))/1000 at hardness >8 mg/L, no guideline at hardness≤8 mg/L

g) BC 30-d WQG (mg/L) = 0.00002 when methylmercury (MeHg) is 0.5% of total Hg, = 0.00001 at 1% MeHg, = 0.00000125 at 8% MeHg; applied middle guideline

h) hardness dependent Zn guideline: BC Max WQG (mg/L) = (33+0.75(hardness-90))/1000; BC 30-d WQG (mg/L) = (7.5+0.75(hardness-90))/1000

nm - not measured

< reported value is <MDL

* = MDLs that are >WQG

123	Indicates concentration exceeding the BC Max WQ Guideline
123	Indicates concentration exceeding the BC 30-d WQ Guideline
123	Indicates concentration exceeding >20% baseline (95th percentile) for parameters without BC WQGs, or parameters without BC WQGs and baseline

Table C-5: Post-event Water Quality in Quesnel River, August 2014 to February 2015

Parameter	Units	BC Water Quality Guidelines for the Protection of Freshwater Aquatic Life[a]				Baseline (95th percentile)	Number of samples	Minimum	Median	95th Percentile	Maximum	Exceedance factor (95th Percentile/ Maximum BC WQG)	Exceedance factor (95th Percentile/ 30-Day BC WQG)
		Maximum	notes	30-Day Average	notes								
Physical Parameters													
Dissolved Oxygen (in situ)	mg/L	5-9	A, Min	8-11	A, Min	13	266	6.0	9.5				
Hardness (Dissolved)	mg/L (as $CaCO_3$)	-	-	-	-	55	281	47	52	59	*67*		
pH (in situ)	pH Unit	6.5 - 8.5	A, DW	6.5 - 9.0	A	8.0	276	7.2	7.9	N/A	**9.4**		
Total Dissolved Solids	mg/L	-	-	-	-	70	159	54	70	84	*89*		
Total Suspended Solids	mg/L	+25 mg/L, +10 mg/L if background 25-100 mg/L	A	+5 mg/L, +10% if background >100 mg/L	A	3	248	<3.0	<3.0	2.5	**44**		
Turbidity (lab)	NTU	+1 NTU if background ≤5 NTU (untreated)	DW	+2 NTU, +10% if background >50 NTU	A	1.0	267	0.12	0.99	**7.3**	**23**		3.7
Nutrients													
Phosphorus (P) Total	mg/L	0.005-0.015 in lakes			A	0.012	159	<0.002	0.0033	0.0067	**0.035**	1.3	
Total Metals													
Cadmium	mg/L	-	-	-	-	nm	299	<0.00001	<0.00001	*0.000014*	*0.00041*		
Copper	mg/L	0.006 - 0.008	A, c	0.002 - 0.003	A, c	0.005	299	0.00051 (<0.0025)	0.0014	**0.0070**[e]	**0.0098**	1.1	3.5
Iron	mg/L	1	A	-	-	0.19	299	<0.03	<0.03	0.12	**2.0**		
Mercury	mg/L	-	-	0.00001	A, e	nm	27	<0.00001*	<0.00005*	<0.00005*	<0.00005*		
Strontium	mg/L	-			-	nm	299	*0.11*	*0.13*	*0.16*	*0.17*		
Dissolved Metals													
Cadmium	mg/L	0.0003 - 0.0004	A, b	0.0001 - 0.0002	A, b	nm	159	<0.00001	<0.00001	0.000019	0.00024		
Copper	mg/L	0.006 - 0.008	A, c	0.002 - 0.003	A, c	0.014	159	<0.0005	0.00098	0.0022	0.0026	0.3	1.1
Mercury	mg/L	-	-	0.00001	A, d	nm	3	<0.000050*	<0.000050*	<0.000050*	<0.000050*		
Strontium	mg/L	-			-	nm	159	*0.11*	*0.13*	*0.15*	*0.16*		

Notes:

Exceedance factors were calculated by dividing the 95th percentile to the cooresponding BC WQG under the most conservative scenario

A = approved guideline, W = working guideline, Min = Minimum concentration requirement based on life stage, IR = irrigation guideline, WW = wildlife water supply guidelines, DW = drinking water guidelines

a) BC Water Quality (BCWQ) guidelines for the protection of freshwater aquatic life except where noted (e.g., pH)

b) hardness dependent dissolved Cd guideline: max BC WQG (mg/L) = (exp(1.03*ln(hardness)-5.274))/1000 BC 30-d WQG (mg/L) = (exp(0.736*ln(hardness)-4.943))/1000

c) hardness dependent Cu guideline: BC Max WQG (mg/L) = (0.094(hardness)+2)/1000; BC 30-d WQG (mg/L) = 0.002 at hardness≤50 mg/L , at hardness >50 mg/L = 0.04*hardness/1000

d) BC 30-d WQG (mg/L) = 0.00002 when methylmercury (MeHg) is 0.5% of total Hg, = 0.00001 at 1% MeHg, = 0.00000125 at 8% MeHg; applied middle guideline

e) value exceeds the guideline at the most conservative scenario but not the least conservative scenario

nm - not measured

< reported value is <MDL

* = MDLs that are >WQG

123	Indicates concentration exceeding the BC Max WQ Guideline
123	Indicates concentration exceeding the BC 30-d WQ Guideline
123	Indicates concentration exceeding >20% baseline (95th percentile) for parameters without BC WQGs, or parameters without BC WQGs and baseline

Parameter	Units	BC Water Quality Guidelines for the Protection of Freshwater Aquatic Life[a]				Quesnel River - Gravelle ferry bridge				
						Pre-event		Post-event		
		Maximum	notes	30-Day Average	notes	Number of Samples	Baseline (95th percentile)	Number of Samples	Maximum	95th Percentile
Physical Parameters										
Conductivity (lab)	µs/cm	-	-	-	-	4	116	54	*147*	*145*
Dissolved Oxygen (Field)	mg/L	5-9	A, Min	8-11	A, Min	2	min 9.31	54	min 8.35	-
Hardness (Dissolved)	mg/L	-	-	-	-	5	51 - 63	54	49 - 77	-
pH (Field)	pH Unit	6.5 - 8.5	A, DW	6.5 - 9.0	A	4	7.8 - 8.0	54	7.4 - 8.0	-
Total Dissolved Solids	mg/L	-	-	-	-	-	nm	6	*90*	*89*
Total Suspended Solids	mg/L	+25 mg/L, +10 mg/L if background 25-100 mg/L	A	+5 mg/L, +10% if background >100 mg/L	A	-	nm	6	40	37
Turbidity	NTU	+1 NTU if background ≤5 NTU (untreated)	DW	+2 NTU, +10% if background >50 NTU	A	5	46.7	53	29	21
Water Temp (Field)	°C	-	A	-	A	-	nm	7	-5 to 5.3	-
Major Ions										
Alkalinity, Total	mg/L (as $CaCO_3$)	see note			W, r	1	47	54	*67*	*65*
Chloride	mg/L	600	A	150	A	4	1.7	54	1.7	-
Fluoride	mg/L	2.1	A, d	-	-	1	0.031	54	0.044	-
Sulphate	mg/L	-	-	218	A, e	-	nm	7	9.8	-
Nutrients										
Ammonia	mg/L (as N)	11.7	A, f	2.0	A, f	3	0.007	53	0.018	-
Nitrate	mg/L (as N)	33	A	3	A	-	nm	7	0.14	-
Nitrite	mg/L (as N)	0.06	A, g	0.02	A, g	-	nm	7	0.0084	-
Total Kjeldhal Nitrogen	mg/L (as N)	-			-	3	0.13	54	*0.40*	*0.27*
Total Phosphorus	mg/L	0.005-0.015 in lakes			A	5	0.10	6	**0.034**	**0.033**
Total Metals										
Aluminum	mg/L	5	A, WW	-	-	6	2.9	50	1.9	-
Antimony	mg/L	-	-	0.009	W	6	<0.0005	52	0.000093	-
Arsenic	mg/L	0.005	A	-	-	6	0.0018	52	0.00094	-
Barium	mg/L	-	-	1	W	6	0.034	52	0.029	-
Beryllium	mg/L	-	-	0.00013	W	6	<0.0001	52	0.000051	-
Boron	mg/L	1.2	A	-	-	6	<0.05	50	0.0041	-
Cadmium	mg/L	no T-Cd WQG, see D-Cd WQG				6	0.000082	52	*0.000044*	*0.000031*
Calcium	mg/L	no T-Ca WQG, see D-Ca WQG				4	20	-	nm	-
Chromium	mg/L	-	-	0.001	W, j	6	0.0057	52	0.0038	0.0025
Cobalt	mg/L	0.11	A	0.004	A	6	0.0020	52	0.0013	-
Copper	mg/L	0.0084	A, k	0.0027	A, k	6	0.0074	52	0.0063	0.0052
Iron	mg/L	1	A	-	-	6	4.2	50	**2.6**	**2.1**
Lead	mg/L	0.033	A, l	0.0046	A, l	6	0.0014	52	0.0011	-
Lithium	mg/L	-			-	2	0.002	52	*0.0026*	*0.0020*
Magnesium	mg/L	-			-	5	3.7	-	nm	-
Manganese	mg/L	1.1	A, m	0.82	A, m	6	0.090	52	0.055	-
Mercury	mg/L	-	-	0.00001	A, n	-	nm	0	nm	-
Molybdenum	mg/L	0.5	A, WW	0.01	A, IR	6	<0.001	52	0.0013	-
Nickel	mg/L	-	-	0.025	W, o	6	0.0064	52	0.0043	-
Selenium	mg/L	-	-	0.002	A	6	0.0002	52	0.00019	-
Silver	mg/L	0.0001	A, p	0.00005	A, p	6	<0.00002	52	0.000013	-
Sodium	mg/L	-			-	4	1.1	-	nm	-
Strontium	mg/L	-			-	6	0.13	52	*0.16*	*0.14*
Thallium	mg/L	-	-	0.0008	W	6	<0.00005	52	*0.000019*	*0.000016*
Tin	mg/L	-			-	6	<0.005	52	*0.000026*	*0.000020*
Titanium	mg/L	-			-	4	0.14	-	nm	-
Uranium	mg/L	-	-	0.0085	W	6	0.0003	52	0.0003	-
Vanadium	mg/L	-			-	6	0.0082	52	*0.0048*	*0.0034*
Zinc	mg/L	0.03	A, q	0.0075	A, q	2	0.0248	49	0.0076	0.0046
Dissolved Metals										
Aluminum	mg/L	0.1	A, h	0.05	A, h	6	0.15	42	**0.15**	0.10
Antimony	mg/L	-	-	0.009	W	6	<0.0005	42	0.000074	-
Arsenic	mg/L	0.005	A	-	-	6	0.00025	42	0.00029	-
Barium	mg/L	-	-	1	W	6	0.0098	42	0.013	-
Beryllium	mg/L	-	-	0.00013	W	6	<0.0001	42	0.000007	-
Boron	mg/L	1.2	A	-	-	6	<0.05	42	0.0042	-
Cadmium	mg/L	0.00028	A, i	0.00013	A, i	6	0.000011	42	0.000018	-
Calcium	mg/L	see note			W, b	5	21	54	*23*	*22*
Chromium	mg/L	-	-	0.001	W, j	6	<0.001	42	0.00027	-
Cobalt	mg/L	0.11	A	0.004	A	6	<0.0005	42	0.00008	-
Copper	mg/L	0.007	A, k	0.002	A, k	6	0.0012	42	0.0026	0.0016
Iron	mg/L	0.35	A	-	-	6	0.15	42	0.14	-
Lead	mg/L	0.033	A, l	0.0046	A, l	6	<0.0002	42	0.000093	-
Lithium	mg/L	-			-	2	0.00081	42	*0.001*	*0.00093*
Magnesium	mg/L	-			-	5	2.7	54	*10*	*3.9*
Manganese	mg/L	1.1	A, m	0.8	A, m	6	0.010	42	0.007	-
Mercury	mg/L	-	-	0.00001	A, n	-	nm	-	nm	-
Molybdenum	mg/L	0.5	A, WW	0.01	A, IR	6	<0.001	42	0.0014	-
Nickel	mg/L	-	-	0.025	W, o	6	<0.001	42	0.001	-
Potassium	mg/L	196-227			W, c	5	0.42	54	3.4	-
Selenium	mg/L	-	-	0.002	A	6	0.00011	42	0.00019	-
Silver	mg/L	0.0001	A, p	0.00005	A, p	6	<0.00002	42	0.000001	-
Sodium	mg/L	-			-	5	0.91	54	*15*	*1.67*
Strontium	mg/L	-			-	6	0.12	42	*0.15*	*0.14*
Thallium	mg/L	-	-	0.0008	W	4	<0.00005	42	0.000004	-
Tin	mg/L	-			-	6	0.0025	42	*0.000008*	*0.000005*
Titanium	mg/L	-			-	-	nm	-	nm	-
Uranium	mg/L	-	-	0.0085	W	4	0.00016	42	0.0003	-
Vanadium	mg/L	-			-	6	<0.005	42	*0.00046*	*0.00041*
Zinc	mg/L	0.03	A, q	0.0075	A, q	6	<0.005	42	0.0005	-

Notes:

A = approved guideline, W = working guideline, Min = Minimum concentration requirement based on life stage, IR = irrigation guideline, WW = wildlife water supply guidelines, DW = drinking water guidelines

a) BC Water Quality (BCWQ) guidelines for the protection of freshwater aquatic life except where noted (e.g., total aluminum, molybdenum, pH)

b) up to 4 - highly sensitive to acid inputs; 4 to 8 - moderately sensitive; over 8 - low sensitivity. Refer to alkalinity, the more restrictive of calcium or alkalinity applies.

c) based on threshold for Daphnia magna immobilization of 373-432 as KCl

d) hardness dependent F guideline: BC Max WQG (mg/L) = 0.4 at hardness of 10 mg/L, otherwise = (-51.73 + (92.57 *log(hardness)))*0.01

e) hardness dependent sulphate guideline: BC 30-d WQG (mg/L) = 128 at hardness <30 mg/L, at hardness 31-75 mg/L = 218, at hardness 76-180 mg/L = 309, at hardness 181-250 mg/L = 429, at hardness >250 mg/L determine base on site water

f) pH and temperature dependent ammonia guideline: values selected from Tables 3 and 4 in BC WQG based on maximum temperature of 20°C and pH 8.2

g) chloride dependent nitrite guideline: BC Max WQG (mg/L) = 0.06 at Cl <2 mg/L, at Cl 2-4 mg/L = 0.12, at Cl 4-6 mg/L = 0.18, at Cl 6-8 mg/L = 0.24, at Cl 8-10 = 0.30, at Cl >10 = 0.6
BC 30-d WQG (mg/L) = 0.02 mg/L at Cl <2 mg/L, at Cl 2-4 mg/l = 0.04, at Cl 4-6 mg/L = 0.06, at Cl 6-8 mg/L = 0.08, at Cl 8-10 mg/L = 0.1, at Cl >10 = 0.2

h) pH dependent dissolved Al guideline: BC Max WQG (mg/L) = 0.1 at pH ≥6.5, at pH <6.5 = EXP(1.209-2.426*(pH)+0.286*(pH2)); BC 30-d WQG (mg/L) = 0.05 at pH ≥6.5, at pH <6.5 = EXP(1.6-3.327*(median pH)+0.402*(median pH2); minimum baseline surface water pH = 5.57

i) hardness dependent dissolved Cd guideline: max BC WQG (mg/L) = (exp(1.03*ln(hardness)-5.274))/1000 BC 30-d WQG (mg/L) = (exp(0.736*ln(hardness)-4.943))/1000

j) guideline is for Cr(VI)

k) hardness dependent Cu guideline: BC Max WQG (mg/L) = (0.094(hardness)+2)/1000; BC 30-d WQG (mg/L) = 0.002 at hardness ≤50 mg/L , at hardness >50 mg/L = 0.04*hardness/1000

l) hardness dependent Pb guideline: BC Max WQG (mg/L) = 0.003 at hardness ≤8 mg/L, at hardness >8 mg/L = (EXP((1.273*ln(hardness))-1.46))/1000; BC 30-d WQG (mg/L) = (3.31+EXP(1.273(ln(hardness))-4.704))/1000 at hardness >8 mg/L, no guideline at hardness ≤8 mg/L

m) hardness dependent Mn guideline: BC Max WQG (mg/L) = 0.01102*(hardness)+0.54; BC 30-d WQG (mg/L) = 0.0044*hardness+0.605

n) BC 30-d WQG (mg/L) = 0.00002 when methylmercury (MeHg) is 0.5% of total Hg, = 0.00001 at 1% MeHg, = 0.00000125 at 8% MeHg; applied middle guideline

o) hardness dependent Ni guideline: BC 30-d WQG = 0.025 at hardness <60 mg/L, at hardness 60-120 mg/L =0.065, at hardness 120-180 mg/L = 0.11, at hardness >180 mg/L = 0.15

p) hardness dependent Ag guideline: BC Max WQG (mg/L) = 0.0001 at hardness ≤100 mg/L, at hardness >100 mg/L = 0.003; BC 30-d WQG (mg/L) = 0.00005 at hardness ≤100 mg/L, at hardness > 100 mg/L = 0.0015

q) hardness dependent Zn guideline: BC Max WQG (mg/L) = (33+0.75(hardness-90))/1000; BC 30-d WQG (mg/L) = (7.5+0.75(hardness-90))/1000

r) up to 10 - highly sensitive to acid inputs; 10 to 20 - moderately sensitive; over 20 - low sensitivity. Refer to calcium regarding sensitivity to acid inputs, the more restrictive of calcium or alkalinity is applicable.

nm - not measured

< reported value is <MDL

123	Indicates concentration exceeding the BC Max WQ Guideline
123	Indicates concentration exceeding the BC 30-d WQ Guideline
123	Indicates concentration exceeding >20% baseline (95th percentile) for parameters without BC WQGs, or parameters without BC WQGs and baseline

Table C-7: Summary of Post-Event Chromium Species Concentrations in Hazeltine Creek

Summary Statistic	Units	Upper Hazeltine Creek		Lower Hazeltine Creek	
		Trivalent Chromium	Hexavalent Chromium	Trivalent Chromium	Hexavalent Chromium
Minimum	mg/L	<0.0050	<0.001	<0.0050	*<0.001*
Median	mg/L	0.0069	<0.001	<0.0050	*<0.001*
95th Percentile	mg/L	**0.0502**	0.001435	**0.0697**	*<0.001*
Maximum	mg/L	**0.0571**	0.0016	**0.0930**	*<0.001*
# Samples	na	4	4	10	10
# Samples < MDL	na	2	3	5	10
% Samples < MDL	%	50	75	50	100

Notes:

Data summarized from HAC-05 (upper Hazeltine Creek) and HAC-01a/b (lower Hazeltine Creek). One half MDL was used for non-detect values when calculating 95th percentile concentrations.

Bold = BC MoE 30-day WQG (0.0089 mg/L for trivalent chromium; 0.001 mg/L for hexavalent chromium).

italics = MDL > BC MoE WQG

mg/L = milligrams per litre; < = less than; # = samples; MDL = method detection limit; % = percent'

BC MoE WQG = British Columbia MoE water quality guidelines for the protection of aquatic life (BC MoE 2014).

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APPENDIX D

Plots of In-situ Water Quality Parameters

1.0 POLLEY LAKE

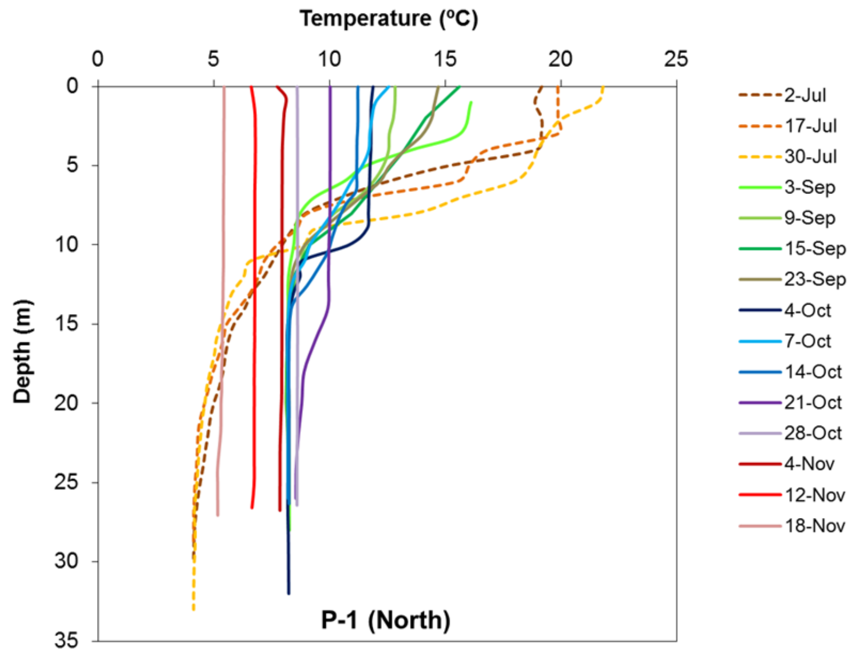
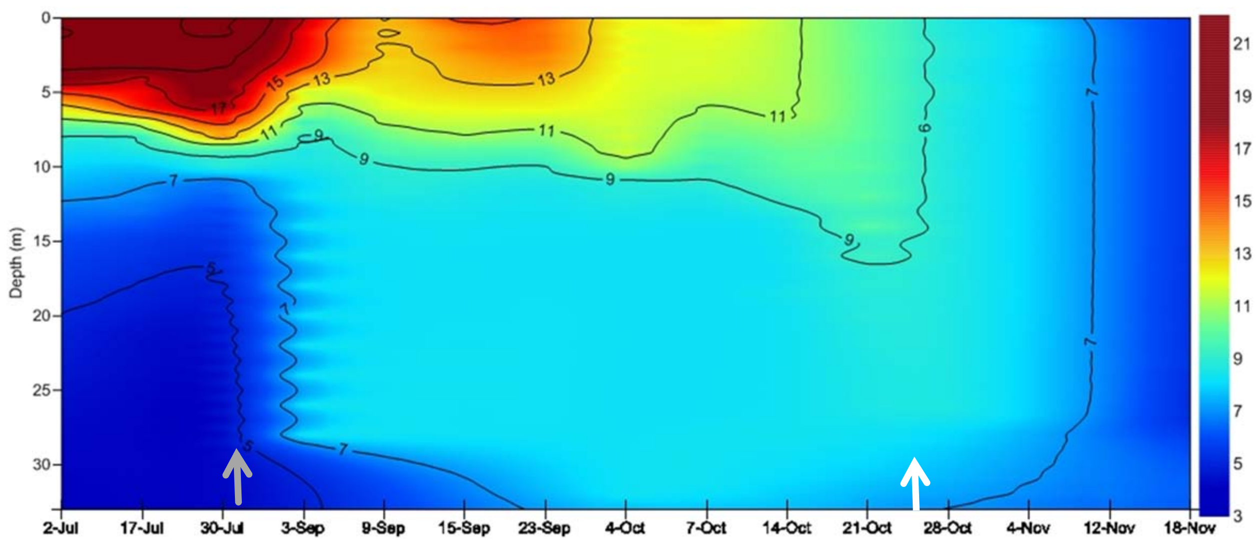


Figure 1: Depth profiles of temperature measured in-situ over time at Station P-1 in Polley Lake pre-event (July 2014) and post-event (September 2014 to November 2014).



Note: The grey arrow represents the approximate timing of the event; the white arrow represents the approximate timing of late-October turnover in Polley Lake

Figure 2: Contours of temperature measured in-situ over time at Station P-1 in Polley Lake pre-event (July 2014) and post-event (September 2014 to November 2014). Temperature (°C) shown on right hand axis.

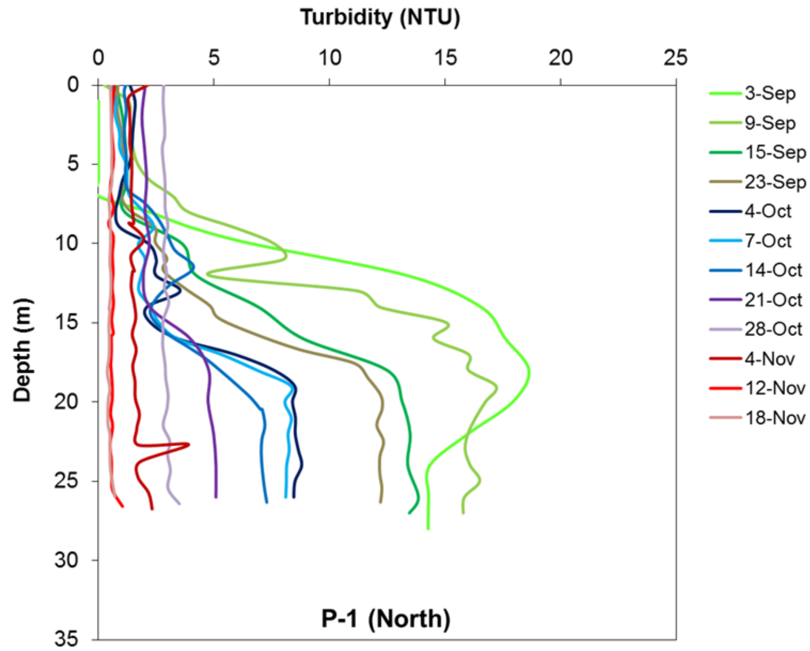
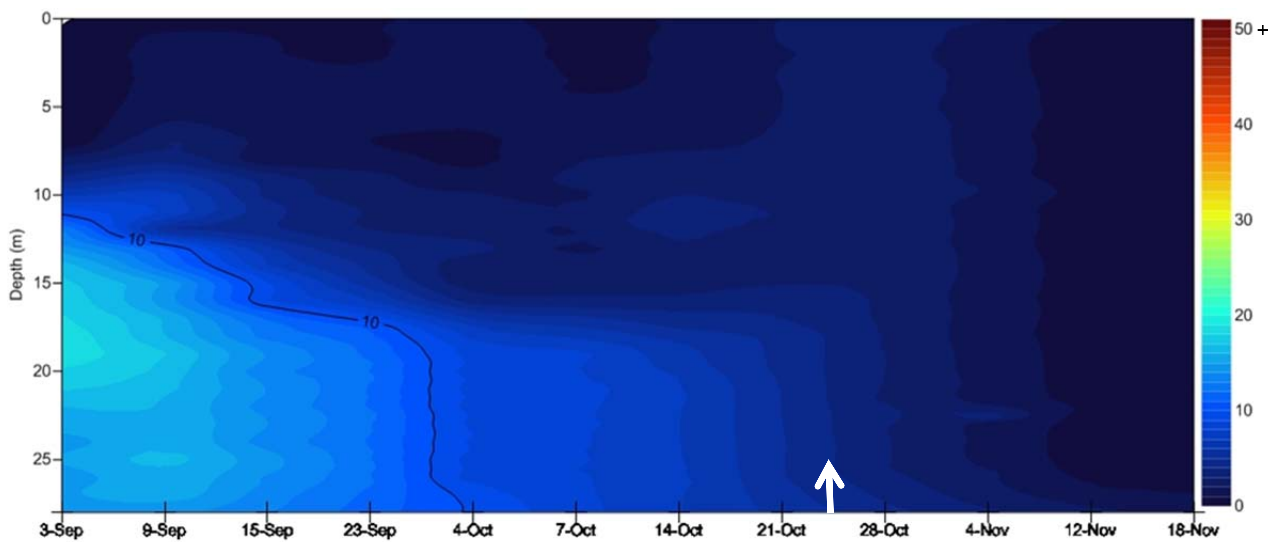


Figure 3: Depth profiles of turbidity measured in-situ over time at Station P-1 in Polley Lake post-event (September 2014 to November 2014).



Note: The white arrow represents the approximate timing of late-October turnover in Polley Lake

Figure 4: Contours of turbidity measured in-situ over time at Station P-1 in Polley Lake and post-event (September 2014 to November 2014). Turbidity (NTU) shown on right hand axis.

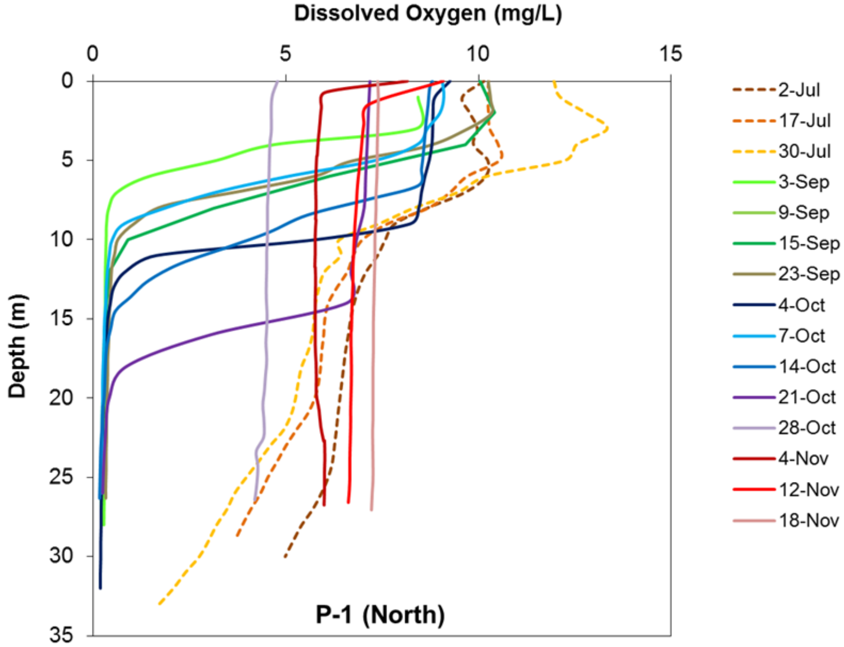
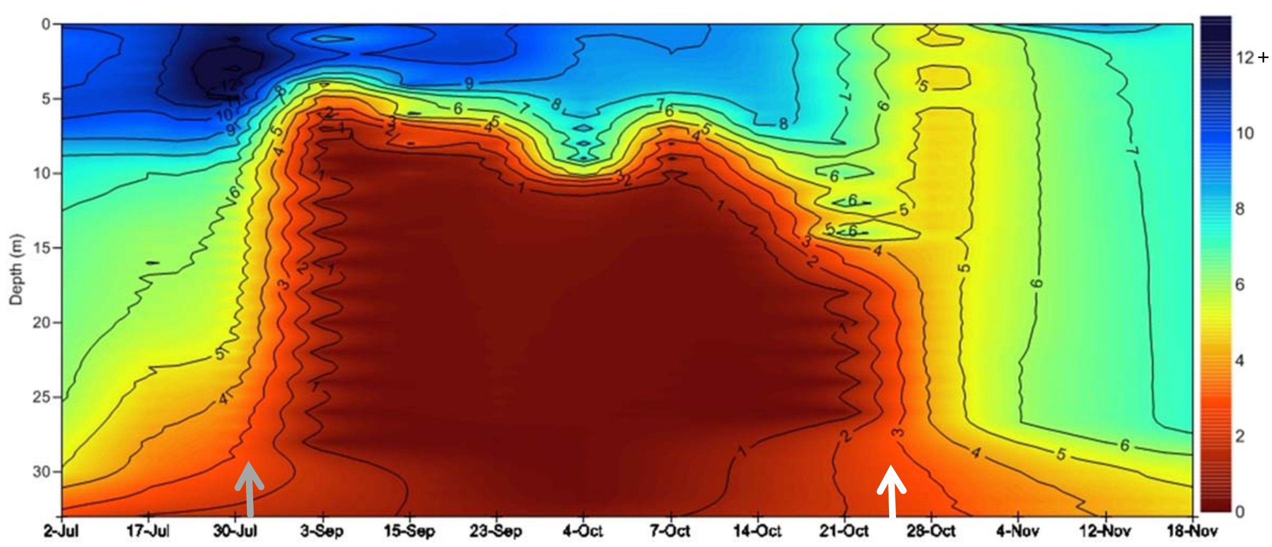


Figure 5: Depth profiles of dissolved oxygen measured in-situ over time at Station P-1 in Polley Lake pre-event (July 2014) and post-event (September 2014 to November 2014).



Note: The grey arrow represents the approximate timing of the event; the white arrow represents the approximate timing of late-October turnover in Polley Lake

Figure 6: Contours of dissolved oxygen measured in-situ over time at Station P-1 in Polley Lake pre-event (July 2014) and post-event (September 2014 to November 2014). Dissolved oxygen (mg/L) shown on right hand axis.

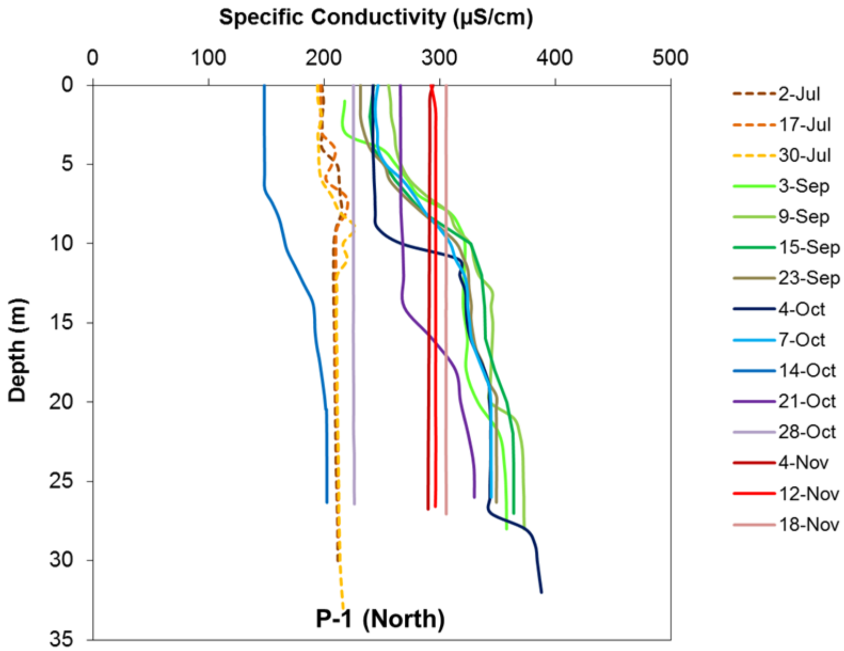
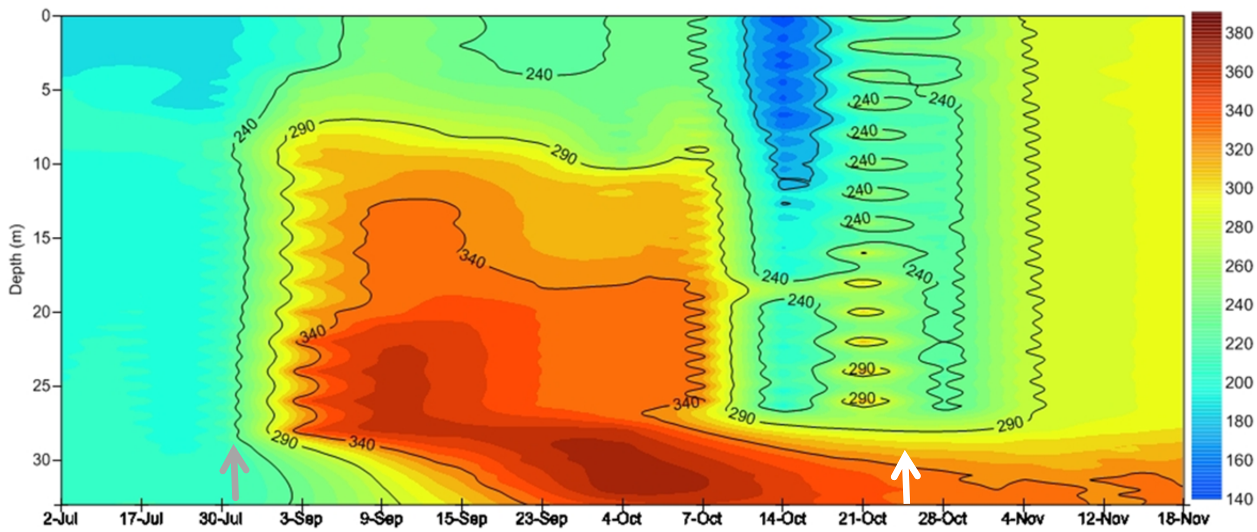


Figure 7: Depth profiles of specific conductivity measured in-situ over time at Station P-1 in Polley Lake pre-event (July 2014) and post-event (September 2014 to November 2014).



Note: The grey arrow represents the approximate timing of the event; the white arrow represents the approximate timing of late-October turnover in Polley Lake

Figure 8: Contours of specific conductivity measured in-situ over time at Station P-1 in Polley Lake pre-event (July 2014) and post-event (September 2014 to November 2014). Specific conductivity (µS/cm) shown on right hand axis.

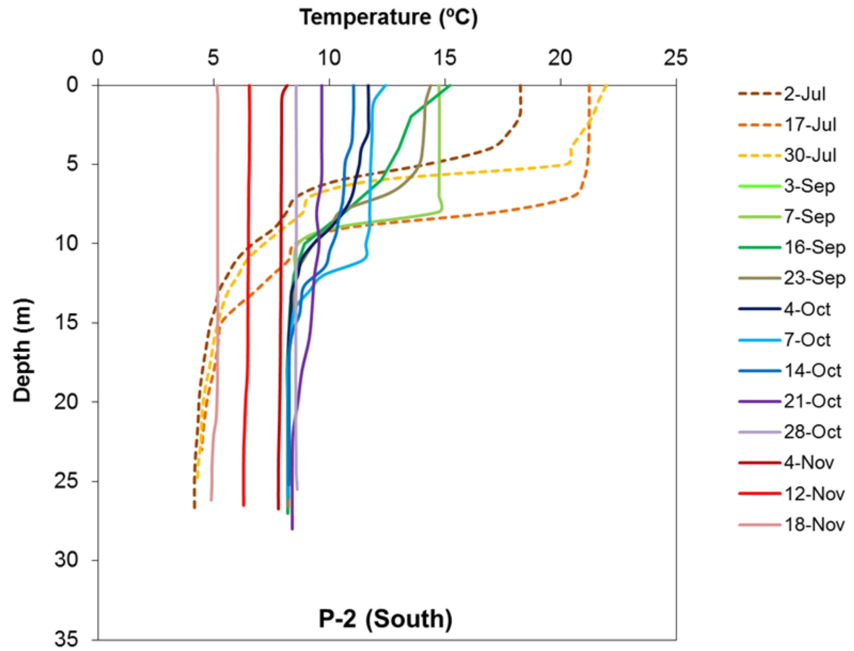
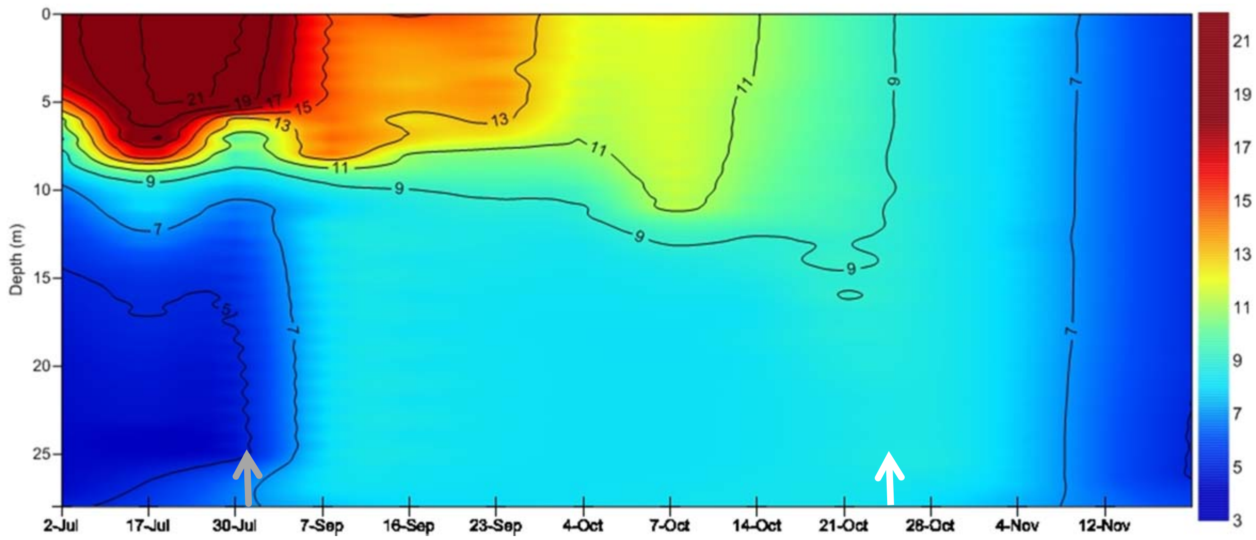


Figure 9: Depth profiles of temperature measured in-situ over time at Station P-2 in Polley Lake pre-event (July 2014) and post-event (September 2014 to November 2014).



Note: The grey arrow represents the approximate timing of the event; the white arrow represents the approximate timing of late-October turnover in Polley Lake

Figure 10: Contours of temperature measured in-situ over time at Station P-2 in Polley Lake pre-event (July 2014) and post-event (September 2014 to November 2014). Temperature (°C) shown on right hand axis.

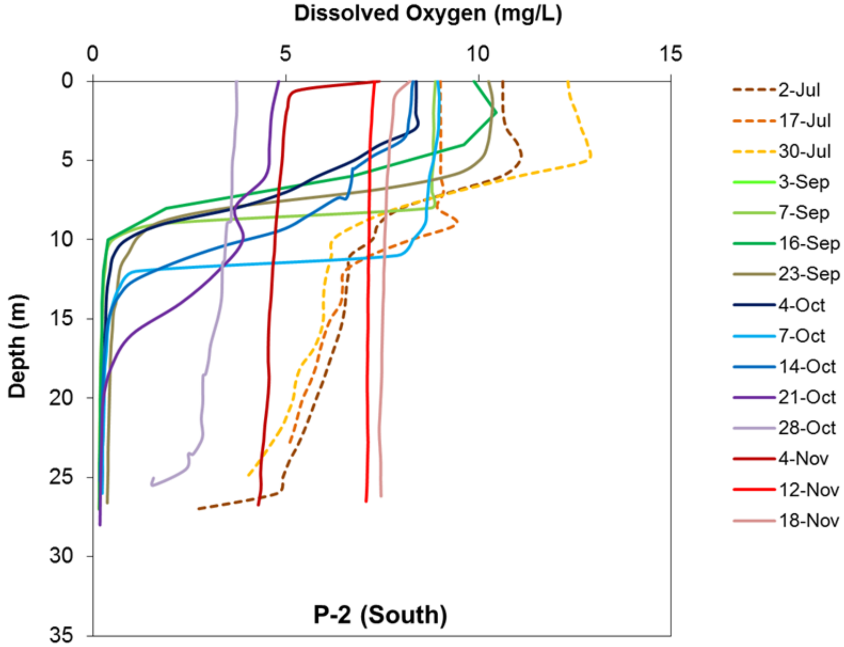
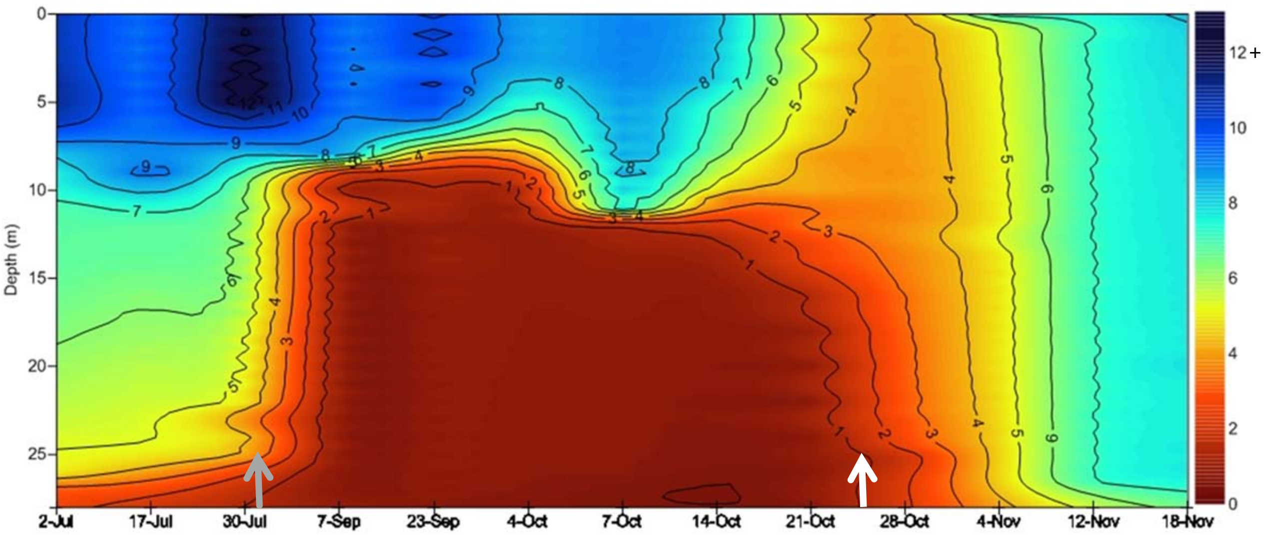


Figure 11: Depth profiles of dissolved oxygen measured in-situ over time at Station P-2 in Polley Lake pre-event (July 2014) and post-event (September 2014 to November 2014).



Note: The grey arrow represents the approximate timing of the event; the white arrow represents the approximate timing of late-October turnover in Polley Lake

Figure 12: Contours of dissolved oxygen measured in-situ over time at Station P-2 Polley Lake pre-event (July 2014) and post-event (September 2014 to November 2014). Dissolved oxygen (mg/L) shown on right hand axis.

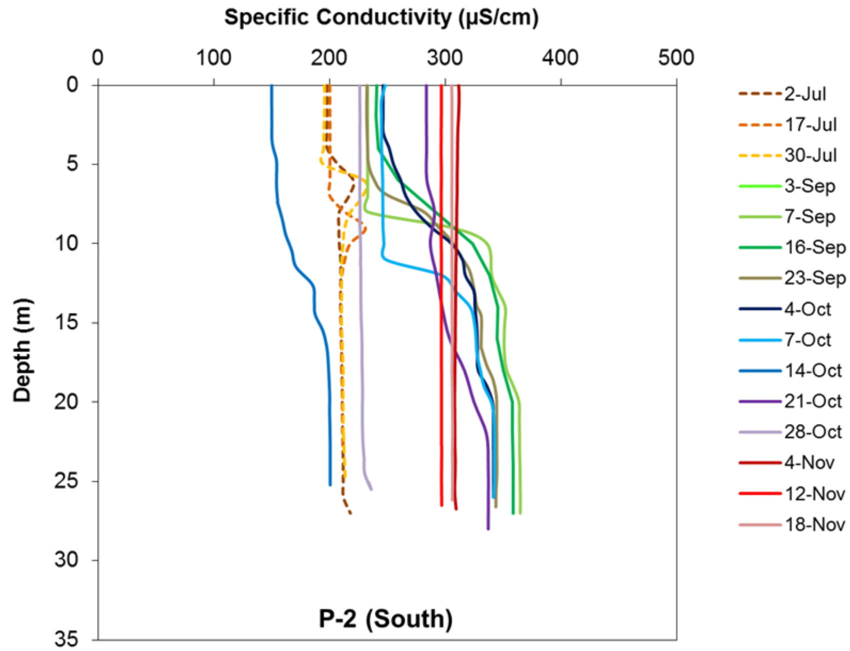
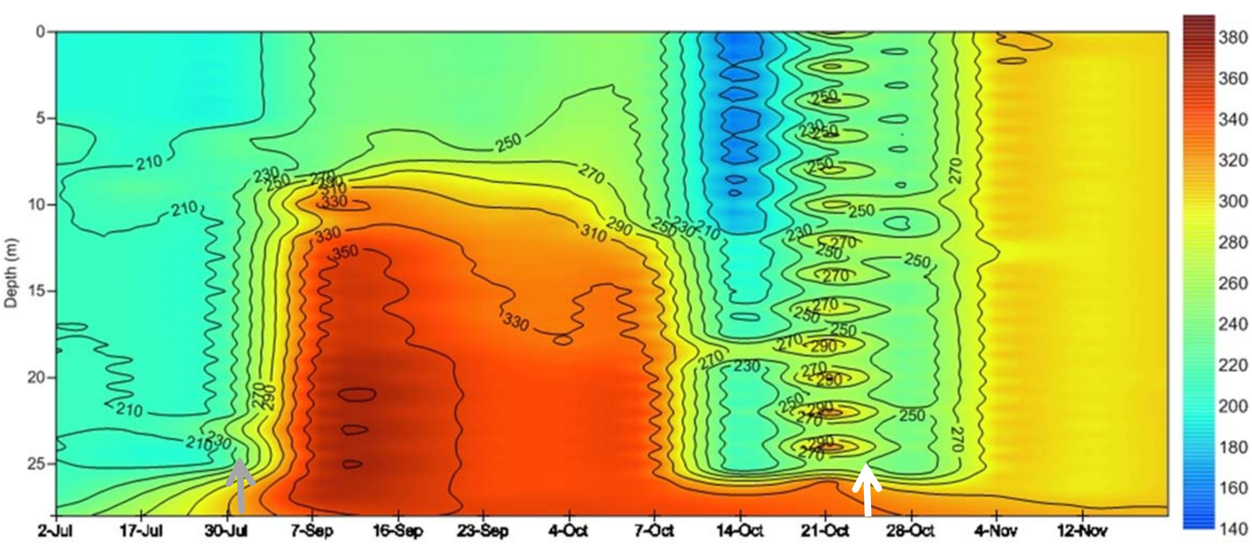


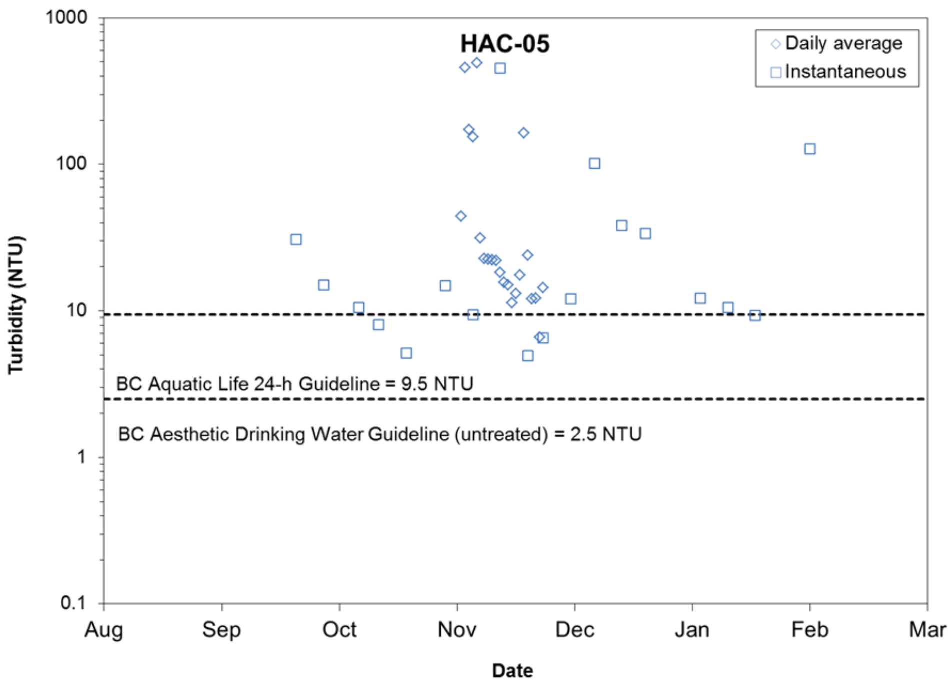
Figure 13: Depth profiles of specific conductivity measured in-situ over time at Station P-2 in Polley Lake pre-event (July 2014) and post-event (September 2014 to November 2014).



Note: The grey arrow represents the approximate timing of the event; the white arrow represents the approximate timing of late-October turnover in Polley Lake

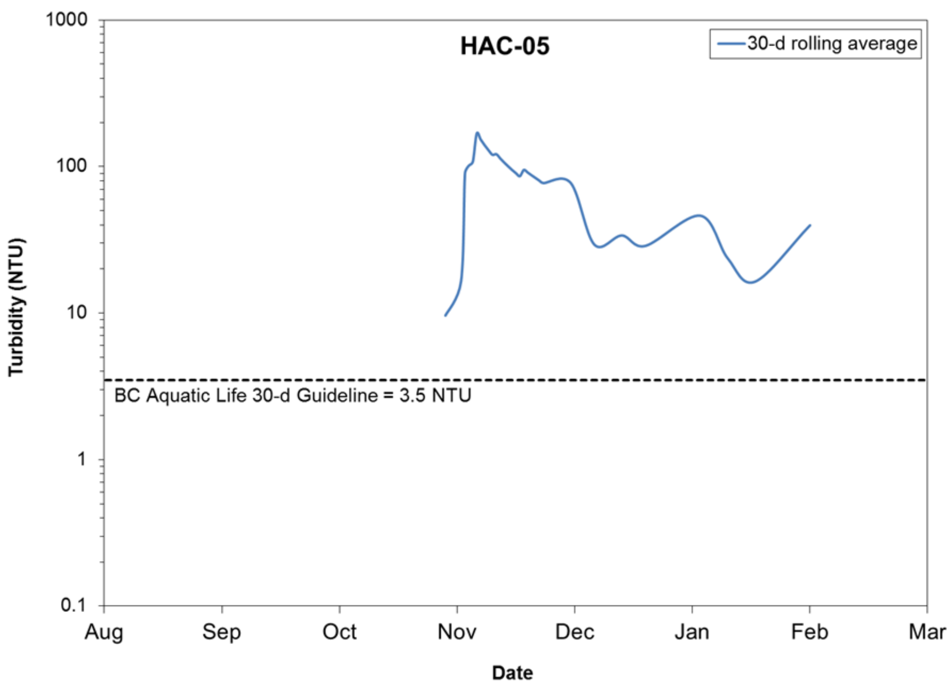
Figure 14: Contours of specific conductivity measured in-situ over time at Station P-2 in Polley Lake pre-event (July 2014) and post-event (September 2014 to November 2014). Specific conductivity (µS/cm) shown on right hand axis.

2.0 HAZELTINE CREEK



Baseline assumed equal to pre-event median baseline of 1.5 NTU.

Figure 15: Turbidity measured in-situ over time at Station HAC-05 in upper Hazeltine Creek post-event (September 2014 to February 2015).



Baseline assumed equal to pre-event median baseline of 1.5 NTU.

Figure 16: 30-day rolling average of turbidity measured in-situ over time at Station HAC-05 in upper Hazeltine Creek post-event (October 2014 to February 2015).

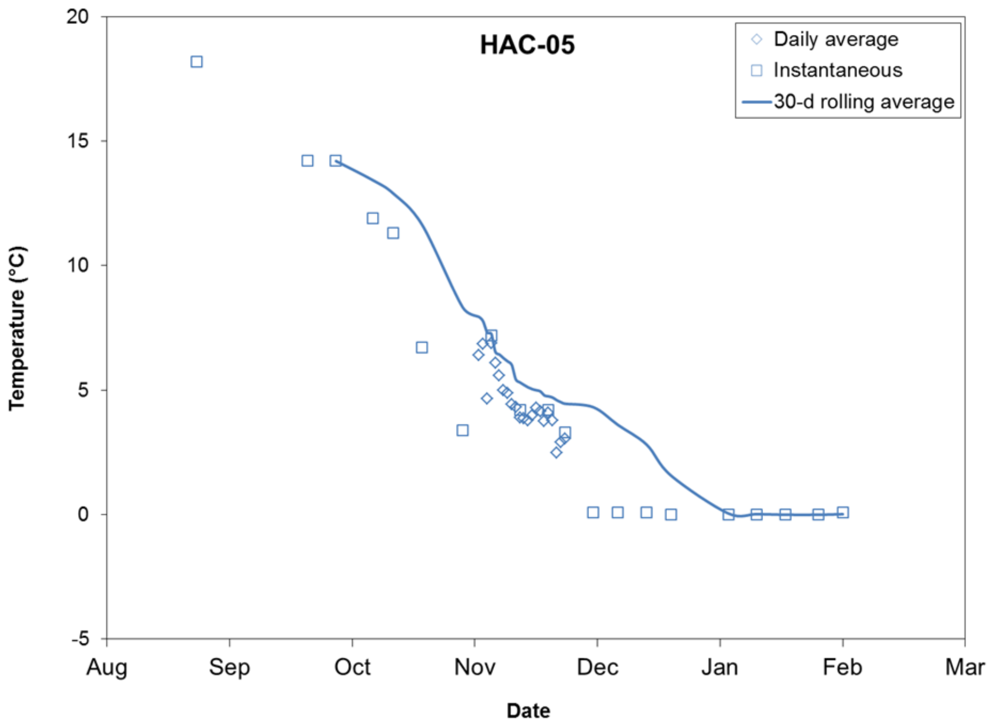


Figure 17: Temperature measured in-situ over time at Station HAC-05 in upper Hazeltine Creek post-event (August 2014 to February 2015).

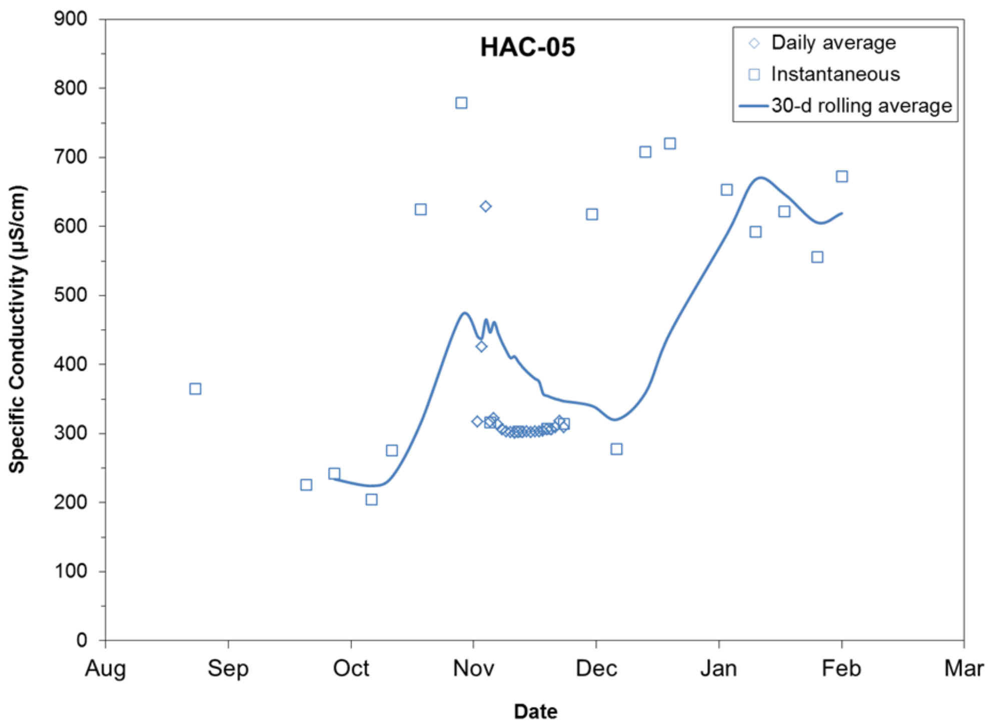
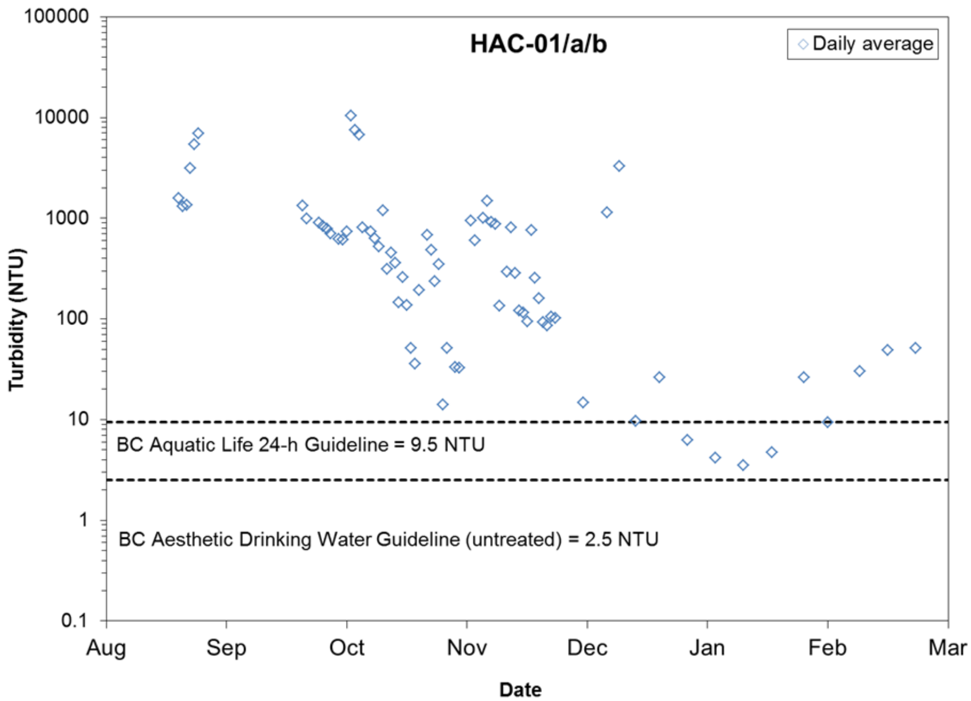
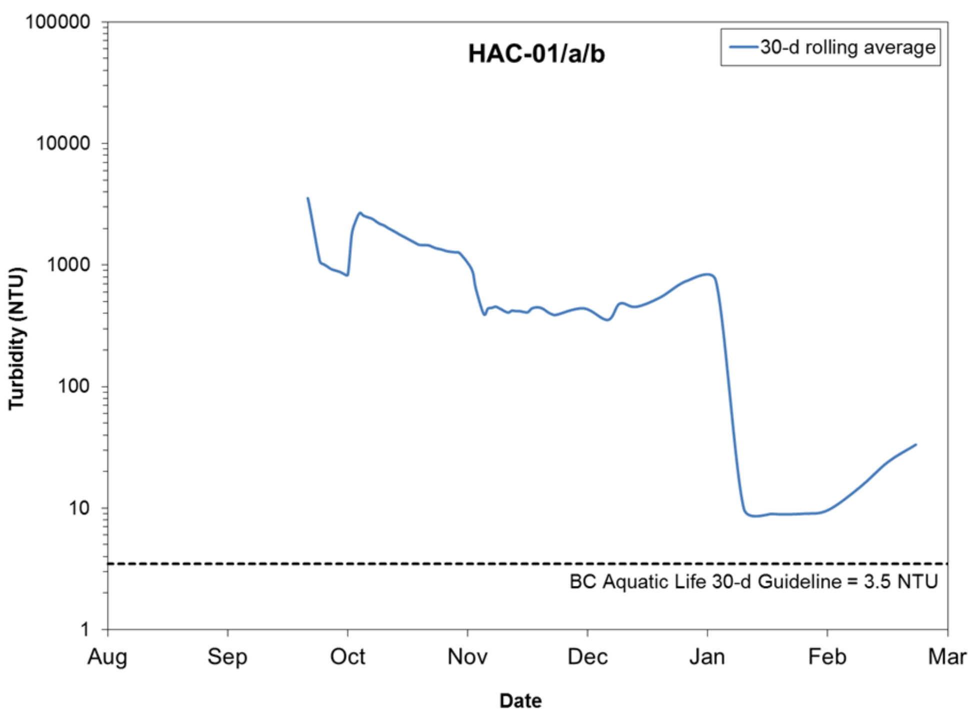


Figure 18: Specific conductivity measured in-situ over time at Station HAC-05 in upper Hazeltine Creek post-event (August 2014 to February 2015).



Baseline assumed equal to pre-event median baseline of 1.5 NTU.

Figure 19: Turbidity measured in-situ over time at Station HAC-01/a/b in lower Hazeltine Creek post-event (August 2014 to February 2015).



Baseline assumed equal to pre-event median baseline of 1.5 NTU.

Figure 20: 30-day rolling average of turbidity measured in-situ over time at Station HAC-01/a/b in lower Hazeltine Creek post-event (September 2014 to February 2015).

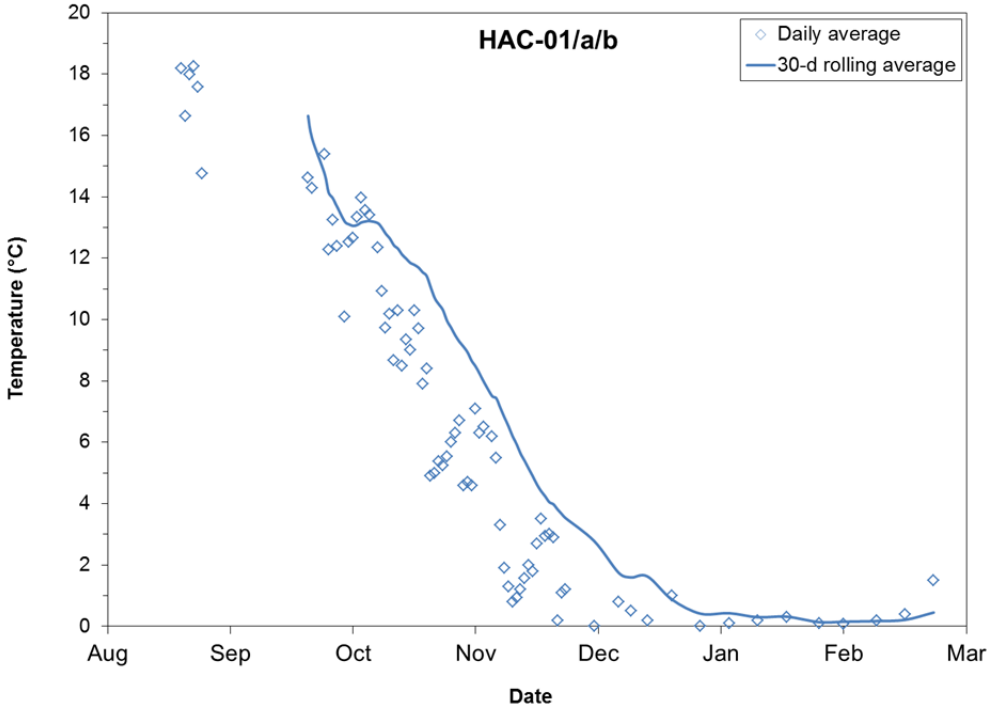


Figure 21: Temperature measured in-situ over time at Station HAC-01/a/b in lower Hazeltine Creek post-event (August 2014 to February 2015).

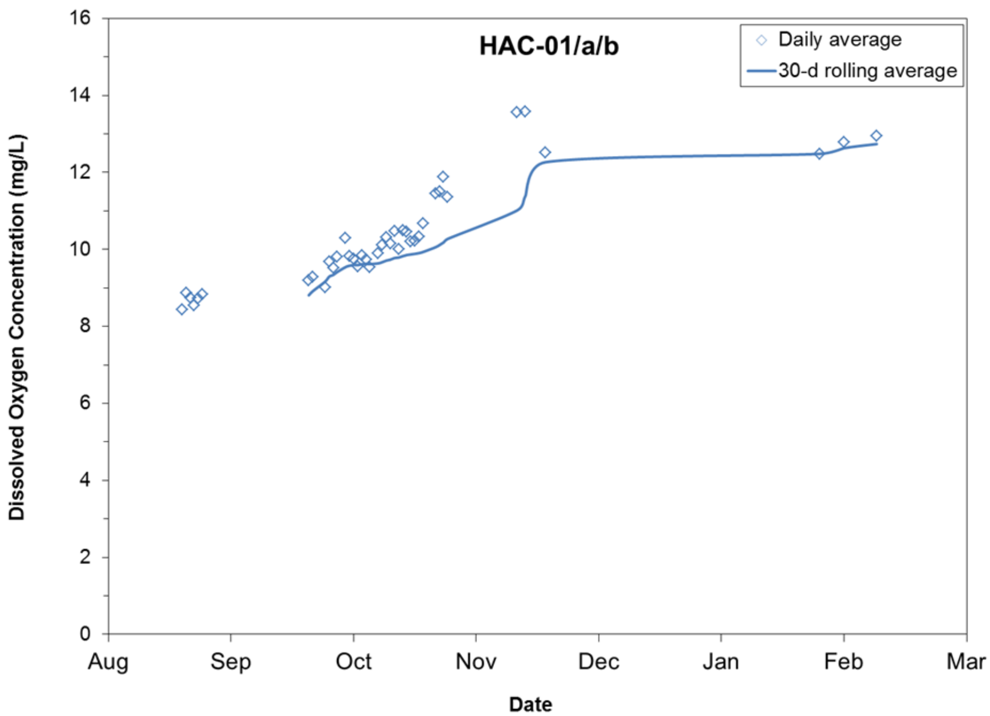


Figure 22: Concentration of dissolved oxygen measured in-situ over time at Station HAC-01/a/b in lower Hazeltine Creek post-event (August 2014 to February 2015).

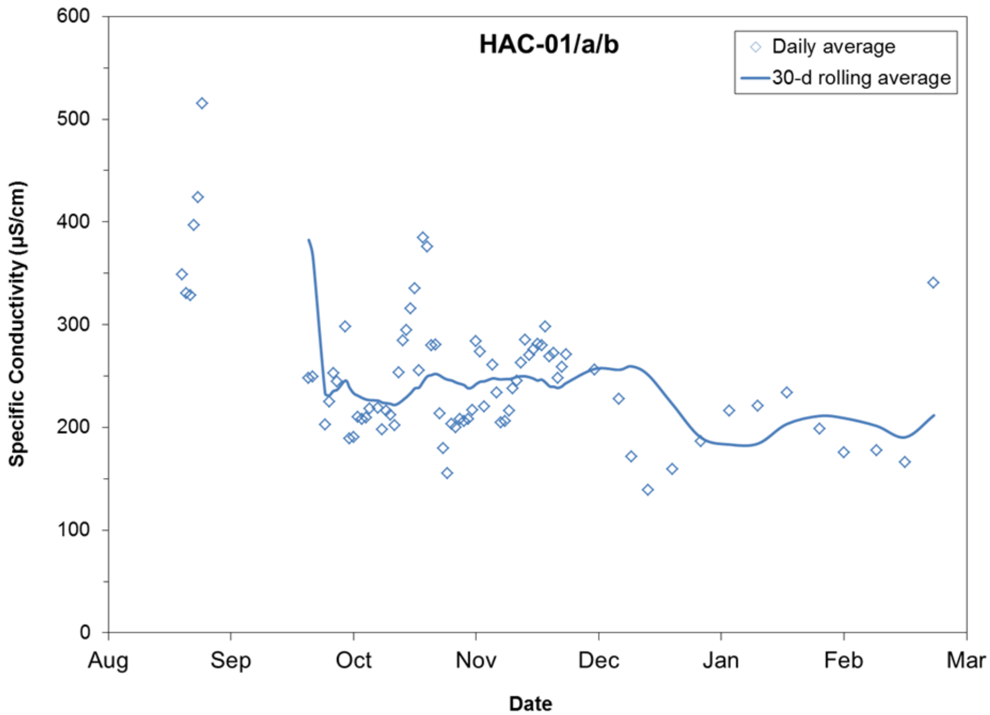


Figure 23: Specific conductivity measured in-situ over time at Station HAC-01/a/b in lower Hazeltine Creek post-event (August 2014 to February 2015).

3.0 QUESNEL LAKE

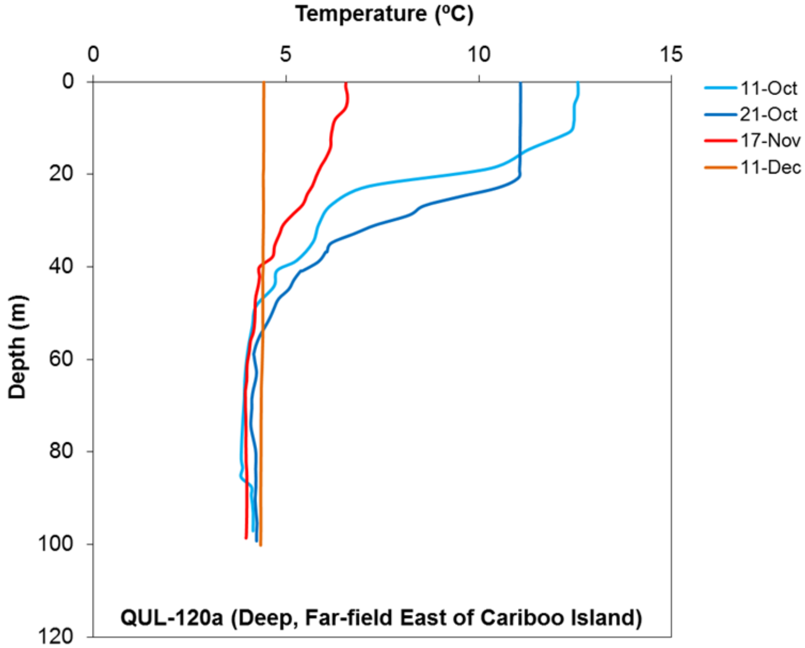
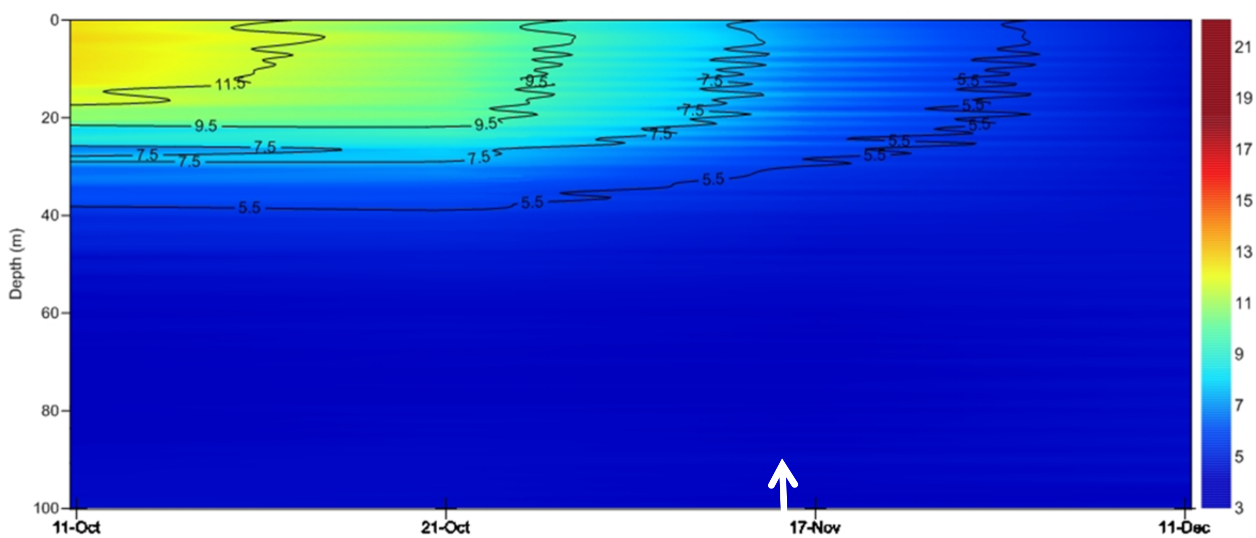


Figure 24: Depth profiles of temperature measured in-situ over time at Station QUL-120a in Quesnel Lake post-event (October 2014 to December 2014).



Note: The white arrow represents the approximate timing of mid-November turnover in Quesnel Lake

Figure 25: Contours of temperature measured in-situ over time at Station QUL-120a in Quesnel Lake post-event (October 2014 to December 2014). Temperature (°C) shown on right hand axis.

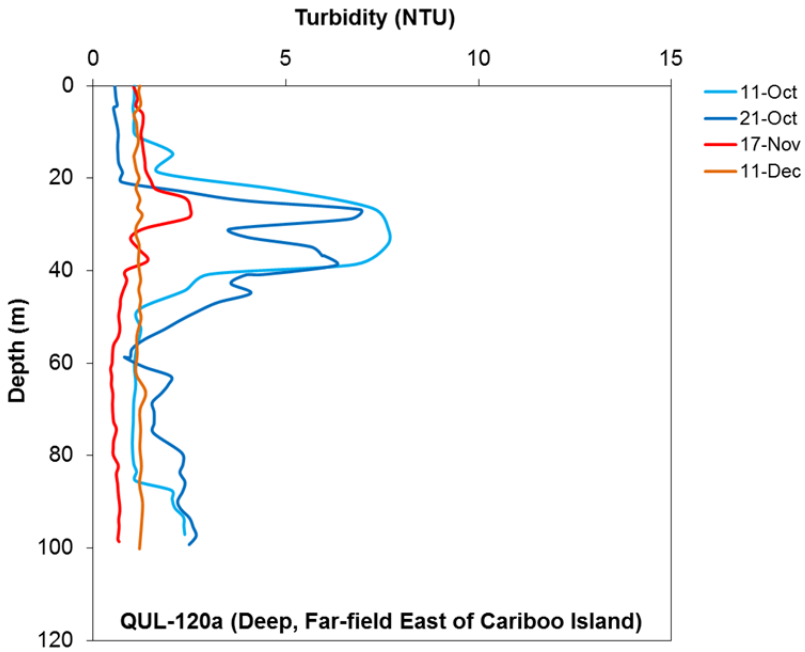
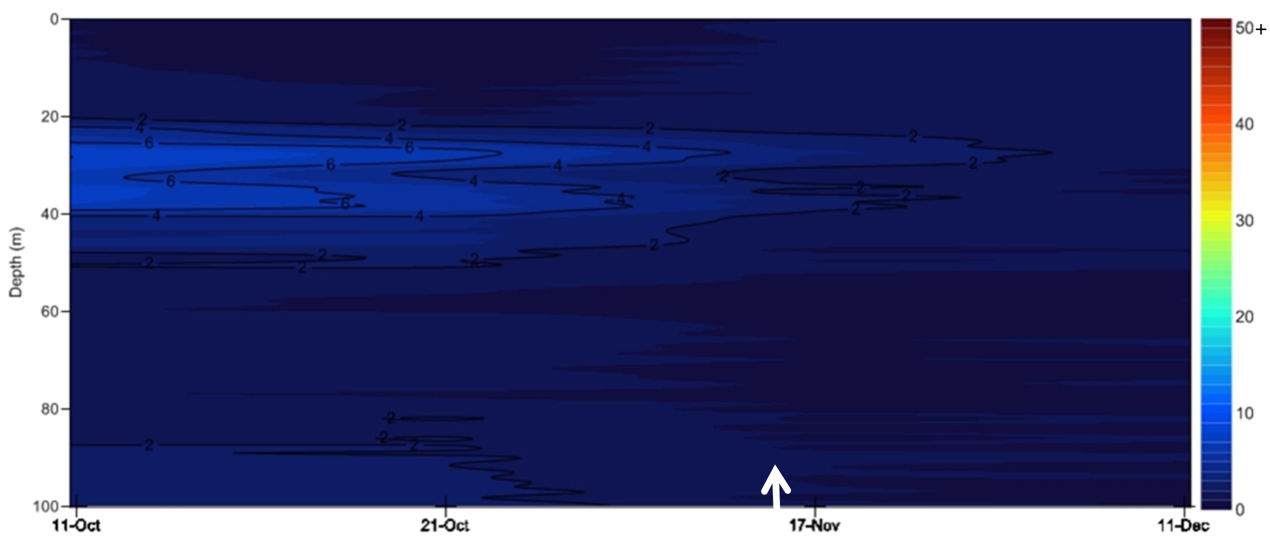


Figure 26: Depth profiles of turbidity measured in-situ over time at Station QUL-120a in Quesnel Lake post-event (October 2014 to December 2014).



Note: The white arrow represents the approximate timing of mid-November turnover in Quesnel Lake

Figure 27: Contours of turbidity measured in-situ over time at Station QUL-120a in Quesnel Lake post-event (October 2014 to December 2014). Turbidity (NTU) shown on right hand axis.

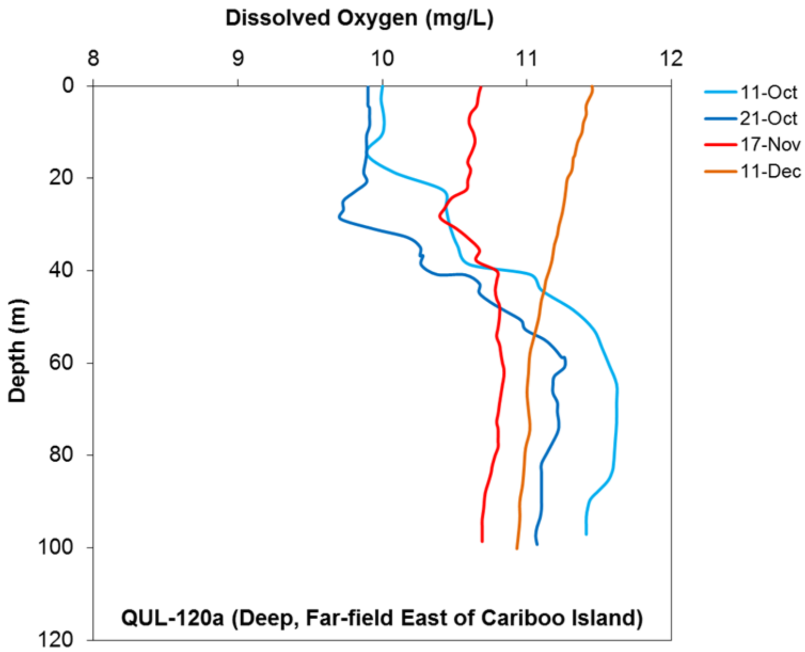


Figure 28: Depth profiles of dissolved oxygen measured in-situ over time at Station QUL-120a in Quesnel Lake post-event (October 2014 to December 2014).

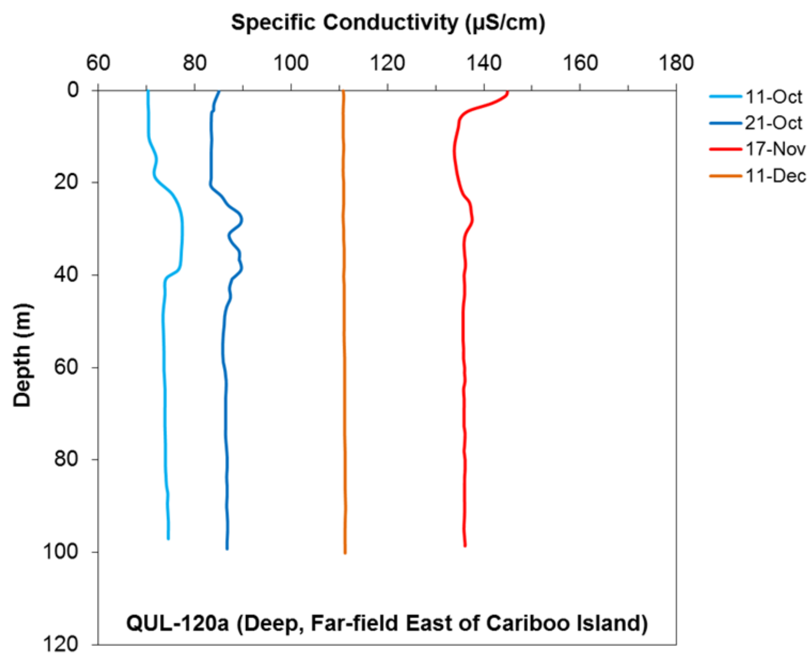
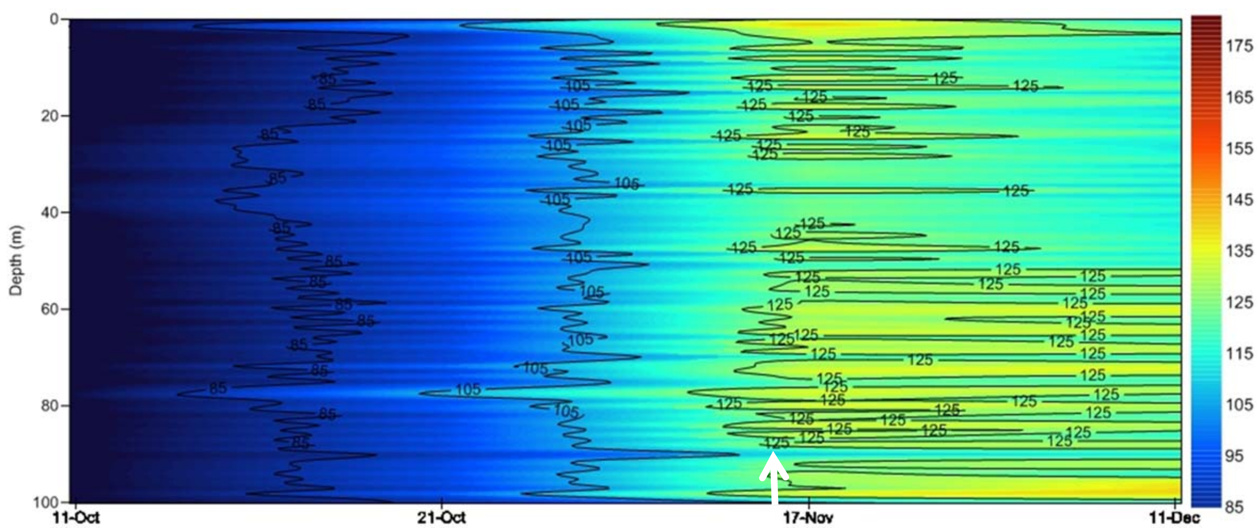
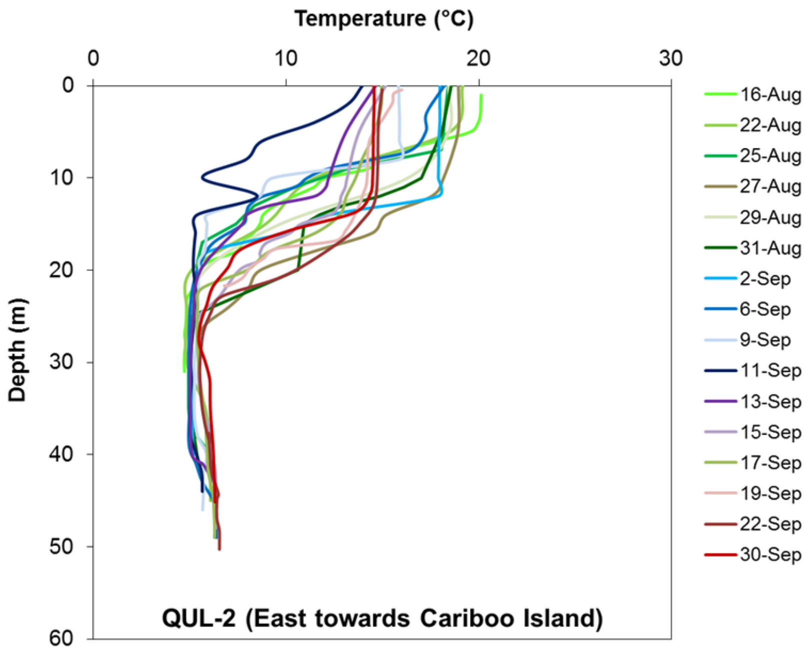


Figure 29: Depth profiles of specific conductivity measured in-situ over time at Station QUL-120a in Quesnel Lake post-event (October 2014 to December 2014).



Note: The white arrow represents the approximate timing of mid-November turnover in Quesnel Lake

Figure 30: Contours of specific conductivity measured in-situ over time at Station QUL-120a in Quesnel Lake post-event (October 2014 to December 2014). Specific conductivity (µS/cm) shown on right hand axis.



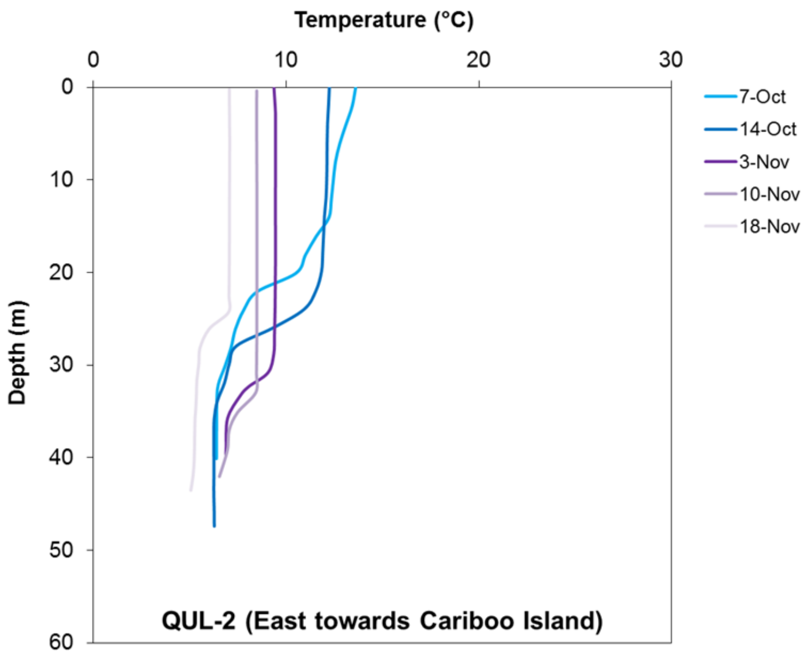
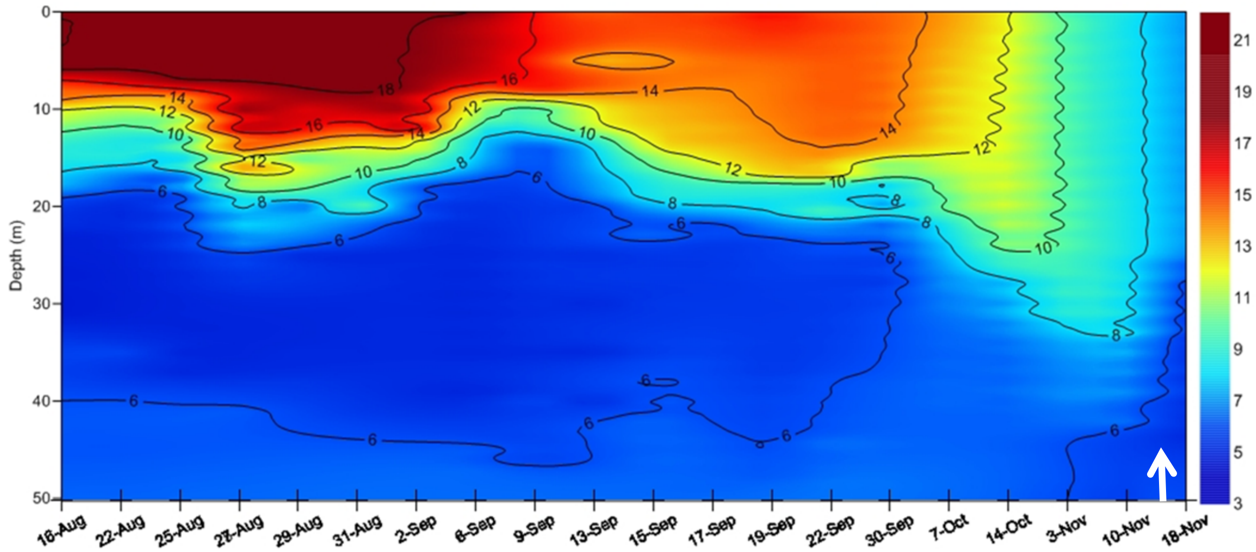
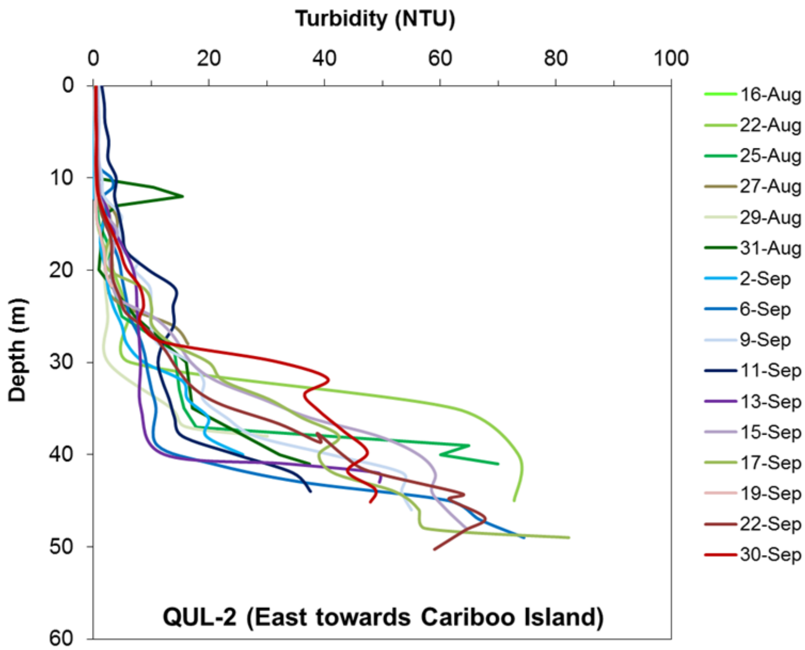


Figure 31: Depth profiles of temperature measured in-situ over time at Station QUL-2 in Quesnel Lake post-event (August 2014 to November 2014).



Note: The white arrow represents the approximate timing of mid-November turnover in Quesnel Lake

Figure 32: Contours of temperature measured in-situ over time at Station QUL-2 in Quesnel Lake post-event (August 2014 to November 2014). Temperature (°C) shown on right hand axis.



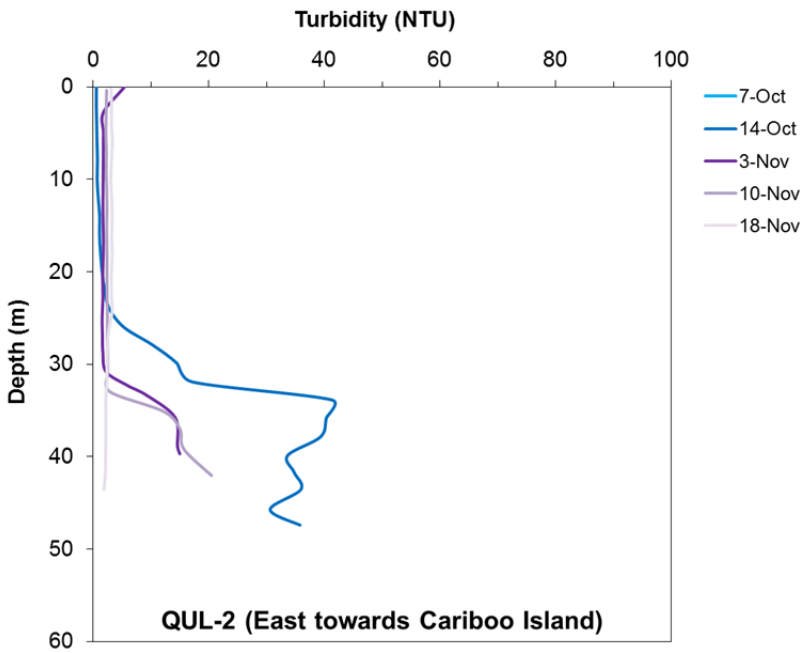
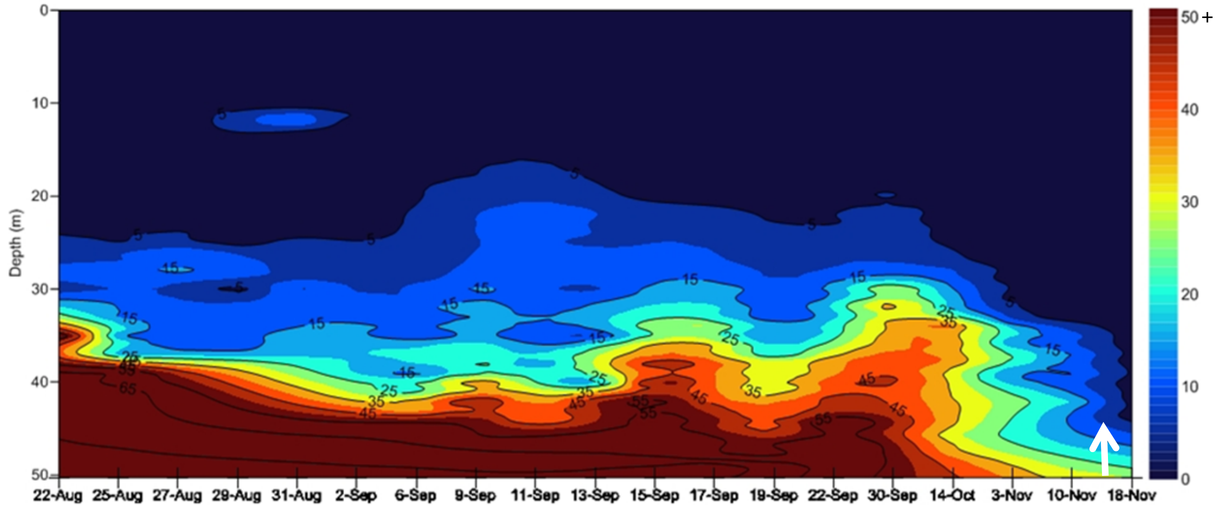
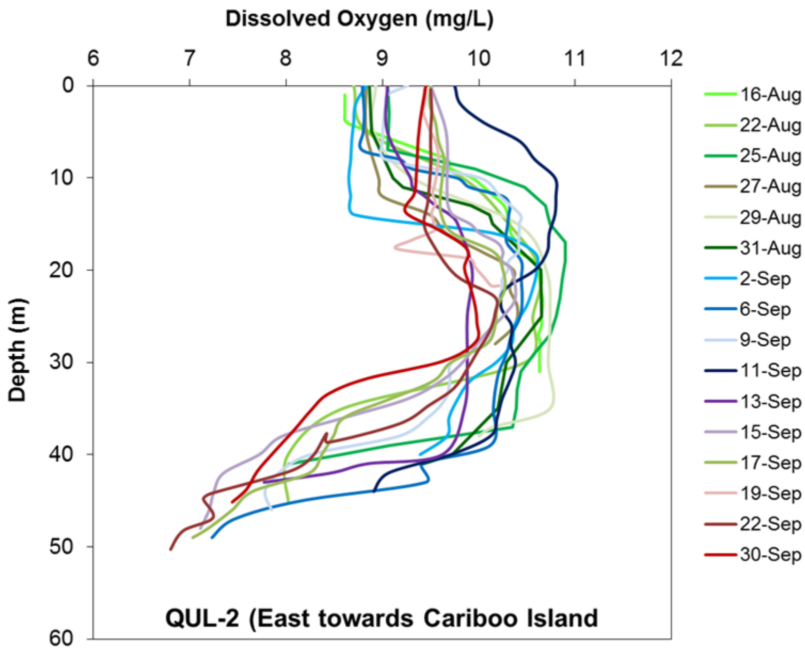


Figure 33: Depth profiles of turbidity measured in-situ over time at Station QUL-2 in Quesnel Lake post-event (August 2014 to November 2014).



Note: The white arrow represents the approximate timing of mid-November turnover in Quesnel Lake

Figure 34: Contours of turbidity measured in-situ over time at Station QUL-2 in Quesnel Lake post-event (August 2014 to November 2014). Turbidity (NTU) shown on right hand axis.



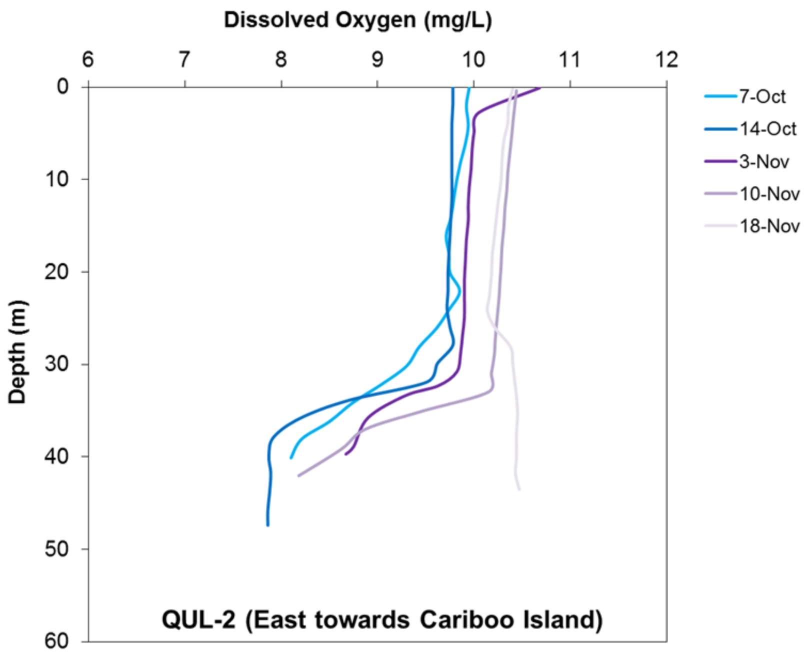
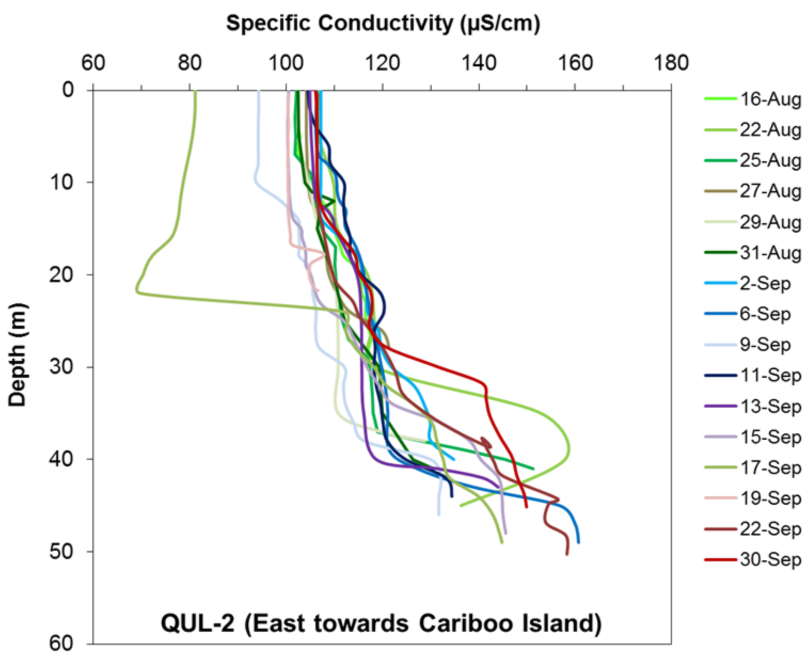


Figure 35: Depth profiles of dissolved oxygen measured in-situ over time at Station QUL-2 in Quesnel Lake post-event (August 2014 to November 2014).



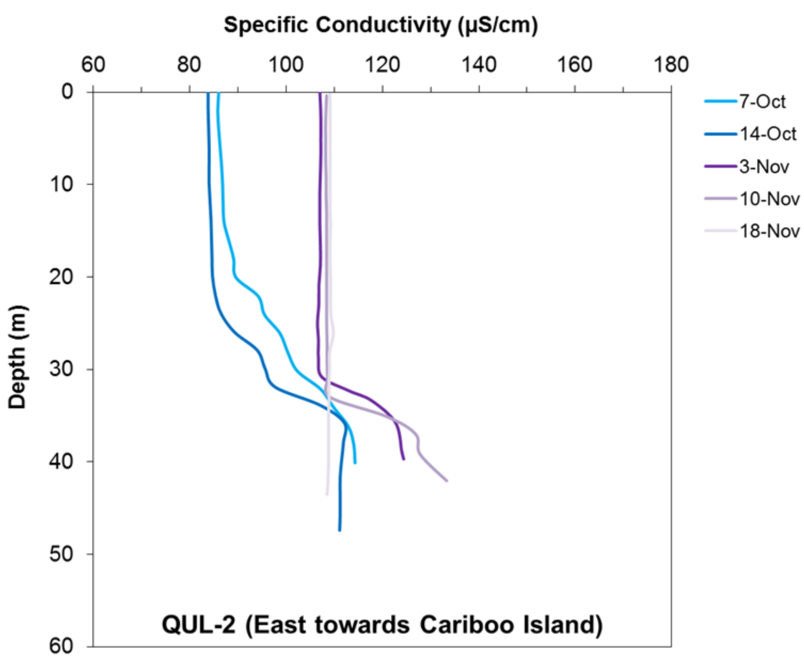
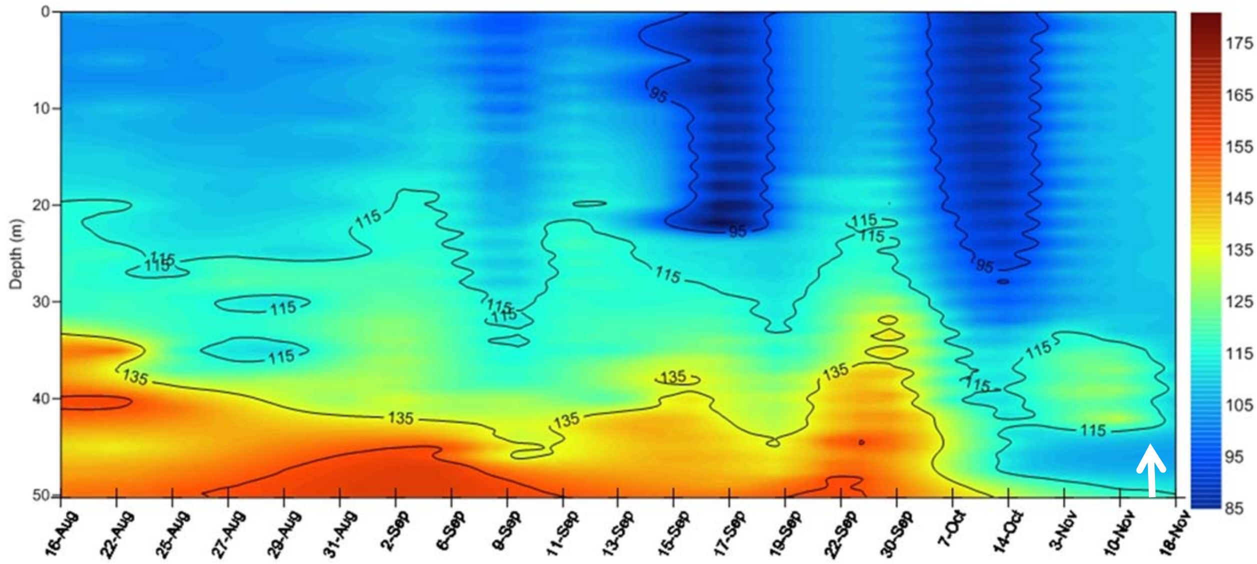
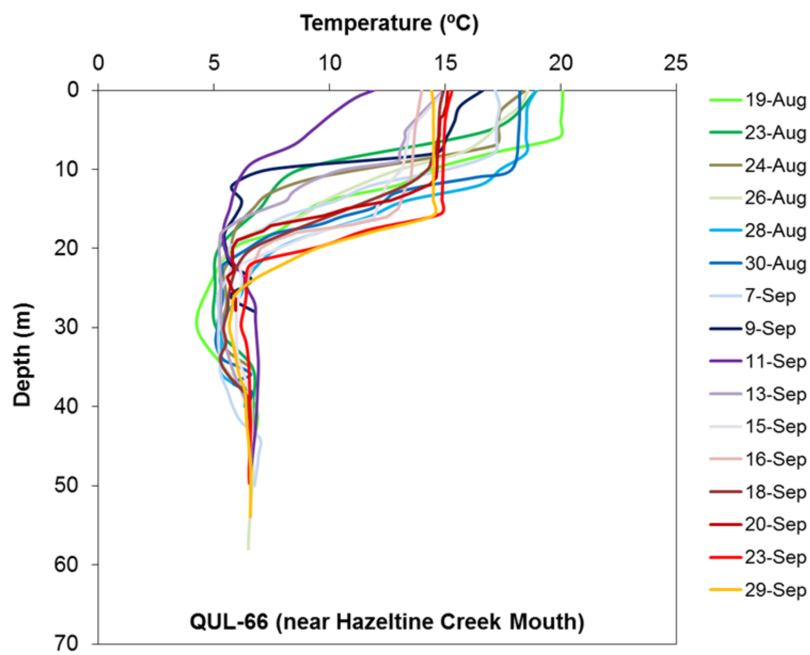


Figure 36: Depth profiles of specific conductivity measured in-situ over time at Station QUL-2 in Quesnel Lake post-event (August 2014 to November 2014).



Note: The white arrow represents the approximate timing of mid-November turnover in Quesnel Lake

Figure 37: Contours of specific conductivity measured in-situ over time at Station QUL-2 in Quesnel Lake post-event (August 2014 to November 2014). Specific conductivity (µS/cm) shown on right hand axis.



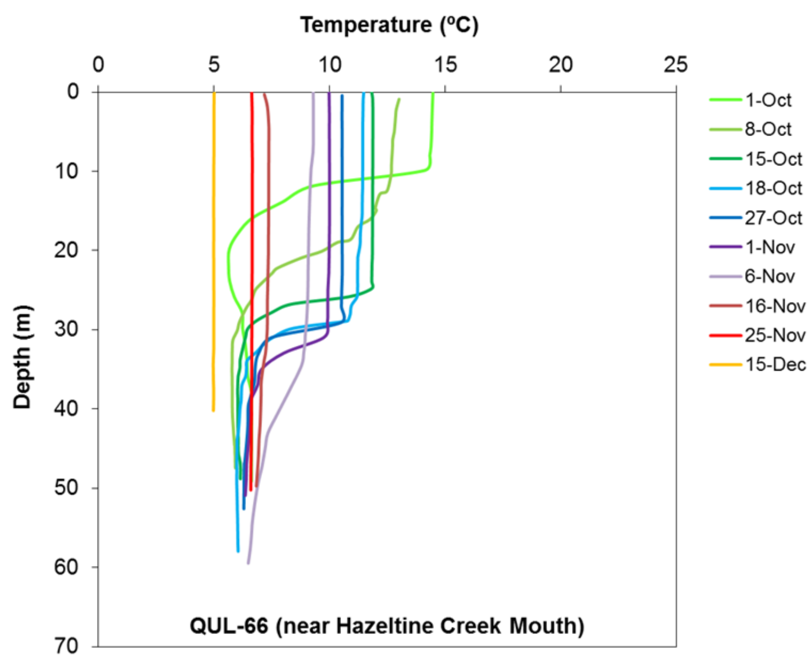
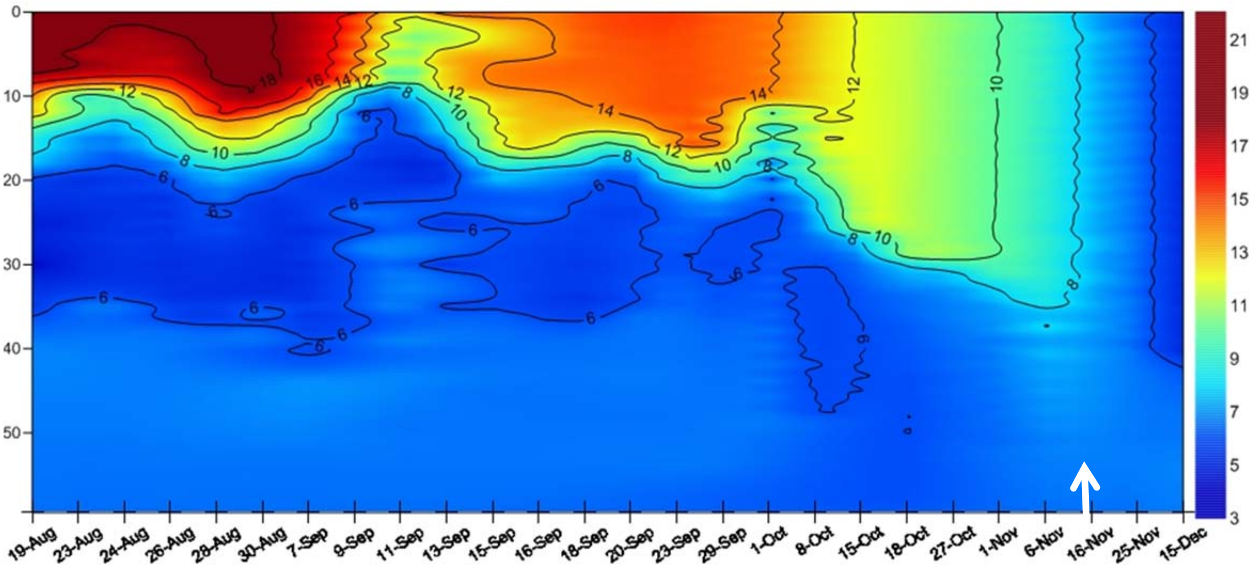
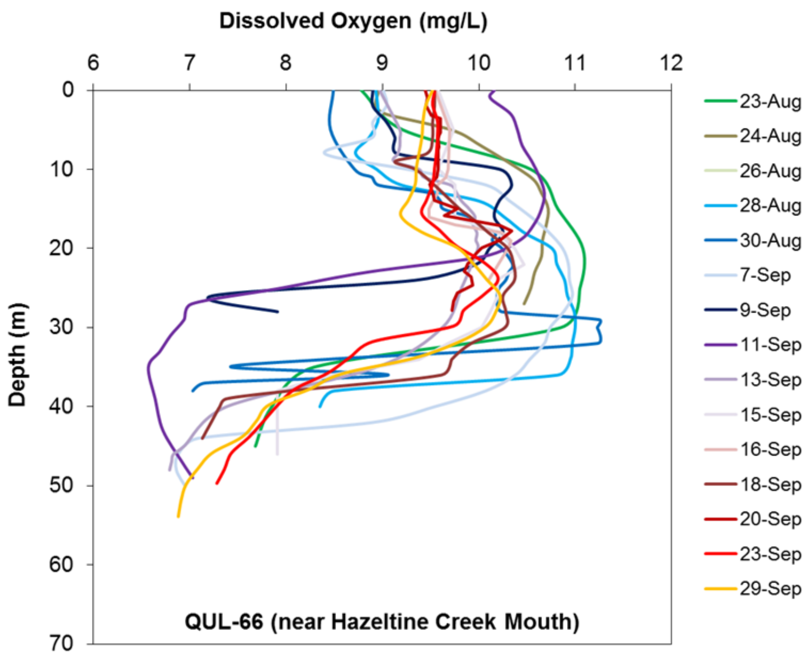


Figure 38: Depth profiles of temperature measured in-situ over time at Station QUL-66 in Quesnel Lake post-event (August 2014 to December 2014).



Note: The white arrow represents the approximate timing of mid-November turnover in Quesnel Lake

Figure 39: Contours of temperature measured in-situ over time at Station QUL-66 in Quesnel Lake post-event (August 2014 to December 2014). Temperature (°C) shown on right hand axis.



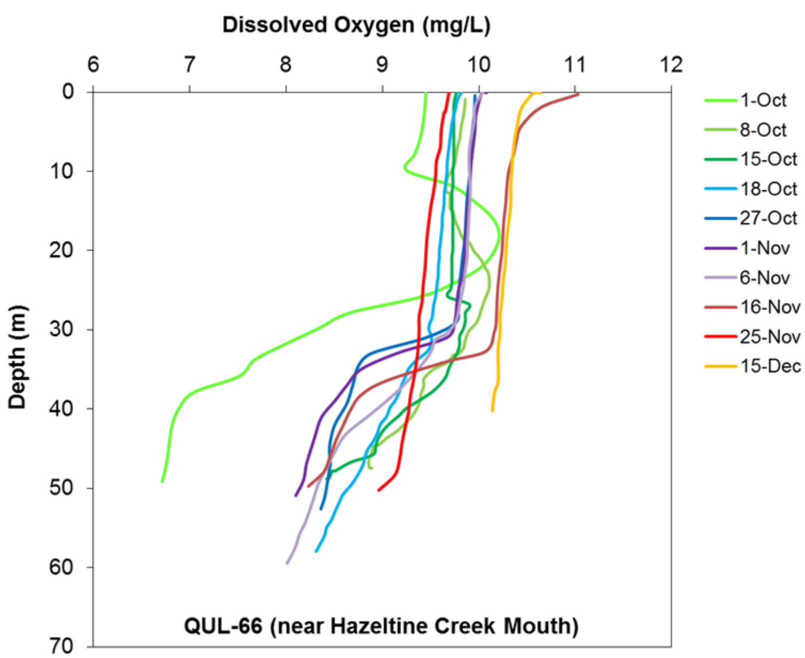


Figure 40: Depth profiles of dissolved oxygen measured in-situ over time at Station QUL-66 in Quesnel Lake post-event (August 2014 to December 2014).

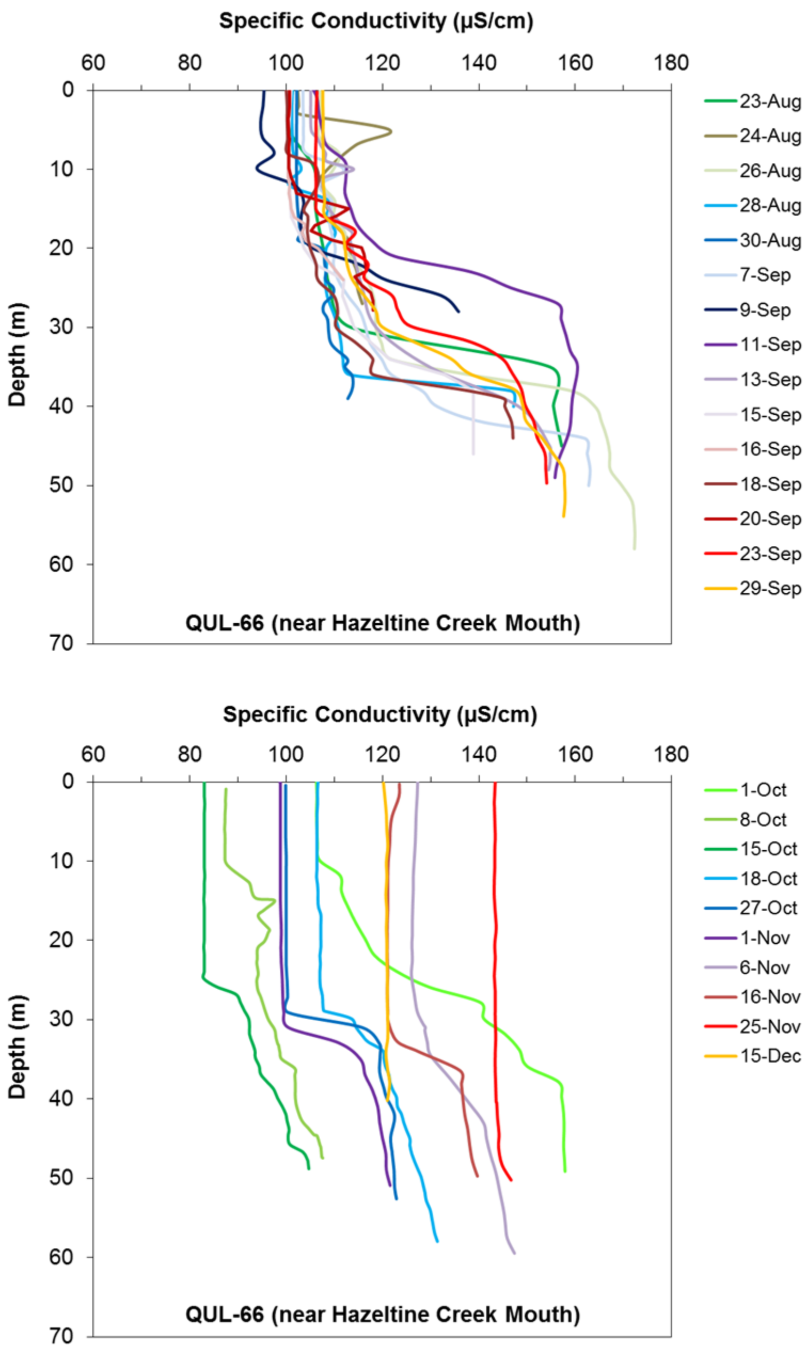
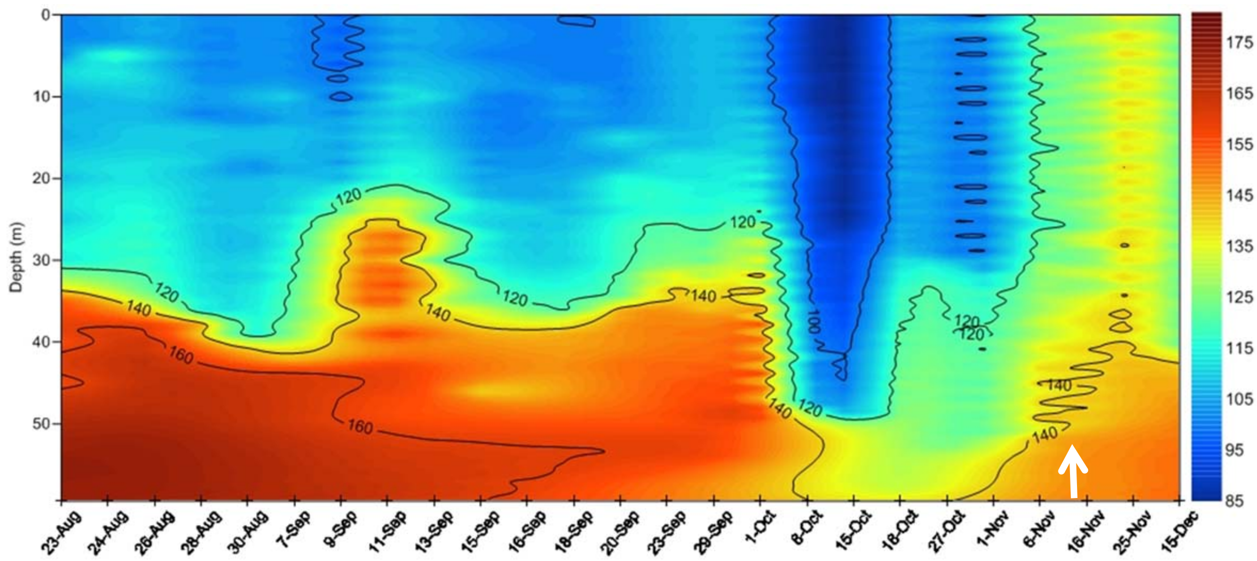


Figure 41: Depth profiles of specific conductivity measured in-situ over time at Station QUL-66 in Quesnel Lake post-event (August 2014 to December 2014).



Note: The white arrow represents the approximate timing of mid-November turnover in Quesnel Lake

Figure 42: Contours of specific conductivity measured in-situ over time at Station QUL-66 in Quesnel Lake post-event (August 2014 to December 2014). Specific conductivity (µS/cm) shown on right hand axis.

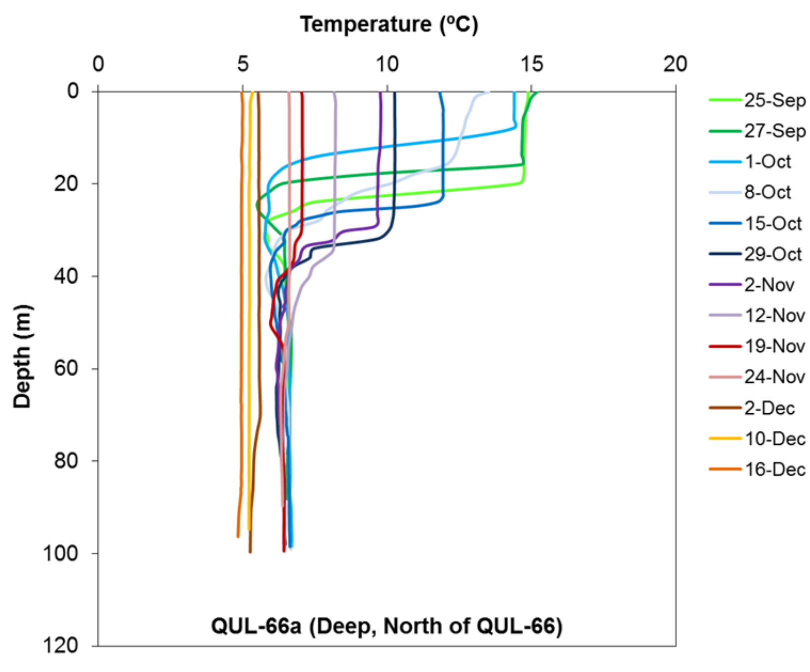
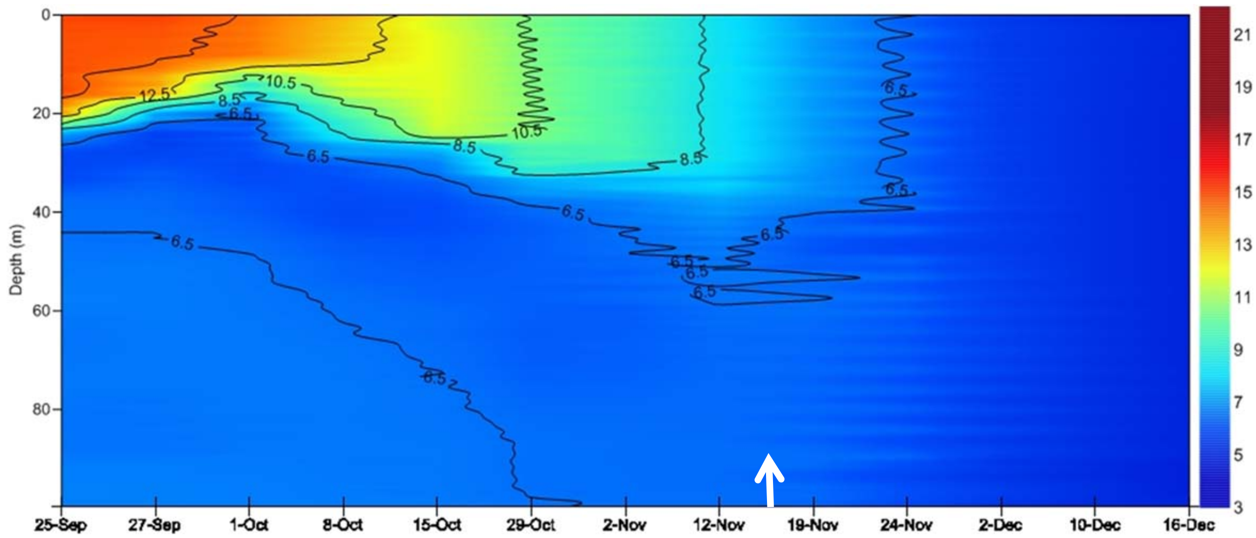


Figure 43: Depth profiles of temperature measured in-situ over time at Station QUL-66a in Quesnel Lake post-event (September 2014 to December 2014).



Note: The white arrow represents the approximate timing of mid-November turnover in Quesnel Lake

Figure 44: Contours of temperature measured in-situ over time at Station QUL-66a in Quesnel Lake post-event (September 2014 to December 2014). Temperature (°C) shown on right hand axis.

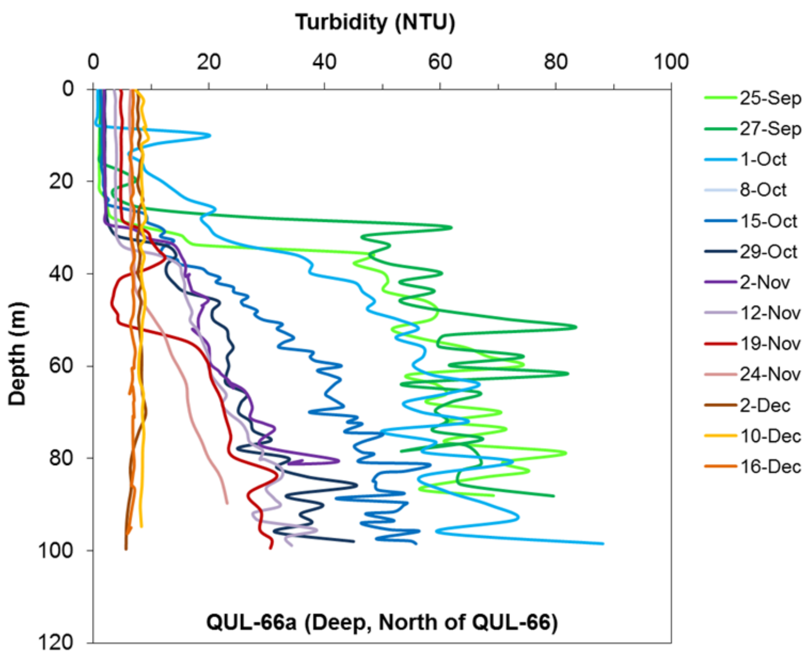
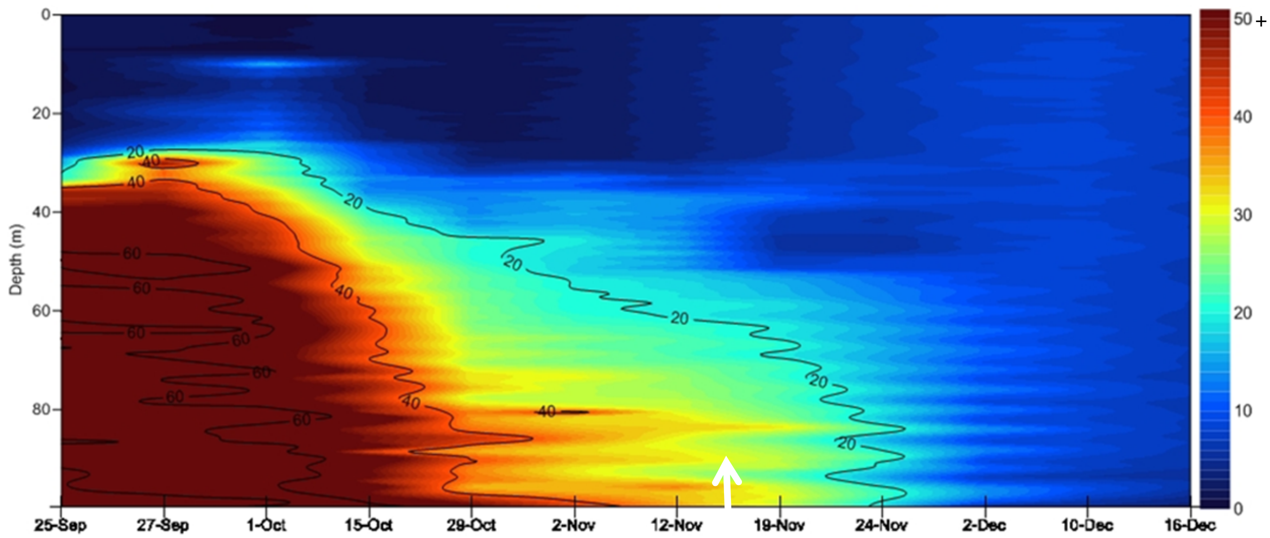


Figure 45: Depth profiles of turbidity measured in-situ over time at Station QUL-66a in Quesnel Lake post-event (September 2014 to December 2014).



Note: The white arrow represents the approximate timing of mid-November turnover in Quesnel Lake

Figure 46: Contours of turbidity measured in-situ over time at Station QUL-66a in Quesnel Lake post-event (September 2014 to December 2014). Turbidity (NTU) shown on right hand axis.

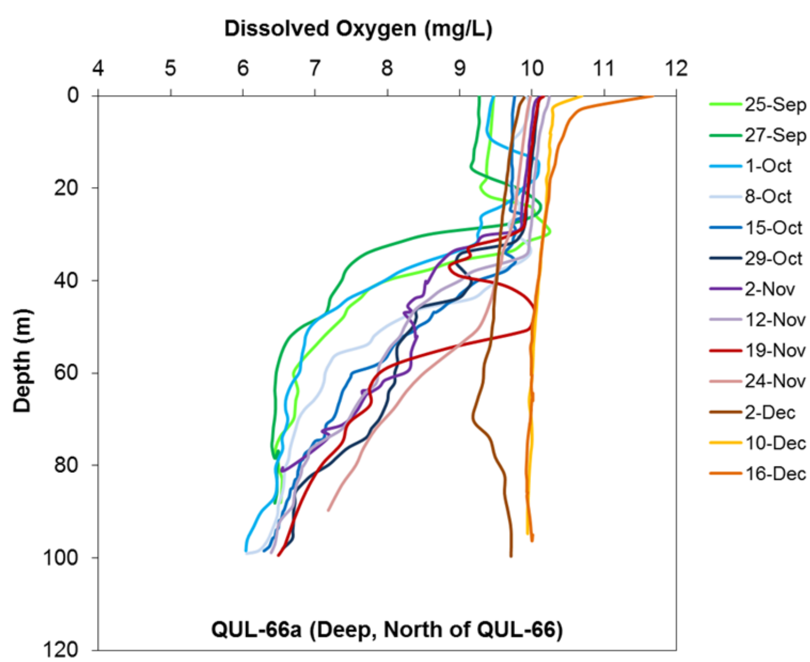


Figure 47: Depth profiles of dissolved oxygen measured in-situ over time at Station QUL-66a in Quesnel Lake post-event (September 2014 to December 2014).

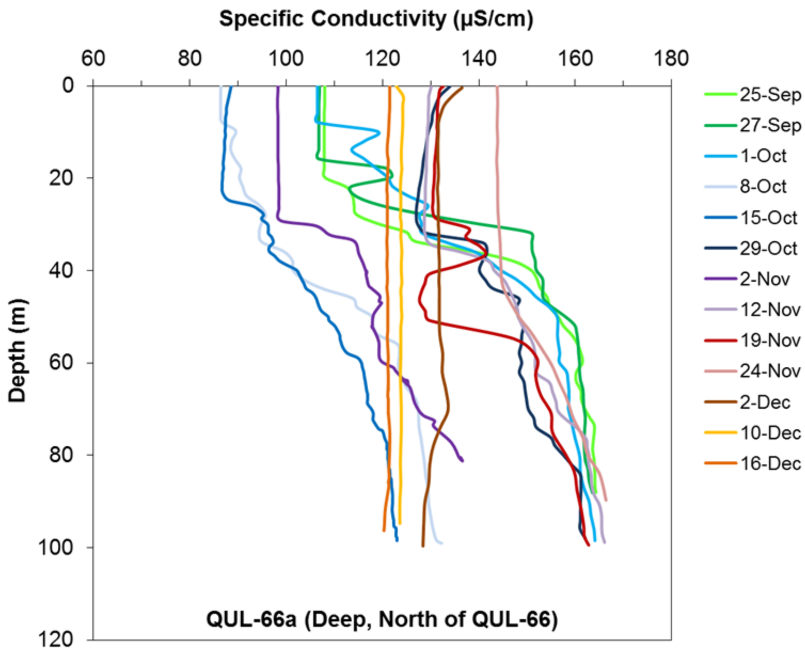
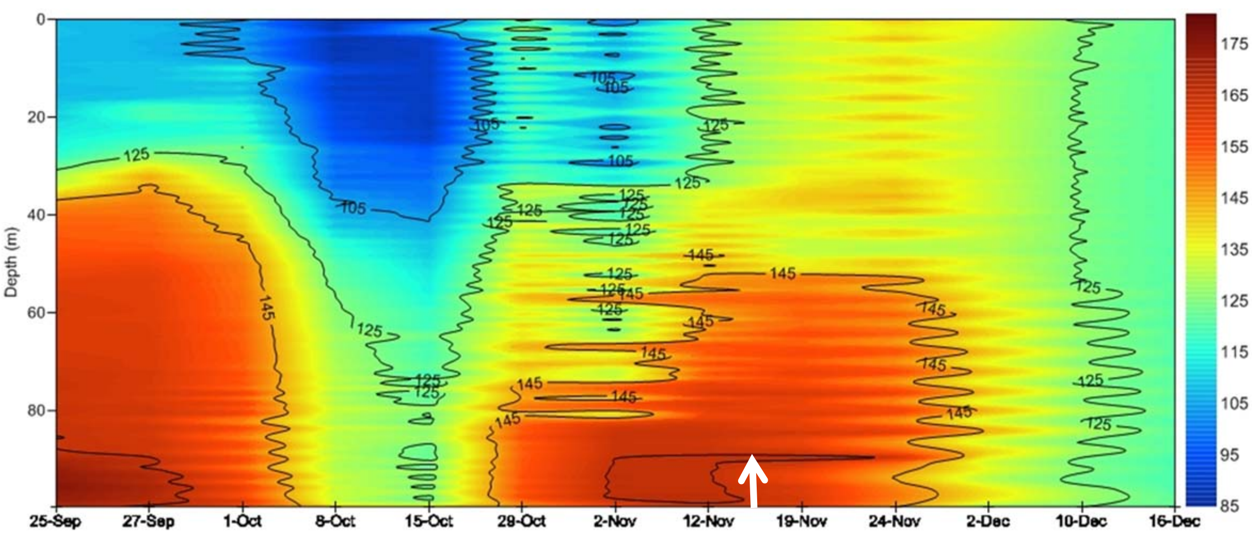


Figure 48: Depth profiles of specific conductivity measured in-situ over time at Station QUL-66a in Quesnel Lake post-event (September 2014 to December 2014).



Note: The white arrow represents the approximate timing of mid-November turnover in Quesnel Lake

Figure 49: Contours of specific conductivity measured in-situ over time at Station QUL-66a in Quesnel Lake post-event (September 2014 to December 2014). Specific conductivity (µS/cm) shown on right hand axis.

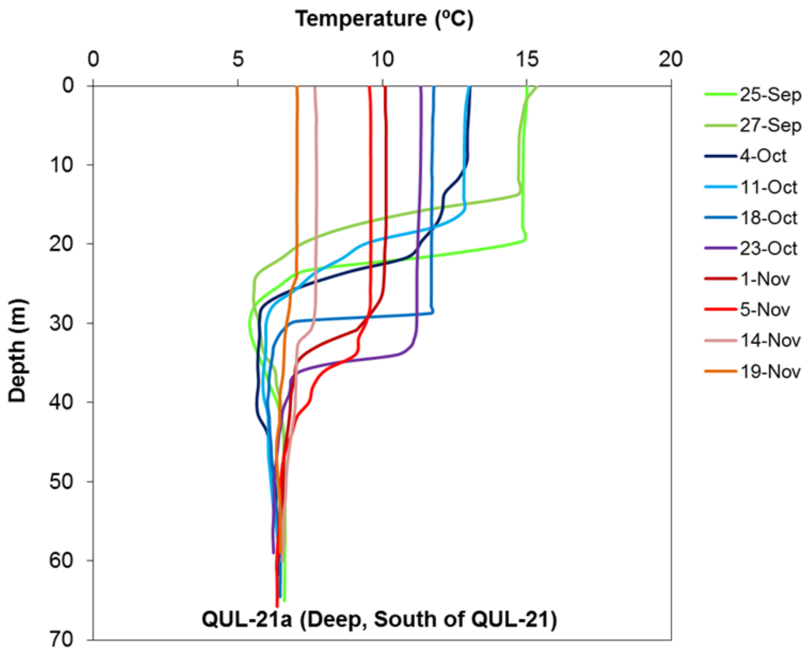
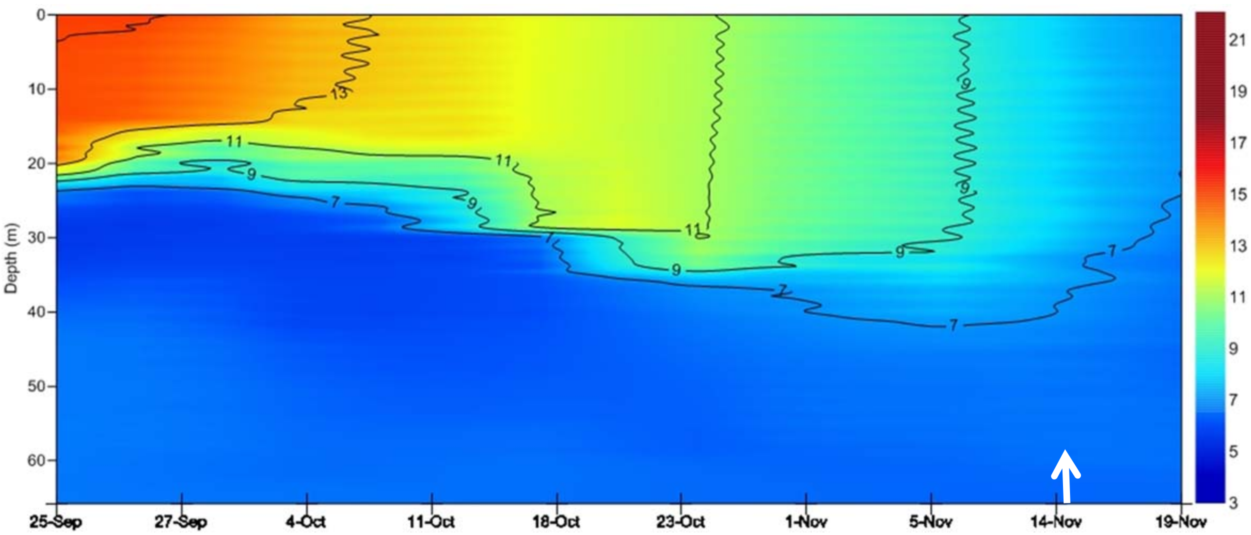


Figure 50: Depth profiles of temperature measured in-situ over time at Station QUL-21a in Quesnel Lake post-event (September 2014 to November 2014).



Note: The white arrow represents the approximate timing of mid-November turnover in Quesnel Lake

Figure 51: Contours of temperature measured in-situ over time at Station QUL-21a in Quesnel Lake post-event (September 2014 to November 2014). Temperature (°C) shown on right hand axis.

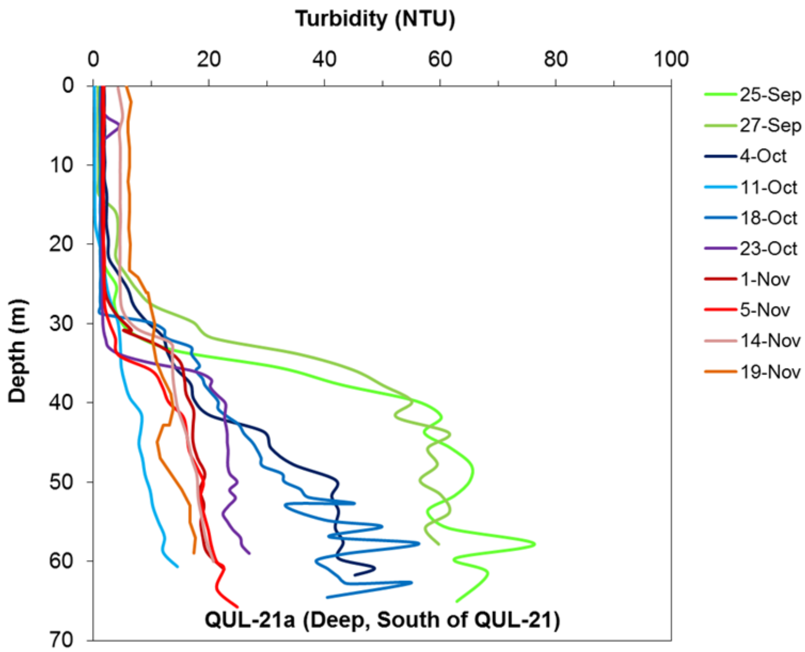
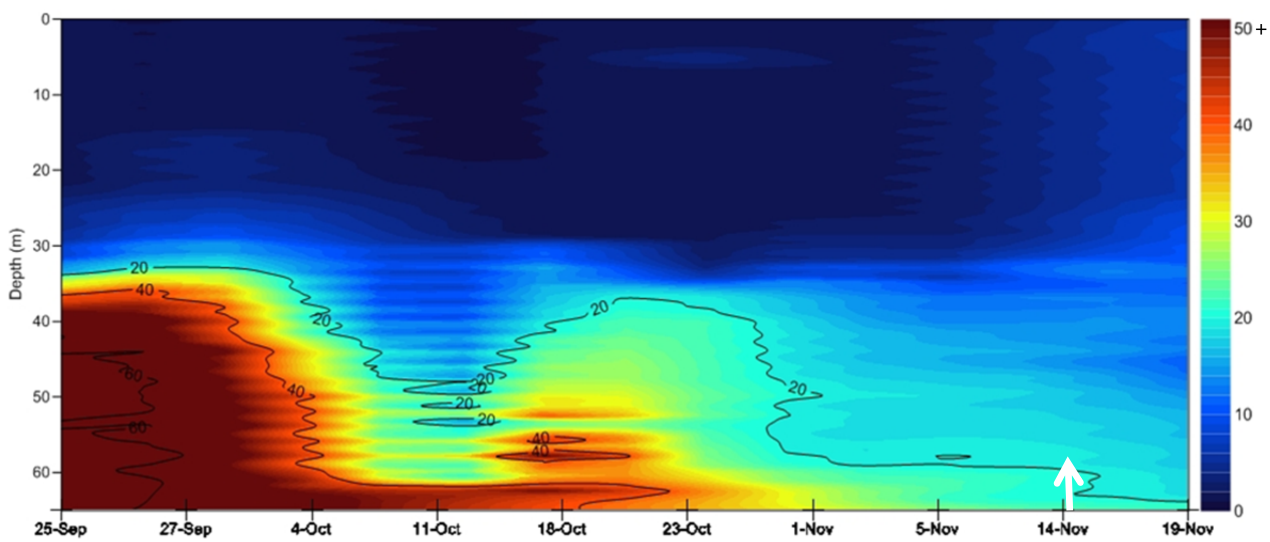


Figure 52: Depth profiles of turbidity measured in-situ over time at Station QUL-21a in Quesnel Lake post-event (September 2014 to November 2014).



Note: The white arrow represents the approximate timing of mid-November turnover in Quesnel Lake

Figure 53: Contours of turbidity measured in-situ over time at Station QUL-21a in Quesnel Lake post-event (September 2014 to November 2014). Turbidity (NTU) shown on right hand axis.

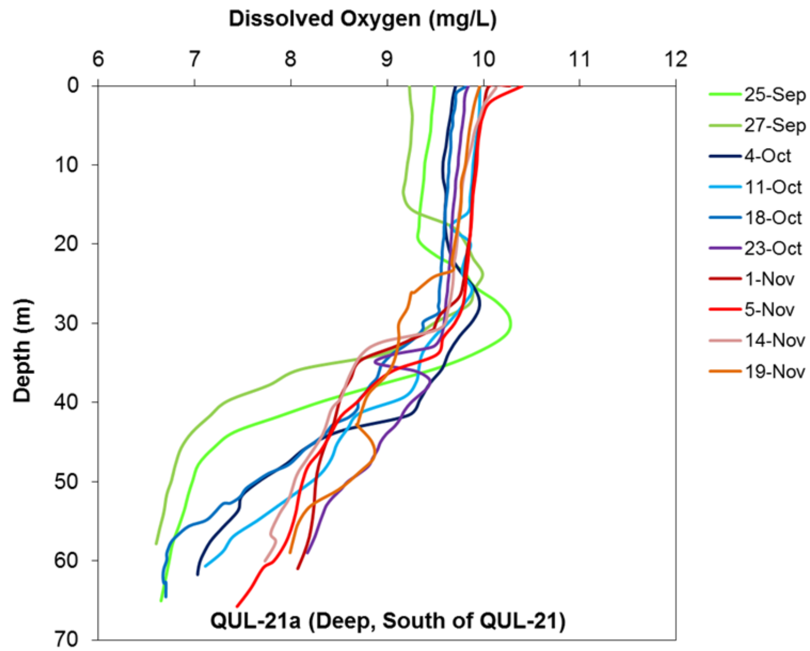


Figure 54: Depth profiles of dissolved oxygen measured in-situ over time at Station QUL-21a in Quesnel Lake post-event (September 2014 to November 2014).

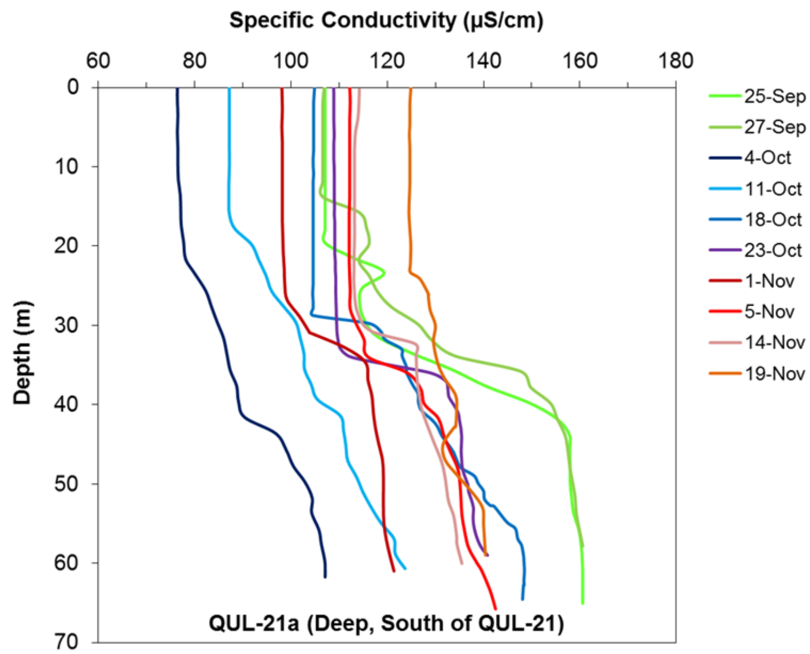
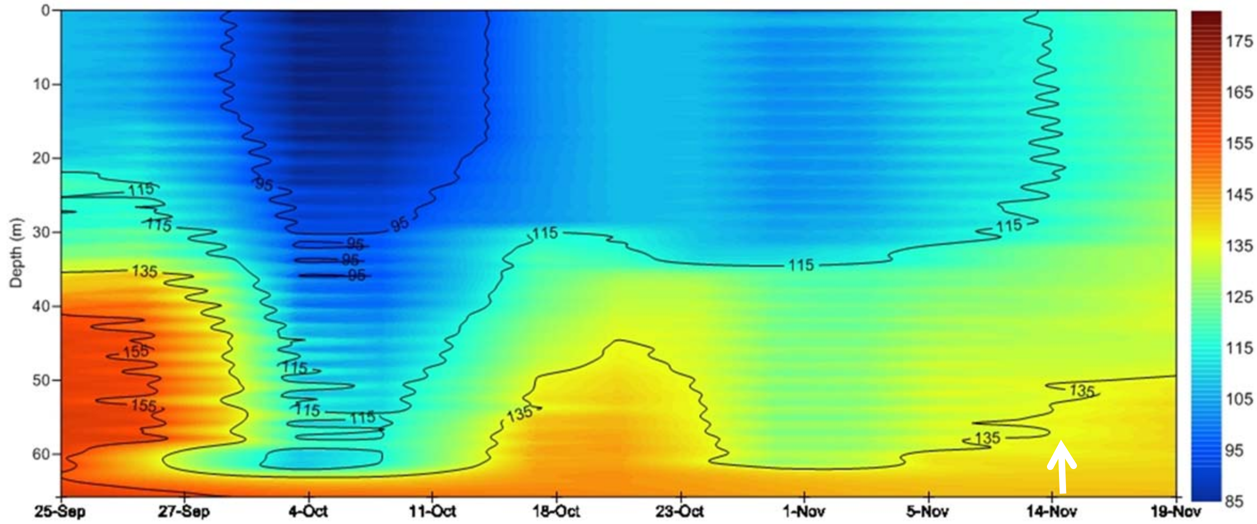
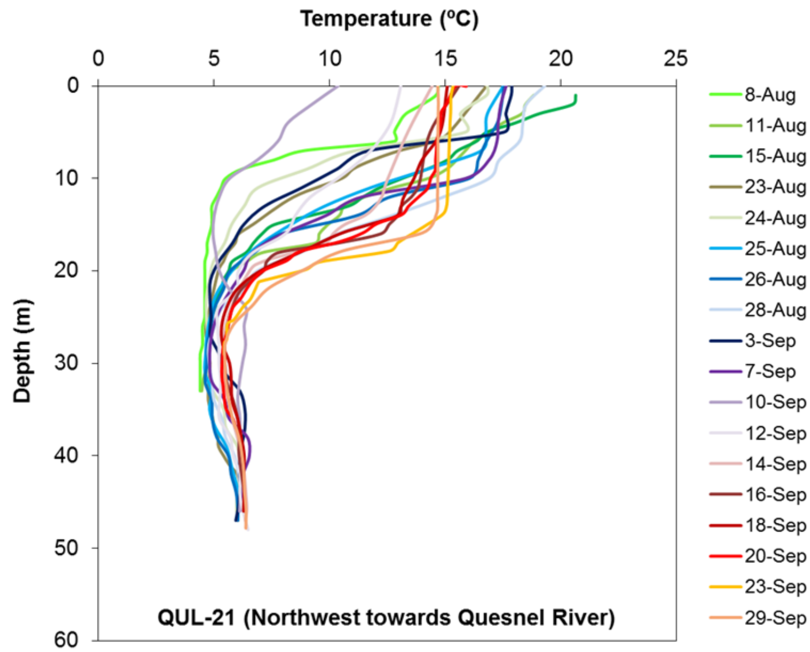


Figure 55: Depth profiles of specific conductivity measured in-situ over time at Station QUL-21a in Quesnel Lake post-event (September 2014 to November 2014).



Note: The white arrow represents the approximate timing of mid-November turnover in Quesnel Lake

Figure 56: Contours of specific conductivity measured in-situ over time at Station QUL-21a in Quesnel Lake post-event (September 2014 to November 2014). Specific conductivity (µS/cm) shown on right hand axis.



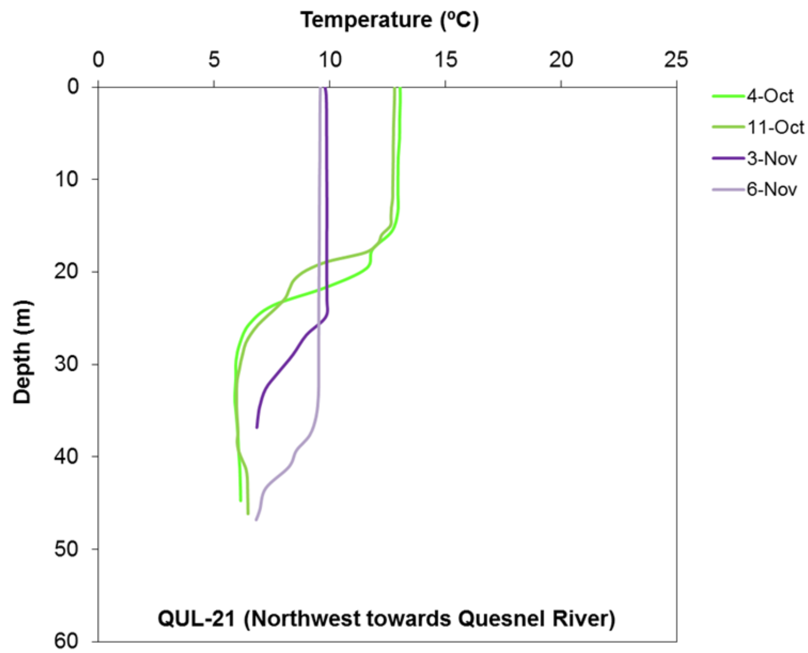


Figure 57: Depth profiles of temperature measured in-situ over time at Station QUL-21 in Quesnel Lake post-event (August 2014 to November 2014).

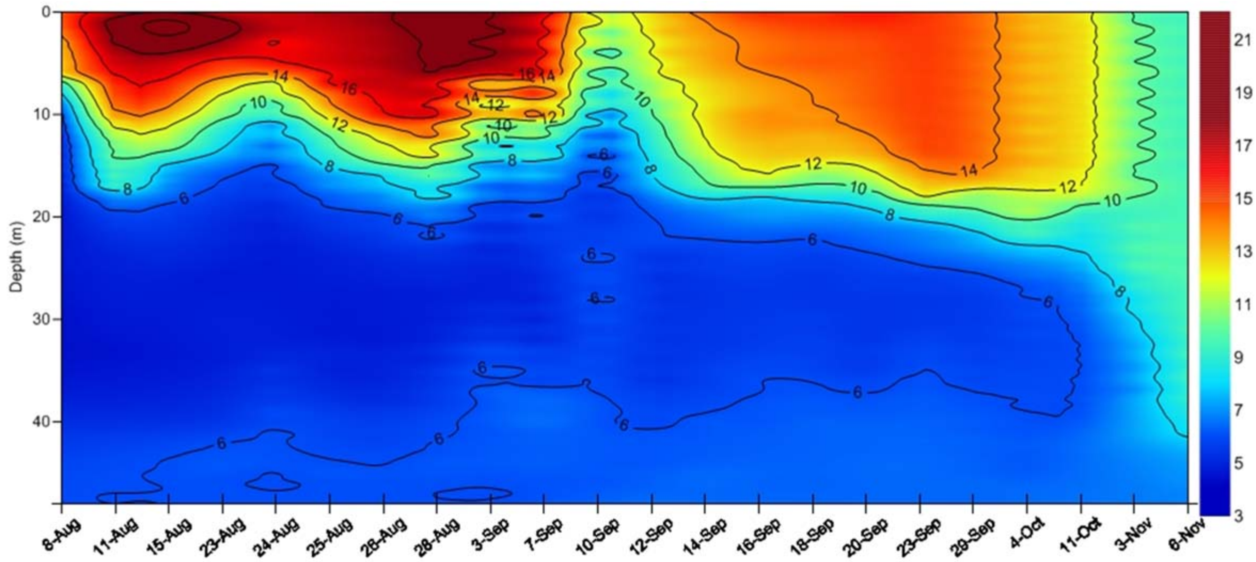
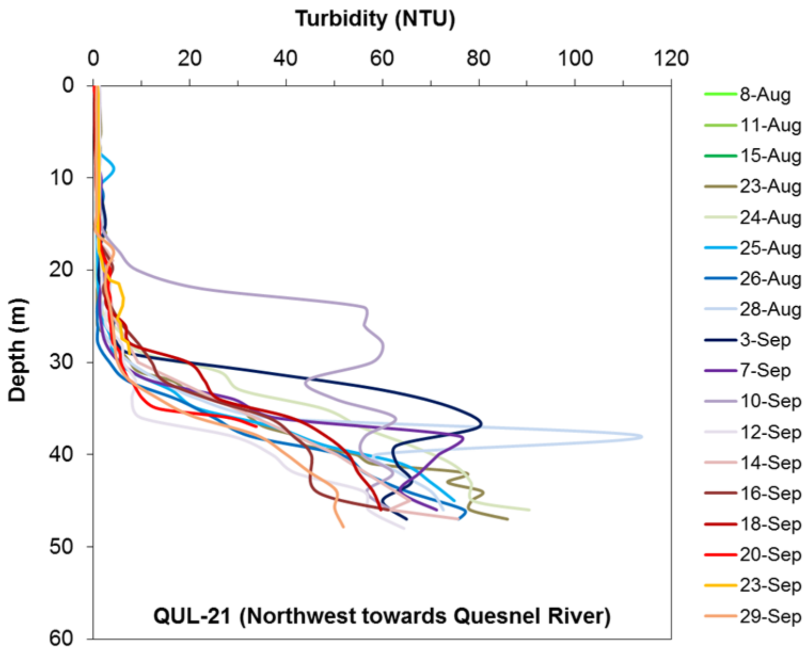


Figure 58: Contours of temperature measured in-situ over time at Station QUL-21 in Quesnel Lake post-event (August 2014 to November 2014). Temperature (°C) shown on right hand axis.



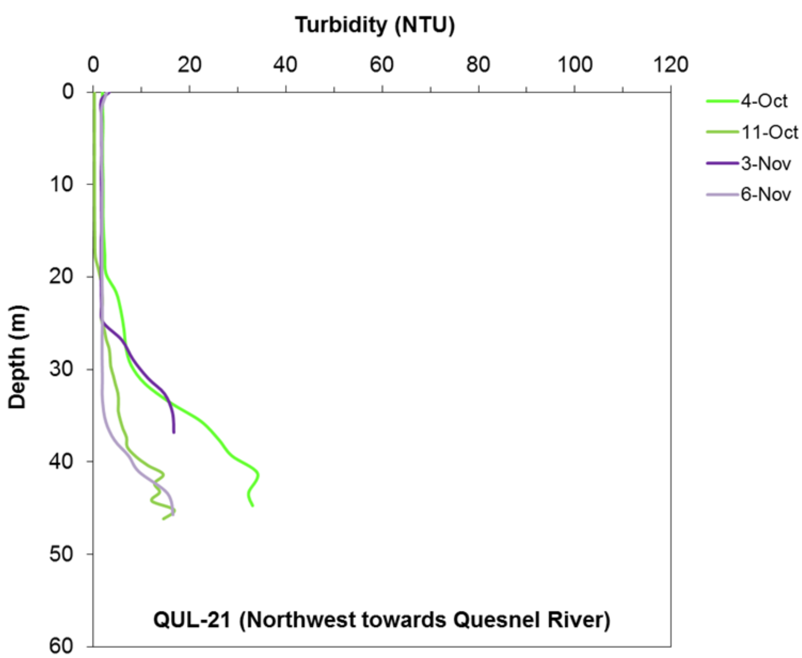


Figure 59: Depth profiles of turbidity measured in-situ over time at Station QUL-21 in Quesnel Lake post-event (August 2014 to November 2014).

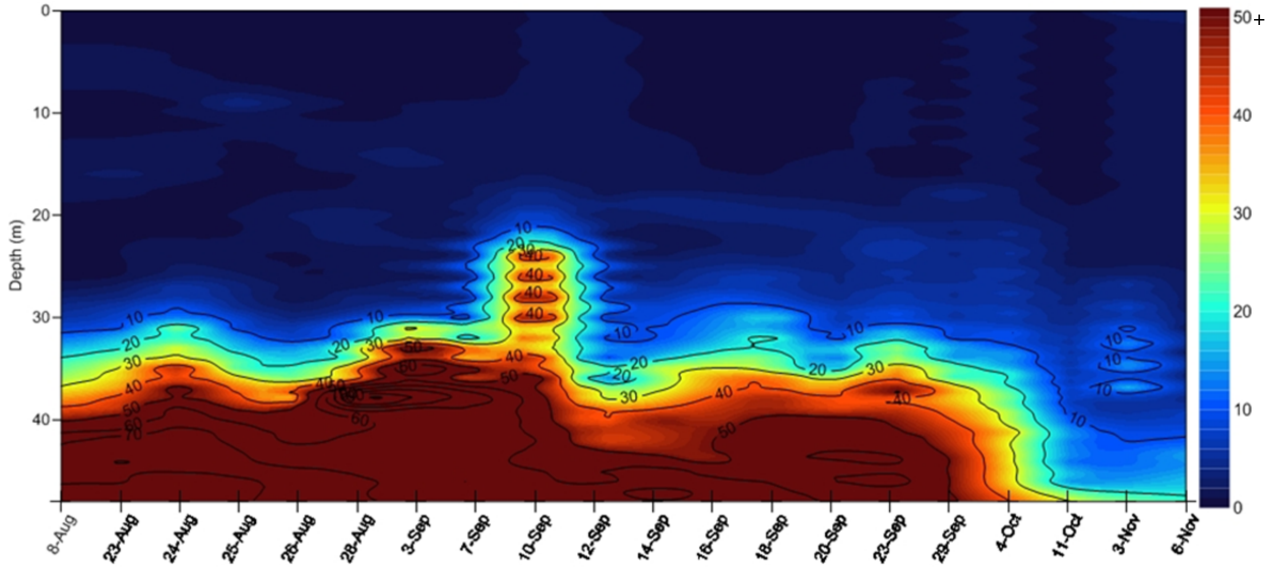
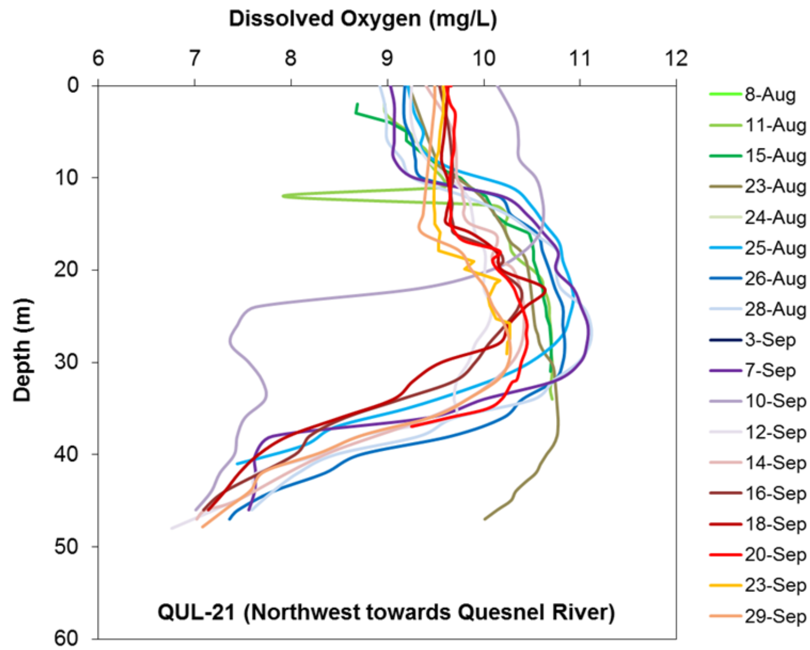


Figure 60: Contours of turbidity measured in-situ over time at Station QUL-21 in Quesnel Lake post-event (August 2014 to November 2014). Turbidity (NTU) shown on right hand axis.



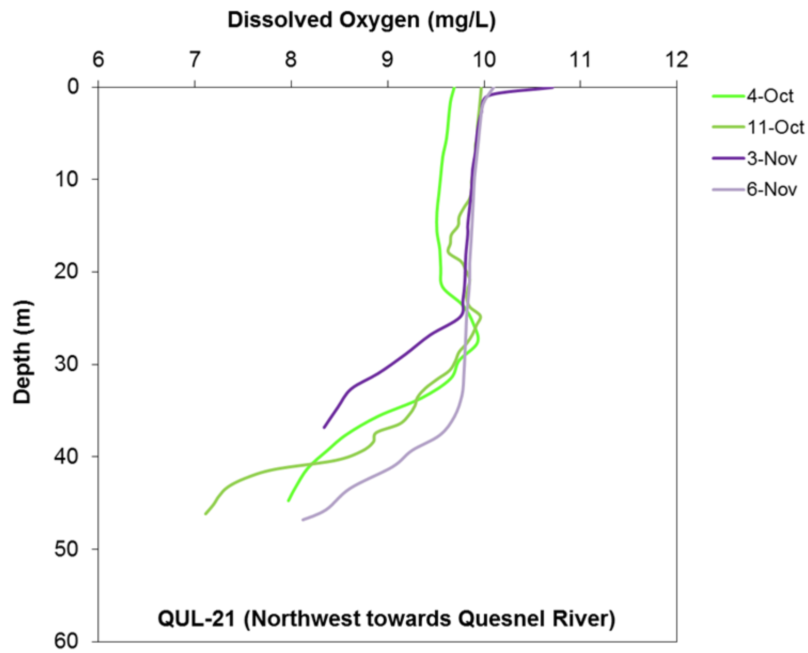
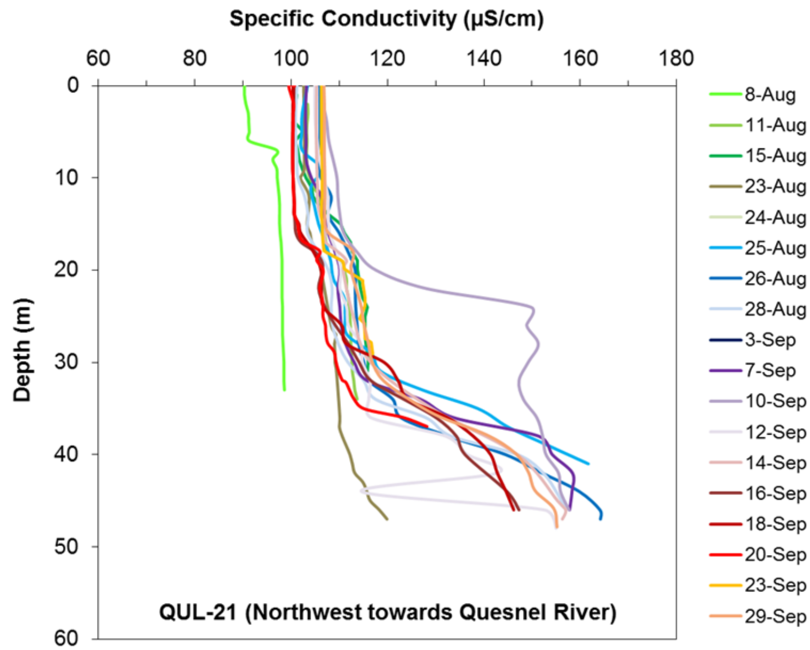


Figure 61: Depth profiles of dissolved oxygen measured in-situ over time at Station QUL-21 in Quesnel Lake post-event (August 2014 to November 2014).



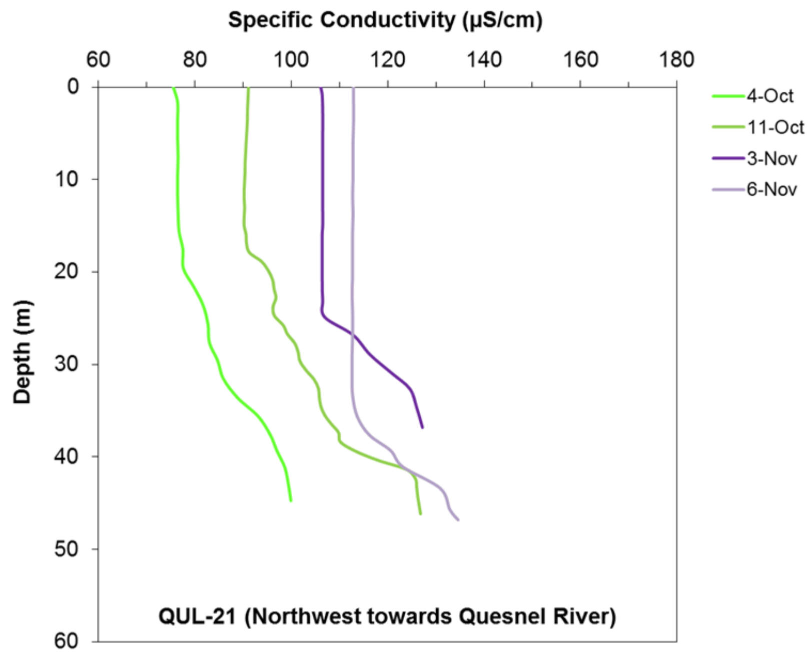


Figure 62: Depth profiles of specific conductivity measured in-situ over time at Station QUL-21 in Quesnel Lake post-event (August 2014 to November 2014).

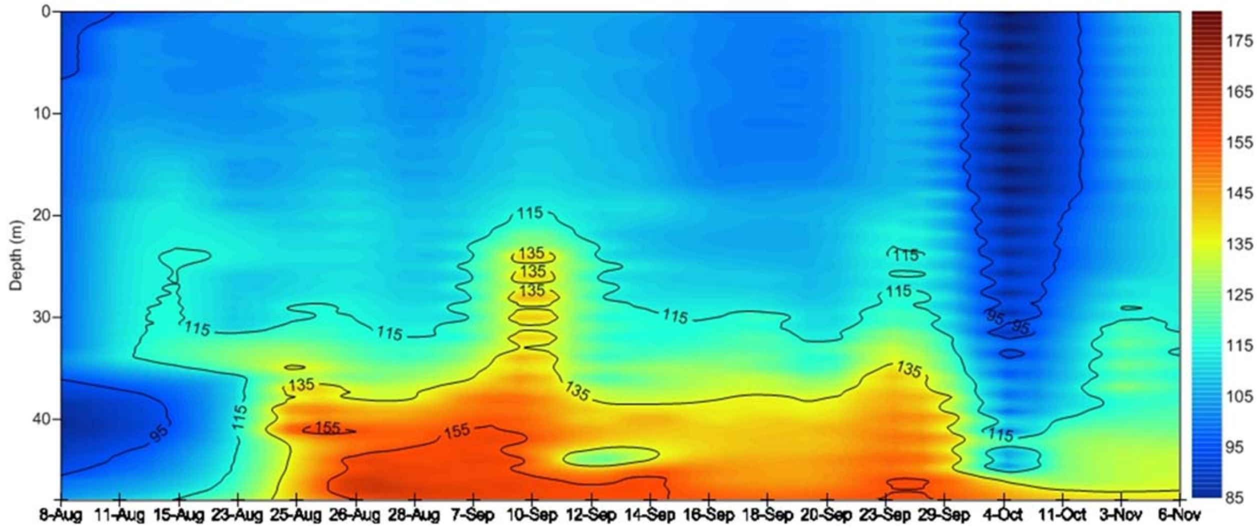


Figure 63: Contours of specific conductivity measured in-situ over time at Station QUL-21 in Quesnel Lake post-event (August 2014 to November 2014). Specific conductivity (µS/cm) shown on right hand axis.

4.0 QUESNEL RIVER

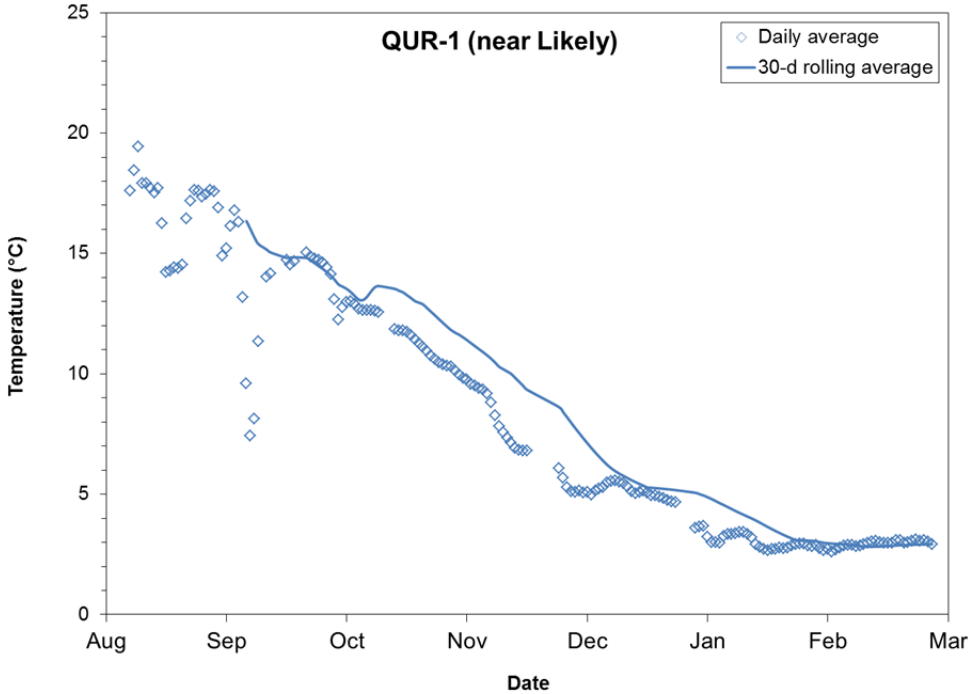


Figure 64: Temperature measured in-situ over time at Station QUR-1 in Quesnel River post-event (August 2014 to February 2015).

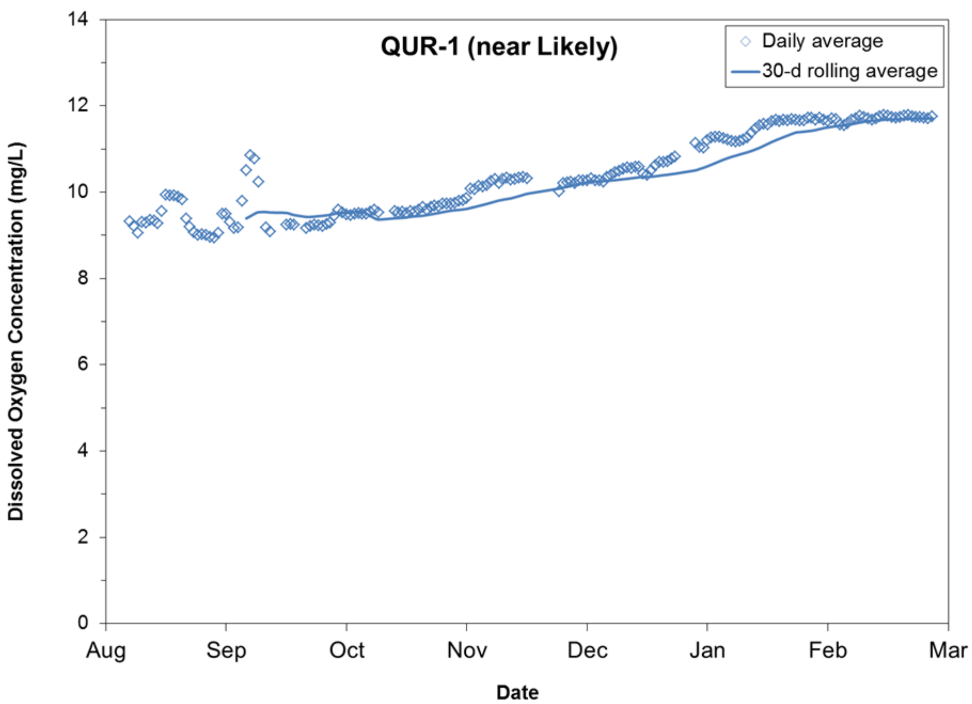


Figure 65: Concentration of dissolved oxygen measured in-situ over time at Station QUR-1 in Quesnel River post-event (August 2014 to February 2015).

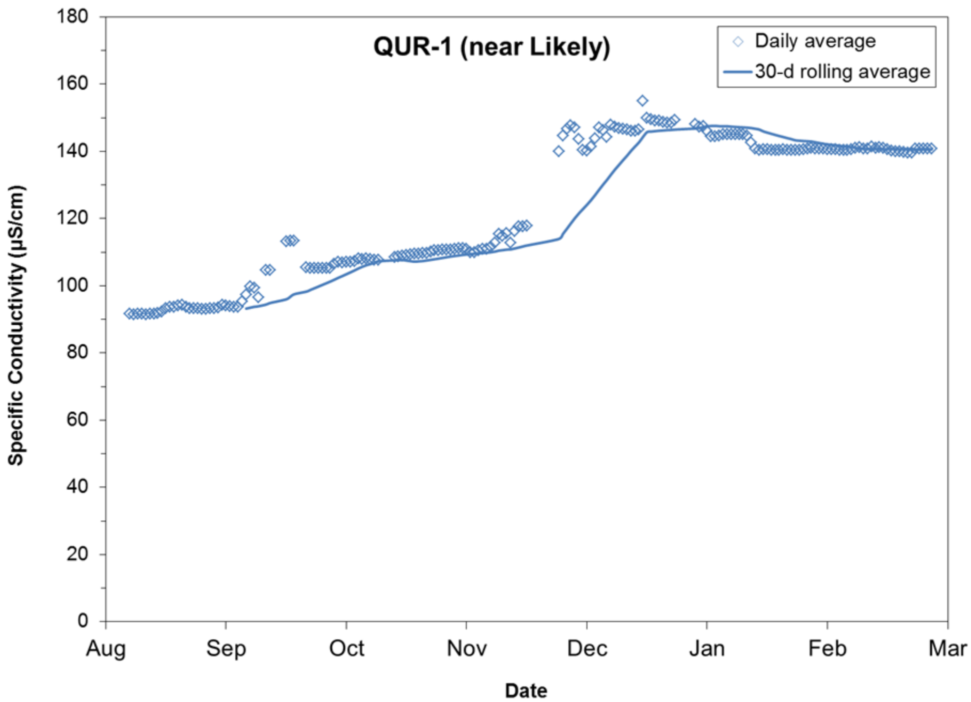


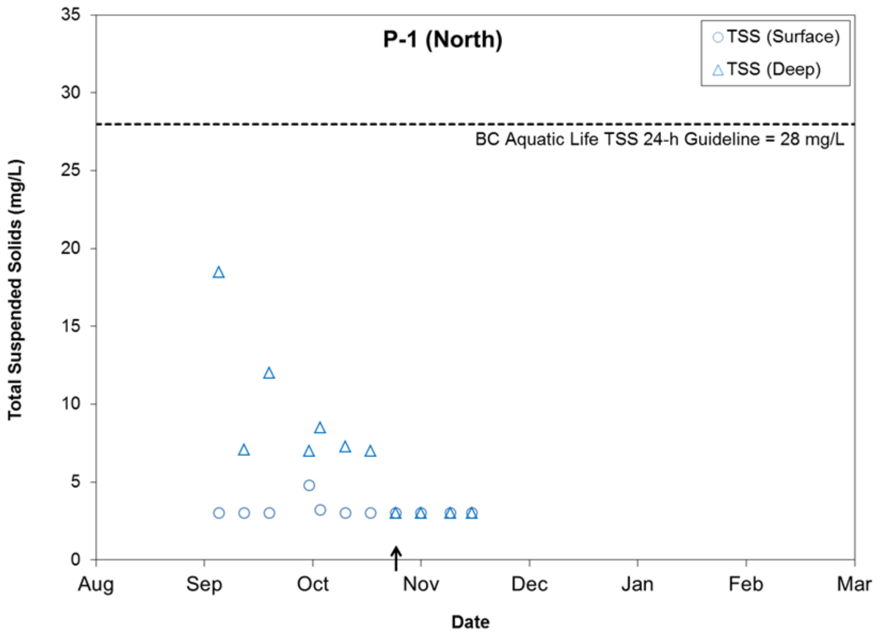
Figure 66: Specific conductivity measured in-situ over time at Station QUR-1 in Quesnel River post-event (August 2014 to February 2015).

APPENDIX E

Time Series Plots of Post-Event Surface Water Quality

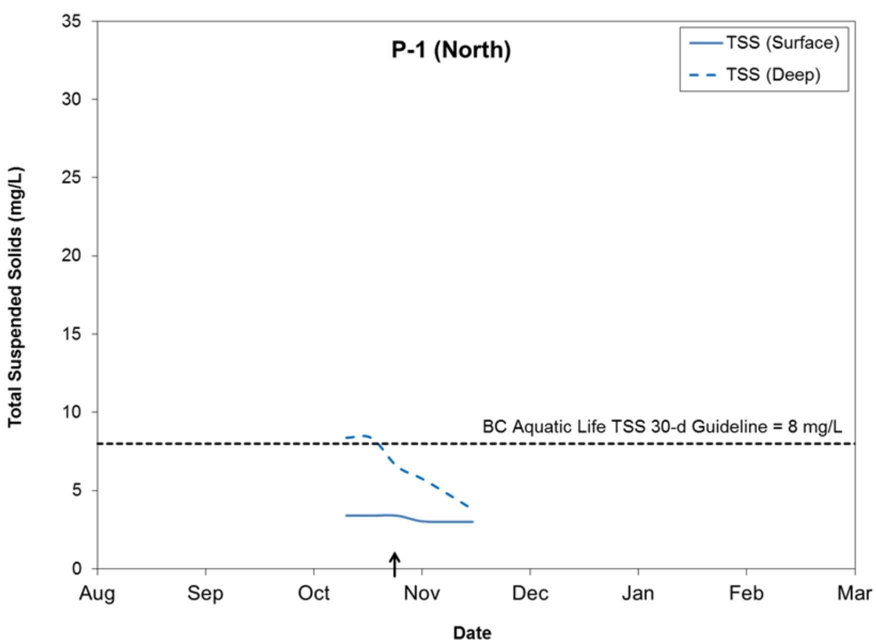
1.0 POLLEY LAKE

1.1 Total Suspended Solids



Note: Arrow represents the approximate timing of late-October turnover in Polley Lake. Baseline assumed equal to the method detection limit (MDL) of 3 mg/L.

Figure 1: Concentrations of total suspended solids at Station P-1 in Polley Lake post-event (September 2014 to November 2014).

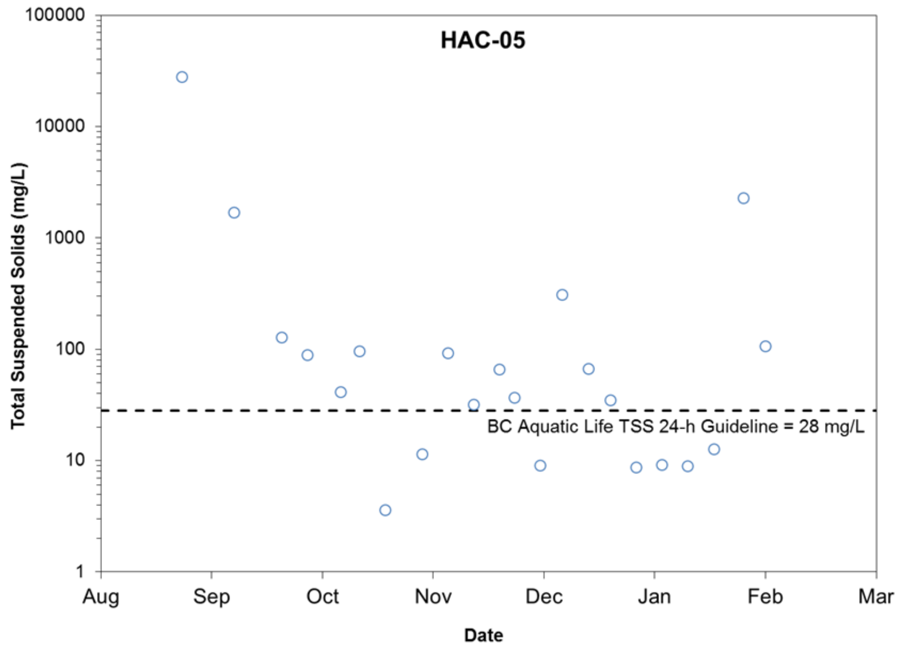


Note: Arrow represents the approximate timing of late-October turnover in Polley Lake. Baseline assumed equal to the MDL of 3 mg/L.

Figure 2: 30-day rolling average concentrations of total suspended solids at Station P-1 in Polley Lake post-event (October 2014 to November 2014).

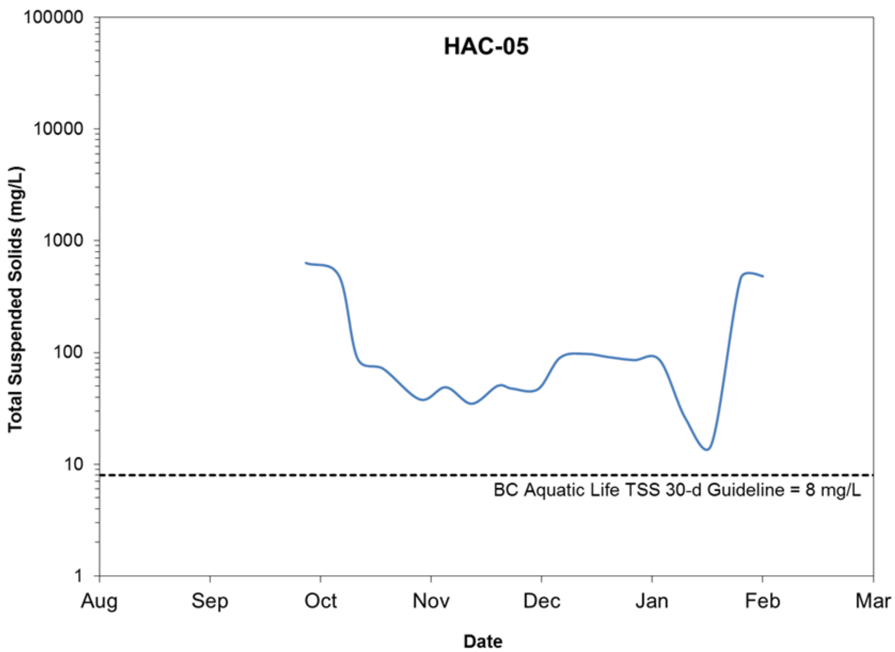
2.0 HAZELTINE CREEK

2.1 Total Suspended Solids



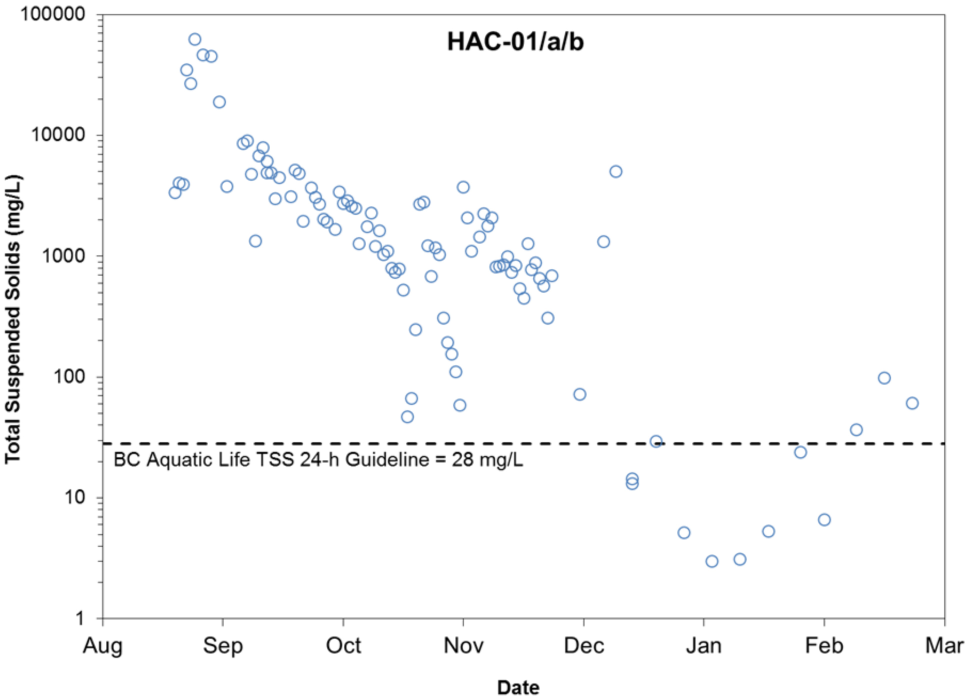
Baseline assumed equal to the MDL of 3 mg/L.

Figure 3: Concentrations of total suspended solids at Station HAC-05 in upper Hazeltine Creek post-event (August 2014 to February 2015).



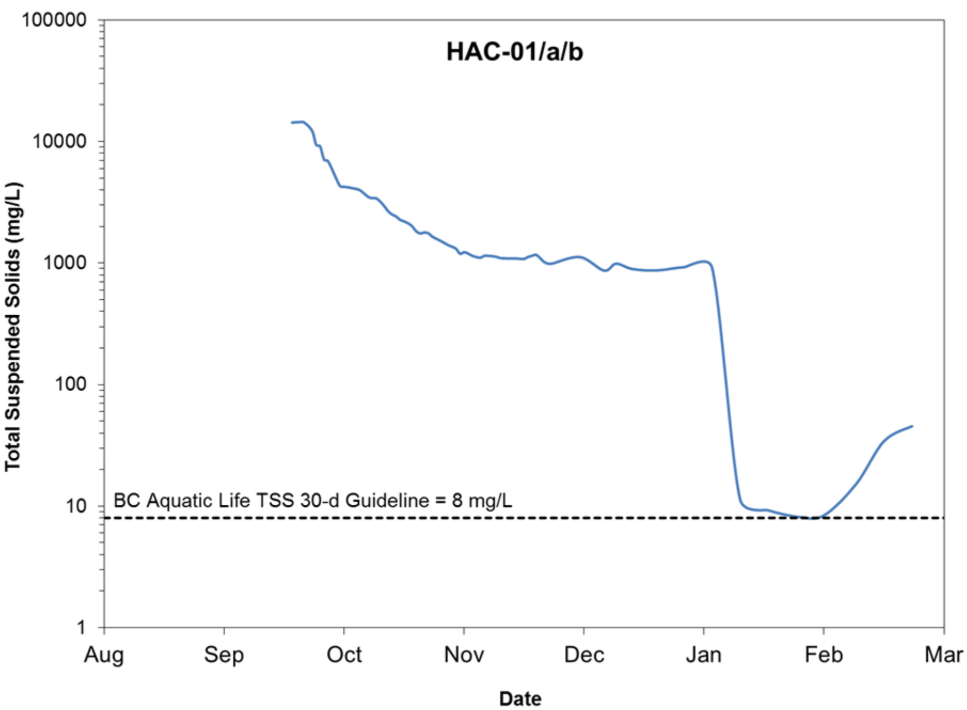
Baseline assumed equal to the MDL of 3 mg/L.

Figure 4: 30-day rolling average concentrations of total suspended solids at Station HAC-05 in upper Hazeltine Creek post-event (September 2014 to February 2015).



Baseline assumed equal to the MDL of 3 mg/L.

Figure 5: Concentrations of total dissolved solids at Station HAC-01/a/b in lower Hazeltine Creek post-event (August 2014 to February 2015).



Baseline assumed equal to the MDL of 3 mg/L.

Figure 6: 30-day rolling average concentrations of total dissolved solids at Station HAC-01/a/b in lower Hazeltine Creek post-event (September 2014 to February 2015).

2.2 Copper

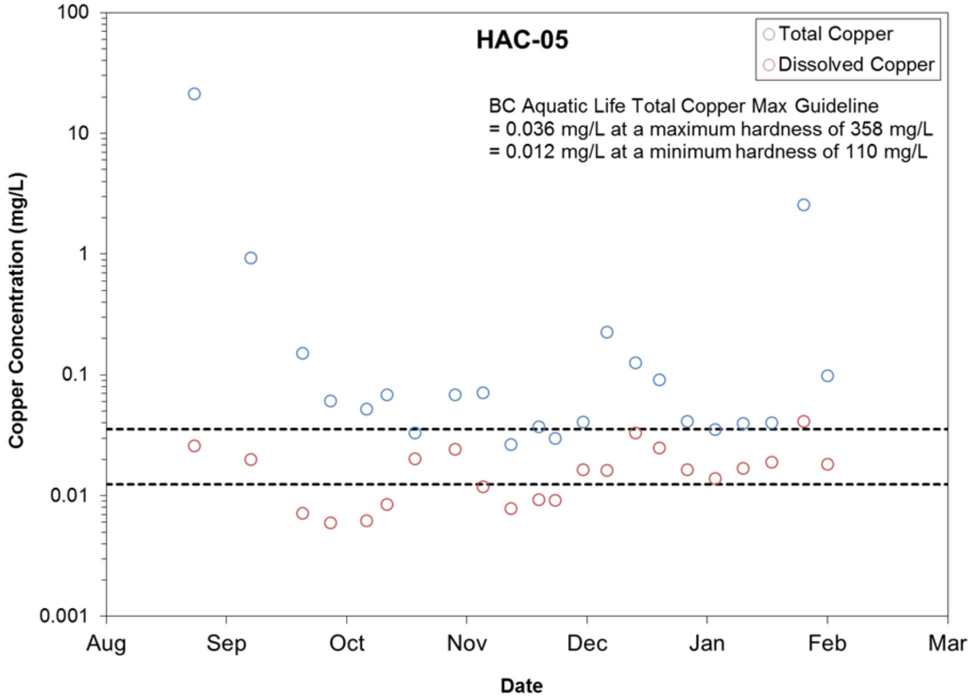


Figure 7: Concentrations of total and dissolved copper at Station HAC-05 in upper Hazeltine Creek post-event (August 2014 to February 2015).

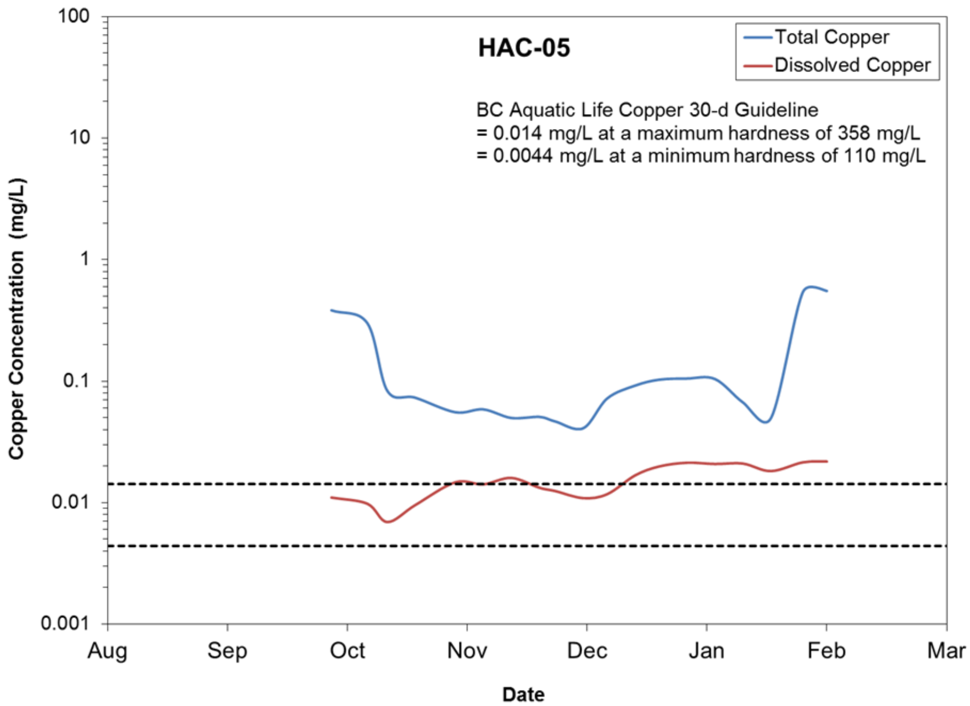


Figure 8: 30-day rolling average concentrations of total and dissolved copper at Station HAC-05 in upper Hazeltine Creek post-event (September 2014 to February 2015).

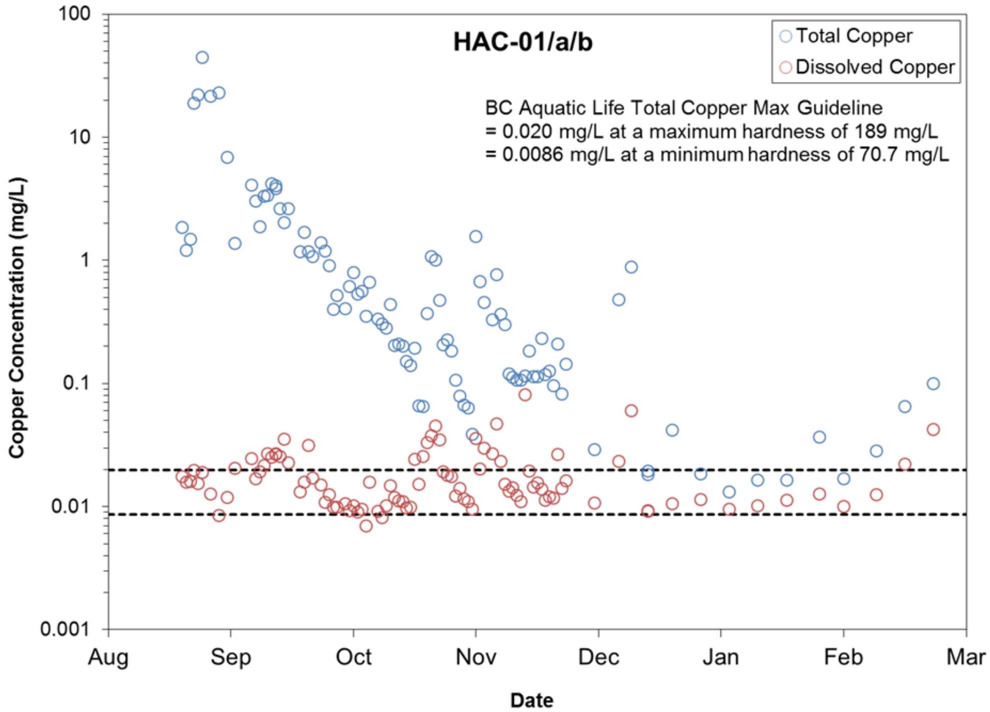


Figure 9: Concentrations of total and dissolved copper at Station HAC-01/a/b in lower Hazeltine Creek post-event (August 2014 to February 2015).

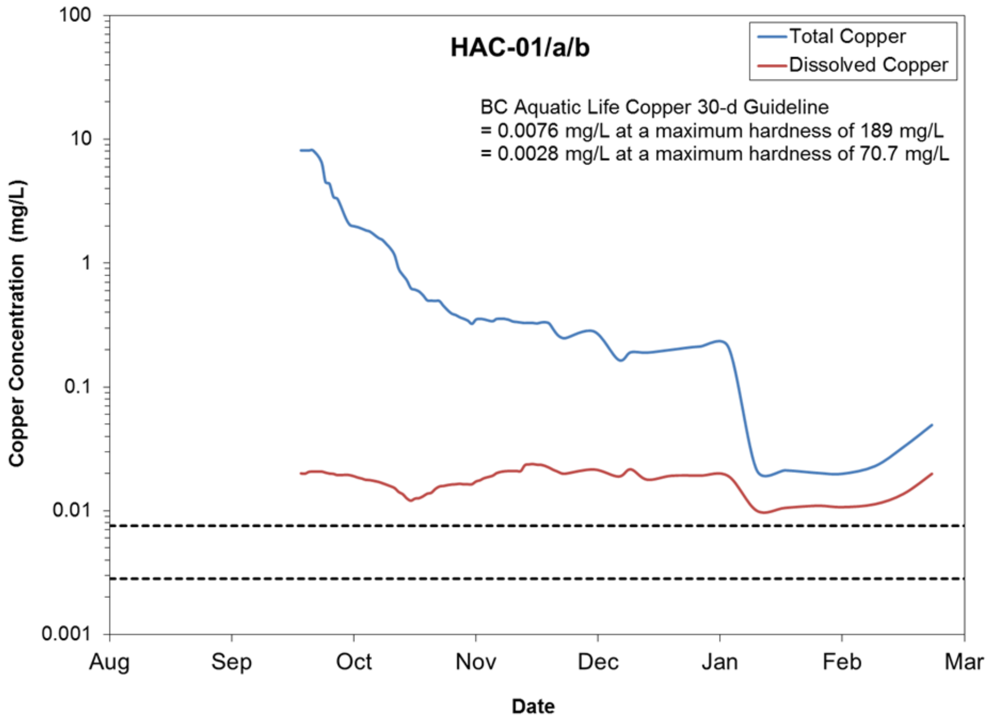


Figure 10: 30-day rolling average concentrations of total and dissolved copper at Station HAC-01/a/b in lower Hazeltine Creek post-event (September 2014 to February 2015).

2.3 Aluminum

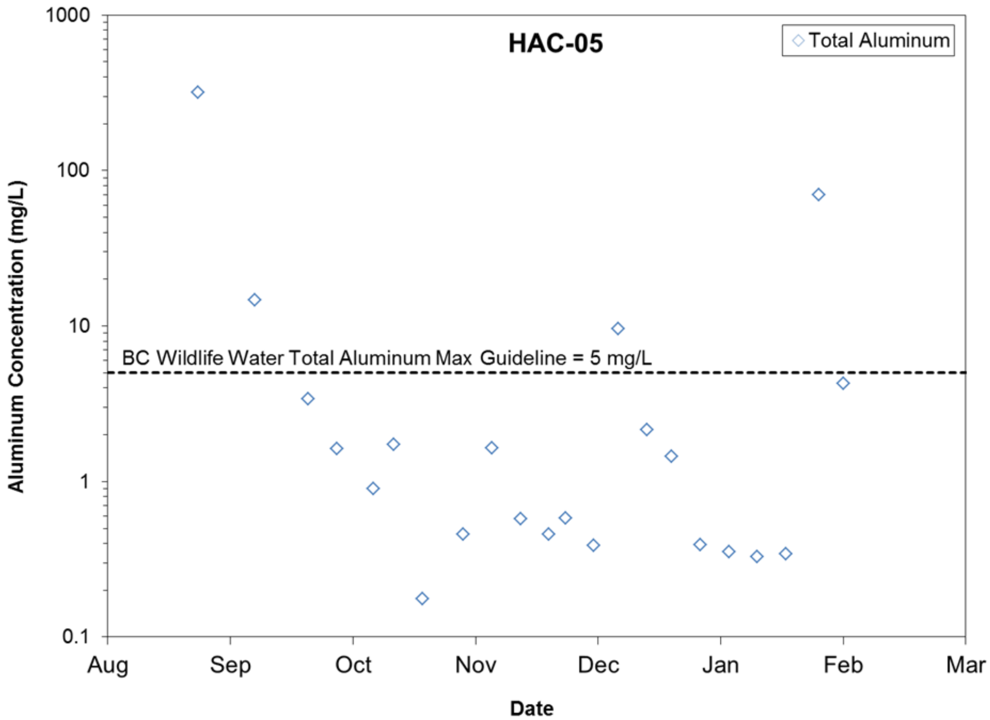


Figure 11: Concentrations of total aluminum at Station HAC-05 in upper Hazeltine Creek post-event (August 2014 to February 2015).

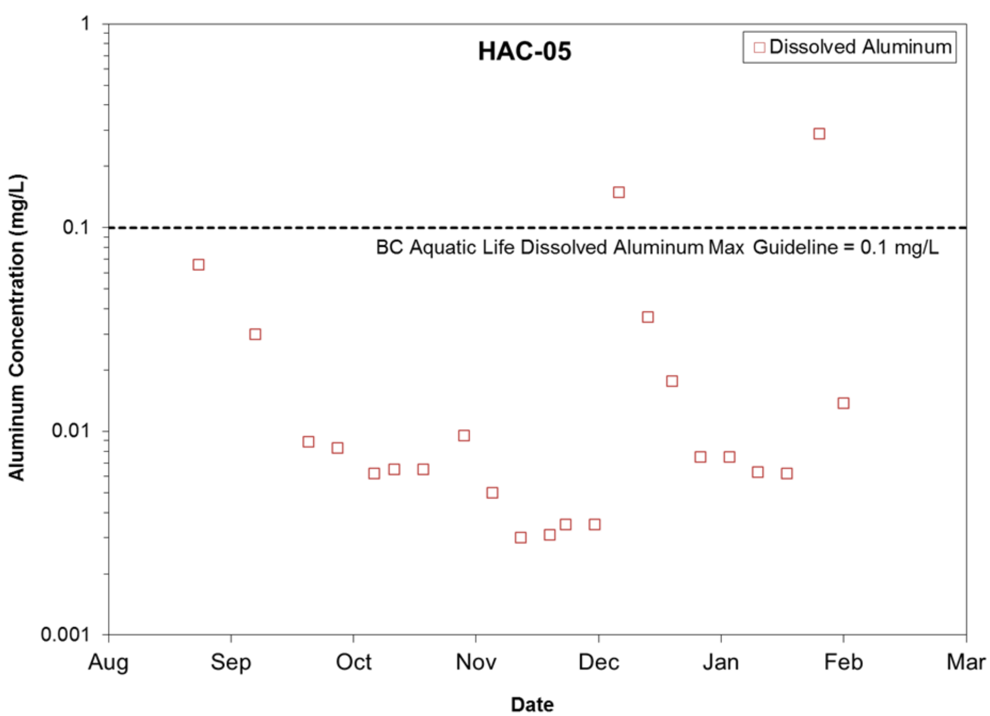


Figure 12: Concentrations of dissolved aluminum at Station HAC-05 in upper Hazeltine Creek post-event (August 2014 to February 2015).

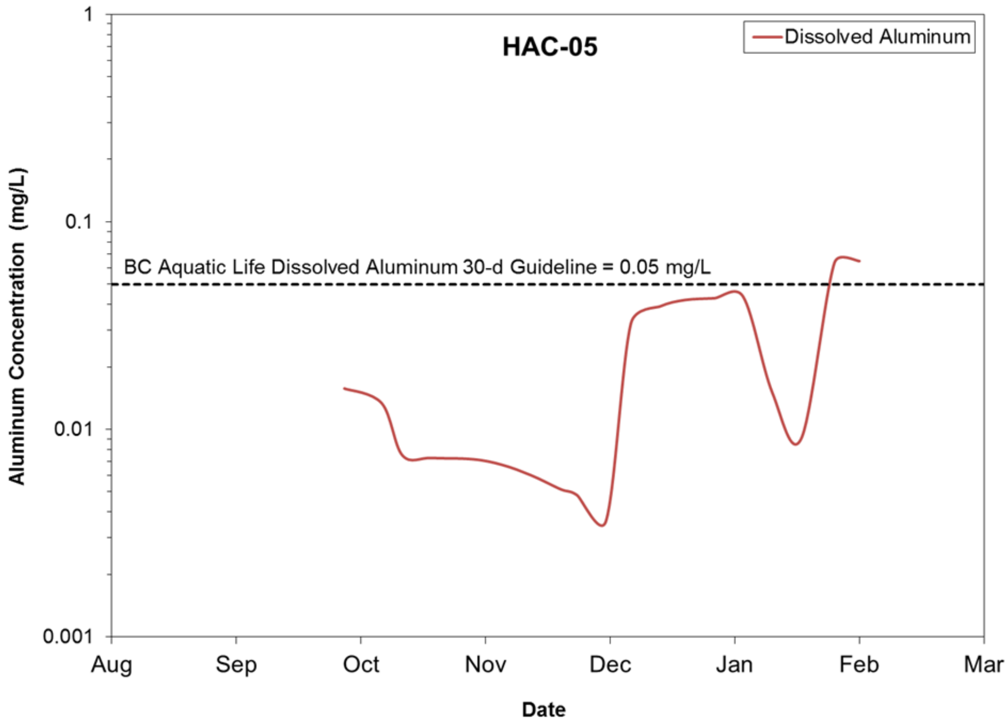


Figure 13: 30-day rolling average concentrations of dissolved aluminum at Station HAC-05 in upper Hazeltine Creek post-event (September 2014 to February 2015).

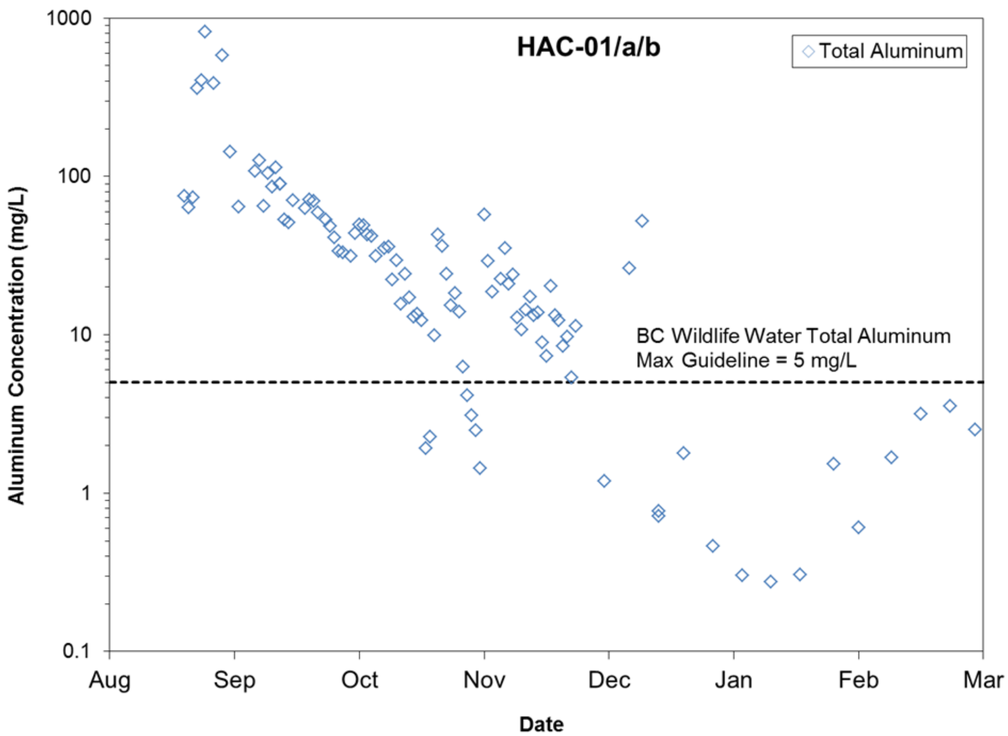


Figure 14: Concentrations of total aluminum at Station HAC-01/a/b in lower Hazeltine Creek post-event (August 2014 to February 2015).

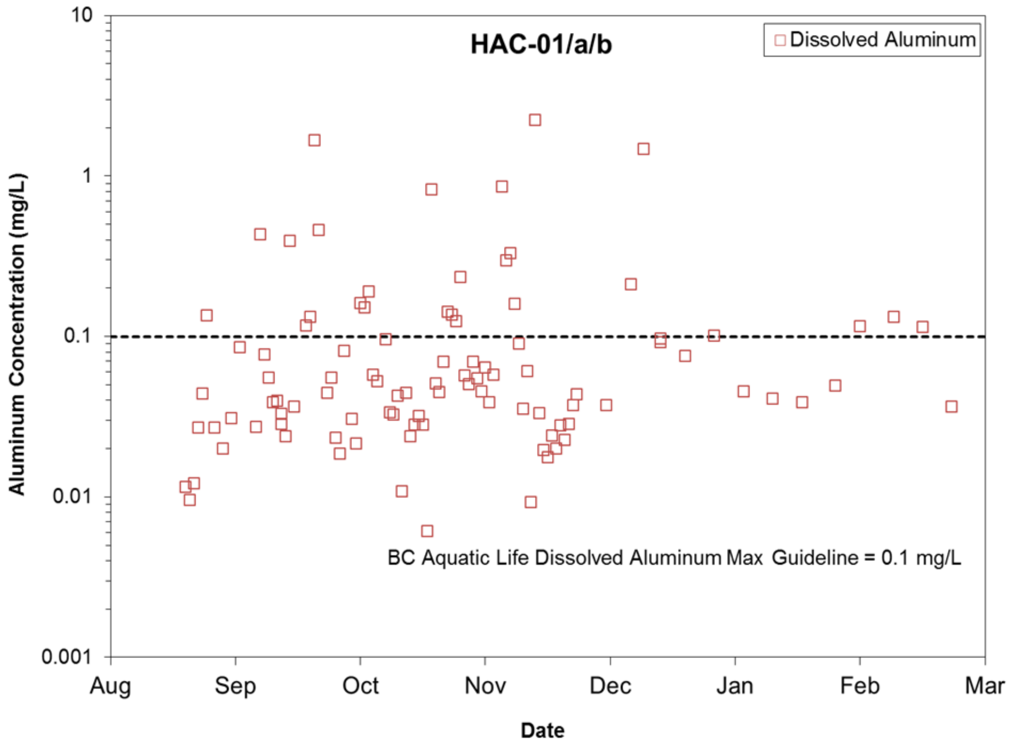


Figure 15: Concentrations of dissolved aluminum at Station HAC-01/a/b in lower Hazeltine Creek post-event (August 2014 to February 2015).

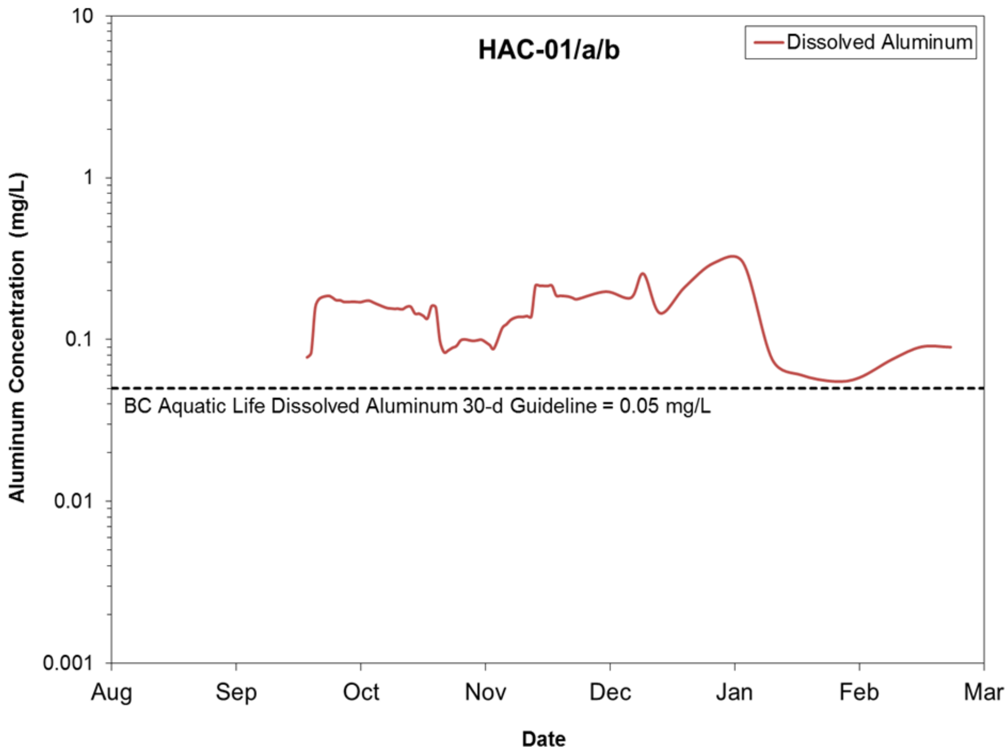


Figure 16: 30-day rolling average concentrations of dissolved aluminum at Station HAC-01/a/b in lower Hazeltine Creek post-event (September 2014 to February 2015).

2.4 Chromium

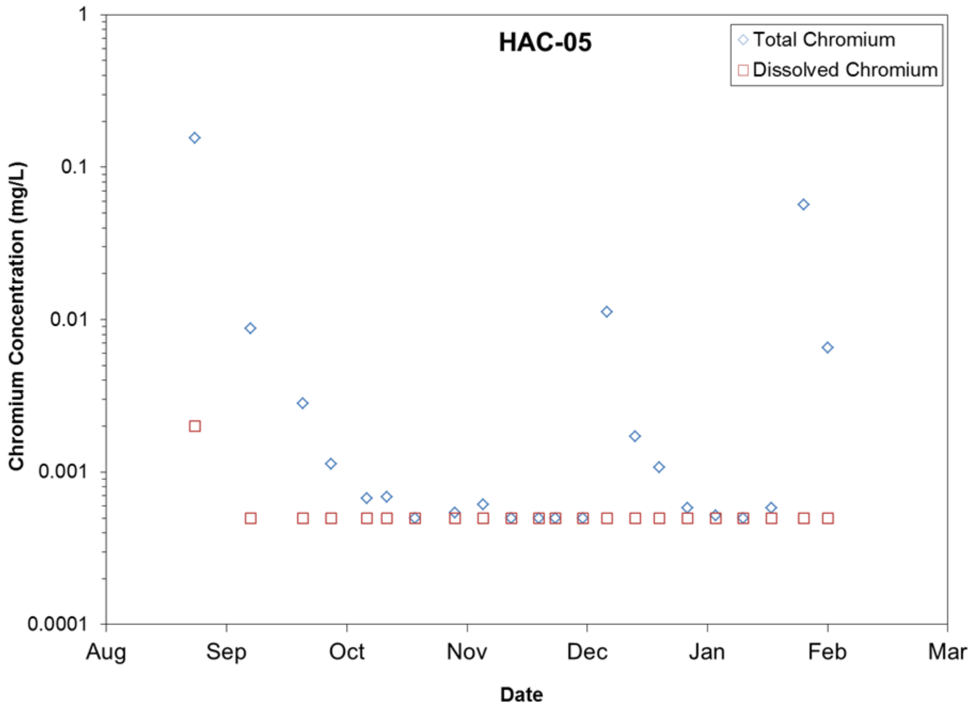


Figure 17: Concentrations of total and dissolved chromium at Station HAC-05 in upper Hazeltine Creek post-event (August 2014 to February 2015).

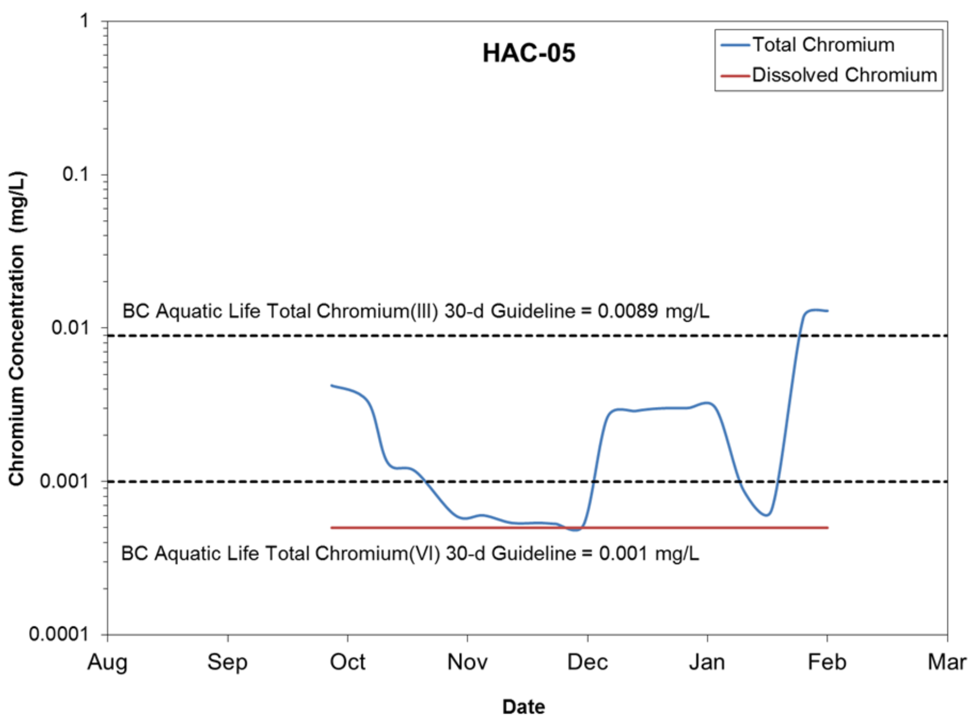


Figure 18: 30-day rolling average concentrations of total and dissolved chromium at Station HAC-05 in upper Hazeltine Creek post-event (September 2014 to February 2015).

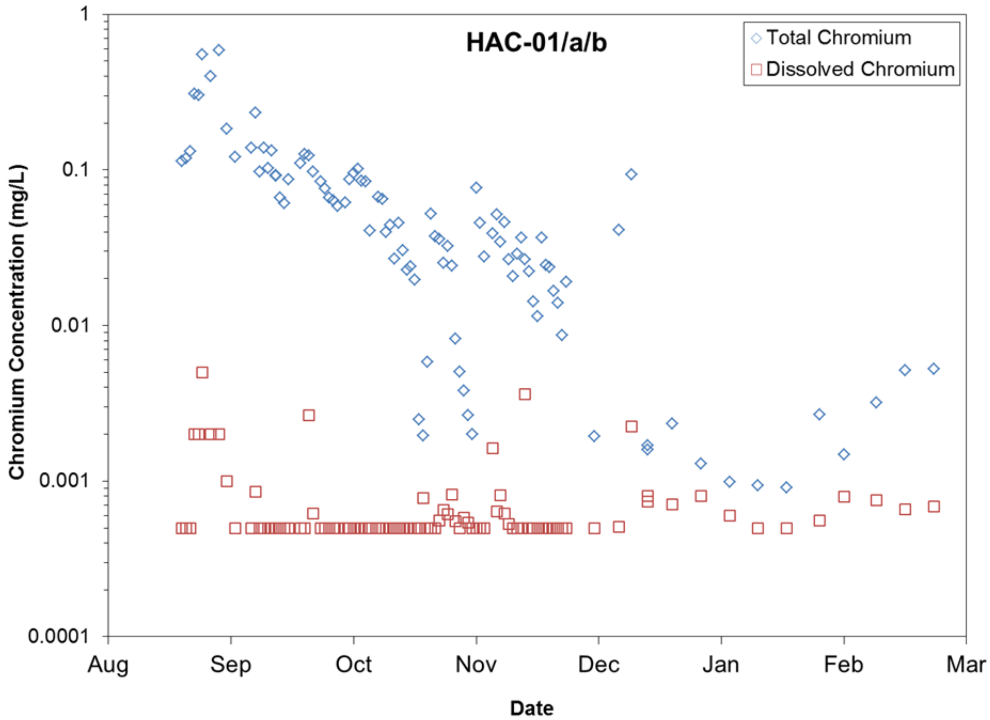


Figure 19: Concentrations of total and dissolved chromium at Station HAC-01/a/b in lower Hazeltine Creek post-event (August 2014 to February 2015).

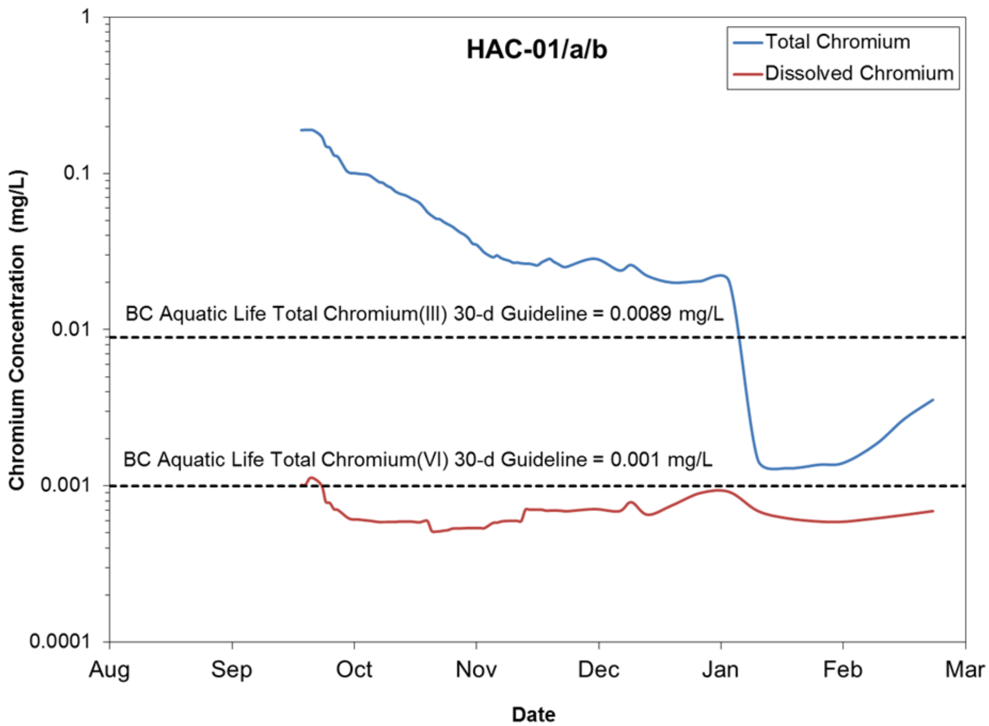


Figure 20: 30-day rolling average concentrations of total and dissolved chromium at Station HAC-01/a/b in lower Hazeltine Creek post-event (September 2014 to February 2015).

2.5 Iron

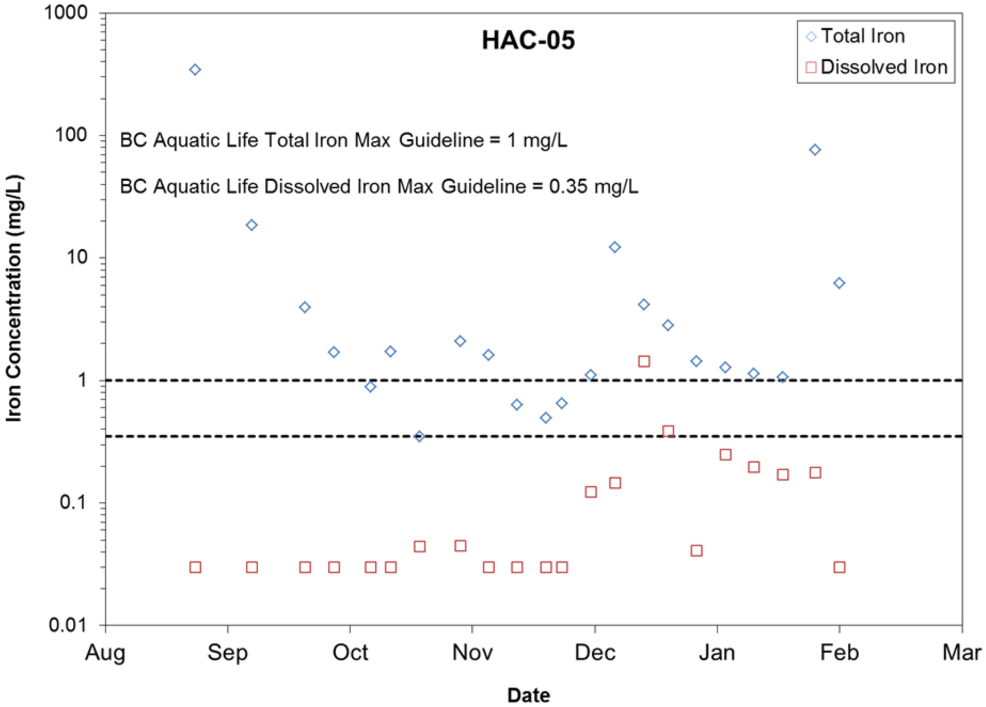


Figure 21: Concentrations of total and dissolved iron at Station HAC-05 in upper Hazeltine Creek post-event (August 2014 to February 2015).

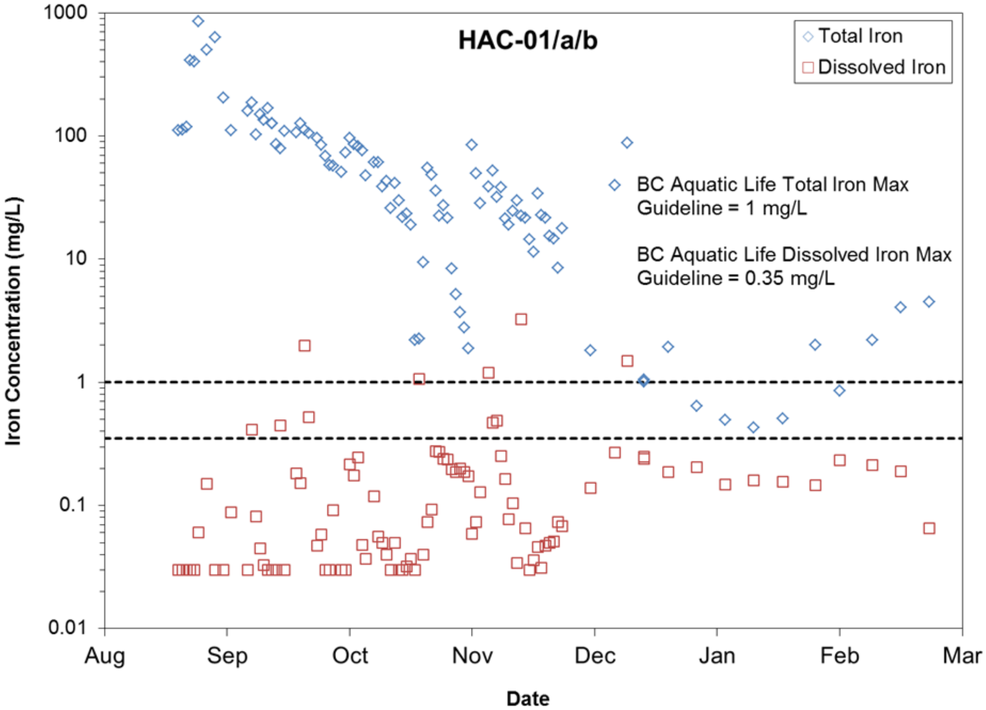


Figure 22: Concentrations of total and dissolved iron at Station HAC-01/a/b in lower Hazeltine Creek post-event (August 2014 to February 2015).

2.6 Molybdenum

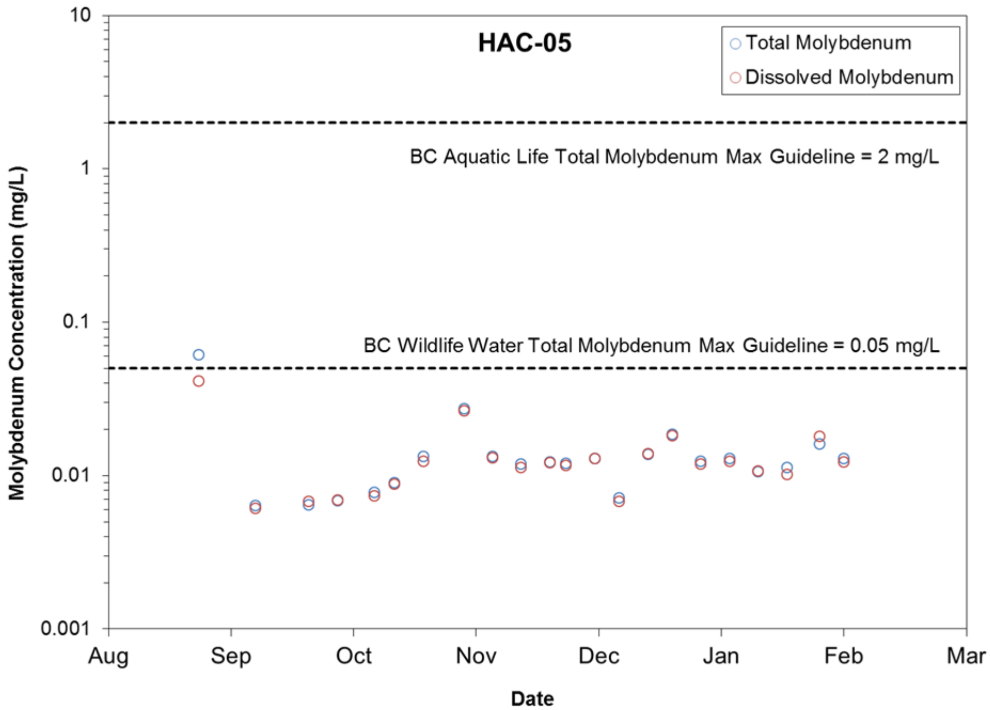


Figure 23: Concentrations of total and dissolved molybdenum at Station HAC-05 in upper Hazeltine Creek post-event (August 2014 to February 2015).

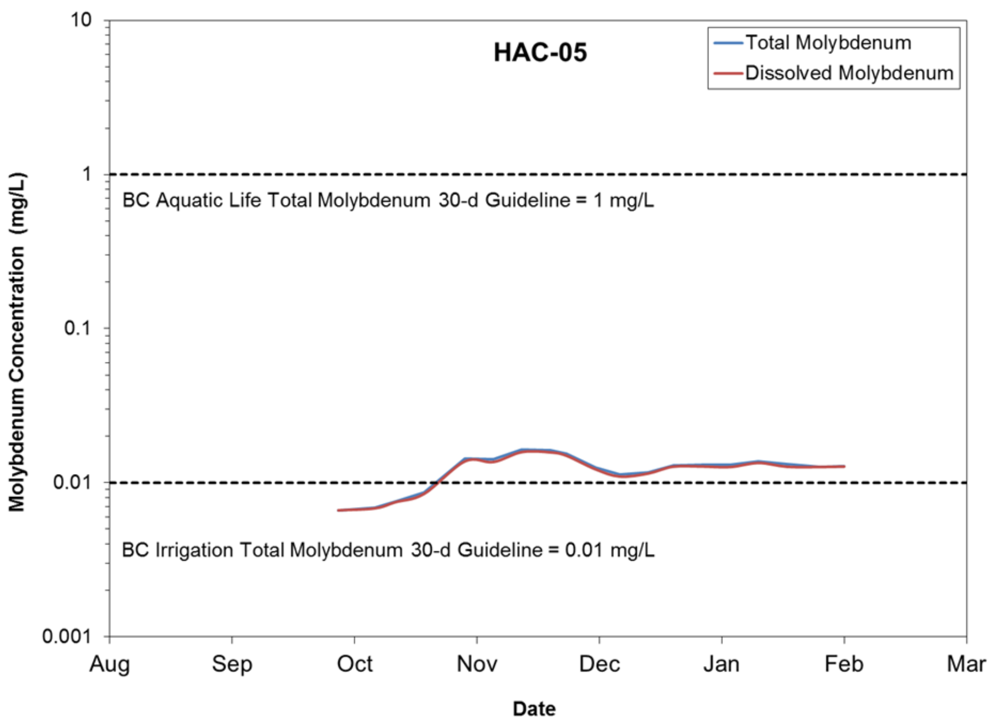


Figure 24: 30-day rolling average concentrations of total and dissolved molybdenum at Station HAC-05 in upper Hazeltine Creek post-event (September 2014 to February 2015).

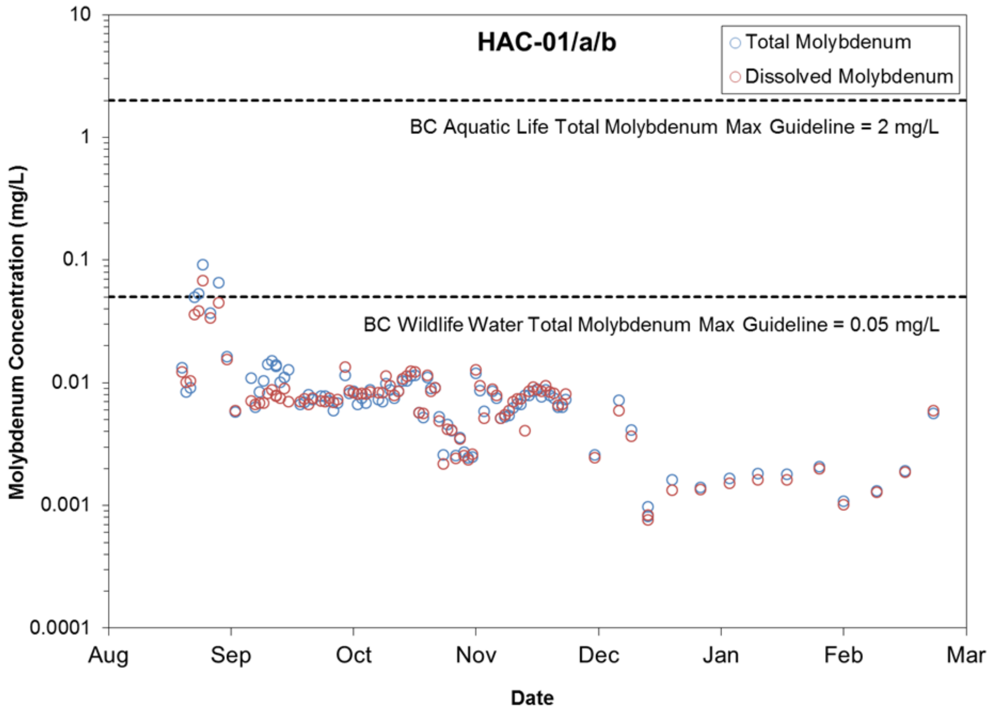


Figure 25: Concentrations of total and dissolved molybdenum at Station HAC-01/a/b in lower Hazeltine Creek post-event (August 2014 to February 2015).

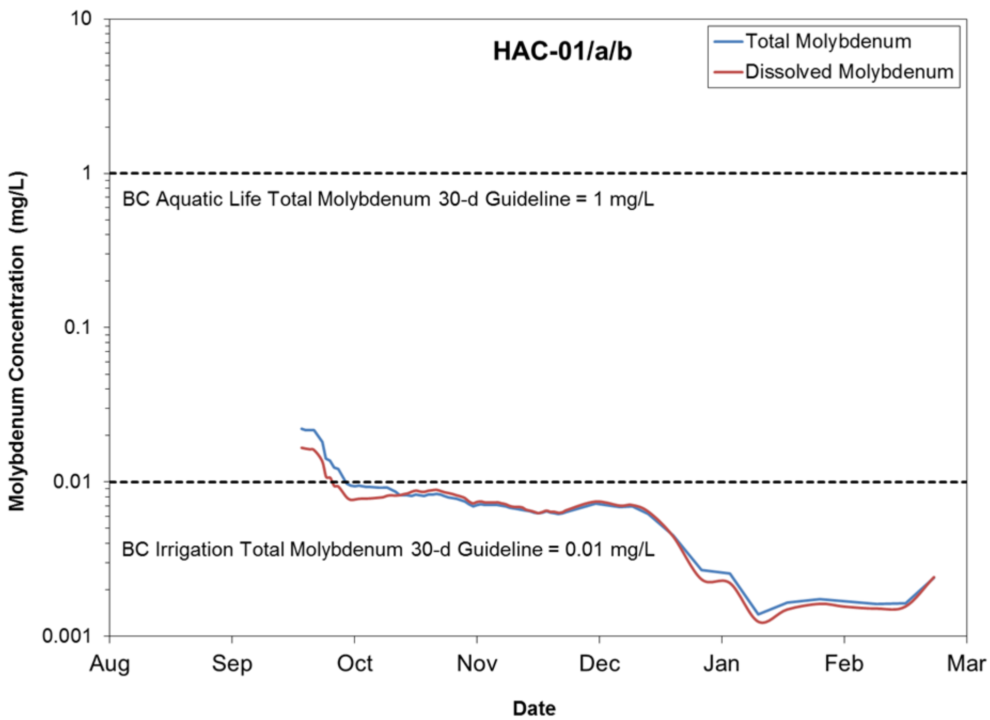


Figure 26: 30-day rolling average concentrations of total and dissolved molybdenum at Station HAC-01/a/b in lower Hazeltine Creek post-event (September 2014 to February 2015)

2.7 Selenium

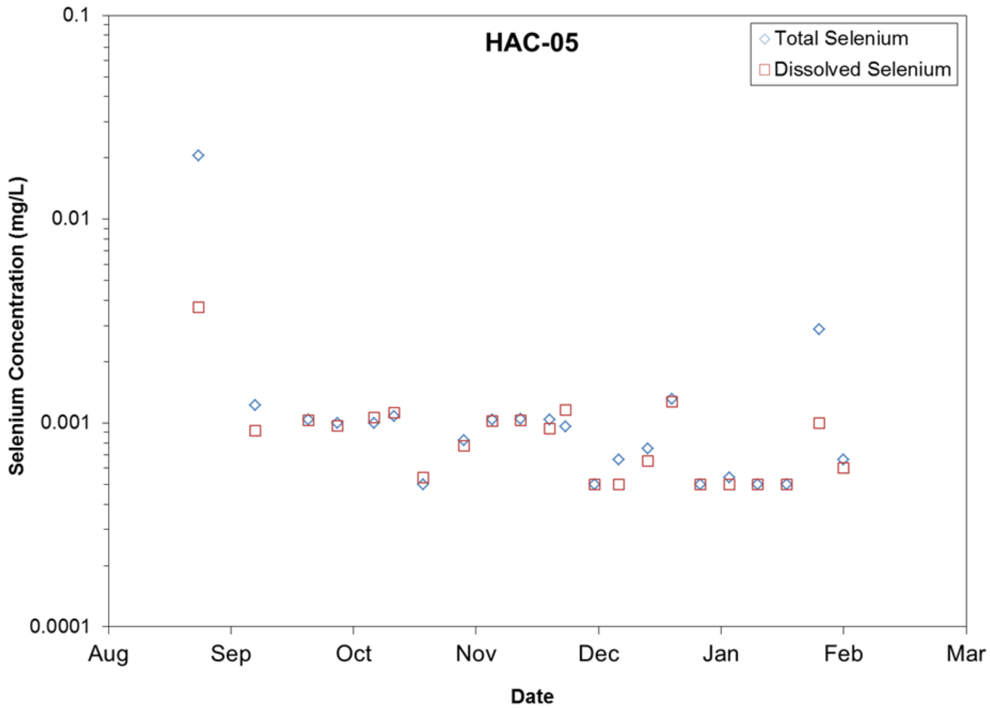


Figure 27: Concentrations of total and dissolved selenium at Station HAC-05 in upper Hazeltine Creek post-event (August 2014 to February 2015).

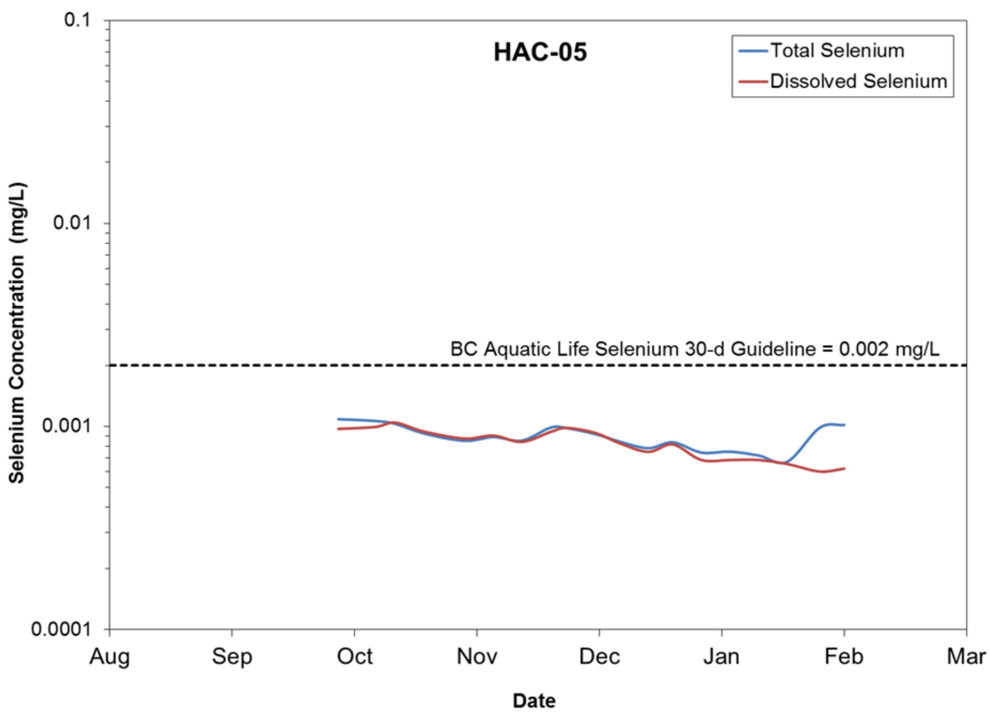


Figure 28: 30-day rolling average concentrations of total and dissolved selenium at Station HAC-05 in upper Hazeltine Creek post-event (September 2014 to February 2015).

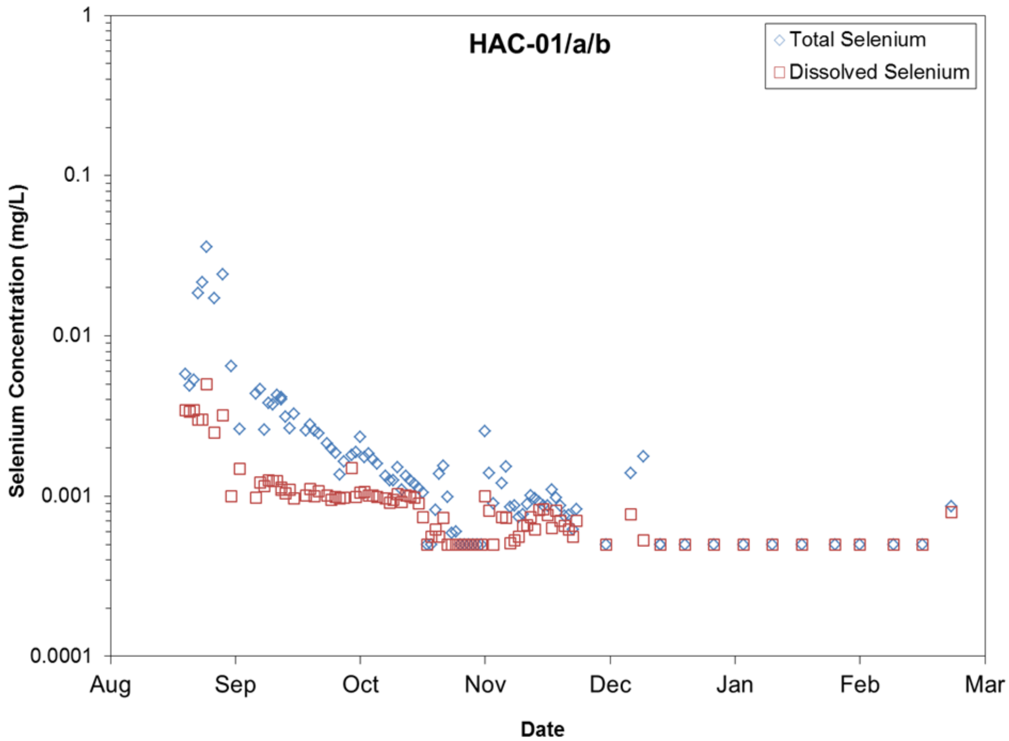


Figure 29: Concentrations of total and dissolved selenium at Station HAC-01/a/b in lower Hazeltine Creek post-event (August 2014 to March 2015).

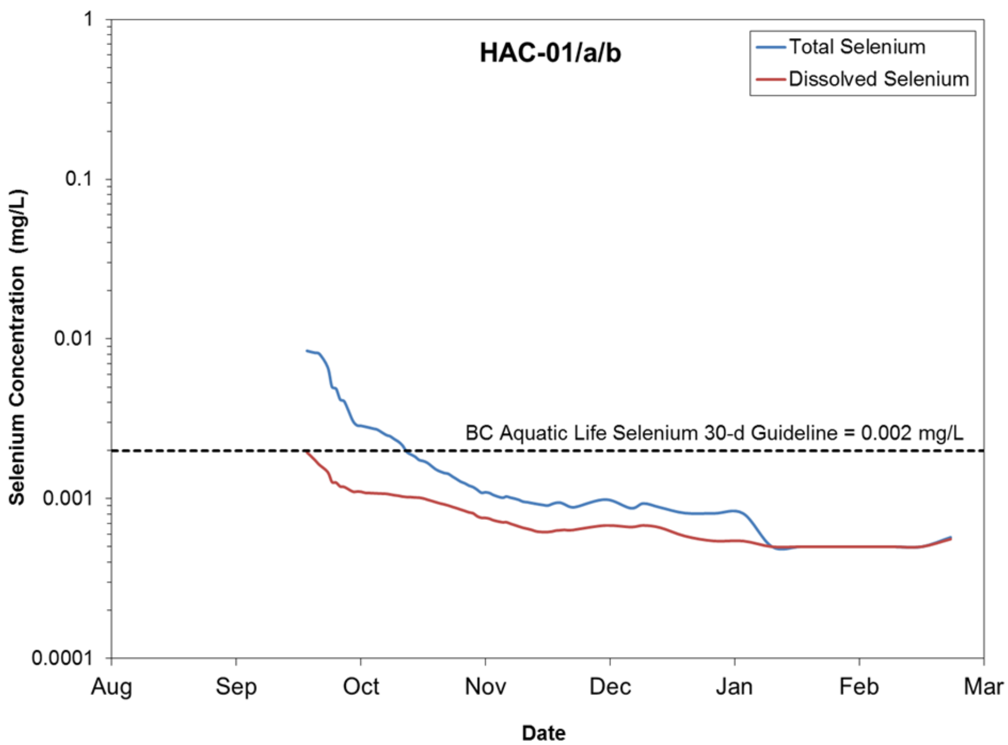
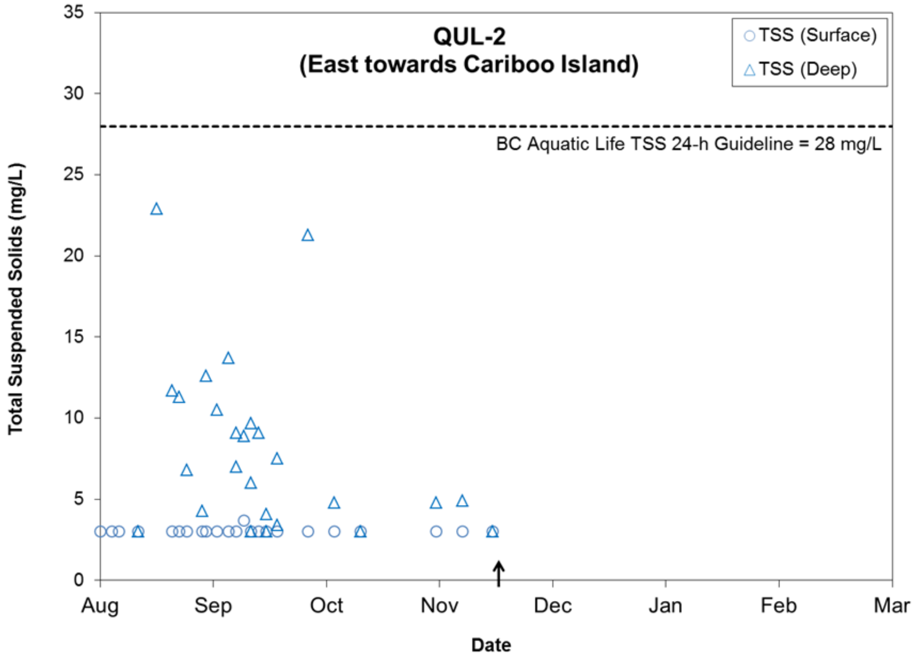


Figure 30: 30-day rolling average concentrations of total and dissolved selenium at Station HAC-01/a/b in lower Hazeltine Creek post-event (September 2014 to March 2015).

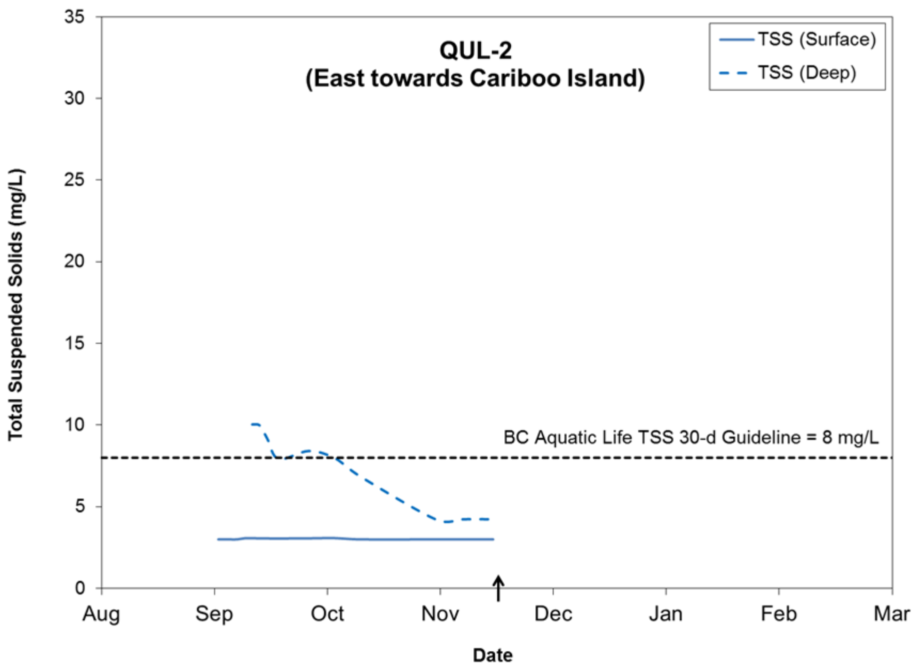
3.0 QUESNEL LAKE

3.1 Total Suspended Solids



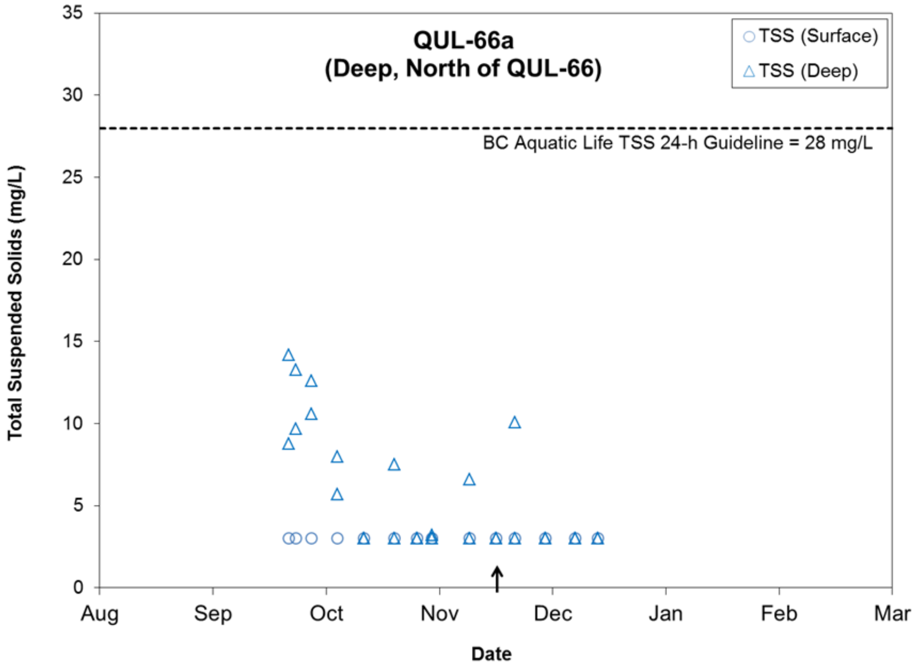
Note: Arrow represents the approximate timing of mid-November turnover in Quesnel Lake. Baseline assumed equal to the MDL of 3 mg/L.

Figure 31: Concentrations of total suspended solids at Station QUL-2 in Quesnel Lake post-event (August 2014 to November 2014).



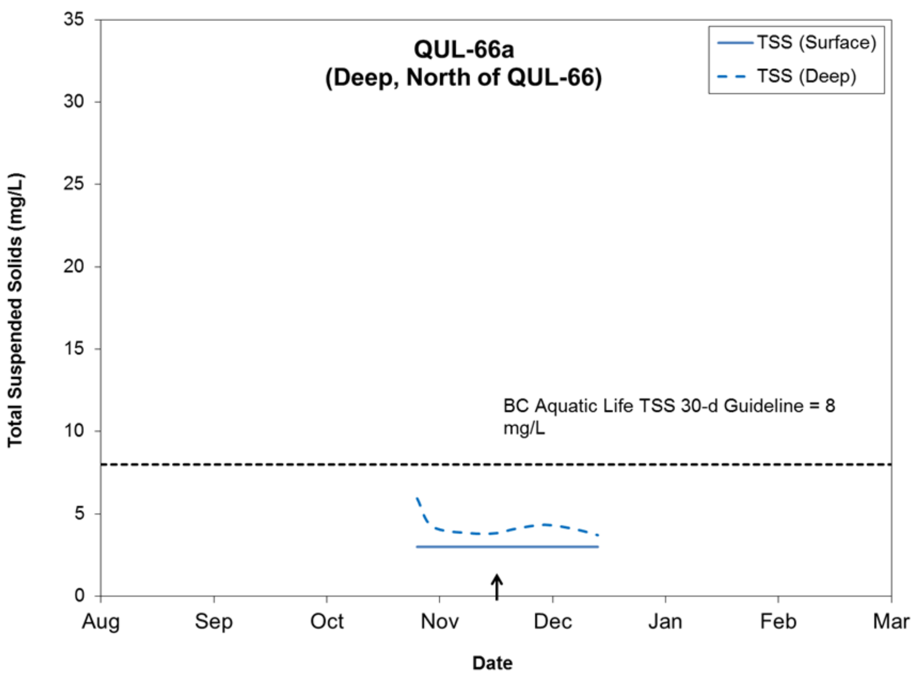
Note: Arrow represents the approximate timing of mid-November turnover in Quesnel Lake. Baseline assumed equal to the MDL of 3 mg/L.

Figure 32: 30-day rolling average concentrations of total suspended solids at Station QUL-2 in Quesnel Lake post-event (September 2014 to November 2014).



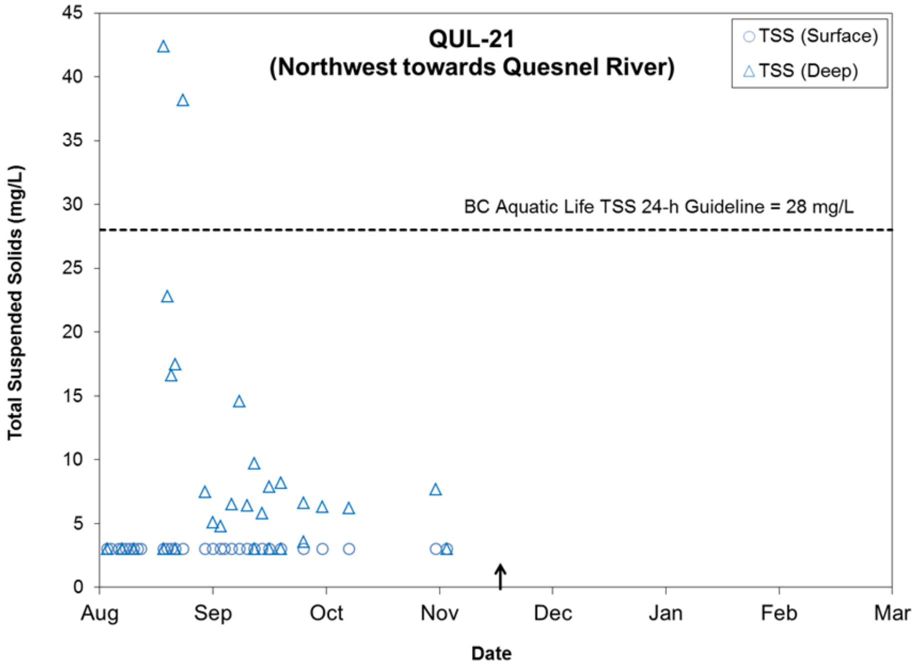
Note: Arrow represents the approximate timing of mid-November turnover in Quesnel Lake. Baseline assumed equal to the MDL of 3 mg/L.

Figure 33: Concentrations of total suspended solids at Station QUL-66a in Quesnel Lake post-event (September 2014 to December 2014).



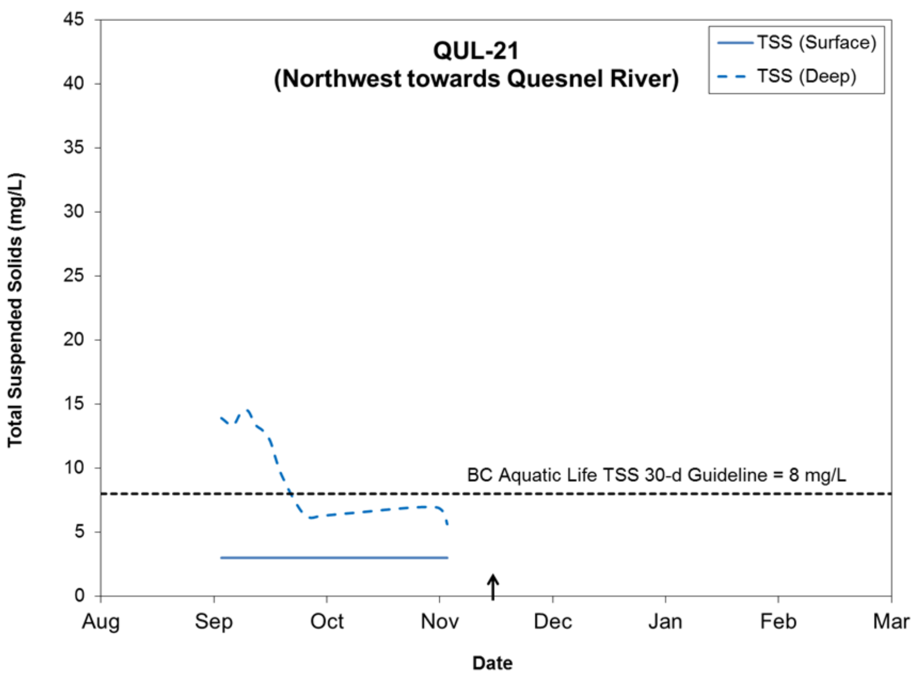
Note: Arrow represents the approximate timing of mid-November turnover in Quesnel Lake. Baseline assumed equal to the MDL of 3 mg/L.

Figure 34: 30-day rolling average concentrations of total suspended solids at Station QUL-66a in Quesnel Lake post-event (October 2014 to December 2014).



Note: Arrow represents the approximate timing of mid-November turnover in Quesnel Lake. Baseline assumed equal to the MDL of 3 mg/L.

Figure 35: Concentrations of total suspended solids at Station QUL-21 in Quesnel Lake post-event (August 2014 to November 2014).



Note: Arrow represents the approximate timing of mid-November turnover in Quesnel Lake. Baseline assumed equal to the MDL of 3 mg/L.

Figure 36: 30-day rolling average concentrations of total suspended solids at Station QUL-21 in Quesnel Lake post-event (September 2014 to November 2014).

APPENDIX F

Background on Turbidity and Total Suspended Solids

1.0 TURBIDITY AND TOTAL SUSPENDED SOLIDS

1.1 Background

Turbidity is a measure of water's cloudiness or haziness, which is caused by individual particles (e.g., total suspended or dissolved solids) that affect water clarity and how much light can be transmitted through a sample. Samples with low light transmission will have greater reported turbidity values than samples with few suspended or dissolved solids. Turbidity data are reported in nephelometric turbidity units (NTU) and measured in relation to standard samples with known turbidities (Birtwell 1999). Turbidity may be measured with relative speed and ease in the field. Field-measured values may range from 1 to 1,000 NTU (Chapman 1992).

Total suspended solids (TSS), including suspended substrate particles (e.g., clay and silt), organic matter (e.g., detritus), planktonic organisms and bacteria, contribute to turbidity (Canadian Council of Ministers of the Environment [CCME] 2002). It is the gravimetric measurement of the dry weight of suspended particulate matter (solids) per unit volume of water; it is generally accepted as the fraction of suspended matter that will not pass through a 1.5 micrometre (µm) filter (Chapman 1992). Results are expressed in terms of milligrams per litre of water (mg/L). Because measurement of TSS concentrations in water requires filtration of samples, TSS is not immediately or directly measureable under field conditions (e.g., Riley 1998). Also, TSS composition and concentrations are largely dependent on site-specific conditions. Fortunately, if site-specific sediment (e.g., particle size) and water (e.g., colour) conditions are known, turbidity data may be used as a surrogate measure of TSS (Birtwell et al. 2008).

Turbidity and TSS data may be influenced by anthropogenic activities that affect waterbodies and watercourses, as well as natural, temporal (i.e., seasonal), and spatial phenomena (Caux et al. 1997). Aquatic sediments disturbed during in-water works, such as dam and water intake construction, are potential sources of elevated turbidity and TSS. Under most natural conditions, soil erosion and weathering are the greatest contributors to turbidity. Runoff during the spring freshet may carry seasonally high concentrations of suspended soil particles; runoff from heavy rainfall may also result in short-duration spikes in turbidity and TSS concentrations within affected waterbodies and watercourses (Chapman 1992). High-flow events may also scour and re-suspend substrates on the streambed, thereby increasing TSS and turbidity (Birtwell 1999). Biological activity, such as the proliferation of planktonic organisms during warm summer months, may also have a seasonal effect on turbidity and TSS measurements (Chapman 1992).

1.2 Implications for Drinking Water

Turbidity may affect drinking water quality by reducing the aesthetic appeal of water and/or reducing the effectiveness of water treatment methods. For example, ultraviolet radiation, which must be transmitted through the water to effectively eliminate pathogens, may be less effective in turbid drinking water (Marquis 2005). Additionally, suspended particles may serve as vectors for adhered pathogens or promote the growth of micro-organisms (Caux et al. 1997; Marquis 2005; Mattioli et al. 2013).

1.3 Implications for Aquatic Life

As stated in Section 1.1, turbidity may be used as a surrogate measure of TSS. Turbidity and suspended solids affect light penetration, which, in turn, has implications for photosynthetic organisms at the base of aquatic food webs (Birtwell et al. 2008). Suspended sediments may also settle out of the water column and fill the interstitial spaces within aquatic substrate, thereby reducing the quantity and quality of cover and habitat available to macroinvertebrates, fish eggs, and fish fry.

Elevated concentrations of suspended solids may affect fish health and survival by abrading or clogging the gills, altering behaviour (e.g., migration), and reducing the foraging efficiency of sight-feeding species (CCME 2002; Newcombe and Jensen 1996; Robertson et al. 2006). Because exposure duration may influence how an organism responds to elevated TSS concentrations, it is possible that fish and other aquatic organisms may withstand high concentrations of TSS for short periods and low levels of TSS for longer periods (e.g., 30 days; Section 1.4) (Birtwell 1999; Newcombe and Jensen 1996). However, TSS concentrations less than 25 mg/L are generally considered safe for aquatic life and lethal effects in fish generally occur only when the TSS concentrations are very high (European Inland Fisheries Advisory Commission 1964). For example, studies that investigated lethal effects of TSS on salmonids showed that it took 31,000 mg/L and 17,600 mg/L to kill 50% of juvenile chinook and sockeye salmon test subjects respectively, over a 96h test period (Servizi and Gordon 1990; Servizi and Martens 1987).These concentrations are not commonly encountered in waterbodies except under extreme circumstances.

1.4 Guidelines

Provincial ambient water quality guidelines for turbidity exist in British Columbia (BC) (Table 1). These guidelines are intended to promote the safety of potable water and protect aquatic life from deleterious health effects (e.g., reduced growth, disease) and habitat alterations (e.g., covering of spawning substrates) (see Sections 1.2 and 1.3, above; Birtwell 1999; Caux et al. 1997). Consequently, the BC ambient water quality guidelines include criteria specifically targeted at the protection of drinking water, aquatic life, recreation and aesthetics, wildlife irrigation, livestock watering, and industrial water supplies (Caux et al. 1997). Provincial turbidity guidelines for the protection of aquatic life are in agreement with guidelines developed by the CCME for clear flow and high flow/turbid conditions (CCME 2002).

Turbidity criteria are based on changes, reported in NTU, that occur relative to background conditions within the receiving environment. It is therefore necessary to understand the naturally occurring range of turbidity levels within the waterbody or watercourse of interest, as well as temporal (e.g., seasonal) trends that may exist. Clear and high flow/turbid conditions referred to in the guidelines (Table 1) are intended to describe different portions of the annual hydrograph (Caux et al. 1997).

In addition to the guidelines for turbidity, BC MoE has ambient water quality guidelines for suspended sediments (Table 2). The guidelines refer to the fraction of a water sample that does not pass through a 1.5 µm glass fibre filter, which includes suspended sediment particles, detritus, and other biotic or abiotic solids (Caux et al. 1997). Like the guidelines for turbidity, the TSS guidelines are intended to protect aquatic life from deleterious health effects and habitat alteration (see Sections 1.2 and 1.3, above; Birtwell 1999; Caux et al. 1997). Specific guidelines therefore exist for aquatic life, wildlife irrigation, livestock watering, and industrial water supplies (Caux et al. 1997).

Table 1: BC MoE Ambient Water Quality Guidelines for Turbidity

Water Use	Background Conditions	Turbidity Guideline, Relative to Background Conditions
Raw drinking water with treatment to remove particulates	≤50 NTU	maximum 5 NTU change
	>50 NTU	maximum 10% change
Raw drinking water without treatment to remove particulates	≤5 NTU	maximum 1 NTU change
	>5 NTU	maximum 5 NTU change
Aquatic life (freshwater, marine and estuarine)[a]	clear flow (<8 NTU)	maximum 8 NTU change over 24-h duration maximum 2 NTU change over 30-d duration
	high flow/turbid conditions (8 to 50 NTU)	maximum 5 NTU change
	high flow/turbid conditions (>50 NTU)	maximum 10% change
Recreation and aesthetics	≤50 NTU	maximum 5 NTU change
	>50 NTU	maximum 10% change
Wildlife irrigation	≤50 NTU	maximum 10 NTU change
	>50 NTU	maximum 20% change
Livestock watering	≤50 NTU	maximum 5 NTU change
	>50 NTU	maximum 10% change
Industrial water supplies	≤50 NTU	maximum 10 NTU change
	>50 NTU	maximum 20% change
	No turbidity increases that will adversely affect established industrial water supplies	

Notes:

[a] The BC MoE guidelines for the protection of aquatic life are in agreement with the Canadian Council of Ministers of the Environment (CCME) guidelines (CCME 2002).

Notes: BC MoE = British Columbia Ministry of Environment; ≤ = less than or equal to; NTU = nephelometric turbidity units; > = greater than; % = percent; < = less than; h = hour; d = day.

Source: Caux et al. 1997.

Table 2: BC MoE Ambient Water Quality Guidelines for Total Suspended Solids

Water Use	Background Conditions	TSS Guideline, Relative to Background Conditions
Raw drinking water with treatment to remove particulates	no guidelines	
Raw drinking water without treatment to remove particulates	no guidelines	
Aquatic life (freshwater, marine and estuarine)	clear flow (<25 mg/L)	maximum 25 mg/L change over a 24-h exposure average maximum 5 mg/L change over a 30-d exposure
	high flow/TSS conditions (25 to 100 mg/L)	maximum 10 mg/L change
	high flow/TSS conditions (> 100 mg/L)	maximum 10% change
Recreation and aesthetics	no guideline	
Wildlife irrigation	≤100 mg/L	maximum 20 mg/L change
	>100 NTU	maximum 20% change
Livestock watering	≤100 mg/L	maximum 10 mg/L change
	>100 mg/L	maximum 10% change
Industrial water supplies	≤100 mg/L	maximum 20 mg/L change
	>100 mg/L	maximum 20% change
	No turbidity increases that will adversely affect established industrial water supplies	

Notes:
BC MoE = British Columbia Ministry of Environment; TSS = total suspended solids; < = less than; mg/L = milligrams per litre; h = hour; d = day; > = greater than; % = percent; ≤ = less than or equal to.
Source: Caux et al. 1997.

The BC MoE ambient water quality guidelines for clear flow conditions are in agreement with CCME clear flow guidelines (CCME 2002). However, the provincial and federal guidelines differ where background concentration are greater than 25 mg/L. Federal guidelines indicate that when background TSS levels are between 25 and 250 mg/L, the maximum allowable increase is equal to 25 mg/L (CCME 2002). When background concentrations are greater than 250 mg/L TSS, a maximum 10% increase relative to background conditions is considered acceptable.

The guidelines in Tables 1 and 2 are generic and intended to be applicable province wide. Erosion control measures and settling ponds are considered practical solutions for managing and reducing turbidity and TSS concentrations in run-off and process waters, prior to their introduction to receiving aquatic environments (Birtwell et al. 2008).

2.0 REFERENCES

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APPENDIX G

Turbidity and Copper Correlation Analysis

1.0 POLLEY LAKE

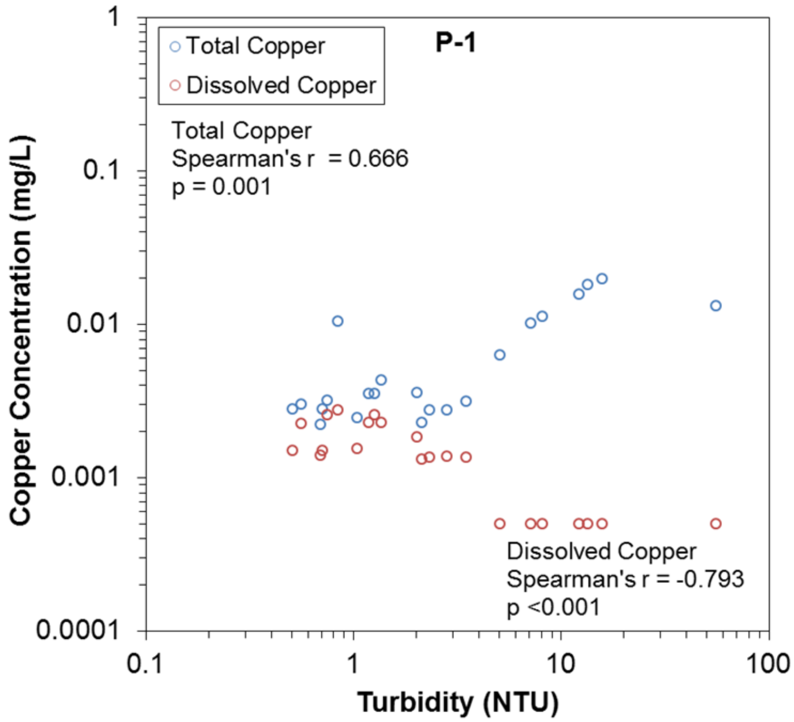

Figure 1: Correlation between turbidity and total and dissolved copper at Station P-1 in Polley Lake post-event.

2.0 HAZELTINE CREEK

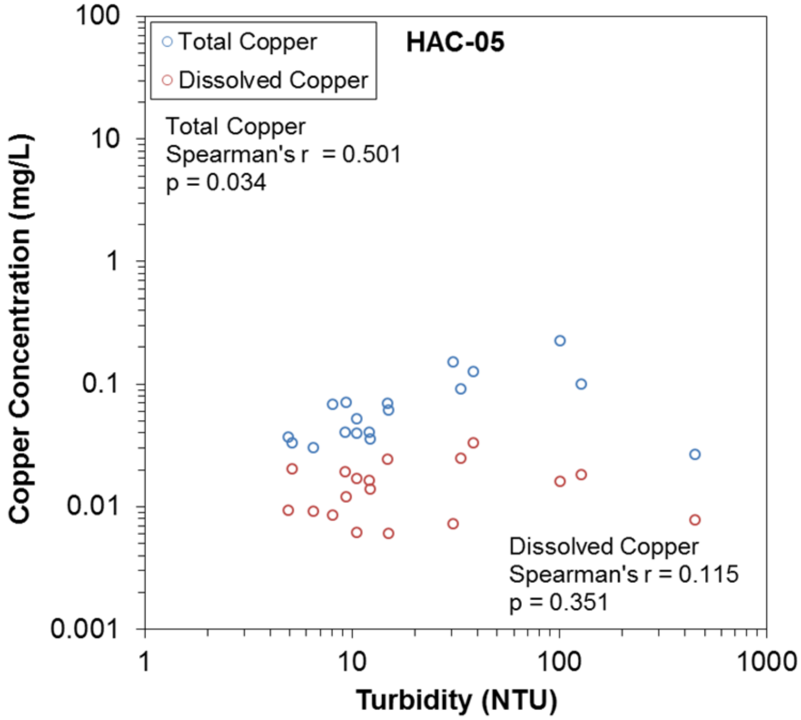

Figure 2: Correlation between turbidity and total and dissolved copper at Station HAC-05 in upper Hazeltine Creek post-event.

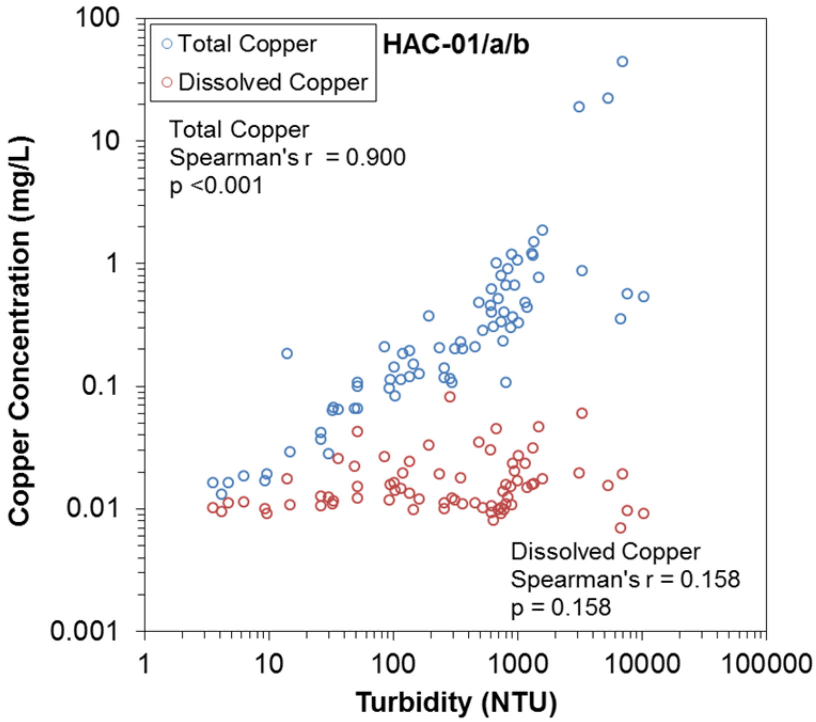

Figure 3: Correlation between turbidity and total and dissolved copper at Station HAC-01/a/b in lower Hazeltine Creek post-event.

3.0 QUESNEL LAKE

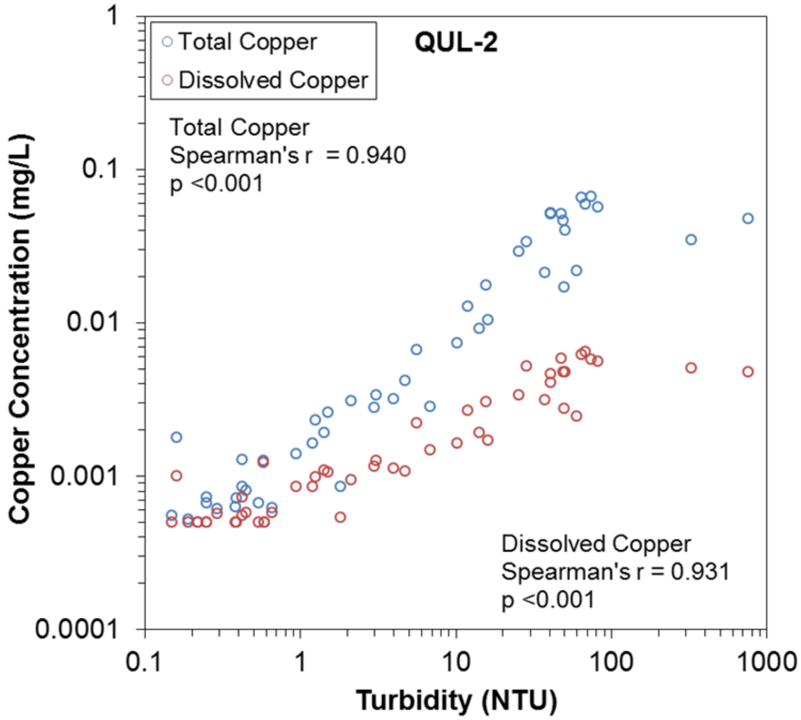

Figure 4: Correlation between turbidity and total and dissolved copper at Station QUL-2 in Quesnel Lake post-event.

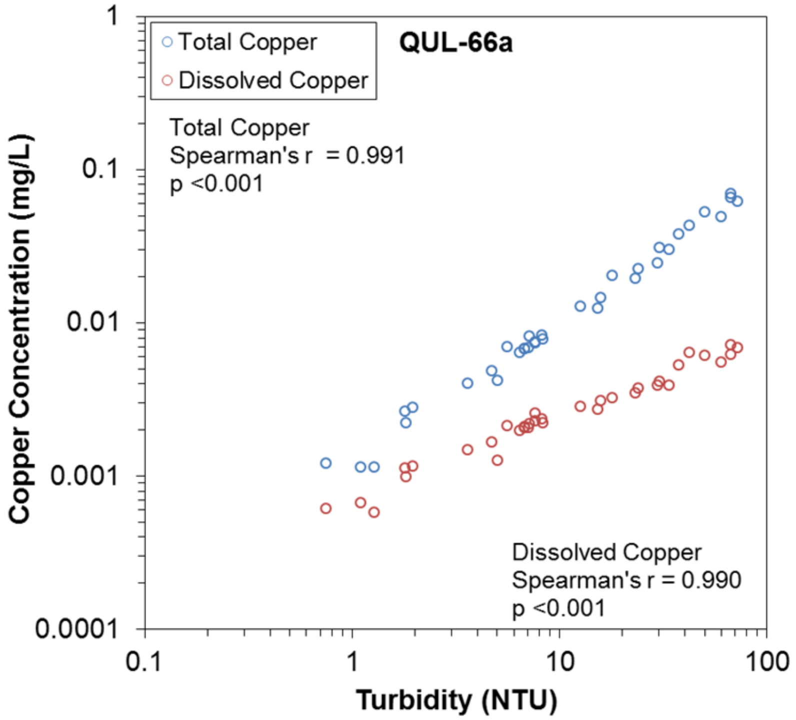

Figure 5: Correlation between turbidity and total and dissolved copper at Station QUL-66a in Quesnel Lake post-event.

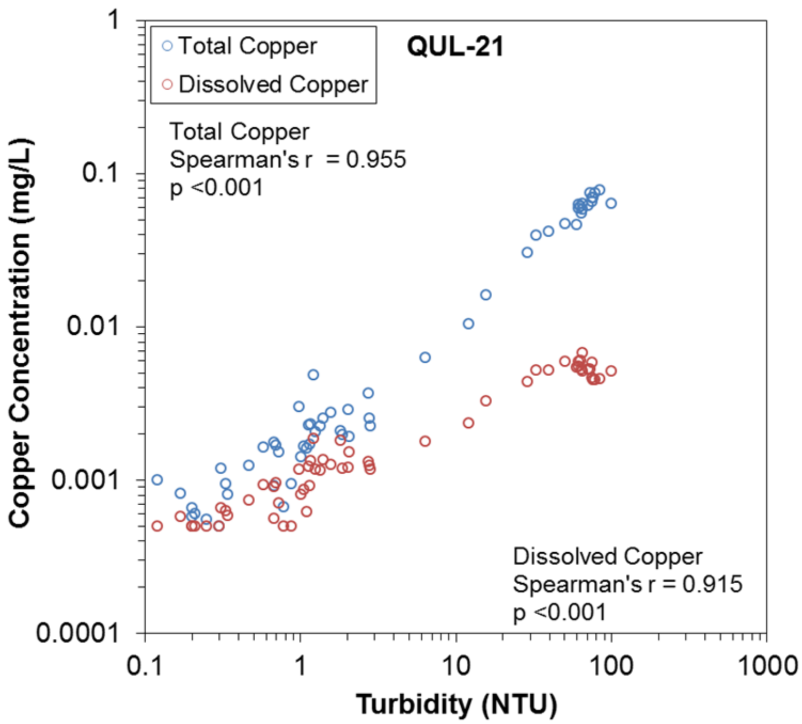

Figure 6: Correlation between turbidity and total and dissolved copper at Station QUL-21 in Quesnel Lake post-event.

4.0 QUESNEL RIVER

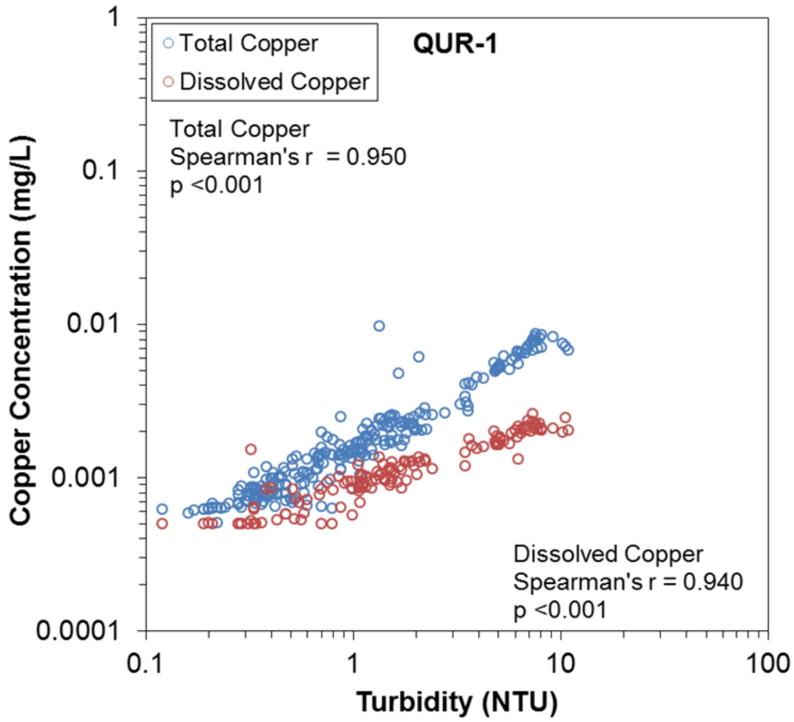

Figure 7: Correlation between turbidity and total and dissolved copper at Station QUR-1 in Quesnel River post-event.

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APPENDIX H

Copper Speciation Technical Memorandum

TECHNICAL MEMORANDUM

DATE June 5, 2015 **PROJECT No.** 1477134/10000/2000

TO Jordana Van Geest, Elaine Irving and Lee Nikl
Golder Associates Ltd.

FROM Kristin Salzsauler and Michael Herrell **EMAIL** mherrell@golder.com

MOUNT POLLEY MINE: GEOCHEMICAL SPECIATION MODELLING OF SURFACE WATER QUALITY MONITORING DATA

1.0 INTRODUCTION

On August 4, 2014, a foundation failure of the Tailings Storage Facility (TSF) dyke and subsequent debris flow occurred at Imperial Metal's Mount Polley Mine causing water and tailings to be released to the downstream environment. The TSF breach resulted in discharge of approximately 10 million cubic meters (m^3) of water and tailings into Polley Lake, Hazeltine Creek and into Quesnel Lake. Surface water quality monitoring results from select monitoring locations within Quesnel Lake and Quesnel River underwent geochemical speciation modelling to evaluate aqueous copper speciation. The geochemical speciation modelling was completed as part of the Surface Water Quality Impact Assessment Technical Report (a component of the Post-Event Environmental Impact Assessment Report [PEEIAR]).

This technical memorandum presents the data and assumptions used to conduct the geochemical speciation modelling, the model approach, and a factual summary of the model results.

2.0 APPROACH

2.1 Input Water Quality

The results of water quality sample analysis from four (4) locations in Quesnel Lake and one (1) location in the Quesnel River were selected for geochemical speciation modelling. The stations were selected to provide spatial representation across the West Basin of Quesnel Lake, the area that received much of the materials released by the breach. Table 1 summarizes the location of each monitoring station, including the number of near surface samples (i.e., water samples collected from less than 20 meters [m] below the water surface), and the number of samples collected from depth (i.e., greater than 20 meters below lake surface) at each location.

Table 1: Post-Event Routine Water Quality Monitoring Stations (August 2014 to February 2015) Selected for Geochemical Speciation Modelling

Area	Station Name	Number of Surface Samples[(a)]	Number of Samples at Depth	Sample Depth Range (meters)	Number of Profiles	Date Range (mm/dd/yyyy)
Quesnel River	QUR-1	293	N/A	N/A	N/A	08/06/2014 - 02/23/2015
Quesnel Lake - near Hazeltine Creek mouth	QUL-66	25	51	10 - 85	28	08/24/2014 - 01/15/2015
Quesnel Lake - near Hazeltine Creek mouth	QUL-66a	14	25	40 - 105	13	09/25/2014 - 12/16/2014
Quesnel Lake east towards Cariboo Island	QUL-2	22	32	8 - 50	21	08/06/2014 - 11/18/2014
Quesnel Lake – northwest towards Quesnel River	QUL-21	30	41	6 - 47	22	08/08/2014 - 11/06/2014

Notes:
(a) Samples collected from a depth of less than 20 meters.
N/A – not applicable

As described in the Surface Water Quality Impact Assessment Technical Report, Quesnel Lake is a large, deep fjord lake; the lake is comprised of East, West and North Arms. The West Basin is a shallower portion of the West Arm that is separated from the rest of the lake by a shallow sill near Cariboo Island, west towards Quesnel River. The West Basin has vertical mixing that is typical of temperate lakes, with thermal stratification for most of the year interrupted by brief turnover periods in the spring and the fall when vertical density gradients are lowest. Quesnel Lake outflows into the Quesnel River, which is a major tributary of the Fraser River located in the Cariboo District of central British Columbia. From its outflow at Quesnel Lake, the Quesnel River flows approximately 100 kilometres (km) to the northwest, descending 2,500 m to its confluence with the Fraser River at the town of Quesnel.

Data from each monitoring location used in the development of inputs to the geochemical speciation model included:

- Field measurements collected using a YSI EXO sondes, including depth, temperature, specific conductance, pH, dissolved oxygen, oxidation-reduction potential (ORP), turbidity, and total dissolved solids (TDS).
- Results of laboratory sample analysis, including:
  - Dissolved and total metals (i.e., aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, selenium, silicon, sodium, strontium, thallium, tin, titanium, uranium, vanadium and zinc);
  - Anions and nutrients (i.e., ammonia, chloride, nitrate, nitrite, total nitrogen, orthophosphate, total phosphorous, total dissolved phosphorous and sulphate);
  - Total mercury;
  - Alkalinity; and
  - Dissolved organic carbon.

Water samples were collected and submitted by Mount Polley Mining Corporation for laboratory analysis at regular intervals over the monitoring periods outlined in Table 1. Field measurements of pH, temperature, and specific conductance taken at the time of sample collection were used for input to the speciation model. ORP was assigned to each sample based on a review of ORP profiles measured over time (monitoring stations QUR-1, QUL-2, QUL-21, QUL-66 and QUL-66a) and with depth (monitoring stations QUL-2, QUL-21, QUL-66 and QUL-66a), as described in Section 2.3.

2.2 Geochemical Modelling

Geochemical speciation was assessed with the equilibrium speciation and mass-transfer code PHREEQC Version 3.0.6-7757 (Parkhurst and Appelo, 1999). PHREEQC predicts the concentration of metal species based on metal concentrations and water quality parameters that are known to affect speciation, such as pH, redox potential and the concentrations of other constituents in solution that may form aqueous complexes with the parameter in question.

2.3 Sensitivity Analysis

Redox potential is a key parameter controlling copper speciation. Field measured ORP ranged from approximately 50 to 300 mV at all stations and depths over time. Therefore, the range in measured ORP values was represented by assigning a lower bound (i.e., 50 to 150) and upper bound (i.e., 300 mV) value to each sample, in order to evaluate speciation sensitivity to redox potential. The field measured ORP was converted to Eh (mV) by adding 200 mV to each field measurement, as per the YSI Sonde specificiations. Eh was then converted to pe according to the Nernst equation, which accounts for the measured field Eh and field temperature.

3.0 RESULTS

Appendix A presents the detailed results of speciation modelling for water quality monitoring locations QUL-1, QUR-2, QUR-21, QUR-66 and QUR-66a. The main species at each monitoring location are presented in Table 2. The results in Table 2 are presented as the average proportion of each species over the monitoring period at each location.

Table 2: Average Proportion of Copper Species in Samples Collected from Select Monitoring Stations August 2014 to February 2015

Monitoring Location		QUR-1		QUL-66		QUL-66a		QUL-2		QUL-21	
Eh		500 mV	300 mV	500 mV	350 mV	500 mV	250 mV	500 mV	300 mV	500 mV	300 mV
Proportion		%	%	%	%	%	%	%	%	%	%
Cu^+	Cu^+	<0.01	0.01	<0.01	<0.01	<0.01	0.1	<0.01	0.01	<0.01	0.02
	CuCl	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	$CuCl_2^-$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	$CuCl_3^{2-}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cu^{2+}	Cu^{2+}	7.1	7.1	6.8	6.8	8.6	8.6	8.0	8.0	9.0	9.0
	$CuCO_3$	82	82	83	83	82	82	82	82	81	81
	$CuOH^+$	7.4	7.4	6.5	6.5	5.9	5.9	7.0	7.0	7.1	7.1
	$Cu(OH)_2$	2.6	2.6	2.3	2.3	2.0	2.0	2.1	2.1	1.9	1.9
	$Cu(CO_3)_2^{2-}$	0.8	0.8	0.8	0.8	0.6	0.6	0.7	0.7	0.6	0.6
	Sum of all other Cu^{2+} species*	0.4	0.4	0.4	0.4	0.5	0.5	0.4	0.4	0.5	0.5

* Individual species present in quantities less than 0.1%.

As presented in detail in Appendix A, redox potential had a minimal effect on copper speciation within the range of modelled (i.e., measured) Eh values. Copper speciation was similar for both the high and low Eh model scenarios. The main controls on copper speciation were pH and the relative concentrations of the complexing species.

Figures 1 through 5 present the relative distribution of each copper species over time in comparison to the dissolved copper concentration measured in each sample for the high Eh model scenario. Figures 2 to 5 present the copper speciation results at depth in Quesnel Lake. Speciation was also completed on samples collected at surface (i.e., at a depth <20m); however, only the speciation results from samples collected at greater than 20 m depth were included on the charts, since these represent the highest observed copper concentrations. Overall, Cu^{2+} species dominated in water quality samples collected from all stations. There was very little variation in copper speciation over time. The main copper species were $CuCO_3$ (on average >80% of total) with minor Cu^{2+}, $CuOH^+$, and $Cu(OH)_2$.

Figure 6 is an example copper speciation diagram. This figure illustrates that under cicum-neutral pH conditions (i.e., pH values of 6 to 8), divalent copper species dominate at Eh values above approximately 185 mV. In most natural waters, Eh cannot be measured unambiguously (Appelo and Postma, 1994). Difficulties in the measurement of redox potentials are attributed to a number of factors including the presence of multiple redox species, a lack of equilibrium between redox species and analytical difficulties in direct measurements of redox potential. For this reason, the redox condition of waters determined from ORP measurements is often compared against the absence or presence of redox species. The presence of dissolved oxygen (~6 to 12 mg/L) and absence of dissolved iron (i.e., typically <0.03 mg/L) are indicative of oxidizing conditions in surface water which is consistent with the ORP measurements.

4.0 SUMMARY

Geochemical speciation modelling was completed as part of the Surface Water Quality Impact Assessment Technical Report (a component of the PEEIAR). The objective of geochemical speciation modelling was to evaluate aqueous copper speciation. The results of water quality sample analysis from four (4) locations in Quesnel Lake (QUL-66, QUL-66a, QUL-21 and QUL-2) and one (1) location in the Quesnel River (QUR-1) were selected for geochemical speciation modelling (Table 1).

Geochemical model results indicate that the main copper species in water quality samples collected from Quesnel Lake and the Quesnel River were $CuCO_3$ with minor Cu^{2+}, $CuOH^+$, and $Cu(OH)_2$; Cu^{2+} species dominated in water quality samples collected from all stations. Copper speciation was similar in high and low Eh model scenarios. The main controls on copper speciation were pH and the relative concentrations of the complexing species.

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Attachments: Figures 1-6
Attachment A – Detailed Results

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REFERENCES

Appelo, C.A.J. and D. Postma, 1994. Geochemistry, Groundwater and Pollution, A.A. Balkema, Rotterdam, Netherlands.

Parkhurst, D.L., and C.A.J. Appelo, 1999. User's Guide to PHREEQC (Version 2) - A Computer Program for Speciation, Batch-Reaction, One-Dimensional Transport, and Inverse Geochemical Calculations, U.S. Geological Survey Water-Resources Investigations Report 99-4259, Denver, CO.

Figure 1
Copper Speciation in Samples Collected from QUR-1 (assumed Eh = 500 mV)

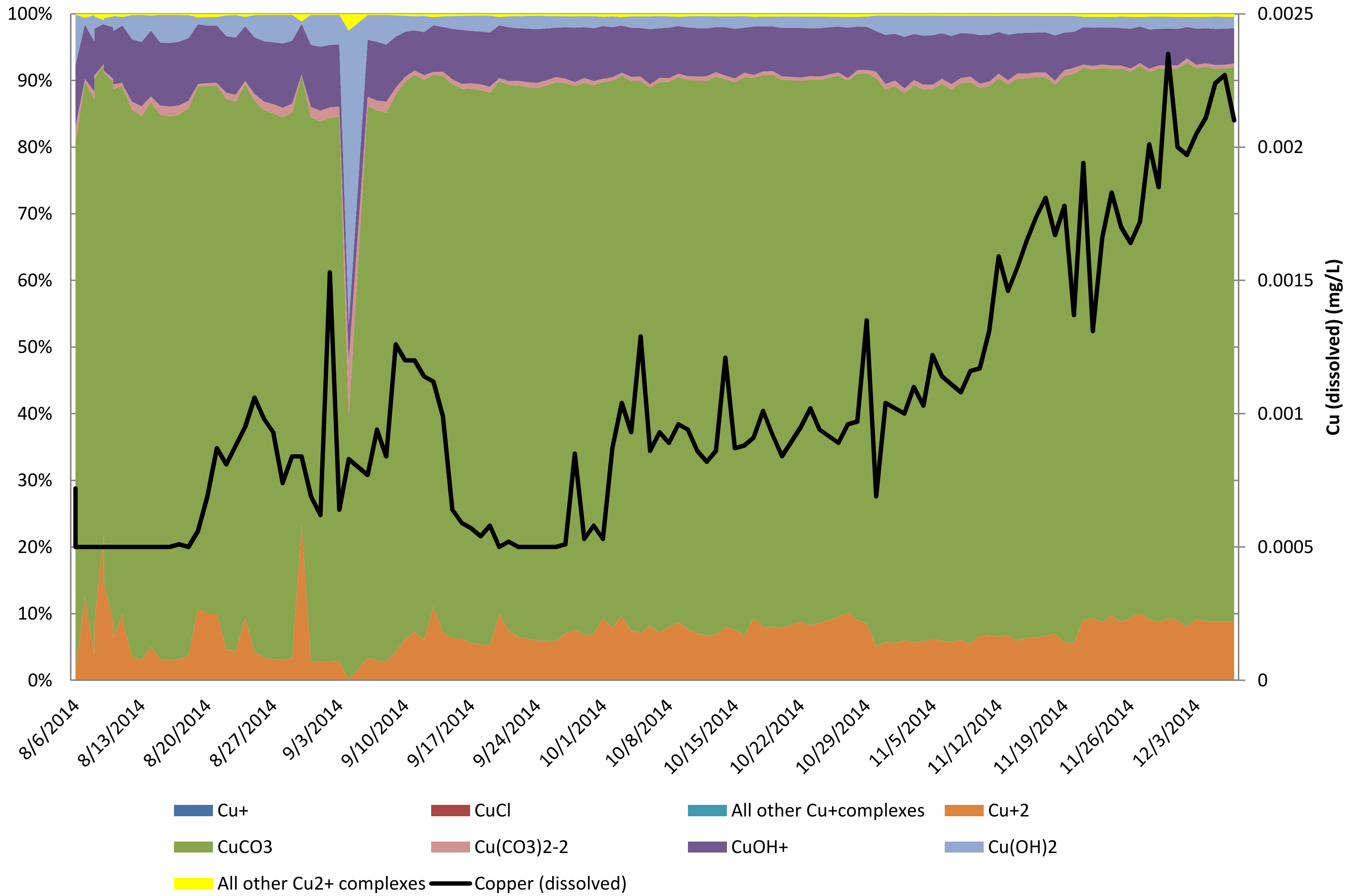
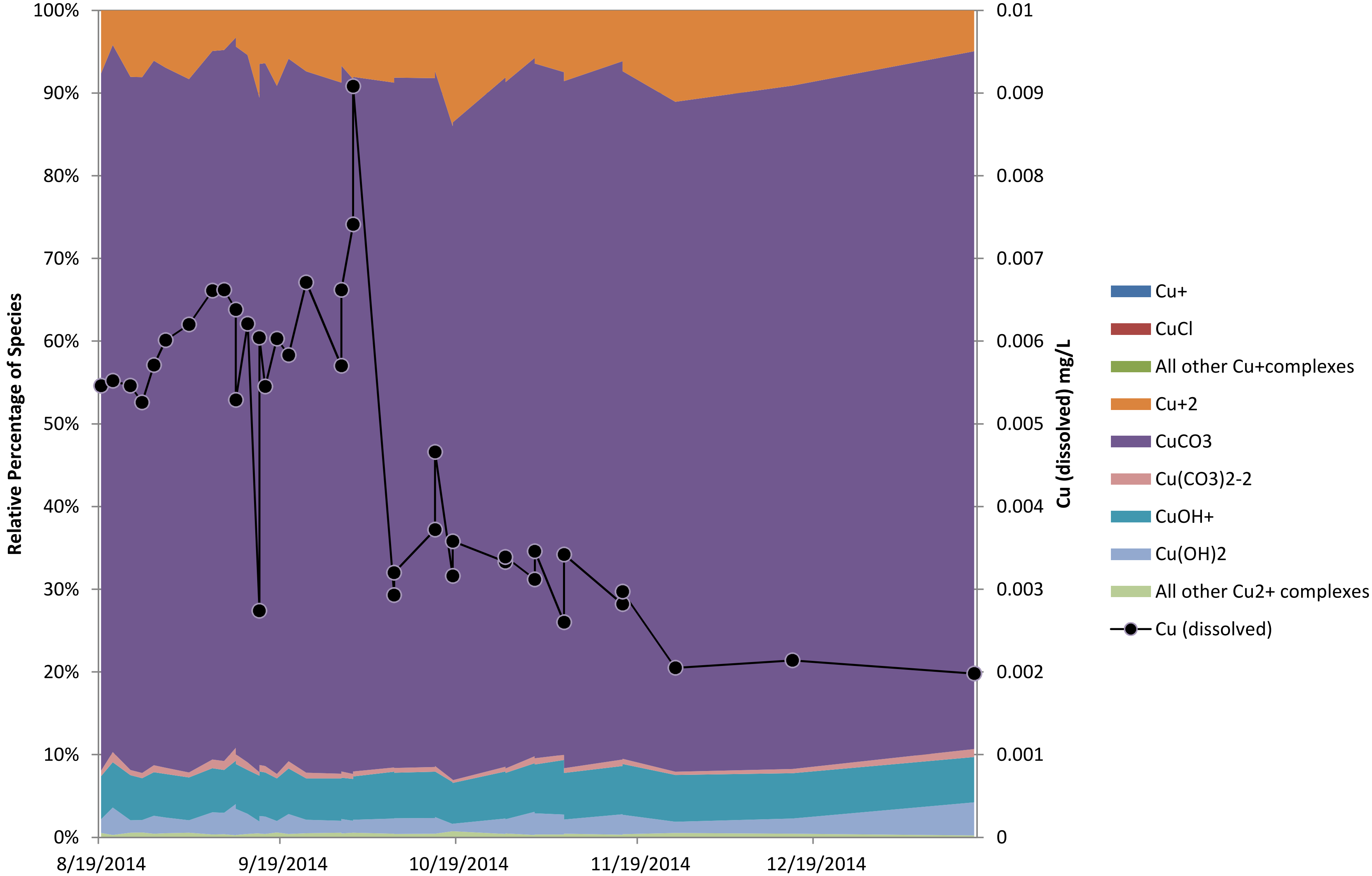


Figure 2

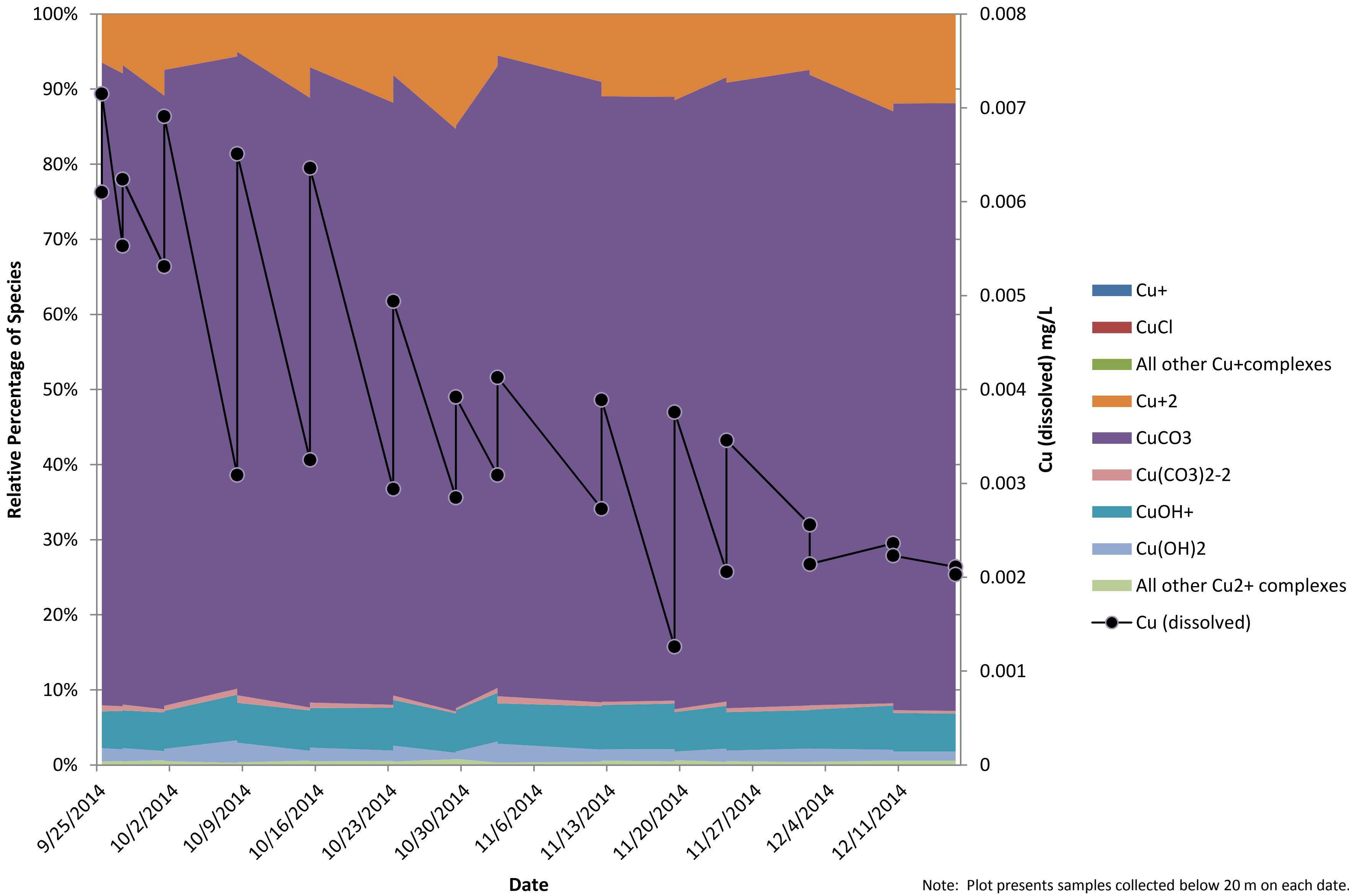
Copper Speciation in Samples Collected from below 20 m - QUL-66 (assumed Eh = 500 mV)



Note: Plot presents samples collected below 20 m on each date.

Figure 3

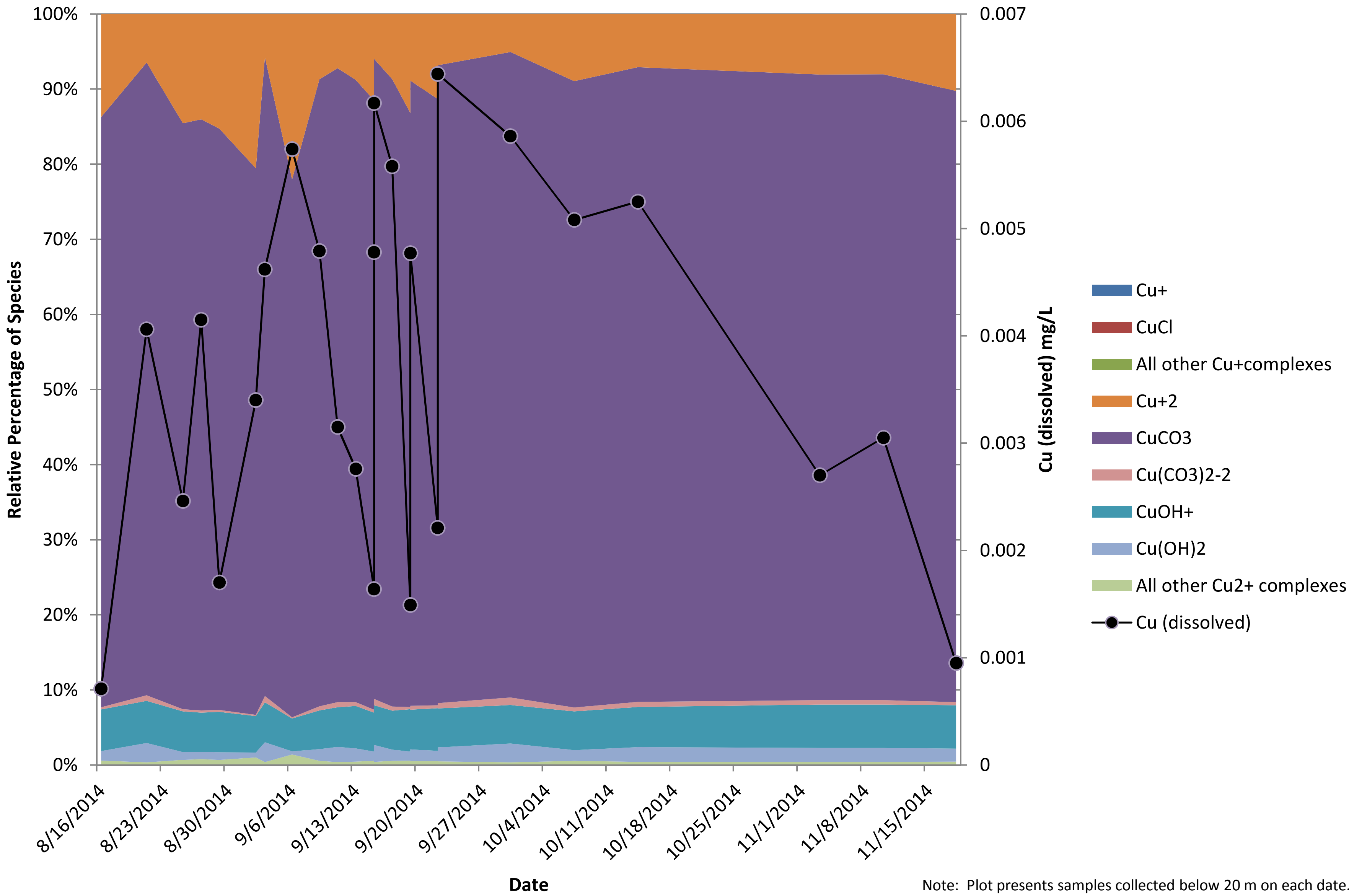
Copper Speciation in Samples Collected from below 20 m - QUL-66a (assumed Eh = 500 mV)



Note: Plot presents samples collected below 20 m on each date.

Figure 4

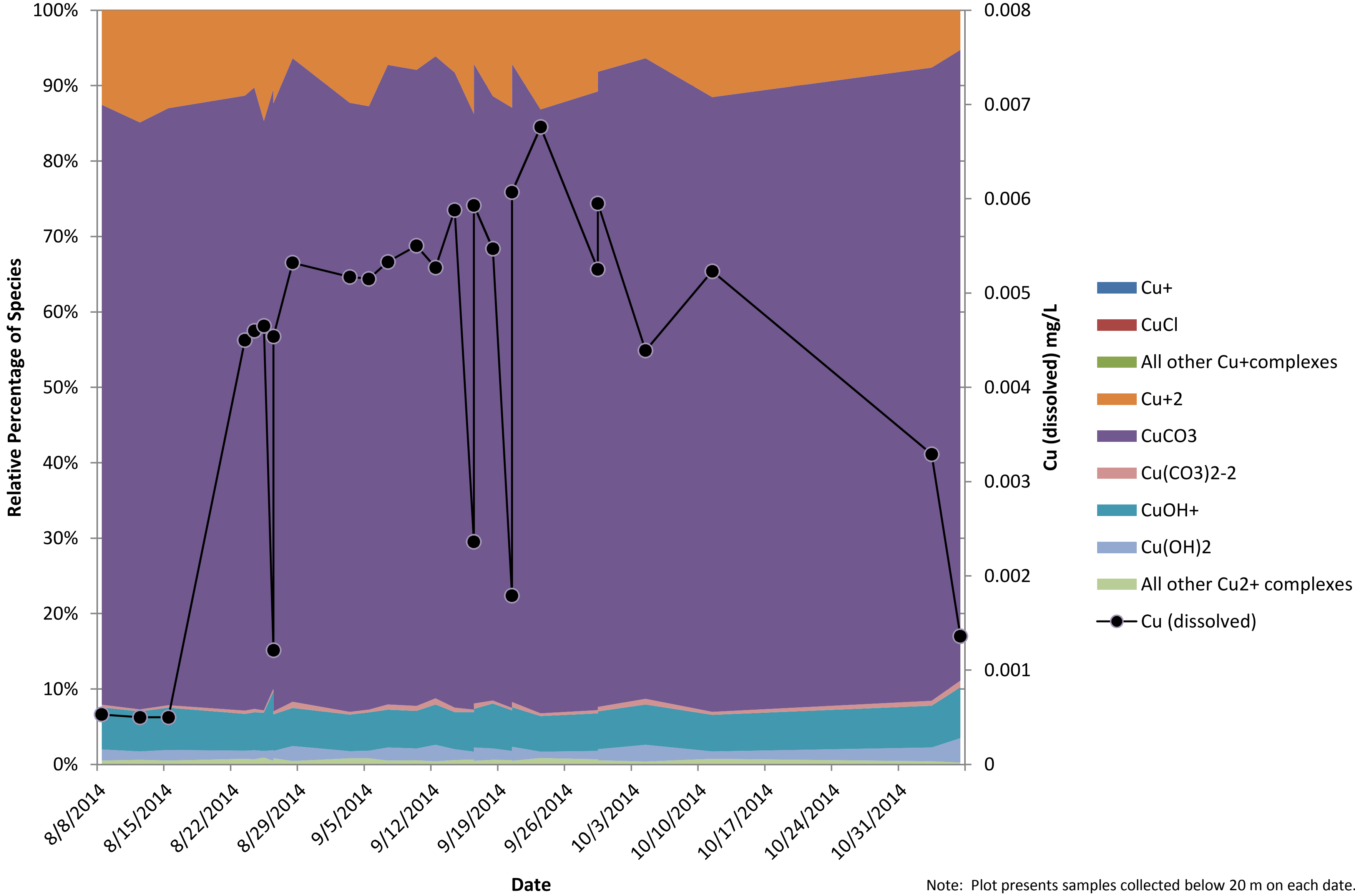
Copper Speciation in Samples Collected from below 20 m - QUL-2 (assumed Eh = 500 mV)



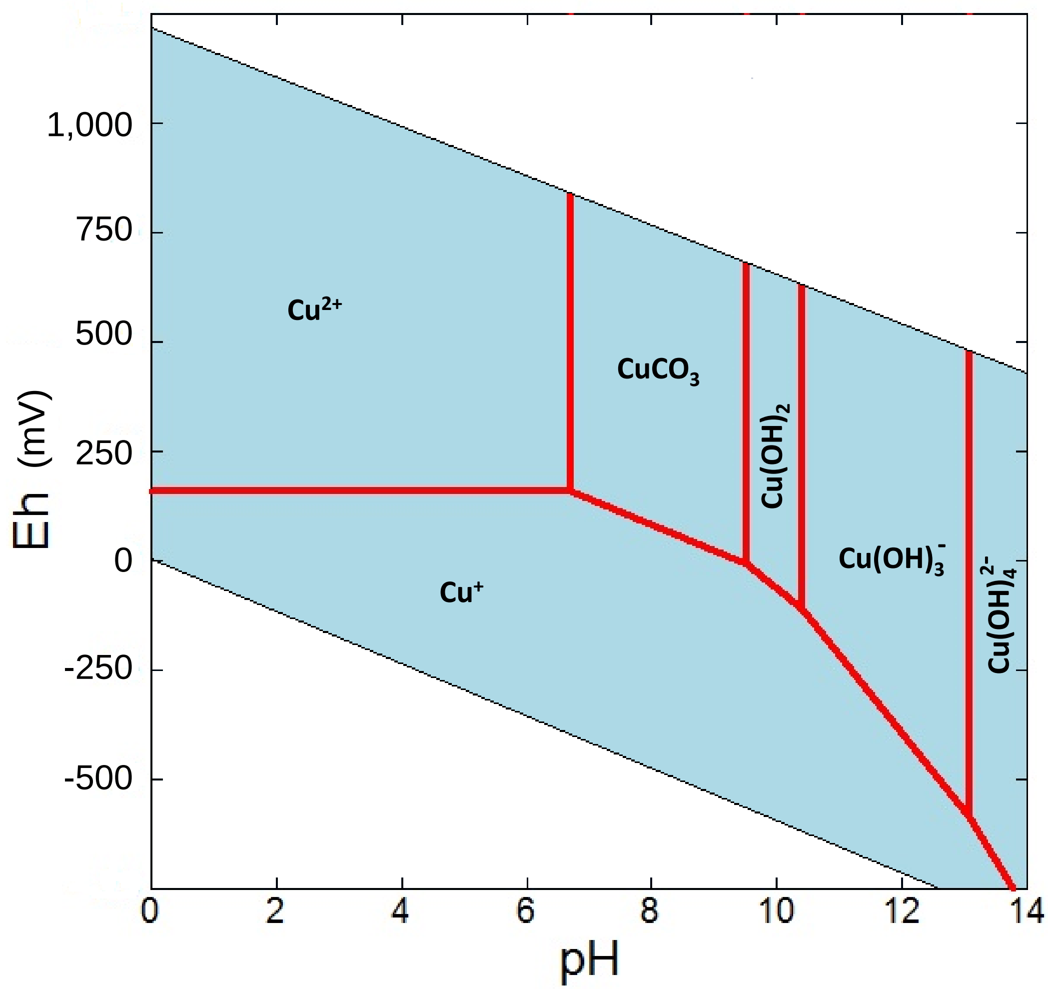
Note: Plot presents samples collected below 20 m on each date.

Figure 5

Copper Speciation in Samples Collected from below 20 m - QUL-21 (assumed Eh = 500 mV)



Note: Plot presents samples collected below 20 m on each date.



Temperature = 25 °C
Cu = 0.008 mg/L
Alkalinity = 50 mg/L as $CaCO_3$

Golder Associates	Title	Copper Eh / pH Diagram		
	Project Name	Mt. Polley Mine	Project No. 1477134	FIGURE 6
	Client Name	xx	Date April 2015	

Quesnel River, QUR-2 - Copper speciation with depth (Eh = 500 mV)

Date		8/6/2014	8/6/2014	8/7/2014	8/8/2014	8/8/2014	8/9/2014	8/9/2014	8/10/2014	8/10/2014	8/11/2014	8/11/2014	8/12/2014	8/13/2014
Time		12:32:00 PM	1:30:00 AM	10:55:00 AM	11:33:00 AM	3:43:00 AM	10:08:00 AM	2:30:00 AM	10:19:00 AM	5:45:00 AM	11:18:00 AM	5:12:00 AM	4:34:00 AM	1:18:00 AM
Charge Balance	%	0.25	0.32	-1.26	-1.76	-0.65	1.84	1.32	-0.57	-0.58	-0.04	0.38	0.27	-1.01
pH	s.u.	8.1	8.5	7.6	8.1	7.8	7.3	7.5	7.8	7.9	7.7	7.7	8.1	8.2
pe	s.u.	8.7	8.7	8.8	8.9	8.9	8.9	8.9	8.8	8.8	8.7	8.7	8.7	8.6
Alkalinity	mg/L as $CaCO_3$	44	45	44	47	47	46	46	46	47	45	45	45	45
Cu	mg/L	0.0007	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
SO_4	mg/L	5.7	5.6	5.7	5.8	5.9	5.9	5.8	5.8	5.8	5.8	5.7	5.7	5.8
Relative % - Copper Species														
Cu+	%	3.5E-06	1.4E-06	8.7E-06	2.0E-06	4.0E-06	9.8E-06	7.4E-06	5.2E-06	3.9E-06	7.8E-06	7.2E-06	3.0E-06	2.8E-06
CuCl	%	5.6E-08	2.3E-08	1.4E-07	3.3E-08	6.4E-08	1.6E-07	1.2E-07	8.5E-08	6.4E-08	1.3E-07	1.2E-07	4.9E-08	4.5E-08
CuCl2-	%	1.7E-10	6.8E-11	4.3E-10	1.0E-10	2.0E-10	4.9E-10	3.6E-10	2.6E-10	1.9E-10	3.8E-10	3.5E-10	1.5E-10	1.3E-10
CuCl3-2	%	5.4E-16	2.2E-16	1.3E-15	3.1E-16	6.1E-16	1.5E-15	1.1E-15	8.1E-16	6.1E-16	1.2E-15	1.1E-15	4.7E-16	4.3E-16
Cu+2	%	4.1	1.7	12.5	3.9	8.6	21.8	14.7	8.9	6.3	10.1	8.9	3.6	3.0
CuCO3	%	82	79	77	83	82	70	76	81	82	79	80	82	82
CuOH+	%	9.5	9.2	8.2	7.5	7.0	6.1	6.9	7.8	8.1	8.6	8.9	9.4	9.6
Cu(OH)2	%	3.2	7.6	1.0	4.0	1.8	0.6	0.9	1.6	2.2	1.2	1.4	3.6	4.1
Cu(CO3)2-2	%	1.1	2.4	0.3	1.2	0.5	0.1	0.3	0.5	0.7	0.4	0.5	1.2	1.4
CuHCO3+	%	1.6E-01	6.5E-02	4.8E-01	1.4E-01	3.1E-01	7.7E-01	5.3E-01	3.4E-01	2.4E-01	4.0E-01	3.6E-01	1.4E-01	1.2E-01
CuSO4	%	3.4E-02	1.4E-02	1.0E-01	3.0E-02	6.6E-02	1.7E-01	1.1E-01	7.0E-02	5.0E-02	8.2E-02	7.2E-02	2.9E-02	2.5E-02
Cu(OH)3-	%	8.3E-03	4.7E-02	8.6E-04	1.2E-02	2.5E-03	2.7E-04	7.1E-04	2.0E-03	3.9E-03	1.3E-03	1.6E-03	1.1E-02	1.4E-02
CuNH3+2	%	1.9E-03	1.7E-03	2.6E-03	3.5E-03	4.7E-03	4.5E-03	4.1E-03	3.3E-03	3.0E-03	2.2E-03	2.1E-03	1.9E-03	1.6E-03
Cu2(OH)2+2	%	2.7E-04	1.8E-04	1.4E-04	1.1E-04	9.6E-05	7.2E-05	9.5E-05	1.2E-04	1.3E-04	1.5E-04	1.6E-04	1.8E-04	1.9E-04
CuCl+	%	7.1E-05	2.9E-05	2.1E-04	6.2E-05	1.4E-04	3.4E-04	2.3E-04	1.5E-04	1.0E-04	1.7E-04	1.5E-04	6.1E-05	5.3E-05
CuNO3+	%	5.1E-05	2.1E-05	1.9E-04	8.3E-05	2.1E-04	5.2E-04	3.3E-04	1.7E-04	1.2E-04	1.5E-04	1.3E-04	4.5E-05	3.3E-05
CuNO2+	%	2.6E-05	1.1E-05	7.9E-05	2.4E-05	5.4E-05	1.4E-04	9.2E-05	5.6E-05	4.0E-05	6.3E-05	5.6E-05	2.2E-05	2.3E-05
Cu(OH)4-2	%	9.1E-08	1.2E-06	3.0E-09	1.5E-07	1.4E-08	5.3E-10	2.2E-09	1.0E-08	2.9E-08	5.4E-09	7.8E-09	1.4E-07	2.0E-07
CuCl2	%	2.2E-10	8.8E-11	5.6E-10	1.4E-10	2.8E-10	6.9E-10	5.1E-10	3.5E-10	2.6E-10	4.9E-10	4.5E-10	1.9E-10	1.7E-10
Cu(NO3)2	%	2.5E-11	1.0E-11	1.2E-10	6.5E-11	1.8E-10	4.4E-10	2.8E-10	1.2E-10	8.4E-11	8.6E-11	7.2E-11	2.3E-11	1.5E-11
Cu(NO2)2	%	1.7E-11	7.1E-12	5.3E-11	1.6E-11	3.6E-11	9.1E-11	6.2E-11	3.8E-11	2.6E-11	4.2E-11	3.7E-11	1.5E-11	1.8E-11
CuCl3-	%	2.5E-17	1.0E-17	6.2E-17	1.4E-17	2.8E-17	6.8E-17	5.2E-17	3.7E-17	2.8E-17	5.5E-17	5.1E-17	2.1E-17	2.0E-17
CuCl4-2	%	2.5E-24	1.0E-24	6.7E-24	1.8E-24	3.6E-24	9.1E-24	6.5E-24	4.4E-24	3.2E-24	5.8E-24	5.2E-24	2.1E-24	1.9E-24

(Shaded) Copper species account for greater than 1% of the total molality of copper.

Quesnel River, QUR-2 - Copper speciation with depth (Eh = 500 mV)

Date		8/14/2014	8/15/2014	8/16/2014	8/17/2014	8/18/2014	8/19/2014	8/20/2014	8/21/2014	8/22/2014	8/23/2014	8/24/2014	8/25/2014
Time		2:45:00 AM	1:28:00 AM	2:59:00 AM	12:20:00 PM	9:18:00 AM	1:27:00 AM	4:40:00 AM	4:28:00 AM	10:40:00 AM	10:25:00 AM	1:47:00 AM	11:21:00 AM
Charge Balance	%	-0.86	-0.80	-0.29	-0.85	-0.30	0.49	1.37	2.34	1.63	1.30	2.24	0.36
pH	s.u.	8.0	8.2	8.2	8.2	8.1	7.6	7.7	7.7	8.1	8.1	7.7	8.1
pe	s.u.	8.6	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.8	8.8	8.8	8.8
Alkalinity	mg/L as $CaCO_3$	46	45	45	45	45	45	45	45	46	45	46	46
Cu	mg/L	0.0005	0.0005	0.0005	0.0005	0.0005	0.0006	0.0007	0.0009	0.0008	0.0009	0.0010	0.0011
SO_4	mg/L	5.7	5.7	5.7	5.7	5.8	5.7	5.7	5.8	5.8	5.9	5.8	5.9
Relative % - Copper Species													
Cu+	%	5.1E-06	2.7E-06	2.7E-06	2.8E-06	3.2E-06	9.4E-06	7.5E-06	7.5E-06	3.1E-06	2.9E-06	6.2E-06	2.9E-06
CuCl	%	8.3E-08	4.4E-08	4.3E-08	4.5E-08	5.2E-08	1.5E-07	1.2E-07	1.2E-07	5.0E-08	4.8E-08	1.0E-07	4.7E-08
CuCl2-	%	2.5E-10	1.3E-10	1.3E-10	1.3E-10	1.6E-10	4.6E-10	3.7E-10	3.6E-10	1.5E-10	1.4E-10	3.0E-10	1.4E-10
CuCl3-2	%	8.0E-16	4.2E-16	4.1E-16	4.3E-16	5.0E-16	1.5E-15	1.2E-15	1.2E-15	4.7E-16	4.5E-16	9.6E-16	4.5E-16
Cu+2	%	5.0	3.2	3.0	3.1	3.8	10.7	10.0	9.9	4.6	4.3	9.3	4.3
CuCO3	%	82	82	82	82	82	78	79	79	83	83	80	83
CuOH+	%	9.9	9.5	9.6	9.5	9.4	9.0	8.6	8.6	8.5	8.6	8.2	8.5
Cu(OH)2	%	2.2	4.1	4.2	4.0	3.4	1.1	1.3	1.3	3.1	3.3	1.4	3.3
Cu(CO3)2-2	%	0.9	1.4	1.5	1.4	1.1	0.4	0.4	0.4	1.0	1.0	0.5	1.1
CuHCO3+	%	2.1E-01	1.3E-01	1.2E-01	1.3E-01	1.5E-01	4.4E-01	3.9E-01	3.9E-01	1.8E-01	1.6E-01	3.6E-01	1.6E-01
CuSO4	%	4.2E-02	2.6E-02	2.5E-02	2.6E-02	3.2E-02	8.7E-02	8.0E-02	8.1E-02	3.7E-02	3.5E-02	7.4E-02	3.5E-02
Cu(OH)3-	%	4.4E-03	1.4E-02	1.5E-02	1.3E-02	9.6E-03	9.7E-04	1.4E-03	1.4E-03	7.6E-03	8.7E-03	1.7E-03	8.6E-03
CuNH3+2	%	1.4E-03	1.8E-03	1.7E-03	1.7E-03	2.0E-03	1.8E-03	2.3E-03	2.4E-03	2.7E-03	2.6E-03	2.8E-03	2.6E-03
Cu2(OH)2+2	%	2.1E-04	1.9E-04	1.9E-04	1.9E-04	1.8E-04	1.9E-04	2.1E-04	2.6E-04	2.4E-04	2.6E-04	2.6E-04	3.1E-04
CuCl+	%	8.9E-05	5.5E-05	5.2E-05	5.4E-05	6.6E-05	1.9E-04	1.7E-04	1.7E-04	7.7E-05	7.2E-05	1.5E-04	7.1E-05
CuNO3+	%	4.7E-05	3.9E-05	3.4E-05	3.5E-05	4.8E-05	1.2E-04	1.5E-04	1.8E-04	7.8E-05	7.0E-05	1.6E-04	7.0E-05
CuNO2+	%	3.2E-05	2.0E-05	1.9E-05	2.0E-05	2.4E-05	6.8E-05	6.3E-05	6.2E-05	2.9E-05	2.7E-05	5.8E-05	2.7E-05
Cu(OH)4-2	%	3.7E-08	1.9E-07	2.2E-07	1.9E-07	1.1E-07	3.8E-09	6.1E-09	6.0E-09	7.8E-08	9.5E-08	8.2E-09	9.4E-08
CuCl2	%	3.1E-10	1.7E-10	1.6E-10	1.7E-10	2.0E-10	5.8E-10	4.8E-10	4.8E-10	2.0E-10	1.9E-10	4.0E-10	1.9E-10
Cu(NO3)2	%	1.8E-11	1.9E-11	1.6E-11	1.6E-11	2.4E-11	5.6E-11	8.5E-11	1.2E-10	5.1E-11	4.4E-11	1.0E-10	4.4E-11
Cu(NO2)2	%	2.1E-11	1.3E-11	1.2E-11	1.3E-11	1.6E-11	4.5E-11	4.2E-11	4.2E-11	1.9E-11	1.8E-11	3.9E-11	1.8E-11
CuCl3-	%	3.7E-17	1.9E-17	1.9E-17	2.0E-17	2.3E-17	6.7E-17	5.3E-17	5.3E-17	2.2E-17	2.1E-17	4.4E-17	2.1E-17
CuCl4-2	%	3.4E-24	1.9E-24	1.9E-24	1.9E-24	2.3E-24	6.6E-24	5.6E-24	5.6E-24	2.4E-24	2.3E-24	4.9E-24	2.3E-24

[shaded box] Copper species account for greater than 1% of the total molality of copper.

Quesnel River, QUR-2 - Copper speciation with depth (Eh = 500 mV)

Date		8/26/2014	8/27/2014	8/28/2014	8/29/2014	8/30/2014	8/31/2014	9/1/2014	9/2/2014	9/3/2014	9/4/2014	9/6/2014	9/7/2014	9/8/2014
Time		10:47:00 AM	11:48:00 AM	2:20:00 AM	1:30:00 AM	3:15:00 AM	2:30:00 AM	1:10:00 AM	2:10:00 AM	2:12:00 AM	5:30:00 AM	12:30:00 PM	8:45:00 AM	1:12:00 AM
Charge Balance	%	1.41	1.23	0.28	0.42	0.72	-0.03	1.89	1.47	1.33	-0.38	-1.81	-1.64	-2.08
pH	s.u.	8.2	8.2	8.2	8.2	7.2	8.2	8.3	8.2	8.2	9.4	8.2	8.2	8.2
pe	s.u.	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
Alkalinity	mg/L as $CaCO_3$	46	45	44	45	45	46	45	46	46	47	48	48	48
Cu	mg/L	0.0010	0.0009	0.0007	0.0008	0.0008	0.0007	0.0006	0.0015	0.0006	0.0008	0.0008	0.0009	0.0008
SO_4	mg/L	5.9	5.9	5.9	5.8	5.8	5.8	5.8	5.8	5.9	5.9	5.9	5.9	6.0
Relative % - Copper Species														
Cu+	%	2.6E-06	2.6E-06	2.7E-06	2.8E-06	2.0E-05	2.4E-06	2.3E-06	2.4E-06	2.4E-06	8.3E-08	2.5E-06	2.4E-06	2.1E-06
CuCl	%	4.2E-08	4.3E-08	4.3E-08	4.6E-08	3.2E-07	3.9E-08	3.8E-08	3.9E-08	3.9E-08	1.3E-09	4.1E-08	3.9E-08	3.4E-08
CuCl2-	%	1.3E-10	1.3E-10	1.3E-10	1.4E-10	9.6E-10	1.2E-10	1.1E-10	1.2E-10	1.2E-10	4.1E-12	1.2E-10	1.2E-10	1.0E-10
CuCl3-2	%	4.1E-16	4.1E-16	4.1E-16	4.4E-16	3.1E-15	3.7E-16	3.6E-16	3.7E-16	3.7E-16	1.3E-17	3.9E-16	3.8E-16	3.3E-16
Cu+2	%	3.4	3.2	3.0	3.3	23.4	2.8	2.7	2.8	2.9	0.1	3.3	3.0	2.8
CuCO3	%	82	82	81	82	67	82	81	82	82	39	83	83	82
CuOH+	%	9.0	9.3	9.6	9.4	7.6	9.3	9.6	9.4	9.3	5.3	8.5	8.8	8.6
Cu(OH)2	%	3.9	4.1	4.3	3.9	0.4	4.5	4.8	4.5	4.4	44.2	3.7	4.0	4.5
Cu(CO3)2-2	%	1.3	1.4	1.4	1.3	0.1	1.6	1.6	1.6	1.5	8.5	1.4	1.5	1.6
CuHCO3+	%	1.3E-01	1.3E-01	1.2E-01	1.3E-01	9.5E-01	1.1E-01	1.1E-01	1.1E-01	1.2E-01	3.6E-03	1.4E-01	1.2E-01	1.1E-01
CuSO4	%	2.8E-02	2.7E-02	2.6E-02	2.7E-02	1.9E-01	2.3E-02	2.3E-02	2.3E-02	2.4E-02	9.8E-04	2.8E-02	2.5E-02	2.3E-02
Cu(OH)3-	%	1.3E-02	1.4E-02	1.5E-02	1.2E-02	1.3E-04	1.7E-02	1.9E-02	1.7E-02	1.6E-02	2.5E+00	1.2E-02	1.4E-02	1.7E-02
CuNH3+2	%	2.1E-03	1.9E-03	1.8E-03	1.8E-03	1.7E-03	1.8E-03	1.8E-03	1.8E-03	2.5E-03	4.9E-04	2.4E-03	1.9E-03	2.0E-03
Cu2(OH)2+2	%	3.3E-04	3.3E-04	2.8E-04	3.1E-04	2.0E-04	2.5E-04	2.3E-04	5.6E-04	2.3E-04	9.4E-05	2.3E-04	3.0E-04	2.5E-04
CuCl+	%	5.7E-05	5.4E-05	5.3E-05	5.7E-05	4.0E-04	4.8E-05	4.7E-05	4.8E-05	4.9E-05	2.0E-06	5.6E-05	5.1E-05	4.7E-05
CuNO3+	%	4.4E-05	3.8E-05	3.3E-05	3.5E-05	2.5E-04	2.8E-05	2.7E-05	2.6E-05	2.6E-05	1.8E-06	4.0E-05	3.0E-05	4.6E-05
CuNO2+	%	2.1E-05	2.0E-05	1.9E-05	2.1E-05	1.5E-04	1.7E-05	1.9E-05	1.7E-05	1.8E-05	7.5E-07	2.1E-05	1.9E-05	1.7E-05
Cu(OH)4-2	%	1.7E-07	1.9E-07	2.2E-07	1.7E-07	2.1E-10	2.7E-07	3.1E-07	2.7E-07	2.5E-07	6.0E-04	1.5E-07	2.0E-07	2.7E-07
CuCl2	%	1.7E-10	1.7E-10	1.6E-10	1.8E-10	1.2E-09	1.5E-10	1.5E-10	1.5E-10	1.5E-10	5.4E-12	1.6E-10	1.5E-10	1.3E-10
Cu(NO3)2	%	2.2E-11	1.8E-11	1.4E-11	1.5E-11	1.0E-10	1.1E-11	1.1E-11	1.0E-11	9.7E-12	1.0E-12	1.8E-11	1.2E-11	3.0E-11
Cu(NO2)2	%	1.4E-11	1.3E-11	1.3E-11	1.4E-11	9.8E-11	1.2E-11	1.4E-11	1.2E-11	1.2E-11	5.0E-13	1.4E-11	1.3E-11	1.2E-11
CuCl3-	%	1.9E-17	1.9E-17	1.9E-17	2.0E-17	1.4E-16	1.7E-17	1.7E-17	1.7E-17	1.7E-17	5.9E-19	1.8E-17	1.7E-17	1.5E-17
CuCl4-2	%	1.9E-24	1.9E-24	1.9E-24	2.0E-24	1.4E-23	1.7E-24	1.7E-24	1.7E-24	1.7E-24	6.4E-26	1.9E-24	1.8E-24	1.6E-24

(Shaded legend box) Copper species account for greater than 1% of the total molality of copper.

Quesnel River, QUR-2 - Copper speciation with depth (Eh = 500 mV)

Date		9/9/2014	9/10/2014	9/11/2014	9/12/2014	9/13/2014	9/14/2014	9/15/2014	9/16/2014	9/17/2014	9/18/2014	9/19/2014	9/20/2014	9/21/2014
Time		1:00:00 AM	1:30:00 AM	11:48:00 AM	12:45:00 PM	1:30:00 AM	11:30:00 AM	12:47:00 PM	10:15:00 AM	2:25:00 AM	12:00:00 PM	1:30:00 AM	9:30:00 AM	9:30:00 AM
Charge Balance	%	-1.01	-1.26	-3.84	-2.19	-0.59	-5.34	-2.25	0.32	-1.27	-1.91	0.83	-0.25	-0.99
pH	s.u.	8.1	7.9	7.9	7.9	7.7	7.8	7.9	7.9	7.9	8.0	8.0	7.7	7.8
pe	s.u.	8.8	8.9	9.0	8.9	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.7
Alkalinity	mg/L as $CaCO_3$	49	50	52	51	49	54	50	48	49	49	48	47	48
Cu	mg/L	0.0013	0.0012	0.0012	0.0011	0.0011	0.0010	0.0006	0.0006	0.0006	0.0005	0.0006	0.0005	0.0005
SO_4	mg/L	6.1	6.2	6.6	6.4	6.2	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
Relative % - Copper Species														
Cu+	%	2.5E-06	2.8E-06	2.7E-06	2.6E-06	5.9E-06	4.0E-06	4.0E-06	4.1E-06	3.7E-06	3.5E-06	3.5E-06	6.8E-06	5.1E-06
CuCl	%	4.1E-08	4.6E-08	4.4E-08	4.2E-08	9.6E-08	6.4E-08	6.4E-08	6.7E-08	5.9E-08	5.7E-08	5.6E-08	1.1E-07	8.3E-08
CuCl2-	%	1.2E-10	1.4E-10	1.3E-10	1.3E-10	2.9E-10	2.0E-10	1.9E-10	2.0E-10	1.8E-10	1.7E-10	1.7E-10	3.3E-10	2.5E-10
CuCl3-2	%	3.9E-16	4.3E-16	4.1E-16	3.9E-16	9.1E-16	6.1E-16	6.1E-16	6.4E-16	5.7E-16	5.5E-16	5.4E-16	1.0E-15	8.0E-16
Cu+2	%	4.3	6.2	7.3	6.1	11.1	7.1	6.3	6.3	5.6	5.3	5.2	10.0	7.4
CuCO3	%	84	84	84	84	80	84	83	83	83	83	83	80	82
CuOH+	%	7.7	6.7	6.0	6.5	7.0	6.7	7.5	8.1	7.9	7.9	8.2	7.9	8.0
Cu(OH)2	%	3.2	2.4	2.1	2.5	1.2	1.6	1.9	2.1	2.3	2.4	2.5	1.2	1.7
Cu(CO3)2-2	%	1.1	0.7	0.6	0.8	0.4	0.6	0.7	0.7	0.8	0.9	0.9	0.4	0.6
CuHCO3+	%	1.7E-01	2.4E-01	2.7E-01	2.3E-01	4.3E-01	3.1E-01	2.6E-01	2.5E-01	2.3E-01	2.2E-01	2.1E-01	4.0E-01	3.0E-01
CuSO4	%	3.5E-02	4.9E-02	6.0E-02	4.9E-02	9.0E-02	5.8E-02	5.2E-02	5.2E-02	4.6E-02	4.4E-02	4.3E-02	8.3E-02	6.2E-02
Cu(OH)3-	%	8.1E-03	4.4E-03	3.4E-03	4.6E-03	1.1E-03	2.2E-03	3.2E-03	3.6E-03	4.3E-03	4.7E-03	5.2E-03	1.3E-03	2.3E-03
CuNH3+2	%	3.4E-03	4.4E-03	5.8E-03	0.0E+00	3.6E-03	3.1E-03	2.8E-03	2.7E-03	2.6E-03	2.6E-03	2.6E-03	2.6E-03	2.5E-03
Cu2(OH)2+2	%	3.0E-04	2.1E-04	1.7E-04	1.9E-04	2.2E-04	1.8E-04	1.5E-04	1.6E-04	1.4E-04	1.4E-04	1.6E-04	1.3E-04	1.4E-04
CuCl+	%	7.0E-05	9.7E-05	1.1E-04	9.4E-05	1.8E-04	1.1E-04	1.0E-04	1.0E-04	9.2E-05	8.8E-05	8.6E-05	1.7E-04	1.2E-04
CuNO3+	%	7.5E-05	1.5E-04	2.1E-04	1.5E-04	2.0E-04	1.2E-04	9.1E-05	8.3E-05	7.2E-05	6.8E-05	6.5E-05	1.2E-04	9.0E-05
CuNO2+	%	2.7E-05	3.9E-05	4.5E-05	3.8E-05	6.9E-05	4.5E-05	4.0E-05	3.9E-05	3.5E-05	3.3E-05	3.3E-05	6.3E-05	4.6E-05
Cu(OH)4-2	%	8.7E-08	3.4E-08	2.3E-08	3.7E-08	4.7E-09	1.3E-08	2.2E-08	2.6E-08	3.4E-08	3.9E-08	4.6E-08	5.5E-09	1.4E-08
CuCl2	%	1.7E-10	2.0E-10	2.0E-10	1.8E-10	4.0E-10	2.7E-10	2.6E-10	2.7E-10	2.4E-10	2.3E-10	2.3E-10	4.4E-10	3.3E-10
Cu(NO3)2	%	4.9E-11	1.3E-10	2.1E-10	1.4E-10	1.3E-10	7.3E-11	5.0E-11	4.2E-11	3.6E-11	3.3E-11	3.1E-11	5.6E-11	4.3E-11
Cu(NO2)2	%	1.8E-11	2.6E-11	3.0E-11	2.5E-11	4.6E-11	3.0E-11	2.6E-11	2.6E-11	2.3E-11	2.2E-11	2.2E-11	4.2E-11	3.1E-11
CuCl3-	%	1.8E-17	2.0E-17	1.9E-17	1.8E-17	4.2E-17	2.8E-17	2.8E-17	2.9E-17	2.6E-17	2.5E-17	2.5E-17	4.8E-17	3.6E-17
CuCl4-2	%	2.1E-24	2.6E-24	2.7E-24	2.4E-24	5.1E-24	3.4E-24	3.2E-24	3.3E-24	2.9E-24	2.8E-24	2.7E-24	5.3E-24	4.0E-24

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Quesnel River, QUR-2 - Copper speciation with depth (Eh = 500 mV)

Date		9/22/2014	9/23/2014	9/24/2014	9/25/2014	9/26/2014	9/27/2014	9/28/2014	9/29/2014	9/30/2014	10/1/2014	10/2/2014	10/3/2014	10/4/2014
Time		12:30:00 PM	1:50:00 AM	2:30:00 AM	12:30:00 PM	12:30:00 PM	12:40:00 PM	11:10:00 AM	12:50:00 PM	1:00:00 AM	12:00:00 AM	2:00:00 AM	11:00:00 AM	3:00:00 AM
Charge Balance	%	-2.23	-3.86	-2.27	-3.62	-5.35	-3.03	0.22	-4.56	-2.77	0.01	-1.76	-1.89	-2.38
pH	s.u.	7.9	7.9	7.9	7.9	7.9	7.8	7.8	7.8	7.8	7.7	7.8	7.7	7.8
pe	s.u.	8.8	8.7	8.7	8.7	8.7	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
Alkalinity	mg/L as $CaCO_3$	50	49	49	51	54	50	47	51	48	47	49	50	50
Cu	mg/L	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0009	0.0005	0.0006	0.0005	0.0009	0.0010	0.0009
SO_4	mg/L	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.3	6.2
Relative % - Copper Species														
Cu+	%	4.5E-06	4.4E-06	4.2E-06	4.1E-06	4.1E-06	4.8E-06	5.2E-06	4.6E-06	4.7E-06	6.1E-06	4.8E-06	5.4E-06	4.3E-06
CuCl	%	7.3E-08	7.1E-08	6.8E-08	6.7E-08	6.7E-08	7.8E-08	8.4E-08	7.5E-08	7.6E-08	9.9E-08	7.8E-08	8.7E-08	7.0E-08
CuCl2-	%	2.2E-10	2.1E-10	2.1E-10	2.0E-10	2.0E-10	2.4E-10	2.5E-10	2.3E-10	2.3E-10	3.0E-10	2.4E-10	2.6E-10	2.1E-10
CuCl3-2	%	6.9E-16	6.8E-16	6.5E-16	6.4E-16	6.4E-16	7.4E-16	8.0E-16	7.1E-16	7.2E-16	9.4E-16	7.4E-16	8.3E-16	6.7E-16
Cu+2	%	6.5	6.2	5.9	5.9	6.0	7.0	7.6	6.8	7.0	9.3	7.9	9.6	7.4
CuCO3	%	83	83	83	83	84	83	82	83	82	81	82	81	83
CuOH+	%	7.9	8.0	8.1	7.8	7.4	7.7	8.2	7.6	7.9	7.9	7.5	7.1	7.4
Cu(OH)2	%	1.8	1.9	2.0	1.9	1.7	1.6	1.7	1.7	1.8	1.4	1.6	1.3	1.7
Cu(CO3)2-2	%	0.7	0.7	0.8	0.8	0.8	0.6	0.6	0.7	0.6	0.5	0.6	0.5	0.6
CuHCO3+	%	2.7E-01	2.6E-01	2.5E-01	2.6E-01	2.7E-01	3.0E-01	3.0E-01	2.9E-01	2.8E-01	3.7E-01	3.2E-01	3.9E-01	3.0E-01
CuSO4	%	5.5E-02	5.2E-02	5.0E-02	4.9E-02	5.0E-02	5.9E-02	6.3E-02	5.7E-02	5.9E-02	7.7E-02	6.5E-02	8.0E-02	6.1E-02
Cu(OH)3-	%	2.9E-03	3.1E-03	3.5E-03	3.2E-03	2.8E-03	2.3E-03	2.4E-03	2.4E-03	2.7E-03	1.6E-03	2.1E-03	1.4E-03	2.5E-03
CuNH3+2	%	2.4E-03	2.4E-03	2.3E-03	2.3E-03	2.3E-03	2.8E-03	2.6E-03	2.6E-03	2.6E-03	2.7E-03	3.4E-03	3.3E-03	3.1E-03
Cu2(OH)2+2	%	1.3E-04	1.3E-04	1.3E-04	1.2E-04	1.1E-04	1.2E-04	2.3E-04	1.3E-04	1.5E-04	1.3E-04	2.0E-04	2.1E-04	2.0E-04
CuCl+	%	1.1E-04	1.0E-04	9.9E-05	9.8E-05	9.9E-05	1.2E-04	1.3E-04	1.1E-04	1.2E-04	1.5E-04	1.3E-04	1.6E-04	1.2E-04
CuNO3+	%	7.6E-05	7.1E-05	6.4E-05	6.3E-05	6.5E-05	7.8E-05	9.4E-05	7.6E-05	7.8E-05	1.1E-04	1.0E-04	1.4E-04	9.4E-05
CuNO2+	%	4.1E-05	3.9E-05	3.7E-05	3.7E-05	3.7E-05	4.4E-05	4.8E-05	4.3E-05	4.4E-05	5.8E-05	5.0E-05	6.0E-05	4.6E-05
Cu(OH)4-2	%	1.9E-08	2.2E-08	2.5E-08	2.3E-08	1.9E-08	1.4E-08	1.4E-08	1.5E-08	1.7E-08	7.4E-09	1.2E-08	6.4E-09	1.5E-08
CuCl2	%	2.9E-10	2.8E-10	2.7E-10	2.7E-10	2.7E-10	3.1E-10	3.4E-10	3.0E-10	3.1E-10	4.0E-10	3.2E-10	3.6E-10	2.9E-10
Cu(NO3)2	%	3.4E-11	3.1E-11	2.7E-11	2.6E-11	2.7E-11	3.3E-11	4.5E-11	3.3E-11	3.4E-11	4.6E-11	4.9E-11	7.9E-11	4.5E-11
Cu(NO2)2	%	2.7E-11	2.6E-11	2.5E-11	2.5E-11	2.5E-11	2.9E-11	3.2E-11	2.8E-11	2.9E-11	3.9E-11	3.3E-11	4.0E-11	3.1E-11
CuCl3-	%	3.2E-17	3.1E-17	3.0E-17	2.9E-17	2.9E-17	3.4E-17	3.7E-17	3.3E-17	3.3E-17	4.3E-17	3.4E-17	3.8E-17	3.1E-17
CuCl4-2	%	3.5E-24	3.4E-24	3.2E-24	3.2E-24	3.2E-24	3.7E-24	4.0E-24	3.6E-24	3.7E-24	4.8E-24	3.9E-24	4.6E-24	3.6E-24

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Quesnel River, QUR-2 - Copper speciation with depth (Eh = 500 mV)

Date		10/5/2014	10/6/2014	10/7/2014	10/8/2014	10/9/2014	10/10/2014	10/11/2014	10/12/2014	10/13/2014	10/14/2014	10/15/2014	10/16/2014
Time		12:00:00 PM	2:00:00 AM	12:00:00 PM	12:20:00 PM	12:20:00 PM	12:10:00 PM	12:00:00 PM	12:30:00 PM	11:30:00 AM	2:41:00 AM	11:00:00 AM	12:30:00 PM
Charge Balance	%	-2.94	4.57	-2.32	-0.62	-2.48	-1.75	-2.57	-2.10	-5.61	-2.28	-0.40	-5.07
pH	s.u.	7.8	7.8	7.8	7.8	7.7	7.8	7.8	7.9	7.8	7.8	7.8	7.8
pe	s.u.	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
Alkalinity	mg/L as $CaCO_3$	51	44	50	48	51	50	51	51	55	50	48	54
Cu	mg/L	0.0013	0.0009	0.0009	0.0009	0.0010	0.0009	0.0009	0.0008	0.0009	0.0012	0.0009	0.0009
SO_4	mg/L	6.2	6.4	6.3	6.3	6.2	6.3	6.3	6.3	6.2	6.2	6.3	6.3
Relative % - Copper Species													
Cu+	%	4.2E-06	4.9E-06	4.2E-06	4.6E-06	5.0E-06	4.5E-06	4.1E-06	3.8E-06	4.0E-06	4.5E-06	4.2E-06	3.7E-06
CuCl	%	6.9E-08	7.9E-08	6.8E-08	7.5E-08	8.1E-08	7.2E-08	6.6E-08	6.2E-08	6.4E-08	7.3E-08	6.8E-08	6.0E-08
CuCl2-	%	2.1E-10	2.4E-10	2.1E-10	2.3E-10	2.5E-10	2.2E-10	2.0E-10	1.9E-10	1.9E-10	2.2E-10	2.1E-10	1.8E-10
CuCl3-2	%	6.5E-16	7.6E-16	6.5E-16	7.1E-16	7.7E-16	6.9E-16	6.2E-16	5.9E-16	6.1E-16	7.0E-16	6.5E-16	5.7E-16
Cu+2	%	7.1	8.2	7.1	8.0	8.7	7.7	7.0	6.7	6.9	8.0	7.6	6.7
CuCO3	%	83	81	83	82	82	82	83	83	84	82	82	84
CuOH+	%	7.3	8.3	7.4	7.5	7.1	7.3	7.2	7.2	6.8	7.3	7.5	6.8
Cu(OH)2	%	1.7	1.9	1.8	1.7	1.4	1.6	1.8	1.9	1.6	1.6	1.9	1.7
Cu(CO3)2-2	%	0.6	0.5	0.6	0.6	0.5	0.6	0.7	0.7	0.7	0.6	0.6	0.7
CuHCO3+	%	2.9E-01	2.9E-01	2.9E-01	3.1E-01	3.6E-01	3.1E-01	2.9E-01	2.8E-01	3.0E-01	3.2E-01	2.9E-01	2.9E-01
CuSO4	%	6.0E-02	7.0E-02	6.0E-02	6.8E-02	7.3E-02	6.5E-02	5.9E-02	5.6E-02	5.7E-02	6.6E-02	6.4E-02	5.6E-02
Cu(OH)3-	%	2.5E-03	2.7E-03	2.7E-03	2.3E-03	1.7E-03	2.3E-03	2.7E-03	2.9E-03	2.3E-03	2.2E-03	2.7E-03	2.6E-03
CuNH3+2	%	3.0E-03	3.4E-03	3.1E-03	3.2E-03	3.2E-03	3.2E-03	3.1E-03	3.1E-03	2.9E-03	3.3E-03	3.5E-03	3.1E-03
Cu2(OH)2+2	%	2.8E-04	2.4E-04	2.1E-04	2.0E-04	2.0E-04	2.0E-04	1.8E-04	1.7E-04	1.6E-04	2.5E-04	1.9E-04	1.6E-04
CuCl+	%	1.2E-04	1.3E-04	1.2E-04	1.3E-04	1.4E-04	1.3E-04	1.1E-04	1.1E-04	1.1E-04	1.3E-04	1.2E-04	1.1E-04
CuNO3+	%	1.0E-04	1.0E-04	8.7E-05	1.0E-04	1.2E-04	9.9E-05	8.8E-05	8.3E-05	8.5E-05	1.0E-04	9.4E-05	8.6E-05
CuNO2+	%	4.5E-05	5.1E-05	4.4E-05	5.0E-05	5.5E-05	4.8E-05	4.4E-05	4.2E-05	4.3E-05	5.0E-05	4.8E-05	4.2E-05
Cu(OH)4-2	%	1.6E-08	1.7E-08	1.7E-08	1.3E-08	8.4E-09	1.3E-08	1.7E-08	1.9E-08	1.4E-08	1.2E-08	1.7E-08	1.6E-08
CuCl2	%	2.8E-10	3.3E-10	2.8E-10	3.1E-10	3.4E-10	3.0E-10	2.7E-10	2.6E-10	2.7E-10	3.0E-10	2.9E-10	2.5E-10
Cu(NO3)2	%	5.8E-11	4.7E-11	4.1E-11	4.9E-11	5.8E-11	4.7E-11	4.2E-11	3.8E-11	4.0E-11	4.8E-11	4.4E-11	4.2E-11
Cu(NO2)2	%	3.0E-11	3.4E-11	3.0E-11	3.3E-11	3.6E-11	3.2E-11	2.9E-11	2.8E-11	2.9E-11	3.3E-11	3.2E-11	2.8E-11
CuCl3-	%	3.0E-17	3.5E-17	2.9E-17	3.3E-17	3.5E-17	3.1E-17	2.8E-17	2.7E-17	2.8E-17	3.2E-17	3.0E-17	2.6E-17
CuCl4-2	%	3.5E-24	4.0E-24	3.5E-24	3.9E-24	4.2E-24	3.7E-24	3.4E-24	3.2E-24	3.3E-24	3.8E-24	3.6E-24	3.2E-24

[shaded box] Copper species account for greater than 1% of the total molality of copper.

Quesnel River, QUR-2 - Copper speciation with depth (Eh = 500 mV)

Date		10/17/2014	10/18/2014	10/19/2014	10/20/2014	10/22/2014	10/23/2014	10/24/2014	10/26/2014	10/27/2014	10/28/2014	10/29/2014	10/30/2014
Time		9:30:00 AM	3:30:00 AM	12:00:00 PM	12:45:00 PM	12:30:00 PM	12:00:00 PM	12:00:00 PM	4:00:00 AM	4:30:00 AM	2:00:00 AM	10:53:00 AM	1:30:00 AM
Charge Balance	%	-0.75	-4.34	-4.82	0.41	0.58	1.23	0.03	-1.01	4.56	-2.46	-2.89	3.26
pH	s.u.	7.7	7.8	7.8	7.8	7.8	7.8	7.8	7.7	7.7	7.7	7.8	8.0
pe	s.u.	8.8	8.8	8.8	8.8	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9
Alkalinity	mg/L as $CaCO_3$	48	53	53	49	46	48	47	49	44	51	53	58
Cu	mg/L	0.0009	0.0010	0.0009	0.0008	0.0010	0.0010	0.0009	0.0009	0.0010	0.0010	0.0014	0.0007
SO_4	mg/L	6.3	6.3	6.4	6.4	6.4	6.5	6.5	6.5	6.5	6.6	6.6	6.7
Relative % - Copper Species													
Cu+	%	5.1E-06	4.3E-06	4.3E-06	4.2E-06	4.6E-06	4.2E-06	4.4E-06	4.7E-06	5.0E-06	4.4E-06	4.1E-06	2.4E-06
CuCl	%	8.3E-08	7.0E-08	6.9E-08	6.8E-08	7.5E-08	6.9E-08	7.1E-08	7.6E-08	8.1E-08	7.0E-08	6.6E-08	3.8E-08
CuCl2-	%	2.5E-10	2.1E-10	2.1E-10	2.1E-10	2.3E-10	2.1E-10	2.2E-10	2.3E-10	2.5E-10	2.2E-10	2.0E-10	1.2E-10
CuCl3-2	%	7.9E-16	6.7E-16	6.6E-16	6.5E-16	7.1E-16	6.5E-16	6.7E-16	7.2E-16	7.7E-16	6.7E-16	6.2E-16	3.6E-16
Cu+2	%	9.4	8.0	8.0	7.9	8.8	8.2	8.6	9.5	10.2	9.0	8.5	5.0
CuCO3	%	81	83	83	82	81	82	82	81	80	82	83	85
CuOH+	%	7.2	6.7	6.7	7.2	7.4	7.2	7.3	6.9	7.5	6.6	6.5	6.1
Cu(OH)2	%	1.5	1.5	1.5	1.7	1.7	1.8	1.7	1.5	1.7	1.5	1.5	2.3
Cu(CO3)2-2	%	0.5	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.4	0.5	0.5	1.0
CuHCO3+	%	3.6E-01	3.4E-01	3.4E-01	3.1E-01	3.2E-01	3.1E-01	3.2E-01	3.6E-01	3.5E-01	3.6E-01	3.4E-01	2.2E-01
CuSO4	%	7.9E-02	6.7E-02	6.7E-02	6.6E-02	7.5E-02	7.0E-02	7.3E-02	8.1E-02	8.7E-02	7.7E-02	7.3E-02	4.2E-02
Cu(OH)3-	%	1.7E-03	1.9E-03	1.9E-03	2.4E-03	2.2E-03	2.4E-03	2.3E-03	1.7E-03	2.0E-03	1.7E-03	1.9E-03	4.7E-03
CuNH3+2	%	3.6E-03	3.3E-03	3.3E-03	3.6E-03	4.0E-03	3.9E-03	4.0E-03	4.3E-03	4.5E-03	4.0E-03	4.0E-03	3.7E-03
Cu2(OH)2+2	%	1.9E-04	1.8E-04	1.6E-04	1.7E-04	2.1E-04	2.1E-04	2.0E-04	1.7E-04	2.2E-04	1.7E-04	2.2E-04	1.0E-04
CuCl+	%	1.5E-04	1.3E-04	1.3E-04	1.3E-04	1.4E-04	1.3E-04	1.4E-04	1.5E-04	1.6E-04	1.4E-04	1.3E-04	7.8E-05
CuNO3+	%	1.2E-04	1.1E-04	1.1E-04	1.1E-04	1.3E-04	1.2E-04	1.3E-04	1.4E-04	1.6E-04	1.4E-04	1.3E-04	1.0E-04
CuNO2+	%	5.9E-05	5.0E-05	5.0E-05	4.9E-05	5.5E-05	5.2E-05	5.4E-05	5.9E-05	6.4E-05	5.6E-05	5.3E-05	3.1E-05
Cu(OH)4-2	%	8.3E-09	1.0E-08	1.0E-08	1.4E-08	1.2E-08	1.4E-08	1.3E-08	8.4E-09	9.8E-09	8.7E-09	9.9E-09	4.0E-08
CuCl2	%	3.5E-10	2.9E-10	2.9E-10	2.9E-10	3.2E-10	2.9E-10	3.0E-10	3.2E-10	3.5E-10	3.0E-10	2.8E-10	1.6E-10
Cu(NO3)2	%	6.1E-11	5.6E-11	5.8E-11	5.4E-11	6.6E-11	6.3E-11	6.7E-11	8.1E-11	8.7E-11	7.8E-11	7.4E-11	7.3E-11
Cu(NO2)2	%	3.9E-11	3.3E-11	3.3E-11	3.3E-11	3.7E-11	3.4E-11	3.6E-11	4.0E-11	4.3E-11	3.8E-11	3.5E-11	2.0E-11
CuCl3-	%	3.6E-17	3.0E-17	3.0E-17	3.0E-17	3.2E-17	3.0E-17	3.1E-17	3.3E-17	3.5E-17	3.0E-17	2.8E-17	1.6E-17
CuCl4-2	%	4.4E-24	3.7E-24	3.7E-24	3.6E-24	4.0E-24	3.7E-24	3.8E-24	4.2E-24	4.5E-24	3.9E-24	3.7E-24	2.1E-24

[shaded box] Copper species account for greater than 1% of the total molality of copper.

Quesnel River, QUR-2 - Copper speciation with depth (Eh = 500 mV)

Date		10/31/2014	11/1/2014	11/2/2014	11/3/2014	11/4/2014	11/5/2014	11/6/2014	11/7/2014	11/8/2014	11/9/2014	11/10/2014	11/11/2014
Time		12:15:00 PM	12:00:00 PM	12:00:00 PM	11:10:00 AM	12:20:00 PM	12:30:00 PM	12:20:00 PM	1:20:00 AM	8:30:00 AM	10:00:00 AM	8:30:00 AM	12:00:00 PM
Charge Balance	%	4.26	-0.66	4.78	-0.35	3.59	4.39	0.33	3.23	-0.80	-2.72	4.33	4.32
pH	s.u.	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
pe	s.u.	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	9.0
Alkalinity	mg/L as $CaCO_3$	46	49	43	49	46	45	49	46	49	52	44	45
Cu	mg/L	0.0010	0.0010	0.0010	0.0011	0.0010	0.0012	0.0011	0.0011	0.0011	0.0012	0.0012	0.0013
SO_4	mg/L	6.7	6.7	6.8	6.9	6.7	6.8	6.8	6.6	6.8	6.8	6.9	7.1
Relative % - Copper Species													
Cu+	%	2.7E-06	2.6E-06	2.8E-06	2.6E-06	2.7E-06	2.8E-06	2.6E-06	2.5E-06	2.7E-06	2.4E-06	2.8E-06	2.7E-06
CuCl	%	4.4E-08	4.3E-08	4.5E-08	4.2E-08	4.3E-08	4.6E-08	4.3E-08	4.1E-08	4.3E-08	3.8E-08	4.6E-08	4.4E-08
CuCl2-	%	1.3E-10	1.3E-10	1.4E-10	1.3E-10	1.3E-10	1.4E-10	1.3E-10	1.3E-10	1.3E-10	1.2E-10	1.4E-10	1.3E-10
CuCl3-2	%	4.2E-16	4.0E-16	4.2E-16	3.9E-16	4.1E-16	4.3E-16	4.1E-16	3.9E-16	4.1E-16	3.6E-16	4.4E-16	4.1E-16
Cu+2	%	5.7	5.6	6.0	5.6	5.9	6.3	5.9	5.7	6.1	5.5	6.7	6.7
CuCO3	%	83	84	82	84	83	82	84	83	84	84	82	82
CuOH+	%	7.4	7.0	7.7	6.9	7.3	7.4	6.8	7.2	6.8	6.5	7.3	7.0
Cu(OH)2	%	2.9	2.7	3.2	2.7	3.0	2.9	2.6	3.1	2.6	2.7	2.9	2.8
Cu(CO3)2-2	%	0.8	0.8	0.7	0.8	0.8	0.7	0.8	0.8	0.8	0.9	0.7	0.7
CuHCO3+	%	2.0E-01	2.1E-01	2.0E-01	2.1E-01	2.0E-01	2.1E-01	2.2E-01	2.0E-01	2.2E-01	2.1E-01	2.2E-01	2.2E-01
CuSO4	%	5.0E-02	4.9E-02	5.2E-02	5.0E-02	5.0E-02	5.4E-02	5.2E-02	4.9E-02	5.3E-02	4.8E-02	5.9E-02	6.0E-02
Cu(OH)3-	%	6.2E-03	5.7E-03	6.9E-03	5.7E-03	6.3E-03	5.9E-03	5.2E-03	6.6E-03	5.0E-03	5.5E-03	5.5E-03	5.5E-03
CuNH3+2	%	4.4E-03	4.3E-03	4.8E-03	5.0E-03	4.7E-03	4.9E-03	4.6E-03	4.9E-03	4.7E-03	4.6E-03	5.5E-03	5.7E-03
Cu2(OH)2+2	%	2.2E-04	2.0E-04	2.3E-04	2.1E-04	2.2E-04	2.6E-04	2.1E-04	2.3E-04	1.9E-04	1.9E-04	2.4E-04	2.5E-04
CuCl+	%	9.0E-05	8.8E-05	9.4E-05	8.8E-05	9.2E-05	9.8E-05	9.2E-05	8.9E-05	9.4E-05	8.5E-05	1.0E-04	1.0E-04
CuNO3+	%	9.2E-05	9.1E-05	1.0E-04	9.8E-05	1.0E-04	1.1E-04	1.0E-04	1.0E-04	1.1E-04	1.0E-04	1.2E-04	1.3E-04
CuNO2+	%	3.6E-05	3.5E-05	3.8E-05	3.9E-05	4.4E-05	3.9E-05	4.1E-05	3.6E-05	4.2E-05	4.5E-05	4.6E-05	4.2E-05
Cu(OH)4-2	%	5.5E-08	4.9E-08	6.3E-08	5.0E-08	5.7E-08	5.0E-08	4.3E-08	6.1E-08	4.1E-08	4.8E-08	4.5E-08	4.5E-08
CuCl2	%	1.9E-10	1.8E-10	1.9E-10	1.8E-10	1.9E-10	2.0E-10	1.9E-10	1.8E-10	1.9E-10	1.7E-10	2.0E-10	1.9E-10
Cu(NO3)2	%	5.3E-11	5.3E-11	6.1E-11	6.1E-11	6.2E-11	6.6E-11	6.4E-11	6.3E-11	7.3E-11	6.6E-11	8.2E-11	9.1E-11
Cu(NO2)2	%	2.4E-11	2.3E-11	2.5E-11	2.8E-11	3.5E-11	2.6E-11	3.0E-11	2.4E-11	3.1E-11	3.9E-11	3.4E-11	2.8E-11
CuCl3-	%	1.9E-17	1.8E-17	1.9E-17	1.8E-17	1.9E-17	2.0E-17	1.8E-17	1.8E-17	1.9E-17	1.7E-17	2.0E-17	1.9E-17
CuCl4-2	%	2.5E-24	2.4E-24	2.5E-24	2.4E-24	2.5E-24	2.6E-24	2.5E-24	2.4E-24	2.5E-24	2.2E-24	2.7E-24	2.6E-24

[Shaded box] Copper species account for greater than 1% of the total molality of copper.

Quesnel River, QUR-2 - Copper speciation with depth (Eh = 500 mV)

Date		11/12/2014	11/13/2014	11/14/2014	11/15/2014	11/16/2014	11/17/2014	11/18/2014	11/19/2014	11/20/2014	11/21/2014	11/22/2014	11/23/2014	11/24/2014
Time		8:30:00 AM	12:00:00 PM	12:30:00 PM	1:00:00 AM	2:30:00 AM	4:30:00 AM	4:00:00 AM	12:30:00 PM	9:00:00 AM	11:00:00 AM	11:11:00 AM	10:18:00 AM	9:51:00 AM
Charge Balance	%	1.00	5.16	-1.24	-0.67	-0.94	0.07	5.77	-4.30	-1.49	-2.71	4.23	-2.34	-2.34
pH	s.u.	7.9	8.0	8.0	7.9	7.9	7.9	8.0	8.0	8.0	7.8	7.8	7.8	7.7
pe	s.u.	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Alkalinity	mg/L as $CaCO_3$	51	46	53	52	52	51	45	56	59	55	53	55	52
Cu	mg/L	0.0016	0.0015	0.0016	0.0017	0.0017	0.0018	0.0017	0.0018	0.0014	0.0019	0.0013	0.0017	0.0018
SO_4	mg/L	7.7	7.5	7.9	8.2	8.3	8.2	8.1	8.2	8.5	8.6	8.8	8.6	8.3
Relative % - Copper Species														
Cu+	%	2.5E-06	2.5E-06	2.2E-06	2.3E-06	2.3E-06	2.4E-06	2.5E-06	2.0E-06	1.9E-06	3.2E-06	3.3E-06	0	0
CuCl	%	4.1E-08	4.1E-08	3.5E-08	3.7E-08	3.7E-08	3.8E-08	4.0E-08	3.3E-08	3.1E-08	5.2E-08	5.2E-08	0.0	0.0
CuCl2-	%	1.3E-10	1.3E-10	1.1E-10	1.1E-10	1.1E-10	1.2E-10	1.2E-10	1.0E-10	9.6E-11	1.6E-10	1.6E-10	1.5E-10	1.7E-10
CuCl3-2	%	3.9E-16	3.9E-16	3.3E-16	3.5E-16	3.5E-16	3.6E-16	3.8E-16	3.1E-16	3.0E-16	5.0E-16	5.0E-16	4.7E-16	5.1E-16
Cu+2	%	6.6	6.7	5.9	6.3	6.5	6.7	7.0	5.7	5.5	9.2	9.3	8.8	9.7
CuCO3	%	84	83	84	84	84	84	82	85	85	83	82	83	82
CuOH+	%	6.2	6.8	6.0	6.1	6.0	6.0	6.8	5.6	5.4	5.6	5.7	5.5	5.7
Cu(OH)2	%	2.4	2.9	2.6	2.5	2.5	2.4	3.0	2.5	2.4	1.5	1.6	1.6	1.6
Cu(CO3)2-2	%	0.7	0.7	0.8	0.7	0.7	0.7	0.6	0.9	0.9	0.5	0.5	0.5	0.5
CuHCO3+	%	2.4E-01	2.2E-01	2.2E-01	2.3E-01	2.4E-01	2.4E-01	2.2E-01	2.2E-01	2.3E-01	3.5E-01	3.4E-01	3.4E-01	3.6E-01
CuSO4	%	6.3E-02	6.3E-02	5.8E-02	6.4E-02	6.6E-02	6.7E-02	7.0E-02	5.7E-02	5.6E-02	9.6E-02	9.7E-02	9.1E-02	9.9E-02
Cu(OH)3-	%	4.4E-03	5.5E-03	5.2E-03	4.8E-03	4.6E-03	4.4E-03	5.7E-03	5.0E-03	4.8E-03	1.9E-03	2.0E-03	2.1E-03	1.9E-03
CuNH3+2	%	5.6E-03	6.2E-03	5.7E-03	5.9E-03	6.1E-03	6.2E-03	6.9E-03	5.7E-03	5.5E-03	6.1E-03	6.3E-03	6.2E-03	6.5E-03
Cu2(OH)2+2	%	2.4E-04	2.6E-04	2.2E-04	2.4E-04	2.4E-04	2.5E-04	2.9E-04	2.2E-04	1.6E-04	2.3E-04	1.7E-04	2.0E-04	2.3E-04
CuCl+	%	9.9E-05	1.0E-04	8.9E-05	9.5E-05	9.7E-05	1.0E-04	1.0E-04	8.5E-05	8.2E-05	1.4E-04	1.4E-04	1.3E-04	1.5E-04
CuNO3+	%	1.5E-04	1.5E-04	1.4E-04	1.6E-04	1.7E-04	1.7E-04	1.8E-04	1.4E-04	1.5E-04	2.5E-04	2.6E-04	2.4E-04	2.6E-04
CuNO2+	%	4.1E-05	4.2E-05	3.7E-05	3.9E-05	4.0E-05	4.1E-05	4.4E-05	3.5E-05	3.4E-05	5.7E-05	5.7E-05	5.4E-05	6.1E-05
Cu(OH)4-2	%	3.3E-08	4.5E-08	4.3E-08	3.8E-08	3.6E-08	3.4E-08	4.7E-08	4.2E-08	4.0E-08	9.7E-09	1.1E-08	1.1E-08	9.4E-09
CuCl2	%	1.8E-10	1.9E-10	1.6E-10	1.7E-10	1.7E-10	1.7E-10	1.8E-10	1.5E-10	1.4E-10	2.4E-10	2.4E-10	2.3E-10	2.5E-10
Cu(NO3)2	%	1.2E-10	1.2E-10	1.1E-10	1.4E-10	1.5E-10	1.5E-10	1.6E-10	1.3E-10	1.5E-10	2.5E-10	2.6E-10	2.3E-10	2.3E-10
Cu(NO2)2	%	2.7E-11	2.8E-11	2.4E-11	2.6E-11	2.7E-11	2.7E-11	2.9E-11	2.3E-11	2.2E-11	3.8E-11	3.8E-11	3.6E-11	4.0E-11
CuCl3-	%	1.7E-17	1.8E-17	1.5E-17	1.6E-17	1.6E-17	1.6E-17	1.7E-17	1.4E-17	1.3E-17	2.2E-17	2.2E-17	2.1E-17	2.3E-17
CuCl4-2	%	2.5E-24	2.5E-24	2.2E-24	2.3E-24	2.3E-24	2.4E-24	2.5E-24	2.0E-24	2.0E-24	3.3E-24	3.3E-24	3.1E-24	3.5E-24

[shaded box] Copper species account for greater than 1% of the total molality of copper.

Quesnel River, QUR-2 - Copper speciation with depth (Eh = 500 mV)

Date		11/25/2014	11/26/2014	11/27/2014	11/28/2014	11/29/2014	11/30/2014	12/1/2014	12/2/2014	12/3/2014	12/4/2014	12/5/2014	12/6/2014	12/7/2014
Time		10:56:00 AM	2:30:00 AM	11:15:00 AM	9:00:00 AM	9:00:00 AM	9:00:00 AM	10:11:00 AM	9:51:00 AM	9:45:00 AM	8:50:00 AM	10:14:00 AM	11:00:00 AM	10:32:00 AM
Charge Balance	%	-3.15	1.80	-2.09	2.01	-1.39	0.89	0.07	-6.67	0.32	-1.28	0.27	-0.54	-2.34
pH	s.u.	7.8	7.8	7.7	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
pe	s.u.	9.0	9.0	9.0	9.0	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1
Alkalinity	mg/L as $CaCO_3$	54	50	54	49	53	52	53	62	53	55	53	53	55
Cu	mg/L	0.0017	0.0016	0.0017	0.0020	0.0019	0.0024	0.0020	0.0020	0.0021	0.0021	0.0022	0.0023	0.0021
SO_4	mg/L	8.3	8.3	8.5	8.6	9.0	9.3	9.4	9.5	9.4	9.5	9.4	9.7	9.7
Relative % - Copper Species														
Cu+	%	0	0	0	0	0	0	0	0	0	0	0	0	0
CuCl	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CuCl2-	%	1.5E-10	1.6E-10	1.7E-10	1.5E-10	1.3E-10	1.4E-10	1.4E-10	1.2E-10	1.4E-10	1.4E-10	1.3E-10	1.4E-10	1.3E-10
CuCl3-2	%	4.6E-16	4.9E-16	5.2E-16	4.5E-16	4.1E-16	4.3E-16	4.2E-16	3.7E-16	4.2E-16	4.1E-16	4.0E-16	4.1E-16	4.0E-16
Cu+2	%	8.8	9.4	10.2	9.1	8.7	9.3	9.0	8.0	9.2	8.9	8.8	8.9	8.6
CuCO3	%	83	82	82	82	83	82	83	85	83	83	83	83	83
CuOH+	%	5.6	6.0	5.5	5.9	5.5	5.5	5.5	4.7	5.4	5.3	5.4	5.4	5.3
Cu(OH)2	%	1.7	1.8	1.4	1.9	1.8	1.8	1.8	1.5	1.8	1.7	1.8	1.8	1.7
Cu(CO3)2-2	%	0.5	0.5	0.4	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.5
CuHCO3+	%	3.3E-01	3.3E-01	3.8E-01	3.1E-01	3.2E-01	3.3E-01	3.2E-01	3.4E-01	3.3E-01	3.3E-01	3.2E-01	3.2E-01	3.3E-01
CuSO4	%	8.9E-02	9.5E-02	1.0E-01	9.5E-02	9.3E-02	1.0E-01	1.0E-01	8.9E-02	1.0E-01	1.0E-01	9.7E-02	1.0E-01	9.9E-02
Cu(OH)3-	%	2.2E-03	2.4E-03	1.6E-03	2.6E-03	2.5E-03	2.3E-03	2.4E-03	2.0E-03	2.3E-03	2.2E-03	2.5E-03	2.4E-03	2.3E-03
CuNH3+2	%	6.4E-03	6.9E-03	6.6E-03	7.5E-03	7.5E-03	7.8E-03	7.7E-03	6.7E-03	7.8E-03	7.5E-03	7.8E-03	7.6E-03	7.3E-03
Cu2(OH)2+2	%	2.1E-04	2.2E-04	2.0E-04	2.7E-04	2.1E-04	2.7E-04	2.3E-04	1.7E-04	2.3E-04	2.2E-04	2.5E-04	2.5E-04	2.2E-04
CuCl+	%	1.3E-04	1.4E-04	1.5E-04	1.3E-04	1.3E-04	1.4E-04	1.3E-04	1.2E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04
CuNO3+	%	2.3E-04	2.5E-04	2.8E-04	2.6E-04	2.7E-04	3.0E-04	2.9E-04	2.6E-04	3.0E-04	3.0E-04	2.9E-04	2.9E-04	2.9E-04
CuNO2+	%	5.4E-05	5.8E-05	6.3E-05	5.7E-05	5.4E-05	5.8E-05	5.6E-05	4.9E-05	5.7E-05	5.5E-05	5.4E-05	5.5E-05	5.3E-05
Cu(OH)4-2	%	1.2E-08	1.3E-08	7.4E-09	1.5E-08	1.5E-08	1.3E-08	1.4E-08	1.1E-08	1.3E-08	1.2E-08	1.5E-08	1.4E-08	1.3E-08
CuCl2	%	2.2E-10	2.4E-10	2.5E-10	2.2E-10	2.0E-10	2.1E-10	2.1E-10	1.8E-10	2.1E-10	2.0E-10	2.0E-10	2.1E-10	2.0E-10
Cu(NO3)2	%	2.1E-10	2.4E-10	2.7E-10	2.5E-10	2.8E-10	3.3E-10	3.3E-10	2.9E-10	3.4E-10	3.4E-10	3.2E-10	3.3E-10	3.3E-10
Cu(NO2)2	%	3.6E-11	3.9E-11	4.2E-11	3.8E-11	3.6E-11	3.8E-11	3.7E-11	3.3E-11	3.8E-11	3.7E-11	3.6E-11	3.7E-11	3.5E-11
CuCl3-	%	2.1E-17	2.2E-17	2.3E-17	2.0E-17	1.8E-17	1.9E-17	1.9E-17	1.7E-17	1.9E-17	1.8E-17	1.8E-17	1.9E-17	1.8E-17
CuCl4-2	%	3.1E-24	3.3E-24	3.5E-24	3.1E-24	2.9E-24	3.0E-24	3.0E-24	2.6E-24	3.0E-24	2.9E-24	2.9E-24	2.9E-24	2.9E-24

[shaded box] Copper species account for greater than 1% of the total molality of copper.

Quesnel River, QUR-2 - Copper speciation with depth (Eh = 300 mV)

Date		8/6/2014	8/6/2014	8/7/2014	8/8/2014	8/8/2014	8/9/2014	8/9/2014	8/10/2014	8/10/2014	8/11/2014	8/11/2014	8/12/2014	8/13/2014
Time		12:32:00 PM	1:30:00 AM	10:55:00 AM	11:33:00 AM	3:43:00 AM	10:08:00 AM	2:30:00 AM	10:19:00 AM	5:45:00 AM	11:18:00 AM	5:12:00 AM	4:34:00 AM	1:18:00 AM
Charge Balance	%	0.25	0.32	-1.25	-1.76	-0.65	1.84	1.32	-0.57	-0.58	-0.04	0.38	0.27	-1.01
pH	s.u.	8.1	8.5	7.6	8.1	7.8	7.3	7.5	7.8	7.9	7.7	7.7	8.1	8.2
pe	s.u.	5.2	5.2	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.2	5.2	5.2	5.2
Alkalinity	mg/L as $CaCO_3$	44	45	44	47	47	46	46	46	47	45	45	45	45
Cu	mg/L	0.0007	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
SO_4	mg/L	5.7	5.6	5.7	5.8	5.9	5.9	5.8	5.8	5.8	5.8	5.7	5.7	5.8
Relative % - Copper Species														
Cu+	%	1.0E-02	4.2E-03	2.7E-02	7.1E-03	1.4E-02	3.6E-02	2.6E-02	1.8E-02	1.3E-02	2.4E-02	2.1E-02	8.9E-03	7.9E-03
CuCl	%	1.7E-04	6.8E-05	4.5E-04	1.2E-04	2.4E-04	5.9E-04	4.2E-04	2.9E-04	2.1E-04	3.8E-04	3.5E-04	1.4E-04	1.3E-04
CuCl2-	%	5.0E-07	2.0E-07	1.3E-06	3.5E-07	7.2E-07	1.8E-06	1.3E-06	8.7E-07	6.4E-07	1.2E-06	1.0E-06	4.3E-07	3.9E-07
CuCl3-2	%	1.6E-12	6.5E-13	4.2E-12	1.1E-12	2.2E-12	5.5E-12	4.0E-12	2.7E-12	2.0E-12	3.7E-12	3.3E-12	1.4E-12	1.2E-12
Cu+2	%	4.1	1.7	12.5	3.9	8.6	21.8	14.7	8.9	6.3	10.1	8.9	3.6	3.0
CuCO3	%	82	79	77	83	82	70	76	81	82	79	80	82	82
CuOH+	%	9.5	9.2	8.2	7.5	7.0	6.1	6.9	7.8	8.1	8.6	8.9	9.4	9.6
Cu(OH)2	%	3.2	7.6	1.0	4.0	1.8	0.6	0.9	1.6	2.2	1.2	1.4	3.6	4.1
Cu(CO3)2-2	%	1.1	2.4	0.3	1.2	0.5	0.1	0.3	0.5	0.7	0.4	0.5	1.2	1.4
CuHCO3+	%	1.6E-01	6.5E-02	4.8E-01	1.4E-01	3.1E-01	7.7E-01	5.3E-01	3.4E-01	2.4E-01	4.0E-01	3.6E-01	1.4E-01	1.2E-01
CuSO4	%	3.4E-02	1.4E-02	1.0E-01	3.0E-02	6.6E-02	1.7E-01	1.1E-01	7.0E-02	5.0E-02	8.2E-02	7.2E-02	2.9E-02	2.5E-02
Cu(OH)3-	%	8.3E-03	4.7E-02	8.6E-04	1.2E-02	2.5E-03	2.7E-04	7.1E-04	2.0E-03	3.9E-03	1.3E-03	1.6E-03	1.1E-02	1.4E-02
CuNH3+2	%	1.9E-03	1.7E-03	2.6E-03	3.5E-03	4.7E-03	4.5E-03	4.1E-03	3.3E-03	3.0E-03	2.2E-03	2.1E-03	1.9E-03	1.6E-03
Cu2(OH)2+2	%	2.7E-04	1.8E-04	1.4E-04	1.1E-04	9.6E-05	7.2E-05	9.5E-05	1.2E-04	1.3E-04	1.5E-04	1.6E-04	1.8E-04	1.9E-04
CuCl+	%	7.1E-05	2.9E-05	2.1E-04	6.2E-05	1.4E-04	3.4E-04	2.3E-04	1.5E-04	1.0E-04	1.7E-04	1.5E-04	6.1E-05	5.3E-05
CuNO3+	%	5.1E-05	2.1E-05	1.9E-04	8.3E-05	2.1E-04	5.2E-04	3.3E-04	1.7E-04	1.2E-04	1.5E-04	1.3E-04	4.5E-05	3.3E-05
CuNO2+	%	2.6E-05	1.1E-05	7.9E-05	2.4E-05	5.4E-05	1.4E-04	9.2E-05	5.6E-05	4.0E-05	6.3E-05	5.6E-05	2.2E-05	2.3E-05
Cu(OH)4-2	%	9.1E-08	1.2E-06	3.0E-09	1.5E-07	1.4E-08	5.3E-10	2.2E-09	1.0E-08	2.9E-08	5.4E-09	7.8E-09	1.4E-07	2.0E-07
CuCl2	%	2.2E-10	8.8E-11	5.6E-10	1.4E-10	2.8E-10	6.9E-10	5.1E-10	3.5E-10	2.6E-10	4.9E-10	4.5E-10	1.9E-10	1.7E-10
Cu(NO3)2	%	2.5E-11	1.0E-11	1.2E-10	6.5E-11	1.8E-10	4.4E-10	2.8E-10	1.2E-10	8.4E-11	8.6E-11	7.2E-11	2.3E-11	1.5E-11
Cu(NO2)2	%	1.7E-11	7.1E-12	5.3E-11	1.6E-11	3.6E-11	9.1E-11	6.2E-11	3.8E-11	2.6E-11	4.2E-11	3.7E-11	1.5E-11	1.8E-11
CuCl3-	%	2.5E-17	1.0E-17	6.2E-17	1.4E-17	2.8E-17	6.8E-17	5.2E-17	3.7E-17	2.8E-17	5.5E-17	5.1E-17	2.1E-17	2.0E-17
CuCl4-2	%	2.5E-24	1.0E-24	6.7E-24	1.8E-24	3.6E-24	9.1E-24	6.5E-24	4.4E-24	3.2E-24	5.8E-24	5.2E-24	2.1E-24	1.9E-24

(Shaded cells:) Copper species account for greater than 1% of the total molality of copper.

Quesnel River, QUR-2 - Copper speciation with depth (Eh = 300 mV)

Date		8/14/2014	8/15/2014	8/16/2014	8/17/2014	8/18/2014	8/19/2014	8/20/2014	8/21/2014	8/22/2014	8/23/2014	8/24/2014	8/25/2014
Time		2:45:00 AM	1:28:00 AM	2:59:00 AM	12:20:00 PM	9:18:00 AM	1:27:00 AM	4:40:00 AM	4:28:00 AM	10:40:00 AM	10:25:00 AM	1:47:00 AM	11:21:00 AM
Charge Balance	%	-0.86	-0.79	-0.29	-0.85	-0.30	0.50	1.37	2.34	1.63	1.31	2.24	0.36
pH	s.u.	8.0	8.2	8.2	8.2	8.1	7.6	7.7	7.7	8.1	8.1	7.7	8.1
pe	s.u.	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.3	5.3	5.3	5.3
Alkalinity	mg/L as $CaCO_3$	46	45	45	45	45	45	45	45	46	45	46	46
Cu	mg/L	0.0005	0.0005	0.0005	0.0005	0.0005	0.0006	0.0007	0.0009	0.0008	0.0009	0.0010	0.0011
SO_4	mg/L	5.7	5.7	5.7	5.7	5.8	5.7	5.7	5.8	5.8	5.9	5.8	5.9
Relative % - Copper Species													
Cu+	%	1.4E-02	8.0E-03	7.7E-03	8.0E-03	9.5E-03	2.7E-02	2.3E-02	2.3E-02	9.8E-03	9.3E-03	2.0E-02	9.2E-03
CuCl	%	2.3E-04	1.3E-04	1.2E-04	1.3E-04	1.5E-04	4.4E-04	3.7E-04	3.7E-04	1.6E-04	1.5E-04	3.2E-04	1.5E-04
CuCl2-	%	6.8E-07	3.9E-07	3.7E-07	3.9E-07	4.6E-07	1.3E-06	1.1E-06	1.1E-06	4.8E-07	4.6E-07	9.7E-07	4.5E-07
CuCl3-2	%	2.2E-12	1.2E-12	1.2E-12	1.2E-12	1.5E-12	4.3E-12	3.6E-12	3.6E-12	1.5E-12	1.4E-12	3.1E-12	1.4E-12
Cu+2	%	5.0	3.2	3.0	3.1	3.8	10.7	10.0	9.9	4.6	4.3	9.3	4.3
CuCO3	%	82	82	82	82	82	78	79	79	83	83	80	83
CuOH+	%	9.9	9.5	9.6	9.5	9.4	9.0	8.6	8.6	8.5	8.6	8.2	8.5
Cu(OH)2	%	2.2	4.1	4.2	4.0	3.4	1.0	1.3	1.3	3.1	3.3	1.4	3.3
Cu(CO3)2-2	%	0.9	1.4	1.5	1.4	1.1	0.4	0.4	0.4	1.0	1.0	0.5	1.1
CuHCO3+	%	2.1E-01	1.3E-01	1.2E-01	1.3E-01	1.5E-01	4.4E-01	3.9E-01	3.9E-01	1.8E-01	1.6E-01	3.6E-01	1.6E-01
CuSO4	%	4.2E-02	2.6E-02	2.5E-02	2.6E-02	3.2E-02	8.7E-02	8.0E-02	8.1E-02	3.7E-02	3.5E-02	7.4E-02	3.5E-02
Cu(OH)3-	%	4.4E-03	1.4E-02	1.5E-02	1.3E-02	9.6E-03	9.7E-04	1.4E-03	1.4E-03	7.6E-03	8.7E-03	1.7E-03	8.6E-03
CuNH3+2	%	1.4E-03	1.8E-03	1.7E-03	1.7E-03	2.0E-03	1.8E-03	2.3E-03	2.4E-03	2.7E-03	2.6E-03	2.8E-03	2.6E-03
Cu2(OH)2+2	%	2.1E-04	1.9E-04	1.9E-04	1.9E-04	1.8E-04	1.9E-04	2.1E-04	2.6E-04	2.4E-04	2.6E-04	2.6E-04	3.1E-04
CuCl+	%	8.9E-05	5.5E-05	5.2E-05	5.4E-05	6.6E-05	1.9E-04	1.7E-04	1.7E-04	7.7E-05	7.2E-05	1.5E-04	7.1E-05
CuNO3+	%	4.7E-05	3.9E-05	3.4E-05	3.5E-05	4.8E-05	1.2E-04	1.5E-04	1.8E-04	7.8E-05	7.0E-05	1.6E-04	7.0E-05
CuNO2+	%	3.2E-05	2.0E-05	1.9E-05	2.0E-05	2.4E-05	6.8E-05	6.3E-05	6.2E-05	2.9E-05	2.7E-05	5.8E-05	2.7E-05
Cu(OH)4-2	%	3.7E-08	1.9E-07	2.2E-07	1.9E-07	1.1E-07	3.8E-09	6.1E-09	6.0E-09	7.8E-08	9.5E-08	8.2E-09	9.4E-08
CuCl2	%	3.1E-10	1.7E-10	1.6E-10	1.7E-10	2.0E-10	5.8E-10	4.8E-10	4.8E-10	2.0E-10	1.9E-10	4.0E-10	1.9E-10
Cu(NO3)2	%	1.8E-11	1.9E-11	1.6E-11	1.6E-11	2.4E-11	5.6E-11	8.5E-11	1.2E-10	5.1E-11	4.4E-11	1.0E-10	4.4E-11
Cu(NO2)2	%	2.1E-11	1.3E-11	1.2E-11	1.3E-11	1.6E-11	4.5E-11	4.2E-11	4.2E-11	1.9E-11	1.8E-11	3.9E-11	1.8E-11
CuCl3-	%	3.7E-17	1.9E-17	1.9E-17	2.0E-17	2.3E-17	6.7E-17	5.3E-17	5.3E-17	2.2E-17	2.1E-17	4.4E-17	2.1E-17
CuCl4-2	%	3.4E-24	1.9E-24	1.9E-24	1.9E-24	2.3E-24	6.6E-24	5.6E-24	5.6E-24	2.4E-24	2.3E-24	4.9E-24	2.3E-24

(Shaded box:) Copper species account for greater than 1% of the total molality of copper.

Quesnel River, QUR-2 - Copper speciation with depth (Eh = 300 mV)

Date		8/26/2014	8/27/2014	8/28/2014	8/29/2014	8/30/2014	8/31/2014	9/1/2014	9/2/2014	9/3/2014	9/4/2014	9/6/2014	9/7/2014	9/8/2014
Time		10:47:00 AM	11:48:00 AM	2:20:00 AM	1:30:00 AM	3:15:00 AM	2:30:00 AM	1:10:00 AM	2:10:00 AM	2:12:00 AM	5:30:00 AM	12:30:00 PM	8:45:00 AM	1:12:00 AM
Charge Balance	%	1.42	1.24	0.29	0.42	0.72	-0.03	1.90	1.47	1.33	-0.38	-1.81	-1.64	-2.08
pH	s.u.	8.2	8.2	8.2	8.2	7.2	8.2	8.3	8.2	8.2	9.4	8.2	8.2	8.2
pe	s.u.	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
Alkalinity	mg/L as $CaCO_3$	46	45	44	45	45	46	45	46	46	47	48	48	48
Cu	mg/L	0.0010	0.0009	0.0007	0.0008	0.0008	0.0007	0.0006	0.0015	0.0006	0.0008	0.0008	0.0009	0.0008
SO_4	mg/L	5.9	5.9	5.9	5.8	5.8	5.8	5.8	5.8	5.9	5.9	5.9	5.9	6.0
Relative % - Copper Species														
Cu+	%	8.0E-03	7.8E-03	7.7E-03	8.3E-03	5.8E-02	7.0E-03	6.8E-03	7.0E-03	7.1E-03	2.6E-04	7.7E-03	7.3E-03	6.4E-03
CuCl	%	1.3E-04	1.3E-04	1.3E-04	1.4E-04	9.5E-04	1.1E-04	1.1E-04	1.1E-04	1.2E-04	4.3E-06	1.2E-04	1.2E-04	1.0E-04
CuCl2-	%	3.9E-07	3.8E-07	3.8E-07	4.1E-07	2.8E-06	3.4E-07	3.3E-07	3.4E-07	3.5E-07	1.3E-08	3.8E-07	3.5E-07	3.1E-07
CuCl3-2	%	1.2E-12	1.2E-12	1.2E-12	1.3E-12	9.1E-12	1.1E-12	1.1E-12	1.1E-12	1.1E-12	4.1E-14	1.2E-12	1.1E-12	1.0E-12
Cu+2	%	3.4	3.2	3.0	3.3	23.3	2.8	2.7	2.8	2.9	0.1	3.3	3.0	2.8
CuCO3	%	82	82	81	82	67	82	81	82	82	39	83	82	82
CuOH+	%	9.0	9.3	9.6	9.4	7.6	9.3	9.6	9.4	9.3	5.3	8.5	8.8	8.6
Cu(OH)2	%	3.9	4.1	4.3	3.9	0.4	4.5	4.8	4.5	4.4	44.2	3.7	4.0	4.5
Cu(CO3)2-2	%	1.3	1.4	1.4	1.3	0.1	1.6	1.6	1.6	1.5	8.5	1.4	1.5	1.6
CuHCO3+	%	1.3E-01	1.3E-01	1.2E-01	1.3E-01	9.5E-01	1.1E-01	1.1E-01	1.1E-01	1.2E-01	3.6E-03	1.4E-01	1.2E-01	1.1E-01
CuSO4	%	2.8E-02	2.7E-02	2.6E-02	2.7E-02	1.9E-01	2.3E-02	2.3E-02	2.3E-02	2.4E-02	9.8E-04	2.8E-02	2.5E-02	2.3E-02
Cu(OH)3-	%	1.3E-02	1.4E-02	1.5E-02	1.2E-02	1.3E-04	1.7E-02	1.9E-02	1.7E-02	1.6E-02	2.5E+00	1.2E-02	1.4E-02	1.7E-02
CuNH3+2	%	2.1E-03	1.9E-03	1.8E-03	1.8E-03	1.7E-03	1.8E-03	1.8E-03	1.8E-03	2.5E-03	4.9E-04	2.4E-03	1.9E-03	2.0E-03
Cu2(OH)2+2	%	3.3E-04	3.3E-04	2.8E-04	3.1E-04	2.0E-04	2.5E-04	2.3E-04	5.6E-04	2.3E-04	9.4E-05	2.3E-04	3.0E-04	2.5E-04
CuCl+	%	5.7E-05	5.4E-05	5.3E-05	5.7E-05	4.0E-04	4.8E-05	4.7E-05	4.8E-05	4.9E-05	2.0E-06	5.6E-05	5.1E-05	4.7E-05
CuNO3+	%	4.4E-05	3.8E-05	3.3E-05	3.5E-05	2.5E-04	2.8E-05	2.7E-05	2.6E-05	2.6E-05	1.8E-06	4.0E-05	3.0E-05	4.6E-05
CuNO2+	%	2.1E-05	2.0E-05	1.9E-05	2.1E-05	1.5E-04	1.7E-05	1.9E-05	1.7E-05	1.8E-05	7.5E-07	2.1E-05	1.9E-05	1.7E-05
Cu(OH)4-2	%	1.7E-07	1.9E-07	2.2E-07	1.7E-07	2.1E-10	2.7E-07	3.1E-07	2.7E-07	2.5E-07	6.0E-04	1.5E-07	2.0E-07	2.7E-07
CuCl2	%	1.7E-10	1.7E-10	1.6E-10	1.8E-10	1.2E-09	1.5E-10	1.5E-10	1.5E-10	1.5E-10	5.4E-12	1.6E-10	1.5E-10	1.3E-10
Cu(NO3)2	%	2.2E-11	1.8E-11	1.4E-11	1.5E-11	1.0E-10	1.1E-11	1.1E-11	1.0E-11	9.7E-12	1.0E-12	1.8E-11	1.2E-11	3.0E-11
Cu(NO2)2	%	1.4E-11	1.3E-11	1.3E-11	1.4E-11	9.8E-11	1.2E-11	1.4E-11	1.2E-11	1.2E-11	5.0E-13	1.4E-11	1.3E-11	1.2E-11
CuCl3-	%	1.9E-17	1.9E-17	1.9E-17	2.0E-17	1.4E-16	1.7E-17	1.7E-17	1.7E-17	1.7E-17	5.9E-19	1.8E-17	1.7E-17	1.5E-17
CuCl4-2	%	1.9E-24	1.9E-24	1.9E-24	2.0E-24	1.4E-23	1.7E-24	1.7E-24	1.7E-24	1.7E-24	6.4E-26	1.9E-24	1.8E-24	1.6E-24

(shaded) Copper species account for greater than 1% of the total molality of copper.

Quesnel River, QUR-2 - Copper speciation with depth (Eh = 300 mV)

Date		9/9/2014	9/10/2014	9/11/2014	9/12/2014	9/13/2014	9/14/2014	9/15/2014	9/16/2014	9/17/2014	9/18/2014	9/19/2014	9/20/2014	9/21/2014
Time		1:00:00 AM	1:30:00 AM	11:48:00 AM	12:45:00 PM	1:30:00 AM	11:30:00 AM	12:47:00 PM	10:15:00 AM	2:25:00 AM	12:00:00 PM	1:30:00 AM	9:30:00 AM	9:30:00 AM
Charge Balance	%	-1.01	-1.26	-3.84	-2.19	-0.58	-5.34	-2.25	0.32	-1.27	-1.91	0.84	-0.25	-0.99
pH	s.u.	8.1	7.9	7.9	7.9	7.7	7.8	7.9	7.9	7.9	8.0	8.0	7.7	7.8
pe	s.u.	5.3	5.3	5.4	5.4	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.2
Alkalinity	mg/L as $CaCO_3$	49	50	52	51	49	54	50	48	49	49	48	47	48
Cu	mg/L	0.0013	0.0012	0.0012	0.0011	0.0011	0.0010	0.0006	0.0006	0.0006	0.0005	0.0006	0.0005	0.0005
SO_4	mg/L	6.1	6.2	6.6	6.4	6.2	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
Relative % - Copper Species														
Cu+	%	8.5E-03	1.0E-02	1.1E-02	9.7E-03	2.0E-02	1.4E-02	1.3E-02	1.3E-02	1.2E-02	1.1E-02	1.1E-02	2.2E-02	1.6E-02
CuCl	%	1.4E-04	1.7E-04	1.7E-04	1.6E-04	3.3E-04	2.2E-04	2.1E-04	2.2E-04	1.9E-04	1.8E-04	1.8E-04	3.5E-04	2.6E-04
CuCl2-	%	4.2E-07	5.1E-07	5.3E-07	4.8E-07	1.0E-06	6.7E-07	6.4E-07	6.5E-07	5.8E-07	5.6E-07	5.5E-07	1.1E-06	7.9E-07
CuCl3-2	%	1.3E-12	1.6E-12	1.6E-12	1.5E-12	3.2E-12	2.1E-12	2.0E-12	2.1E-12	1.8E-12	1.8E-12	1.7E-12	3.3E-12	2.5E-12
Cu+2	%	4.3	6.2	7.3	6.1	11.1	7.1	6.3	6.3	5.6	5.3	5.2	10.0	7.4
CuCO3	%	84	84	84	84	80	84	83	82	83	83	83	80	82
CuOH+	%	7.7	6.7	6.0	6.5	7.0	6.7	7.5	8.1	7.9	7.9	8.2	7.9	8.0
Cu(OH)2	%	3.2	2.4	2.1	2.5	1.2	1.6	1.9	2.1	2.3	2.4	2.5	1.2	1.7
Cu(CO3)2-2	%	1.1	0.7	0.6	0.8	0.4	0.6	0.7	0.7	0.8	0.9	0.9	0.4	0.6
CuHCO3+	%	1.7E-01	2.4E-01	2.7E-01	2.3E-01	4.3E-01	3.1E-01	2.6E-01	2.5E-01	2.3E-01	2.2E-01	2.1E-01	4.0E-01	3.0E-01
CuSO4	%	3.5E-02	4.9E-02	6.0E-02	4.9E-02	9.0E-02	5.8E-02	5.2E-02	5.2E-02	4.6E-02	4.4E-02	4.3E-02	8.3E-02	6.2E-02
Cu(OH)3-	%	8.1E-03	4.4E-03	3.4E-03	4.6E-03	1.1E-03	2.2E-03	3.2E-03	3.6E-03	4.3E-03	4.7E-03	5.2E-03	1.3E-03	2.3E-03
CuNH3+2	%	3.4E-03	4.4E-03	5.8E-03	0.0E+00	3.6E-03	3.1E-03	2.8E-03	2.7E-03	2.6E-03	2.6E-03	2.6E-03	2.6E-03	2.5E-03
Cu2(OH)2+2	%	3.0E-04	2.1E-04	1.7E-04	1.9E-04	2.2E-04	1.8E-04	1.5E-04	1.6E-04	1.4E-04	1.4E-04	1.6E-04	1.3E-04	1.4E-04
CuCl+	%	7.0E-05	9.7E-05	1.1E-04	9.4E-05	1.8E-04	1.1E-04	1.0E-04	1.0E-04	9.2E-05	8.8E-05	8.6E-05	1.7E-04	1.2E-04
CuNO3+	%	7.5E-05	1.5E-04	2.1E-04	1.5E-04	2.0E-04	1.2E-04	9.1E-05	8.3E-05	7.2E-05	6.8E-05	6.5E-05	1.2E-04	9.0E-05
CuNO2+	%	2.7E-05	3.9E-05	4.5E-05	3.8E-05	6.9E-05	4.5E-05	4.0E-05	3.9E-05	3.5E-05	3.3E-05	3.3E-05	6.3E-05	4.6E-05
Cu(OH)4-2	%	8.7E-08	3.4E-08	2.3E-08	3.7E-08	4.7E-09	1.3E-08	2.2E-08	2.6E-08	3.4E-08	3.9E-08	4.6E-08	5.5E-09	1.4E-08
CuCl2	%	1.7E-10	2.0E-10	2.0E-10	1.8E-10	4.0E-10	2.7E-10	2.6E-10	2.7E-10	2.4E-10	2.3E-10	2.3E-10	4.4E-10	3.3E-10
Cu(NO3)2	%	4.9E-11	1.3E-10	2.1E-10	1.4E-10	1.3E-10	7.3E-11	5.0E-11	4.2E-11	3.6E-11	3.3E-11	3.1E-11	5.6E-11	4.3E-11
Cu(NO2)2	%	1.8E-11	2.6E-11	3.0E-11	2.5E-11	4.6E-11	3.0E-11	2.6E-11	2.6E-11	2.3E-11	2.2E-11	2.2E-11	4.2E-11	3.1E-11
CuCl3-	%	1.8E-17	2.0E-17	1.9E-17	1.8E-17	4.2E-17	2.8E-17	2.8E-17	2.9E-17	2.6E-17	2.5E-17	2.5E-17	4.8E-17	3.6E-17
CuCl4-2	%	2.1E-24	2.6E-24	2.7E-24	2.4E-24	5.1E-24	3.4E-24	3.2E-24	3.3E-24	2.9E-24	2.8E-24	2.7E-24	5.3E-24	4.0E-24

(shaded) Copper species account for greater than 1% of the total molality of copper.

Quesnel River, QUR-2 - Copper speciation with depth (Eh = 300 mV)

Date		9/22/2014	9/23/2014	9/24/2014	9/25/2014	9/26/2014	9/27/2014	9/28/2014	9/29/2014	9/30/2014	10/1/2014	10/2/2014	10/3/2014	10/4/2014
Time		12:30:00 PM	1:50:00 AM	2:30:00 AM	12:30:00 PM	12:30:00 PM	12:40:00 PM	11:10:00 AM	12:50:00 PM	1:00:00 AM	12:00:00 AM	2:00:00 AM	11:00:00 AM	3:00:00 AM
Charge Balance	%	-2.22	-3.86	-2.27	-3.62	-5.35	-3.03	0.22	-4.56	-2.77	0.01	-1.76	-1.89	-2.38
pH	s.u.	7.9	7.9	7.9	7.9	7.9	7.8	7.8	7.8	7.8	7.7	7.8	7.7	7.8
pe	s.u.	5.3	5.2	5.2	5.2	5.2	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
Alkalinity	mg/L as $CaCO_3$	50	49	49	51	54	50	47	51	48	47	49	50	50
Cu	mg/L	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0009	0.0005	0.0006	0.0005	0.0009	0.0010	0.0009
SO_4	mg/L	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.3	6.2
Relative % - Copper Species														
Cu+	%	1.4E-02	1.4E-02	1.3E-02	1.3E-02	1.3E-02	1.5E-02	1.6E-02	1.5E-02	1.5E-02	2.0E-02	1.6E-02	1.8E-02	1.5E-02
CuCl	%	2.3E-04	2.2E-04	2.1E-04	2.1E-04	2.1E-04	2.5E-04	2.7E-04	2.4E-04	2.4E-04	3.2E-04	2.6E-04	3.0E-04	2.3E-04
CuCl2-	%	6.9E-07	6.7E-07	6.5E-07	6.4E-07	6.4E-07	7.5E-07	8.1E-07	7.2E-07	7.3E-07	9.6E-07	7.8E-07	9.0E-07	7.1E-07
CuCl3-2	%	2.2E-12	2.1E-12	2.0E-12	2.0E-12	2.0E-12	2.4E-12	2.5E-12	2.3E-12	2.3E-12	3.0E-12	2.5E-12	2.8E-12	2.2E-12
Cu+2	%	6.5	6.2	5.9	5.9	6.0	7.0	7.6	6.8	7.0	9.3	7.9	9.6	7.4
CuCO3	%	83	83	83	83	84	83	82	83	82	80	82	81	83
CuOH+	%	7.9	8.0	8.1	7.8	7.4	7.7	8.2	7.6	7.9	7.9	7.5	7.1	7.4
Cu(OH)2	%	1.8	1.9	2.0	1.9	1.7	1.6	1.7	1.7	1.8	1.4	1.6	1.3	1.7
Cu(CO3)2-2	%	0.7	0.7	0.8	0.8	0.8	0.6	0.6	0.7	0.6	0.5	0.6	0.5	0.6
CuHCO3+	%	2.7E-01	2.6E-01	2.5E-01	2.6E-01	2.7E-01	3.0E-01	3.0E-01	2.9E-01	2.8E-01	3.7E-01	3.2E-01	3.9E-01	3.0E-01
CuSO4	%	5.5E-02	5.2E-02	5.0E-02	4.9E-02	5.0E-02	5.9E-02	6.3E-02	5.7E-02	5.9E-02	7.7E-02	6.5E-02	8.0E-02	6.1E-02
Cu(OH)3-	%	2.9E-03	3.1E-03	3.5E-03	3.2E-03	2.8E-03	2.3E-03	2.4E-03	2.4E-03	2.7E-03	1.6E-03	2.1E-03	1.4E-03	2.5E-03
CuNH3+2	%	2.4E-03	2.4E-03	2.3E-03	2.3E-03	2.3E-03	2.8E-03	2.6E-03	2.6E-03	2.6E-03	2.7E-03	3.4E-03	3.3E-03	3.1E-03
Cu2(OH)2+2	%	1.3E-04	1.3E-04	1.3E-04	1.2E-04	1.1E-04	1.2E-04	2.3E-04	1.3E-04	1.5E-04	1.3E-04	2.0E-04	2.1E-04	2.0E-04
CuCl+	%	1.1E-04	1.0E-04	9.9E-05	9.8E-05	9.9E-05	1.2E-04	1.3E-04	1.1E-04	1.2E-04	1.5E-04	1.3E-04	1.6E-04	1.2E-04
CuNO3+	%	7.6E-05	7.1E-05	6.4E-05	6.3E-05	6.5E-05	7.8E-05	9.4E-05	7.6E-05	7.8E-05	1.1E-04	1.0E-04	1.4E-04	9.4E-05
CuNO2+	%	4.1E-05	3.9E-05	3.7E-05	3.7E-05	3.7E-05	4.4E-05	4.8E-05	4.3E-05	4.4E-05	5.8E-05	4.9E-05	6.0E-05	4.6E-05
Cu(OH)4-2	%	1.9E-08	2.2E-08	2.5E-08	2.3E-08	1.9E-08	1.4E-08	1.4E-08	1.5E-08	1.7E-08	7.4E-09	1.2E-08	6.4E-09	1.5E-08
CuCl2	%	2.9E-10	2.8E-10	2.7E-10	2.7E-10	2.7E-10	3.1E-10	3.4E-10	3.0E-10	3.1E-10	4.0E-10	3.2E-10	3.6E-10	2.9E-10
Cu(NO3)2	%	3.4E-11	3.1E-11	2.7E-11	2.6E-11	2.7E-11	3.3E-11	4.5E-11	3.3E-11	3.4E-11	4.6E-11	4.9E-11	7.9E-11	4.5E-11
Cu(NO2)2	%	2.7E-11	2.6E-11	2.5E-11	2.5E-11	2.5E-11	2.9E-11	3.2E-11	2.8E-11	2.9E-11	3.9E-11	3.3E-11	4.0E-11	3.1E-11
CuCl3-	%	3.2E-17	3.1E-17	3.0E-17	2.9E-17	2.9E-17	3.4E-17	3.7E-17	3.3E-17	3.3E-17	4.3E-17	3.4E-17	3.8E-17	3.1E-17
CuCl4-2	%	3.5E-24	3.4E-24	3.2E-24	3.2E-24	3.2E-24	3.7E-24	4.0E-24	3.6E-24	3.7E-24	4.8E-24	3.9E-24	4.5E-24	3.6E-24

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Quesnel River, QUR-2 - Copper speciation with depth (Eh = 300 mV)

Date		10/5/2014	10/6/2014	10/7/2014	10/8/2014	10/9/2014	10/10/2014	10/11/2014	10/12/2014	10/13/2014	10/14/2014	10/15/2014	10/16/2014
Time		12:00:00 PM	2:00:00 AM	12:00:00 PM	12:20:00 PM	12:20:00 PM	12:10:00 PM	12:00:00 PM	12:30:00 PM	11:30:00 AM	2:41:00 AM	11:00:00 AM	12:30:00 PM
Charge Balance	%	-2.93	4.57	-2.32	-0.62	-2.48	-1.75	-2.57	-2.10	-5.61	-2.28	-0.40	-5.07
pH	s.u.	7.8	7.8	7.8	7.8	7.7	7.8	7.8	7.9	7.8	7.8	7.8	7.8
pe	s.u.	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
Alkalinity	mg/L as $CaCO_3$	51	44	50	48	51	50	51	51	55	50	48	54
Cu	mg/L	0.0013	0.0009	0.0009	0.0009	0.0010	0.0009	0.0009	0.0008	0.0009	0.0012	0.0009	0.0009
SO_4	mg/L	6.2	6.4	6.3	6.3	6.2	6.3	6.3	6.3	6.2	6.2	6.3	6.3
Relative % - Copper Species													
Cu+	%	1.4E-02	1.6E-02	1.4E-02	1.6E-02	1.7E-02	1.5E-02	1.4E-02	1.3E-02	1.3E-02	1.5E-02	1.4E-02	1.3E-02
CuCl	%	2.3E-04	2.6E-04	2.3E-04	2.5E-04	2.7E-04	2.4E-04	2.2E-04	2.1E-04	2.2E-04	2.5E-04	2.3E-04	2.1E-04
CuCl2-	%	6.9E-07	8.0E-07	6.9E-07	7.7E-07	8.3E-07	7.4E-07	6.7E-07	6.3E-07	6.6E-07	7.5E-07	7.1E-07	6.3E-07
CuCl3-2	%	2.2E-12	2.5E-12	2.2E-12	2.4E-12	2.6E-12	2.3E-12	2.1E-12	2.0E-12	2.1E-12	2.4E-12	2.2E-12	2.0E-12
Cu+2	%	7.1	8.2	7.1	8.0	8.7	7.7	7.0	6.7	6.9	8.0	7.6	6.7
CuCO3	%	83	81	83	82	82	82	83	83	84	82	82	84
CuOH+	%	7.3	8.3	7.4	7.5	7.1	7.3	7.2	7.2	6.8	7.3	7.5	6.8
Cu(OH)2	%	1.7	1.9	1.8	1.7	1.4	1.6	1.8	1.9	1.6	1.6	1.9	1.7
Cu(CO3)2-2	%	0.6	0.5	0.6	0.6	0.5	0.6	0.7	0.7	0.7	0.6	0.6	0.7
CuHCO3+	%	2.9E-01	2.9E-01	2.9E-01	3.1E-01	3.6E-01	3.1E-01	2.9E-01	2.8E-01	3.0E-01	3.2E-01	2.9E-01	2.9E-01
CuSO4	%	6.0E-02	7.0E-02	6.0E-02	6.8E-02	7.3E-02	6.5E-02	5.9E-02	5.6E-02	5.7E-02	6.6E-02	6.4E-02	5.6E-02
Cu(OH)3-	%	2.5E-03	2.7E-03	2.7E-03	2.3E-03	1.7E-03	2.2E-03	2.7E-03	2.9E-03	2.3E-03	2.2E-03	2.7E-03	2.6E-03
CuNH3+2	%	3.0E-03	3.4E-03	3.1E-03	3.2E-03	3.2E-03	3.2E-03	3.1E-03	3.1E-03	2.9E-03	3.3E-03	3.5E-03	3.1E-03
Cu2(OH)2+2	%	2.8E-04	2.4E-04	2.1E-04	2.0E-04	2.0E-04	2.0E-04	1.8E-04	1.7E-04	1.6E-04	2.5E-04	1.9E-04	1.6E-04
CuCl+	%	1.2E-04	1.3E-04	1.2E-04	1.3E-04	1.4E-04	1.3E-04	1.1E-04	1.1E-04	1.1E-04	1.3E-04	1.2E-04	1.1E-04
CuNO3+	%	1.0E-04	1.0E-04	8.7E-05	1.0E-04	1.2E-04	9.9E-05	8.8E-05	8.3E-05	8.5E-05	1.0E-04	9.4E-05	8.6E-05
CuNO2+	%	4.5E-05	5.1E-05	4.4E-05	5.0E-05	5.5E-05	4.8E-05	4.4E-05	4.2E-05	4.3E-05	5.0E-05	4.8E-05	4.2E-05
Cu(OH)4-2	%	1.6E-08	1.7E-08	1.7E-08	1.3E-08	8.4E-09	1.3E-08	1.7E-08	1.9E-08	1.4E-08	1.2E-08	1.7E-08	1.6E-08
CuCl2	%	2.8E-10	3.3E-10	2.8E-10	3.1E-10	3.4E-10	3.0E-10	2.7E-10	2.6E-10	2.7E-10	3.0E-10	2.9E-10	2.5E-10
Cu(NO3)2	%	5.8E-11	4.7E-11	4.1E-11	4.9E-11	5.8E-11	4.7E-11	4.2E-11	3.8E-11	4.0E-11	4.8E-11	4.4E-11	4.2E-11
Cu(NO2)2	%	3.0E-11	3.4E-11	3.0E-11	3.3E-11	3.6E-11	3.2E-11	2.9E-11	2.8E-11	2.9E-11	3.3E-11	3.2E-11	2.8E-11
CuCl3-	%	3.0E-17	3.5E-17	2.9E-17	3.3E-17	3.5E-17	3.1E-17	2.8E-17	2.7E-17	2.8E-17	3.2E-17	3.0E-17	2.6E-17
CuCl4-2	%	3.5E-24	4.0E-24	3.5E-24	3.9E-24	4.2E-24	3.7E-24	3.4E-24	3.2E-24	3.3E-24	3.8E-24	3.6E-24	3.2E-24

(Shaded) Copper species account for greater than 1% of the total molality of copper.

Quesnel River, QUR-2 - Copper speciation with depth (Eh = 300 mV)

Date		10/17/2014	10/18/2014	10/19/2014	10/20/2014	10/22/2014	10/23/2014	10/24/2014	10/26/2014	10/27/2014	10/28/2014	10/29/2014	10/30/2014
Time		9:30:00 AM	3:30:00 AM	12:00:00 PM	12:45:00 PM	12:30:00 PM	12:00:00 PM	12:00:00 PM	4:00:00 AM	4:30:00 AM	2:00:00 AM	10:53:00 AM	1:30:00 AM
Charge Balance	%	-0.75	-4.34	-4.82	0.42	0.58	1.23	0.03	-1.01	4.56	-2.46	-2.89	3.26
pH	s.u.	7.7	7.8	7.8	7.8	7.8	7.8	7.8	7.7	7.7	7.7	7.8	8.0
pe	s.u.	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
Alkalinity	mg/L as $CaCO_3$	48	53	53	49	46	48	47	49	44	51	53	58
Cu	mg/L	0.0009	0.0010	0.0009	0.0008	0.0010	0.0010	0.0009	0.0009	0.0010	0.0010	0.0014	0.0007
SO_4	mg/L	6.3	6.3	6.4	6.4	6.4	6.5	6.5	6.5	6.5	6.6	6.6	6.7
Relative % - Copper Species													
Cu+	%	1.8E-02	1.5E-02	1.5E-02	1.5E-02	1.6E-02	1.5E-02	1.5E-02	1.7E-02	1.8E-02	1.6E-02	1.5E-02	8.5E-03
CuCl	%	2.8E-04	2.4E-04	2.4E-04	2.4E-04	2.6E-04	2.4E-04	2.5E-04	2.7E-04	2.9E-04	2.5E-04	2.4E-04	1.4E-04
CuCl2-	%	8.7E-07	7.4E-07	7.3E-07	7.2E-07	7.9E-07	7.4E-07	7.6E-07	8.3E-07	8.9E-07	7.7E-07	7.2E-07	4.2E-07
CuCl3-2	%	2.7E-12	2.3E-12	2.3E-12	2.2E-12	2.5E-12	2.3E-12	2.4E-12	2.6E-12	2.7E-12	2.4E-12	2.2E-12	1.3E-12
Cu+2	%	9.4	8.0	8.0	7.9	8.8	8.2	8.6	9.5	10.2	9.0	8.5	5.0
CuCO3	%	81	83	83	82	81	82	82	81	80	82	83	85
CuOH+	%	7.2	6.7	6.7	7.2	7.4	7.2	7.3	6.9	7.5	6.6	6.5	6.1
Cu(OH)2	%	1.5	1.5	1.5	1.7	1.7	1.8	1.7	1.5	1.7	1.5	1.5	2.3
Cu(CO3)2-2	%	0.5	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.4	0.5	0.5	1.0
CuHCO3+	%	3.6E-01	3.4E-01	3.4E-01	3.1E-01	3.2E-01	3.1E-01	3.2E-01	3.6E-01	3.5E-01	3.6E-01	3.4E-01	2.2E-01
CuSO4	%	7.9E-02	6.7E-02	6.7E-02	6.6E-02	7.5E-02	7.0E-02	7.3E-02	8.1E-02	8.7E-02	7.7E-02	7.3E-02	4.2E-02
Cu(OH)3-	%	1.7E-03	1.9E-03	1.9E-03	2.4E-03	2.2E-03	2.4E-03	2.3E-03	1.7E-03	2.0E-03	1.7E-03	1.9E-03	4.7E-03
CuNH3+2	%	3.6E-03	3.3E-03	3.3E-03	3.6E-03	4.0E-03	3.9E-03	4.0E-03	4.3E-03	4.5E-03	4.0E-03	4.0E-03	3.7E-03
Cu2(OH)2+2	%	1.9E-04	1.8E-04	1.6E-04	1.7E-04	2.1E-04	2.1E-04	2.0E-04	1.7E-04	2.2E-04	1.7E-04	2.2E-04	1.0E-04
CuCl+	%	1.5E-04	1.3E-04	1.3E-04	1.3E-04	1.4E-04	1.3E-04	1.4E-04	1.5E-04	1.6E-04	1.4E-04	1.3E-04	7.8E-05
CuNO3+	%	1.2E-04	1.1E-04	1.1E-04	1.1E-04	1.3E-04	1.2E-04	1.3E-04	1.4E-04	1.6E-04	1.4E-04	1.3E-04	1.0E-04
CuNO2+	%	5.9E-05	5.0E-05	5.0E-05	4.9E-05	5.5E-05	5.2E-05	5.4E-05	5.9E-05	6.4E-05	5.6E-05	5.3E-05	3.1E-05
Cu(OH)4-2	%	8.3E-09	1.0E-08	1.0E-08	1.4E-08	1.2E-08	1.4E-08	1.3E-08	8.4E-09	9.8E-09	8.7E-09	9.9E-09	4.0E-08
CuCl2	%	3.5E-10	2.9E-10	2.9E-10	2.9E-10	3.2E-10	2.9E-10	3.0E-10	3.2E-10	3.5E-10	3.0E-10	2.8E-10	1.6E-10
Cu(NO3)2	%	6.1E-11	5.6E-11	5.8E-11	5.4E-11	6.6E-11	6.3E-11	6.7E-11	8.1E-11	8.7E-11	7.8E-11	7.4E-11	7.3E-11
Cu(NO2)2	%	3.9E-11	3.3E-11	3.3E-11	3.3E-11	3.7E-11	3.4E-11	3.6E-11	4.0E-11	4.3E-11	3.8E-11	3.5E-11	2.0E-11
CuCl3-	%	3.6E-17	3.0E-17	3.0E-17	3.0E-17	3.2E-17	3.0E-17	3.1E-17	3.3E-17	3.5E-17	3.0E-17	2.8E-17	1.6E-17
CuCl4-2	%	4.4E-24	3.7E-24	3.7E-24	3.6E-24	4.0E-24	3.7E-24	3.8E-24	4.2E-24	4.5E-24	3.9E-24	3.7E-24	2.1E-24

(Shaded) Copper species account for greater than 1% of the total molality of copper.

Appendix A
Detailed Copper Speciation Results

Quesnel River, QUR-2 - Copper speciation with depth (Eh = 300 mV)

Date		10/31/2014	11/1/2014	11/2/2014	11/3/2014	11/4/2014	11/5/2014	11/6/2014	11/7/2014	11/8/2014	11/9/2014	11/10/2014	11/11/2014
Time		12:15:00 PM	12:00:00 PM	12:00:00 PM	11:10:00 AM	12:20:00 PM	12:30:00 PM	12:20:00 PM	1:20:00 AM	8:30:00 AM	10:00:00 AM	8:30:00 AM	12:00:00 PM
Charge Balance	%	4.26	-0.66	4.78	-0.35	3.59	4.39	0.33	3.23	-0.80	-2.72	4.33	4.32
pH	s.u.	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
pe	s.u.	5.3	5.3	5.3	5.3	5.3	5.3	5.4	5.4	5.4	5.4	5.4	5.4
Alkalinity	mg/L as $CaCO_3$	46	49	43	49	46	45	49	46	49	52	44	45
Cu	mg/L	0.0010	0.0010	0.0010	0.0011	0.0010	0.0012	0.0011	0.0011	0.0011	0.0012	0.0012	0.0013
SO_4	mg/L	6.7	6.7	6.8	6.9	6.7	6.8	6.8	6.6	6.8	6.8	6.9	7.1
Relative % - Copper Species													
Cu+	%	9.8E-03	9.5E-03	1.0E-02	9.4E-03	9.8E-03	1.0E-02	9.7E-03	9.4E-03	9.9E-03	8.9E-03	1.1E-02	1.0E-02
CuCl	%	1.6E-04	1.5E-04	1.6E-04	1.5E-04	1.6E-04	1.7E-04	1.6E-04	1.5E-04	1.6E-04	1.4E-04	1.7E-04	1.7E-04
CuCl2-	%	4.9E-07	4.7E-07	5.0E-07	4.7E-07	4.8E-07	5.1E-07	4.8E-07	4.7E-07	4.9E-07	4.4E-07	5.3E-07	5.1E-07
CuCl3-2	%	1.5E-12	1.5E-12	1.5E-12	1.4E-12	1.5E-12	1.6E-12	1.5E-12	1.4E-12	1.5E-12	1.4E-12	1.6E-12	1.6E-12
Cu+2	%	5.7	5.6	6.0	5.6	5.9	6.3	5.9	5.7	6.1	5.5	6.7	6.7
CuCO3	%	83	84	82	84	83	82	84	83	84	84	82	82
CuOH+	%	7.4	7.0	7.7	6.9	7.3	7.4	6.8	7.2	6.8	6.5	7.3	7.0
Cu(OH)2	%	2.9	2.7	3.2	2.7	3.0	2.9	2.6	3.1	2.6	2.7	2.9	2.8
Cu(CO3)2-2	%	0.8	0.8	0.7	0.8	0.8	0.7	0.8	0.8	0.8	0.9	0.7	0.7
CuHCO3+	%	2.0E-01	2.1E-01	2.0E-01	2.1E-01	2.0E-01	2.1E-01	2.2E-01	2.0E-01	2.2E-01	2.1E-01	2.2E-01	2.2E-01
CuSO4	%	5.0E-02	4.9E-02	5.2E-02	5.0E-02	5.0E-02	5.4E-02	5.2E-02	4.9E-02	5.3E-02	4.8E-02	5.9E-02	6.0E-02
Cu(OH)3-	%	6.2E-03	5.7E-03	6.9E-03	5.7E-03	6.3E-03	5.9E-03	5.2E-03	6.6E-03	5.0E-03	5.5E-03	5.5E-03	5.5E-03
CuNH3+2	%	4.4E-03	4.3E-03	4.8E-03	5.0E-03	4.7E-03	4.9E-03	4.6E-03	4.9E-03	4.7E-03	4.6E-03	5.5E-03	5.7E-03
Cu2(OH)2+2	%	2.2E-04	2.0E-04	2.3E-04	2.1E-04	2.2E-04	2.6E-04	2.1E-04	2.3E-04	1.9E-04	1.9E-04	2.4E-04	2.5E-04
CuCl+	%	9.0E-05	8.8E-05	9.4E-05	8.8E-05	9.2E-05	9.8E-05	9.2E-05	8.9E-05	9.4E-05	8.5E-05	1.0E-04	1.0E-04
CuNO3+	%	9.2E-05	9.1E-05	1.0E-04	9.8E-05	1.0E-04	1.1E-04	1.0E-04	1.0E-04	1.1E-04	1.0E-04	1.2E-04	1.3E-04
CuNO2+	%	3.6E-05	3.5E-05	3.8E-05	3.9E-05	4.4E-05	3.9E-05	4.1E-05	3.6E-05	4.2E-05	4.5E-05	4.6E-05	4.2E-05
Cu(OH)4-2	%	5.5E-08	4.9E-08	6.3E-08	5.0E-08	5.7E-08	5.0E-08	4.3E-08	6.1E-08	4.1E-08	4.8E-08	4.5E-08	4.5E-08
CuCl2	%	1.9E-10	1.8E-10	1.9E-10	1.8E-10	1.9E-10	2.0E-10	1.9E-10	1.8E-10	1.9E-10	1.7E-10	2.0E-10	1.9E-10
Cu(NO3)2	%	5.3E-11	5.3E-11	6.1E-11	6.1E-11	6.2E-11	6.6E-11	6.4E-11	6.3E-11	7.3E-11	6.6E-11	8.2E-11	9.1E-11
Cu(NO2)2	%	2.4E-11	2.3E-11	2.5E-11	2.8E-11	3.5E-11	2.6E-11	3.0E-11	2.4E-11	3.1E-11	3.9E-11	3.4E-11	2.8E-11
CuCl3-	%	1.9E-17	1.8E-17	1.9E-17	1.8E-17	1.9E-17	2.0E-17	1.8E-17	1.8E-17	1.9E-17	1.7E-17	2.0E-17	1.9E-17
CuCl4-2	%	2.5E-24	2.4E-24	2.5E-24	2.4E-24	2.5E-24	2.6E-24	2.5E-24	2.4E-24	2.5E-24	2.2E-24	2.7E-24	2.6E-24

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Quesnel River, QUR-2 - Copper speciation with depth (Eh = 300 mV)

Date		11/12/2014	11/13/2014	11/14/2014	11/15/2014	11/16/2014	11/17/2014	11/18/2014	11/19/2014	11/20/2014	11/21/2014	11/22/2014	11/23/2014	11/24/2014
Time		8:30:00 AM	12:00:00 PM	12:30:00 PM	1:00:00 AM	2:30:00 AM	4:30:00 AM	4:00:00 AM	12:30:00 PM	9:00:00 AM	11:00:00 AM	11:11:00 AM	10:18:00 AM	9:51:00 AM
Charge Balance	%	1.00	5.16	-1.24	-0.67	-0.94	0.07	5.77	-4.29	-1.49	-2.71	4.23	-2.34	-2.34
pH	s.u.	7.9	8.0	8.0	7.9	7.9	7.9	8.0	8.0	8.0	7.8	7.8	7.8	7.7
pe	s.u.	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
Alkalinity	mg/L as $CaCO_3$	51	46	53	52	52	51	45	56	59	55	53	55	52
Cu	mg/L	0.0016	0.0015	0.0016	0.0017	0.0017	0.0018	0.0017	0.0018	0.0014	0.0019	0.0013	0.0017	0.0018
SO_4	mg/L	7.7	7.5	7.9	8.2	8.3	8.2	8.1	8.2	8.5	8.6	8.8	8.6	8.3
Relative % - Copper Species														
Cu+	%	9.8E-03	9.9E-03	8.6E-03	9.1E-03	9.2E-03	9.4E-03	9.9E-03	8.0E-03	7.7E-03	1.3E-02	1.3E-02	0	0
CuCl	%	1.6E-04	1.6E-04	1.4E-04	1.5E-04	1.5E-04	1.5E-04	1.6E-04	1.3E-04	1.2E-04	2.1E-04	2.1E-04	0.0	0.0
CuCl2-	%	4.9E-07	4.9E-07	4.3E-07	4.5E-07	4.6E-07	4.7E-07	4.9E-07	4.0E-07	3.8E-07	6.4E-07	6.5E-07	6.1E-07	6.8E-07
CuCl3-2	%	1.5E-12	1.5E-12	1.3E-12	1.4E-12	1.4E-12	1.4E-12	1.5E-12	1.2E-12	1.2E-12	2.0E-12	2.0E-12	1.9E-12	2.1E-12
Cu+2	%	6.6	6.7	5.9	6.3	6.4	6.7	7.0	5.7	5.5	9.2	9.3	8.8	9.7
CuCO3	%	84	83	84	84	84	84	82	85	85	83	82	83	82
CuOH+	%	6.2	6.8	6.0	6.1	6.0	6.0	6.8	5.6	5.4	5.6	5.7	5.5	5.7
Cu(OH)2	%	2.4	2.9	2.6	2.5	2.5	2.4	3.0	2.5	2.4	1.5	1.6	1.6	1.6
Cu(CO3)2-2	%	0.7	0.7	0.8	0.7	0.7	0.7	0.6	0.9	0.9	0.5	0.5	0.5	0.5
CuHCO3+	%	2.4E-01	2.2E-01	2.2E-01	2.3E-01	2.4E-01	2.4E-01	2.2E-01	2.2E-01	2.3E-01	3.5E-01	3.4E-01	3.4E-01	3.6E-01
CuSO4	%	6.3E-02	6.3E-02	5.8E-02	6.4E-02	6.6E-02	6.7E-02	7.0E-02	5.7E-02	5.6E-02	9.6E-02	9.7E-02	9.1E-02	9.9E-02
Cu(OH)3-	%	4.4E-03	5.5E-03	5.2E-03	4.8E-03	4.6E-03	4.4E-03	5.7E-03	5.0E-03	4.8E-03	1.9E-03	2.0E-03	2.1E-03	1.9E-03
CuNH3+2	%	5.6E-03	6.2E-03	5.7E-03	5.9E-03	6.1E-03	6.2E-03	6.9E-03	5.7E-03	5.5E-03	6.1E-03	6.3E-03	6.2E-03	6.5E-03
Cu2(OH)2+2	%	2.4E-04	2.6E-04	2.2E-04	2.4E-04	2.4E-04	2.5E-04	2.9E-04	2.2E-04	1.6E-04	2.3E-04	1.7E-04	2.0E-04	2.3E-04
CuCl+	%	9.9E-05	1.0E-04	8.9E-05	9.5E-05	9.7E-05	1.0E-04	1.0E-04	8.5E-05	8.2E-05	1.4E-04	1.4E-04	1.3E-04	1.5E-04
CuNO3+	%	1.5E-04	1.5E-04	1.4E-04	1.6E-04	1.7E-04	1.7E-04	1.8E-04	1.4E-04	1.5E-04	2.5E-04	2.6E-04	2.4E-04	2.6E-04
CuNO2+	%	4.1E-05	4.2E-05	3.7E-05	3.9E-05	4.0E-05	4.1E-05	4.4E-05	3.5E-05	3.4E-05	5.7E-05	5.7E-05	5.4E-05	6.1E-05
Cu(OH)4-2	%	3.3E-08	4.5E-08	4.3E-08	3.8E-08	3.6E-08	3.4E-08	4.7E-08	4.2E-08	4.0E-08	9.7E-09	1.1E-08	1.1E-08	9.4E-09
CuCl2	%	1.8E-10	1.9E-10	1.6E-10	1.7E-10	1.7E-10	1.7E-10	1.8E-10	1.5E-10	1.4E-10	2.4E-10	2.4E-10	2.3E-10	2.5E-10
Cu(NO3)2	%	1.2E-10	1.2E-10	1.1E-10	1.4E-10	1.5E-10	1.5E-10	1.6E-10	1.3E-10	1.5E-10	2.5E-10	2.6E-10	2.3E-10	2.3E-10
Cu(NO2)2	%	2.7E-11	2.8E-11	2.4E-11	2.6E-11	2.7E-11	2.7E-11	2.9E-11	2.3E-11	2.2E-11	3.8E-11	3.8E-11	3.6E-11	4.0E-11
CuCl3-	%	1.7E-17	1.8E-17	1.5E-17	1.6E-17	1.6E-17	1.6E-17	1.7E-17	1.4E-17	1.3E-17	2.2E-17	2.2E-17	2.1E-17	2.3E-17
CuCl4-2	%	2.5E-24	2.5E-24	2.2E-24	2.3E-24	2.3E-24	2.4E-24	2.5E-24	2.0E-24	2.0E-24	3.3E-24	3.3E-24	3.1E-24	3.5E-24

[shaded box] Copper species account for greater than 1% of the total molality of copper.

Quesnel River, QUR-2 - Copper speciation with depth (Eh = 300 mV)

Date		11/25/2014	11/26/2014	11/27/2014	11/28/2014	11/29/2014	11/30/2014	12/1/2014	12/2/2014	12/3/2014	12/4/2014	12/5/2014	12/6/2014	12/7/2014
Time		10:56:00 AM	2:30:00 AM	11:15:00 AM	9:00:00 AM	9:00:00 AM	9:00:00 AM	10:11:00 AM	9:51:00 AM	9:45:00 AM	8:50:00 AM	10:14:00 AM	11:00:00 AM	10:32:00 AM
Charge Balance	%	-3.15	1.80	-2.09	2.01	-1.39	0.89	0.07	-6.67	0.32	-1.28	0.27	-0.54	-2.34
pH	s.u.	7.8	7.8	7.7	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
pe	s.u.	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
Alkalinity	mg/L as $CaCO_3$	54	50	54	49	53	52	53	62	53	55	53	53	55
Cu	mg/L	0.0017	0.0016	0.0017	0.0020	0.0019	0.0024	0.0020	0.0020	0.0021	0.0021	0.0022	0.0023	0.0021
SO_4	mg/L	8.3	8.3	8.5	8.6	9.0	9.3	9.4	9.5	9.4	9.5	9.4	9.7	9.7
Relative % - Copper Species														
Cu+	%	0	0	0	0	0	0	0	0	0	0	0	0	0
CuCl	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CuCl2-	%	6.1E-07	6.4E-07	6.9E-07	6.1E-07	5.6E-07	5.9E-07	5.8E-07	5.1E-07	5.9E-07	5.7E-07	5.6E-07	5.7E-07	5.6E-07
CuCl3-2	%	1.9E-12	2.0E-12	2.1E-12	1.9E-12	1.7E-12	1.8E-12	1.8E-12	1.6E-12	1.8E-12	1.7E-12	1.7E-12	1.7E-12	1.7E-12
Cu+2	%	8.8	9.4	10.2	9.1	8.7	9.3	9.0	8.0	9.2	8.9	8.8	8.9	8.6
CuCO3	%	83	82	82	82	83	82	83	85	83	83	83	83	83
CuOH+	%	5.6	6.0	5.5	5.9	5.5	5.5	5.5	4.7	5.4	5.3	5.4	5.4	5.3
Cu(OH)2	%	1.7	1.8	1.4	1.9	1.8	1.8	1.8	1.5	1.8	1.7	1.8	1.8	1.7
Cu(CO3)2-2	%	0.5	0.5	0.4	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.5
CuHCO3+	%	3.3E-01	3.3E-01	3.8E-01	3.1E-01	3.2E-01	3.3E-01	3.2E-01	3.4E-01	3.3E-01	3.3E-01	3.2E-01	3.2E-01	3.3E-01
CuSO4	%	8.9E-02	9.5E-02	1.0E-01	9.5E-02	9.3E-02	1.0E-01	1.0E-01	8.9E-02	1.0E-01	1.0E-01	9.7E-02	1.0E-01	9.9E-02
Cu(OH)3-	%	2.2E-03	2.4E-03	1.6E-03	2.6E-03	2.5E-03	2.3E-03	2.4E-03	2.0E-03	2.3E-03	2.2E-03	2.5E-03	2.4E-03	2.3E-03
CuNH3+2	%	6.4E-03	6.9E-03	6.6E-03	7.5E-03	7.5E-03	7.8E-03	7.7E-03	6.7E-03	7.8E-03	7.5E-03	7.8E-03	7.6E-03	7.3E-03
Cu2(OH)2+2	%	2.1E-04	2.2E-04	2.0E-04	2.7E-04	2.1E-04	2.7E-04	2.3E-04	1.7E-04	2.3E-04	2.2E-04	2.5E-04	2.5E-04	2.2E-04
CuCl+	%	1.3E-04	1.4E-04	1.5E-04	1.3E-04	1.3E-04	1.4E-04	1.3E-04	1.2E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04
CuNO3+	%	2.3E-04	2.5E-04	2.8E-04	2.6E-04	2.7E-04	3.0E-04	2.9E-04	2.6E-04	3.0E-04	3.0E-04	2.9E-04	2.9E-04	2.9E-04
CuNO2+	%	5.4E-05	5.8E-05	6.3E-05	5.7E-05	5.4E-05	5.8E-05	5.6E-05	4.9E-05	5.7E-05	5.5E-05	5.4E-05	5.5E-05	5.3E-05
Cu(OH)4-2	%	1.2E-08	1.3E-08	7.4E-09	1.5E-08	1.5E-08	1.3E-08	1.4E-08	1.1E-08	1.3E-08	1.2E-08	1.5E-08	1.4E-08	1.3E-08
CuCl2	%	2.2E-10	2.4E-10	2.5E-10	2.2E-10	2.0E-10	2.1E-10	2.1E-10	1.8E-10	2.1E-10	2.0E-10	2.0E-10	2.1E-10	2.0E-10
Cu(NO3)2	%	2.1E-10	2.4E-10	2.7E-10	2.5E-10	2.8E-10	3.3E-10	3.3E-10	2.9E-10	3.4E-10	3.4E-10	3.2E-10	3.3E-10	3.3E-10
Cu(NO2)2	%	3.6E-11	3.9E-11	4.2E-11	3.8E-11	3.6E-11	3.8E-11	3.7E-11	3.3E-11	3.8E-11	3.7E-11	3.6E-11	3.7E-11	3.5E-11
CuCl3-	%	2.1E-17	2.2E-17	2.3E-17	2.0E-17	1.8E-17	1.9E-17	1.9E-17	1.7E-17	1.9E-17	1.8E-17	1.8E-17	1.9E-17	1.8E-17
CuCl4-2	%	3.1E-24	3.3E-24	3.5E-24	3.1E-24	2.9E-24	3.0E-24	3.0E-24	2.6E-24	3.0E-24	2.9E-24	2.9E-24	2.9E-24	2.9E-24

[shaded box] Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-66 - Copper speciation with depth (Eh = 500 mV)

Date		8/19/2014	8/21/2014	8/24/2014	8/24/2014	8/26/2014	8/26/2014	8/26/2014	8/28/2014	8/28/2014	8/28/2014	8/30/2014
Time		3:30:00 AM	11:13:00 AM	2:26:00 AM	3:25:00 AM	2:15:00 AM	4:00:00 AM	2:45:00 AM	9:50:00 AM	12:30:00 PM	11:20:00 AM	11:09:00 AM
Depth		40	40	0	40	0	10	58	0	18	40	0
Charge Balance	%	1.58	1.05	2.66	-0.16	1.80	-3.20	0.88	-5.77	-0.83	-1.11	0.27
pH	s.u.	7.8	8.1	7.9	7.8	7.7	7.7	7.8	8.1	8.0	7.9	8.0
pe	s.u.	9.0	9.0	8.6	9.0	8.6	8.8	9.0	8.6	8.9	9.0	8.7
Alkalinity	mg/L as $CaCO_3$	60	59	44	59	44	52	62	45	50	60	45
Cu	mg/L	0.0055	0.0055	0.0009	0.0055	0.0010	0.0029	0.0053	0.0005	0.0034	0.0057	0.0006
SO_4	mg/L	18.1	16.5	5.7	16.9	5.9	6.7	18.8	5.3	6.4	16.2	5.7
Relative Percent (%) - Copper Species												
Cu+	%	2.6E-06	1.5E-06	6.1E-06	3.0E-06	8.6E-06	5.5E-06	2.7E-06	3.6E-06	2.3E-06	2.0E-06	4.0E-06
CuCl	%	5.1E-08	2.6E-08	1.0E-07	5.3E-08	1.4E-07	8.9E-08	5.4E-08	5.8E-07	3.7E-08	3.4E-08	6.5E-08
CuCl2-	%	1.9E-10	9.0E-11	3.0E-10	1.8E-10	4.2E-10	2.7E-10	2.1E-10	1.7E-08	1.1E-10	1.1E-10	1.9E-10
CuCl3-2	%	7.3E-16	3.1E-16	9.6E-16	6.2E-16	1.3E-15	8.5E-16	7.9E-16	5.6E-13	3.5E-16	3.5E-16	6.2E-16
Cu+2	%	7.6	4.2	6.7	8.1	9.3	9.3	8.1	3.8	5.1	6.1	4.4
CuCO3	%	84	85	81	84	79	81	84	82	84	85	82
CuOH+	%	5.2	5.5	9.8	5.5	9.4	7.1	5.1	9.8	6.8	5.3	9.7
Cu(OH)2	%	1.6	3.3	1.9	1.5	1.3	1.2	1.5	3.2	3.0	2.2	2.9
Cu(CO3)2-2	%	0.7	1.2	0.6	0.6	0.4	0.5	0.6	1.2	0.9	0.8	1.0
CuHCO3+	%	3.2E-01	1.7E-01	2.7E-01	3.4E-01	3.8E-01	3.9E-01	3.4E-01	1.6E-01	1.9E-01	2.5E-01	1.8E-01
CuSO4	%	1.6E-01	8.0E-02	5.5E-02	1.6E-01	7.9E-02	8.4E-02	1.7E-01	2.9E-02	4.2E-02	1.1E-01	3.6E-02
Cu(OH)3-	%	2.3E-03	8.9E-03	3.0E-03	2.0E-03	1.4E-03	1.4E-03	2.0E-03	8.7E-03	6.8E-03	4.0E-03	6.8E-03
CuNH3+2	%	5.8E-02	4.3E-02	1.8E-03	4.7E-02	1.7E-03	3.2E-03	6.6E-02	1.6E-03	6.8E-03	6.0E-02	1.7E-03
Cu2(OH)2+2	%	5.8E-04	6.5E-04	3.7E-04	6.4E-04	3.6E-04	5.9E-04	5.3E-04	2.2E-04	6.1E-04	6.1E-04	2.3E-04
CuCl+	%	1.4E-04	6.9E-05	1.2E-04	1.3E-04	1.6E-04	1.5E-04	1.4E-04	6.6E-04	8.0E-05	9.2E-05	7.7E-05
CuNO3+	%	3.6E-04	1.8E-04	7.0E-05	3.6E-04	9.0E-05	1.6E-04	4.1E-04	3.7E-05	1.2E-04	2.7E-04	3.9E-05
CuNO2+	%	7.4E-05	3.6E-05	4.2E-05	6.9E-05	5.8E-05	5.8E-05	1.1E-04	2.4E-04	3.2E-05	5.2E-05	2.8E-05
Cu(OH)4-2	%	1.4E-08	1.0E-07	1.9E-08	1.1E-08	6.2E-09	6.2E-09	1.1E-08	1.0E-07	6.5E-08	3.1E-08	6.7E-08
CuCl2	%	2.8E-10	1.3E-10	3.8E-10	2.6E-10	5.3E-10	3.7E-10	3.0E-10	2.2E-08	1.6E-10	1.6E-10	2.5E-10
Cu(NO3)2	%	5.9E-10	2.7E-10	3.0E-11	5.7E-10	3.5E-11	9.9E-11	7.4E-10	1.5E-11	1.0E-10	4.1E-10	1.4E-11
Cu(NO2)2	%	7.7E-11	3.3E-11	2.8E-11	6.3E-11	3.9E-11	3.9E-11	1.7E-10	1.6E-09	2.1E-11	4.8E-11	1.9E-11
CuCl3-	%	3.2E-17	1.4E-17	4.4E-17	2.7E-17	6.2E-17	3.9E-17	3.5E-17	2.6E-14	1.6E-17	1.5E-17	2.9E-17
CuCl4-2	%	5.9E-24	2.3E-24	4.3E-24	4.3E-24	5.9E-24	4.5E-24	6.5E-24	2.4E-20	2.1E-24	2.4E-24	2.8E-24

[shaded box] Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-66 - Copper speciation with depth (Eh = 500 mV)

Date		8/30/2014	8/30/2014	9/3/2014	9/3/2014	9/3/2014	9/7/2014	9/7/2014	9/7/2014	9/9/2014	9/9/2014	9/11/2014
Time		11:09:00 AM	11:09:00 AM	2:51:00 AM	3:18:00 AM	3:30:00 AM	10:45:00 AM	11:30:00 AM	12:00:00 PM	3:30:00 AM	3:40:00 AM	2:33:00 AM
Depth		16	39	0	14	45	0	10	50	0	46	0
Charge Balance	%	0.13	0.57	-0.14	-0.73	-0.89	-2.53	-0.56	-0.56	-2.70	-1.30	-2.46
pH	s.u.	7.7	7.9	7.8	7.7	7.8	8.1	7.8	8.0	8.0	8.0	8.0
pe	s.u.	8.9	9.0	8.6	9.0	9.0	8.7	8.7	9.0	8.7	9.0	8.8
Alkalinity	mg/L as $CaCO_3$	49	60	45	49	60	47	47	60	48	62	49
Cu	mg/L	0.0040	0.0060	0.0007	0.0017	0.0062	0.0007	0.0016	0.0066	0.0013	0.0066	0.0011
SO_4	mg/L	6.2	18.2	5.8	6.2	17.8	5.8	6.1	17.4	5.9	18.2	6.0
Relative Percent (%) - Copper Species												
Cu+	%	5.5E-06	2.4E-06	6.9E-06	4.0E-06	2.9E-06	3.2E-06	5.3E-06	1.7E-06	3.8E-06	1.6E-06	3.1E-06
CuCl	%	8.9E-08	4.7E-08	1.1E-07	6.5E-08	5.2E-08	5.2E-08	8.6E-08	3.1E-08	6.2E-08	3.1E-08	5.0E-08
CuCl2-	%	2.7E-10	1.8E-10	3.4E-10	2.0E-10	1.8E-10	1.6E-10	2.6E-10	1.1E-10	1.9E-10	1.2E-10	1.5E-10
CuCl3-2	%	8.4E-16	6.9E-16	1.1E-15	6.1E-16	6.5E-16	5.0E-16	8.2E-16	3.8E-16	6.0E-16	4.3E-16	4.8E-16
Cu+2	%	11.4	6.9	7.5	12.5	8.3	3.9	7.5	4.9	4.8	4.8	5.7
CuCO3	%	80	85	81	80	84	83	82	86	83	86	83
CuOH+	%	6.8	5.3	9.4	5.7	5.2	9.0	8.2	5.3	8.7	5.2	7.3
Cu(OH)2	%	1.2	1.9	1.5	1.3	1.5	3.2	1.7	2.7	2.5	2.6	2.4
Cu(CO3)2-2	%	0.4	0.7	0.6	0.3	0.6	1.2	0.6	1.1	0.9	1.1	0.8
CuHCO3+	%	4.3E-01	2.8E-01	3.1E-01	4.3E-01	3.4E-01	1.6E-01	3.0E-01	2.0E-01	2.0E-01	2.0E-01	2.2E-01
CuSO4	%	9.1E-02	1.4E-01	6.3E-02	9.5E-02	1.7E-01	3.2E-02	6.4E-02	9.9E-02	4.1E-02	1.0E-01	4.6E-02
Cu(OH)3-	%	1.2E-03	3.0E-03	2.0E-03	1.3E-03	1.9E-03	8.4E-03	2.3E-03	6.0E-03	5.2E-03	5.8E-03	4.7E-03
CuNH3+2	%	5.7E-03	7.6E-02	1.7E-03	7.6E-03	5.4E-02	1.9E-03	2.5E-03	5.3E-02	2.0E-03	6.5E-02	3.4E-03
Cu2(OH)2+2	%	7.2E-04	6.5E-04	2.7E-04	2.0E-04	6.5E-04	2.3E-04	4.5E-04	7.3E-04	4.0E-04	6.9E-04	2.4E-04
CuCl+	%	1.8E-04	1.3E-04	1.3E-04	1.8E-04	1.4E-04	6.6E-05	1.3E-04	8.2E-05	8.2E-05	8.3E-05	9.2E-05
CuNO3+	%	2.5E-04	3.0E-04	5.8E-05	3.4E-04	3.1E-04	3.1E-05	5.9E-05	1.8E-04	4.5E-05	2.0E-04	9.1E-05
CuNO2+	%	7.1E-05	1.2E-04	4.7E-05	7.8E-05	1.3E-04	2.4E-05	4.7E-05	1.0E-04	3.0E-05	7.0E-05	3.6E-05
Cu(OH)4-2	%	4.8E-09	2.0E-08	1.1E-08	5.2E-09	1.1E-08	9.4E-08	1.4E-08	5.7E-08	4.7E-08	5.6E-08	3.8E-08
CuCl2	%	3.8E-10	2.6E-10	4.2E-10	3.0E-10	2.7E-10	2.0E-10	3.4E-10	1.6E-10	2.4E-10	1.7E-10	2.1E-10
Cu(NO3)2	%	2.1E-10	4.6E-10	1.8E-11	3.3E-10	4.0E-10	9.9E-12	1.8E-11	2.2E-10	1.6E-11	3.0E-10	5.3E-11
Cu(NO2)2	%	4.7E-11	2.2E-10	3.2E-11	5.2E-11	2.1E-10	1.6E-11	3.2E-11	2.4E-10	2.0E-11	1.1E-10	2.4E-11
CuCl3-	%	3.8E-17	3.0E-17	5.0E-17	2.8E-17	2.9E-17	2.3E-17	3.8E-17	1.7E-17	2.7E-17	1.9E-17	2.2E-17
CuCl4-2	%	4.9E-24	5.7E-24	4.8E-24	4.2E-24	4.9E-24	2.3E-24	4.1E-24	2.9E-24	2.8E-24	3.5E-24	2.7E-24

(Shaded) Copper species account for greater than 1% of the total molality of copper.

Detailed Copper Speciation Results

Quesnel Lake West Basin, QUL-66 - Copper speciation with depth (Eh = 500 mV)

Date		9/11/2014	9/11/2014	9/13/2014	9/13/2014	9/13/2014	9/15/2014	9/15/2014	9/15/2014	9/16/2014	9/16/2014	9/18/2014
Time		2:57:00 AM	2:22:00 AM	3:00:00 AM	3:20:00 AM	3:40:00 AM	2:35:00 AM	3:30:00 AM	2:56:00 AM	11:15:00 AM	11:00:00 AM	12:30:00 PM
Depth		34	50	0	10	48	0	24	48	0	40	0
Charge Balance	%	-3.48	-1.39	-0.89	-2.07	-0.42	-1.21	-1.80	1.25	-1.49	-0.74	-0.56
pH	s.u.	8.2	8.1	7.9	7.9	8.0	8.0	7.7	7.9	7.9	7.9	8.0
pe	s.u.	9.0	9.0	8.8	8.9	9.0	8.7	9.0	9.0	8.8	9.0	8.8
Alkalinity	mg/L as $CaCO_3$	62	59	48	49	60	48	53	58	48	59	47
Cu	mg/L	0.0064	0.0053	0.0006	0.0015	0.0062	0.0005	0.0027	0.0060	0.0005	0.0055	0.0005
SO_4	mg/L	17.3	13.7	6.0	6.4	17.1	6.1	7.5	16.3	6.0	14.6	6.1
Relative Percent (%) - Copper Species												
Cu+	%	1.2E-06	1.5E-06	4.3E-06	2.9E-06	1.8E-06	3.4E-06	3.5E-06	2.2E-06	4.1E-06	2.2E-06	3.2E-06
CuCl	%	2.1E-08	2.4E-08	6.9E-08	4.8E-08	3.2E-08	5.5E-08	5.7E-08	3.5E-08	6.6E-08	3.5E-08	5.1E-08
CuCl2-	%	7.1E-11	7.4E-11	2.1E-10	1.5E-10	1.1E-10	1.6E-10	1.8E-10	1.1E-10	2.0E-10	1.1E-10	1.5E-10
CuCl3-2	%	2.5E-16	2.3E-16	6.6E-16	4.5E-16	3.5E-16	5.2E-16	5.4E-16	3.3E-16	6.3E-16	3.3E-16	4.9E-16
Cu+2	%	3.3	4.4	6.2	6.0	5.4	4.8	10.6	6.5	6.4	6.4	4.5
CuCO3	%	86	86	82	83	86	83	82	85	83	85	83
CuOH+	%	5.2	5.4	8.2	7.0	5.3	8.3	5.6	5.4	7.9	5.3	8.4
Cu(OH)2	%	3.8	3.2	2.1	2.4	2.4	2.7	1.4	2.1	2.1	2.1	2.9
Cu(CO3)2-2	%	1.6	1.2	0.7	0.8	1.0	0.9	0.4	0.8	0.7	0.8	1.0
CuHCO3+	%	1.4E-01	1.8E-01	2.5E-01	2.3E-01	2.2E-01	1.9E-01	3.9E-01	2.6E-01	2.6E-01	2.6E-01	1.8E-01
CuSO4	%	6.6E-02	7.0E-02	5.1E-02	5.0E-02	1.1E-01	4.0E-02	9.7E-02	1.2E-01	5.2E-02	1.1E-01	3.8E-02
Cu(OH)3-	%	1.2E-02	8.1E-03	3.6E-03	4.6E-03	5.0E-03	6.0E-03	1.5E-03	3.7E-03	3.4E-03	3.6E-03	7.0E-03
CuNH3+2	%	4.4E-02	4.3E-02	2.5E-03	4.0E-03	6.1E-02	2.4E-03	8.0E-03	6.1E-02	2.8E-03	4.3E-02	2.5E-03
Cu2(OH)2+2	%	6.8E-04	6.0E-04	1.6E-04	2.9E-04	6.8E-04	1.4E-04	3.2E-04	6.9E-04	1.3E-04	6.0E-04	1.4E-04
CuCl+	%	5.4E-05	6.4E-05	1.0E-04	9.5E-05	8.5E-05	8.0E-05	1.6E-04	9.5E-05	1.0E-04	9.3E-05	7.6E-05
CuNO3+	%	1.2E-04	1.5E-04	8.1E-05	9.1E-05	2.1E-04	5.9E-05	3.2E-04	2.5E-04	8.0E-05	2.4E-04	5.2E-05
CuNO2+	%	6.2E-05	5.4E-05	3.9E-05	3.8E-05	7.6E-05	3.0E-05	6.6E-05	9.1E-05	4.0E-05	5.5E-05	2.9E-05
Cu(OH)4-2	%	1.7E-07	8.8E-08	2.6E-08	3.7E-08	4.4E-08	5.6E-08	7.1E-09	2.7E-08	2.4E-08	2.7E-08	6.9E-08
CuCl2	%	1.0E-10	1.1E-10	2.8E-10	2.0E-10	1.6E-10	2.2E-10	2.6E-10	1.6E-10	2.7E-10	1.6E-10	2.0E-10
Cu(NO3)2	%	1.6E-10	1.8E-10	4.1E-11	5.1E-11	2.9E-10	2.8E-11	3.3E-10	3.4E-10	3.8E-11	3.2E-10	2.3E-11
Cu(NO2)2	%	1.3E-10	7.1E-11	2.6E-11	2.5E-11	1.1E-10	2.0E-11	4.4E-11	1.4E-10	2.7E-11	5.0E-11	1.9E-11
CuCl3-	%	1.1E-17	1.0E-17	3.0E-17	2.1E-17	1.6E-17	2.4E-17	2.4E-17	1.5E-17	2.9E-17	1.5E-17	2.2E-17
CuCl4-2	%	1.8E-24	1.5E-24	3.3E-24	2.6E-24	2.5E-24	2.6E-24	3.7E-24	2.2E-24	3.3E-24	2.2E-24	2.4E-24

[shaded box] Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-66 - Copper speciation with depth (Eh = 500 mV)

Date		9/18/2014	9/18/2014	9/20/2014	9/20/2014	9/20/2014	9/23/2014	9/23/2014	9/23/2014	9/29/2014	9/29/2014	9/29/2014
Time		12:45:00 PM	1:00:00 AM	1:30:00 AM	1:45:00 AM	2:15:00 AM	1:00:00 AM	1:15:00 AM	1:30:00 AM	11:15:00 AM	11:30:00 AM	11:45:00 AM
Depth		15	40	0	15	45	0	15	50	0	40	50
Charge Balance	%	-0.58	-0.27	-2.53	-4.82	-0.60	-3.27	-2.86	-2.65	-3.14	-2.48	-3.09
pH	s.u.	7.8	7.7	8.0	8.1	8.0	8.0	8.0	7.8	8.2	7.8	7.9
pe	s.u.	8.9	9.0	8.7	8.9	9.0	8.7	8.8	9.0	8.8	9.0	9.0
Alkalinity	mg/L as $CaCO_3$	50	60	48	53	57	50	50	63	51	60	63
Cu	mg/L	0.0037	0.0060	0.0005	0.0028	0.0058	0.0006	0.0007	0.0067	0.0008	0.0057	0.0066
SO_4	mg/L	7.0	15.8	6.0	7.2	16.7	6.1	6.1	16.2	6.1	14.7	16.7
Relative Percent (%) - Copper Species												
Cu+	%	4.1E-06	3.1E-06	3.2E-06	2.1E-06	2.0E-06	3.4E-06	3.6E-06	2.5E-06	2.2E-06	2.9E-06	2.3E-06
CuCl	%	6.7E-08	5.0E-08	5.2E-08	3.4E-08	3.6E-08	5.4E-08	5.9E-08	4.2E-08	3.6E-08	4.7E-08	3.9E-08
CuCl2-	%	2.0E-10	1.5E-10	1.6E-10	1.0E-10	1.2E-10	1.6E-10	1.8E-10	1.4E-10	1.1E-10	1.5E-10	1.3E-10
CuCl3-2	%	6.4E-16	4.7E-16	5.0E-16	3.2E-16	4.3E-16	5.2E-16	5.6E-16	4.6E-16	3.5E-16	4.5E-16	4.1E-16
Cu+2	%	8.4	9.1	4.6	4.3	5.8	4.7	5.2	7.4	3.4	8.7	6.7
CuCO3	%	82	83	83	85	85	83	83	85	84	84	85
CuOH+	%	6.8	5.2	8.3	6.7	5.5	8.1	8.0	5.0	7.8	5.1	5.0
Cu(OH)2	%	1.6	1.4	2.8	3.1	2.4	2.5	2.3	1.6	3.6	1.4	1.7
Cu(CO3)2-2	%	0.5	0.5	1.0	1.1	0.9	1.0	0.9	0.7	1.4	0.6	0.8
CuHCO3+	%	3.3E-01	3.7E-01	1.9E-01	1.7E-01	2.3E-01	2.0E-01	2.2E-01	3.2E-01	1.4E-01	3.6E-01	2.9E-01
CuSO4	%	7.6E-02	1.7E-01	3.8E-02	4.0E-02	1.1E-01	3.9E-02	4.4E-02	1.4E-01	2.8E-02	1.5E-01	1.3E-01
Cu(OH)3-	%	2.1E-03	1.6E-03	6.5E-03	8.0E-03	4.7E-03	5.5E-03	4.6E-03	2.3E-03	1.1E-02	1.8E-03	2.7E-03
CuNH3+2	%	4.0E-03	5.4E-02	2.4E-03	5.3E-03	5.3E-02	2.9E-03	2.4E-03	5.2E-02	2.4E-03	4.7E-02	5.3E-02
Cu2(OH)2+2	%	6.8E-04	6.2E-04	1.4E-04	5.0E-04	6.9E-04	1.5E-04	1.8E-04	6.5E-04	1.9E-04	5.8E-04	6.4E-04
CuCl+	%	1.3E-04	1.3E-04	7.6E-05	6.7E-05	9.6E-05	7.9E-05	8.7E-05	1.1E-04	5.6E-05	1.3E-04	1.0E-04
CuNO3+	%	1.2E-04	3.4E-04	5.1E-05	7.6E-05	2.3E-04	5.1E-05	5.6E-05	2.8E-04	3.7E-05	3.3E-04	2.6E-04
CuNO2+	%	5.2E-05	1.2E-04	2.9E-05	2.7E-05	7.5E-05	2.9E-05	3.3E-05	9.5E-05	2.1E-05	1.1E-04	1.2E-04
Cu(OH)4-2	%	1.2E-08	8.1E-09	6.4E-08	8.6E-08	3.9E-08	5.0E-08	3.8E-08	1.4E-08	1.4E-07	9.3E-09	1.8E-08
CuCl2	%	2.9E-10	2.3E-10	2.1E-10	1.4E-10	1.8E-10	2.2E-10	2.3E-10	2.0E-10	1.5E-10	2.1E-10	1.9E-10
Cu(NO3)2	%	6.5E-11	4.6E-10	2.2E-11	4.9E-11	3.2E-10	2.2E-11	2.3E-11	3.7E-10	1.5E-11	4.3E-10	3.5E-10
Cu(NO2)2	%	3.5E-11	1.8E-10	1.9E-11	1.8E-11	1.0E-10	2.0E-11	2.2E-11	1.3E-10	1.4E-11	1.6E-10	2.2E-10
CuCl3-	%	2.9E-17	2.1E-17	2.3E-17	1.5E-17	1.9E-17	2.4E-17	2.6E-17	2.0E-17	1.6E-17	2.0E-17	1.8E-17
CuCl4-2	%	3.7E-24	3.2E-24	2.5E-24	1.9E-24	3.2E-24	2.6E-24	2.8E-24	3.2E-24	1.8E-24	3.0E-24	2.9E-24

(shaded) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-66 - Copper speciation with depth (Eh = 500 mV)

Date		10/1/2014	10/1/2014	10/1/2014	10/8/2014	10/8/2014	10/8/2014	10/15/2014	10/15/2014	10/15/2014	10/18/2014	10/18/2014
Time		11:15:00 AM	11:30:00 AM	11:45:00 AM	11:00:00 AM	11:20:00 AM	11:40:00 AM	11:15:00 AM	11:30:00 AM	11:45:00 AM	10:45:00 AM	11:00:00 AM
Depth		0	40	50	0	40	45	0	40	48	0	40
Charge Balance	%	-3.52	-2.69	-0.71	-0.52	-0.15	-1.25	-2.04	-1.22	-0.53	-4.63	-4.51
pH	s.u.	7.9	7.8	7.8	8.1	7.8	7.8	8.1	7.8	7.9	7.9	7.5
pe	s.u.	8.8	9.0	9.0	8.8	9.0	9.0	8.8	9.0	9.0	8.9	9.0
Alkalinity	mg/L as $CaCO_3$	49	62	61	48	52	54	48	54	55	52	56
Cu	mg/L	0.0006	0.0074	0.0091	0.0010	0.0029	0.0032	0.0009	0.0037	0.0047	0.0010	0.0032
SO_4	mg/L	6.0	16.7	17.1	6.2	9.1	9.7	6.4	11.0	13.1	6.4	9.6
Relative Percent (%) - Copper Species												
Cu+	%	3.9E-06	2.9E-06	2.7E-06	2.3E-06	2.8E-06	2.7E-06	2.0E-06	2.7E-06	2.4E-06	3.0E-06	4.7E-06
CuCl	%	6.4E-08	6.8E-08	6.5E-08	3.7E-08	4.6E-08	4.3E-08	3.3E-08	4.3E-08	3.9E-08	4.9E-08	7.5E-08
CuCl2-	%	1.9E-10	3.2E-10	3.0E-10	1.1E-10	1.4E-10	1.3E-10	1.0E-10	1.3E-10	1.2E-10	1.5E-10	2.3E-10
CuCl3-2	%	6.1E-16	1.5E-15	1.4E-15	3.6E-16	4.3E-16	4.0E-16	3.2E-16	4.1E-16	3.7E-16	4.6E-16	7.1E-16
Cu+2	%	5.9	8.3	8.0	3.9	8.7	8.1	3.8	8.2	7.4	5.8	14.0
CuCO3	%	83	84	84	83	83	83	83	83	84	84	79
CuOH+	%	7.9	5.1	5.2	7.8	5.6	5.5	7.5	5.6	5.5	6.9	5.1
Cu(OH)2	%	2.1	1.4	1.6	3.6	1.8	1.9	3.9	1.9	2.0	2.2	0.9
Cu(CO3)2-2	%	0.8	0.6	0.6	1.2	0.5	0.6	1.2	0.6	0.7	0.8	0.3
CuHCO3+	%	2.4E-01	3.5E-01	3.3E-01	1.5E-01	3.2E-01	3.0E-01	1.4E-01	3.0E-01	2.8E-01	2.4E-01	5.5E-01
CuSO4	%	4.9E-02	1.6E-01	1.6E-01	3.2E-02	9.6E-02	9.5E-02	3.2E-02	1.1E-01	1.1E-01	4.9E-02	1.6E-01
Cu(OH)3-	%	3.7E-03	1.8E-03	2.1E-03	1.0E-02	2.5E-03	2.7E-03	1.2E-02	2.7E-03	3.2E-03	4.1E-03	6.7E-04
CuNH3+2	%	2.6E-03	5.5E-02	5.7E-02	3.0E-03	2.1E-02	2.1E-02	3.4E-03	2.5E-02	3.4E-02	3.5E-03	1.4E-02
Cu2(OH)2+2	%	1.5E-04	7.4E-04	9.7E-04	2.4E-04	3.6E-04	3.7E-04	2.0E-04	4.5E-04	5.5E-04	1.9E-04	3.1E-04
CuCl+	%	9.8E-05	1.8E-04	1.7E-04	6.3E-05	1.3E-04	1.2E-04	6.1E-05	1.2E-04	1.1E-04	9.2E-05	2.1E-04
CuNO3+	%	6.4E-05	3.3E-04	3.2E-04	4.9E-05	3.0E-04	2.8E-04	6.2E-05	2.9E-04	2.8E-04	8.5E-05	4.9E-04
CuNO2+	%	3.7E-05	1.3E-04	1.5E-04	2.4E-05	5.4E-05	5.0E-05	2.4E-05	7.6E-05	1.8E-04	3.6E-05	8.7E-05
Cu(OH)4-2	%	2.7E-08	9.7E-09	1.2E-08	1.2E-07	1.5E-08	1.6E-08	1.5E-07	1.7E-08	2.1E-08	3.2E-08	2.1E-09
CuCl2	%	2.6E-10	4.7E-10	4.4E-10	1.5E-10	2.1E-10	2.0E-10	1.4E-10	2.0E-10	1.8E-10	2.1E-10	3.5E-10
Cu(NO3)2	%	2.7E-11	4.6E-10	4.5E-10	2.3E-11	3.6E-10	3.3E-10	3.7E-11	3.6E-10	3.8E-10	4.6E-11	6.0E-10
Cu(NO2)2	%	2.5E-11	2.2E-10	2.9E-10	1.6E-11	3.6E-11	3.3E-11	1.6E-11	7.5E-11	4.5E-10	2.4E-11	5.8E-11
CuCl3-	%	2.8E-17	6.5E-17	6.0E-17	1.6E-17	1.9E-17	1.8E-17	1.4E-17	1.8E-17	1.7E-17	2.1E-17	3.2E-17
CuCl4-2	%	3.1E-24	1.5E-23	1.3E-23	1.9E-24	3.0E-24	2.8E-24	1.8E-24	2.8E-24	2.5E-24	2.6E-24	4.8E-24

Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-66 - Copper speciation with depth (Eh = 500 mV)

Date		10/18/2014	10/27/2014	10/27/2014	10/27/2014	11/1/2014	11/1/2014	11/1/2014	11/6/2014	11/6/2014	11/6/2014	11/16/2014
Time		11:45:00 AM	2:00:00 AM	2:15:00 AM	2:30:00 AM	11:00:00 AM	11:15:00 AM	11:30:00 AM	11:30:00 AM	12:00:00 PM	12:30:00 PM	1:00:00 AM
Depth		50	0	40	50	0	40	48	0	40	55	0
Charge Balance	%	-4.29	-4.57	0.13	0.70	-1.22	-0.17	1.15	0.71	4.04	-0.20	2.30
pH	s.u.	7.6	8.0	7.8	7.8	8.2	8.0	7.9	8.2	7.9	7.8	8.1
pe	s.u.	9.0	8.9	9.0	9.0	8.9	9.0	9.0	8.9	9.0	9.0	9.0
Alkalinity	mg/L as $CaCO_3$	58	53	54	54	48	53	52	47	48	54	46
Cu	mg/L	0.0036	0.0010	0.0033	0.0034	0.0013	0.0031	0.0035	0.0013	0.0026	0.0034	0.0015
SO_4	mg/L	11.1	6.6	11.2	11.6	6.7	11.2	11.8	6.9	9.7	11.2	7.7
Relative Percent (%) - Copper Species												
Cu+	%	4.4E-06	2.2E-06	2.8E-06	2.9E-06	1.6E-06	2.0E-06	2.2E-06	1.5E-06	2.9E-06	3.0E-06	1.9E-06
CuCl	%	7.1E-08	3.6E-08	4.4E-08	4.7E-08	2.5E-08	3.2E-08	3.5E-08	2.5E-08	4.6E-08	4.8E-08	3.0E-08
CuCl2-	%	2.2E-10	1.1E-10	1.4E-10	1.4E-10	7.7E-11	9.9E-11	1.1E-10	7.6E-11	1.4E-10	1.5E-10	9.3E-11
CuCl3-2	%	6.8E-16	3.4E-16	4.2E-16	4.4E-16	2.4E-16	3.0E-16	3.3E-16	2.3E-16	4.4E-16	4.5E-16	2.8E-16
Cu+2	%	13.6	4.6	8.1	8.7	3.4	5.8	6.4	3.5	7.5	8.6	5.1
CuCO3	%	80	85	83	83	83	84	84	83	83	83	83
CuOH+	%	5.0	6.6	5.7	5.6	7.1	5.9	5.9	7.1	6.6	5.6	6.8
Cu(OH)2	%	0.9	2.8	1.9	1.7	4.7	2.8	2.6	4.9	2.4	1.7	3.9
Cu(CO3)2-2	%	0.3	1.0	0.6	0.5	1.4	0.8	0.7	1.3	0.6	0.5	0.9
CuHCO3+	%	5.4E-01	1.9E-01	3.0E-01	3.2E-01	1.2E-01	2.1E-01	2.3E-01	1.2E-01	2.6E-01	3.2E-01	1.7E-01
CuSO4	%	1.8E-01	4.0E-02	1.1E-01	1.2E-01	2.9E-02	7.8E-02	9.1E-02	3.1E-02	8.9E-02	1.1E-01	4.9E-02
Cu(OH)3-	%	6.9E-04	6.6E-03	2.7E-03	2.3E-03	1.7E-02	5.8E-03	4.9E-03	1.7E-02	4.0E-03	2.3E-03	1.0E-02
CuNH3+2	%	1.9E-02	3.8E-03	7.3E-03	7.5E-03	4.0E-03	6.2E-03	6.5E-03	4.5E-03	6.0E-03	6.3E-03	6.2E-03
Cu2(OH)2+2	%	3.4E-04	1.7E-04	4.1E-04	4.1E-04	2.5E-04	4.1E-04	4.6E-04	2.5E-04	4.4E-04	4.2E-04	2.7E-04
CuCl+	%	2.0E-04	7.3E-05	1.2E-04	1.3E-04	5.3E-05	8.5E-05	9.5E-05	5.4E-05	1.1E-04	1.3E-04	7.7E-05
CuNO3+	%	5.1E-04	7.2E-05	3.1E-04	3.4E-04	5.5E-05	2.3E-04	2.7E-04	6.5E-05	2.5E-04	3.4E-04	1.2E-04
CuNO2+	%	1.6E-04	2.9E-05	3.3E-04	4.0E-04	2.3E-05	5.7E-05	6.8E-05	2.2E-05	4.6E-05	5.3E-05	3.2E-05
Cu(OH)4-2	%	2.3E-09	6.5E-08	1.6E-08	1.3E-08	2.5E-07	5.1E-08	3.9E-08	2.6E-07	2.9E-08	1.3E-08	1.1E-07
CuCl2	%	3.3E-10	1.6E-10	2.0E-10	2.2E-10	1.1E-10	1.5E-10	1.6E-10	1.1E-10	2.1E-10	2.2E-10	1.4E-10
Cu(NO3)2	%	6.6E-10	4.1E-11	4.1E-10	4.6E-10	3.2E-11	3.3E-10	3.9E-10	4.4E-11	3.0E-10	4.8E-10	1.0E-10
Cu(NO2)2	%	2.0E-10	1.9E-11	1.4E-09	2.0E-09	1.7E-11	6.0E-11	7.6E-11	1.5E-11	3.1E-11	3.5E-11	2.1E-11
CuCl3-	%	3.0E-17	1.6E-17	1.9E-17	2.0E-17	1.1E-17	1.4E-17	1.5E-17	1.1E-17	2.0E-17	2.0E-17	1.3E-17
CuCl4-2	%	4.6E-24	2.0E-24	2.8E-24	3.0E-24	1.4E-24	2.0E-24	2.2E-24	1.4E-24	2.8E-24	3.0E-24	1.9E-24

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-66 - Copper speciation with depth (Eh = 500 mV)

Date		11/16/2014	11/16/2014	11/25/2014	11/25/2014	11/25/2014	12/15/2014	12/15/2014	12/15/2014	1/15/2015	1/15/2015
Time		12:30:00 PM	12:45:00 PM	11:40:00 AM	12:10:00 PM	12:45:00 PM	11:00:00 AM	12:00:00 PM	1:00:00 AM	10:30:00 AM	11:30:00 AM
Depth		40	50	0	20	45	0	20	40	0	85
Charge Balance	%	-1.24	2.29	-1.19	0.10	-1.81	-1.01	-0.95	-0.91	-0.55	-0.46
pH	s.u.	7.9	7.9	7.8	7.7	7.7	8.0	7.8	7.8	7.9	8.1
pe	s.u.	9.0	9.0	9.0	9.0	9.0	9.1	9.1	9.1	9.1	9.1
Alkalinity	mg/L as $CaCO_3$	54	50	51	50	52	52	52	52	51	51
Cu	mg/L	0.0028	0.0030	0.0021	0.0021	0.0021	0.0020	0.0020	0.0021	0.0019	0.0020
SO_4	mg/L	11.2	11.7	8.9	9.0	8.9	9.0	9.0	8.9	8.6	8.7
Relative Percent (%) - Copper Species											
Cu+	%	2.2E-06	2.6E-06	3.0E-06	3.5E-06	3.8E-06	1.6E-06	2.8E-06	2.8E-06	2.0E-06	1.3E-06
CuCl	%	3.6E-08	4.2E-08	4.8E-08	5.7E-08	6.2E-08	2.6E-08	4.5E-08	4.4E-08	3.2E-08	2.1E-08
CuCl2-	%	1.1E-10	1.3E-10	1.5E-10	1.7E-10	1.9E-10	8.0E-11	1.4E-10	1.4E-10	1.0E-10	6.6E-11
CuCl3-2	%	3.6E-16	4.0E-16	4.5E-16	5.4E-16	5.9E-16	2.4E-16	4.3E-16	4.2E-16	3.0E-16	2.0E-16
Cu+2	%	6.1	7.4	8.5	10.1	11.0	5.3	9.3	9.1	7.6	4.9
CuCO3	%	84	83	83	81	81	85	83	83	83	84
CuOH+	%	5.8	6.2	5.9	5.9	5.7	5.7	5.5	5.5	5.4	5.5
Cu(OH)2	%	2.5	2.3	1.9	1.6	1.3	3.4	1.8	1.8	2.6	4.0
Cu(CO3)2-2	%	0.8	0.6	0.5	0.4	0.4	0.9	0.5	0.5	0.6	1.0
CuHCO3+	%	2.3E-01	2.6E-01	3.1E-01	3.6E-01	4.1E-01	1.9E-01	3.3E-01	3.2E-01	2.5E-01	1.6E-01
CuSO4	%	8.3E-02	1.0E-01	9.3E-02	1.1E-01	1.2E-01	5.7E-02	1.0E-01	9.7E-02	7.7E-02	5.0E-02
Cu(OH)3-	%	4.7E-03	3.9E-03	2.6E-03	1.9E-03	1.4E-03	8.0E-03	2.3E-03	2.5E-03	4.4E-03	1.1E-02
CuNH3+2	%	5.8E-03	6.5E-03	6.5E-03	6.7E-03	6.5E-03	7.4E-03	7.9E-03	7.9E-03	9.6E-03	8.7E-03
Cu2(OH)2+2	%	3.7E-04	4.4E-04	2.7E-04	2.8E-04	2.5E-04	2.5E-04	2.3E-04	2.5E-04	2.1E-04	2.2E-04
CuCl+	%	9.3E-05	1.1E-04	1.3E-04	1.5E-04	1.6E-04	7.7E-05	1.4E-04	1.3E-04	1.1E-04	7.1E-05
CuNO3+	%	2.3E-04	3.0E-04	2.6E-04	3.0E-04	3.3E-04	1.7E-04	3.0E-04	2.9E-04	2.5E-04	1.6E-04
CuNO2+	%	3.8E-05	4.5E-05	5.3E-05	6.3E-05	6.9E-05	3.3E-05	5.8E-05	5.7E-05	4.7E-05	3.1E-05
Cu(OH)4-2	%	3.7E-08	2.8E-08	1.6E-08	9.7E-09	6.1E-09	8.1E-08	1.3E-08	1.4E-08	3.2E-08	1.2E-07
CuCl2	%	1.7E-10	1.9E-10	2.2E-10	2.6E-10	2.8E-10	1.2E-10	2.1E-10	2.1E-10	1.6E-10	1.0E-10
Cu(NO3)2	%	3.2E-10	4.2E-10	2.7E-10	3.2E-10	3.5E-10	1.8E-10	3.2E-10	3.1E-10	2.7E-10	1.8E-10
Cu(NO2)2	%	2.5E-11	3.0E-11	3.5E-11	4.2E-11	4.6E-11	2.2E-11	3.8E-11	3.8E-11	3.1E-11	2.0E-11
CuCl3-	%	1.6E-17	1.8E-17	2.0E-17	2.4E-17	2.6E-17	1.1E-17	1.9E-17	1.9E-17	1.4E-17	9.0E-18
CuCl4-2	%	2.4E-24	2.6E-24	3.0E-24	3.6E-24	3.9E-24	1.7E-24	3.0E-24	3.0E-24	2.3E-24	1.5E-24

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-66 - Copper speciation with depth (Eh = 350 mV)

Date		8/19/2014	8/21/2014	8/24/2014	8/24/2014	8/26/2014	8/26/2014	8/26/2014	8/28/2014	8/28/2014	8/28/2014	8/30/2014
Time		3:30:00 AM	11:13:00 AM	2:26:00 AM	3:25:00 AM	2:15:00 AM	4:00:00 AM	2:45:00 AM	9:50:00 AM	12:30:00 PM	11:20:00 AM	11:09:00 AM
Depth		40	40	0	40	0	10	58	0	18	40	0
Charge Balance	%	1.58	1.05	2.66	-0.16	1.80	-3.20	0.88	-5.77	-0.83	-1.11	0.28
pH	s.u.	7.8	8.1	7.9	7.8	7.7	7.7	7.8	8.1	8.0	7.9	8.0
pe	s.u.	6.3	6.3	6.1	6.3	6.0	6.2	6.3	6.0	6.2	6.3	6.1
Alkalinity	mg/L as $CaCO_3$	60	59	44	59	44	52	62	45	50	60	45
Cu	mg/L	0.0055	0.0055	0.0009	0.0055	0.0010	0.0029	0.0053	0.0005	0.0034	0.0057	0.0006
SO_4	mg/L	18.1	16.5	5.7	16.9	5.9	6.7	18.8	5.3	6.4	16.2	5.7
Relative Percent (%) - Copper Species												
Cu+	%	1.3E-03	7.3E-04	2.4E-03	1.5E-03	3.4E-03	2.4E-03	1.4E-03	1.4E-03	1.1E-03	1.0E-03	1.6E-03
CuCl	%	2.6E-05	1.3E-05	3.9E-05	2.6E-05	5.4E-05	3.9E-05	2.7E-05	2.2E-04	1.7E-05	1.7E-05	2.5E-05
CuCl2-	%	9.7E-08	4.5E-08	1.2E-07	8.9E-08	1.6E-07	1.2E-07	1.0E-07	6.7E-06	5.3E-08	5.5E-08	7.6E-08
CuCl3-2	%	3.7E-13	1.6E-13	3.7E-13	3.0E-13	5.2E-13	3.7E-13	4.0E-13	2.2E-10	1.7E-13	1.8E-13	2.4E-13
Cu+2	%	7.6	4.2	6.7	8.1	9.3	9.3	8.1	3.8	5.1	6.1	4.4
CuCO3	%	84	85	81	84	79	81	84	82	84	85	82
CuOH+	%	5.2	5.5	9.8	5.5	9.4	7.1	5.1	9.8	6.8	5.3	9.7
Cu(OH)2	%	1.6	3.3	1.9	1.5	1.3	1.2	1.5	3.2	3.0	2.2	2.9
Cu(CO3)2-2	%	0.7	1.2	0.6	0.6	0.4	0.5	0.6	1.2	0.9	0.8	1.0
CuHCO3+	%	3.2E-01	1.7E-01	2.7E-01	3.4E-01	3.8E-01	3.9E-01	3.4E-01	1.6E-01	1.9E-01	2.5E-01	1.8E-01
CuSO4	%	1.6E-01	8.0E-02	5.5E-02	1.6E-01	7.9E-02	8.4E-02	1.7E-01	2.9E-02	4.2E-02	1.1E-01	3.6E-02
Cu(OH)3-	%	2.3E-03	8.9E-03	3.0E-03	2.0E-03	1.4E-03	1.4E-03	2.0E-03	8.7E-03	6.8E-03	4.0E-03	6.8E-03
CuNH3+2	%	5.8E-02	4.3E-02	1.8E-03	4.7E-02	1.7E-03	3.2E-03	6.6E-02	1.6E-03	6.8E-03	6.0E-02	1.7E-03
Cu2(OH)2+2	%	5.8E-04	6.5E-04	3.7E-04	6.4E-04	3.6E-04	5.9E-04	5.3E-04	2.2E-04	6.1E-04	6.1E-04	2.3E-04
CuCl+	%	1.4E-04	6.9E-05	1.2E-04	1.3E-04	1.6E-04	1.5E-04	1.4E-04	6.6E-04	8.0E-05	9.2E-05	7.7E-05
CuNO3+	%	3.6E-04	1.8E-04	7.0E-05	3.6E-04	9.0E-05	1.6E-04	4.1E-04	3.7E-05	1.2E-04	2.7E-04	3.9E-05
CuNO2+	%	7.4E-05	3.6E-05	4.2E-05	6.9E-05	5.8E-05	5.8E-05	1.1E-04	2.4E-04	3.2E-05	5.2E-05	2.8E-05
Cu(OH)4-2	%	1.4E-08	1.0E-07	1.9E-08	1.1E-08	6.2E-09	6.2E-09	1.1E-08	1.0E-07	6.5E-08	3.1E-08	6.7E-08
CuCl2	%	2.8E-10	1.3E-10	3.8E-10	2.6E-10	5.3E-10	3.7E-10	3.0E-10	2.2E-08	1.6E-10	1.6E-10	2.5E-10
Cu(NO3)2	%	5.9E-10	2.7E-10	3.0E-11	5.7E-10	3.5E-11	9.9E-11	7.4E-10	1.5E-11	1.0E-10	4.1E-10	1.4E-11
Cu(NO2)2	%	7.7E-11	3.3E-11	2.8E-11	6.3E-11	3.9E-11	3.9E-11	1.7E-10	1.6E-09	2.1E-11	4.8E-11	1.9E-11
CuCl3-	%	3.2E-17	1.4E-17	4.4E-17	2.7E-17	6.2E-17	3.9E-17	3.5E-17	2.6E-14	1.6E-17	1.5E-17	2.9E-17
CuCl4-2	%	5.9E-24	2.3E-24	4.3E-24	4.3E-24	5.9E-24	4.5E-24	6.5E-24	2.4E-20	2.1E-24	2.4E-24	2.8E-24

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-66 - Copper speciation with depth (Eh = 350 mV)

Date		8/30/2014	8/30/2014	9/3/2014	9/3/2014	9/3/2014	9/7/2014	9/7/2014	9/7/2014	9/9/2014	9/9/2014	9/11/2014
Time		11:09:00 AM	11:09:00 AM	2:51:00 AM	3:18:00 AM	3:30:00 AM	10:45:00 AM	11:30:00 AM	12:00:00 PM	3:30:00 AM	3:40:00 AM	2:33:00 AM
Depth		16	39	0	14	45	0	10	50	0	46	0
Charge Balance	%	0.13	0.57	-0.14	-0.72	-0.89	-2.53	-0.56	-0.55	-2.70	-1.30	-2.45
pH	s.u.	7.7	7.9	7.8	7.7	7.8	8.1	7.8	8.0	8.0	8.0	8.0
pe	s.u.	6.2	6.3	6.1	6.3	6.3	6.1	6.1	6.3	6.1	6.3	6.2
Alkalinity	mg/L as $CaCO_3$	49	60	45	49	60	47	47	60	48	62	49
Cu	mg/L	0.0040	0.0060	0.0007	0.0017	0.0062	0.0007	0.0016	0.0066	0.0013	0.0066	0.0011
SO_4	mg/L	6.2	18.2	5.8	6.2	17.8	5.8	6.1	17.4	5.9	18.2	6.0
Relative Percent (%) - Copper Species												
Cu+	%	2.5E-03	1.2E-03	2.7E-03	2.1E-03	1.4E-03	1.3E-03	2.2E-03	8.5E-04	1.6E-03	8.3E-04	1.4E-03
CuCl	%	4.1E-05	2.4E-05	4.4E-05	3.3E-05	2.6E-05	2.1E-05	3.6E-05	1.5E-05	2.5E-05	1.6E-05	2.3E-05
CuCl2-	%	1.3E-07	9.0E-08	1.3E-07	1.0E-07	9.2E-08	6.3E-08	1.1E-07	5.5E-08	7.6E-08	5.9E-08	6.9E-08
CuCl3-2	%	3.9E-13	3.5E-13	4.2E-13	3.1E-13	3.3E-13	2.0E-13	3.4E-13	1.9E-13	2.4E-13	2.2E-13	2.1E-13
Cu+2	%	11.4	6.9	7.5	12.5	8.3	3.9	7.5	4.9	4.8	4.8	5.7
CuCO3	%	80	85	81	80	84	83	82	86	83	86	83
CuOH+	%	6.8	5.3	9.4	5.7	5.2	9.0	8.2	5.3	8.7	5.2	7.3
Cu(OH)2	%	1.2	1.9	1.5	1.3	1.5	3.2	1.7	2.7	2.5	2.6	2.4
Cu(CO3)2-2	%	0.4	0.7	0.6	0.3	0.6	1.2	0.6	1.1	0.9	1.1	0.8
CuHCO3+	%	4.3E-01	2.8E-01	3.1E-01	4.3E-01	3.4E-01	1.6E-01	3.0E-01	2.0E-01	2.0E-01	2.0E-01	2.2E-01
CuSO4	%	9.1E-02	1.4E-01	6.3E-02	9.5E-02	1.7E-01	3.2E-02	6.4E-02	9.9E-02	4.1E-02	1.0E-01	4.6E-02
Cu(OH)3-	%	1.2E-03	3.0E-03	2.0E-03	1.3E-03	1.9E-03	8.4E-03	2.3E-03	6.0E-03	5.2E-03	5.8E-03	4.7E-03
CuNH3+2	%	5.7E-03	7.6E-02	1.7E-03	7.6E-03	5.4E-02	1.9E-03	2.5E-03	5.3E-02	2.0E-03	6.5E-02	3.4E-03
Cu2(OH)2+2	%	7.2E-04	6.5E-04	2.7E-04	2.0E-04	6.5E-04	2.3E-04	4.5E-04	7.3E-04	4.0E-04	6.9E-04	2.4E-04
CuCl+	%	1.8E-04	1.3E-04	1.3E-04	1.8E-04	1.4E-04	6.6E-05	1.3E-04	8.2E-05	8.2E-05	8.3E-05	9.2E-05
CuNO3+	%	2.5E-04	3.0E-04	5.8E-05	3.4E-04	3.1E-04	3.1E-05	5.9E-05	1.8E-04	4.5E-05	2.0E-04	9.1E-05
CuNO2+	%	7.1E-05	1.2E-04	4.7E-05	7.8E-05	1.3E-04	2.4E-05	4.7E-05	1.0E-04	3.0E-05	7.0E-05	3.6E-05
Cu(OH)4-2	%	4.8E-09	2.0E-08	1.1E-08	5.2E-09	1.1E-08	9.4E-08	1.4E-08	5.7E-08	4.7E-08	5.6E-08	3.8E-08
CuCl2	%	3.8E-10	2.6E-10	4.2E-10	3.0E-10	2.7E-10	2.0E-10	3.4E-10	1.6E-10	2.4E-10	1.7E-10	2.1E-10
Cu(NO3)2	%	2.1E-10	4.6E-10	1.8E-11	3.3E-10	4.0E-10	9.9E-12	1.8E-11	2.2E-10	1.6E-11	3.0E-10	5.3E-11
Cu(NO2)2	%	4.7E-11	2.2E-10	3.2E-11	5.2E-11	2.1E-10	1.6E-11	3.1E-11	2.4E-10	2.0E-11	1.1E-10	2.4E-11
CuCl3-	%	3.8E-17	3.0E-17	5.0E-17	2.8E-17	2.9E-17	2.3E-17	3.8E-17	1.7E-17	2.7E-17	1.9E-17	2.2E-17
CuCl4-2	%	4.9E-24	5.7E-24	4.8E-24	4.2E-24	4.9E-24	2.3E-24	4.1E-24	2.9E-24	2.8E-24	3.5E-24	2.7E-24

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-66 - Copper speciation with depth (Eh = 350 mV)

Date		9/11/2014	9/11/2014	9/13/2014	9/13/2014	9/13/2014	9/15/2014	9/15/2014	9/15/2014	9/16/2014	9/16/2014	9/18/2014
Time		2:57:00 AM	2:22:00 AM	3:00:00 AM	3:20:00 AM	3:40:00 AM	2:35:00 AM	3:30:00 AM	2:56:00 AM	11:15:00 AM	11:00:00 AM	12:30:00 PM
Depth		34	50	0	10	48	0	24	48	0	40	0
Charge Balance	%	-3.48	-1.39	-0.89	-2.07	-0.42	-1.21	-1.80	1.25	-1.49	-0.74	-0.56
pH	s.u.	8.2	8.1	7.9	7.9	8.0	8.0	7.7	7.9	7.9	7.9	8.0
pe	s.u.	6.3	6.3	6.1	6.2	6.3	6.1	6.3	6.3	6.1	6.3	6.1
Alkalinity	mg/L as $CaCO_3$	62	59	48	49	60	48	53	58	48	59	47
Cu	mg/L	0.0064	0.0053	0.0006	0.0015	0.0062	0.0005	0.0027	0.0060	0.0005	0.0055	0.0005
SO_4	mg/L	17.3	13.7	6.0	6.4	17.1	6.1	7.5	16.3	6.0	14.6	6.1
Relative Percent (%) - Copper Species												
Cu+	%	5.8E-04	7.5E-04	1.8E-03	1.4E-03	9.3E-04	1.4E-03	1.8E-03	1.1E-03	1.8E-03	1.1E-03	1.3E-03
CuCl	%	1.0E-05	1.2E-05	2.9E-05	2.2E-05	1.6E-05	2.3E-05	2.9E-05	1.8E-05	2.8E-05	1.8E-05	2.2E-05
CuCl2-	%	3.6E-08	3.7E-08	8.8E-08	6.7E-08	5.3E-08	6.9E-08	9.0E-08	5.5E-08	8.6E-08	5.4E-08	6.5E-08
CuCl3-2	%	1.2E-13	1.1E-13	2.8E-13	2.1E-13	1.8E-13	2.2E-13	2.8E-13	1.7E-13	2.7E-13	1.7E-13	2.1E-13
Cu+2	%	3.3	4.4	6.2	6.0	5.4	4.8	10.6	6.5	6.4	6.4	4.5
CuCO3	%	86	86	82	83	86	83	82	85	83	85	83
CuOH+	%	5.2	5.4	8.2	7.0	5.3	8.3	5.6	5.4	7.9	5.3	8.4
Cu(OH)2	%	3.8	3.2	2.1	2.4	2.4	2.7	1.4	2.1	2.1	2.1	2.9
Cu(CO3)2-2	%	1.6	1.2	0.7	0.8	1.0	0.9	0.4	0.8	0.7	0.8	1.0
CuHCO3+	%	1.4E-01	1.8E-01	2.5E-01	2.3E-01	2.2E-01	1.9E-01	3.9E-01	2.6E-01	2.6E-01	2.6E-01	1.8E-01
CuSO4	%	6.6E-02	7.0E-02	5.1E-02	5.0E-02	1.1E-01	4.0E-02	9.7E-02	1.2E-01	5.2E-02	1.1E-01	3.8E-02
Cu(OH)3-	%	1.2E-02	8.1E-03	3.6E-03	4.6E-03	5.0E-03	6.0E-03	1.5E-03	3.7E-03	3.4E-03	3.6E-03	7.0E-03
CuNH3+2	%	4.4E-02	4.3E-02	2.5E-03	4.0E-03	6.1E-02	2.4E-03	8.0E-03	6.1E-02	2.8E-03	4.3E-02	2.5E-03
Cu2(OH)2+2	%	6.8E-04	6.0E-04	1.6E-04	2.9E-04	6.8E-04	1.4E-04	3.2E-04	6.9E-04	1.3E-04	6.0E-04	1.4E-04
CuCl+	%	5.4E-05	6.4E-05	1.0E-04	9.5E-05	8.5E-05	8.0E-05	1.6E-04	9.5E-05	1.0E-04	9.3E-05	7.6E-05
CuNO3+	%	1.2E-04	1.5E-04	8.1E-05	9.1E-05	2.1E-04	5.9E-05	3.2E-04	2.5E-04	8.0E-05	2.4E-04	5.2E-05
CuNO2+	%	6.2E-05	5.4E-05	3.9E-05	3.8E-05	7.6E-05	3.0E-05	6.6E-05	9.1E-05	4.0E-05	5.5E-05	2.9E-05
Cu(OH)4-2	%	1.7E-07	8.8E-08	2.6E-08	3.7E-08	4.4E-08	5.6E-08	7.1E-09	2.7E-08	2.4E-08	2.7E-08	6.9E-08
CuCl2	%	1.0E-10	1.1E-10	2.8E-10	2.0E-10	1.6E-10	2.2E-10	2.6E-10	1.6E-10	2.7E-10	1.6E-10	2.0E-10
Cu(NO3)2	%	1.6E-10	1.8E-10	4.1E-11	5.1E-11	2.9E-10	2.8E-11	3.3E-10	3.4E-10	3.8E-11	3.2E-10	2.3E-11
Cu(NO2)2	%	1.3E-10	7.1E-11	2.6E-11	2.5E-11	1.1E-10	2.0E-11	4.4E-11	1.4E-10	2.7E-11	5.0E-11	1.9E-11
CuCl3-	%	1.1E-17	1.0E-17	3.0E-17	2.1E-17	1.6E-17	2.4E-17	2.4E-17	1.5E-17	2.9E-17	1.5E-17	2.2E-17
CuCl4-2	%	1.8E-24	1.5E-24	3.3E-24	2.6E-24	2.5E-24	2.6E-24	3.7E-24	2.2E-24	3.3E-24	2.2E-24	2.4E-24

(Shaded) Copper species account for greater than 1% of the total molality of copper.

Detailed Copper Speciation Results

Quesnel Lake West Basin, QUL-66 - Copper speciation with depth (Eh = 350 mV)

Date		9/18/2014	9/18/2014	9/20/2014	9/20/2014	9/20/2014	9/23/2014	9/23/2014	9/23/2014	9/29/2014	9/29/2014	9/29/2014
Time		12:45:00 PM	1:00:00 AM	1:30:00 AM	1:45:00 AM	2:15:00 AM	1:00:00 AM	1:15:00 AM	1:30:00 AM	11:15:00 AM	11:30:00 AM	11:45:00 AM
Depth		15	40	0	15	45	0	15	50	0	40	50
Charge Balance	%	-0.58	-0.27	-2.53	-4.82	-0.60	-3.26	-2.86	-2.65	-3.14	-2.48	-3.09
pH	s.u.	7.8	7.7	8.0	8.1	8.0	8.0	8.0	7.8	8.2	7.8	7.9
pe	s.u.	6.2	6.3	6.1	6.2	6.3	6.1	6.1	6.3	6.1	6.3	6.3
Alkalinity	mg/L as $CaCO_3$	50	60	48	53	57	50	50	63	51	60	63
Cu	mg/L	0.0037	0.0060	0.0005	0.0028	0.0058	0.0006	0.0007	0.0067	0.0008	0.0057	0.0066
SO_4	mg/L	7.0	15.8	6.0	7.2	16.7	6.1	6.1	16.2	6.1	14.7	16.7
Relative Percent (%) - Copper Species												
Cu+	%	1.9E-03	1.6E-03	1.4E-03	9.6E-04	1.0E-03	1.4E-03	1.5E-03	1.3E-03	9.6E-04	1.5E-03	1.2E-03
CuCl	%	3.1E-05	2.5E-05	2.2E-05	1.6E-05	1.8E-05	2.3E-05	2.5E-05	2.1E-05	1.5E-05	2.4E-05	2.0E-05
CuCl2-	%	9.4E-08	7.7E-08	6.6E-08	4.8E-08	6.3E-08	6.9E-08	7.5E-08	7.0E-08	4.7E-08	7.4E-08	6.4E-08
CuCl3-2	%	2.9E-13	2.4E-13	2.1E-13	1.5E-13	2.2E-13	2.2E-13	2.4E-13	2.3E-13	1.5E-13	2.3E-13	2.1E-13
Cu+2	%	8.4	9.1	4.6	4.3	5.8	4.7	5.2	7.4	3.4	8.7	6.7
CuCO3	%	82	83	83	85	85	83	83	85	84	84	85
CuOH+	%	6.8	5.2	8.3	6.7	5.5	8.1	8.0	5.0	7.8	5.1	5.0
Cu(OH)2	%	1.6	1.4	2.8	3.1	2.4	2.5	2.3	1.6	3.6	1.4	1.7
Cu(CO3)2-2	%	0.5	0.5	1.0	1.1	0.9	1.0	0.9	0.7	1.4	0.6	0.8
CuHCO3+	%	3.3E-01	3.7E-01	1.9E-01	1.7E-01	2.3E-01	2.0E-01	2.2E-01	3.2E-01	1.4E-01	3.6E-01	2.9E-01
CuSO4	%	7.6E-02	1.7E-01	3.8E-02	4.0E-02	1.1E-01	3.9E-02	4.4E-02	1.4E-01	2.8E-02	1.5E-01	1.3E-01
Cu(OH)3-	%	2.1E-03	1.6E-03	6.5E-03	8.0E-03	4.7E-03	5.5E-03	4.6E-03	2.3E-03	1.1E-02	1.8E-03	2.7E-03
CuNH3+2	%	4.0E-03	5.4E-02	2.4E-03	5.3E-03	5.3E-02	2.9E-03	2.4E-03	5.2E-02	2.4E-03	4.7E-02	5.3E-02
Cu2(OH)2+2	%	6.8E-04	6.2E-04	1.4E-04	5.0E-04	6.9E-04	1.5E-04	1.8E-04	6.5E-04	1.9E-04	5.8E-04	6.4E-04
CuCl+	%	1.3E-04	1.3E-04	7.6E-05	6.7E-05	9.6E-05	7.9E-05	8.7E-05	1.1E-04	5.6E-05	1.3E-04	1.0E-04
CuNO3+	%	1.2E-04	3.4E-04	5.1E-05	7.6E-05	2.3E-04	5.1E-05	5.6E-05	2.8E-04	3.7E-05	3.3E-04	2.6E-04
CuNO2+	%	5.2E-05	1.2E-04	2.9E-05	2.7E-05	7.5E-05	2.9E-05	3.3E-05	9.5E-05	2.1E-05	1.1E-04	1.2E-04
Cu(OH)4-2	%	1.2E-08	8.1E-09	6.4E-08	8.6E-08	3.9E-08	5.0E-08	3.8E-08	1.4E-08	1.4E-07	9.3E-09	1.8E-08
CuCl2	%	2.9E-10	2.3E-10	2.1E-10	1.4E-10	1.8E-10	2.2E-10	2.3E-10	2.0E-10	1.5E-10	2.1E-10	1.9E-10
Cu(NO3)2	%	6.5E-11	4.6E-10	2.2E-11	4.9E-11	3.2E-10	2.2E-11	2.3E-11	3.7E-10	1.5E-11	4.3E-10	3.5E-10
Cu(NO2)2	%	3.5E-11	1.8E-10	1.9E-11	1.8E-11	1.0E-10	2.0E-11	2.2E-11	1.3E-10	1.4E-11	1.6E-10	2.2E-10
CuCl3-	%	2.9E-17	2.1E-17	2.3E-17	1.5E-17	1.9E-17	2.4E-17	2.6E-17	2.0E-17	1.6E-17	2.0E-17	1.8E-17
CuCl4-2	%	3.7E-24	3.2E-24	2.5E-24	1.9E-24	3.2E-24	2.6E-24	2.8E-24	3.2E-24	1.8E-24	3.0E-24	2.9E-24

(Shaded cells) Copper species account for greater than 1% of the total molality of copper.

Appendix A
Detailed Copper Speciation Results

Quesnel Lake West Basin, QUL-66 - Copper speciation with depth (Eh = 350 mV)

Date		10/1/2014	10/1/2014	10/1/2014	10/8/2014	10/8/2014	10/8/2014	10/15/2014	10/15/2014	10/15/2014	10/18/2014	10/18/2014
Time		11:15:00 AM	11:30:00 AM	11:45:00 AM	11:00:00 AM	11:20:00 AM	11:40:00 AM	11:15:00 AM	11:30:00 AM	11:45:00 AM	10:45:00 AM	11:00:00 AM
Depth		0	40	50	0	40	45	0	40	48	0	40
Charge Balance	%	-3.51	-2.69	-0.71	-0.52	-0.15	-1.25	-2.04	-1.22	-0.53	-4.63	-4.51
pH	s.u.	7.9	7.8	7.8	8.1	7.8	7.8	8.1	7.8	7.9	7.9	7.5
pe	s.u.	6.1	6.3	6.3	6.2	6.3	6.3	6.2	6.3	6.3	6.2	6.3
Alkalinity	mg/L as $CaCO_3$	49	62	61	48	52	54	48	54	55	52	56
Cu	mg/L	0.0006	0.0074	0.0091	0.0010	0.0029	0.0032	0.0009	0.0037	0.0047	0.0010	0.0032
SO_4	mg/L	6.0	16.7	17.1	6.2	9.1	9.7	6.4	11.0	13.1	6.4	9.6
Relative Percent (%) - Copper Species												
Cu+	%	1.7E-03	1.4E-03	1.4E-03	1.0E-03	1.5E-03	1.4E-03	9.2E-04	1.4E-03	1.2E-03	1.4E-03	2.4E-03
CuCl	%	2.7E-05	3.4E-05	3.3E-05	1.6E-05	2.3E-05	2.2E-05	1.5E-05	2.2E-05	2.0E-05	2.2E-05	3.8E-05
CuCl2-	%	8.2E-08	1.6E-07	1.5E-07	5.0E-08	7.3E-08	6.8E-08	4.6E-08	6.9E-08	6.2E-08	6.8E-08	1.2E-07
CuCl3-2	%	2.6E-13	7.4E-13	6.9E-13	1.6E-13	2.2E-13	2.1E-13	1.4E-13	2.1E-13	1.9E-13	2.1E-13	3.6E-13
Cu+2	%	5.9	8.3	8.0	3.9	8.7	8.1	3.8	8.2	7.4	5.8	14.0
CuCO3	%	83	84	84	83	83	83	83	83	84	84	79
CuOH+	%	7.9	5.1	5.2	7.8	5.6	5.5	7.5	5.6	5.5	6.9	5.1
Cu(OH)2	%	2.1	1.4	1.6	3.6	1.8	1.9	3.9	1.9	2.0	2.2	0.9
Cu(CO3)2-2	%	0.8	0.6	0.6	1.2	0.5	0.6	1.2	0.6	0.7	0.8	0.3
CuHCO3+	%	2.4E-01	3.5E-01	3.3E-01	1.5E-01	3.2E-01	3.0E-01	1.4E-01	3.0E-01	2.8E-01	2.4E-01	5.5E-01
CuSO4	%	4.9E-02	1.6E-01	1.6E-01	3.2E-02	9.6E-02	9.5E-02	3.2E-02	1.1E-01	1.1E-01	4.9E-02	1.6E-01
Cu(OH)3-	%	3.7E-03	1.8E-03	2.1E-03	1.0E-02	2.5E-03	2.7E-03	1.2E-02	2.7E-03	3.2E-03	4.1E-03	6.7E-04
CuNH3+2	%	2.6E-03	5.5E-02	5.7E-02	3.0E-03	2.1E-02	2.1E-02	3.4E-03	2.5E-02	3.4E-02	3.5E-03	1.4E-02
Cu2(OH)2+2	%	1.5E-04	7.4E-04	9.7E-04	2.4E-04	3.6E-04	3.7E-04	2.0E-04	4.5E-04	5.5E-04	1.9E-04	3.1E-04
CuCl+	%	9.8E-05	1.8E-04	1.7E-04	6.3E-05	1.3E-04	1.2E-04	6.1E-05	1.2E-04	1.1E-04	9.2E-05	2.1E-04
CuNO3+	%	6.4E-05	3.3E-04	3.2E-04	4.9E-05	3.0E-04	2.8E-04	6.2E-05	2.9E-04	2.8E-04	8.5E-05	4.9E-04
CuNO2+	%	3.7E-05	1.3E-04	1.5E-04	2.4E-05	5.4E-05	5.0E-05	2.4E-05	7.6E-05	1.8E-04	3.6E-05	8.7E-05
Cu(OH)4-2	%	2.7E-08	9.7E-09	1.2E-08	1.2E-07	1.5E-08	1.6E-08	1.5E-07	1.7E-08	2.1E-08	3.2E-08	2.1E-09
CuCl2	%	2.6E-10	4.7E-10	4.4E-10	1.5E-10	2.1E-10	2.0E-10	1.4E-10	2.0E-10	1.8E-10	2.1E-10	3.5E-10
Cu(NO3)2	%	2.7E-11	4.6E-10	4.5E-10	2.3E-11	3.6E-10	3.3E-10	3.7E-11	3.6E-10	3.8E-10	4.6E-11	6.0E-10
Cu(NO2)2	%	2.5E-11	2.2E-10	2.9E-10	1.6E-11	3.6E-11	3.3E-11	1.6E-11	7.5E-11	4.5E-10	2.4E-11	5.8E-11
CuCl3-	%	2.8E-17	6.5E-17	6.0E-17	1.6E-17	1.9E-17	1.8E-17	1.4E-17	1.8E-17	1.7E-17	2.1E-17	3.2E-17
CuCl4-2	%	3.1E-24	1.5E-23	1.3E-23	1.9E-24	3.0E-24	2.8E-24	1.8E-24	2.8E-24	2.5E-24	2.6E-24	4.8E-24

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-66 - Copper speciation with depth (Eh = 350 mV)

Date		10/18/2014	10/27/2014	10/27/2014	10/27/2014	11/1/2014	11/1/2014	11/1/2014	11/6/2014	11/6/2014	11/6/2014	11/16/2014
Time		11:45:00 AM	2:00:00 AM	2:15:00 AM	2:30:00 AM	11:00:00 AM	11:15:00 AM	11:30:00 AM	11:30:00 AM	12:00:00 PM	12:30:00 PM	1:00:00 AM
Depth		50	0	40	50	0	40	48	0	40	55	0
Charge Balance	%	-4.29	-4.57	0.13	0.70	-1.22	-0.17	1.15	0.71	4.04	-0.20	2.30
pH	s.u.	7.6	8.0	7.8	7.8	8.2	8.0	7.9	8.2	7.9	7.8	8.1
pe	s.u.	6.3	6.2	6.3	6.3	6.2	6.3	6.3	6.2	6.3	6.3	6.3
Alkalinity	mg/L as $CaCO_3$	58	53	54	54	48	53	52	47	48	54	46
Cu	mg/L	0.0036	0.0010	0.0033	0.0034	0.0013	0.0031	0.0035	0.0013	0.0026	0.0034	0.0015
SO_4	mg/L	11.1	6.6	11.2	11.6	6.7	11.2	11.8	6.9	9.7	11.2	7.7
Relative Percent (%) - Copper Species												
Cu+	%	2.3E-03	1.0E-03	1.4E-03	1.5E-03	7.3E-04	1.0E-03	1.1E-03	7.3E-04	1.4E-03	1.5E-03	9.3E-04
CuCl	%	3.7E-05	1.7E-05	2.3E-05	2.4E-05	1.2E-05	1.6E-05	1.8E-05	1.2E-05	2.3E-05	2.4E-05	1.5E-05
CuCl2-	%	1.1E-07	5.1E-08	7.0E-08	7.4E-08	3.6E-08	5.0E-08	5.5E-08	3.6E-08	7.0E-08	7.4E-08	4.6E-08
CuCl3-2	%	3.5E-13	1.6E-13	2.1E-13	2.3E-13	1.1E-13	1.5E-13	1.7E-13	1.1E-13	2.1E-13	2.3E-13	1.4E-13
Cu+2	%	13.6	4.6	8.1	8.7	3.4	5.8	6.4	3.5	7.5	8.6	5.1
CuCO3	%	80	85	83	83	83	84	84	83	83	83	83
CuOH+	%	5.0	6.6	5.7	5.6	7.1	5.9	5.9	7.1	6.6	5.6	6.8
Cu(OH)2	%	0.9	2.8	1.9	1.7	4.7	2.8	2.6	4.9	2.4	1.7	3.9
Cu(CO3)2-2	%	0.3	1.0	0.6	0.5	1.4	0.8	0.7	1.3	0.6	0.5	0.9
CuHCO3+	%	5.4E-01	1.9E-01	3.0E-01	3.2E-01	1.2E-01	2.1E-01	2.3E-01	1.2E-01	2.6E-01	3.2E-01	1.7E-01
CuSO4	%	1.8E-01	4.0E-02	1.1E-01	1.2E-01	2.9E-02	7.8E-02	9.1E-02	3.1E-02	8.9E-02	1.1E-01	4.9E-02
Cu(OH)3-	%	6.9E-04	6.6E-03	2.7E-03	2.3E-03	1.7E-02	5.8E-03	4.9E-03	1.7E-02	4.0E-03	2.3E-03	1.0E-02
CuNH3+2	%	1.9E-02	3.8E-03	7.3E-03	7.5E-03	4.0E-03	6.2E-03	6.5E-03	4.5E-03	6.0E-03	6.3E-03	6.2E-03
Cu2(OH)2+2	%	3.4E-04	1.7E-04	4.1E-04	4.1E-04	2.5E-04	4.1E-04	4.6E-04	2.5E-04	4.4E-04	4.2E-04	2.7E-04
CuCl+	%	2.0E-04	7.3E-05	1.2E-04	1.3E-04	5.3E-05	8.5E-05	9.5E-05	5.4E-05	1.1E-04	1.3E-04	7.7E-05
CuNO3+	%	5.1E-04	7.2E-05	3.1E-04	3.4E-04	5.5E-05	2.3E-04	2.7E-04	6.5E-05	2.5E-04	3.4E-04	1.2E-04
CuNO2+	%	1.6E-04	2.9E-05	3.3E-04	4.0E-04	2.3E-05	5.7E-05	6.8E-05	2.2E-05	4.6E-05	5.3E-05	3.2E-05
Cu(OH)4-2	%	2.3E-09	6.5E-08	1.6E-08	1.3E-08	2.5E-07	5.1E-08	3.9E-08	2.6E-07	2.9E-08	1.3E-08	1.1E-07
CuCl2	%	3.3E-10	1.6E-10	2.0E-10	2.2E-10	1.1E-10	1.5E-10	1.6E-10	1.1E-10	2.1E-10	2.2E-10	1.4E-10
Cu(NO3)2	%	6.6E-10	4.1E-11	4.1E-10	4.6E-10	3.2E-11	3.3E-10	3.9E-10	4.4E-11	3.0E-10	4.8E-10	1.0E-10
Cu(NO2)2	%	2.0E-10	1.9E-11	1.4E-09	2.0E-09	1.7E-11	6.0E-11	7.6E-11	1.5E-11	3.1E-11	3.5E-11	2.1E-11
CuCl3-	%	3.0E-17	1.6E-17	1.9E-17	2.0E-17	1.1E-17	1.4E-17	1.5E-17	1.1E-17	2.0E-17	2.0E-17	1.3E-17
CuCl4-2	%	4.6E-24	2.0E-24	2.8E-24	3.0E-24	1.4E-24	2.0E-24	2.2E-24	1.4E-24	2.8E-24	3.0E-24	1.9E-24

(shaded box) Copper species account for greater than 1% of the total molality of copper.

Detailed Copper Speciation Results

Quesnel Lake West Basin, QUL-66 - Copper speciation with depth (Eh = 350 mV)

Date		11/16/2014	11/16/2014	11/25/2014	11/25/2014	11/25/2014	12/15/2014	12/15/2014	12/15/2014	1/15/2015	1/15/2015
Time		12:30:00 PM	12:45:00 PM	11:40:00 AM	12:10:00 PM	12:45:00 PM	11:00:00 AM	12:00:00 PM	1:00:00 AM	10:30:00 AM	11:30:00 AM
Depth		40	50	0	20	45	0	20	40	0	85
Charge Balance	%	-1.23	2.29	-1.19	0.10	-1.81	-1.01	-0.95	-0.91	-0.55	-0.45
pH	s.u.	7.9	7.9	7.8	7.7	7.7	8.0	7.8	7.8	7.9	8.1
pe	s.u.	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.4	6.4
Alkalinity	mg/L as $CaCO_3$	54	50	51	50	52	52	52	52	51	51
Cu	mg/L	0.0028	0.0030	0.0021	0.0021	0.0021	0.0020	0.0020	0.0021	0.0019	0.0020
SO_4	mg/L	11.2	11.7	8.9	9.0	8.9	9.0	9.0	8.9	8.6	8.7
Relative Percent (%) - Copper Species											
Cu+	%	1.1E-03	1.3E-03	1.5E-03	1.8E-03	1.9E-03	8.4E-04	1.5E-03	1.4E-03	1.1E-03	7.1E-04
CuCl	%	1.8E-05	2.1E-05	2.4E-05	2.9E-05	3.1E-05	1.3E-05	2.4E-05	2.3E-05	1.8E-05	1.2E-05
CuCl2-	%	5.7E-08	6.5E-08	7.4E-08	8.8E-08	9.7E-08	4.2E-08	7.4E-08	7.2E-08	5.5E-08	3.6E-08
CuCl3-2	%	1.8E-13	2.0E-13	2.3E-13	2.7E-13	3.0E-13	1.3E-13	2.2E-13	2.2E-13	1.7E-13	1.1E-13
Cu+2	%	6.1	7.4	8.5	10.1	11.0	5.3	9.3	9.1	7.6	4.9
CuCO3	%	84	83	83	81	81	85	83	83	83	84
CuOH+	%	5.8	6.2	5.9	5.9	5.7	5.7	5.5	5.5	5.4	5.5
Cu(OH)2	%	2.5	2.3	1.9	1.6	1.3	3.4	1.8	1.8	2.6	4.0
Cu(CO3)2-2	%	0.8	0.6	0.5	0.4	0.4	0.9	0.5	0.5	0.6	1.0
CuHCO3+	%	2.3E-01	2.6E-01	3.1E-01	3.6E-01	4.1E-01	1.9E-01	3.3E-01	3.2E-01	2.5E-01	1.6E-01
CuSO4	%	8.3E-02	1.0E-01	9.3E-02	1.1E-01	1.2E-01	5.7E-02	1.0E-01	9.7E-02	7.7E-02	5.0E-02
Cu(OH)3-	%	4.7E-03	3.9E-03	2.6E-03	1.9E-03	1.4E-03	8.0E-03	2.3E-03	2.5E-03	4.4E-03	1.1E-02
CuNH3+2	%	5.8E-03	6.5E-03	6.5E-03	6.7E-03	6.5E-03	7.4E-03	7.9E-03	7.9E-03	9.6E-03	8.7E-03
Cu2(OH)2+2	%	3.7E-04	4.4E-04	2.7E-04	2.8E-04	2.5E-04	2.5E-04	2.3E-04	2.5E-04	2.1E-04	2.2E-04
CuCl+	%	9.3E-05	1.1E-04	1.3E-04	1.5E-04	1.6E-04	7.7E-05	1.4E-04	1.3E-04	1.1E-04	7.1E-05
CuNO3+	%	2.3E-04	3.0E-04	2.6E-04	3.0E-04	3.3E-04	1.7E-04	3.0E-04	2.9E-04	2.5E-04	1.6E-04
CuNO2+	%	3.8E-05	4.5E-05	5.3E-05	6.3E-05	6.9E-05	3.3E-05	5.8E-05	5.7E-05	4.7E-05	3.1E-05
Cu(OH)4-2	%	3.7E-08	2.8E-08	1.6E-08	9.7E-09	6.1E-09	8.1E-08	1.3E-08	1.4E-08	3.2E-08	1.2E-07
CuCl2	%	1.7E-10	1.9E-10	2.2E-10	2.6E-10	2.8E-10	1.2E-10	2.1E-10	2.1E-10	1.6E-10	1.0E-10
Cu(NO3)2	%	3.2E-10	4.2E-10	2.7E-10	3.2E-10	3.5E-10	1.8E-10	3.2E-10	3.1E-10	2.7E-10	1.8E-10
Cu(NO2)2	%	2.5E-11	3.0E-11	3.5E-11	4.2E-11	4.6E-11	2.2E-11	3.8E-11	3.8E-11	3.1E-11	2.0E-11
CuCl3-	%	1.6E-17	1.8E-17	2.0E-17	2.4E-17	2.6E-17	1.1E-17	1.9E-17	1.9E-17	1.4E-17	9.0E-18
CuCl4-2	%	2.4E-24	2.6E-24	3.0E-24	3.6E-24	3.9E-24	1.7E-24	3.0E-24	3.0E-24	2.3E-24	1.5E-24

(Shaded) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-2 - Copper speciation with depth (Eh = 500 mV)

Date		8/6/2014	8/9/2014	8/11/2014	8/16/2014	8/16/2014	8/16/2014	8/21/2014	8/25/2014	8/25/2014	8/25/2014	8/27/2014	8/27/2014	8/27/2014
Time		5:45:00 AM	12:54:00 PM	12:56:00 PM	12:20:00 PM	12:40:00 PM	1:10:00 AM	1:16:00 AM	2:25:00 AM	2:50:00 AM	3:10:00 AM	1:00:00 AM	1:30:00 AM	2:00:00 AM
Depth		0	0	0	0	10	30	47	0	8	40	0	15	42
Charge Balance	%	1.18	1.24	-0.08	1.44	1.62	0.19	-0.28	1.43	0.66	1.00	0.56	0.67	0.83
pH	s.u.	8.1	7.8	7.7	8.1	7.9	7.6	7.9	7.9	8.0	7.6	8.0	7.8	7.6
pe	s.u.	8.6	8.7	8.6	8.6	8.8	9.1	9.0	8.6	8.7	9.0	8.6	8.8	9.0
Alkalinity	mg/L as $CaCO_3$	44	43	44	43	44	48	55	44	45	51	45	45	54
Cu	mg/L	0.0006	0.0005	0.0005	0.0005	0.0005	0.0007	0.0041	0.0005	0.0006	0.0025	0.0005	0.0011	0.0042
SO_4	mg/L	5.6	5.5	5.6	5.6	5.8	6.3	12.0	5.8	5.9	8.9	5.8	6.1	12.8
Relative Percent (%) - Copper Species														
Cu+	%	3.8E-06	7.0E-06	9.7E-06	4.3E-06	3.9E-06	4.1E-06	2.0E-06	5.2E-06	4.2E-06	4.8E-06	4.9E-06	5.3E-06	4.6E-06
CuCl	%	6.1E-08	1.1E-07	1.6E-07	6.9E-08	6.3E-08	6.6E-08	3.2E-08	8.5E-08	6.8E-08	7.7E-08	7.9E-08	8.6E-08	7.3E-08
CuCl2-	%	1.8E-10	3.4E-10	4.7E-10	2.1E-10	1.9E-10	2.1E-10	1.0E-10	2.5E-10	2.0E-10	2.4E-10	2.4E-10	2.6E-10	2.3E-10
CuCl3-2	%	5.9E-16	1.1E-15	1.5E-15	6.6E-16	6.0E-16	6.2E-16	3.1E-16	8.1E-16	6.5E-16	7.3E-16	7.6E-16	8.2E-16	6.9E-16
Cu+2	%	3.5	7.9	9.2	4.1	7.1	13.7	6.5	5.7	5.7	14.6	5.1	7.7	14.0
CuCO3	%	81	80	79	81	82	79	84	81	82	78	82	81	79
CuOH+	%	10.6	9.6	10.0	10.5	8.0	5.6	5.6	9.8	8.9	5.4	9.8	8.4	5.2
Cu(OH)2	%	3.4	1.6	1.2	3.0	2.3	1.3	2.6	2.2	2.4	1.0	2.4	1.8	1.0
Cu(CO3)2-2	%	1.2	0.5	0.4	1.1	0.6	0.3	0.8	0.8	0.8	0.3	0.9	0.6	0.3
CuHCO3+	%	1.4E-01	3.1E-01	3.8E-01	1.7E-01	2.5E-01	4.5E-01	2.3E-01	2.3E-01	2.2E-01	5.2E-01	2.1E-01	3.0E-01	5.2E-01
CuSO4	%	2.9E-02	6.3E-02	7.7E-02	3.4E-02	5.5E-02	1.1E-01	9.0E-02	4.8E-02	4.7E-02	1.6E-01	4.3E-02	6.5E-02	2.1E-01
Cu(OH)3-	%	9.9E-03	2.1E-03	1.3E-03	7.7E-03	3.9E-03	1.2E-03	4.9E-03	4.1E-03	4.7E-03	8.0E-04	4.8E-03	2.5E-03	7.7E-04
CuNH3+2	%	1.3E-03	1.8E-03	1.4E-03	1.4E-03	3.7E-03	8.7E-03	4.1E-02	1.8E-03	2.4E-03	1.6E-02	1.6E-03	2.6E-03	4.5E-02
Cu2(OH)2+2	%	2.7E-04	1.9E-04	2.1E-04	2.5E-04	1.3E-04	8.3E-05	4.9E-04	2.0E-04	1.8E-04	2.8E-04	2.0E-04	3.3E-04	4.3E-04
CuCl+	%	6.2E-05	1.4E-04	1.6E-04	7.2E-05	1.1E-04	2.0E-04	9.4E-05	1.0E-04	9.6E-05	2.1E-04	8.9E-05	1.3E-04	2.1E-04
CuNO3+	%	3.3E-05	8.5E-05	9.4E-05	3.4E-05	1.2E-04	4.1E-04	2.6E-04	5.4E-05	8.5E-05	5.1E-04	4.4E-05	1.3E-04	5.5E-04
CuNO2+	%	2.2E-05	4.9E-05	5.8E-05	2.6E-05	4.5E-05	8.6E-05	4.0E-05	3.6E-05	3.6E-05	9.0E-05	3.2E-05	4.8E-05	8.6E-05
Cu(OH)4-2	%	1.2E-07	1.2E-08	5.6E-09	8.2E-08	2.7E-08	4.4E-09	3.9E-08	3.2E-08	3.8E-08	2.7E-09	4.1E-08	1.5E-08	2.6E-09
CuCl2	%	2.2E-10	4.3E-10	5.8E-10	2.6E-10	2.7E-10	3.1E-10	1.5E-10	3.2E-10	2.7E-10	3.6E-10	3.0E-10	3.4E-10	3.4E-10
Cu(NO3)2	%	1.3E-11	3.7E-11	3.9E-11	1.1E-11	8.2E-11	4.2E-10	3.7E-10	2.0E-11	4.9E-11	6.1E-10	1.5E-11	8.0E-11	7.6E-10
Cu(NO2)2	%	1.5E-11	3.3E-11	3.9E-11	1.7E-11	3.0E-11	5.7E-11	2.6E-11	2.4E-11	2.4E-11	6.0E-11	2.1E-11	3.2E-11	5.7E-11
CuCl3-	%	2.7E-17	5.0E-17	7.0E-17	3.1E-17	2.8E-17	2.8E-17	1.4E-17	3.8E-17	3.0E-17	3.3E-17	3.5E-17	3.8E-17	3.1E-17
CuCl4-2	%	2.4E-24	4.9E-24	6.4E-24	2.8E-24	3.3E-24	4.5E-24	2.1E-24	3.6E-24	3.2E-24	5.0E-24	3.3E-24	4.1E-24	4.8E-24

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-2 - Copper speciation with depth (Eh = 500 mV)

Date		8/29/2014	8/29/2014	9/2/2014	9/2/2014	9/2/2014	9/3/2014	9/3/2014	9/6/2014	9/6/2014	9/6/2014	9/9/2014	9/9/2014
Time		1:25:00 AM	1:43:00 AM	12:23:00 PM	1:50:00 AM	12:50:00 PM	11:23:00 AM	11:49:00 AM	12:00:00 PM	1:00:00 AM	1:30:00 AM	2:00:00 AM	2:17:00 AM
Depth		0	37	0	14	40	0	47	0	9	49	0	13
Charge Balance	%	1.23	0.18	2.04	1.11	1.07	-0.38	0.31	-1.95	-2.29	-2.05	-2.77	-2.73
pH	s.u.	8.1	7.6	8.1	7.8	7.4	7.9	8.0	7.8	7.6	7.3	8.1	7.7
pe	s.u.	8.6	9.1	8.7	8.9	9.1	8.7	9.1	8.7	8.8	9.0	8.7	9.0
Alkalinity	mg/L as $CaCO_3$	44	50	44	46	52	46	57	47	48	60	48	50
Cu	mg/L	0.0005	0.0017	0.0005	0.0020	0.0034	0.0006	0.0046	0.0006	0.0009	0.0057	0.0009	0.0011
SO_4	mg/L	5.7	7.2	5.8	6.0	10.5	5.7	14.3	5.8	6.0	16.9	5.9	6.5
Relative Percent (%) - Copper Species													
Cu+	%	3.3E-06	4.7E-06	3.8E-06	4.1E-06	6.3E-06	5.6E-06	1.8E-06	6.9E-06	6.9E-06	7.4E-06	3.0E-06	3.5E-06
CuCl	%	5.4E-08	7.6E-08	6.1E-08	6.6E-08	1.0E-07	9.1E-08	2.8E-08	1.1E-07	1.1E-07	1.3E-07	4.9E-08	5.6E-08
CuCl2-	%	1.6E-10	2.4E-10	1.8E-10	2.0E-10	3.1E-10	2.7E-10	8.7E-11	3.4E-10	3.4E-10	4.6E-10	1.5E-10	1.7E-10
CuCl3-2	%	5.2E-16	7.2E-16	5.9E-16	6.3E-16	9.6E-16	8.7E-16	2.7E-16	1.1E-15	1.1E-15	1.6E-15	4.6E-16	5.3E-16
Cu+2	%	3.6	15.3	4.3	7.9	20.5	6.4	5.7	7.7	12.5	22.0	4.0	10.5
CuCO3	%	82	77	82	82	73	81	85	81	79	72	83	81
CuOH+	%	9.9	5.4	9.7	7.5	4.9	9.2	5.3	9.0	7.1	4.4	8.5	5.7
Cu(OH)2	%	3.6	1.0	3.0	1.9	0.6	1.9	2.7	1.4	1.0	0.4	3.1	1.6
Cu(CO3)2-2	%	1.2	0.3	1.0	0.6	0.2	0.7	0.9	0.6	0.3	0.2	1.1	0.4
CuHCO3+	%	1.4E-01	5.2E-01	1.7E-01	2.9E-01	7.3E-01	2.7E-01	2.2E-01	3.3E-01	4.8E-01	9.1E-01	1.7E-01	3.7E-01
CuSO4	%	3.0E-02	1.3E-01	3.5E-02	6.3E-02	2.5E-01	5.3E-02	9.5E-02	6.4E-02	1.0E-01	4.3E-01	3.3E-02	8.4E-02
Cu(OH)3-	%	1.0E-02	7.9E-04	7.5E-03	2.8E-03	3.3E-04	3.0E-03	5.4E-03	1.8E-03	8.5E-04	1.7E-04	8.1E-03	1.8E-03
CuNH3+2	%	1.7E-03	8.4E-03	2.3E-03	8.4E-03	3.5E-02	1.8E-03	6.5E-02	2.5E-03	4.3E-03	5.7E-02	2.2E-03	7.2E-03
Cu2(OH)2+2	%	2.0E-04	1.9E-04	1.9E-04	4.3E-04	3.1E-04	1.9E-04	5.0E-04	2.0E-04	1.7E-04	4.3E-04	2.5E-04	1.3E-04
CuCl+	%	6.3E-05	2.2E-04	7.4E-05	1.3E-04	3.0E-04	1.1E-04	8.3E-05	1.3E-04	2.0E-04	3.6E-04	6.8E-05	1.6E-04
CuNO3+	%	3.2E-05	4.9E-04	3.5E-05	1.7E-04	7.5E-04	5.2E-05	2.5E-04	6.4E-05	2.4E-04	8.9E-04	3.9E-05	2.7E-04
CuNO2+	%	2.3E-05	9.5E-05	2.7E-05	5.0E-05	1.3E-04	4.0E-05	4.2E-05	4.8E-05	7.8E-05	2.7E-04	2.5E-05	6.6E-05
Cu(OH)4-2	%	1.3E-07	2.6E-09	7.9E-08	1.8E-08	7.2E-10	2.0E-08	4.8E-08	9.8E-09	3.0E-09	3.1E-10	8.9E-08	8.4E-09
CuCl2	%	2.0E-10	3.6E-10	2.3E-10	2.8E-10	4.7E-10	3.5E-10	1.3E-10	4.3E-10	4.7E-10	6.8E-10	1.9E-10	2.6E-10
Cu(NO3)2	%	1.1E-11	5.3E-10	1.2E-11	1.3E-10	9.3E-10	1.7E-11	3.8E-10	2.1E-11	1.7E-10	1.3E-09	1.4E-11	2.5E-10
Cu(NO2)2	%	1.5E-11	6.4E-11	1.8E-11	3.3E-11	8.4E-11	2.7E-11	3.3E-11	3.2E-11	5.2E-11	3.5E-10	1.7E-11	4.4E-11
CuCl3-	%	2.4E-17	3.2E-17	2.7E-17	2.9E-17	4.3E-17	4.0E-17	1.2E-17	5.0E-17	4.9E-17	7.0E-17	2.1E-17	2.4E-17
CuCl4-2	%	2.3E-24	5.1E-24	2.7E-24	3.6E-24	6.8E-24	4.0E-24	1.9E-24	4.8E-24	5.9E-24	1.2E-23	2.3E-24	3.6E-24

[shaded box] Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-2 - Copper speciation with depth (Eh = 500 mV)

Date		9/9/2014	9/11/2014	9/11/2014	9/13/2014	9/13/2014	9/13/2014	9/15/2014	9/15/2014	9/15/2014	9/15/2014	9/17/2014	9/17/2014	9/17/2014
Time		2:32:00 AM	12:15:00 PM	12:52:00 PM	1:00:00 AM	1:30:00 AM	2:00:00 AM	12:38:00 PM	1:15:00 AM	1:51:00 AM	12:47:00 PM	12:30:00 PM	1:30:00 AM	2:40:00 AM
Depth		48	0	44	0	13	43	0	25	38	50	0	16	47
Charge Balance	%	-1.09	-2.22	-2.79	-0.06	-0.66	0.17	-3.37	-5.75	-2.75	-2.14	-1.65	-1.22	-2.53
pH	s.u.	7.8	8.1	7.9	7.9	7.8	7.8	8.0	7.7	7.8	7.9	8.0	7.8	7.8
pe	s.u.	9.0	8.8	9.0	8.8	8.9	9.0	8.7	9.0	9.0	9.0	8.7	8.9	9.0
Alkalinity	mg/L as $CaCO_3$	58	49	57	47	48	53	48	55	57	59	49	49	59
Cu	mg/L	0.0048	0.0011	0.0032	0.0005	0.0010	0.0028	0.0005	0.0016	0.0048	0.0062	0.0005	0.0012	0.0056
SO_4	mg/L	13.9	5.9	9.4	6.0	6.1	8.8	6.1	7.6	14.1	16.3	6.0	6.1	15.7
Relative Percent (%) - Copper Species														
Cu+	%	2.8E-06	2.7E-06	2.3E-06	4.4E-06	3.6E-06	2.9E-06	3.2E-06	3.6E-06	2.5E-06	2.0E-06	3.6E-06	4.1E-06	2.9E-06
CuCl	%	4.4E-08	4.4E-08	3.7E-08	7.1E-08	5.9E-08	4.7E-08	5.2E-08	5.9E-08	3.9E-08	3.2E-08	5.8E-08	6.6E-08	4.6E-08
CuCl2-	%	1.4E-10	1.3E-10	1.1E-10	2.2E-10	1.8E-10	1.5E-10	1.6E-10	1.8E-10	1.2E-10	9.9E-11	1.8E-10	2.0E-10	1.4E-10
CuCl3-2	%	4.2E-16	4.2E-16	3.5E-16	6.8E-16	5.6E-16	4.5E-16	5.0E-16	5.5E-16	3.8E-16	3.0E-16	5.6E-16	6.3E-16	4.4E-16
Cu+2	%	8.7	4.2	7.2	6.5	8.4	8.8	4.6	11.5	7.5	6.0	5.2	7.8	8.7
CuCO3	%	83	83	84	82	82	83	83	81	84	85	83	82	84
CuOH+	%	5.1	7.9	5.3	8.2	6.7	5.6	8.3	5.2	5.3	5.3	8.1	7.2	5.2
Cu(OH)2	%	1.6	3.1	2.0	2.0	1.9	1.8	2.8	1.2	1.9	2.3	2.4	1.8	1.5
Cu(CO3)2-2	%	0.6	1.1	0.7	0.7	0.5	0.5	1.0	0.4	0.7	0.8	0.9	0.6	0.6
CuHCO3+	%	3.4E-01	1.7E-01	2.8E-01	2.6E-01	3.0E-01	3.2E-01	1.9E-01	4.4E-01	2.9E-01	2.4E-01	2.1E-01	3.0E-01	3.5E-01
CuSO4	%	1.4E-01	3.4E-02	8.1E-02	5.4E-02	6.6E-02	9.3E-02	3.9E-02	1.1E-01	1.2E-01	1.1E-01	4.3E-02	6.3E-02	1.6E-01
Cu(OH)3-	%	2.0E-03	7.9E-03	3.2E-03	3.3E-03	2.6E-03	2.4E-03	6.5E-03	1.2E-03	2.8E-03	4.2E-03	4.9E-03	2.6E-03	1.9E-03
CuNH3+2	%	5.7E-02	2.7E-03	2.3E-02	2.6E-03	5.0E-03	1.8E-02	2.4E-03	1.1E-02	4.0E-02	5.2E-02	2.4E-03	3.7E-03	5.3E-02
Cu2(OH)2+2	%	4.9E-04	2.7E-04	3.4E-04	1.4E-04	1.8E-04	3.4E-04	1.4E-04	1.7E-04	5.2E-04	6.7E-04	1.3E-04	2.4E-04	5.8E-04
CuCl+	%	1.3E-04	6.9E-05	1.1E-04	1.1E-04	1.3E-04	1.3E-04	7.6E-05	1.7E-04	1.1E-04	8.7E-05	8.6E-05	1.2E-04	1.3E-04
CuNO3+	%	3.5E-04	5.2E-05	2.3E-04	8.3E-05	1.5E-04	2.9E-04	5.5E-05	3.6E-04	2.7E-04	2.2E-04	6.0E-05	1.3E-04	3.2E-04
CuNO2+	%	8.5E-05	2.6E-05	4.5E-05	4.1E-05	5.3E-05	5.5E-05	2.9E-05	7.2E-05	1.0E-04	8.7E-05	3.2E-05	4.9E-05	1.0E-04
Cu(OH)4-2	%	1.1E-08	8.5E-08	2.1E-08	2.3E-08	1.5E-08	1.3E-08	6.3E-08	4.9E-09	1.8E-08	3.3E-08	4.1E-08	1.6E-08	1.0E-08
CuCl2	%	2.0E-10	1.8E-10	1.7E-10	2.9E-10	2.6E-10	2.2E-10	2.1E-10	2.7E-10	1.8E-10	1.5E-10	2.3E-10	2.8E-10	2.1E-10
Cu(NO3)2	%	4.9E-10	2.4E-11	2.6E-10	4.1E-11	9.3E-11	3.2E-10	2.6E-11	3.8E-10	3.4E-10	2.9E-10	2.7E-11	7.9E-11	4.1E-10
Cu(NO2)2	%	9.0E-11	1.8E-11	3.0E-11	2.7E-11	3.5E-11	3.6E-11	1.9E-11	4.8E-11	1.5E-10	1.4E-10	2.2E-11	3.2E-11	1.3E-10
CuCl3-	%	1.9E-17	1.9E-17	1.6E-17	3.1E-17	2.5E-17	2.0E-17	2.3E-17	2.5E-17	1.7E-17	1.4E-17	2.5E-17	2.9E-17	2.0E-17
CuCl4-2	%	2.9E-24	2.2E-24	2.4E-24	3.4E-24	3.4E-24	3.0E-24	2.5E-24	3.9E-24	2.6E-24	2.1E-24	2.8E-24	3.5E-24	3.0E-24

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-2 - Copper speciation with depth (Eh = 500 mV)

Date		9/19/2014	9/19/2014	9/19/2014	9/22/2014	9/22/2014	9/22/2014	9/30/2014	9/30/2014	10/7/2014	10/7/2014	10/14/2014	10/14/2014	11/3/2014
Time		12:45:00 PM	2:20:00 AM	2:00:00 AM	12:30:00 PM	12:30:00 PM	1:00:00 AM	1:00:00 AM	1:45:00 AM	1:30:00 AM	2:00:00 AM	12:15:00 PM	12:30:00 PM	12:30:00 PM
Depth		0	25	48	0	25	47	0	40	0	40	0	40	0
Charge Balance	%	-4.16	-1.10	-1.01	-4.20	-2.85	-4.36	-2.38	-3.11	-3.83	-3.49	-3.05	-2.01	-1.42
pH	s.u.	8.0	7.6	7.8	8.0	7.7	7.9	8.3	8.0	8.0	7.7	8.1	7.9	8.0
pe	s.u.	8.7	9.0	9.0	8.7	9.0	9.0	8.8	9.0	8.8	9.0	8.8	9.0	8.9
Alkalinity	mg/L as $CaCO_3$	51	49	57	48	51	60	50	62	50	59	49	58	48
Cu	mg/L	0.0005	0.0015	0.0048	0.0005	0.0022	0.0064	0.0007	0.0059	0.0005	0.0051	0.0012	0.0053	0.0010
SO_4	mg/L	6.0	6.4	13.0	6.0	7.1	16.5	6.1	15.6	6.2	13.7	6.1	14.2	6.6
Relative Percent (%) - Copper Species														
Cu+	%	3.5E-06	4.2E-06	2.9E-06	3.2E-06	3.8E-06	2.3E-06	1.5E-06	1.7E-06	2.9E-06	3.0E-06	2.3E-06	2.4E-06	2.2E-06
CuCl	%	5.7E-08	6.9E-08	4.7E-08	5.2E-08	6.1E-08	4.0E-08	2.4E-08	2.8E-08	4.7E-08	4.8E-08	3.7E-08	4.1E-08	3.6E-08
CuCl2-	%	1.7E-10	2.1E-10	1.5E-10	1.6E-10	1.9E-10	1.3E-10	7.4E-11	8.9E-11	1.4E-10	1.5E-10	1.1E-10	1.4E-10	1.1E-10
CuCl3-2	%	5.5E-16	6.5E-16	4.5E-16	4.9E-16	5.8E-16	4.4E-16	2.3E-16	2.9E-16	4.5E-16	4.6E-16	3.6E-16	4.5E-16	3.4E-16
Cu+2	%	4.7	13.2	8.9	4.6	11.3	6.8	2.2	5.1	4.6	9.0	4.1	7.1	5.0
CuCO3	%	84	79	83	83	81	85	82	86	84	83	84	85	84
CuOH+	%	8.1	5.6	5.3	8.3	5.7	5.2	7.9	5.1	7.6	5.2	7.4	5.3	6.9
Cu(OH)2	%	2.4	1.2	1.5	2.8	1.4	1.9	5.5	2.5	2.7	1.4	3.4	1.9	3.2
Cu(CO3)2-2	%	1.0	0.3	0.5	1.0	0.4	0.7	2.0	1.0	1.0	0.5	1.1	0.7	0.9
CuHCO3+	%	2.0E-01	4.5E-01	3.5E-01	1.9E-01	4.0E-01	2.8E-01	9.2E-02	2.1E-01	1.9E-01	3.7E-01	1.6E-01	2.8E-01	1.8E-01
CuSO4	%	3.9E-02	1.0E-01	1.4E-01	3.8E-02	9.8E-02	1.3E-01	1.9E-02	9.1E-02	3.9E-02	1.4E-01	3.4E-02	1.2E-01	4.3E-02
Cu(OH)3-	%	5.1E-03	1.1E-03	1.9E-03	6.5E-03	1.4E-03	3.0E-03	2.5E-02	5.4E-03	6.2E-03	1.7E-03	8.9E-03	3.1E-03	7.7E-03
CuNH3+2	%	2.1E-03	7.5E-03	3.9E-02	2.4E-03	8.6E-03	5.0E-02	2.2E-03	4.5E-02	2.7E-03	4.1E-02	3.2E-03	3.2E-02	4.6E-03
Cu2(OH)2+2	%	1.4E-04	1.8E-04	5.1E-04	1.4E-04	2.7E-04	6.7E-04	1.9E-04	5.9E-04	1.3E-04	5.2E-04	2.7E-04	5.8E-04	1.8E-04
CuCl+	%	7.9E-05	2.0E-04	1.3E-04	7.6E-05	1.7E-04	1.1E-04	3.7E-05	7.6E-05	7.6E-05	1.3E-04	6.7E-05	1.1E-04	7.8E-05
CuNO3+	%	5.2E-05	3.5E-04	3.2E-04	5.3E-05	3.4E-04	2.6E-04	2.5E-05	2.0E-04	5.7E-05	3.3E-04	5.4E-05	2.8E-04	8.9E-05
CuNO2+	%	2.9E-05	8.3E-05	6.0E-05	2.9E-05	7.1E-05	9.2E-05	1.4E-05	2.0E-04	2.9E-05	1.9E-04	2.6E-05	2.4E-04	3.2E-05
Cu(OH)4-2	%	4.5E-08	4.2E-09	1.0E-08	6.3E-08	6.3E-09	2.0E-08	5.0E-07	4.9E-08	5.9E-08	8.7E-09	1.0E-07	2.1E-08	7.7E-08
CuCl2	%	2.3E-10	3.2E-10	2.2E-10	2.1E-10	2.8E-10	2.0E-10	9.8E-11	1.3E-10	1.9E-10	2.2E-10	1.6E-10	2.0E-10	1.6E-10
Cu(NO3)2	%	2.3E-11	3.2E-10	4.0E-10	2.3E-11	3.6E-10	3.5E-10	1.1E-11	2.7E-10	2.7E-11	4.3E-10	2.7E-11	3.8E-10	5.6E-11
Cu(NO2)2	%	2.0E-11	5.5E-11	4.3E-11	1.9E-11	4.7E-11	1.3E-10	9.4E-12	8.8E-10	1.9E-11	4.2E-10	1.7E-11	9.0E-10	2.1E-11
CuCl3-	%	2.5E-17	2.9E-17	2.0E-17	2.3E-17	2.6E-17	2.0E-17	1.1E-17	1.3E-17	2.0E-17	2.1E-17	1.6E-17	2.0E-17	1.5E-17
CuCl4-2	%	2.6E-24	4.5E-24	3.0E-24	2.5E-24	3.9E-24	3.2E-24	1.2E-24	2.0E-24	2.3E-24	3.1E-24	2.0E-24	3.3E-24	2.1E-24

[shaded box] Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-2 - Copper speciation with depth (Eh = 500 mV)

Date		11/3/2014	11/10/2014	11/10/2014	11/18/2014	11/18/2014
Time		1:00:00 AM	12:00:00 PM	12:30:00 PM	1:45:00 AM	2:30:00 AM
Depth		40	0	40	0	40
Charge Balance	%	-1.62	4.44	-0.08	-0.83	-0.47
pH	s.u.	7.8	7.9	7.8	7.9	7.8
pe	s.u.	9.0	9.0	9.0	9.0	9.1
Alkalinity	mg/L as $CaCO_3$	53	43	54	49	49
Cu	mg/L	0.0027	0.0011	0.0031	0.0013	0.0010
SO_4	mg/L	10.4	7.0	12.2	7.3	7.0
Relative Percent (%) - Copper Species						
Cu+	%	2.9E-06	3.1E-06	2.9E-06	2.8E-06	3.2E-06
CuCl	%	4.6E-08	5.0E-08	4.6E-08	4.6E-08	5.2E-08
CuCl2-	%	1.4E-10	1.5E-10	1.4E-10	1.4E-10	1.6E-10
CuCl3-2	%	4.4E-16	4.7E-16	4.4E-16	4.4E-16	4.8E-16
Cu+2	%	8.1	7.5	8.0	7.9	10.3
CuCO3	%	83	82	83	83	81
CuOH+	%	5.8	7.3	5.8	6.3	5.8
Cu(OH)2	%	1.9	2.7	1.8	2.2	1.7
Cu(CO3)2-2	%	0.6	0.6	0.6	0.6	0.4
CuHCO3+	%	3.0E-01	2.4E-01	3.0E-01	2.7E-01	3.5E-01
CuSO4	%	1.0E-01	6.6E-02	1.2E-01	7.1E-02	8.7E-02
Cu(OH)3-	%	2.7E-03	4.7E-03	2.7E-03	3.5E-03	2.1E-03
CuNH3+2	%	6.2E-03	5.8E-03	6.1E-03	6.4E-03	8.0E-03
Cu2(OH)2+2	%	3.5E-04	2.2E-04	3.9E-04	1.9E-04	1.2E-04
CuCl+	%	1.2E-04	1.2E-04	1.2E-04	1.2E-04	1.5E-04
CuNO3+	%	3.0E-04	1.6E-04	3.3E-04	1.8E-04	3.1E-04
CuNO2+	%	5.0E-05	4.7E-05	5.0E-05	4.9E-05	6.4E-05
Cu(OH)4-2	%	1.6E-08	3.5E-08	1.6E-08	2.3E-08	1.1E-08
CuCl2	%	2.1E-10	2.2E-10	2.1E-10	2.1E-10	2.4E-10
Cu(NO3)2	%	3.9E-10	1.2E-10	4.9E-10	1.4E-10	3.3E-10
Cu(NO2)2	%	3.3E-11	3.1E-11	3.3E-11	3.3E-11	4.3E-11
CuCl3-	%	2.0E-17	2.1E-17	1.9E-17	2.0E-17	2.2E-17
CuCl4-2	%	2.9E-24	2.9E-24	2.9E-24	2.9E-24	3.4E-24

(Shaded) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-2 - Copper speciation with depth (Eh = 300 mV)

Date		8/6/2014	8/9/2014	8/11/2014	8/16/2014	8/16/2014	8/16/2014	8/21/2014	8/25/2014	8/25/2014	8/25/2014	8/27/2014	8/27/2014
Time		5:45:00 AM	12:54:00 PM	12:56:00 PM	12:20:00 PM	12:40:00 PM	1:10:00 AM	1:16:00 AM	2:25:00 AM	2:50:00 AM	3:10:00 AM	1:00:00 AM	1:30:00 AM
Depth (m)		0	0	0	0	10	30	47	0	8	40	0	15
Charge Balance	%	1.18	1.24	-0.08	1.44	1.62	0.19	-0.28	1.44	0.67	1.00	0.56	0.67
pH	s.u.	8.1	7.8	7.7	8.1	7.9	7.6	7.9	7.9	8.0	7.6	8.0	7.8
pe	s.u.	5.1	5.2	5.2	5.2	5.3	5.4	5.4	5.2	5.2	5.4	5.2	5.3
Alkalinity	mg/L as $CaCO_3$	44	43	44	43	44	48	55	44	45	51	45	45
Cu	mg/L	0.0006	0.0005	0.0005	0.0005	0.0005	0.0007	0.0041	0.0005	0.0006	0.0025	0.0005	0.0011
SO_4	mg/L	5.6	5.5	5.6	5.6	5.8	6.3	12.0	5.8	5.9	8.9	5.8	6.1
Relative Percent (%) - Copper Species													
Cu+	%	1.0E-02	2.0E-02	2.7E-02	1.2E-02	1.3E-02	1.7E-02	8.4E-03	1.5E-02	1.3E-02	2.0E-02	1.4E-02	1.7E-02
CuCl	%	1.7E-04	3.3E-04	4.3E-04	1.9E-04	2.2E-04	2.8E-04	1.3E-04	2.4E-04	2.1E-04	3.1E-04	2.2E-04	2.7E-04
CuCl2-	%	4.9E-07	9.9E-07	1.3E-06	5.7E-07	6.6E-07	8.7E-07	4.2E-07	7.3E-07	6.3E-07	9.7E-07	6.7E-07	8.2E-07
CuCl3-2	%	1.6E-12	3.2E-12	4.2E-12	1.8E-12	2.1E-12	2.6E-12	1.3E-12	2.3E-12	2.0E-12	3.0E-12	2.1E-12	2.6E-12
Cu+2	%	3.5	7.9	9.2	4.1	7.1	13.7	6.5	5.7	5.7	14.5	5.1	7.7
CuCO3	%	81	80	79	81	82	79	84	81	82	78	82	81
CuOH+	%	10.6	9.6	10.0	10.5	8.0	5.6	5.6	9.8	8.9	5.4	9.8	8.4
Cu(OH)2	%	3.4	1.6	1.2	3.0	2.3	1.3	2.6	2.2	2.4	1.0	2.4	1.8
Cu(CO3)2-2	%	1.2	0.5	0.4	1.1	0.6	0.3	0.8	0.8	0.8	0.3	0.9	0.6
CuHCO3+	%	1.4E-01	3.1E-01	3.8E-01	1.7E-01	2.5E-01	4.5E-01	2.3E-01	2.3E-01	2.2E-01	5.2E-01	2.1E-01	3.0E-01
CuSO4	%	2.9E-02	6.3E-02	7.7E-02	3.4E-02	5.5E-02	1.1E-01	9.0E-02	4.8E-02	4.7E-02	1.6E-01	4.3E-02	6.5E-02
Cu(OH)3-	%	9.9E-03	2.1E-03	1.3E-03	7.7E-03	3.9E-03	1.2E-03	4.9E-03	4.1E-03	4.7E-03	8.0E-04	4.8E-03	2.5E-03
CuNH3+2	%	1.3E-03	1.8E-03	1.4E-03	1.4E-03	3.7E-03	8.7E-03	4.1E-02	1.8E-03	2.4E-03	1.6E-02	1.6E-03	2.6E-03
Cu2(OH)2+2	%	2.7E-04	1.9E-04	2.1E-04	2.5E-04	1.3E-04	8.3E-05	4.9E-04	2.0E-04	1.8E-04	2.8E-04	2.0E-04	3.3E-04
CuCl+	%	6.2E-05	1.4E-04	1.6E-04	7.2E-05	1.1E-04	2.0E-04	9.4E-05	1.0E-04	9.6E-05	2.1E-04	8.9E-05	1.3E-04
CuNO3+	%	3.3E-05	8.5E-05	9.4E-05	3.4E-05	1.2E-04	4.1E-04	2.6E-04	5.4E-05	8.5E-05	5.1E-04	4.4E-05	1.3E-04
CuNO2+	%	2.2E-05	4.9E-05	5.8E-05	2.6E-05	4.5E-05	8.6E-05	4.0E-05	3.6E-05	3.6E-05	9.0E-05	3.2E-05	4.8E-05
Cu(OH)4-2	%	1.2E-07	1.2E-08	5.6E-09	8.2E-08	2.7E-08	4.4E-09	3.9E-08	3.2E-08	3.8E-08	2.7E-09	4.1E-08	1.5E-08
CuCl2	%	2.2E-10	4.3E-10	5.8E-10	2.6E-10	2.7E-10	3.1E-10	1.5E-10	3.2E-10	2.7E-10	3.5E-10	3.0E-10	3.4E-10
Cu(NO3)2	%	1.3E-11	3.7E-11	3.9E-11	1.1E-11	8.2E-11	4.2E-10	3.7E-10	2.0E-11	4.9E-11	6.1E-10	1.5E-11	8.0E-11
Cu(NO2)2	%	1.5E-11	3.3E-11	3.9E-11	1.7E-11	3.0E-11	5.7E-11	2.6E-11	2.4E-11	2.4E-11	6.0E-11	2.1E-11	3.2E-11
CuCl3-	%	2.7E-17	5.0E-17	7.0E-17	3.1E-17	2.8E-17	2.8E-17	1.4E-17	3.8E-17	3.0E-17	3.3E-17	3.5E-17	3.8E-17
CuCl4-2	%	2.4E-24	4.9E-24	6.4E-24	2.8E-24	3.3E-24	4.5E-24	2.1E-24	3.6E-24	3.2E-24	5.0E-24	3.3E-24	4.1E-24

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Detailed Copper Speciation Results

Quesnel Lake West Basin, QUL-2 - Copper speciation with depth (Eh = 300 mV)

Date		8/27/2014	8/29/2014	8/29/2014	9/2/2014	9/2/2014	9/2/2014	9/3/2014	9/3/2014	9/6/2014	9/6/2014	9/6/2014
Time		2:00:00 AM	1:25:00 AM	1:43:00 AM	12:23:00 PM	1:50:00 AM	12:50:00 PM	11:23:00 AM	11:49:00 AM	12:00:00 PM	1:00:00 AM	1:30:00 AM
Depth (m)		42	0	37	0	14	40	0	47	0	9	49
Charge Balance	%	0.83	1.23	0.18	2.04	1.11	1.07	-0.38	0.31	-1.95	-2.28	-2.05
pH	s.u.	7.6	8.1	7.6	8.1	7.8	7.4	7.9	8.0	7.8	7.6	7.3
pe	s.u.	5.4	5.2	5.4	5.2	5.3	5.4	5.2	5.4	5.2	5.3	5.4
Alkalinity	mg/L as $CaCO_3$	54	44	50	44	46	52	46	57	47	48	60
Cu	mg/L	0.0042	0.0005	0.0017	0.0005	0.0020	0.0034	0.0006	0.0046	0.0006	0.0009	0.0057
SO_4	mg/L	12.8	5.7	7.2	5.8	6.0	10.5	5.7	14.3	5.8	6.0	16.9
Relative Percent (%) - Copper Species												
Cu+	%	1.9E-02	9.5E-03	2.0E-02	1.1E-02	1.4E-02	2.6E-02	1.6E-02	7.3E-03	2.0E-02	2.4E-02	3.0E-02
CuCl	%	3.0E-04	1.6E-04	3.2E-04	1.8E-04	2.3E-04	4.3E-04	2.7E-04	1.2E-04	3.2E-04	3.8E-04	5.4E-04
CuCl2-	%	9.3E-07	4.6E-07	9.9E-07	5.3E-07	7.1E-07	1.3E-06	8.0E-07	3.6E-07	9.7E-07	1.2E-06	1.9E-06
CuCl3-2	%	2.8E-12	1.5E-12	3.0E-12	1.7E-12	2.2E-12	4.0E-12	2.5E-12	1.1E-12	3.1E-12	3.6E-12	6.4E-12
Cu+2	%	14.0	3.6	15.3	4.3	7.9	20.5	6.4	5.7	7.7	12.5	22.0
CuCO3	%	79	82	77	82	82	73	81	85	81	79	72
CuOH+	%	5.2	9.9	5.4	9.7	7.5	4.9	9.2	5.3	9.0	7.1	4.4
Cu(OH)2	%	1.0	3.6	1.0	3.0	1.9	0.6	1.9	2.7	1.4	1.0	0.4
Cu(CO3)2-2	%	0.3	1.2	0.3	1.0	0.6	0.2	0.7	0.9	0.6	0.3	0.2
CuHCO3+	%	5.2E-01	1.4E-01	5.2E-01	1.7E-01	2.9E-01	7.3E-01	2.7E-01	2.2E-01	3.3E-01	4.8E-01	9.1E-01
CuSO4	%	2.1E-01	3.0E-02	1.3E-01	3.5E-02	6.3E-02	2.5E-01	5.3E-02	9.5E-02	6.4E-02	1.0E-01	4.3E-01
Cu(OH)3-	%	7.7E-04	1.0E-02	7.9E-04	7.5E-03	2.8E-03	3.3E-04	3.0E-03	5.4E-03	1.8E-03	8.5E-04	1.7E-04
CuNH3+2	%	4.5E-02	1.7E-03	8.4E-03	2.3E-03	8.4E-03	3.5E-02	1.8E-03	6.5E-02	2.5E-03	4.3E-03	5.7E-02
Cu2(OH)2+2	%	4.3E-04	2.0E-04	1.9E-04	1.9E-04	4.3E-04	3.1E-04	1.9E-04	5.0E-04	2.0E-04	1.7E-04	4.3E-04
CuCl+	%	2.0E-04	6.3E-05	2.2E-04	7.4E-05	1.3E-04	3.0E-04	1.1E-04	8.3E-05	1.3E-04	2.0E-04	3.6E-04
CuNO3+	%	5.5E-04	3.2E-05	4.9E-04	3.5E-05	1.7E-04	7.5E-04	5.2E-05	2.5E-04	6.4E-05	2.4E-04	8.9E-04
CuNO2+	%	8.6E-05	2.3E-05	9.5E-05	2.7E-05	5.0E-05	1.3E-04	4.0E-05	4.2E-05	4.8E-05	7.8E-05	2.7E-04
Cu(OH)4-2	%	2.6E-09	1.3E-07	2.6E-09	7.9E-08	1.8E-08	7.2E-10	2.0E-08	4.8E-08	9.7E-09	3.0E-09	3.1E-10
CuCl2	%	3.4E-10	2.0E-10	3.6E-10	2.3E-10	2.8E-10	4.7E-10	3.5E-10	1.3E-10	4.3E-10	4.7E-10	6.8E-10
Cu(NO3)2	%	7.6E-10	1.1E-11	5.3E-10	1.2E-11	1.3E-10	9.3E-10	1.7E-11	3.8E-10	2.1E-11	1.7E-10	1.3E-09
Cu(NO2)2	%	5.7E-11	1.5E-11	6.4E-11	1.8E-11	3.3E-11	8.4E-11	2.7E-11	3.3E-11	3.2E-11	5.2E-11	3.5E-10
CuCl3-	%	3.1E-17	2.4E-17	3.2E-17	2.7E-17	2.9E-17	4.3E-17	4.0E-17	1.2E-17	5.0E-17	4.9E-17	7.0E-17
CuCl4-2	%	4.8E-24	2.3E-24	5.1E-24	2.7E-24	3.6E-24	6.8E-24	4.0E-24	1.9E-24	4.8E-24	5.9E-24	1.2E-23

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-2 - Copper speciation with depth (Eh = 300 mV)

Date		9/9/2014	9/9/2014	9/9/2014	9/11/2014	9/11/2014	9/13/2014	9/13/2014	9/13/2014	9/15/2014	9/15/2014	9/15/2014
Time		2:00:00 AM	2:17:00 AM	2:32:00 AM	12:15:00 PM	12:52:00 PM	1:00:00 AM	1:30:00 AM	2:00:00 AM	12:38:00 PM	1:15:00 AM	1:51:00 AM
Depth (m)		0	13	48	0	44	0	13	43	0	25	38
Charge Balance	%	-2.76	-2.73	-1.09	-2.22	-2.79	-0.06	-0.66	0.18	-3.37	-5.75	-2.74
pH	s.u.	8.1	7.7	7.8	8.1	7.9	7.9	7.8	7.8	8.0	7.7	7.8
pe	s.u.	5.2	5.4	5.4	5.3	5.4	5.3	5.4	5.4	5.2	5.4	5.4
Alkalinity	mg/L as $CaCO_3$	48	50	58	49	57	47	48	53	48	55	57
Cu	mg/L	0.0009	0.0011	0.0048	0.0011	0.0032	0.0005	0.0010	0.0028	0.0005	0.0016	0.0048
SO_4	mg/L	5.9	6.5	13.9	5.9	9.4	6.0	6.1	8.8	6.1	7.6	14.1
Relative Percent (%) - Copper Species												
Cu+	%	9.2E-03	1.4E-02	1.1E-02	8.8E-03	9.5E-03	1.4E-02	1.4E-02	1.2E-02	1.0E-02	1.5E-02	1.0E-02
CuCl	%	1.5E-04	2.3E-04	1.8E-04	1.4E-04	1.5E-04	2.3E-04	2.2E-04	1.9E-04	1.6E-04	2.4E-04	1.6E-04
CuCl2-	%	4.5E-07	7.1E-07	5.6E-07	4.3E-07	4.7E-07	6.9E-07	6.8E-07	5.9E-07	5.0E-07	7.6E-07	5.0E-07
CuCl3-2	%	1.4E-12	2.2E-12	1.7E-12	1.4E-12	1.5E-12	2.2E-12	2.1E-12	1.8E-12	1.6E-12	2.3E-12	1.5E-12
Cu+2	%	4.0	10.5	8.7	4.2	7.2	6.5	8.4	8.8	4.6	11.5	7.5
CuCO3	%	83	81	83	83	84	82	82	83	83	81	84
CuOH+	%	8.5	5.7	5.1	7.9	5.3	8.2	6.7	5.6	8.3	5.2	5.3
Cu(OH)2	%	3.1	1.5	1.6	3.1	2.0	2.0	1.9	1.8	2.8	1.2	1.9
Cu(CO3)2-2	%	1.1	0.4	0.6	1.1	0.7	0.7	0.5	0.5	1.0	0.4	0.7
CuHCO3+	%	1.7E-01	3.7E-01	3.4E-01	1.7E-01	2.8E-01	2.6E-01	3.0E-01	3.2E-01	1.9E-01	4.4E-01	2.9E-01
CuSO4	%	3.3E-02	8.4E-02	1.4E-01	3.4E-02	8.1E-02	5.4E-02	6.6E-02	9.3E-02	3.9E-02	1.1E-01	1.2E-01
Cu(OH)3-	%	8.1E-03	1.8E-03	2.0E-03	7.9E-03	3.2E-03	3.3E-03	2.6E-03	2.4E-03	6.5E-03	1.2E-03	2.8E-03
CuNH3+2	%	2.2E-03	7.2E-03	5.7E-02	2.7E-03	2.3E-02	2.6E-03	5.0E-03	1.8E-02	2.4E-03	1.1E-02	4.0E-02
Cu2(OH)2+2	%	2.5E-04	1.3E-04	4.9E-04	2.7E-04	3.4E-04	1.4E-04	1.8E-04	3.4E-04	1.4E-04	1.7E-04	5.2E-04
CuCl+	%	6.8E-05	1.6E-04	1.3E-04	6.9E-05	1.1E-04	1.1E-04	1.3E-04	1.3E-04	7.6E-05	1.7E-04	1.1E-04
CuNO3+	%	3.9E-05	2.7E-04	3.5E-04	5.2E-05	2.3E-04	8.3E-05	1.5E-04	2.9E-04	5.5E-05	3.6E-04	2.7E-04
CuNO2+	%	2.5E-05	6.6E-05	8.5E-05	2.6E-05	4.5E-05	4.1E-05	5.3E-05	5.5E-05	2.9E-05	7.2E-05	1.0E-04
Cu(OH)4-2	%	8.9E-08	8.4E-09	1.1E-08	8.5E-08	2.1E-08	2.3E-08	1.5E-08	1.3E-08	6.3E-08	4.9E-09	1.8E-08
CuCl2	%	1.9E-10	2.6E-10	2.0E-10	1.8E-10	1.7E-10	2.9E-10	2.6E-10	2.2E-10	2.1E-10	2.7E-10	1.8E-10
Cu(NO3)2	%	1.4E-11	2.5E-10	4.9E-10	2.4E-11	2.6E-10	4.1E-11	9.3E-11	3.2E-10	2.6E-11	3.8E-10	3.4E-10
Cu(NO2)2	%	1.7E-11	4.4E-11	9.0E-11	1.8E-11	3.0E-11	2.7E-11	3.5E-11	3.6E-11	1.9E-11	4.8E-11	1.5E-10
CuCl3-	%	2.1E-17	2.4E-17	1.9E-17	1.9E-17	1.6E-17	3.1E-17	2.5E-17	2.0E-17	2.3E-17	2.5E-17	1.7E-17
CuCl4-2	%	2.3E-24	3.6E-24	2.9E-24	2.2E-24	2.4E-24	3.4E-24	3.4E-24	3.0E-24	2.5E-24	3.9E-24	2.6E-24

(Shaded cells:) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-2 - Copper speciation with depth (Eh = 300 mV)

Date		9/15/2014	9/17/2014	9/17/2014	9/17/2014	9/19/2014	9/19/2014	9/19/2014	9/22/2014	9/22/2014	9/22/2014	9/30/2014	9/30/2014
Time		12:47:00 PM	12:30:00 PM	1:30:00 AM	2:40:00 AM	12:45:00 PM	2:20:00 AM	2:00:00 AM	12:30:00 PM	12:30:00 PM	1:00:00 AM	1:00:00 AM	1:45:00 AM
Depth (m)		50	0	16	47	0	25	48	0	25	47	0	40
Charge Balance	%	-2.14	-1.65	-1.22	-2.53	-4.16	-1.10	-1.01	-4.20	-2.85	-4.36	-2.38	-3.11
pH	s.u.	7.9	8.0	7.8	7.8	8.0	7.6	7.8	8.0	7.7	7.9	8.3	8.0
pe	s.u.	5.4	5.2	5.3	5.4	5.2	5.4	5.4	5.2	5.4	5.4	5.3	5.4
Alkalinity	mg/L as $CaCO_3$	59	49	49	59	51	49	57	48	51	60	50	62
Cu	mg/L	0.0062	0.0005	0.0012	0.0056	0.0005	0.0015	0.0048	0.0005	0.0022	0.0064	0.0007	0.0059
SO_4	mg/L	16.3	6.0	6.1	15.7	6.0	6.4	13.0	6.0	7.1	16.5	6.1	15.6
Relative Percent (%) - Copper Species													
Cu+	%	8.1E-03	1.1E-02	1.4E-02	1.2E-02	1.1E-02	1.8E-02	1.2E-02	1.0E-02	1.5E-02	9.3E-03	4.8E-03	6.8E-03
CuCl	%	1.3E-04	1.8E-04	2.3E-04	1.9E-04	1.8E-04	2.8E-04	1.9E-04	1.6E-04	2.5E-04	1.6E-04	7.8E-05	1.1E-04
CuCl2-	%	4.0E-07	5.6E-07	7.0E-07	5.8E-07	5.3E-07	8.8E-07	5.9E-07	4.9E-07	7.7E-07	5.4E-07	2.4E-07	3.6E-07
CuCl3-2	%	1.2E-12	1.8E-12	2.2E-12	1.8E-12	1.7E-12	2.7E-12	1.8E-12	1.6E-12	2.4E-12	1.8E-12	7.4E-13	1.2E-12
Cu+2	%	6.0	5.2	7.7	8.7	4.7	13.2	8.9	4.6	11.3	6.8	2.2	5.1
CuCO3	%	85	83	82	84	84	79	83	83	81	85	82	86
CuOH+	%	5.3	8.1	7.2	5.2	8.1	5.6	5.3	8.3	5.7	5.2	7.9	5.1
Cu(OH)2	%	2.3	2.4	1.8	1.5	2.4	1.2	1.5	2.8	1.4	1.9	5.5	2.5
Cu(CO3)2-2	%	0.8	0.9	0.6	0.6	1.0	0.3	0.5	1.0	0.4	0.7	2.0	1.0
CuHCO3+	%	2.4E-01	2.1E-01	3.0E-01	3.5E-01	2.0E-01	4.5E-01	3.5E-01	1.9E-01	4.0E-01	2.8E-01	9.2E-02	2.1E-01
CuSO4	%	1.1E-01	4.3E-02	6.3E-02	1.6E-01	3.9E-02	1.0E-01	1.4E-01	3.8E-02	9.8E-02	1.3E-01	1.9E-02	9.1E-02
Cu(OH)3-	%	4.2E-03	4.9E-03	2.6E-03	1.9E-03	5.1E-03	1.1E-03	1.9E-03	6.5E-03	1.4E-03	3.0E-03	2.5E-02	5.4E-03
CuNH3+2	%	5.2E-02	2.4E-03	3.7E-03	5.3E-02	2.1E-03	7.5E-03	3.9E-02	2.4E-03	8.6E-03	5.0E-02	2.2E-03	4.5E-02
Cu2(OH)2+2	%	6.7E-04	1.3E-04	2.4E-04	5.8E-04	1.4E-04	1.8E-04	5.1E-04	1.4E-04	2.7E-04	6.7E-04	1.9E-04	5.9E-04
CuCl+	%	8.7E-05	8.6E-05	1.2E-04	1.3E-04	7.9E-05	2.0E-04	1.3E-04	7.6E-05	1.7E-04	1.1E-04	3.7E-05	7.6E-05
CuNO3+	%	2.2E-04	6.0E-05	1.3E-04	3.2E-04	5.2E-05	3.5E-04	3.2E-04	5.3E-05	3.4E-04	2.6E-04	2.5E-05	2.0E-04
CuNO2+	%	8.7E-05	3.2E-05	4.9E-05	1.0E-04	2.9E-05	8.3E-05	6.0E-05	2.9E-05	7.1E-05	9.2E-05	1.4E-05	2.0E-04
Cu(OH)4-2	%	3.3E-08	4.1E-08	1.6E-08	1.0E-08	4.5E-08	4.2E-09	1.0E-08	6.3E-08	6.3E-09	2.0E-08	5.0E-07	4.9E-08
CuCl2	%	1.5E-10	2.3E-10	2.8E-10	2.1E-10	2.3E-10	3.2E-10	2.2E-10	2.1E-10	2.8E-10	2.0E-10	9.8E-11	1.3E-10
Cu(NO3)2	%	2.9E-10	2.7E-11	7.9E-11	4.1E-10	2.3E-11	3.2E-10	4.0E-10	2.3E-11	3.6E-10	3.5E-10	1.1E-11	2.7E-10
Cu(NO2)2	%	1.4E-10	2.2E-11	3.2E-11	1.3E-10	2.0E-11	5.5E-11	4.3E-11	1.9E-11	4.7E-11	1.3E-10	9.4E-12	8.8E-10
CuCl3-	%	1.4E-17	2.5E-17	2.9E-17	2.0E-17	2.5E-17	2.9E-17	2.0E-17	2.3E-17	2.6E-17	2.0E-17	1.1E-17	1.3E-17
CuCl4-2	%	2.1E-24	2.8E-24	3.5E-24	3.0E-24	2.6E-24	4.5E-24	3.0E-24	2.5E-24	3.9E-24	3.2E-24	1.2E-24	2.0E-24

Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-2 - Copper speciation with depth (Eh = 300 mV)

Date		10/7/2014	10/7/2014	10/14/2014	10/14/2014	11/3/2014	11/3/2014	11/10/2014	11/10/2014	11/18/2014	11/18/2014
Time		1:30:00 AM	2:00:00 AM	12:15:00 PM	12:30:00 PM	12:30:00 PM	1:00:00 AM	12:00:00 PM	12:30:00 PM	1:45:00 AM	2:30:00 AM
Depth (m)		0	40	0	40	0	40	0	40	0	40
Charge Balance	%	-3.83	-3.49	-3.04	-2.01	-1.42	-1.62	4.44	-0.08	-0.83	-0.47
pH	s.u.	8.0	7.7	8.1	7.9	8.0	7.8	7.9	7.8	7.9	7.8
pe	s.u.	5.3	5.4	5.3	5.4	5.4	5.4	5.4	5.4	5.4	5.4
Alkalinity	mg/L as $CaCO_3$	50	59	49	58	48	53	43	54	49	49
Cu	mg/L	0.0005	0.0051	0.0012	0.0053	0.0010	0.0027	0.0011	0.0031	0.0013	0.0010
SO_4	mg/L	6.2	13.7	6.1	14.2	6.6	10.4	7.0	12.2	7.3	7.0
Relative Percent (%) - Copper Species											
Cu+	%	9.5E-03	1.2E-02	7.9E-03	9.6E-03	8.2E-03	1.1E-02	1.2E-02	1.1E-02	1.1E-02	1.3E-02
CuCl	%	1.5E-04	2.0E-04	1.3E-04	1.7E-04	1.3E-04	1.8E-04	1.9E-04	1.8E-04	1.8E-04	2.2E-04
CuCl2-	%	4.7E-07	6.0E-07	3.9E-07	5.5E-07	4.1E-07	5.7E-07	5.8E-07	5.6E-07	5.6E-07	6.7E-07
CuCl3-2	%	1.5E-12	1.9E-12	1.2E-12	1.8E-12	1.3E-12	1.7E-12	1.8E-12	1.7E-12	1.7E-12	2.0E-12
Cu+2	%	4.6	8.9	4.1	7.1	5.0	8.1	7.5	8.0	7.9	10.3
CuCO3	%	84	83	84	85	84	83	82	83	83	81
CuOH+	%	7.6	5.2	7.4	5.3	6.9	5.8	7.3	5.8	6.3	5.8
Cu(OH)2	%	2.7	1.4	3.4	1.9	3.2	1.9	2.7	1.8	2.2	1.7
Cu(CO3)2-2	%	1.0	0.5	1.1	0.7	0.9	0.6	0.6	0.6	0.6	0.4
CuHCO3+	%	1.9E-01	3.7E-01	1.6E-01	2.8E-01	1.8E-01	3.0E-01	2.4E-01	3.0E-01	2.7E-01	3.5E-01
CuSO4	%	3.9E-02	1.4E-01	3.4E-02	1.2E-01	4.3E-02	1.0E-01	6.6E-02	1.2E-01	7.1E-02	8.7E-02
Cu(OH)3-	%	6.2E-03	1.7E-03	8.9E-03	3.1E-03	7.7E-03	2.7E-03	4.7E-03	2.7E-03	3.5E-03	2.1E-03
CuNH3+2	%	2.7E-03	4.1E-02	3.2E-03	3.2E-02	4.6E-03	6.2E-03	5.8E-03	6.1E-03	6.4E-03	8.0E-03
Cu2(OH)2+2	%	1.3E-04	5.2E-04	2.7E-04	5.8E-04	1.8E-04	3.5E-04	2.2E-04	3.9E-04	1.9E-04	1.2E-04
CuCl+	%	7.6E-05	1.3E-04	6.7E-05	1.1E-04	7.8E-05	1.2E-04	1.2E-04	1.2E-04	1.2E-04	1.5E-04
CuNO3+	%	5.7E-05	3.3E-04	5.4E-05	2.8E-04	8.9E-05	3.0E-04	1.6E-04	3.3E-04	1.8E-04	3.1E-04
CuNO2+	%	2.9E-05	1.9E-04	2.6E-05	2.4E-04	3.2E-05	5.0E-05	4.7E-05	5.0E-05	4.9E-05	6.4E-05
Cu(OH)4-2	%	5.9E-08	8.7E-09	1.0E-07	2.1E-08	7.7E-08	1.6E-08	3.5E-08	1.6E-08	2.3E-08	1.1E-08
CuCl2	%	1.9E-10	2.2E-10	1.6E-10	2.0E-10	1.6E-10	2.1E-10	2.2E-10	2.1E-10	2.1E-10	2.4E-10
Cu(NO3)2	%	2.7E-11	4.3E-10	2.7E-11	3.8E-10	5.6E-11	3.9E-10	1.2E-10	4.9E-10	1.4E-10	3.3E-10
Cu(NO2)2	%	1.9E-11	4.2E-10	1.7E-11	9.0E-10	2.1E-11	3.3E-11	3.1E-11	3.3E-11	3.3E-11	4.3E-11
CuCl3-	%	2.0E-17	2.1E-17	1.6E-17	2.0E-17	1.5E-17	2.0E-17	2.1E-17	1.9E-17	2.0E-17	2.2E-17
CuCl4-2	%	2.3E-24	3.1E-24	2.0E-24	3.3E-24	2.1E-24	2.9E-24	2.9E-24	2.9E-24	2.9E-24	3.4E-24

(Shaded) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-21 - Copper speciation with depth (Eh = 500 mV)

Date		8/8/2014	8/8/2014	8/8/2014	8/9/2014	8/11/2014	8/12/2014	8/12/2014	8/12/2014	8/13/2014	8/14/2014	8/15/2014	8/15/2014	8/15/2014
Time		4:15:00 AM	4:35:00 AM	4:55:00 AM	3:24:00 AM	2:05:00 AM	11:15:00 AM	11:35:00 AM	11:45:00 AM	3:05:00 AM	11:10:00 AM	11:30:00 AM	11:50:00 AM	12:15:00 PM
Depth		0	7	30	0	0	0	12	30	0	0	0	10	30
Charge Balance	%	1.85	1.89	1.36	1.99	-0.33	0.31	-0.82	-0.10	-0.77	2.16	1.59	1.37	0.70
pH	s.u.	7.9	7.9	7.7	7.8	7.9	8.0	7.8	7.6	7.6	7.9	8.1	7.8	7.7
pe	s.u.	8.8	8.9	9.1	8.7	8.6	8.6	8.8	9.1	8.6	8.6	8.6	8.8	9.1
Alkalinity	mg/L as $CaCO_3$	44	44	48	43	44	44	45	50	44	43	43	45	48
Cu	mg/L	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
SO_4	mg/L	5.6	5.7	6.1	5.5	5.6	5.7	5.8	6.2	5.6	5.6	5.6	5.8	6.2
Relative Percent (%) - Copper Species														
Cu+	%	4.5E-06	3.5E-06	3.6E-06	6.0E-06	6.6E-06	5.2E-06	4.8E-06	4.4E-06	1.3E-05	7.4E-06	3.9E-06	4.8E-06	3.8E-06
CuCl	%	7.4E-08	5.7E-08	5.9E-08	9.8E-08	1.1E-07	8.4E-08	7.7E-08	7.1E-08	2.1E-07	1.2E-07	6.4E-08	7.8E-08	6.2E-08
CuCl2-	%	2.2E-10	1.7E-10	1.8E-10	2.9E-10	3.2E-10	2.5E-10	2.3E-10	2.2E-10	6.2E-10	3.6E-10	1.9E-10	2.4E-10	1.9E-10
CuCl3-2	%	7.0E-16	5.4E-16	5.5E-16	9.3E-16	1.0E-15	8.1E-16	7.3E-16	6.6E-16	2.0E-15	1.2E-15	6.1E-16	7.5E-16	5.8E-16
Cu+2	%	6.6	8.3	12.5	7.9	6.6	4.9	8.0	14.9	11.5	6.5	3.6	8.0	13.0
CuCO3	%	81	81	80	80	81	81	81	78	77	80	81	81	79
CuOH+	%	8.8	7.2	5.6	9.1	10.0	10.4	8.1	5.3	9.8	10.7	10.7	8.1	5.6
Cu(OH)2	%	2.3	2.2	1.5	1.8	1.8	2.4	1.9	1.1	0.9	1.7	3.4	1.9	1.4
Cu(CO3)2-2	%	0.7	0.5	0.3	0.5	0.6	0.9	0.5	0.3	0.3	0.7	1.2	0.5	0.3
CuHCO3+	%	2.5E-01	2.8E-01	4.1E-01	3.0E-01	2.7E-01	2.0E-01	2.9E-01	5.0E-01	4.9E-01	2.7E-01	1.5E-01	2.9E-01	4.2E-01
CuSO4	%	5.1E-02	6.0E-02	9.3E-02	6.2E-02	5.5E-02	4.1E-02	6.3E-02	1.1E-01	9.7E-02	5.4E-02	3.0E-02	6.3E-02	9.7E-02
Cu(OH)3-	%	3.9E-03	3.4E-03	1.5E-03	2.5E-03	2.7E-03	5.0E-03	2.7E-03	8.8E-04	6.9E-04	2.7E-03	9.6E-03	2.7E-03	1.3E-03
CuNH3+2	%	2.7E-03	5.5E-03	9.1E-03	2.4E-03	1.5E-03	1.4E-03	3.4E-03	8.6E-03	1.3E-03	1.3E-03	1.3E-03	3.3E-03	8.8E-03
Cu2(OH)2+2	%	1.6E-04	1.0E-04	6.2E-05	1.7E-04	2.1E-04	2.3E-04	1.3E-04	5.3E-05	2.0E-04	2.4E-04	2.4E-04	1.3E-04	5.9E-05
CuCl+	%	1.1E-04	1.3E-04	1.8E-04	1.3E-04	1.2E-04	8.7E-05	1.3E-04	2.2E-04	2.1E-04	1.2E-04	6.4E-05	1.3E-04	1.9E-04
CuNO3+	%	1.1E-04	1.7E-04	3.8E-04	1.2E-04	7.4E-05	5.3E-05	1.4E-04	4.4E-04	9.9E-05	5.2E-05	2.8E-05	1.5E-04	3.9E-04
CuNO2+	%	4.2E-05	5.2E-05	7.9E-05	5.0E-05	4.2E-05	3.1E-05	5.1E-05	9.3E-05	7.3E-05	4.1E-05	2.3E-05	5.1E-05	8.1E-05
Cu(OH)4-2	%	2.8E-08	2.2E-08	6.3E-09	1.4E-08	1.8E-08	4.3E-08	1.6E-08	3.0E-09	2.3E-09	1.7E-08	1.1E-07	1.6E-08	5.5E-09
CuCl2	%	3.0E-10	2.5E-10	2.8E-10	3.8E-10	4.0E-10	3.1E-10	3.2E-10	3.4E-10	7.6E-10	4.4E-10	2.3E-10	3.2E-10	2.9E-10
Cu(NO3)2	%	7.6E-11	1.3E-10	3.9E-10	6.7E-11	3.4E-11	2.3E-11	9.8E-11	4.4E-10	3.5E-11	1.7E-11	8.8E-12	1.0E-10	3.9E-10
Cu(NO2)2	%	2.8E-11	3.5E-11	5.2E-11	3.3E-11	2.8E-11	2.1E-11	3.4E-11	6.2E-11	4.9E-11	2.7E-11	1.5E-11	3.4E-11	5.4E-11
CuCl3-	%	3.2E-17	2.5E-17	2.5E-17	4.3E-17	4.8E-17	3.7E-17	3.4E-17	3.0E-17	9.3E-17	5.4E-17	2.9E-17	3.4E-17	2.6E-17
CuCl4-2	%	3.5E-24	3.3E-24	4.0E-24	4.5E-24	4.4E-24	3.4E-24	3.9E-24	4.8E-24	8.2E-24	4.7E-24	2.5E-24	4.0E-24	4.2E-24

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-21 - Copper speciation with depth (Eh = 500 mV)

Date		8/16/2014	8/17/2014	8/23/2014	8/23/2014	8/23/2014	8/24/2014	8/24/2014	8/25/2014	8/25/2014	8/25/2014	8/26/2014	8/26/2014
Time		3:27:00 AM	2:58:00 AM	12:40:00 PM	1:15:00 AM	1:45:00 AM	12:50:00 PM	1:03:00 AM	3:40:00 AM	3:55:00 AM	4:10:00 AM	11:55:00 AM	12:30:00 PM
Depth		0	0	0	20	46	0	46	0	9	45	0	21
Charge Balance	%	0.64	0.03	1.91	1.02	2.11	1.70	1.19	1.28	1.73	2.78	0.75	1.36
pH	s.u.	8.2	7.9	7.8	7.4	7.6	8.0	7.7	7.8	7.9	7.5	7.8	7.7
pe	s.u.	8.6	8.6	8.7	9.1	9.0	8.7	9.0	8.7	8.8	9.0	8.7	8.8
Alkalinity	mg/L as $CaCO_3$	44	44	44	48	60	45	60	44	44	56	45	45
Cu	mg/L	0.0005	0.0005	0.0009	0.0007	0.0045	0.0009	0.0046	0.0009	0.0014	0.0047	0.0010	0.0012
SO_4	mg/L	5.6	5.6	5.7	6.1	16.8	5.7	16.5	5.8	6.0	16.7	5.8	6.0
Relative Percent (%) - Copper Species													
Cu+	%	3.1E-06	6.7E-06	6.7E-06	6.5E-06	3.7E-06	4.5E-06	3.3E-06	7.1E-06	4.8E-06	4.8E-06	6.1E-06	6.0E-06
CuCl	%	5.1E-08	1.1E-07	1.1E-07	1.1E-07	6.4E-08	7.3E-08	5.7E-08	1.2E-07	7.9E-08	8.3E-08	9.9E-08	9.8E-08
CuCl2-	%	1.5E-10	3.2E-10	3.3E-10	3.3E-10	2.2E-10	2.2E-10	1.9E-10	3.5E-10	2.4E-10	2.8E-10	3.0E-10	3.0E-10
CuCl3-2	%	4.9E-16	1.0E-15	1.0E-15	9.9E-16	7.4E-16	7.0E-16	6.1E-16	1.1E-15	7.5E-16	9.3E-16	9.5E-16	9.3E-16
Cu+2	%	2.9	6.0	8.4	21.1	11.3	5.6	10.3	8.3	7.4	14.7	7.1	10.4
CuCO3	%	81	81	80	72	82	82	82	80	81	78	81	80
CuOH+	%	10.5	10.5	9.1	5.2	4.9	9.2	5.0	9.2	8.5	5.1	9.3	7.8
Cu(OH)2	%	4.1	1.9	1.6	0.7	1.1	2.4	1.2	1.5	2.0	0.9	1.8	1.4
Cu(CO3)2-2	%	1.5	0.7	0.5	0.2	0.4	0.8	0.5	0.5	0.6	0.3	0.6	0.4
CuHCO3+	%	1.2E-01	2.5E-01	3.3E-01	7.0E-01	4.6E-01	2.2E-01	4.2E-01	3.3E-01	2.7E-01	5.6E-01	2.9E-01	3.8E-01
CuSO4	%	2.4E-02	5.1E-02	6.7E-02	1.6E-01	2.2E-01	4.5E-02	1.9E-01	6.9E-02	6.0E-02	2.8E-01	5.9E-02	8.4E-02
Cu(OH)3-	%	1.4E-02	3.1E-03	2.0E-03	3.6E-04	9.9E-04	4.6E-03	1.3E-03	1.8E-03	3.0E-03	6.5E-04	2.6E-03	1.5E-03
CuNH3+2	%	1.3E-03	1.3E-03	2.1E-03	7.8E-03	6.8E-02	2.1E-03	6.3E-02	1.9E-03	2.9E-03	6.0E-02	1.9E-03	3.5E-03
Cu2(OH)2+2	%	2.3E-04	2.3E-04	3.0E-04	7.2E-05	4.2E-04	3.2E-04	4.5E-04	3.3E-04	4.0E-04	4.7E-04	3.4E-04	2.9E-04
CuCl+	%	5.2E-05	1.1E-04	1.4E-04	3.1E-04	1.8E-04	9.5E-05	1.6E-04	1.4E-04	1.2E-04	2.3E-04	1.2E-04	1.7E-04
CuNO3+	%	2.4E-05	4.8E-05	1.1E-04	6.1E-04	5.5E-04	7.1E-05	5.0E-04	1.0E-04	1.1E-04	7.1E-04	8.1E-05	1.6E-04
CuNO2+	%	1.8E-05	3.8E-05	5.3E-05	1.3E-04	1.2E-04	3.5E-05	1.1E-04	5.2E-05	4.6E-05	1.8E-04	4.5E-05	6.5E-05
Cu(OH)4-2	%	2.1E-07	2.1E-08	1.1E-08	8.1E-10	4.0E-09	3.7E-08	5.7E-09	9.7E-09	2.0E-08	2.1E-09	1.6E-08	6.9E-09
CuCl2	%	1.9E-10	4.0E-10	4.2E-10	5.0E-10	3.2E-10	2.8E-10	2.7E-10	4.4E-10	3.2E-10	4.1E-10	3.8E-10	4.0E-10
Cu(NO3)2	%	8.0E-12	1.6E-11	5.2E-11	6.1E-10	9.4E-10	3.6E-11	8.4E-10	5.1E-11	6.6E-11	1.2E-09	3.6E-11	9.3E-11
Cu(NO2)2	%	1.2E-11	2.5E-11	3.5E-11	8.8E-11	1.5E-10	2.3E-11	1.2E-10	3.5E-11	3.1E-11	2.3E-10	3.0E-11	4.4E-11
CuCl3-	%	2.3E-17	4.8E-17	4.8E-17	4.5E-17	3.3E-17	3.2E-17	2.7E-17	5.1E-17	3.4E-17	4.1E-17	4.4E-17	4.2E-17
CuCl4-2	%	2.0E-24	4.3E-24	4.9E-24	7.0E-24	5.6E-24	3.3E-24	4.4E-24	5.1E-24	3.8E-24	6.8E-24	4.3E-24	5.0E-24

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-21 - Copper speciation with depth (Eh = 500 mV)

Date		8/26/2014	8/28/2014	8/28/2014	8/28/2014	9/3/2014	9/3/2014	9/3/2014	9/5/2014	9/5/2014	9/5/2014	9/7/2014	9/7/2014	9/7/2014
Time		12:50:00 PM	1:35:00 AM	2:10:00 AM	1:50:00 AM	1:15:00 AM	2:10:00 AM	1:45:00 AM	12:00:00 PM	12:30:00 PM	1:00:00 AM	1:00:00 AM	1:25:00 AM	1:50:00 AM
Depth		47	0	16	46	0	6	47	0	10	45	0	11	46
Charge Balance	%	-0.54	-0.14	-0.46	-1.01	0.26	-0.14	0.16	-3.93	0.14	2.44	-1.25	-0.55	-1.26
pH	s.u.	7.6	8.1	7.8	7.9	8.0	7.4	7.6	7.6	7.6	7.6	8.0	7.7	7.8
pe	s.u.	9.0	8.6	8.9	9.0	8.7	8.8	9.0	8.7	8.9	9.0	8.7	8.8	9.0
Alkalinity	mg/L as $CaCO_3$	60	45	47	62	46	46	60	46	47	57	47	47	62
Cu	mg/L	0.0045	0.0006	0.0012	0.0053	0.0006	0.0019	0.0052	0.0006	0.0013	0.0052	0.0007	0.0013	0.0053
SO_4	mg/L	17.0	5.8	6.0	17.4	5.7	6.0	16.3	5.8	6.0	16.7	5.8	5.9	16.7
Relative Percent (%) - Copper Species														
Cu+	%	4.0E-06	3.7E-06	4.6E-06	2.1E-06	4.0E-06	1.0E-05	4.0E-06	9.5E-06	5.6E-06	4.2E-06	3.7E-06	5.4E-06	2.4E-06
CuCl	%	6.9E-08	6.0E-08	7.4E-08	3.7E-08	6.5E-08	1.7E-07	6.4E-08	1.5E-07	9.1E-08	7.1E-08	6.0E-08	8.8E-08	4.2E-08
CuCl2-	%	2.3E-10	1.8E-10	2.3E-10	1.3E-10	2.0E-10	5.0E-10	2.0E-10	4.6E-10	2.8E-10	2.3E-10	1.8E-10	2.7E-10	1.5E-10
CuCl3-2	%	7.7E-16	5.7E-16	7.0E-16	4.4E-16	6.2E-16	1.6E-15	6.4E-16	1.5E-15	8.6E-16	7.6E-16	5.8E-16	8.4E-16	5.1E-16
Cu+2	%	12.3	3.7	9.5	6.4	4.6	17.7	12.3	11.6	13.6	12.7	4.3	9.2	7.3
CuCO3	%	81	82	81	85	82	74	81	78	78	80	83	81	85
CuOH+	%	4.9	9.9	7.1	5.0	9.4	6.9	4.8	8.5	6.4	5.1	9.1	7.7	5.0
Cu(OH)2	%	1.0	3.2	1.6	2.0	2.7	0.7	1.0	0.9	1.1	1.0	2.8	1.5	1.7
Cu(CO3)2-2	%	0.4	1.2	0.4	0.8	1.0	0.2	0.4	0.3	0.3	0.4	1.0	0.5	0.7
CuHCO3+	%	5.0E-01	1.6E-01	3.4E-01	2.7E-01	1.9E-01	6.7E-01	5.0E-01	4.8E-01	4.8E-01	5.0E-01	1.8E-01	3.5E-01	3.0E-01
CuSO4	%	2.4E-01	3.2E-02	7.5E-02	1.3E-01	3.7E-02	1.4E-01	2.3E-01	9.6E-02	1.0E-01	2.4E-01	3.6E-02	7.4E-02	1.4E-01
Cu(OH)3-	%	8.2E-04	8.7E-03	2.0E-03	3.4E-03	6.1E-03	3.7E-04	8.2E-04	8.0E-04	9.3E-04	8.5E-04	6.6E-03	1.8E-03	2.5E-03
CuNH3+2	%	6.2E-02	1.5E-03	6.4E-03	7.2E-02	2.0E-03	5.1E-03	6.6E-02	2.4E-03	8.5E-03	7.7E-02	1.8E-03	3.2E-03	6.9E-02
Cu2(OH)2+2	%	4.2E-04	2.4E-04	2.3E-04	5.2E-04	2.2E-04	3.6E-04	4.7E-04	1.8E-04	2.1E-04	5.2E-04	2.3E-04	3.0E-04	5.2E-04
CuCl+	%	1.9E-04	6.6E-05	1.5E-04	1.0E-04	7.9E-05	2.9E-04	1.8E-04	2.0E-04	2.1E-04	2.0E-04	7.4E-05	1.5E-04	1.2E-04
CuNO3+	%	6.0E-04	3.5E-05	2.1E-04	3.1E-04	3.8E-05	3.2E-04	5.6E-04	9.9E-05	3.4E-04	5.9E-04	3.5E-05	1.1E-04	3.4E-04
CuNO2+	%	2.0E-04	2.4E-05	6.0E-05	7.3E-05	2.9E-05	1.1E-04	9.7E-05	7.3E-05	8.6E-05	1.5E-04	2.7E-05	5.8E-05	8.8E-05
Cu(OH)4-2	%	3.0E-09	9.9E-08	1.0E-08	2.5E-08	5.8E-08	9.0E-10	3.0E-09	2.8E-09	3.3E-09	3.1E-09	6.6E-08	8.9E-09	1.6E-08
CuCl2	%	3.4E-10	2.2E-10	3.2E-10	1.9E-10	2.5E-10	6.9E-10	3.0E-10	6.0E-10	4.0E-10	3.4E-10	2.3E-10	3.6E-10	2.2E-10
Cu(NO3)2	%	1.0E-09	1.3E-11	1.6E-10	5.3E-10	1.3E-11	2.1E-10	9.1E-10	3.3E-11	3.0E-10	9.6E-10	1.1E-11	4.8E-11	5.4E-10
Cu(NO2)2	%	3.6E-10	1.6E-11	4.0E-11	9.1E-11	1.9E-11	7.4E-11	8.3E-11	4.9E-11	5.7E-11	1.8E-10	1.8E-11	3.9E-11	1.2E-10
CuCl3-	%	3.4E-17	2.6E-17	3.2E-17	2.0E-17	2.9E-17	7.2E-17	2.8E-17	6.8E-17	3.9E-17	3.4E-17	2.7E-17	3.8E-17	2.2E-17
CuCl4-2	%	5.7E-24	2.5E-24	4.1E-24	3.4E-24	2.8E-24	8.5E-24	4.5E-24	6.9E-24	5.4E-24	5.5E-24	2.6E-24	4.5E-24	3.9E-24

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-21 - Copper speciation with depth (Eh = 500 mV)

Date		9/8/2014	9/10/2014	9/10/2014	9/10/2014	9/12/2014	9/12/2014	9/12/2014	9/14/2014	9/14/2014	9/14/2014	9/16/2014	9/16/2014	9/16/2014
Time		2:37:00 AM	12:45:00 PM	1:10:00 AM	1:30:00 AM	11:30:00 AM	12:20:00 PM	12:00:00 PM	1:40:00 AM	2:00:00 AM	2:30:00 AM	1:21:00 AM	1:34:00 AM	1:09:00 AM
Depth		0	0	8	46	0	15	46	0	18	47	0	30	46
Charge Balance	%	0.17	-1.85	2.77	-1.71	-0.90	-1.63	-1.26	-2.08	-1.12	-2.38	-1.60	-1.57	-1.44
pH	s.u.	8.2	7.7	7.6	7.8	7.9	7.6	7.9	7.8	7.6	7.8	8.0	7.6	7.8
pe	s.u.	8.7	8.9	9.0	9.0	8.8	9.0	9.0	8.8	9.0	9.0	8.7	9.0	9.0
Alkalinity	mg/L as $CaCO_3$	46	49	45	62	48	49	59	48	49	63	49	53	61
Cu	mg/L	0.0007	0.0013	0.0012	0.0055	0.0009	0.0012	0.0053	0.0006	0.0012	0.0059	0.0005	0.0024	0.0059
SO_4	mg/L	5.8	6.0	6.1	16.6	6.0	6.1	15.1	6.0	6.1	17.2	6.1	8.0	16.3
Relative Percent (%) - Copper Species														
Cu+	%	2.5E-06	5.0E-06	5.5E-06	2.6E-06	3.8E-06	4.9E-06	2.1E-06	4.9E-06	5.6E-06	2.8E-06	3.7E-06	4.3E-06	2.4E-06
CuCl	%	4.1E-08	8.1E-08	8.9E-08	4.4E-08	6.2E-08	8.0E-08	3.3E-08	7.9E-08	9.0E-08	5.0E-08	5.9E-08	7.0E-08	4.0E-08
CuCl2-	%	1.2E-10	2.5E-10	2.7E-10	1.4E-10	1.9E-10	2.5E-10	1.0E-10	2.4E-10	2.8E-10	1.8E-10	1.8E-10	2.2E-10	1.3E-10
CuCl3-2	%	3.9E-16	7.7E-16	8.4E-16	4.7E-16	5.9E-16	7.6E-16	3.2E-16	7.6E-16	8.5E-16	6.2E-16	5.7E-16	6.6E-16	4.3E-16
Cu+2	%	3.1	10.5	15.3	7.9	6.4	12.3	6.1	7.3	13.6	8.3	5.0	13.7	7.1
CuCO3	%	82	80	76	84	83	79	85	82	78	84	83	79	85
CuOH+	%	9.2	6.8	6.2	5.0	7.8	6.2	5.3	8.0	6.2	4.9	8.3	5.3	5.1
Cu(OH)2	%	4.2	1.3	1.1	1.6	2.2	1.2	2.2	1.7	1.1	1.4	2.4	1.1	1.8
Cu(CO3)2-2	%	1.4	0.4	0.2	0.6	0.7	0.3	0.8	0.6	0.3	0.6	0.9	0.3	0.7
CuHCO3+	%	1.2E-01	3.9E-01	4.9E-01	3.3E-01	2.5E-01	4.5E-01	2.5E-01	3.0E-01	4.9E-01	3.5E-01	2.1E-01	5.0E-01	3.0E-01
CuSO4	%	2.5E-02	8.2E-02	1.2E-01	1.5E-01	5.2E-02	9.6E-02	1.1E-01	6.0E-02	1.1E-01	1.6E-01	4.2E-02	1.3E-01	1.3E-01
Cu(OH)3-	%	1.4E-02	1.4E-03	9.1E-04	2.1E-03	3.7E-03	1.1E-03	4.0E-03	2.5E-03	8.7E-04	1.8E-03	5.1E-03	8.7E-04	2.7E-03
CuNH3+2	%	1.9E-03	4.3E-03	7.0E-03	7.1E-02	3.1E-03	5.5E-03	5.1E-02	3.4E-03	5.9E-03	6.7E-02	2.2E-03	1.0E-02	5.3E-02
Cu2(OH)2+2	%	2.6E-04	2.4E-04	1.7E-04	5.3E-04	2.2E-04	1.7E-04	5.8E-04	1.6E-04	1.7E-04	5.6E-04	1.4E-04	2.5E-04	6.0E-04
CuCl+	%	5.3E-05	1.7E-04	2.3E-04	1.2E-04	1.0E-04	1.9E-04	8.9E-05	1.2E-04	2.1E-04	1.4E-04	8.4E-05	2.0E-04	1.1E-04
CuNO3+	%	2.6E-05	2.4E-04	4.1E-04	3.7E-04	9.0E-05	3.1E-04	2.3E-04	9.9E-05	3.2E-04	3.5E-04	6.2E-05	4.5E-04	2.9E-04
CuNO2+	%	1.9E-05	6.6E-05	9.6E-05	1.0E-04	4.0E-05	7.7E-05	7.1E-05	4.6E-05	8.5E-05	1.3E-04	3.1E-05	8.6E-05	8.7E-05
Cu(OH)4-2	%	2.1E-07	6.4E-09	3.1E-09	1.2E-08	2.7E-08	4.3E-09	3.1E-08	1.5E-08	3.0E-09	9.6E-09	4.4E-08	3.0E-09	1.7E-08
CuCl2	%	1.6E-10	3.5E-10	4.1E-10	2.1E-10	2.6E-10	3.6E-10	1.5E-10	3.2E-10	4.0E-10	2.6E-10	2.3E-10	3.3E-10	1.9E-10
Cu(NO3)2	%	8.4E-12	2.0E-10	3.9E-10	5.9E-10	4.8E-11	2.8E-10	3.1E-10	5.1E-11	2.6E-10	5.2E-10	3.0E-11	5.1E-10	4.3E-10
Cu(NO2)2	%	1.3E-11	4.4E-11	6.4E-11	1.4E-10	2.7E-11	5.1E-11	8.9E-11	3.1E-11	5.7E-11	2.2E-10	2.1E-11	5.7E-11	1.1E-10
CuCl3-	%	1.8E-17	3.5E-17	3.8E-17	2.1E-17	2.7E-17	3.4E-17	1.4E-17	3.5E-17	3.9E-17	2.7E-17	2.6E-17	3.0E-17	1.9E-17
CuCl4-2	%	1.8E-24	4.5E-24	5.6E-24	3.4E-24	3.2E-24	4.8E-24	2.1E-24	3.9E-24	5.4E-24	4.8E-24	2.8E-24	4.6E-24	3.1E-24

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-21 - Copper speciation with depth (Eh = 500 mV)

Date		9/18/2014	9/18/2014	9/18/2014	9/20/2014	9/20/2014	9/20/2014	9/23/2014	9/23/2014	9/23/2014	9/29/2014	9/29/2014	9/29/2014	10/4/2014
Time		2:00:00 AM	2:15:00 AM	2:30:00 AM	3:00:00 AM	3:30:00 AM	3:45:00 AM	11:00:00 AM	11:30:00 AM	11:45:00 AM	12:30:00 PM	12:45:00 PM	1:00:00 AM	1:30:00 AM
Depth		0	18	46	0	30	45	0	20	47	0	40	45	0
Charge Balance	%	1.37	0.13	6.44	-3.30	-3.68	-0.98	-3.32	-3.20	-2.48	-3.67	-3.90	-3.85	-2.41
pH	s.u.	7.9	7.5	7.7	8.1	7.6	7.9	7.8	7.6	7.5	8.2	7.7	7.8	8.3
pe	s.u.	8.7	8.9	9.0	8.7	9.1	9.0	8.7	8.9	9.0	8.8	9.0	9.0	8.8
Alkalinity	mg/L as $CaCO_3$	45	48	49	47	51	59	50	51	62	51	60	62	50
Cu	mg/L	0.0005	0.0018	0.0055	0.0005	0.0018	0.0061	0.0005	0.0015	0.0068	0.0006	0.0053	0.0060	0.0012
SO_4	mg/L	6.1	6.2	13.6	6.0	7.1	16.3	6.1	6.2	16.1	6.1	14.3	15.3	6.2
Relative Percent (%) - Copper Species														
Cu+	%	4.2E-06	6.3E-06	3.8E-06	2.9E-06	4.0E-06	2.4E-06	5.1E-06	4.9E-06	4.4E-06	2.2E-06	3.6E-06	2.7E-06	1.6E-06
CuCl	%	6.8E-08	1.0E-07	6.1E-08	4.7E-08	6.5E-08	4.0E-08	8.3E-08	8.0E-08	7.3E-08	3.6E-08	5.7E-08	4.4E-08	2.5E-08
CuCl2-	%	2.1E-10	3.2E-10	1.9E-10	1.4E-10	2.0E-10	1.3E-10	2.5E-10	2.4E-10	2.4E-10	1.1E-10	1.8E-10	1.4E-10	7.6E-11
CuCl3-2	%	6.5E-16	9.7E-16	5.8E-16	4.5E-16	6.2E-16	4.3E-16	8.0E-16	7.5E-16	7.6E-16	3.4E-16	5.4E-16	4.2E-16	2.4E-16
Cu+2	%	6.0	15.2	11.4	4.0	12.9	7.1	7.2	11.6	13.2	3.3	10.8	8.2	2.6
CuCO3	%	82	77	80	83	80	85	82	80	80	84	82	84	83
CuOH+	%	8.6	6.2	6.0	8.5	5.4	5.2	8.0	6.2	4.7	7.8	5.0	5.0	7.6
Cu(OH)2	%	2.3	0.9	1.5	3.2	1.2	1.9	1.6	1.2	0.8	3.7	1.1	1.5	5.1
Cu(CO3)2-2	%	0.7	0.3	0.4	1.1	0.3	0.7	0.6	0.4	0.3	1.4	0.4	0.6	1.7
CuHCO3+	%	2.3E-01	5.4E-01	3.9E-01	1.6E-01	4.6E-01	2.9E-01	3.1E-01	4.4E-01	5.6E-01	1.4E-01	4.4E-01	3.5E-01	1.0E-01
CuSO4	%	5.0E-02	1.2E-01	1.8E-01	3.4E-02	1.1E-01	1.3E-01	6.0E-02	9.2E-02	2.4E-01	2.7E-02	1.8E-01	1.5E-01	2.2E-02
Cu(OH)3-	%	4.3E-03	6.9E-04	1.6E-03	8.6E-03	1.1E-03	2.9E-03	2.2E-03	1.1E-03	6.2E-04	1.1E-02	1.1E-03	1.9E-03	2.1E-02
CuNH3+2	%	2.5E-03	5.2E-03	5.4E-02	2.3E-03	7.6E-03	5.6E-02	2.3E-03	5.1E-03	5.3E-02	2.3E-03	4.4E-02	4.6E-02	2.7E-03
Cu2(OH)2+2	%	1.5E-04	2.7E-04	7.5E-04	1.5E-04	2.0E-04	6.5E-04	1.3E-04	2.3E-04	5.9E-04	1.4E-04	5.0E-04	5.8E-04	2.8E-04
CuCl+	%	1.0E-04	2.3E-04	1.7E-04	6.7E-05	1.9E-04	1.1E-04	1.2E-04	1.8E-04	2.0E-04	5.4E-05	1.6E-04	1.2E-04	4.2E-05
CuNO3+	%	6.9E-05	3.2E-04	3.9E-04	4.5E-05	4.2E-04	2.9E-04	7.6E-05	2.5E-04	5.1E-04	3.5E-05	4.0E-04	3.1E-04	3.2E-05
CuNO2+	%	3.8E-05	9.5E-05	1.3E-04	2.5E-05	8.1E-05	8.7E-05	4.5E-05	7.3E-05	1.7E-04	2.0E-05	9.9E-05	1.1E-04	1.6E-05
Cu(OH)4-2	%	3.3E-08	2.1E-09	7.6E-09	9.6E-08	4.1E-09	1.9E-08	1.3E-08	4.4E-09	2.0E-09	1.5E-07	4.5E-09	1.0E-08	3.6E-07
CuCl2	%	2.7E-10	4.5E-10	2.8E-10	1.9E-10	3.1E-10	2.0E-10	3.3E-10	3.5E-10	3.5E-10	1.4E-10	2.6E-10	2.0E-10	1.0E-10
Cu(NO3)2	%	3.1E-11	2.5E-10	4.8E-10	2.0E-11	4.6E-10	4.1E-10	3.1E-11	1.9E-10	6.9E-10	1.5E-11	5.2E-10	4.1E-10	1.5E-11
Cu(NO2)2	%	2.5E-11	6.4E-11	1.5E-10	1.7E-11	5.4E-11	1.1E-10	3.0E-11	4.8E-11	2.3E-10	1.4E-11	9.8E-11	1.6E-10	1.1E-11
CuCl3-	%	3.0E-17	4.4E-17	2.6E-17	2.1E-17	2.8E-17	1.9E-17	3.6E-17	3.4E-17	3.3E-17	1.6E-17	2.4E-17	1.9E-17	1.1E-17
CuCl4-2	%	3.2E-24	6.0E-24	3.9E-24	2.2E-24	4.3E-24	3.1E-24	3.9E-24	4.7E-24	5.3E-24	1.7E-24	3.7E-24	2.8E-24	1.3E-24

(Shaded) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-21 - Copper speciation with depth (Eh = 500 mV)

Date		10/4/2014	10/11/2014	10/11/2014	11/3/2014	11/3/2014	11/6/2014	11/6/2014
Time		1:45:00 AM	11:30:00 AM	11:45:00 AM	1:30:00 AM	2:00:00 AM	1:00:00 AM	1:30:00 AM
Depth		40	0	40	0	40	0	40
Charge Balance	%	-3.20	-3.24	-2.53	-0.90	-3.96	-0.17	-0.11
pH	s.u.	7.9	7.3	7.6	8.2	7.8	8.5	8.0
pe	s.u.	9.0	8.8	9.0	8.9	9.0	8.9	8.9
Alkalinity	mg/L as $CaCO_3$	58	50	61	48	56	48	48
Cu	mg/L	0.0044	0.0008	0.0052	0.0012	0.0033	0.0013	0.0014
SO_4	mg/L	12.4	6.2	15.3	6.6	11.4	6.6	6.6
Relative Percent (%) - Copper Species								
Cu+	%	2.1E-06	1.1E-05	3.8E-06	1.5E-06	2.7E-06	8.6E-07	2.2E-06
CuCl	%	3.4E-08	1.9E-07	6.1E-08	2.5E-08	4.3E-08	1.4E-08	3.5E-08
CuCl2-	%	1.0E-10	5.7E-10	1.9E-10	7.5E-11	1.3E-10	4.3E-11	1.1E-10
CuCl3-2	%	3.2E-16	1.8E-15	5.8E-16	2.3E-16	4.1E-16	1.3E-16	3.3E-16
Cu+2	%	6.4	19.7	11.5	3.3	7.6	1.9	5.3
CuCO3	%	85	72	82	83	84	81	84
CuOH+	%	5.3	6.3	4.8	7.1	5.5	6.9	6.8
Cu(OH)2	%	2.2	0.5	1.0	4.9	1.8	8.2	3.2
Cu(CO3)2-2	%	0.8	0.2	0.4	1.4	0.6	2.2	0.9
CuHCO3+	%	2.5E-01	8.1E-01	4.8E-01	1.2E-01	3.0E-01	6.9E-02	1.9E-01
CuSO4	%	9.3E-02	1.6E-01	2.0E-01	2.8E-02	1.0E-01	1.6E-02	4.4E-02
Cu(OH)3-	%	3.9E-03	2.2E-04	8.8E-04	1.8E-02	2.7E-03	5.0E-02	7.5E-03
CuNH3+2	%	3.3E-02	2.8E-03	4.1E-02	4.1E-03	5.9E-03	3.6E-03	5.2E-03
Cu2(OH)2+2	%	4.8E-04	1.3E-04	4.8E-04	2.4E-04	3.9E-04	2.3E-04	2.4E-04
CuCl+	%	9.3E-05	3.2E-04	1.7E-04	5.2E-05	1.1E-04	3.0E-05	8.1E-05
CuNO3+	%	2.3E-04	2.5E-04	4.6E-04	5.5E-05	3.1E-04	3.3E-05	9.2E-05
CuNO2+	%	5.9E-05	1.2E-04	4.8E-04	2.1E-05	4.7E-05	1.2E-05	3.3E-05
Cu(OH)4-2	%	2.9E-08	4.4E-10	3.4E-09	2.7E-07	1.7E-08	1.3E-06	7.3E-08
CuCl2	%	1.5E-10	7.7E-10	2.8E-10	1.1E-10	2.0E-10	6.1E-11	1.6E-10
Cu(NO3)2	%	3.0E-10	1.2E-10	6.5E-10	3.2E-11	4.5E-10	2.0E-11	5.7E-11
Cu(NO2)2	%	5.8E-11	8.2E-11	2.2E-09	1.4E-11	3.1E-11	8.1E-12	2.2E-11
CuCl3-	%	1.4E-17	8.1E-17	2.6E-17	1.1E-17	1.8E-17	6.0E-18	1.5E-17
CuCl4-2	%	2.2E-24	9.5E-24	3.9E-24	1.4E-24	2.7E-24	8.0E-25	2.1E-24

[Shaded box] Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-21 - Copper speciation with depth (Eh = 300 mV)

Date		8/8/2014	8/8/2014	8/8/2014	8/9/2014	8/11/2014	8/12/2014	8/12/2014	8/12/2014	8/13/2014	8/14/2014	8/15/2014	8/15/2014	8/15/2014
Time		4:15:00 AM	4:35:00 AM	4:55:00 AM	3:24:00 AM	2:05:00 AM	11:15:00 AM	11:35:00 AM	11:45:00 AM	3:05:00 AM	11:10:00 AM	11:30:00 AM	11:50:00 AM	12:15:00 PM
Depth (m)		0	7	30	0	0	0	12	30	0	0	0	10	30
Charge Balance	%	1.85	1.89	1.36	1.99	-0.33	0.31	-0.82	-0.10	-0.77	2.16	1.59	1.37	0.70
pH	s.u.	7.9	7.9	7.7	7.8	7.9	8.0	7.8	7.6	7.6	7.9	8.1	7.8	7.7
pe	s.u.	5.3	5.4	5.4	5.2	5.2	5.2	5.3	5.4	5.1	5.1	5.1	5.3	5.4
Alkalinity	mg/L as $CaCO_3$	44	44	48	43	44	44	45	50	44	43	43	45	48
Cu	mg/L	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
SO_4	mg/L	5.6	5.7	6.1	5.5	5.6	5.7	5.8	6.2	5.6	5.6	5.6	5.8	6.2
Relative Percent (%) - Copper Species														
Cu+	%	1.4E-02	1.3E-02	1.6E-02	1.8E-02	1.8E-02	1.4E-02	1.6E-02	1.9E-02	3.4E-02	2.0E-02	1.1E-02	1.6E-02	1.6E-02
CuCl	%	2.3E-04	2.1E-04	2.5E-04	3.0E-04	3.0E-04	2.3E-04	2.6E-04	3.0E-04	5.6E-04	3.2E-04	1.7E-04	2.6E-04	2.6E-04
CuCl2-	%	7.1E-07	6.6E-07	7.8E-07	9.0E-07	8.9E-07	6.9E-07	7.9E-07	9.4E-07	1.7E-06	9.5E-07	5.1E-07	7.9E-07	8.2E-07
CuCl3-2	%	2.2E-12	2.0E-12	2.4E-12	2.9E-12	2.9E-12	2.2E-12	2.5E-12	2.8E-12	5.4E-12	3.1E-12	1.7E-12	2.5E-12	2.5E-12
Cu+2	%	6.6	8.3	12.5	7.9	6.6	4.9	8.0	14.9	11.5	6.5	3.6	8.0	13.0
CuCO3	%	81	81	80	80	81	81	81	78	77	80	81	81	79
CuOH+	%	8.8	7.2	5.6	9.1	10.0	10.4	8.1	5.3	9.8	10.7	10.7	8.1	5.6
Cu(OH)2	%	2.3	2.2	1.5	1.8	1.8	2.4	1.9	1.1	0.9	1.7	3.4	1.9	1.4
Cu(CO3)2-2	%	0.7	0.5	0.3	0.5	0.6	0.9	0.5	0.3	0.3	0.7	1.2	0.5	0.3
CuHCO3+	%	2.4E-01	2.8E-01	4.1E-01	3.0E-01	2.7E-01	2.0E-01	2.9E-01	5.0E-01	4.9E-01	2.7E-01	1.5E-01	2.9E-01	4.2E-01
CuSO4	%	5.1E-02	6.0E-02	9.2E-02	6.2E-02	5.5E-02	4.1E-02	6.3E-02	1.1E-01	9.7E-02	5.4E-02	3.0E-02	6.3E-02	9.7E-02
Cu(OH)3-	%	3.9E-03	3.4E-03	1.5E-03	2.5E-03	2.7E-03	5.0E-03	2.7E-03	8.8E-04	6.9E-04	2.7E-03	9.6E-03	2.7E-03	1.3E-03
CuNH3+2	%	2.7E-03	5.5E-03	9.1E-03	2.4E-03	1.5E-03	1.4E-03	3.4E-03	8.6E-03	1.3E-03	1.3E-03	1.3E-03	3.3E-03	8.8E-03
Cu2(OH)2+2	%	1.6E-04	1.0E-04	6.2E-05	1.7E-04	2.1E-04	2.3E-04	1.3E-04	5.3E-05	2.0E-04	2.4E-04	2.4E-04	1.3E-04	5.9E-05
CuCl+	%	1.1E-04	1.3E-04	1.8E-04	1.3E-04	1.2E-04	8.7E-05	1.3E-04	2.2E-04	2.1E-04	1.2E-04	6.4E-05	1.3E-04	1.9E-04
CuNO3+	%	1.1E-04	1.7E-04	3.8E-04	1.2E-04	7.4E-05	5.3E-05	1.4E-04	4.4E-04	9.9E-05	5.2E-05	2.8E-05	1.5E-04	3.9E-04
CuNO2+	%	4.2E-05	5.2E-05	7.9E-05	5.0E-05	4.2E-05	3.1E-05	5.1E-05	9.3E-05	7.3E-05	4.1E-05	2.3E-05	5.1E-05	8.1E-05
Cu(OH)4-2	%	2.8E-08	2.2E-08	6.3E-09	1.4E-08	1.8E-08	4.3E-08	1.6E-08	3.0E-09	2.3E-09	1.7E-08	1.1E-07	1.6E-08	5.5E-09
CuCl2	%	3.0E-10	2.5E-10	2.8E-10	3.8E-10	4.0E-10	3.1E-10	3.2E-10	3.4E-10	7.6E-10	4.3E-10	2.3E-10	3.2E-10	2.9E-10
Cu(NO3)2	%	7.6E-11	1.3E-10	3.9E-10	6.7E-11	3.4E-11	2.3E-11	9.8E-11	4.4E-10	3.5E-11	1.7E-11	8.8E-12	1.0E-10	3.9E-10
Cu(NO2)2	%	2.8E-11	3.5E-11	5.2E-11	3.3E-11	2.8E-11	2.1E-11	3.4E-11	6.2E-11	4.9E-11	2.7E-11	1.5E-11	3.4E-11	5.4E-11
CuCl3-	%	3.2E-17	2.5E-17	2.5E-17	4.3E-17	4.8E-17	3.7E-17	3.4E-17	3.0E-17	9.3E-17	5.4E-17	2.9E-17	3.4E-17	2.6E-17
CuCl4-2	%	3.5E-24	3.3E-24	4.0E-24	4.5E-24	4.4E-24	3.4E-24	3.9E-24	4.8E-24	8.2E-24	4.7E-24	2.5E-24	4.0E-24	4.2E-24

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-21 - Copper speciation with depth (Eh = 300 mV)

Date		8/16/2014	8/17/2014	8/23/2014	8/23/2014	8/23/2014	8/24/2014	8/24/2014	8/25/2014	8/25/2014	8/25/2014	8/26/2014	8/26/2014
Time		3:27:00 AM	2:58:00 AM	12:40:00 PM	1:15:00 AM	1:45:00 AM	12:50:00 PM	1:03:00 AM	3:40:00 AM	3:55:00 AM	4:10:00 AM	11:55:00 AM	12:30:00 PM
Depth (m)		0	0	0	20	46	0	46	0	9	45	0	21
Charge Balance	%	0.64	0.03	1.91	1.02	2.11	1.71	1.19	1.28	1.73	2.79	0.76	1.36
pH	s.u.	8.2	7.9	7.8	7.4	7.6	8.0	7.7	7.8	7.9	7.5	7.8	7.7
pe	s.u.	5.2	5.1	5.2	5.4	5.4	5.2	5.4	5.2	5.3	5.4	5.2	5.3
Alkalinity	mg/L as $CaCO_3$	44	44	44	48	60	45	60	44	44	56	45	45
Cu	mg/L	0.0005	0.0005	0.0009	0.0007	0.0045	0.0009	0.0046	0.0009	0.0014	0.0047	0.0010	0.0012
SO_4	mg/L	5.6	5.6	5.7	6.1	16.8	5.7	16.5	5.8	6.0	16.7	5.8	6.0
Relative Percent (%) - Copper Species													
Cu+	%	8.5E-03	1.8E-02	2.0E-02	2.7E-02	1.5E-02	1.3E-02	1.4E-02	2.1E-02	1.6E-02	2.0E-02	1.8E-02	2.0E-02
CuCl	%	1.4E-04	2.9E-04	3.3E-04	4.4E-04	2.6E-04	2.2E-04	2.3E-04	3.4E-04	2.5E-04	3.4E-04	2.9E-04	3.3E-04
CuCl2-	%	4.1E-07	8.7E-07	9.9E-07	1.4E-06	8.9E-07	6.6E-07	7.6E-07	1.0E-06	7.7E-07	1.1E-06	8.7E-07	1.0E-06
CuCl3-2	%	1.3E-12	2.8E-12	3.1E-12	4.2E-12	3.0E-12	2.1E-12	2.5E-12	3.3E-12	2.4E-12	3.8E-12	2.8E-12	3.1E-12
Cu+2	%	2.9	6.0	8.4	21.1	11.3	5.6	10.3	8.3	7.4	14.7	7.1	10.4
CuCO3	%	81	81	80	72	82	82	82	80	81	78	81	79
CuOH+	%	10.5	10.5	9.1	5.2	4.9	9.2	5.0	9.2	8.5	5.1	9.3	7.8
Cu(OH)2	%	4.1	1.9	1.6	0.7	1.1	2.4	1.2	1.5	2.0	0.9	1.8	1.4
Cu(CO3)2-2	%	1.5	0.7	0.5	0.2	0.4	0.8	0.5	0.5	0.6	0.3	0.6	0.4
CuHCO3+	%	1.2E-01	2.5E-01	3.3E-01	7.0E-01	4.6E-01	2.2E-01	4.2E-01	3.3E-01	2.7E-01	5.6E-01	2.9E-01	3.8E-01
CuSO4	%	2.4E-02	5.1E-02	6.7E-02	1.6E-01	2.2E-01	4.5E-02	1.9E-01	6.9E-02	6.0E-02	2.8E-01	5.9E-02	8.4E-02
Cu(OH)3-	%	1.4E-02	3.1E-03	2.0E-03	3.6E-04	9.9E-04	4.6E-03	1.3E-03	1.8E-03	3.0E-03	6.5E-04	2.6E-03	1.5E-03
CuNH3+2	%	1.3E-03	1.3E-03	2.1E-03	7.8E-03	6.8E-02	2.1E-03	6.3E-02	1.9E-03	2.9E-03	6.0E-02	1.9E-03	3.5E-03
Cu2(OH)2+2	%	2.3E-04	2.3E-04	3.0E-04	7.1E-05	4.2E-04	3.2E-04	4.5E-04	3.3E-04	4.0E-04	4.7E-04	3.4E-04	2.9E-04
CuCl+	%	5.2E-05	1.1E-04	1.4E-04	3.1E-04	1.8E-04	9.5E-05	1.6E-04	1.4E-04	1.2E-04	2.3E-04	1.2E-04	1.7E-04
CuNO3+	%	2.4E-05	4.8E-05	1.1E-04	6.1E-04	5.5E-04	7.1E-05	5.0E-04	1.0E-04	1.1E-04	7.1E-04	8.1E-05	1.6E-04
CuNO2+	%	1.8E-05	3.8E-05	5.3E-05	1.3E-04	1.2E-04	3.5E-05	1.1E-04	5.2E-05	4.6E-05	1.8E-04	4.5E-05	6.5E-05
Cu(OH)4-2	%	2.1E-07	2.1E-08	1.1E-08	8.1E-10	4.0E-09	3.7E-08	5.7E-09	9.7E-09	2.0E-08	2.1E-09	1.6E-08	6.9E-09
CuCl2	%	1.9E-10	4.0E-10	4.2E-10	5.0E-10	3.2E-10	2.8E-10	2.7E-10	4.4E-10	3.2E-10	4.1E-10	3.8E-10	4.0E-10
Cu(NO3)2	%	8.0E-12	1.6E-11	5.2E-11	6.0E-10	9.4E-10	3.6E-11	8.4E-10	5.1E-11	6.6E-11	1.2E-09	3.6E-11	9.3E-11
Cu(NO2)2	%	1.2E-11	2.5E-11	3.5E-11	8.8E-11	1.5E-10	2.3E-11	1.2E-10	3.5E-11	3.1E-11	2.3E-10	3.0E-11	4.4E-11
CuCl3-	%	2.3E-17	4.8E-17	4.8E-17	4.5E-17	3.3E-17	3.2E-17	2.7E-17	5.1E-17	3.4E-17	4.1E-17	4.4E-17	4.2E-17
CuCl4-2	%	2.0E-24	4.3E-24	4.9E-24	7.0E-24	5.6E-24	3.3E-24	4.4E-24	5.1E-24	3.8E-24	6.8E-24	4.3E-24	5.0E-24

(shaded) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-21 - Copper speciation with depth (Eh = 300 mV)

Date		8/26/2014	8/28/2014	8/28/2014	8/28/2014	9/3/2014	9/3/2014	9/3/2014	9/5/2014	9/5/2014	9/5/2014	9/7/2014	9/7/2014	9/7/2014
Time		12:50:00 PM	1:35:00 AM	2:10:00 AM	1:50:00 AM	1:15:00 AM	2:10:00 AM	1:45:00 AM	12:00:00 PM	12:30:00 PM	1:00:00 AM	1:00:00 AM	1:25:00 AM	1:50:00 AM
Depth (m)		47	0	16	46	0	6	47	0	10	45	0	11	46
Charge Balance	%	-0.54	-0.14	-0.46	-1.00	0.26	-0.14	0.16	-3.93	0.14	2.44	-1.24	-0.55	-1.26
pH	s.u.	7.6	8.1	7.8	7.9	8.0	7.4	7.6	7.6	7.6	7.6	8.0	7.7	7.8
pe	s.u.	5.4	5.2	5.3	5.4	5.2	5.3	5.4	5.2	5.4	5.4	5.2	5.3	5.4
Alkalinity	mg/L as $CaCO_3$	60	45	47	62	46	46	60	46	47	57	47	47	62
Cu	mg/L	0.0045	0.0006	0.0012	0.0053	0.0006	0.0019	0.0052	0.0006	0.0013	0.0052	0.0007	0.0013	0.0053
SO_4	mg/L	17.0	5.8	6.0	17.4	5.7	6.0	16.3	5.8	6.0	16.7	5.8	5.9	16.7
Relative Percent (%) - Copper Species														
Cu+	%	1.6E-02	1.0E-02	1.6E-02	8.5E-03	1.2E-02	3.4E-02	1.6E-02	2.8E-02	2.1E-02	1.7E-02	1.1E-02	1.8E-02	9.7E-03
CuCl	%	2.8E-04	1.7E-04	2.7E-04	1.5E-04	1.9E-04	5.6E-04	2.6E-04	4.6E-04	3.5E-04	2.9E-04	1.8E-04	3.0E-04	1.7E-04
CuCl2-	%	9.4E-07	5.0E-07	8.2E-07	5.2E-07	5.7E-07	1.7E-06	8.3E-07	1.4E-06	1.1E-06	9.4E-07	5.3E-07	9.0E-07	6.0E-07
CuCl3-2	%	3.1E-12	1.6E-12	2.5E-12	1.8E-12	1.8E-12	5.3E-12	2.6E-12	4.4E-12	3.3E-12	3.1E-12	1.7E-12	2.8E-12	2.1E-12
Cu+2	%	12.3	3.7	9.5	6.4	4.6	17.7	12.3	11.6	13.6	12.7	4.3	9.2	7.3
CuCO3	%	81	82	81	85	82	74	81	78	78	80	82	81	85
CuOH+	%	4.9	9.9	7.1	5.0	9.4	6.9	4.8	8.5	6.4	5.1	9.1	7.7	5.0
Cu(OH)2	%	1.0	3.2	1.6	2.0	2.7	0.7	1.0	0.9	1.1	1.0	2.8	1.5	1.7
Cu(CO3)2-2	%	0.4	1.2	0.4	0.8	1.0	0.2	0.4	0.3	0.3	0.4	1.0	0.5	0.7
CuHCO3+	%	5.0E-01	1.6E-01	3.4E-01	2.7E-01	1.9E-01	6.7E-01	5.0E-01	4.8E-01	4.8E-01	5.0E-01	1.8E-01	3.5E-01	3.0E-01
CuSO4	%	2.4E-01	3.2E-02	7.5E-02	1.3E-01	3.7E-02	1.4E-01	2.3E-01	9.6E-02	1.0E-01	2.4E-01	3.6E-02	7.4E-02	1.4E-01
Cu(OH)3-	%	8.2E-04	8.7E-03	2.0E-03	3.4E-03	6.1E-03	3.7E-04	8.2E-04	8.0E-04	9.3E-04	8.5E-04	6.6E-03	1.8E-03	2.5E-03
CuNH3+2	%	6.2E-02	1.5E-03	6.4E-03	7.2E-02	2.0E-03	5.1E-03	6.6E-02	2.4E-03	8.5E-03	7.7E-02	1.8E-03	3.2E-03	6.9E-02
Cu2(OH)2+2	%	4.2E-04	2.4E-04	2.3E-04	5.2E-04	2.2E-04	3.6E-04	4.7E-04	1.8E-04	2.1E-04	5.2E-04	2.3E-04	3.0E-04	5.2E-04
CuCl+	%	1.9E-04	6.6E-05	1.5E-04	1.0E-04	7.9E-05	2.9E-04	1.8E-04	2.0E-04	2.1E-04	2.0E-04	7.4E-05	1.5E-04	1.2E-04
CuNO3+	%	6.0E-04	3.5E-05	2.1E-04	3.1E-04	3.8E-05	3.2E-04	5.6E-04	9.9E-05	3.4E-04	5.9E-04	3.5E-05	1.1E-04	3.4E-04
CuNO2+	%	2.0E-04	2.4E-05	6.0E-05	7.3E-05	2.9E-05	1.1E-04	9.7E-05	7.3E-05	8.6E-05	1.5E-04	2.7E-05	5.8E-05	8.8E-05
Cu(OH)4-2	%	3.0E-09	9.9E-08	1.0E-08	2.5E-08	5.8E-08	9.0E-10	3.0E-09	2.8E-09	3.3E-09	3.1E-09	6.6E-08	8.9E-09	1.6E-08
CuCl2	%	3.4E-10	2.2E-10	3.2E-10	1.9E-10	2.5E-10	6.9E-10	3.0E-10	6.0E-10	4.0E-10	3.4E-10	2.3E-10	3.6E-10	2.2E-10
Cu(NO3)2	%	1.0E-09	1.3E-11	1.6E-10	5.3E-10	1.3E-11	2.1E-10	9.1E-10	3.3E-11	3.0E-10	9.6E-10	1.1E-11	4.8E-11	5.4E-10
Cu(NO2)2	%	3.6E-10	1.6E-11	4.0E-11	9.1E-11	1.9E-11	7.4E-11	8.3E-11	4.9E-11	5.7E-11	1.8E-10	1.8E-11	3.9E-11	1.2E-10
CuCl3-	%	3.4E-17	2.6E-17	3.2E-17	2.0E-17	2.9E-17	7.2E-17	2.8E-17	6.8E-17	3.9E-17	3.4E-17	2.7E-17	3.8E-17	2.2E-17
CuCl4-2	%	5.7E-24	2.5E-24	4.1E-24	3.4E-24	2.8E-24	8.5E-24	4.5E-24	6.9E-24	5.4E-24	5.5E-24	2.6E-24	4.5E-24	3.9E-24

(Shaded legend box) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-21 - Copper speciation with depth (Eh = 300 mV)

Date		9/8/2014	9/10/2014	9/10/2014	9/10/2014	9/12/2014	9/12/2014	9/12/2014	9/14/2014	9/14/2014	9/14/2014	9/16/2014	9/16/2014	9/16/2014
Time		2:37:00 AM	12:45:00 PM	1:10:00 AM	1:30:00 AM	11:30:00 AM	12:20:00 PM	12:00:00 PM	1:40:00 AM	2:00:00 AM	2:30:00 AM	1:21:00 AM	1:34:00 AM	1:09:00 AM
Depth (m)		0	0	8	46	0	15	46	0	18	47	0	30	46
Charge Balance	%	0.17	-1.85	2.77	-1.71	-0.90	-1.63	-1.26	-2.07	-1.12	-2.38	-1.60	-1.57	-1.44
pH	s.u.	8.2	7.7	7.6	7.8	7.9	7.6	7.9	7.8	7.6	7.8	8.0	7.6	7.8
pe	s.u.	5.2	5.3	5.4	5.4	5.3	5.4	5.4	5.3	5.4	5.4	5.2	5.4	5.4
Alkalinity	mg/L as $CaCO_3$	46	49	45	62	48	49	59	48	49	63	49	53	61
Cu	mg/L	0.0007	0.0013	0.0012	0.0055	0.0009	0.0012	0.0053	0.0006	0.0012	0.0059	0.0005	0.0024	0.0059
SO_4	mg/L	5.8	6.0	6.1	16.6	6.0	6.1	15.1	6.0	6.1	17.2	6.1	8.0	16.3
Relative Percent (%) - Copper Species														
Cu+	%	7.5E-03	1.8E-02	2.2E-02	1.1E-02	1.3E-02	1.9E-02	8.4E-03	1.6E-02	2.1E-02	1.1E-02	1.1E-02	1.8E-02	9.6E-03
CuCl	%	1.2E-04	2.9E-04	3.6E-04	1.8E-04	2.1E-04	3.1E-04	1.3E-04	2.5E-04	3.4E-04	2.0E-04	1.8E-04	2.9E-04	1.6E-04
CuCl2-	%	3.7E-07	8.9E-07	1.1E-06	5.8E-07	6.3E-07	9.4E-07	4.1E-07	7.7E-07	1.1E-06	7.1E-07	5.5E-07	9.0E-07	5.3E-07
CuCl3-2	%	1.2E-12	2.8E-12	3.3E-12	1.9E-12	2.0E-12	2.9E-12	1.3E-12	2.4E-12	3.2E-12	2.5E-12	1.8E-12	2.7E-12	1.7E-12
Cu+2	%	3.1	10.5	15.3	7.9	6.4	12.3	6.1	7.3	13.6	8.3	5.0	13.7	7.1
CuCO3	%	82	80	76	84	83	79	85	82	78	84	83	79	85
CuOH+	%	9.2	6.8	6.2	5.0	7.8	6.2	5.3	8.0	6.2	4.9	8.3	5.3	5.1
Cu(OH)2	%	4.2	1.3	1.1	1.6	2.2	1.2	2.2	1.7	1.1	1.4	2.4	1.1	1.8
Cu(CO3)2-2	%	1.4	0.4	0.2	0.6	0.7	0.3	0.8	0.6	0.3	0.6	0.9	0.3	0.7
CuHCO3+	%	1.2E-01	3.9E-01	4.9E-01	3.3E-01	2.5E-01	4.5E-01	2.5E-01	3.0E-01	4.9E-01	3.5E-01	2.1E-01	5.0E-01	3.0E-01
CuSO4	%	2.5E-02	8.2E-02	1.2E-01	1.5E-01	5.2E-02	9.6E-02	1.1E-01	6.0E-02	1.1E-01	1.6E-01	4.2E-02	1.3E-01	1.3E-01
Cu(OH)3-	%	1.4E-02	1.4E-03	9.1E-04	2.1E-03	3.7E-03	1.1E-03	4.0E-03	2.5E-03	8.7E-04	1.8E-03	5.1E-03	8.7E-04	2.7E-03
CuNH3+2	%	1.9E-03	4.3E-03	7.0E-03	7.1E-02	3.1E-03	5.5E-03	5.1E-02	3.4E-03	5.9E-03	6.7E-02	2.2E-03	1.0E-02	5.3E-02
Cu2(OH)2+2	%	2.6E-04	2.4E-04	1.7E-04	5.3E-04	2.2E-04	1.7E-04	5.8E-04	1.6E-04	1.7E-04	5.6E-04	1.4E-04	2.5E-04	6.0E-04
CuCl+	%	5.3E-05	1.7E-04	2.3E-04	1.2E-04	1.0E-04	1.9E-04	8.9E-05	1.2E-04	2.1E-04	1.4E-04	8.4E-05	2.0E-04	1.1E-04
CuNO3+	%	2.6E-05	2.4E-04	4.1E-04	3.7E-04	9.0E-05	3.1E-04	2.3E-04	9.9E-05	3.2E-04	3.5E-04	6.2E-05	4.5E-04	2.9E-04
CuNO2+	%	1.9E-05	6.6E-05	9.6E-05	1.0E-04	4.0E-05	7.7E-05	7.1E-05	4.6E-05	8.5E-05	1.3E-04	3.1E-05	8.5E-05	8.7E-05
Cu(OH)4-2	%	2.1E-07	6.4E-09	3.1E-09	1.2E-08	2.7E-08	4.3E-09	3.1E-08	1.5E-08	3.0E-09	9.6E-09	4.4E-08	3.0E-09	1.7E-08
CuCl2	%	1.6E-10	3.5E-10	4.1E-10	2.1E-10	2.6E-10	3.6E-10	1.5E-10	3.2E-10	4.0E-10	2.6E-10	2.3E-10	3.3E-10	1.9E-10
Cu(NO3)2	%	8.4E-12	2.0E-10	3.8E-10	5.9E-10	4.8E-11	2.8E-10	3.1E-10	5.1E-11	2.6E-10	5.2E-10	3.0E-11	5.1E-10	4.3E-10
Cu(NO2)2	%	1.3E-11	4.4E-11	6.4E-11	1.4E-10	2.7E-11	5.1E-11	8.9E-11	3.1E-11	5.7E-11	2.2E-10	2.1E-11	5.7E-11	1.1E-10
CuCl3-	%	1.8E-17	3.5E-17	3.8E-17	2.1E-17	2.7E-17	3.4E-17	1.4E-17	3.5E-17	3.9E-17	2.7E-17	2.6E-17	3.0E-17	1.9E-17
CuCl4-2	%	1.8E-24	4.5E-24	5.6E-24	3.4E-24	3.2E-24	4.8E-24	2.1E-24	3.9E-24	5.4E-24	4.8E-24	2.8E-24	4.6E-24	3.1E-24

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-21 - Copper speciation with depth (Eh = 300 mV)

Date		9/18/2014	9/18/2014	9/18/2014	9/20/2014	9/20/2014	9/20/2014	9/23/2014	9/23/2014	9/23/2014	9/29/2014	9/29/2014	9/29/2014	10/4/2014
Time		2:00:00 AM	2:15:00 AM	2:30:00 AM	3:00:00 AM	3:30:00 AM	3:45:00 AM	11:00:00 AM	11:30:00 AM	11:45:00 AM	12:30:00 PM	12:45:00 PM	1:00:00 AM	1:30:00 AM
Depth (m)		0	18	46	0	30	45	0	20	47	0	40	45	0
Charge Balance	%	1.37	0.13	6.44	-3.30	-3.68	-0.98	-3.32	-3.20	-2.48	-3.67	-3.90	-3.85	-2.41
pH	s.u.	7.9	7.5	7.7	8.1	7.6	7.9	7.8	7.6	7.5	8.2	7.7	7.8	8.3
pe	s.u.	5.2	5.4	5.4	5.2	5.4	5.4	5.2	5.4	5.4	5.3	5.4	5.4	5.3
Alkalinity	mg/L as $CaCO_3$	45	48	49	47	51	59	50	51	62	51	60	62	50
Cu	mg/L	0.0005	0.0018	0.0055	0.0005	0.0018	0.0061	0.0005	0.0015	0.0068	0.0006	0.0053	0.0060	0.0012
SO_4	mg/L	6.1	6.2	13.6	6.0	7.1	16.3	6.1	6.2	16.1	6.1	14.3	15.3	6.2
Relative Percent (%) - Copper Species														
Cu+	%	1.3E-02	2.4E-02	1.5E-02	9.0E-03	1.7E-02	9.6E-03	1.6E-02	1.8E-02	1.8E-02	7.1E-03	1.5E-02	1.1E-02	5.2E-03
CuCl	%	2.1E-04	3.9E-04	2.5E-04	1.5E-04	2.7E-04	1.6E-04	2.6E-04	3.0E-04	3.0E-04	1.1E-04	2.3E-04	1.8E-04	8.4E-05
CuCl2-	%	6.5E-07	1.2E-06	7.7E-07	4.4E-07	8.5E-07	5.3E-07	7.9E-07	9.2E-07	9.5E-07	3.5E-07	7.2E-07	5.5E-07	2.5E-07
CuCl3-2	%	2.0E-12	3.7E-12	2.4E-12	1.4E-12	2.6E-12	1.8E-12	2.5E-12	2.8E-12	3.1E-12	1.1E-12	2.2E-12	1.7E-12	8.0E-13
Cu+2	%	6.0	15.2	11.4	4.0	12.9	7.1	7.2	11.6	13.2	3.3	10.8	8.2	2.6
CuCO3	%	82	77	80	83	80	85	82	80	80	84	82	84	83
CuOH+	%	8.6	6.2	6.0	8.5	5.4	5.2	8.0	6.2	4.7	7.8	5.0	5.0	7.6
Cu(OH)2	%	2.3	0.9	1.5	3.2	1.2	1.9	1.6	1.2	0.8	3.7	1.1	1.5	5.1
Cu(CO3)2-2	%	0.7	0.3	0.4	1.1	0.3	0.7	0.6	0.4	0.3	1.4	0.4	0.6	1.7
CuHCO3+	%	2.3E-01	5.4E-01	3.8E-01	1.6E-01	4.6E-01	2.9E-01	3.1E-01	4.4E-01	5.6E-01	1.4E-01	4.4E-01	3.5E-01	1.0E-01
CuSO4	%	5.0E-02	1.2E-01	1.8E-01	3.4E-02	1.1E-01	1.3E-01	6.0E-02	9.2E-02	2.4E-01	2.7E-02	1.8E-01	1.5E-01	2.2E-02
Cu(OH)3-	%	4.3E-03	6.9E-04	1.6E-03	8.6E-03	1.1E-03	2.9E-03	2.2E-03	1.1E-03	6.2E-04	1.1E-02	1.1E-03	1.9E-03	2.1E-02
CuNH3+2	%	2.5E-03	5.2E-03	5.4E-02	2.3E-03	7.6E-03	5.6E-02	2.3E-03	5.1E-03	5.3E-02	2.3E-03	4.4E-02	4.6E-02	2.7E-03
Cu2(OH)2+2	%	1.5E-04	2.7E-04	7.5E-04	1.5E-04	2.0E-04	6.5E-04	1.3E-04	2.3E-04	5.9E-04	1.4E-04	5.0E-04	5.8E-04	2.8E-04
CuCl+	%	1.0E-04	2.3E-04	1.7E-04	6.7E-05	1.9E-04	1.1E-04	1.2E-04	1.8E-04	2.0E-04	5.4E-05	1.6E-04	1.2E-04	4.2E-05
CuNO3+	%	6.9E-05	3.2E-04	3.9E-04	4.5E-05	4.2E-04	2.9E-04	7.6E-05	2.5E-04	5.1E-04	3.5E-05	4.0E-04	3.1E-04	3.2E-05
CuNO2+	%	3.8E-05	9.5E-05	1.3E-04	2.5E-05	8.1E-05	8.7E-05	4.5E-05	7.3E-05	1.7E-04	2.0E-05	9.9E-05	1.1E-04	1.6E-05
Cu(OH)4-2	%	3.3E-08	2.1E-09	7.6E-09	9.6E-08	4.1E-09	1.9E-08	1.3E-08	4.4E-09	2.0E-09	1.5E-07	4.5E-09	1.0E-08	3.6E-07
CuCl2	%	2.7E-10	4.5E-10	2.8E-10	1.9E-10	3.1E-10	2.0E-10	3.3E-10	3.5E-10	3.5E-10	1.4E-10	2.6E-10	2.0E-10	1.0E-10
Cu(NO3)2	%	3.1E-11	2.5E-10	4.8E-10	2.0E-11	4.6E-10	4.1E-10	3.1E-11	1.9E-10	6.9E-10	1.5E-11	5.2E-10	4.1E-10	1.5E-11
Cu(NO2)2	%	2.5E-11	6.4E-11	1.5E-10	1.7E-11	5.4E-11	1.1E-10	3.0E-11	4.8E-11	2.3E-10	1.4E-11	9.8E-11	1.6E-10	1.1E-11
CuCl3-	%	3.0E-17	4.4E-17	2.6E-17	2.1E-17	2.8E-17	1.9E-17	3.6E-17	3.4E-17	3.3E-17	1.6E-17	2.4E-17	1.9E-17	1.1E-17
CuCl4-2	%	3.2E-24	6.0E-24	3.9E-24	2.2E-24	4.3E-24	3.1E-24	3.9E-24	4.7E-24	5.3E-24	1.7E-24	3.7E-24	2.8E-24	1.3E-24

(shaded)	Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-21 - Copper speciation with depth (Eh = 300 mV)

Date		10/4/2014	10/11/2014	10/11/2014	11/3/2014	11/3/2014	11/6/2014	11/6/2014
Time		1:45:00 AM	11:30:00 AM	11:45:00 AM	1:30:00 AM	2:00:00 AM	1:00:00 AM	1:30:00 AM
Depth (m)		40	0	40	0	40	0	40
Charge Balance	%	-3.20	-3.24	-2.53	-0.89	-3.96	-0.17	-0.11
pH	s.u.	7.9	7.3	7.6	8.2	7.8	8.5	8.0
pe	s.u.	5.4	5.3	5.4	5.3	5.4	5.3	5.4
Alkalinity	mg/L as $CaCO_3$	58	50	61	48	56	48	48
Cu	mg/L	0.0044	0.0008	0.0052	0.0012	0.0033	0.0013	0.0014
SO_4	mg/L	12.4	6.2	15.3	6.6	11.4	6.6	6.6
Relative Percent (%) - Copper Species								
Cu+	%	8.6E-03	3.9E-02	1.5E-02	5.6E-03	1.1E-02	3.2E-03	8.2E-03
CuCl	%	1.4E-04	6.2E-04	2.5E-04	9.0E-05	1.7E-04	5.2E-05	1.3E-04
CuCl2-	%	4.2E-07	1.9E-06	7.7E-07	2.8E-07	5.3E-07	1.6E-07	4.1E-07
CuCl3-2	%	1.3E-12	5.9E-12	2.4E-12	8.5E-13	1.6E-12	4.9E-13	1.3E-12
Cu+2	%	6.4	19.7	11.5	3.3	7.6	1.9	5.3
CuCO3	%	85	72	82	83	84	81	84
CuOH+	%	5.3	6.3	4.8	7.1	5.5	6.9	6.8
Cu(OH)2	%	2.2	0.5	1.0	4.9	1.8	8.2	3.2
Cu(CO3)2-2	%	0.8	0.2	0.4	1.4	0.6	2.2	0.9
CuHCO3+	%	2.5E-01	8.1E-01	4.8E-01	1.2E-01	3.0E-01	6.9E-02	1.9E-01
CuSO4	%	9.3E-02	1.6E-01	2.0E-01	2.8E-02	1.0E-01	1.6E-02	4.4E-02
Cu(OH)3-	%	3.9E-03	2.2E-04	8.8E-04	1.8E-02	2.7E-03	5.0E-02	7.5E-03
CuNH3+2	%	3.3E-02	2.8E-03	4.1E-02	4.1E-03	5.9E-03	3.6E-03	5.2E-03
Cu2(OH)2+2	%	4.8E-04	1.3E-04	4.8E-04	2.4E-04	3.9E-04	2.3E-04	2.4E-04
CuCl+	%	9.3E-05	3.2E-04	1.7E-04	5.2E-05	1.1E-04	3.0E-05	8.1E-05
CuNO3+	%	2.3E-04	2.5E-04	4.6E-04	5.5E-05	3.1E-04	3.3E-05	9.2E-05
CuNO2+	%	5.9E-05	1.2E-04	4.8E-04	2.1E-05	4.7E-05	1.2E-05	3.3E-05
Cu(OH)4-2	%	2.9E-08	4.3E-10	3.4E-09	2.7E-07	1.7E-08	1.3E-06	7.3E-08
CuCl2	%	1.5E-10	7.7E-10	2.8E-10	1.1E-10	2.0E-10	6.1E-11	1.6E-10
Cu(NO3)2	%	3.0E-10	1.2E-10	6.5E-10	3.2E-11	4.5E-10	2.0E-11	5.7E-11
Cu(NO2)2	%	5.8E-11	8.2E-11	2.2E-09	1.4E-11	3.1E-11	8.1E-12	2.2E-11
CuCl3-	%	1.4E-17	8.1E-17	2.6E-17	1.1E-17	1.8E-17	6.0E-18	1.5E-17
CuCl4-2	%	2.2E-24	9.5E-24	3.9E-24	1.4E-24	2.7E-24	8.0E-25	2.1E-24

(shaded) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-66a - Copper speciation with depth (Eh = 500 mV)

Date		9/25/2014	9/25/2014	9/25/2014	9/27/2014	9/27/2014	9/27/2014	10/1/2014	10/1/2014	10/1/2014	10/8/2014	10/8/2014	10/8/2014
Time		12:45:00 PM	1:00:00 AM	1:15:00 AM	1:10:00 AM	1:30:00 AM	1:45:00 AM	10:30:00 AM	10:30:00 AM	10:45:00 AM	1:00:00 AM	1:30:00 AM	1:45:00 AM
Depth		0	40	85	0	40	80	0	40	80	0	40	80
Charge Balance	%	-4.27	-4.48	-2.77	-1.83	-1.30	-0.96	-2.99	-1.85	-2.61	-1.23	0.71	-0.33
pH	s.u.	8.0	7.7	7.9	8.0	7.8	7.9	7.9	7.7	7.8	8.1	8.0	8.0
pe	s.u.	8.8	9.0	9.0	8.7	9.0	9.0	8.8	9.0	9.0	8.8	9.0	9.0
Alkalinity	mg/L as $CaCO_3$	52	64	65	49	61	63	49	58	62	48	51	60
Cu	mg/L	0.0006	0.0061	0.0072	0.0007	0.0055	0.0062	0.0006	0.0053	0.0069	0.0008	0.0031	0.0065
SO_4	mg/L	6.1	15.5	18.2	6.1	15.7	17.9	6.0	13.6	17.7	6.2	9.5	17.6
Relative Percent (%) - Copper Species													
Cu+	%	3.2E-06	2.9E-06	2.2E-06	3.4E-06	2.7E-06	2.3E-06	4.0E-06	3.6E-06	2.5E-06	2.5E-06	2.0E-06	1.7E-06
CuCl	%	5.2E-08	4.6E-08	4.0E-08	5.5E-08	4.3E-08	4.3E-08	6.6E-08	7.2E-08	6.5E-08	4.0E-08	3.2E-08	3.2E-08
CuCl2-	%	1.6E-10	1.4E-10	1.4E-10	1.6E-10	1.3E-10	1.6E-10	2.0E-10	2.8E-10	3.2E-10	1.2E-10	9.7E-11	1.1E-10
CuCl3-2	%	4.9E-16	4.4E-16	5.2E-16	5.2E-16	4.1E-16	5.7E-16	6.2E-16	1.1E-15	1.6E-15	3.8E-16	3.0E-16	4.1E-16
Cu+2	%	4.6	8.6	6.5	4.8	7.9	6.8	6.1	10.9	7.4	4.0	5.7	5.0
CuCO3	%	84	84	86	83	84	85	83	82	85	83	84	86
CuOH+	%	7.7	4.8	4.9	8.1	5.1	5.0	7.9	5.2	5.1	7.9	6.0	5.3
Cu(OH)2	%	2.5	1.3	1.8	2.6	1.6	1.8	2.1	1.2	1.6	3.4	3.0	2.6
Cu(CO3)2-2	%	1.0	0.6	0.8	1.0	0.6	0.8	0.7	0.4	0.7	1.1	0.8	1.0
CuHCO3+	%	2.0E-01	3.8E-01	2.9E-01	2.0E-01	3.3E-01	2.9E-01	2.5E-01	4.3E-01	3.2E-01	1.6E-01	2.0E-01	2.1E-01
CuSO4	%	3.9E-02	1.5E-01	1.3E-01	4.0E-02	1.4E-01	1.4E-01	5.0E-02	1.7E-01	1.5E-01	3.4E-02	6.5E-02	1.0E-01
Cu(OH)3-	%	5.4E-03	1.5E-03	2.8E-03	5.5E-03	2.1E-03	2.7E-03	3.5E-03	1.2E-03	2.3E-03	9.3E-03	6.5E-03	5.7E-03
CuNH3+2	%	2.3E-03	4.6E-02	6.3E-02	2.3E-03	5.4E-02	6.7E-02	2.6E-03	4.4E-02	6.1E-02	2.8E-03	1.7E-02	5.3E-02
Cu2(OH)2+2	%	1.4E-04	5.5E-04	6.7E-04	1.8E-04	5.6E-04	6.1E-04	1.5E-04	5.5E-04	6.9E-04	2.0E-04	4.3E-04	7.1E-04
CuCl+	%	7.7E-05	1.2E-04	1.1E-04	8.0E-05	1.2E-04	1.2E-04	1.0E-04	2.0E-04	1.7E-04	6.6E-05	8.4E-05	8.5E-05
CuNO3+	%	5.1E-05	3.2E-04	2.7E-04	5.5E-05	3.0E-04	2.9E-04	6.6E-05	4.1E-04	3.0E-04	5.2E-05	1.9E-04	2.1E-04
CuNO2+	%	2.9E-05	8.9E-05	1.2E-04	3.0E-05	9.7E-05	1.3E-04	3.8E-05	8.0E-05	1.5E-04	2.5E-05	3.5E-05	1.7E-04
Cu(OH)4-2	%	4.9E-08	7.6E-09	1.9E-08	5.0E-08	1.2E-08	1.8E-08	2.6E-08	5.0E-09	1.4E-08	1.1E-07	6.0E-08	5.3E-08
CuCl2	%	2.1E-10	2.1E-10	2.1E-10	2.2E-10	1.9E-10	2.3E-10	2.6E-10	4.1E-10	4.7E-10	1.6E-10	1.4E-10	1.7E-10
Cu(NO3)2	%	2.1E-11	4.2E-10	4.1E-10	2.4E-11	4.1E-10	4.3E-10	2.8E-11	5.3E-10	4.4E-10	2.6E-11	2.2E-10	3.1E-10
Cu(NO2)2	%	1.9E-11	9.9E-11	2.3E-10	2.0E-11	1.3E-10	2.8E-10	2.5E-11	6.3E-11	3.2E-10	1.7E-11	2.3E-11	6.1E-10
CuCl3-	%	2.3E-17	2.0E-17	2.3E-17	2.4E-17	1.8E-17	2.5E-17	2.9E-17	4.7E-17	7.0E-17	1.8E-17	1.3E-17	1.8E-17
CuCl4-2	%	2.5E-24	3.0E-24	4.0E-24	2.6E-24	2.7E-24	4.5E-24	3.2E-24	8.9E-24	1.7E-23	2.0E-24	2.0E-24	3.2E-24

(Shaded) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-66a - Copper speciation with depth (Eh = 500 mV)

Date		10/15/2014	10/15/2014	10/15/2014	10/23/2014	10/23/2014	10/23/2014	10/29/2014	10/29/2014	10/29/2014	11/2/2014	11/2/2014
Time		10:30:00 AM	10:45:00 AM	11:00:00 AM	1:45:00 AM	2:00:00 AM	2:15:00 AM	11:00:00 AM	11:30:00 AM	12:00:00 PM	3:00:00 AM	2:20:00 AM
Depth		0	40	80	0	40	80	0	40	80	0	40
Charge Balance	%	-0.76	-1.41	-0.77	6.43	1.07	6.30	4.32	-1.29	4.37	-0.77	4.50
pH	s.u.	8.0	7.7	7.9	8.0	7.7	7.9	7.4	7.5	7.6	8.3	7.9
pe	s.u.	8.8	9.0	9.0	8.8	9.0	9.0	8.9	9.0	9.0	8.9	9.0
Alkalinity	mg/L as $CaCO_3$	48	54	60	42	50	50	43	54	51	48	47
Cu	mg/L	0.0010	0.0033	0.0064	0.0010	0.0029	0.0049	0.0012	0.0029	0.0039	0.0011	0.0031
SO_4	mg/L	6.4	11.1	17.7	6.6	9.8	16.7	6.7	9.8	15.4	6.8	10.6
Relative Percent (%) - Copper Species												
Cu+	%	3.1E-06	3.7E-06	2.4E-06	3.5E-06	3.9E-06	2.8E-06	8.9E-06	5.2E-06	5.0E-06	1.4E-06	2.4E-06
CuCl	%	5.1E-08	6.0E-08	4.9E-08	5.7E-08	6.2E-08	6.7E-08	1.4E-07	8.4E-08	8.6E-08	2.3E-08	3.9E-08
CuCl2-	%	1.5E-10	1.9E-10	1.9E-10	1.7E-10	1.9E-10	3.1E-10	4.4E-10	2.6E-10	2.9E-10	6.9E-11	1.2E-10
CuCl3-2	%	4.8E-16	5.9E-16	7.7E-16	5.4E-16	5.9E-16	1.4E-15	1.4E-15	8.0E-16	9.6E-16	2.1E-16	3.7E-16
Cu+2	%	5.8	11.2	7.1	6.6	11.8	8.1	18.8	15.3	14.9	3.1	7.0
CuCO3	%	83	81	85	81	80	83	73	78	78	83	83
CuOH+	%	7.4	5.4	5.3	8.4	5.7	6.1	6.8	5.3	5.5	7.0	6.5
Cu(OH)2	%	2.5	1.3	1.8	2.8	1.4	2.1	0.8	0.8	1.0	5.2	2.8
Cu(CO3)2-2	%	0.8	0.4	0.7	0.7	0.4	0.6	0.2	0.3	0.3	1.5	0.7
CuHCO3+	%	2.2E-01	4.2E-01	2.9E-01	2.2E-01	4.1E-01	2.8E-01	6.3E-01	5.8E-01	5.3E-01	1.1E-01	2.3E-01
CuSO4	%	4.9E-02	1.5E-01	1.4E-01	5.8E-02	1.4E-01	1.6E-01	1.6E-01	1.8E-01	2.7E-01	2.7E-02	8.9E-02
Cu(OH)3-	%	4.8E-03	1.3E-03	2.8E-03	5.4E-03	1.4E-03	3.3E-03	4.6E-04	6.0E-04	7.6E-04	2.0E-02	5.3E-03
CuNH3+2	%	3.6E-03	2.7E-02	4.7E-02	4.0E-03	1.2E-02	1.7E-02	5.1E-03	7.1E-03	6.8E-03	4.0E-03	6.9E-03
Cu2(OH)2+2	%	2.2E-04	3.6E-04	6.9E-04	2.9E-04	3.7E-04	7.1E-04	2.1E-04	3.0E-04	4.6E-04	2.2E-04	5.0E-04
CuCl+	%	9.3E-05	1.7E-04	1.3E-04	1.1E-04	1.7E-04	1.8E-04	3.0E-04	2.3E-04	2.3E-04	4.8E-05	1.0E-04
CuNO3+	%	1.2E-04	4.0E-04	3.1E-04	1.0E-04	4.2E-04	3.7E-04	3.1E-04	5.5E-04	7.1E-04	5.2E-05	2.6E-04
CuNO2+	%	3.7E-05	1.4E-04	6.4E-04	4.1E-05	2.2E-04	1.1E-03	3.5E-04	4.7E-04	6.9E-04	2.5E-05	6.9E-05
Cu(OH)4-2	%	3.9E-08	5.7E-09	1.9E-08	4.4E-08	6.0E-09	2.2E-08	1.1E-09	1.8E-09	2.5E-09	3.3E-07	4.2E-08
CuCl2	%	2.1E-10	2.8E-10	2.9E-10	2.4E-10	2.9E-10	4.6E-10	6.2E-10	3.9E-10	4.3E-10	9.9E-11	1.8E-10
Cu(NO3)2	%	8.4E-11	5.1E-10	4.7E-10	5.6E-11	5.2E-10	6.0E-10	1.8E-10	6.8E-10	1.2E-09	3.2E-11	3.4E-10
Cu(NO2)2	%	2.4E-11	2.0E-10	6.2E-09	2.7E-11	4.4E-10	1.5E-08	7.1E-10	1.6E-09	3.5E-09	2.2E-11	7.3E-11
CuCl3-	%	2.2E-17	2.6E-17	3.4E-17	2.5E-17	2.6E-17	6.3E-17	6.2E-17	3.6E-17	4.3E-17	9.8E-18	1.7E-17
CuCl4-2	%	2.7E-24	4.1E-24	6.6E-24	3.0E-24	4.1E-24	1.4E-23	8.1E-24	5.4E-24	7.0E-24	1.3E-24	2.5E-24

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-66a - Copper speciation with depth (Eh = 500 mV)

Date		11/2/2014	11/12/2014	11/12/2014	11/12/2014	11/19/2014	11/19/2014	11/19/2014	11/24/2014	11/24/2014	11/24/2014	12/2/2014
Time		2:45:00 AM	1:15:00 AM	1:30:00 AM	1:45:00 AM	10:30:00 AM	11:00:00 AM	11:30:00 AM	1:08:00 AM	2:29:00 AM	2:48:00 AM	11:45:00 AM
Depth		80	0	40	80	0	40	80	0	40	95	0
Charge Balance	%	-0.54	-1.26	-0.50	5.51	2.47	1.95	0.56	-1.55	-2.53	-2.09	0.95
pH	s.u.	8.0	8.0	7.8	7.7	8.0	7.7	7.6	7.8	7.8	7.7	7.9
pe	s.u.	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Alkalinity	mg/L as $CaCO_3$	58	51	54	50	46	47	56	52	54	59	49
Cu	mg/L	0.0041	0.0015	0.0027	0.0039	0.0017	0.0013	0.0038	0.0020	0.0021	0.0035	0.0023
SO_4	mg/L	15.9	7.3	10.3	14.6	7.8	7.4	14.1	8.9	9.0	13.5	9.1
Relative Percent (%) - Copper Species												
Cu+	%	1.9E-06	2.1E-06	3.3E-06	3.7E-06	2.4E-06	3.7E-06	3.9E-06	2.7E-06	2.9E-06	3.1E-06	2.5E-06
CuCl	%	3.9E-08	3.4E-08	5.3E-08	5.9E-08	3.8E-08	6.0E-08	6.2E-08	4.4E-08	4.7E-08	4.9E-08	4.0E-08
CuCl2-	%	1.6E-10	1.1E-10	1.6E-10	1.8E-10	1.2E-10	1.9E-10	1.9E-10	1.4E-10	1.5E-10	1.5E-10	1.2E-10
CuCl3-2	%	6.2E-16	3.2E-16	5.1E-16	5.7E-16	3.6E-16	5.7E-16	5.9E-16	4.2E-16	4.5E-16	4.7E-16	3.8E-16
Cu+2	%	5.5	5.3	9.1	11.0	6.6	11.0	11.5	7.9	8.4	9.1	7.8
CuCO3	%	85	84	83	81	83	80	81	83	83	83	83
CuOH+	%	5.4	6.4	5.8	5.9	6.6	6.1	5.3	5.8	5.7	5.1	6.0
Cu(OH)2	%	2.5	3.0	1.6	1.5	2.9	1.6	1.1	2.0	1.8	1.4	2.4
Cu(CO3)2-2	%	0.9	0.9	0.5	0.4	0.7	0.4	0.4	0.6	0.6	0.5	0.6
CuHCO3+	%	2.2E-01	2.0E-01	3.5E-01	3.8E-01	2.2E-01	3.7E-01	4.5E-01	2.9E-01	3.2E-01	3.7E-01	2.6E-01
CuSO4	%	1.0E-01	4.9E-02	1.1E-01	1.9E-01	6.4E-02	1.0E-01	1.9E-01	8.5E-02	9.2E-02	1.4E-01	8.6E-02
Cu(OH)3-	%	5.1E-03	6.6E-03	2.0E-03	1.7E-03	5.8E-03	1.8E-03	1.1E-03	3.0E-03	2.4E-03	1.6E-03	3.9E-03
CuNH3+2	%	5.9E-03	5.2E-03	5.8E-03	7.0E-03	6.5E-03	7.3E-03	6.3E-03	6.4E-03	6.3E-03	6.1E-03	7.7E-03
Cu2(OH)2+2	%	4.6E-04	2.4E-04	3.5E-04	5.2E-04	2.8E-04	1.8E-04	4.0E-04	2.6E-04	2.6E-04	3.5E-04	3.1E-04
CuCl+	%	1.0E-04	8.1E-05	1.4E-04	1.6E-04	9.9E-05	1.6E-04	1.7E-04	1.2E-04	1.3E-04	1.3E-04	1.1E-04
CuNO3+	%	2.8E-04	1.1E-04	3.2E-04	5.4E-04	1.6E-04	3.8E-04	5.4E-04	2.3E-04	2.5E-04	4.1E-04	2.5E-04
CuNO2+	%	3.4E-05	3.3E-05	5.6E-05	6.7E-05	4.1E-05	6.9E-05	7.0E-05	4.9E-05	5.2E-05	5.6E-05	4.9E-05
Cu(OH)4-2	%	4.4E-08	6.2E-08	1.1E-08	8.1E-09	4.8E-08	8.8E-09	4.4E-09	1.9E-08	1.4E-08	8.1E-09	2.7E-08
CuCl2	%	2.3E-10	1.5E-10	2.4E-10	2.7E-10	1.7E-10	2.8E-10	2.8E-10	2.0E-10	2.2E-10	2.3E-10	1.9E-10
Cu(NO3)2	%	5.0E-10	8.6E-11	4.1E-10	9.2E-10	1.4E-10	4.5E-10	8.9E-10	2.4E-10	2.7E-10	6.5E-10	2.7E-10
Cu(NO2)2	%	2.2E-11	2.2E-11	3.7E-11	4.4E-11	2.7E-11	4.6E-11	4.6E-11	3.2E-11	3.5E-11	3.7E-11	3.2E-11
CuCl3-	%	2.8E-17	1.5E-17	2.3E-17	2.5E-17	1.6E-17	2.6E-17	2.6E-17	1.9E-17	2.0E-17	2.1E-17	1.7E-17
CuCl4-2	%	5.4E-24	2.1E-24	3.3E-24	3.8E-24	2.4E-24	3.9E-24	4.0E-24	2.8E-24	3.0E-24	3.2E-24	2.6E-24

(Shaded) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-66a - Copper speciation with depth (Eh = 500 mV)

Date		12/2/2014	12/2/2014	12/10/2014	12/10/2014	12/10/2014	12/16/2014	12/16/2014	12/16/2014
Time		12:00:00 PM	12:30:00 PM	11:00:00 AM	11:25:00 AM	11:45:00 AM	11:15:00 AM	11:45:00 AM	12:15:00 PM
Depth		40	100	0	40	100	0	40	105
Charge Balance	%	-7.01	-5.53	-3.39	3.96	-2.65	-0.71	-3.80	-2.25
pH	s.u.	7.8	7.8	7.9	7.7	7.6	7.8	7.6	7.6
pe	s.u.	9.0	9.1	9.1	9.1	9.1	9.1	9.1	9.1
Alkalinity	mg/L as $CaCO_3$	59	57	55	47	55	50	55	54
Cu	mg/L	0.0026	0.0021	0.0022	0.0024	0.0022	0.0021	0.0021	0.0020
SO_4	mg/L	9.0	8.8	9.4	9.3	9.2	9.1	9.0	8.9
Relative Percent (%) - Copper Species									
Cu+	%	2.4E-06	2.5E-06	1.9E-06	4.0E-06	3.7E-06	2.6E-06	3.6E-06	3.7E-06
CuCl	%	3.8E-08	4.0E-08	3.1E-08	6.5E-08	5.9E-08	4.3E-08	5.8E-08	5.9E-08
CuCl2-	%	1.2E-10	1.2E-10	9.7E-11	2.0E-10	1.8E-10	1.3E-10	1.8E-10	1.8E-10
CuCl3-2	%	3.6E-16	3.8E-16	3.0E-16	6.1E-16	5.6E-16	4.0E-16	5.4E-16	5.6E-16
Cu+2	%	7.5	8.1	6.2	13.0	11.9	8.8	11.9	12.1
CuCO3	%	85	84	85	79	81	83	81	81
CuOH+	%	5.1	5.2	5.4	5.9	5.1	5.7	5.1	5.2
Cu(OH)2	%	1.8	1.8	2.5	1.4	1.2	2.0	1.2	1.2
Cu(CO3)2-2	%	0.6	0.6	0.8	0.3	0.4	0.5	0.4	0.4
CuHCO3+	%	3.0E-01	3.1E-01	2.3E-01	4.1E-01	4.4E-01	3.0E-01	4.5E-01	4.4E-01
CuSO4	%	8.1E-02	8.5E-02	7.0E-02	1.4E-01	1.3E-01	9.5E-02	1.3E-01	1.3E-01
Cu(OH)3-	%	2.6E-03	2.5E-03	4.7E-03	1.4E-03	1.1E-03	2.9E-03	1.1E-03	1.2E-03
CuNH3+2	%	6.6E-03	7.1E-03	7.0E-03	8.4E-03	7.4E-03	8.1E-03	7.6E-03	7.8E-03
Cu2(OH)2+2	%	2.5E-04	2.2E-04	2.4E-04	3.1E-04	2.2E-04	2.5E-04	2.1E-04	2.1E-04
CuCl+	%	1.1E-04	1.2E-04	9.1E-05	1.9E-04	1.7E-04	1.3E-04	1.7E-04	1.8E-04
CuNO3+	%	2.3E-04	2.5E-04	2.1E-04	4.3E-04	3.9E-04	2.8E-04	3.8E-04	3.8E-04
CuNO2+	%	4.6E-05	5.0E-05	3.9E-05	8.1E-05	7.4E-05	5.5E-05	7.4E-05	7.5E-05
Cu(OH)4-2	%	1.6E-08	1.5E-08	3.8E-08	6.0E-09	4.6E-09	1.8E-08	4.6E-09	4.7E-09
CuCl2	%	1.8E-10	1.9E-10	1.5E-10	3.0E-10	2.8E-10	2.0E-10	2.7E-10	2.8E-10
Cu(NO3)2	%	2.5E-10	2.6E-10	2.4E-10	4.8E-10	4.4E-10	3.1E-10	4.1E-10	4.2E-10
Cu(NO2)2	%	3.1E-11	3.3E-11	2.6E-11	5.4E-11	4.9E-11	3.6E-11	4.9E-11	5.0E-11
CuCl3-	%	1.6E-17	1.7E-17	1.3E-17	2.7E-17	2.5E-17	1.8E-17	2.4E-17	2.5E-17
CuCl4-2	%	2.5E-24	2.7E-24	2.1E-24	4.3E-24	3.9E-24	2.9E-24	3.9E-24	4.0E-24

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-66a - Copper speciation with depth (Eh = 250 mV)

Date		9/25/2014	9/25/2014	9/25/2014	9/27/2014	9/27/2014	9/27/2014	10/1/2014	10/1/2014	10/1/2014	10/8/2014	10/8/2014	10/8/2014
Time		12:45:00 PM	1:00:00 AM	1:15:00 AM	1:10:00 AM	1:30:00 AM	1:45:00 AM	10:30:00 AM	10:30:00 AM	10:45:00 AM	1:00:00 AM	1:30:00 AM	1:45:00 AM
Depth (m)		0	40	85	0	40	80	0	40	80	0	40	80
Charge Balance	%	-4.26	-4.47	-2.77	-1.83	-1.30	-0.96	-2.99	-1.85	-2.61	-1.23	0.71	-0.33
pH	s.u.	8.0	7.7	7.9	8.0	7.8	7.9	7.9	7.7	7.8	8.1	8.0	8.0
pe	s.u.	4.4	4.5	4.5	4.4	4.5	4.5	4.4	4.5	4.5	4.4	4.5	4.5
Alkalinity	mg/L as $CaCO_3$	52	64	65	49	61	63	49	58	62	48	51	60
Cu	mg/L	0.0006	0.0061	0.0072	0.0007	0.0055	0.0062	0.0006	0.0053	0.0069	0.0008	0.0031	0.0065
SO_4	mg/L	6.1	15.5	18.2	6.1	15.7	17.9	6.0	13.6	17.7	6.2	9.5	17.6
Relative Percent (%) - Copper Species													
Cu+	%	7.6E-02	9.3E-02	7.0E-02	7.9E-02	8.6E-02	7.4E-02	9.8E-02	1.2E-01	8.1E-02	6.2E-02	6.3E-02	5.5E-02
CuCl	%	1.2E-03	1.5E-03	1.3E-03	1.3E-03	1.4E-03	1.4E-03	1.6E-03	2.3E-03	2.1E-03	1.0E-03	1.0E-03	1.0E-03
CuCl2-	%	3.7E-06	4.6E-06	4.6E-06	3.9E-06	4.2E-06	5.0E-06	4.8E-06	9.0E-06	1.0E-05	3.0E-06	3.1E-06	3.6E-06
CuCl3-2	%	1.2E-11	1.4E-11	1.7E-11	1.2E-11	1.3E-11	1.8E-11	1.5E-11	3.4E-11	5.1E-11	9.5E-12	9.6E-12	1.3E-11
Cu+2	%	4.6	8.6	6.5	4.8	7.9	6.8	6.1	10.9	7.4	4.0	5.7	5.0
CuCO3	%	84	84	86	83	84	85	83	82	85	83	84	86
CuOH+	%	7.7	4.8	4.9	8.1	5.1	5.0	7.9	5.2	5.1	7.9	6.0	5.3
Cu(OH)2	%	2.5	1.3	1.8	2.5	1.6	1.8	2.1	1.2	1.6	3.4	3.0	2.6
Cu(CO3)2-2	%	1.0	0.6	0.8	1.0	0.6	0.8	0.7	0.4	0.7	1.1	0.8	1.0
CuHCO3+	%	2.0E-01	3.8E-01	2.9E-01	2.0E-01	3.3E-01	2.9E-01	2.5E-01	4.3E-01	3.2E-01	1.6E-01	2.0E-01	2.1E-01
CuSO4	%	3.9E-02	1.5E-01	1.3E-01	4.0E-02	1.4E-01	1.4E-01	5.0E-02	1.7E-01	1.5E-01	3.4E-02	6.5E-02	1.0E-01
Cu(OH)3-	%	5.4E-03	1.5E-03	2.8E-03	5.5E-03	2.1E-03	2.7E-03	3.5E-03	1.2E-03	2.3E-03	9.3E-03	6.5E-03	5.7E-03
CuNH3+2	%	2.3E-03	4.6E-02	6.3E-02	2.3E-03	5.4E-02	6.7E-02	2.6E-03	4.4E-02	6.1E-02	2.8E-03	1.7E-02	5.3E-02
Cu2(OH)2+2	%	1.4E-04	5.5E-04	6.7E-04	1.8E-04	5.6E-04	6.1E-04	1.5E-04	5.5E-04	6.9E-04	2.0E-04	4.3E-04	7.1E-04
CuCl+	%	7.7E-05	1.2E-04	1.1E-04	7.9E-05	1.2E-04	1.2E-04	1.0E-04	2.0E-04	1.7E-04	6.6E-05	8.4E-05	8.5E-05
CuNO3+	%	5.1E-05	3.2E-04	2.7E-04	5.5E-05	3.0E-04	2.9E-04	6.6E-05	4.1E-04	3.0E-04	5.2E-05	1.9E-04	2.1E-04
CuNO2+	%	2.9E-05	8.9E-05	1.2E-04	3.0E-05	9.6E-05	1.3E-04	3.8E-05	8.0E-05	1.5E-04	2.5E-05	3.5E-05	1.7E-04
Cu(OH)4-2	%	4.9E-08	7.6E-09	1.9E-08	5.0E-08	1.2E-08	1.8E-08	2.6E-08	5.0E-09	1.4E-08	1.1E-07	6.0E-08	5.3E-08
CuCl2	%	2.1E-10	2.1E-10	2.1E-10	2.2E-10	1.9E-10	2.3E-10	2.6E-10	4.1E-10	4.7E-10	1.6E-10	1.4E-10	1.7E-10
Cu(NO3)2	%	2.1E-11	4.2E-10	4.1E-10	2.4E-11	4.1E-10	4.3E-10	2.8E-11	5.3E-10	4.4E-10	2.6E-11	2.2E-10	3.1E-10
Cu(NO2)2	%	1.9E-11	9.9E-11	2.3E-10	2.0E-11	1.3E-10	2.8E-10	2.5E-11	6.3E-11	3.2E-10	1.7E-11	2.3E-11	6.1E-10
CuCl3-	%	2.3E-17	2.0E-17	2.3E-17	2.4E-17	1.8E-17	2.5E-17	2.9E-17	4.7E-17	7.0E-17	1.7E-17	1.3E-17	1.8E-17
CuCl4-2	%	2.5E-24	3.0E-24	4.0E-24	2.6E-24	2.7E-24	4.5E-24	3.2E-24	8.8E-24	1.7E-23	2.0E-24	2.0E-24	3.2E-24

(shaded) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-66a - Copper speciation with depth (Eh = 250 mV)

Date		10/15/2014	10/15/2014	10/15/2014	10/23/2014	10/23/2014	10/23/2014	10/29/2014	10/29/2014	10/29/2014	11/2/2014	11/2/2014
Time		10:30:00 AM	10:45:00 AM	11:00:00 AM	1:45:00 AM	2:00:00 AM	2:15:00 AM	11:00:00 AM	11:30:00 AM	12:00:00 PM	3:00:00 AM	2:20:00 AM
Depth (m)		0	40	80	0	40	80	0	40	80	0	40
Charge Balance	%	-0.76	-1.41	-0.77	6.43	1.08	6.30	4.32	-1.29	4.37	-0.77	4.50
pH	s.u.	8.0	7.7	7.9	8.0	7.7	7.9	7.4	7.5	7.6	8.3	7.9
pe	s.u.	4.4	4.5	4.5	4.4	4.5	4.5	4.4	4.5	4.5	4.5	4.5
Alkalinity	mg/L as $CaCO_3$	48	54	60	42	50	50	43	54	51	48	47
Cu	mg/L	0.0010	0.0033	0.0064	0.0010	0.0029	0.0049	0.0012	0.0029	0.0039	0.0011	0.0031
SO_4	mg/L	6.4	11.1	17.7	6.6	9.8	16.7	6.7	9.8	15.4	6.8	10.6
Relative Percent (%) - Copper Species												
Cu+	%	8.3E-02	1.2E-01	7.7E-02	9.4E-02	1.3E-01	8.9E-02	2.5E-01	1.7E-01	1.6E-01	4.0E-02	7.7E-02
CuCl	%	1.3E-03	2.0E-03	1.6E-03	1.5E-03	2.0E-03	2.1E-03	4.0E-03	2.7E-03	2.8E-03	6.5E-04	1.2E-03
CuCl2-	%	4.1E-06	6.2E-06	6.2E-06	4.6E-06	6.3E-06	9.9E-06	1.2E-05	8.4E-06	9.3E-06	2.0E-06	3.8E-06
CuCl3-2	%	1.3E-11	1.9E-11	2.5E-11	1.4E-11	1.9E-11	4.6E-11	3.8E-11	2.6E-11	3.1E-11	6.1E-12	1.2E-11
Cu+2	%	5.8	11.2	7.1	6.6	11.8	8.1	18.7	15.3	14.9	3.1	7.0
CuCO3	%	83	81	85	81	80	83	72	77	77	83	83
CuOH+	%	7.4	5.4	5.3	8.4	5.7	6.1	6.8	5.2	5.5	7.0	6.5
Cu(OH)2	%	2.5	1.3	1.8	2.8	1.4	2.1	0.8	0.8	1.0	5.2	2.8
Cu(CO3)2-2	%	0.8	0.4	0.7	0.7	0.4	0.6	0.2	0.3	0.3	1.5	0.7
CuHCO3+	%	2.2E-01	4.2E-01	2.9E-01	2.2E-01	4.1E-01	2.8E-01	6.3E-01	5.7E-01	5.3E-01	1.1E-01	2.3E-01
CuSO4	%	4.9E-02	1.5E-01	1.4E-01	5.7E-02	1.4E-01	1.6E-01	1.6E-01	1.8E-01	2.7E-01	2.7E-02	8.9E-02
Cu(OH)3-	%	4.8E-03	1.3E-03	2.8E-03	5.4E-03	1.4E-03	3.3E-03	4.5E-04	6.0E-04	7.6E-04	2.0E-02	5.3E-03
CuNH3+2	%	3.5E-03	2.7E-02	4.7E-02	4.0E-03	1.2E-02	1.7E-02	5.0E-03	7.1E-03	6.8E-03	4.0E-03	6.9E-03
Cu2(OH)2+2	%	2.2E-04	3.6E-04	6.9E-04	2.9E-04	3.6E-04	7.1E-04	2.1E-04	3.0E-04	4.6E-04	2.2E-04	5.0E-04
CuCl+	%	9.3E-05	1.7E-04	1.3E-04	1.1E-04	1.7E-04	1.8E-04	3.0E-04	2.3E-04	2.3E-04	4.8E-05	1.0E-04
CuNO3+	%	1.2E-04	4.0E-04	3.1E-04	9.9E-05	4.2E-04	3.7E-04	3.1E-04	5.5E-04	7.1E-04	5.2E-05	2.6E-04
CuNO2+	%	3.7E-05	1.4E-04	6.4E-04	4.1E-05	2.2E-04	1.1E-03	3.5E-04	4.7E-04	6.9E-04	2.5E-05	6.9E-05
Cu(OH)4-2	%	3.9E-08	5.7E-09	1.9E-08	4.4E-08	6.0E-09	2.2E-08	1.1E-09	1.8E-09	2.5E-09	3.3E-07	4.2E-08
CuCl2	%	2.1E-10	2.8E-10	2.9E-10	2.4E-10	2.9E-10	4.5E-10	6.2E-10	3.9E-10	4.3E-10	9.9E-11	1.8E-10
Cu(NO3)2	%	8.4E-11	5.1E-10	4.7E-10	5.6E-11	5.2E-10	6.0E-10	1.8E-10	6.8E-10	1.2E-09	3.2E-11	3.4E-10
Cu(NO2)2	%	2.4E-11	2.0E-10	6.2E-09	2.7E-11	4.4E-10	1.5E-08	7.1E-10	1.6E-09	3.5E-09	2.2E-11	7.3E-11
CuCl3-	%	2.2E-17	2.6E-17	3.4E-17	2.5E-17	2.6E-17	6.3E-17	6.2E-17	3.6E-17	4.3E-17	9.8E-18	1.7E-17
CuCl4-2	%	2.7E-24	4.1E-24	6.6E-24	3.0E-24	4.0E-24	1.4E-23	8.1E-24	5.4E-24	7.0E-24	1.3E-24	2.5E-24

(Shaded cell) Copper species account for greater than 1% of the total molality of copper.

Quesnel Lake West Basin, QUL-66a - Copper speciation with depth (Eh = 250 mV)

Date		11/2/2014	11/12/2014	11/12/2014	11/12/2014	11/19/2014	11/19/2014	11/19/2014	11/24/2014	11/24/2014	11/24/2014	12/2/2014
Time		2:45:00 AM	1:15:00 AM	1:30:00 AM	1:45:00 AM	10:30:00 AM	11:00:00 AM	11:30:00 AM	1:08:00 AM	2:29:00 AM	2:48:00 AM	11:45:00 AM
Depth (m)		80	0	40	80	0	40	80	0	40	95	0
Charge Balance	%	-0.54	-1.26	-0.50	5.51	2.47	1.95	0.56	-1.55	-2.53	-2.09	0.95
pH	s.u.	8.0	8.0	7.8	7.7	8.0	7.7	7.6	7.8	7.8	7.7	7.9
pe	s.u.	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Alkalinity	mg/L as $CaCO_3$	58	51	54	50	46	47	56	52	54	59	49
Cu	mg/L	0.0041	0.0015	0.0027	0.0039	0.0017	0.0013	0.0038	0.0020	0.0021	0.0035	0.0023
SO_4	mg/L	15.9	7.3	10.3	14.6	7.8	7.4	14.1	8.9	9.0	13.5	9.1
Relative Percent (%) - Copper Species												
Cu+	%	6.0E-02	6.4E-02	1.0E-01	1.2E-01	7.5E-02	1.2E-01	1.2E-01	8.7E-02	9.3E-02	9.9E-02	8.2E-02
CuCl	%	1.2E-03	1.0E-03	1.7E-03	1.9E-03	1.2E-03	2.0E-03	2.0E-03	1.4E-03	1.5E-03	1.6E-03	1.3E-03
CuCl2-	%	5.0E-06	3.2E-06	5.1E-06	5.9E-06	3.7E-06	6.0E-06	6.2E-06	4.3E-06	4.6E-06	4.9E-06	4.1E-06
CuCl3-2	%	2.0E-11	9.8E-12	1.6E-11	1.8E-11	1.1E-11	1.8E-11	1.9E-11	1.3E-11	1.4E-11	1.5E-11	1.3E-11
Cu+2	%	5.5	5.3	9.0	11.0	6.6	11.0	11.5	7.9	8.4	9.1	7.8
CuCO3	%	85	84	83	81	83	80	81	83	83	83	83
CuOH+	%	5.4	6.4	5.8	5.9	6.6	6.1	5.2	5.8	5.7	5.1	6.0
Cu(OH)2	%	2.5	3.0	1.6	1.5	2.9	1.6	1.1	2.0	1.8	1.4	2.4
Cu(CO3)2-2	%	0.9	0.9	0.5	0.4	0.7	0.4	0.4	0.6	0.6	0.5	0.6
CuHCO3+	%	2.2E-01	2.0E-01	3.4E-01	3.8E-01	2.2E-01	3.7E-01	4.5E-01	2.9E-01	3.2E-01	3.7E-01	2.6E-01
CuSO4	%	1.0E-01	4.9E-02	1.1E-01	1.9E-01	6.4E-02	1.0E-01	1.9E-01	8.5E-02	9.2E-02	1.4E-01	8.6E-02
Cu(OH)3-	%	5.1E-03	6.6E-03	2.0E-03	1.7E-03	5.8E-03	1.8E-03	1.1E-03	3.0E-03	2.4E-03	1.6E-03	3.9E-03
CuNH3+2	%	5.9E-03	5.2E-03	5.8E-03	7.0E-03	6.5E-03	7.3E-03	6.3E-03	6.4E-03	6.3E-03	6.1E-03	7.7E-03
Cu2(OH)2+2	%	4.6E-04	2.4E-04	3.5E-04	5.2E-04	2.8E-04	1.8E-04	4.0E-04	2.6E-04	2.6E-04	3.5E-04	3.1E-04
CuCl+	%	1.0E-04	8.1E-05	1.4E-04	1.6E-04	9.9E-05	1.6E-04	1.7E-04	1.2E-04	1.3E-04	1.3E-04	1.1E-04
CuNO3+	%	2.8E-04	1.1E-04	3.2E-04	5.4E-04	1.6E-04	3.8E-04	5.4E-04	2.3E-04	2.5E-04	4.1E-04	2.5E-04
CuNO2+	%	3.4E-05	3.3E-05	5.6E-05	6.7E-05	4.1E-05	6.9E-05	7.0E-05	4.9E-05	5.2E-05	5.6E-05	4.9E-05
Cu(OH)4-2	%	4.4E-08	6.2E-08	1.0E-08	8.0E-09	4.8E-08	8.8E-09	4.4E-09	1.9E-08	1.4E-08	8.1E-09	2.7E-08
CuCl2	%	2.3E-10	1.5E-10	2.4E-10	2.7E-10	1.7E-10	2.8E-10	2.8E-10	2.0E-10	2.2E-10	2.3E-10	1.9E-10
Cu(NO3)2	%	5.0E-10	8.6E-11	4.1E-10	9.2E-10	1.4E-10	4.5E-10	8.9E-10	2.4E-10	2.7E-10	6.5E-10	2.7E-10
Cu(NO2)2	%	2.2E-11	2.2E-11	3.7E-11	4.4E-11	2.7E-11	4.6E-11	4.6E-11	3.2E-11	3.5E-11	3.7E-11	3.2E-11
CuCl3-	%	2.8E-17	1.5E-17	2.3E-17	2.5E-17	1.6E-17	2.6E-17	2.6E-17	1.9E-17	2.0E-17	2.1E-17	1.7E-17
CuCl4-2	%	5.4E-24	2.1E-24	3.3E-24	3.8E-24	2.4E-24	3.9E-24	4.0E-24	2.8E-24	3.0E-24	3.2E-24	2.6E-24

(shaded)	Copper species account for greater than 1% of the total molality of copper.

Detailed Copper Speciation Results

Quesnel Lake West Basin, QUL-66a - Copper speciation with depth (Eh = 250 mV)

Date		12/2/2014	12/2/2014	12/10/2014	12/10/2014	12/10/2014	12/16/2014	12/16/2014	12/16/2014
Time		12:00:00 PM	12:30:00 PM	11:00:00 AM	11:25:00 AM	11:45:00 AM	11:15:00 AM	11:45:00 AM	12:15:00 PM
Depth (m)		40	100	0	40	100	0	40	105
Charge Balance	%	-7.01	-5.53	-3.39	3.96	-2.65	-0.71	-3.80	-2.24
pH	s.u.	7.8	7.8	7.9	7.7	7.6	7.8	7.6	7.6
pe	s.u.	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Alkalinity	mg/L as $CaCO_3$	59	57	55	47	55	50	55	54
Cu	mg/L	0.0026	0.0021	0.0022	0.0024	0.0022	0.0021	0.0021	0.0020
SO_4	mg/L	9.0	8.8	9.4	9.3	9.2	9.1	9.0	8.9
Relative Percent (%) - Copper Species									
Cu+	%	7.9E-02	8.4E-02	6.5E-02	1.3E-01	1.2E-01	9.0E-02	1.2E-01	1.2E-01
CuCl	%	1.3E-03	1.4E-03	1.1E-03	2.2E-03	2.0E-03	1.5E-03	2.0E-03	2.0E-03
CuCl2-	%	3.9E-06	4.2E-06	3.3E-06	6.7E-06	6.2E-06	4.5E-06	6.1E-06	6.2E-06
CuCl3-2	%	1.2E-11	1.3E-11	9.9E-12	2.1E-11	1.9E-11	1.4E-11	1.8E-11	1.9E-11
Cu+2	%	7.4	8.1	6.2	12.9	11.9	8.8	11.9	12.1
CuCO3	%	85	84	85	79	81	83	81	80
CuOH+	%	5.1	5.2	5.4	5.9	5.1	5.7	5.1	5.2
Cu(OH)2	%	1.8	1.8	2.5	1.4	1.2	2.0	1.2	1.2
Cu(CO3)2-2	%	0.6	0.6	0.8	0.3	0.4	0.5	0.4	0.4
CuHCO3+	%	3.0E-01	3.1E-01	2.3E-01	4.1E-01	4.4E-01	3.0E-01	4.4E-01	4.4E-01
CuSO4	%	8.1E-02	8.5E-02	7.0E-02	1.4E-01	1.3E-01	9.5E-02	1.3E-01	1.3E-01
Cu(OH)3-	%	2.6E-03	2.5E-03	4.7E-03	1.4E-03	1.1E-03	2.9E-03	1.1E-03	1.2E-03
CuNH3+2	%	6.6E-03	7.1E-03	7.0E-03	8.4E-03	7.4E-03	8.1E-03	7.6E-03	7.8E-03
Cu2(OH)2+2	%	2.5E-04	2.2E-04	2.4E-04	3.1E-04	2.2E-04	2.5E-04	2.0E-04	2.1E-04
CuCl+	%	1.1E-04	1.2E-04	9.1E-05	1.9E-04	1.7E-04	1.3E-04	1.7E-04	1.8E-04
CuNO3+	%	2.3E-04	2.5E-04	2.1E-04	4.3E-04	3.9E-04	2.8E-04	3.8E-04	3.8E-04
CuNO2+	%	4.6E-05	5.0E-05	3.9E-05	8.1E-05	7.4E-05	5.5E-05	7.4E-05	7.5E-05
Cu(OH)4-2	%	1.6E-08	1.5E-08	3.8E-08	6.0E-09	4.6E-09	1.8E-08	4.6E-09	4.7E-09
CuCl2	%	1.8E-10	1.9E-10	1.5E-10	3.0E-10	2.8E-10	2.0E-10	2.7E-10	2.8E-10
Cu(NO3)2	%	2.5E-10	2.6E-10	2.3E-10	4.8E-10	4.4E-10	3.1E-10	4.1E-10	4.2E-10
Cu(NO2)2	%	3.1E-11	3.3E-11	2.6E-11	5.4E-11	4.9E-11	3.6E-11	4.9E-11	5.0E-11
CuCl3-	%	1.6E-17	1.7E-17	1.3E-17	2.7E-17	2.5E-17	1.8E-17	2.4E-17	2.5E-17
CuCl4-2	%	2.5E-24	2.7E-24	2.1E-24	4.3E-24	3.9E-24	2.9E-24	3.9E-24	4.0E-24

(Shaded box) Copper species account for greater than 1% of the total molality of copper.

Provided on CD

APPENDIX I

Post-event Water Quality Raw Data

Provided on CD

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

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APPENDIX G: TERRESTRIAL WILDLIFE AND VEGETATION

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POST-EVENT IMPACT ASSESSMENT REPORT: Terrestrial Wildlife and Vegetation

Prepared for: Mount Polley Mining Corporation

SNC-LAVALIN INC.

May 28, 2015

FINAL REPORT / V-01
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EXECUTIVE SUMMARY

The scope of the terrestrial wildlife and vegetation assessment included characterization of the effects of the Mount Polley tailings dam failure on terrestrial wildlife and vegetation species and plant communities that are classified federally or provincially as at risk, are listed as regionally important by the Cariboo-Chilcotin Land and Resource Management Plan, or are subjects of provincial legal or policy directions or harvest management. Sensitive habitats that are subjects of provincial or federal legal or policy directions - defined as old-growth forest and wetlands – affected by the tailings dam failure were quantified. The study area was delineated by terrain specialists from aerial imagery and from field surveys by terrain and soils specialists. The terrestrial study area includes all terrestrial areas that were subjected to tailings or debris deposition or to active erosion resulting from the tailings dam failure. It does not include the Hazeltine Creek channel area (6 ha) as impacts on that area will be reported as part of the Fish and Fish Habitat Impact Assessment.

Assessment of the effects on terrestrial wildlife and vegetation was difficult due to the lack of baseline data on the habitats and species that were present in the study area. Terrestrial Ecosystem Mapping (TEM) and data from post-event field visits to the study area were used as the basis for the assessment. The tailings dam failure affected 234.3 ha of terrestrial habitat (the study area), which included 200.3 ha designated by the province as Old Growth Management Area (OGMA) and 4.9 ha of wetland habitat. Site series associated with three different at-risk ecological communities, as defined by the province, were mapped within the study area: the Red-listed Scrub birch-Sedges-Peat moss (4.9 ha), the Blue-listed Western Redcedar / Oak Fern / Electrified Cat's-Tail Moss (53.4 ha), and the Blue-listed Western Redcedar / Falsebox (29.5 ha).

The potential impacts of the tailings dam failure on specific rare plant occurrences cannot be quantified. There are no occurrence records for rare plants within the study area as no rare plant surveys are known to have been performed there before the tailings dam failure. Any rare plant occurrences that survived after the initial dam failure would face greatly altered habitat conditions that could reduce their viability.

The flood of tailings and debris from the tailings dam failure would likely have resulted in some degree of wildlife mortality but the extent of that mortality cannot be quantified. Based on natural history characteristics, mortality effects are inferred as probable for the provincially Blue-listed western toad (*Anaxyrus boreas*) and are inferred as possible for two SARA-listed endangered bat species, little brown myotis (*Myotis lucifugus*) and northern myotis (*Myotis septentrionalis*). Mortality effects are inferred as possible for any beavers (*Castor canadensis*) that may have occupied lodges on Hazeltine Creek. One wetland identified as moderate suitability moose winter habitat was removed. The tailings dam failure also resulted in loss of summer habitat for mule deer (*Odocoileus hemionus*), breeding habitat for fishers (*Pekania pennanti*), breeding habitat for

western toad, living habitat for beavers, and roosting habitat for bats. No provincially-designated Wildlife Habitat Areas or designated winter ranges for mule deer or caribou (*Rangifer tarandus*) were affected. The Mount Polley Mine is located within an area where grizzly bears (*Ursus arctos*) are considered extirpated so the tailings dam failure did not result in impacts on that species. The habitat effects of the tailings dam failure are not likely to result in effects to regional wildlife populations based on the size of the study area and the amount of alternative habitat available. The assessment of potential long-term effects on wildlife, plants and ecosystems will be carried out in a future Ecological Risk Assessment (ERA).

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ABBREVIATIONS

BCCDC	British Columbia Conservation Data Centre
COPC	Contaminants of Potential Concern
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
EA	Environmental Assessment
GIF	Ground Inspection Form
HSRMP	Horsefly Sustainable Resource Management Plan
ICH	Interior Cedar-Hemlock
ICHmk3	Horsefly moist cool Interior Cedar-Hemlock variant
ICHwk1	Quesnel wet, cool Interior Cedar-Hemlock variant
LU	Landscape Unit
MPM	Mount Polley Mine
OGMA	Old-growth Management Area
PEM	Predictive Ecosystem Mapping
RIC	Resources Inventory Committee
SARA	Species At Risk Act
TEM	Terrestrial Ecosystem Mapping
TSF	Tailings Storage Facility
UWR	Ungulate Winter Range
VRI	Vegetation Resources Inventory (mapping)
WHA	Wildlife Habitat Area

UNITS OF MEASURE

ha	hectares
km	kilometres
m	metres

GLOSSARY

Anthropogenic	Created by people.
Bioterrain	A classification system that combines recognizable permanent terrain and landscape features with recognizable biological and inferred soil drainage characteristics.
Blue list	Refers to species and ecological communities with a conservation status of Special Concern in British Columbia.
Coniferous	Refers to trees that have needles or scales instead of leaves.
Deciduous	Refers to trees that have broad leaves that are shed in the fall.
Duff	The litter layer of fallen leaves, small twigs, needles and other plant debris on the surface of the soil.
Edaphic	Characteristics relating to soils
Emergent	Refers to a plant that is rooted in a waterbody and grows out of the water (e.g., cattail).
Ephemeral	Refers to a habitat feature that is not always present (e.g., an ephemeral waterbody only contains water at certain times of the year).
Extirpated	Refers to a species that is no longer present in a particular area but still exists elsewhere (i.e., is not extinct).
Gastropod	A class of molluscs that includes slugs and snails.
Generalist	Refers to an organism that uses a variety of foods or habitats.
Mustelid	A member of the weasel family.
Non-vascular plants	Mosses, liverworts and lichens.
Raptor	Species of predatory birds that have a hooked beak and feet with talons.
Red list	Refers to species and ecological communities with a conservation status of Extirpated, Endangered, or Threatened in British Columbia.
Riparian	Refers to the terrestrial ecosystems adjacent to a water body that are influenced by the presence of the water body.
Rut	The mating season of ungulates.
Seral	Refers to the stages of ecological succession.

GLOSSARY (Cont'd)

Snag	A standing dead tree.
Terrestrial Ecosystem Mapping	A provincial standard system of mapping that uses bioterrain characteristics combined with vegetation cover to delineate terrestrial ecosystems.
Ungulate	A hoofed mammal; in this report includes deer, moose and caribou.
Vascular plants	Trees, shrubs, grasses, herbs, and forbs.
Veteran	Refers to a large old tree that is older and larger than the surrounding trees and has survived previous disturbances.

1 INTRODUCTION

Early on August 4, 2014, a tailings dam failure occurred at Mount Polley Mine (MPM) causing water and tailings to be released. SNC-Lavalin was retained to prepare an assessment of the impacts on terrestrial ecosystems, vegetation and wildlife. Those impacts include an assessment of the immediate physical impacts of the tailings dam failure and potential long-term effects on habitats and food webs. The scope and objectives of this report are defined and described below.

1.1 Scope and Objectives

The objectives of this assessment are to:

- Characterize the ecosystems, wildlife and plant species known present or likely present in the study area before the tailings dam failure. The characterization will be focused on ecosystems and taxa that are at-risk or of regional importance.
- Describe the extent and nature of the immediate impacts of the tailings dam failure on the ecosystems, wildlife and plant species, focused on the ecosystems and taxa identified through the first objective. The effects of the ongoing remediation work are not considered in this assessment.

The long-term effects of contamination of water, soil and vegetation, will be assessed in a future Ecological Risk Assessment (ERA).

<u>Spatial and Temporal Boundaries</u>

The MPM is located within the Quesnel Highland Ecosection, which is part of the Columbia Highlands Ecoregion. The Quesnel Highland Ecosection is a highland area, situated between plateaus on the west and higher mountain ranges to the east (Demarchi 2011). Moist air flowing east from the Pacific Ocean generates considerable precipitation as either rain or snow, and cold Arctic air in the winter months can result in sub-zero temperatures for extended periods. Wet Interior Cedar – Hemlock (ICH) forests are prevalent in the valleys and lower slopes, while cold-tolerant Engelmann Spruce – Subalpine Fir (ESSF) forests dominate the upper slopes and lower mountain summits (Demarchi 2011).

Climate, as well as geological and anthropogenic processes (e.g., historic and current mining activities, forestry, and settlements) have shaped the current ecosystems and associated seral stages found in the general area. The Horsefly Sustainable Resource Management Plan (HSRMP) was led by the provincial government as part of the implementation of the Cariboo Chilcotin Land Use Plan to manage multiple interests within the general area. The plan provides detailed area-based resource targets and strategies for a number of uses, such as timber harvesting, mining, fishing, biodiversity conservation, and tourism (HSRMP 2005).

1.1.1 Study Area

The terrestrial study area (the 'study area') is 234.3 ha in total (Figure 1-1). The study area was delineated by terrain specialists from aerial imagery and from field surveys by terrain and soils specialists (see Soil Quality Impact Assessment). The terrestrial study area includes all terrestrial areas that were subjected to tailings or debris deposition or to active erosion resulting from the tailings dam failure. It does not include the Hazeltine Creek channel area (6 ha) as impacts on that area will be reported as part of the Fish and Fish Habitat Impact Assessment.

The study area is located within the ICH biogeoclimatic zone, and includes two biogeoclimatic subzone variants: the Horsefly moist cool ICH variant (ICHmk3) and the Quesnel wet cool ICH variant (ICHwk2). Brief descriptions are provided below from Steen and Coupé (1997).

The ICHmk3 occurs on gently rolling terrain along the eastern flank of the Fraser Plateau and adjacent portions of the Quesnel Highland from Quesnel Lake in the north to McNeil Lake in the south, at elevations between 780 m and 1250 m (Steen and Coupé 1997). The ICHmk3 is characterized by drier climates and absence of western hemlock (*Tsuga heterophylla*). Dominant tree species include western redcedar (*Thuja plicata*), hybrid white spruce (*Picea glauca x engelmannii*) and Douglas-fir (*Pseudotsuga menziesii*). The understory typically includes falsebox (*Paxistima myrsinites*), and moss species such as red-stemmed feathermoss (*Pleurozium schreberi*) and knight's plume (*Ptilium crista-castrensis*).

The ICHwk2 occurs in moist valleys of the Quesnel Highland and Cariboo Mountains south of Mitchell Lake, and is centred on Quesnel Lake. The ICHwk2 lies east and north of the ICHmk3 in wetter climates at similar elevations (725 m to 1250 m). Dominant tree species in this variant are western hemlock and western redcedar, as well as hybrid white spruce. Understory species include oval-leaved blueberry (*Vaccinium ovalifolium*) and bunchberry (*Cornus canadensis*), with step moss (*Hylocomium splendens*) and pipecleaner moss (*Rhytidiopsis robusta*) common in the moss layer.

1.1.2 Acknowledgements

The terrestrial wildlife and vegetation assessment was prepared by Lorraine Andrusiak, M.Sc. R.P.Bio., supervised by Shawn Hilton, B.Sc., R.P.Bio. The assessment of effects on rare plants was provided by Randy Krichbaum, M.Sc., R.P.Bio. (Eagle Cap Consulting). Andrea Paetow, R.P.Bio. contributed to fieldwork and initial drafts. Map preparation and spatial analyses were completed by Lara Hoshizaki, M.Sc., and Cameron Wallace, B.Sc. The Project Sponsor was Gordon Johnson, M.Sc., P.Eng.

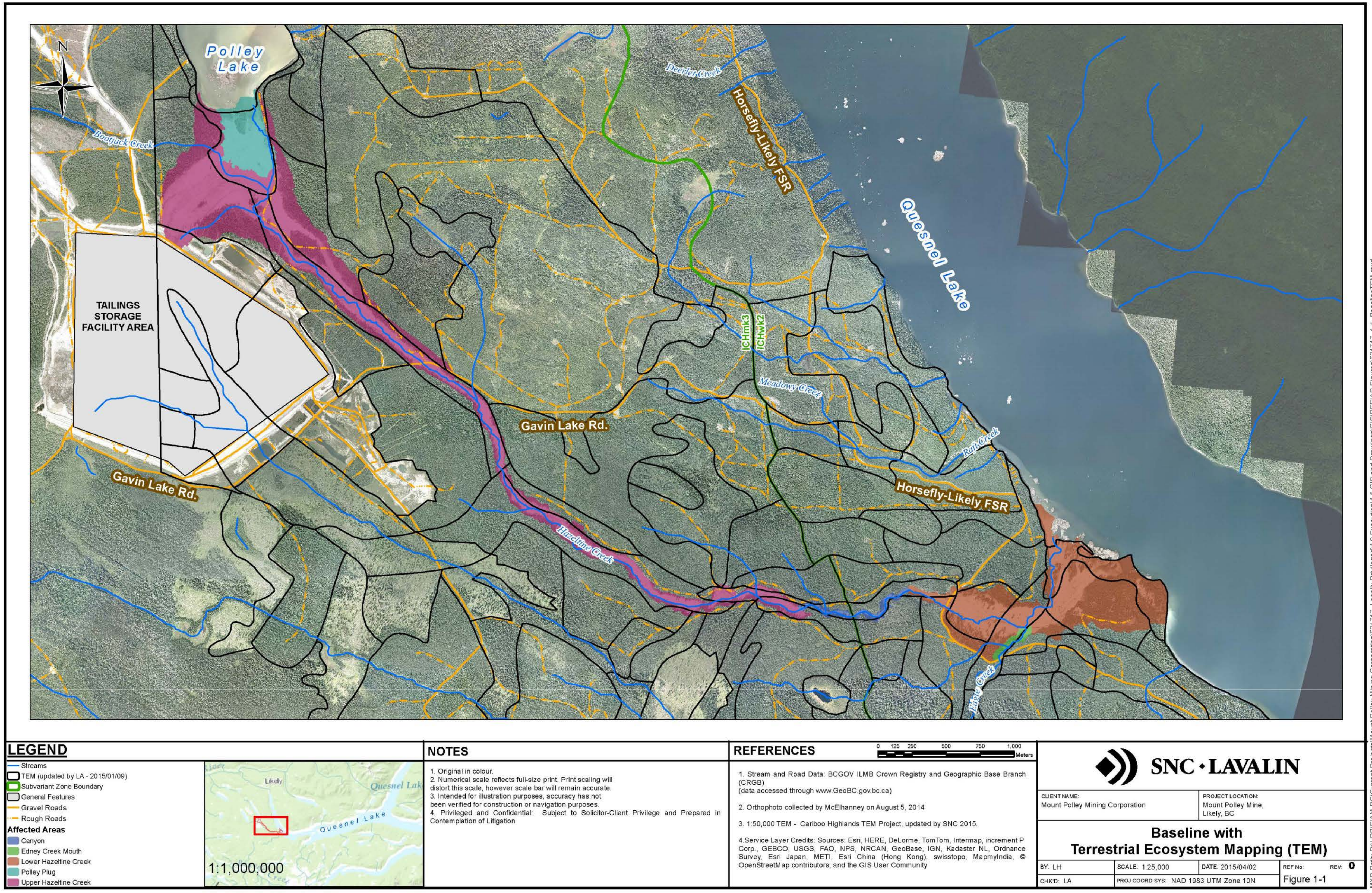

Figure 1-1: Study area

2 METHODS

Provincial wildlife and vegetation databases available through Data BC (http://maps.gov.bc.ca/ess/sv/imapbc/) were queried to locate any relevant pre-existing data for the study area. No records of terrestrial wildlife or vegetation surveys near Polley Lake or Hazeltine Creek could be located. The baseline for terrestrial wildlife and vegetation has been characterized based on:

- Field data obtained from field assessments and sampling activities occurring after the tailings dam failure in unaffected habitats just outside the borders of the study area;
- Map data from a Terrestrial Ecosystem Mapping project (Geowest 2001);
- Spatial boundaries of provincially managed habitat areas delineated within the study area, including Old Growth Management Areas (OGMAs) and high-value moose (Alces americanus) wetlands, obtained from the Province;
- Regional species checklists and known species occurrences;
- Published and unpublished literature on plants, wildlife, and wildlife use of habitat types found in the study area; and
- Professional judgement.

Focal species were selected based on methodology described in BC Ministry of Environment (2014), which includes consideration of species for which there are government legal or policy objectives or harvest management, and those that have federal or provincial status as species at risk. Information on species distribution and provincial and federal status was obtained from the BC Conservation Data Centre's website (BC Conservation Data Centre 2014a), and from Province of BC (2014). The immediate effects of the tailings dam failure on ecosystems were quantified by overlaying the extent of the study area with the ecosystem mapping and summarizing the ecosystems within the overlapping area.

2.1 Vegetation

2.1.1 Terrestrial Ecosystem Mapping

Terrestrial Ecosystem Mapping (TEM) can be used to provide quantitative information about the physical and vegetation characteristics of the study area and the impacts on habitat that occurred due to the tailings dam failure. TEM is a provincial standard method of ecosystem mapping that includes both bioterrain and ecosystem attributes (RIC 1998). Site series are described and defined by the BC Ministry of Forests as sites within a biogeoclimatic subzone or variant that are capable of producing the same mature or climax vegetation. Mapped ecosystems are typically drawn from a combination of forested site series defined in the relevant regional site series guidebook produced by the BC Ministry of Forests (e.g., Steen and Coupé 1994), wetland units defined in MacKenzie and Moran (2004), and anthropogenic/nonvegetated units defined by the BC Ministry of Environment (2008). Additional map units may be defined on a project-specific basis. The age/seral stage of a mapped ecosystem is indicated by its structural stage (Table 2-1).

Table 2-1: Structural Stage Definitions (RIC 1998)

Structural Stage	Definition
3a	**Low Shrub:** Shrubs less than 2 m tall, time since disturbance less than 20 years for normal forest succession
3b	**Tall Shrub**: shrubs less than 10 metres tall, less than 40 years old in normal forest succession
4	**Pole /Sapling**: trees greater than 10 metres tall, usually less than 40 years old
5	**Young Forest**: trees typically 40 to 80 years old
6	**Mature Forest**: trees 80 to 250 years old
7	**Old Forest**: greater than 250 years old

TEM polygons delineate distinct areas on the landscape composed of up to three different ecosystem unit/structural stage combinations. TEM was completed in 2001 at 1:50,000 scale for the East Cariboo Highlands area east of Likely, and that mapping covers the eastern portion of the Mount Polley tailings facility, the southeast portion of Polley Lake, Hazeltine Creek and Quesnel Lake (Geowest 2001). Predictive Ecosystem Mapping (PEM) at 1:20,000 (2008) was also available for the Quesnel Lake area (Moon 2008). As PEM is generated from computer algorithms, while TEM polygons are characterized individually by an ecologist from aerial photographs, the TEM was chosen for use in this assessment.

Ecosystem field data were collected during sampling after the tailings dam failure occurred, in order to check the accuracy of the TEM. Plots were generally done in undisturbed vegetation just beyond the boundaries of the deposition zone. The field results were compared to the labels of the TEM polygons in which the plots were located. The map polygons within 1 km of the study area were edited to reflect structural stage changes from recent harvesting, forest growth and mine development, and some ecosystem editing was done based on the data from the field plots. Vegetation Resources Inventory (VRI) mapping was used to confirm the structural stage updates.

The study area was delineated by terrain specialists from aerial imagery and from field surveys by terrain and soils specialists (see Soil Quality Impact Assessment). The study area was overlain with the updated TEM and divided into sub-areas – remediation units - for the purpose of assessment. The ecosystems within the study area were quantified by multiplying the area of the portion of each TEM polygon within the study area by the contribution of each ecosystem decile, and summarized by affected area.

2.1.2 Rare Ecological Communities

An ecological community can be defined as a particular suite of living organisms (plants, animals, fungi, bacteria, etc.) that co-occur on particular associated environmental site characteristics including soil, landform, nutrient, and moisture regimes. At-risk ecological communities are defined and ranked by the BC Conservation Data Centre (CDC) and placed on the provincial Red or Blue list according to a number of criteria such as the degree of threat, trend in area of occupancy, number of protected and managed occurrences, intrinsic vulnerability, specificity of habitat requirements, and other considerations (BC Conservation Data Centre 2004). Forest or wetland plant communities listed by the CDC are usually – but not always – associated with one or more forest or wetland site series. The association indicates that the site series has the potential to support the community in question but the community will not necessarily be present at each occurrence of the site series. Information on at-risk plant communities potentially present within the subzone variants of the study area was obtained from the BC Conservation Data Centre (2014a).

2.1.3 Old-growth Forest and Old-growth Management Areas

Old forests provide valuable habitat for plant and animal species that prefer large-diameter trees, multi-layered stands, high densities of snags and other characteristics that require many years to develop (Richardson 2005). Old forest habitat takes a long time to regenerate once it is lost. For the purposes of this report, old-growth forest is defined as forest in structural stage 7.

The identification of Old-growth Management Areas (OGMAs) is a key component in biodiversity planning in forested areas of the province. OGMAs are areas reserved from timber harvest and are intended to help maintain the environmental and non-timber values of old forest (Biodiversity Conservation Strategy Committee 2011). The province has been divided into Landscape Units for the purposes of provincial biodiversity conservation planning, and the amount of forest to be reserved as OGMAs (OGMA 'target') is dependent on the biodiversity emphasis assigned to each Landscape Unit and on the biogeoclimatic subzones present. OGMA management in the Cariboo-Chilcotin incorporates three types of OGMAs (Biodiversity Conservation Strategy Committee 2011):

- Permanent (static) OGMAS with fixed boundaries. These OGMAs may not always be old forest as they are subject to natural disturbance, but they will remain designated as OGMAs.

- Rotating OGMAs that will be harvested and replaced, which have been established in areas with a higher frequency of large natural disturbance. Eventually, these will be replaced with permanent static OGMAs.
- Transition OGMAs are temporary and will be in place until the other contributing no-harvest areas in a landscape unit develop into old forest, or until twenty years after the Land Use Order was declared (June 2010).

The study area is located within the Polley Landscape Unit (LU), which is 44,193 ha in size and has been assigned a 'High' Biodiversity Emphasis. Permanent OGMAs have been identified within this LU along Hazeltine Creek between Polley Lake and Quesnel Lake. During OGMA establishment in 2013 it was noted that there was insufficient old forest available within the Polley LU to make up the full target for old forest (Cariboo-Chilcotin Region Higher Level Plan 2013), so the identified OGMAs consist of mature as well as old forest. The mature forest will eventually develop the structural characteristics of old growth. The spatial boundaries of the OGMAs were obtained from the provincial government and overlain with the study area to quantify the amount of OGMA affected.

For the purposes of this assessment, old forest was quantified by overlaying the revised TEM polygons with the boundaries of the study area. The area of forest mapped as structural stage 7 was summarized by remediation area.

2.1.4 Wetlands

Wetlands cover about 6% of the province and perform essential hydrological and ecological functions (BC Ministry of Forests 2000). The TEM was used to identify areas mapped as wetland ecosystems. The area of wetland within the study area was summarized.

2.1.5 Rare Plants

A preliminary list of rare plants potentially occurring within the general vicinity of MPM is presented in Appendix 1. The list was generated by querying the CDC data for Red- and Blue-listed vascular plant taxa associated with the ICHmk or ICHwk subzones. The query for mosses included taxa associated with the entire ICH zone. The list of potential rare plants includes 46 vascular plants and 25 mosses. Limited reconnaissance-level surveys were conducted by a botanist during field visits of the study area.

The habitat affinities of the potential rare plants listed in Appendix 1 were reviewed and compared with the ecosystems known to be present in the study area. Based on the community descriptions in the relevant provincial guides (Steen and Coupé 1997; MacKenzie and Moran 2004), and a site visit in October of 2014, a list of the ecosystem units with the highest potential for occurrence of rare plant species was generated and used to assess project effects.

2.2 Wildlife

Wildlife species detected during fieldwork after the tailings dam failure (e.g., reconnaissance terrestrial survey, soils monitoring surveys, construction monitoring) are listed in Table 2-2 below. That table is not a complete list of species expected to occur but indicates those that were documented in the vicinity after the tailings dam failure and are likely to be some of the more common species that use the area during fall and winter. A list of bird species expected to occur in the Cariboo region was obtained from the BC Bird Atlas (Bird Studies Canada 2014) and is presented in Appendix 2. This list includes species present in the entire region and not all of them will be, or would have been, found in the vicinity of Polley Lake.

Table 2-2: Wildlife Species Detected During Field Surveys

Scientific Name	English Name	Comments
Mammals		
Alces americanus	Moose	Observed
Odocoileus hemionus	Mule Deer	Observed
Castor canadensis	Beaver	Tracks, cuttings
Canis lupus	Gray Wolf	Tracks
Ursus americanus	Black Bear	Tracks
Puma concolor	Cougar	Tracks
Lynx canadensis	Lynx	Tracks
Vulpes vulpes	Red Fox	Observed
Lontra canadensis	River otter	Observed
Tamiasciurus hudsonicus	Red Squirrel	Observed
Lepus americanus	Snowshoe Hare	Observed
Birds		
Anas platyrhynchos	Mallard	Observed
Bucephala albeola	Bufflehead	Observed
Aythya collaris	Ring-necked Duck	Observed
Bucephala clangula	Common Goldeneye	Observed
Glaucidium gnoma	Northern Pygmy-owl	Heard

Table 2-2 (Cont'd): Wildlife Species Detected During Field Surveys

Scientific Name	English Name	Comments
Picoides villosus	Hairy Woodpecker	Observed
Dryocopus pileatus	Pileated Woodpecker	Cavities observed
Bonasa umbellus	Ruffed Grouse	Observed
Falcipennis canadensis	Spruce Grouse	Observed
Herptiles		
Thamnophis sirtalis	Common Gartersnake	Observed
Pseudacris regilla	Pacific Treefrog	Heard
Anaxyrus boreas	Western Toad	Observed
Rana luteiventris	Columbia spotted frog	Observed

2.2.1 Species at Risk

Species and ecological communities in British Columbia are assigned by the BC Conservation Data Centre to one of three lists, based on their provincial Conservation Status Rank. Red-listed species and ecological communities are Extirpated, Endangered, or Threatened in British Columbia. Blue-listed species and ecological communities are of Special Concern (formerly Vulnerable) and Yellow-listed species and ecological communities are secure (Province of BC 2015).

The list of at-risk terrestrial wildlife for the ICHwk2 and ICHmk3 subzones in the Cariboo region obtained from the BC Conservation Data Centre was refined to include only taxa for which potential habitat was present in the vicinity of the study area. For example, grizzly bear (*Ursus arctos*) was removed from consideration because grizzly bears are not managed by the province in the area west of the west arm of Quesnel Lake as the province considers the species to be extirpated from the local area (Province of BC 2014a). Mountain caribou (*Rangifer tarandus*) was removed from consideration within this assessment as caribou have been extirpated from the area west of the west arm of Quesnel Lake (Province of BC 2014a). Species at risk that are potentially present in the study area are listed in Table 2-3. Brief descriptions of each are provided below.

Table 2-3: At-Risk Terrestrial Wildlife Species Potentially Present in the Study Area

Scientific Name	Common Name	BC List	Other List
Enallagma hageni	Hagen's Bluet	Blue	-
Magnipelta mycophaga	Magnum Mantleslug	Blue	-
Anaxyrus boreas	Western Toad	Blue	SARA Schedule 1 – Special Concern
Ardea herodias herodias	Great Blue Heron, *herodias* subspecies	Blue	-
Chordeiles minor	Common Nighthawk	Yellow	SARA Schedule 1 - Threatened
Contopus cooperi	Olive-sided Flycatcher	Blue	SARA Schedule 1 - Threatened
Gulo gulo luscus	Wolverine, *luscus* subspecies	Blue	-
Myotis lucifugus	Little Brown Myotis	Yellow	SARA Schedule 1 - Endangered
Myotis septentrionalis	Northern Myotis	Blue	SARA Schedule 1 - Endangered
Pekania pennanti	Fisher	Blue	-

- Hagen's bluet (*Enallagma hageni*) is a blue damselfly that inhabits marshy lake edges, slow streams and ponds. It is associated with marsh and fen wetland types and flies in June and July (Royal British Columbia Museum and the Spencer Entomological Museum 2004).
- The magnum mantleslug (*Magnipelta mycophaga*) has rarely been detected in Canada (COSEWIC 2012a). Only 13 records of the species are known for BC, and the closest occurrence to Mount Polley is in Wells Gray Park. COSEWIC (2012a) does not list any surveys for terrestrial gastropods completed near Quesnel Lake. The magnum mantleslug has been found in moist microsites in heavily shaded coniferous forests in the ICH and ESSF biogeoclimatic zones. Individuals have been located both on the ground surface and under bark, logs or rocks. Important habitat features may include seepage sites, coarse woody debris, and undisturbed forests with intact duff layers (COSEWIC 2012a).
- The western toad (*Anaxyrus boreas*) is an amphibian that is widely distributed across the province (COSEWIC 2012b). Adult western toads may be found in a variety of habitats including grasslands, forests, shrublands, riparian areas and wetlands. Adult toads congregate to breed communally in the spring and exhibit fidelity to their breeding sites. Females lay strings of eggs

in stream margins, wetlands, river backchannels, ponds, and human-made sites such as ditches, road ruts, and tailings ponds (COSEWIC 2012b). The eggs hatch into tadpoles that metamorphose in 4-12 weeks and leave the water by late July or August. Adults may move up to several kilometres away from breeding sites, and show a strong fidelity to summer foraging sites. Adult western toads feed on invertebrates including worms (Clitellata), slugs (Gastropoda), spiders (Arachnida), bees (Hymenoptera), beetles (Coleoptera), sow bugs (Isopoda), grasshoppers (Orthoptera), caddisflies (Trichoptera), moths and butterflies (Lepidoptera), flies (Diptera), true bugs (Hemiptera), and ants (Formicidae) (reviewed in COSEWIC 2012b). Larvae eat organic detritus, filamentous algae and carrion (ibid). Adult toads hibernate underground during the winter.

- The Great Blue Heron (*Ardea herodias*) is a large wading bird that feeds on fish, amphibians, small mammals, snakes, and aquatic insects (Gebauer and Moul 2001). The *arodias* subspecies is provincially Blue-listed and is the subspecies present in the Cariboo region. Herons are present in the Cariboo region between April and November (Roberts et al. 2013). During the rest of the year, they winter in southern BC or further south. Herons are colonial nesters and build bulky stick nests in coniferous or deciduous trees. The closest known colony to the study area is the Big Lake FSR colony (Colony 502-005), which was active between 1997 and 1999 and was located 2.4 km west of the north end of Polley Lake (Great Blue Heron Management Team 2015).
- The Common Nighthawk (*Chordeiles minor*) is a brown, black and grey-mottled bird that forages aerially for flying insects. Nighthawks are migratory and may be present in the Cariboo region between the beginning of June and mid-September (Roberts et al. 2013). Nighthawks lay their eggs on the ground in sparsely-vegetated areas and may nest in disturbed sites such as roadsides, gravel pits and recent clear-cuts. They breed from May to September in BC (Campbell et al. 2006).
- The Olive-sided Flycatcher (*Contopus cooperi*) is a robin-sized songbird that frequents forest edges. It forages from a perch on a tree or snag from which it makes short flights in pursuit of flying insects. Olive-sided Flycatchers are migratory and are present in the Cariboo region between May and mid-August (Roberts et al. 2013).
- The wolverine (*Gulo gulo*) is a large mustelid that feeds on a wide variety of prey from small mammals to ungulates. The *luscus* subspecies is provincially Blue-listed and is the subspecies present in the Cariboo region. Although it is associated with high-elevation forests and large areas of wilderness, wolverine distribution is governed more by food supply than by particular habitats. It is both a generalist and an opportunist and will readily scavenge carrion. Wolverines range widely (50-100 km^2 for females and up to 1580 km^2 for males) and may become nomadic if food is scarce (COSEWIC 2014).

- The little brown myotis (*Myotis lucifugus*) and northern myotis (*M. septentrionalis*) are small insectivorous bats that roost in tree cavities, under loose bark, in buildings and in rock fissures. Although the little brown myotis has been described as the most common and widely distributed Canadian bat species (van Zyll de Jong 1985), both it and the northern myotis are now listed under SARA as endangered due to a fungal disease known as white-nose syndrome (Government of Canada 2014). The disease is not currently present in western Canada but is spreading westward from the eastern provinces. The northern myotis is very difficult to distinguish from similar species in the field and its identification must be confirmed via DNA typing. Little brown myotis and one individual field-identified as a northern myotis were captured in 2012 near Spanish Lake (approximately 11 km northeast of the mouth of Hazeltine Creek) (data file at http://a100.gov.bc.ca/pub/siwe/details.do?id=5044). A species account for little brown myotis and northern myotis is presented in Appendix 3.
- The fisher (*Pekania pennanti*) is a large mustelid or weasel. Fishers are forest-dwellers that feed primarily on small mammals. Females require cavities in large deciduous trees for use as reproductive dens. There are large-diameter *Populus balsamifera* present along Hazeltine Creek that are potential natal den sites for fishers. A fisher species account is presented in Appendix 3.

The suitability of the habitats affected by the tailings dam failure was quantified for the species at risk identified in Section 2.2 for which wildlife habitat suitability mapping at 1:50,000 is appropriate. Specifically, habitat suitability ratings were completed for fisher and northern myotis/little brown myotis (grouped as these two bat species use similar roosting habitat). Some species were not suitable candidates for habitat maps. Western toads can breed in ephemeral ponds and ditches that are not mappable at the scale of the TEM, and impacts to breeding ponds along Hazeltine Creek are described in the Fish and Fish Habitat Assessment. Great Blue Herons would primarily forage along Hazeltine Creek and the shorelines of Polley and Quesnel Lakes – also assessed within the Fish and Fish Habitat Assessment – and Olive-sided Flycatchers use tall trees or snags along forested edge habitats. Wolverines are not associated with any particular habitat types (RIC 1999), and there is insufficient information available on habitat requirements of the magnum mantleslug to rate habitat for this species. Hagen's bluet could potentially use any of the wetlands and natural waterbodies within the study area, and Common Nighthawks use sparsely-vegetated habitats for nesting.

2.2.2 Regionally-important Species

The study area is located within Wildlife Management Unit 5-02. Species of regional importance that are not classified as at risk are listed in Province of BC (2014). Those for the Cariboo region include moose, mule deer (*Odocoileus hemionus*) and Bald Eagle (*Haliaeetus leucocephalus*). Other species of economic importance include furbearers, which are commercially trapped by local residents, black bear (*Ursus americanus*), waterfowl, and game birds.

Moose are the largest ungulates native to the Cariboo region, and moose populations in this region are thought to be declining for unknown reasons (McNay et al. 2013). Moose eat a wide variety of browse and other vegetation (reviewed in Keystone Wildlife Research Ltd. 2006). Willows and other deciduous shrubs (Table 2-4) are eaten year-round and aquatic and emergent plants are consumed during the growing season (Shackleton 1999). Moose home ranges in the Cariboo region are 5 to 50 square kilometres (km^2) but 5-10 km^2 is more typical in the winter (Youds 1999). Moose rut during September and October and cows give birth to one to three calves in June (Shackleton 1999). Wolves (*Canis lupus*) and bears (*Ursus* spp.) are the main moose predators in BC (ibid).

Table 2-4: Preferred Moose Forage Plants (Keystone Wildlife Research Ltd. 2006)

Common Name	Scientific Name
Willows	*Salix* spp
Aspen	*Populus tremuloides*
Balsam poplar	*Populus trichocarpa*
Paper birch	*Betula papyrifera*
Subalpine fir	*Abies lasiocarpa*
Douglas maple	*Acer glabrum*
Red-osier dogwood	*Cornus stolonifera*
Saskatoon	*Amelanchier alnifolia*
Snowbrush	*Ceanothus velutinus*
Falsebox	*Paxistima myrsinites*
Chokecherry	*Prunus virginiana,*
Sitka mountain ash	*Sorbus sitchensis*
Hazelnut	*Corylus cornuta*
Bog birch	*Betula glandulosa*

Mule deer are widely distributed across the province and are important game animals for local communities. Mule deer are most likely to occupy the study area during the growing season as deep snowfall limits their presence during the winter. A mule deer species account is presented in Appendix 3.

The Bald Eagle is a large raptor that feeds primarily on fish, waterfowl and carrion. This species is highly adaptable and may occupy diverse habitats. Adults (>5 years of age) are easily recognized by their white head and neck that contrasts with dark body and wings. Bald Eagles in the 100 Mile House forest district nested close to water, mainly in dominant or codominant veteran Douglas-fir (*Pseudotsuga menziesii*) or black cottonwood trees (Packham 2005). Nest sites are re-used from year to year, and nest trees are protected under the BC *Wildlife Act*. One to three young are fledged annually, depending on the amount of food supplied by the parents (Beebe 1974). Management recommendations for eagle habitat in the ICH include the retention of veteran trees suitable as nest trees within 104 m of fish-bearing water (Packham 2005).

Other terrestrial wildlife species of economic importance include commonly-trapped furbearers, upland game birds, waterfowl, and black bear (*Ursus americanus*). Furbearers known or likely present in or near the study area (other than fisher and wolverine, which are discussed above) are listed in Table 2-5. Black bears are hunted by resident and non-resident hunters and are important as meat sources and as trophies for clients of guides and outfitters. Ruffed Grouse (*Bonasa umbellus)* and Spruce Grouse (*Falcipennis canadensis)* are hunted for food and for recreation.

Table 2-5: Furbearers Known or Potentially Present Near the Study Area

English Name	Scientific Name
American mink	*Neovison vison*
Ermine	*Mustela ermine*
long-tailed weasel	*Mustela frenata*
American marten	*Martes americana*
river otter	*Lontra canadensis*
Coyote	*Canis latrans*
red fox	*Vulpes vulpes*
grey wolf	*Canis lupus*
Canada lynx	*Lynx canadensis*
Bobcat	*Lynx rufus*
red squirrel	*Tamiasciurus hudsonicus*
common muskrat	*Ondontra zibethicus*
American beaver	*Castor canadensis*

Areas Managed for Wildlife

Ungulate Winter Range (UWR) and Wildlife Habitat Area (WHA) boundaries near the Mount Polley Mine were obtained from the province (Province of BC 2014a). No UWR for deer, goats, or caribou or WHAs are present within the study area. Mount Polley is located within the very deep snowpack zone where mule deer are not expected to winter (Armleder et al. 1986). The closest UWR is u-5-002, located on the east side of the west arm of Quesnel Lake, approximately 1.4 km across the lake from the mouth of Hazeltine Creek. The closest WHA is WHA 5-106 for mountain caribou, located on higher elevations north and east of Spanish Lake, approximately 17 km from the mouth of Hazeltine Creek.

High-value wetlands for moose have been mapped in the Cariboo region using methodology consistent with provincial standards for wildlife habitat ratings (Intrepid Biological Consulting 2003; Keystone Wildlife Research Ltd. 2006). The wetland mapping includes ratings for both summer and winter moose habitat. Spatial data for that mapping project were obtained from the province and overlain with the study area to quantify the amount of moose wetland habitat affected.

3 IMPACT ASSESSMENT

3.1 *Vegetation*

3.1.1 Terrestrial Ecosystems

Ecosystem Units of the Study Area

Field Surveys

An assessment of the accuracy of the TEM in the study area was done using 12 plots from the field visits on October 6-8, 2014. Twelve visual or Ground Inspection Form (GIF) plots were completed (Figure 3-1). Plots were generally done in undisturbed vegetation just beyond the boundaries of the deposition zone. The field results were compared to the labels of the TEM polygons in which the plots were located (Table 3-1). The subzone, ecosystem and structural stage of the TEM polygon matched the field plot card for five plots. One plot matched the subzone and structural stage of the TEM but was assessed as a different ecosystem than the one typed in the TEM. One plot less than 200 m from the subzone boundary matched the ecosystem (zonal) and the structural stage, but was judged to be ICHmk3 although the TEM placed it in the ICHwk2. The field data, though limited, indicate that the TEM accuracy is acceptable for the purposes of this assessment.

Table 3-1: Ecosystem Field Plots Compared to Corresponding TEM Labels

'Small Wetland' Plots	Incorrect Wetland Plots	Plots with Ecosystem and Structural Stage Correct	Plots with Subzone and Structural Stage Correct	Plots with Subzone, Ecosystem and Structural Stage Correct	Total Plots
2	3	1	1	5	12

Two plots were done in small wetlands that were minor components of a forested polygon. The labels for the associated TEM polygons did not include any wetland components, but ecosystems making up less than 20% of a polygon are not normally identified in a TEM polygon label according to standard TEM methodology (RIC 1998).

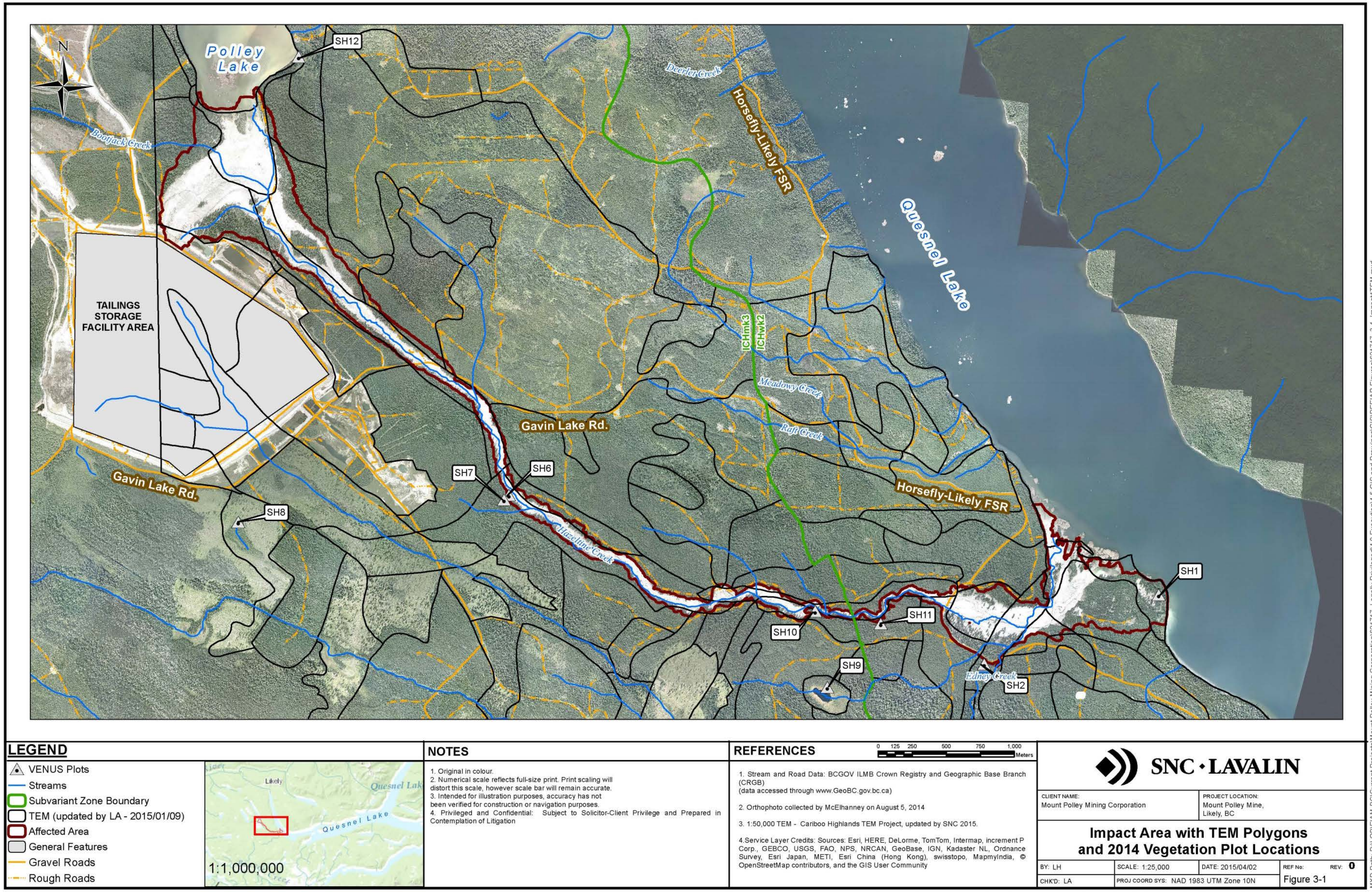

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Figure 3-1: Impact Area with 2014 Field Plots

Three plots in wetland polygons did not match the wetland type mapped. One, on the shores of Polley Lake, was identified as a Ws02 Mountain alder – Pink spirea – Sitka sedge swamp in the field but was located within the LA Lake polygon in the TEM. That disparity is likely to be a function of map scale and/or lake level fluctuation. The remaining two wetland plots were identified in the field as Wb08 Black spruce – Soft-leaved sedge – Peat-moss bog and Wb05 Black spruce – Water sedge – Peat-moss Bog/Poor Fen, but were typed in the TEM as the BS Scrub birch / sedges / peat-mosses fen. Both the Wb08 and Wb05 are sparsely-treed wetlands dominated by scrub birch, Labrador-tea, sedges and peat mosses, very similar to the description of the BS unit. The differences in the map units and the field plots reflect the often-overlapping characteristics of many wetland ecosystems.

Summary of Affected Ecosystems

The total area of terrestrial ecosystems affected by inundation and/or erosion was 234.3 ha (see Section 1.1.1). The ecosystems within the study area are summarized in Table 3-2 below.

Table 3-2: Summary of Ecosystems in the Study Area

<table>
<tr><th>Affected Area</th><th>Biogeoclimatic Subzone Variant</th><th>Ecosystem Name (Site Series)</th><th>Ecosystem Symbol and Structural Stage</th><th>Total (ha)</th></tr>
<tr><td rowspan="6">Canyon Hazeltine Creek</td><td rowspan="4">ICHmk3</td><td rowspan="3">CwSxw-Falsebox-Knight's Plume (01)</td><td>RF6</td><td>1.6</td></tr>
<tr><td>RF7</td><td>0.2</td></tr>
<tr><td>RFs5</td><td>0.1</td></tr>
<tr><td>SxwCw-Oak fern (05)</td><td>SF6</td><td>0.3</td></tr>
<tr><td rowspan="2">ICHwk2</td><td>CwHw-Oak fern (01)</td><td>HO6</td><td>2.1</td></tr>
<tr><td>Sxw-Twinberry-Oak fern (06)</td><td>ST6</td><td>0.4</td></tr>
<tr><td rowspan="2">Edney Creek Mouth</td><td rowspan="2">ICHwk2</td><td>CwHw-Oak fern (01)</td><td>HO4</td><td>0.7</td></tr>
<tr><td>Sxw-Twinberry-Oak fern (06)</td><td>ST6</td><td>1.6</td></tr>
<tr><td rowspan="9">Lower Hazeltine Creek</td><td rowspan="9">ICHwk2</td><td rowspan="5">CwHw-Oak fern (01)</td><td>HO4</td><td>6.6</td></tr>
<tr><td>HO5</td><td>0.2</td></tr>
<tr><td>HO6</td><td>2.4</td></tr>
<tr><td>HO7</td><td>0.1</td></tr>
<tr><td>HOn6</td><td>12.8</td></tr>
<tr><td>CwHw-Devil's club-Lady fern (07)</td><td>RD4</td><td>17.5</td></tr>
<tr><td>SxwCw-Oak fern (05)</td><td>SO4</td><td>7.5</td></tr>
<tr><td>Sxw-Twinberry-Oak fern (06)</td><td>ST6</td><td>22.2</td></tr>
<tr><td>Willow-Red-osier dogwood floodplain (00)</td><td>WDn3b</td><td>5.5</td></tr>
</table>

Table 3-2 (Cont'd): Summary of Ecosystems in the Study Area

Affected Area	Biogeoclimatic Subzone Variant	Ecosystem Name (Site Series)	Ecosystem Symbol and Structural Stage	Total (ha)
Polley Plug	ICHmk3	Scrub birch-Sedge-Sphagnum (00)	BS3a	3.0
		Lake (00)	LA	1.9
		CwSxw-Devil's club-Horsetail (07)	RHp6	12.0
		CwSxw-Oak fern-Cat's tail moss (04)	SO6	0.1
			SO7	0.1
Upper Hazeltine Creek	ICHmk3	Scrub birch-Sedge-Sphagnum (00)	BS3a	1.9
		Lake (00)	LA	0.4
		Mine (00)	MI	2.1
		CwHw-Devil's club-Lady fern (06)	RD7	9.2
		CwSxw-Falsebox-Knight's Plume (01)	RF4	2.2
			RF5	0.1
			RF6	23.9
			RF7	1.5
			RFs5	0.5
		CwSxw-Devil's club-Horsetail (07)	RHp6	7.5
		SxwCw-Oak fern (05)	SF6	12.2
			SF7	18.5
		CwSxw-Oak fern-Cat's tail moss (04)	SO4	4.1
			SO5	3.0
			SO6	33.7
			SO7	11.3
		Snowberry-Red-osier dogwood floodplain (00)	WD3a	3.1
Grand Total				**234.3**

As described in the Soil Quality Impact Assessment, the tailings dam failure removed existing vegetation, altered soil conditions, and changed hydrologic flow patterns within the study area. This creates conditions for early seral plant species (both native and non-native) to colonize these areas. As succession proceeds, the native early-colonizers are typically replaced with mid- and late-seral species, but some of the non-natives can persist and affect plant community structure and composition for years. Invasive weed species that have been documented at the MPM (Mount Polley Mining Corporation 2013, 2014) include oxeye daisy (*Chrysanthemum leucanthemum*), white cockle (*Lychnis alba*), thistles (*Cirsium* spp.), curled dock (*Rumex crispus*), scentless camomile (*Matricaria maritima*), pigweed (*Amaranthus retroflexus*), Dalmatian toadflax (*Linaria dalmatica*), pineapple weed (*Matricaria discoidea*), yellow hawkweed (*Hieracium* spp.), and dandelion (*Taraxacum officinale*).

It is difficult to predict how the altered soil conditions in the study area will affect primary succession in terms of the plant communities that will develop. 'Tremendous variability in succession' has been noted following large-scale disturbances (Turner et al. 1998). In general, disturbance (including both anthropogenic disturbance and natural events such as landslides) promotes the establishment of non-native weedy species (Hobbs and Huenneke 1992; Walker et al. 2009), and it is reasonable to assume that this will likely be the case in the study area. Ongoing reclamation activities that consider the processes of succession of natural disturbances (Polster 2009) should help to control the establishment and spread of weeds, and promote restoration of functional ecosystems that are resistant to non-native species invasion.

As described in the Soil Quality Impact Assessment, changes to soil thermal and moisture regimes are expected to occur. Those alterations as well as differences in topsoil distribution will affect the decomposition of organic matter and nutrient cycling, which may have long-term impacts related to plant nutrient availability and ecological function. Where topsoil has been inundated, the availability of its nutrients to plants and to soil fauna would be expected to diminish as the thickness of the deposited tailings layer increases, as thicker deposits will bury the topsoil layer beyond the rooting depths of most species. Analysis presented in the Soil Quality Impact Assessment indicates that the tailings in the study area have higher pH levels, lower soil nutrient levels, and increased metal concentrations compared to the background soils immediately adjacent. This altered edaphic environment, especially when combined with the physical landform modifications such as scouring and changes in drainage, is expected to affect the future regeneration of ecosystems in the study area. The long-term impacts on ecosystems will be the subject of the ERA.

3.1.2 Rare Ecological Communities

One Red-listed and two Blue-listed communities are defined for the mapped ecosystems within the ICHmk3 subzone variant that overlap the study area (BC Conservation Data Centre 2014a). None of the mapped ecosystems within the ICHwk2 subzone that overlap the study area are provincially listed as at-risk. Brief descriptions of each of the at-risk ecological communities are provided below.

Scrub Birch / Sedges / Peat-Mosses

This fen community is provincially Red-listed, and has not been associated with a particular site series in the ICHmk3 by the CDC. A site description provided by the CDC (2014b) is as follows:

> This is a wetland community with very low productivity. The soils are organic and seepage is commonly present above 20 cm. It occurs in areas of cold-air ponding or cold air drainage (Delong 2003).
>
> *Pinus contorta* (lodgepole pine) cover does not usually exceed five percent. Shrub cover is low to moderate, consisting of *Betula nana* (scrub birch), *Lonicera involucrata* (black twinberry), [*Rhododendron groenlandicum* (Labrador-tea)] and various willows. The herb cover may be as high as seventy percent, dominated primarily by *Carex* spp. (sedges). Other herbs present may include *Equisetum arvense* (common horsetail), *Senecio triangularis* (arrow-leaved groundsel), and *Gaultheria hispidula* (creeping snowberry). The moss layer is well developed with up to 65 percent cover, dominated by *Sphagnum* spp. (sphagnum species), *Pleurozium schreberi* (red-stemmed feathermoss), and *Aulacomnium palustre* (glow-moss).

A similar wetland TEM unit was mapped in the ICHmk3. The BS Scrub birch-Sedge-Sphagnum wetland is briefly described in the TEM expanded legend (Geowest Environmental Consultants Ltd. 2001) as a nutrient-poor organic wetland in depressions with a near surface water table. It is dominated by sphagnum mosses, scrub birch and sedges, and associate species are listed as Labrador-tea, marsh cinquefoil and bog cranberry. There are 4.9 ha mapped as the ICHmk3 BS unit within the study area, in the Polley Plug and Upper Hazeltine affected areas. It cannot be confirmed that the now-removed BS wetlands contained the Red-listed wetland community but it is possible given the similarity of the two ecosystems.

Western Redcedar / Oak Fern / Electrified Cat's-Tail Moss

This forested community is provincially Blue-listed and is associated with the 04 site series in the ICHmk3 subzone. A site description of the 04 site series is provided by Steen and Coupé (1997):

> ...occurs on sites that are slightly more moist (mesic-subhygric) than zonal sites. They occur primarily on mid and lower slope positions where they receive low volumes of intermittent seepage. Soils are frequently mottled and forest floors are relatively thick (7 - 12 cm). The forest canopy is moderately closed and dominated by redcedar, with subalpine fir and hybrid white spruce in the lower canopy. Regeneration is dominated by redcedar and is often moderately dense. In addition to species common on zonal sites, characteristic species on these sites include devil's club [*Oplopanax horridus*], oak fern [*Gymnocarpium dryopteris*], rosy twistedstalk [*Streptopus lanceolatus*], and sweet-scented bedstraw [*Galium triflorum*]. The moss layer is typically well developed and dominated by electrified cat's-tail moss [*Rhytidiadelphis triquetris*], woodsy ragged moss [*Brachythecium hylotapetum*], and leafy mosses [*Mnium* spp.].

The 04 site series in the ICHmk3 subzone variant was mapped as the SO map unit. In total, 53.4 ha of the SO ecosystem was mapped in the study area, in the Polley Plug and Upper Hazeltine Creek remediation units.

Western Redcedar / Falsebox

This forested community is provincially Blue-listed and is associated with the 01 site series in the ICHmk3. The 01 site series is the most common site series within a biogeoclimatic subzone variant. A description of the 01 site series is provided by Steen and Coupé (1997):

> ...dominates the ICHmk3 landscape. It occurs on gentle to moderately sloping terrain with deep, medium-textured soils. Late seral and climax stands have closed canopies dominated by western redcedar and subalpine fir. Hybrid white spruce is frequently scattered throughout the stand. Western hemlock rarely occurs in the overstory and only occasionally occurs in the understory. A very dense cover of redcedar and subalpine fir regeneration is a characteristic. Seral stands are frequently dominated by Douglas-fir and lodgepole pine. Paper birch [*Betula papyrifera*] is frequently present in seral stands and occasionally forms nearly pure stands. The undergrowth, except for the dense regeneration layer, contains a moderate to sparse cover of falsebox and black huckleberry [*Vaccinium membranaceum*] as well as several forbs including wild sarsaparilla [*Aralia nudicaulis*], foamflower [*Tiarella trifoliata*], queen's cup [*Clintonia uniflora*], bunchberry, twinflower [*Linnaea borealis*], and five-leaved bramble [*Rubus pedatus*]. Ferns are generally lacking. The moss layer usually forms a nearly continuous carpet dominated by red-stemmed feathermoss, step moss, and knight's plume.

The 01 site series was mapped as the RF map unit. In total, 29.5 ha of RF was mapped in the study area, in the Polley Plug, Canyon Hazeltine Creek and Upper Hazeltine Creek affected areas.

In summary, the total area of the study area mapped as site series associated with Blue-listed forested communities is 81.9 ha (Table 3-2). An additional 4.9 ha may have been a Red-listed wetland community.

3.1.3 Old-growth Forest and Old-Growth Management Areas

OGMA targets for the Polley Landscape Unit were met before the tailings dam failure (C. Webb, pers. comm. 2015). Designated permanent OGMAs along Hazeltine Creek, Bootjack Creek and Edney Creek were affected by the tailings dam failure as observed during field visits, ranging in intensity from complete loss (erosion of the soil and/or loss of all vegetation cover, including trees) to deposition of a shallow layer of tailings on the ground surface with retention of tree and shrub cover.

The area of OGMA within the study area totals slightly over 200 ha. A summary of the amount of OGMAs affected is provided in Table 3-3 below, and in Figure 3-2.

Table 3-3: Summary of Old Growth Management Areas in the study area

Affected Area	Biogeoclimatic Subzone Variant		Grand Total (ha)
	ICHmk3	ICHwk2	
Canyon Hazeltine Creek Total	2.2	2.5	4.7
Edney Creek Mouth Total	0.0	2.3	2.3
Lower Hazeltine Creek	0.0	51.8	51.8
Polley Plug Total	15.3	0.0	15.3
Upper Hazeltine Creek Total	126.3	0.0	126.3
Grand Total	**143.8**	**56.6**	**200.3**

Old growth (structural stage 7) mapped in the study area (both within and outside of OGMAs) totalled 41 ha. Tailings deposition may affect old forest values in the OGMAs through several pathways. Depending on the depth of the deposition layer, the survival of certain individual trees may be threatened. Research on flood events in riparian zones suggest that certain species tolerate alluvial deposition better than others (Stone and Vasey 1968; Hukusima and Yoshikawa 1997). Tree species adapted to repeated alluvial deposition, such as cottonwoods, would be expected to resist the effects of tailings deposition better than non-riparian species. Cottonwoods develop adventitious roots in response to deposition events, which research suggests may play a role in their survival (Schier and Campbell 1976; Krasny et al. 1998; Yoshikawa and Hukusima 1997).

Figure 3-2: OGMAs and High-Value Wetlands Affected by the Tailings Dam Failure

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3.1.4 Wetlands

The only wetland mapped within the study area is the 00/BS (Scrub birch/ Sedges/ Peat-mosses) unit. The study area includes 4.9 ha of this ecosystem, in both the ICHmk3 and ICHwk2 subzone variants (Table 3-2).

3.1.5 Rare Plants

Impacts on specific rare plant occurrences cannot be quantified due to the physical changes in the study area resulting from the tailings dam failure. There are no occurrence records for rare plants within the study area; however, no rare plant surveys are known to have been performed there before the tailings dam failure. No rare plants were detected during reconnaissance field surveys in and around the study area following the tailings dam failure, but the timing of the surveys was poor, as most plants are dormant or senescent at the beginning of October. Based on the review of rare plant habitat affinities, it was determined that six ecosystem units had the highest potential for occurrence of rare plant species (Table 3-4). These were primarily the wetter site series (hygric to hydric soils) associated with creeks, lakes and wetlands. A total of 85.8 ha in the study area were mapped as higher-potential rare plant habitats. It should be noted that this is only a coarse-level analysis of rare plant potential. It has not been conclusively determined that rare plants occur in the identified ecosystems, or that they would not be found in the lower-potential ecosystems.

Table 3-4: Ecosystems in the Study Area with a Higher Potential for Occurrence of Rare Plants

Remediation Unit	Biogeoclimatic Subzone Variant	Ecosystem Name (Site Series)	Ecosystem Symbol and Structural Stage	Total (ha)
Edney Creek Mouth	ICHwk2	Sxw-Twinberry-Oak fern (06)	ST6	1.6
Lower Hazeltine Creek	ICHwk2	CwHw-Devil's club-Lady fern (07)	RD4	17.5
		Sxw-Twinberry-Oak fern (06)	ST6	22.2
		Willow-Red-osier dogwood floodplain (00)	WDn3b	5.5
Polley Plug	ICHmk3	Scrub birch-Sedge-Sphagnum (00)	BS3a	3.0
Polley Plug	ICHmk3	Lake (00)	LA	1.9
		CwSxw-Devil's club-Horsetail (07)	RHp6	12.0

Table 3-4 (Cont'd): Ecosystems in the Study Area with a Higher Potential for Occurrence of Rare Plants

Remediation Unit	Biogeoclimatic Subzone Variant	Ecosystem Name (Site Series)	Ecosystem Symbol and Structural Stage	Total (ha)
Upper Hazeltine Creek	ICHmk3	Scrub birch-Sedge-Sphagnum (00)	BS3a	1.9
		Lake (00)	LA	0.4
		CwHw-Devil's club-Lady fern (06)	RD7	9.2
		CwSxw-Devil's club-Horsetail (07)	RHp6	7.5
		Snowberry-Red-osier dogwood floodplain (00)	WD3a	3.1
Grand Total				**22.1**

Potential effects of the tailings dam failure on rare plants include:

- removal of existing rare plant occurrences in the tailings deposition zone;
- reduced extent and/or vigour of existing rare plant occurrences;
- reduced long-term viability of existing rare plant occurrences; and
- reduced suitability of unoccupied rare plant habitat.

If rare plants were present in the study area, The largest impacts to rare plant occurrences (if any) would have likely taken place immediately following the tailings dam failure when occurrences were removed due to burial or scouring.

Rare plants, if any, surviving in the study area would face altered habitat conditions in some areas that could reduce their viability. Rare plants are often habitat specialists and require a narrow range of edaphic, biotic, and climatic conditions to survive (Williams et al. 2009; Lomba *et al*. 2010). Comparative soil analyses of the tailings deposits indicate that, compared to the background soils immediately adjacent, the tailings show higher pH levels, lower soil nutrient levels, and increased metal concentrations. This altered edaphic environment, especially when combined with the physical modifications brought about by the tailings dam failure, would be expected to reduce the viability, and perhaps eliminate, rare plant occurrences remaining in the study area.

Likewise, the suitability of any existing unoccupied rare plant habitat in the study area would have been altered by the tailings dam failure. Tailings deposition, vegetation removal, and topsoil scouring have dramatically changed the land's potential to support colonization by rare plants. The range of potential impacts to rare plants from tailings deposition on topsoil resources will likely vary depending on the rooting depths of the species. However, the exact nature of these changes on future habitat suitability is difficult to predict. Studies on large infrequent disturbances show that primary and secondary succession following major disturbance events such as landslides and volcanic eruptions is often complex and proceeds in unexpected ways (Turner et al. 1998; Crisafulli et al. 2005). Rare plant habitat suitability would be expected to develop over time along similar complex pathways.

3.2 Wildlife

Potential effects of the tailings dam failure on wildlife include:

- habitat loss from tailings deposition and erosion;
- mortality from burial by tailings and debris;
- changes to food supply from effects to fish and other aquatic prey; and
- adverse health effects from exposure to increased levels of metals.

Interim results from the Geochemical Characterization of Spilled Tailings report [SRK Consulting (Canada) Inc. 2015] indicate that the tailings are not acid-generating or leachable. The potential for long-term effects on wildlife from changes to soil chemistry and exposure to metals will be addressed as part of the ERA planned for later in 2015.

The flood of tailings and debris from the tailings dam failure would likely have resulted in some degree of wildlife mortality but the extent of that mortality is impossible to quantify. Large and/or highly mobile species may have been able to avoid the flow but small species such as amphibians, snakes and small mammals (especially burrowing species) may not have been able to escape the flow from the tailings dam failure. Some organisms would likely have survived on refugia (e.g., undisturbed 'islands', in or on trees that remained standing, inside large logs) providing sources for recolonization of the area. Variations in topography would have resulted in corresponding variation in impacts, with differences in the amount of debris deposited. More wildlife would likely have survived where thinner layers were deposited by the debris flow (Crisafulli *et al.* 2005).

The tailings dam failure occurred on August 4, a date when most bird species in the area have already completed nesting for the year (Environment Canada 2014). Impacts on active nests are less likely than if the failure had occurred earlier in the growing season. Ground nests – such as those of Common Nighthawk - in the flow path would have been lost. Elevated nests – potentially including those of Olive-sided Flycatcher - may have been lost when shrubs and trees were uprooted by the flow and by erosion (Figure 3-3). Falling trees may have resulted in mortality of tree-roosting bats. Wildlife mortality was not observed, but it cannot be discounted, as any remains of small animals would likely have been buried under sediment and debris.

Figure 3-3: Large *Populus* Uprooted by Erosion along Stream Channel

3.2.1 Species at Risk

The impacts on species at risk cannot be quantified as no previous detailed surveys occurred before the tailings dam failure to document species presence and assess specific habitat suitability in the study area affected by the dam failure. The list of at-risk species potentially affected (see 2.2.1) is based on potential occurrence. Species presence and the timing and duration of their residence in the study area will vary according to habitat characteristics as well as factors such as natural and anthropogenic mortality, social interactions, timing of life history events, seasonal and inter-annual variation in habitat use, population cycling, migration routes and timing, and weather. Habitat losses can be directly quantified and can help guide mitigation strategies that increase, enhance, or replace the habitat degraded.

The likelihood of direct mortality of species at risk from the physical effects of the tailings dam failure can be inferred from the habitat types lost. Western toads were documented near the study area during field visits (see Table 2-2) and were probably present in the affected habitats. Their presence suggests they could recolonize the study area if suitable habitat was restored. The beaver ponds documented in Hazeltine and Edney creeks (see Fish and Fish Habitat Assessment) may have provided breeding habitat for toads. Toads are slow-moving and it is likely that individual animals were buried by the flood of sediment and debris. Sediment can bury and smother amphibian eggs, and increased sediment loads were found to decrease survival of western toad tadpoles under laboratory conditions (Wood 2007).

Hagen's bluet may also have used the wetlands within the study area, but the range of this species is poorly documented and there are no records for it in the vicinity of MPM. The lack of available data on distribution and habitat of the magnum mantleslug precludes an assessment of potential impacts of habitat loss on this species.

The large old trees found in older riparian forests are attractive as roosting habitat for bats (Barclay and Kurta 2007). Tree-roosting bats may have been killed when large trees were uprooted (Figure 3-3) during the debris flow. Mortality to the other species listed in Table 2-3 from the physical effects of the tailings dam failure is less likely as the remaining species would have been able to escape the flow.

The potential for effects on Great Blue Herons due to habitat loss is considered to be low as no nesting colonies were known to be affected. Changes in fish and amphibian numbers or availability may affect the food supply for Great Blue Herons at the local level (Hazeltine Creek). There may be impacts of the tailings dam failure on recruitment of the Polley Lake population of Rainbow Trout (*Oncorhynchus mykiss;* see Fish and Fish Habitat Impact Assessment). Herons take a variety of fish species as prey and the level of dependence of local herons on Rainbow Trout in particular is unknown. The potential for long-term effects on herons will be assessed in the ERA.

Loss of treed habitats will decrease the amount of potential nesting habitat available for Olive-sided Flycatcher. Conversely, the loss of vegetation cover may produce nesting habitat suitable for Common Nighthawks, which are known to nest on gravelled areas, log sorts, abandoned industrial areas and other habitats with bare soil and sparse vegetation (Campbell et al. 2006).

The potential for effects on wolverines due to habitat loss is low. Wolverines travel widely in search of food and are not restricted to particular habitat types (COSEWIC 2014). The study area is very small in proportion to the size of a wolverine's home range.

The habitat suitability for fishers within the study area is presented in Table 3-5. Approximately 90 ha of moderate-suitability fisher reproducing habitat was present in the study area. Female fishers in BC occupy home ranges that are generally over 23 km^2 in size (Weir and Almuedo 2010).

Table 3-5: Habitat suitability for fisher (Reproducing-birthing)

Habitat Suitability Rating	Area Affected (ha)
Moderate	87.7
Low	86.2
Nil	60.4
Grand Total	*234.3*

The habitat suitability for the little brown myotis and northern myotis within the study area is presented in Table 3-6. Approximately 88 ha of high-suitability and 87 ha of moderate-suitability security-thermal (roosting) habitat were present in the study area. Habitat losses of this magnitude are not anticipated to affect regional populations of little brown myotis or northern myotis.

Table 3-6: Habitat suitability for *Myotis* bats (security-thermal)

Habitat Suitability Rating	Area Affected (ha)
High	87.6
Moderate	86.8
Low	42.0
Nil	17.9
Grand Total	*234.3*

Little brown myotis and northern myotis forage on flying insects, including the adult stages of aquatic insects such as caddisflies. Aquatic insect numbers may potentially be affected by changes in water quality such as increased sedimentation (See Fish and Fish Habitat Impact Assessment).

3.2.2 Regionally-important Species

Tailings were deposited over a polygon of identified moose habitat at the south end of Polley Lake (Figure 3-2). The 25.3 ha polygon had been rated as Class 3 (Moderate) for both winter capability and suitability, and as Class 2 (moderately high) summer suitability. The moose habitat polygon overlaps with a TEM polygon mapped as 80% RH (CwSxw-Devil's club-Horsetail) in structural stage 6 (mature forest) and 20% BS (Scrub birch-Sedge-Sphagnum) in structural stage 3a (low shrub). The loss of the wetland may affect the local movement patterns of individual moose but is not expected to affect regional moose populations.

The growing-season habitat suitability for mule deer within the study area is presented in Table 3-7. Approximately 53 ha of moderately-high suitability security-thermal habitat and 163 ha of moderate-suitability security-thermal habitat was present in the study area. There were 62 ha of moderately-high suitability feeding habitat and 114 ha of moderate-suitability feeding habitat in the study area. Ungulate winter ranges are considered critical habitats for ungulates (Safford 2004) but growing season habitat is not usually considered limiting for mule deer in BC. The loss of growing-season habitat due to the tailings dam failure is not expected to affect regional deer populations. No winter range for mule deer has been identified in the study area.

Table 3-7: Habitat Suitability for Mule Deer in the Growing Season

Habitat Suitability Rating	Area Affected (ha)
Security-Thermal Habitat	
2	53.0
3	163.4
4	13.5
6	4.4
Grand Total	*234.3*
Feeding habitat	
2	61.5
3	114.2
4	56.1
6	2.3
Grand Total	*234.2*

No Bald Eagle nests were documented in the study area before the failure occurred but due to lack of previous surveys, the possible presence of a nest cannot be ruled out. Eagles may use a variety of treed habitats as roosting sites. The loss of roosting habitat is not likely to affect eagle numbers. Changes in fish numbers or availability (see Fish and Fish Habitat Assessment) may also affect eagles. Bald Eagles can take a variety of fish species as prey (Blood and Anweiler 1994) and the importance of Rainbow Trout in the diet of eagles that use the study area is unknown.

Polley Lake, Edney Creek and Hazeltine Creek would have provided suitable habitat for beaver and for river otter. Both species are mainly restricted to waterbodies and the riparian habitats around them. Beaver ponds were noted in Edney Creek and in Reach 2 of Hazeltine Creek (see Fish and Fish Habitat Impact Assessment). Mortality of beavers from the debris flow is possible although the numbers of animals lost cannot be confirmed. An average of five animals per colony is used when assessing beaver populations in the province (Hatler and Beal 2003).

The other furbearer species listed in Table 2-5) may also have used the forested habitats that were present within the study area. The physical habitat changes from the tailings dam failure are unlikely to result in population impacts to furbearers at the regional scale. Local effects are possible for species with relatively small home ranges, such as red squirrels, and those that are associated with riparian habitats, such as beaver and mink. Quantification of shoreline and aquatic habitats affected by the dam failure is provided in the Fish and Fish Habitat Impact Assessment and is reproduced in Table 3-8: Areas of Aquatic and Riparian Habitat Affected by the Tailings Dam Failure (from Fish and Fish Habitat Impact Assessment).

Table 3-8: Areas of Aquatic and Riparian Habitat Affected by the Tailings Dam Failure (from Fish and Fish Habitat Impact Assessment)

Water Body	Area of Aquatic Habitat Affected (m^2)	Area of Riparian Habitat Affected (m^2)	Length of Shoreline Affected (m)	Littoral Area Affected (m^3)
Hazeltine Creek	62,616	712,741	-	-
Edney Creek	2,390	20,215	-	-
Quesnel Lake	-	-	2,081	94,394

Black bears are generalists in terms of both their habitat use and diet. Bears have been sighted in the Hazeltine Creek channel during restoration work. The study area is no longer suitable as bear foraging habitat. If the study area is revegetated with bear forage species (either naturally or through remediation planting), bears may be attracted to the study area for feeding. Bears that use open areas are at greater risk of being killed by legal or illegal hunting unless access management is employed to restrict human access to the study area (Cristescu et al. 2012).

The grouse in the study area can use a variety of forested habitat types. The tailings dam failure has resulted in habitat losses for grouse. The habitat effects are not likely to result in effects to regional populations based on the size of the study area and the amount of alternative habitat available. There may be impacts to waterfowl related to the changes in aquatic systems, including changes in numbers and availability of some forage fish species (see Aquatic Impact Assessment and Fish and Fish Habitat Impact Assessment).

Areas Managed for Wildlife

No Wildlife Habitat Areas or Ungulate Winter Ranges were affected as none have been delineated by the province within 1 km of the study area boundaries.

4 RECOMMENDATIONS FOR ADDITIONAL WORK

The duration of the impacts of the tailings dam failure to ecosystems and wildlife will be dependent on the nature and success of the remediation works. The characterization of terrestrial effects should be reassessed once the remediation plan is completed. The potential effects of changes in levels of metals in water and soil are still undetermined. The ERA will consider the implications of these changes on terrestrial ecosystems and wildlife at a future date.

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6 PERSONAL COMMUNICATIONS

Webb, C. Land and Resource Specialist, Ministry of Forests, Lands and Natural Resource Operations, Williams Lake, B.C. Email to L. Andrusiak, SNC-Lavalin. March 23, 2015.

7 CLOSURE

This report was prepared based on objectives and available information at the time of writing.

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APPENDIX 1

Rare Vascular Plants and Mosses Potentially Occurring Within the General Area

Rare Vascular Plants and Mosses Potentially Occurring Within the General Area

Scientific Name	Common Name	BC List	Comments
Agastache urticifolia	Nettle-leaved Giant-hyssop	Blue	Vascular plant
Agoseris lackschewitzii	Pink Agoseris	Blue	Vascular plant
Antennaria corymbosa	Flat-top Pussytoes	Red	Vascular plant
Botrychium crenulatum	Dainty Moonwort	Blue	Vascular plant
Botrychium montanum	Mountain Moonwort	Red	Vascular plant
Botrychium simplex var. *compositum*	Least Moonwort	Blue	Vascular plant
Carex crawei	Crawe's Sedge	Blue	Vascular plant
Carex geyeri	Elk Sedge	Blue	Vascular plant
Carex membranacea	Fragile Sedge	Blue	Vascular plant
Carex tenera	Tender Sedge	Blue	Vascular plant
Castilleja gracillima	Slender Paintbrush	Blue	Vascular plant
Chenopodium atrovirens	Dark Lamb's-quarters	Red	Vascular plant
Cryptantha ambigua	Obscure Cryptantha	Blue	Vascular plant
Delphinium sutherlandii	Sutherland's Larkspur	Blue	Vascular plant
Dicentra uniflora	Steer's Head	Blue	Vascular plant
Dryopteris cristata	Crested Wood Fern	Blue	Vascular plant
Eleocharis elliptica	Elliptic Spike-rush	Blue	Vascular plant
Elodea nuttallii	Nuttall's Waterweed	Blue	Vascular plant
Epilobium halleanum	Hall's Willowherb	Blue	Vascular plant
Epilobium x treleasianum	Trelease's Hybrid Willowherb	Blue	Vascular plant
Floerkea proserpinacoides	False-mermaid	Blue	Vascular plant
Galium labradoricum	Northern Bog Bedstraw	Blue	Vascular plant
Gayophytum humile	Dwarf Groundsmoke	Blue	Vascular plant
Gentianopsis macounii	Macoun's Fringed Gentian	Blue	Vascular plant
Hypericum scouleri ssp. *nortoniae*	Western St. John's-wort	Blue	Vascular plant
Juncus confusus	Colorado Rush	Red	Vascular plant

Scientific Name	Common Name	BC List	Comments
Lappula occidentalis var. *cupulata*	Western Stickseed	Red	Vascular plant
Leptosiphon septentrionalis	Northern Linanthus	Blue	Vascular plant
Lomatium sandbergii	Sandberg's Desert-parsley	Blue	Vascular plant
Melica spectabilis	Purple Oniongrass	Blue	Vascular plant
Mimulus breviflorus	Short-flowered Monkey-flower	Blue	Vascular plant
Mimulus breweri	Brewer's Monkey-flower	Blue	Vascular plant
Mimulus patulus	Stalk-leaved Monkey-flower	Red	Vascular plant
Navarretia intertexta	Needle-leaved Navarretia	Red	Vascular plant
Orobanche corymbosa ssp. *mutabilis*	Flat-topped Broomrape	Blue	Vascular plant
Pedicularis parviflora ssp. *parviflora*	Small-flowered Lousewort	Blue	Vascular plant
Pinus albicaulis	Whitebark Pine	Blue	Vascular plant; SARA Schedule 1- Endangered
Polygonum polygaloides ssp. *confertiflorum*	Close-flowered Knotweed	Red	Vascular plant
Polygonum polygaloides ssp. *kelloggii*	Kellogg's Knotweed	Blue	Vascular plant
Ranunculus pedatifidus ssp. *affinis*	Birdfoot Buttercup	Blue	Vascular plant
Salix boothii	Booth's Willow	Blue	Vascular plant
Senecio hydrophiloides	Sweet-marsh Butterweed	Red	Vascular plant
Solidago nemoralis ssp. *decemflora*	Field Goldenrod	Blue	Vascular plant
Sphenopholis intermedia	Slender Wedgegrass	Blue	Vascular plant
Stellaria obtusa	Blunt-sepaled Starwort	Blue	Vascular plant
Thermopsis rhombifolia	Prairie Golden Bean	Red	Vascular plant
Torreyochloa pallida	Fernald's False Manna	Red	Vascular plant
Barbula convoluta var. *eustegia*	No common name	Red	Moss

Scientific Name	Common Name	BC List	Comments
Bartramia halleriana	Haller's Apple Moss	Red	Moss; SARA Schedule 1 - Threatened
Brachythecium holzingeri	No common name	Blue	Moss
Campylium calcareum	No common name	Red	Moss
Campylium radicale	No common name	Blue	Moss
Encalypta mutica	No common name	Blue	Moss
Entosthodon fascicularis	Banded Cord-moss	Blue	Moss; SARA Schedule 1 – Special Concern
Grimmia mollis	No common name	Blue	Moss
Hygrohypnum alpinum	No common name	Blue	Moss
Hygrohypnum norvegicum	No common name	Red	Moss
Oreas martiana	No common name	Red	Moss
Orthotrichum pallens	No common name	Blue	Moss
Philonotis marchica	No common name	Blue	Moss
Philonotis yezoana	No common name	Blue	Moss
Platyhypnidium riparioides	No common name	Blue	Moss
Pohlia elongata	No common name	Blue	Moss
Pylaisia intricata	No common name	Red	Moss
Rhodobryum roseum	No common name	Blue	Moss
Scouleria marginata	Margined Streamside Moss	Red	Moss; SARA Schedule 1 - Endangered
Seligeria tristichoides	No common name	Blue	Moss
Sphagnum jensenii	No common name	Red	Moss
Sphagnum wulfianum	No common name	Blue	Moss
Tortula obtusifolia	No common name	Blue	Moss
Ulota curvifolia	No common name	Blue	Moss
Warnstorfia tundrae	No common name	Red	Moss

APPENDIX 2

Bird Species Expected to Occur in the Vicinity of the Study Area
(Bird Studies Canada 2014). Excludes Non-Native Species and Species with a Probability of Observation <2%.

Bird Species Expected to Occur in the Vicinity of the Study Area (Bird Studies Canada 2014). Excludes Non-Native Species and Species with a Probability of Observation <2%.

Species	English Name	Scientific Name	BC List	Identified Wildlife	SARA
Canada Goose	Canada Goose	*Branta canadensis*	Yellow	-	-
Wood Duck	Wood Duck	*Aix sponsa*	Yellow	-	-
Gadwall	Gadwall	*Anas strepera*	Yellow	-	-
American Wigeon	American Wigeon	*Anas americana*	Yellow	-	-
Mallard	Mallard	*Anas platyrhynchos*	Yellow	-	-
Blue-winged Teal	Blue-winged Teal	*Anas discors*	Yellow	-	-
Cinnamon Teal	Cinnamon Teal	*Anas cyanoptera*	Yellow	-	-
Northern Shoveler	Northern Shoveler	*Anas clypeata*	Yellow	-	-
Northern Pintail	Northern Pintail	*Anas acuta*	Yellow	-	-
Green-winged Teal	Green-winged Teal	*Anas crecca*	Yellow	-	-
Canvasback	Canvasback	*Aythya valisineria*	Yellow	-	-
Redhead	Redhead	*Aythya americana*	Yellow	-	-
Ring-necked Duck	Ring-necked Duck	*Aythya collaris*	Yellow	-	-
Lesser Scaup	Lesser Scaup	*Aythya affinis*	Yellow	-	-
Bufflehead	Bufflehead	*Bucephala albeola*	Yellow	-	-
Common Goldeneye	Common Goldeneye	*Bucephala clangula*	Yellow	-	-
Barrow's Goldeneye	Barrow's Goldeneye	*Bucephala islandica*	Yellow	-	-
Hooded Merganser	Hooded Merganser	*Lophodytes cucullatus*	Yellow	-	-
Common Merganser	Common Merganser	*Mergus merganser*	Yellow	-	-
Ruddy Duck	Ruddy Duck	*Oxyura jamaicensis*	Yellow	-	-
Ruffed Grouse	Ruffed Grouse	*Bonasa umbellus*	Yellow	-	-
Spruce Grouse	Spruce Grouse	*Falcipennis canadensis*	Yellow	-	-
Dusky Grouse	Dusky Grouse	*Dendragapus obscurus*	Yellow	-	-
Sharp-tailed Grouse	Sharp-tailed Grouse	*Tympanuchus phasianellus*	Yellow	-	-
Common Loon	Common Loon	*Gavia immer*	Yellow	-	-
Pied-billed Grebe	Pied-billed Grebe	*Podilymbus podiceps*	Yellow	-	-

Species	English Name	Scientific Name	BC List	Identified Wildlife	SARA
Horned Grebe	Horned Grebe	*Podiceps auritus*	Yellow	-	-
Red-necked Grebe	Red-necked Grebe	*Podiceps grisegena*	Yellow	-	-
Eared Grebe	Eared Grebe	*Podiceps nigricollis*	Yellow	-	-
American Bittern	American Bittern	*Botaurus lentiginosus*	Blue	-	-
Great Blue Heron	Great Blue Heron	*Ardea herodias herodias*	Blue	-	-
Turkey Vulture	Turkey Vulture	*Cathartes aura*	Yellow	-	-
Osprey	Osprey	*Pandion haliaetus*	Yellow	-	-
Bald Eagle	Bald Eagle	*Haliaeetus leucocephalus*	Yellow	-	-
Northern Harrier	Northern Harrier	*Circus cyaneus*	Yellow	-	-
Sharp-shinned Hawk	Sharp-shinned Hawk	*Accipiter striatus*	Yellow	-	-
Cooper's Hawk	Cooper's Hawk	*Accipiter cooperii*	Yellow	-	-
Northern Goshawk	Northern Goshawk	*Accipiter gentilis*	Yellow	-	-
Red-tailed Hawk	Red-tailed Hawk	*Buteo jamaicensis*	Yellow	-	-
Golden Eagle	Golden Eagle	*Aquila chrysaetos*	Yellow	-	-
American Kestrel	American Kestrel	*Falco sparverius*	Yellow	-	-
Merlin	Merlin	*Falco columbarius*	Yellow	-	-
Peregrine Falcon	Peregrine Falcon	*Falco peregrinus anatum*	Red	-	1-SC
Virginia Rail	Virginia Rail	*Rallus limicola*	Yellow	-	-
Sora	Sora	*Porzana carolina*	Yellow	-	-
American Coot	American Coot	*Fulica americana*	Yellow	-	-
Sandhill Crane	Sandhill Crane	*Grus canadensis*	Yellow	Yes	-
Killdeer	Killdeer	*Charadrius vociferus*	Yellow	-	-
Spotted Sandpiper	Spotted Sandpiper	*Actitis macularius*	Yellow	-	-
Solitary Sandpiper	Solitary Sandpiper	*Tringa solitaria*	Yellow	-	-
Greater Yellowlegs	Greater Yellowlegs	*Tringa melanoleuca*	Yellow	-	-
Long-billed Curlew	Long-billed Curlew	*Numenius americanus*	Blue	Yes	1-SC

Species	English Name	Scientific Name	BC List	Identified Wildlife	SARA
Wilson's Snipe	Wilson's Snipe	*Gallinago delicata*	Yellow	-	-
Wilson's Phalarope	Wilson's Phalarope	*Phalaropus tricolor*	Yellow	-	-
Bonaparte's Gull	Bonaparte's Gull	*Chroicocephalus philadelphia*	Yellow	-	-
Ring-billed Gull	Ring-billed Gull	*Larus delawarensis*	Yellow	-	-
Herring Gull	Herring Gull	*Larus argentatus*	Yellow	-	-
Black Tern	Black Tern	*Chlidonias niger*	Yellow	-	-
Mourning Dove	Mourning Dove	*Zenaida macroura*	Yellow	-	-
Flammulated Owl	Flammulated Owl	*Psiloscops flammeolus*	Blue	Yes	1-SC
Great Horned Owl	Great Horned Owl	*Bubo virginianus*	Yellow	-	-
Northern Pygmy-Owl	Northern Pygmy-Owl	*Glaucidium gnoma*	Yellow	-	-
Barred Owl	Barred Owl	*Strix varia*	Yellow	-	-
Great Gray Owl	Great Gray Owl	*Strix nebulosa*	Yellow	-	-
Northern Saw-whet Owl	Northern Saw-whet Owl	*Aegolius acadicus*	Yellow	-	-
Common Nighthawk	Common Nighthawk	*Chordeiles minor*	Yellow	-	1-T
Vaux's Swift	Vaux's Swift	*Chaetura vauxi*	Yellow	-	-
White-throated Swift	White-throated Swift	*Aeronautes saxatalis*	Yellow	-	-
Calliope Hummingbird	Calliope Hummingbird	*Selasphorus calliope*	Yellow	-	-
Rufous Hummingbird	Rufous Hummingbird	*Selasphorus rufus*	Yellow	-	-
Belted Kingfisher	Belted Kingfisher	*Megaceryle alcyon*	Yellow	-	-
Lewis's Woodpecker	Lewis's Woodpecker	*Melanerpes lewis*	Red	Yes	1-T
Red-naped Sapsucker	Red-naped Sapsucker	*Sphyrapicus nuchalis*	Yellow	-	-
Red-breasted Sapsucker	Red-breasted Sapsucker	*Sphyrapicus ruber*	Yellow	-	-
Downy Woodpecker	Downy Woodpecker	*Picoides pubescens*	Yellow	-	-
Hairy Woodpecker	Hairy Woodpecker	*Picoides villosus*	Yellow	-	-

Species	English Name	Scientific Name	BC List	Identified Wildlife	SARA
American Three-toed Woodpecker	American Three-toed Woodpecker	*Picoides dorsalis*	Yellow	-	-
Black-backed Woodpecker	Black-backed Woodpecker	*Picoides arcticus*	Yellow	-	-
Northern Flicker	Northern Flicker	*Colaptes auratus*	Yellow	-	-
Pileated Woodpecker	Pileated Woodpecker	*Dryocopus pileatus*	Yellow	-	-
Olive-sided Flycatcher	Olive-sided Flycatcher	*Contopus cooperi*	Blue	-	1-T
Western Wood-Pewee	Western Wood-Pewee	*Contopus sordidulus*	Yellow	-	-
Alder Flycatcher	Alder Flycatcher	*Empidonax alnorum*	Yellow	-	-
Willow Flycatcher	Willow Flycatcher	*Empidonax traillii*	Yellow	-	-
Least Flycatcher	Least Flycatcher	*Empidonax minimus*	Yellow	-	-
Hammond's Flycatcher	Hammond's Flycatcher	*Empidonax hammondii*	Yellow	-	-
Dusky Flycatcher	Dusky Flycatcher	*Empidonax oberholseri*	Yellow	-	-
Pacific-slope Flycatcher	Pacific-slope Flycatcher	*Empidonax difficilis*	Yellow	-	-
Say's Phoebe	Say's Phoebe	*Sayornis saya*	Yellow	-	-
Western Kingbird	Western Kingbird	*Tyrannus verticalis*	Yellow	-	-
Eastern Kingbird	Eastern Kingbird	*Tyrannus tyrannus*	Yellow	-	-
Cassin's Vireo	Cassin's Vireo	*Vireo cassinii*	Yellow	-	-
Warbling Vireo	Warbling Vireo	*Vireo gilvus*	Yellow	-	-
Red-eyed Vireo	Red-eyed Vireo	*Vireo olivaceus*	Yellow	-	-
Gray Jay	Gray Jay	*Perisoreus canadensis*	Yellow	-	-
Steller's Jay	Steller's Jay	*Cyanocitta stelleri*	Yellow	-	-
Clark's Nutcracker	Clark's Nutcracker	*Nucifraga columbiana*	Yellow	-	-
Black-billed Magpie	Black-billed Magpie	*Pica hudsonia*	Yellow	-	-
American Crow	American Crow	*Corvus brachyrhynchos*	Yellow	-	-

Species	English Name	Scientific Name	BC List	Identified Wildlife	SARA
Common Raven	Common Raven	*Corvus corax*	Yellow	-	-
Horned Lark	Horned Lark	*Eremophila alpestris*	Yellow	-	-
Tree Swallow	Tree Swallow	*Tachycineta bicolor*	Yellow	-	-
Violet-green Swallow	Violet-green Swallow	*Tachycineta thalassina*	Yellow	-	-
Northern Rough-winged Swallow	Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	Yellow	-	-
Bank Swallow	Bank Swallow	*Riparia riparia*	Yellow	-	-
Cliff Swallow	Cliff Swallow	*Petrochelidon pyrrhonota*	Yellow	-	-
Barn Swallow	Barn Swallow	*Hirundo rustica*	Blue	-	-
Black-capped Chickadee	Black-capped Chickadee	*Poecile atricapillus*	Yellow	-	-
Mountain Chickadee	Mountain Chickadee	*Poecile gambeli*	Yellow	-	-
Chestnut-backed Chickadee	Chestnut-backed Chickadee	*Poecile rufescens*	Yellow	-	-
Boreal Chickadee	Boreal Chickadee	*Poecile hudsonicus*	Yellow	-	-
Red-breasted Nuthatch	Red-breasted Nuthatch	*Sitta canadensis*	Yellow	-	-
Brown Creeper	Brown Creeper	*Certhia americana*	Yellow	-	-
Pacific Wren	Pacific Wren	*Troglodytes pacificus*	Yellow	-	-
Marsh Wren	Marsh Wren	*Cistothorus palustris*	Yellow	-	-
American Dipper	American Dipper	*Cinclus mexicanus*	Yellow	-	-
Golden-crowned Kinglet	Golden-crowned Kinglet	*Regulus satrapa*	Yellow	-	-
Ruby-crowned Kinglet	Ruby-crowned Kinglet	*Regulus calendula*	Yellow	-	-
Mountain Bluebird	Mountain Bluebird	*Sialia currucoides*	Yellow	-	-
Townsend's Solitaire	Townsend's Solitaire	*Myadestes townsendi*	Yellow	-	-
Veery	Veery	*Catharus fuscescens*	Yellow	-	-
Swainson's Thrush	Swainson's Thrush	*Catharus ustulatus*	Yellow	-	-
Hermit Thrush	Hermit Thrush	*Catharus guttatus*	Yellow	-	-

Species	English Name	Scientific Name	BC List	Identified Wildlife	SARA
American Robin	American Robin	*Turdus migratorius*	Yellow	-	-
Varied Thrush	Varied Thrush	*Ixoreus naevius*	Yellow	-	-
Gray Catbird	Gray Catbird	*Dumetella carolinensis*	Yellow	-	-
Cedar Waxwing	Cedar Waxwing	*Bombycilla cedrorum*	Yellow	-	-
Tennessee Warbler	Tennessee Warbler	*Oreothlypis peregrina*	Yellow	-	-
Orange-crowned Warbler	Orange-crowned Warbler	*Oreothlypis celata*	Yellow	-	-
Nashville Warbler	Nashville Warbler	*Oreothlypis ruficapilla*	Yellow	-	-
Yellow Warbler	Yellow Warbler	*Setophaga petechia*	Yellow	-	-
Magnolia Warbler	Magnolia Warbler	*Setophaga magnolia*	Yellow	-	-
Yellow-rumped Warbler	Yellow-rumped Warbler	*Setophaga coronata*	Yellow	-	-
Townsend's Warbler	Townsend's Warbler	*Setophaga townsendi*	Yellow	-	-
Blackpoll Warbler	Blackpoll Warbler	*Setophaga striata*	Yellow	-	-
American Redstart	American Redstart	*Setophaga ruticilla*	Yellow	-	-
Northern Waterthrush	Northern Waterthrush	*Parkesia noveboracensis*	Yellow	-	-
MacGillivray's Warbler	MacGillivray's Warbler	*Geothlypis tolmiei*	Yellow	-	-
Common Yellowthroat	Common Yellowthroat	*Geothlypis trichas*	Yellow	-	-
Wilson's Warbler	Wilson's Warbler	*Cardellina pusilla*	Yellow	-	-
Spotted Towhee	Spotted Towhee	*Pipilo maculatus*	Yellow	-	-
Chipping Sparrow	Chipping Sparrow	*Spizella passerina*	Yellow	-	-
Clay-colored Sparrow	Clay-colored Sparrow	*Spizella pallida*	Yellow	-	-
Vesper Sparrow	Vesper Sparrow	*Pooecetes gramineus*	Yellow		-
Savannah Sparrow	Savannah Sparrow	*Passerculus sandwichensis*	Yellow	-	-
Fox Sparrow	Fox Sparrow	*Passerella iliaca*	Yellow	-	-
Song Sparrow	Song Sparrow	*Melospiza melodia*	Yellow	-	-
Lincoln's Sparrow	Lincoln's Sparrow	*Melospiza lincolnii*	Yellow	-	-

Species	English Name	Scientific Name	BC List	Identified Wildlife	SARA
White-throated Sparrow	White-throated Sparrow	*Zonotrichia albicollis*	Yellow	-	-
White-crowned Sparrow	White-crowned Sparrow	*Zonotrichia leucophrys*	Yellow	-	-
Dark-eyed Junco	Dark-eyed Junco	*Junco hyemalis*	Yellow	-	-
Western Tanager	Western Tanager	*Piranga ludoviciana*	Yellow	-	-
Lazuli Bunting	Lazuli Bunting	*Passerina amoena*	Yellow	-	-
Bobolink	Bobolink	*Dolichonyx oryzivorus*	Blue	-	-
Red-winged Blackbird	Red-winged Blackbird	*Agelaius phoeniceus*	Yellow	-	-
Western Meadowlark	Western Meadowlark	*Sturnella neglecta*	Yellow	-	-
Yellow-headed Blackbird	Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	Yellow	-	-
Brewer's Blackbird	Brewer's Blackbird	*Euphagus cyanocephalus*	Yellow	-	-
Brown-headed Cowbird	Brown-headed Cowbird	*Molothrus ater*	Yellow	-	-
Bullock's Oriole	Bullock's Oriole	*Icterus bullockii*	Yellow	-	-
Pine Grosbeak	Pine Grosbeak	*Pinicola enucleator*	Yellow	-	-
Purple Finch	Purple Finch	*Haemorhous purpureus*	Yellow	-	-
Cassin's Finch	Cassin's Finch	*Haemorhous cassinii*	Yellow	-	-
House Finch	House Finch	*Haemorhous mexicanus*	Yellow	-	-
Red Crossbill	Red Crossbill	*Loxia curvirostra*	Yellow	-	-
White-winged Crossbill	White-winged Crossbill	*Loxia leucoptera*	Yellow	-	-
Pine Siskin	Pine Siskin	*Spinus pinus*	Yellow	-	-
American Goldfinch	American Goldfinch	*Spinus tristis*	Yellow	-	-
Evening Grosbeak	Evening Grosbeak	*Coccothraustes vespertinus*	Yellow	-	-

APPENDIX 3

Wildlife Species Accounts

WILDLIFE SPECIES ACCOUNT: MULE DEER

This species account has been adapted from the mule deer accounts provided in:

Geowest Environmental Consultants Ltd. and Keystone Wildlife Research Ltd. 2001. Terrestrial Ecosystem Mapping for the East Cariboo Area, Williams Lake, British Columbia Volume II: Wildlife Species Profiles and Habitat Suitability Assessment. Report to BC Ministry of Environment, Lands and Parks, Williams Lake.

and

JMJ Holdings Inc., BA Sinclair, and G. Burns. 2000. Chilcotin West IFPA Wildlife Species Accounts.

Species Data

Species Name: Mule Deer

Scientific Name: *Odocoileus hemionus*

Species Code: M-ODHE

Provincial Status: Yellow-Listed (not at risk)

Identified Wildlife Status: No

COSEWIC Status: Not At Risk

Project Data

Ecoprovince: Southern Interior Mountains

Ecoregion: Columbia Highlands

Ecosection: Quesnel Highland

Biogeoclimatic Subzone Variants: ICHmk3, ICHwk2

Map Scale: 1:50,000

INTRODUCTION

The mule deer is one of the most abundant ungulates in the province, and is prized as a game animal. There are three subspecies in the province; the Columbian black-tailed deer (Odocoileus hemionus columbianus), which inhabits Vancouver Island and the southern coast, the Sitka black-tailed deer (Odocoileus hemionus sitkensis) found on the north coast of the province, and the mule deer (Odocoileus hemionus hemionus) which is found in the interior of the province, including the Mount Polley area (Shackleton 2013).

DISTRIBUTION

Mule deer may be found in all biogeoclimatic zones (Stevens 1995) but are rare in the north half of the province. Mule deer have difficulty moving through snow deeper than 30 cm (MELP 2015). Therefore, mule deer are expected to be found throughout the Mount Polley study area during the growing season but are not expected to winter there due to deep snow. No deer winter ranges have been mapped by the province near the Mount Polley Mine. Only growing season habitat is considered in this species account.

Distribution in the Project Area

Densities of mule deer within the project area are unknown. Deer are widely dispersed in summer and probably occur in low numbers (<1/ km2) in the Mount Polley area. Because of their secretive behaviour, habitat use by does with young is most difficult to document.

ECOLOGY AND KEY HABITAT REQUIREMENTS

Mule deer rut during mid-October and early December (Stevens and Lofts 1988). Fawns are born in June after a gestation of approximately 210 days (Banfield 1981). Optimum fawning habitat has a dense understory of low shrubs or small trees from 0.6 - 1.8 m tall and a tree overstory of approximately 50% crown closure. Good fawning habitat is in close proximity to suitable foraging areas (Stevens and Lofts 1988).

Average home range for mule deer varies widely between individuals, sexes, and habitat occupied. Bucks generally use larger areas than the does.

Feeding

Mule deer are considered generalists and are capable of digesting a wide variety of plants. They are mainly browsers of shrubby vegetation, but they will also eat forbs and grasses, especially during the spring season. Forage preferences are determined by a combination of seasonal variations in forage digestibility and protein content, and by the nutritional requirements of the animals. Summer forage plants are listed in Table 1.

Table 1: Important Growing-Season Forage Plantsfor Mule Deer in the Central Interior of British Columbia.

Type	Species
Trees	Douglas-fir *Pseudotsuga menziesii* black cottonwood *Populus balsamifera* trembling aspen *Populus tremuloides*
Shrubs	saskatoon *Amelanchier alnifolia* red-osier dogwood *Cornus stolonifera* high-bush cranberry *Viburnum edule* Sitka mountain ash *Sorbus sitchensis* Oregon-grape *Mahonia* sp. Common rabbitbush *Ericameria nauseosa* snowbrush *Ceanothus velutinus* red-stemmed ceanothus *Ceanothus sanguineus* Douglas maple *Acer glabrum* soopolallie *Shepherdia canadensis* birch-leaved spirea *Spiraea betulifolia* ssp. *lucida* willow *Salix* spp. black twinberry *Lonicera involucrata* choke cherry *Prunus virginiana* pin cherry *Prunus pensylvanica* snowberry *Symphoricarpos albus* falsebox *Paxistima myrsinites* scrub birch *Betula nana* kinnikinnick *Arctostaphylos uva-ursi* prickly rose *Rosa acicularis* blueberries *Vaccinium* spp. thimbleberry *Rubus parviflorus* twinflower *Linnaea borealis*

Table 1 (Cont'd): Important Growing-Season Forage Plantsfor Mule Deer in the Central Interior of British Columbia.

Type	Species
Forbs	lupine *Lupinus* spp. fireweed *Epilobium* spp. horsetail *Equisetum* spp. goldenrod *Solidago* spp. *Penstemon* spp. Solomon's seal *Maianthemum* spp. broadleaf arnica *Arnica latifolia* wild strawberry *Fragaria virginiana* *Aster* spp. wild sarsaparilla *Aralia nudicaulis* *Anemone* spp.
	Sitka valerian *Valeriana sitchensis* clasping twistedstalk *Streptopus amplexifolius* bunchberry *Cornus canadensis* northern bedstraw *Galium triflorum* yarrow *Achillea millefolium* *Arnica* spp. pussytoes *Antennaria* spp. clover *Trifolium* spp.
Graminoids	sedges *Carex* spp. bluegrasses *Poa* spp. bunchgrasses *Elymus* spp. Fescues *Festuca* spp. junegrass *Koeleria macrantha* pinegrass *Calamagrostis rubescens* bluejoint *Calamagrostis canadensis* timothy *Phleum pratense* rushes *Juncus* spp.
Lichens	*Bryoria* spp. *Alectoria* spp.

During the growing season, mule deer will forage in a variety of habitats ranging from grassy openings to old growth forest. During the spring, areas of early green-up are important for feeding. These habitats occur at low elevations on moderate to steep, south and west-facing slopes.

Summer habitat consists of areas with a suitable mix of young to old forest areas, with an adequate supply of forage and cover elements. Few deer are expected to use very dense forest where little light penetrates the canopy or ecosystem units with limited understory growth. Lush, moist sites are preferred. Foods used in the growing season consist of a wide variety of herbs, grasses and shrubs. Food is considered to be superabundant and is not limiting, especially in the moist forest types favoured by deer in the growing season.

Security and Thermal Habitat

Growing season thermal habitat (shade) is used to prevent overheating during hot summer months. Any habitat with shrubs or trees in structural stage 3 or older can provide adequate shade but cool aspects and riparian areas are likely to provide the coolest sites. Canopy closure ranges of 26-35% will provide adequate thermal cover during hot weather (Demarchi and Bunnell 1993).

The most effective security cover for mule deer hides 90% of the animal at a distance of 60 m or less, and security patches should to be 180 m or more in diameter (Nyberg & Janz 1990). Sufficient hiding cover is provided by understory and dense low branches 1-2 m in height. In general, old growth forests with a patchy conifer understory and most well-stocked stands of young trees with live branches will satisfy security cover requirements. Areas of steep broken terrain can also be used as security habitat. (Nyberg & Janz 1990). Riparian areas with dense shrubby cover are used for fawning in the spring. At a landscape scale, Robinson et al. (2006) found that there was a strong selection of spruce/fir forests by both sexes, both preferred older stands, and both avoided stands with >55% canopy closure during summer.

Migration Habitat

Mule deer often use high-elevation forests in summer and migrate to lower elevation drier subzones and warm aspect slopes for the winter (Hayden et al. 2008; D'Eon and Serrouya 2005). Most animals move off winter ranges in late April or May and move directly to summering areas which they occupy from late May through September. Some does move to spring ranges in April or early May, remaining there until late May or early June. They move to summer ranges just before fawning. Spring ranges may be well removed from winter or summer ranges.

Limiting Habitat

Mule deer likely use the project area in the spring, summer, and early fall (growing season). Male and female deer exhibit similar habitat use except in summer when females with young choose more densely forested sites than males do. Ground cover, sufficiently tall and dense to conceal bedded fawns, is believed to be a key habitat component. Visual cover for adult deer and wet ground, which may hindered scent tracking of adults by predators, is also considered important.

Birthing areas may be the most important component of habitats used by deer in the growing season; however, since summer ranges are very small, all life requisites must be found within small areas (8 km^2). Based on results of other studies (Simpson and Gyug 1991), most sites (60%) where fawns were born were forest and the rest were in sedge meadows or riparian areas. However, fawning habitats cannot be considered independently of the needs of the adults so they have been rated as an essential component of mule deer summer range.

SEASONS OF USE

For the purposes of this species account, the definition of the growing season (spring, summer, and fall) is based on that defined by RIC (1999). Table 2 presents the seasonal divisions for mule deer in the Southern Interior Mountains.

Table 2: Seasons of Use for Mule Deer in the Southern Interior Mountains (RIC 1999)

Month	Season
November-April	Winter
May- June	Growing Season (Spring)
July-August	Growing Season (Summer)
September-October	Growing Season (Fall)

HABITAT USE AND ECOSYSTEM ATTRIBUTES

Characteristics of expected high-value habitats for mule deer during the growing season are summarized in Table 3.

Table 3: Key Habitat Attributes for Mule Deer in the Growing Season

Secondary Life Requisite	Primary Life Requisite	Attributes Required	Structural Stage
Living	Security/thermal cover (ST)	dense understory of vegetation >1.5 m tall	3b to 7
	Feeding (FD)	mosaic of small shrubby or grassy openings with lush forage plants, interspersed with cover; herb wetlands	2 to 7

Provincial Benchmark

The provincial benchmark for mule deer growing season habitat is the ESSFdk Subalpine Meadow in the Southern Interior Mountains ecoprovince (RIC 1999). The subzones within the study area are not known to be particularly productive for deer during the growing season. The maximum rating applied will be Moderately High.

Rating Scheme

A six-class rating scheme (Table 4) was used to rate mule deer habitat. Mule deer habitats were rated for Living/Growing/Feeding (LI/G/FD), and Living/Growing/Security-Thermal (LI/G/ST).

Table 4: Six and Four-Class Rating Schemes Used for Habitat Ratings (RIC 1999)

% of Provincial Best*	Substantial Knowledge of Habitat Use (6-class)		Intermediate Knowledge of Habitat Use (4-class)	
	Rating	Code	Rating	Code
100 - 76%	High	1	High	H
75 - 51%	Moderately High	2	Moderate	M
50 - 26%	Moderate	3		
25 - 6%	Low	4	Low	L
5 - 1%	Very Low	5		
0%	Nil	6	Nil	N

*"Provincial Best" is the provincial benchmark habitat for a species against which all other habitats are compared.

Rating Assumptions

This habitat rating scheme assumes that security cover used by mule deer in the early-spring season is not appreciably different from that used during the remainder of the growing season. Security habitat used during the growing season is assumed to also provide adequate thermal habitat during the growing season. Riparian forests and wetlands provide the best reproductive habitats for mule deer as noted in studies in other areas.

1) Cutblocks or other openings in structural stage 3 should be rated up to 2 for feeding and up to 3 for cover.

2) Riparian forest and moist to mesic forest in structural stages 5-7 should be rated up to 2 for feeding and cover.

3) Drier than mesic forest in structural stages 5-7 should be rated up to 3 for feeding and cover.

4) Wetlands are rated up to 3 for feeding and 4 for cover. Shrub floodplains should be rated up to 2 for feeding and 4 for cover.

A summary of the ratings assigned to ecosystems within the study area is provided below (Table 5).

Table 5: Ratings for Feeding (FD) and Security-Thermal (ST) Habitat for Mule Deer in the Growing Season

Subzone Variant	Ecosystem Code	Site Series Number	Modifier	Structural Stage	Name	FD	ST
ICHmk3	RF	01		4	CwSxw-Falsebox-Knight's Plume	4	3
ICHmk3	RF	01		5	CwSxw-Falsebox-Knight's Plume	3	3
ICHmk3	RF	01		6	CwSxw-Falsebox-Knight's Plume	3	3
ICHmk3	RF	01		7	CwSxw-Falsebox-Knight's Plume	3	3
ICHmk3	RF	01	s	5	CwSxw-Falsebox-Knight's Plume	3	3
ICHmk3	RH	07	p	6	CwSxw-Devil's club-Horsetail	2	2
ICHmk3	SF	05		4	SxwCw-Oak fern	4	3
ICHmk3	SF	05		5	SxwCw-Oak fern	3	3
ICHmk3	SF	05		6	SxwCw-Oak fern	4	3
ICHmk3	SF	05		7	SxwCw-Oak fern	3	3
ICHmk3	SO	04		3	CwSxw-Oak fern-Cat's tail moss	2	3
ICHmk3	SO	04		4	CwSxw-Oak fern-Cat's tail moss	4	3
ICHmk3	SO	04		5	CwSxw-Oak fern-Cat's tail moss	5	3
ICHmk3	SO	04		6	CwSxw-Oak fern-Cat's tail moss	3	3
ICHmk3	SO	04		7	CwSxw-Oak fern-Cat's tail moss	3	3
ICHmk3	RD	06		6	CwHw-Devil's club-Lady fern	2	2
ICHmk3	RD	06		7	CwHw-Devil's club-Lady fern	2	2
ICHmk3	BS			3a	Scrub birch-Sedge-Sphagnum	3	4
ICHmk3	MI				Mine	5	6
ICHmk3	WD			3a	Willow-Red-osier dogwood floodplain	2	4

Table 5 (Cont'd): Ratings for Feeding (FD) and Security-Thermal (ST) Habitat for Mule Deer in the Growing Season

Subzone Variant	Ecosystem Code	Site Series Number	Modifier	Structural Stage	Name	FD	ST
ICHwk2	HM			6	HwCw-Step Moss	4	3
ICHwk2	HO	01		4	CwHw-Oak fern	4	3
ICHwk2	HO	01		5	CwHw-Oak fern	3	3
ICHwk2	HO	01		6	CwHw-Oak fern	3	3
ICHwk2	HO	01		7	CwHw-Oak fern	3	3
ICHwk2	HO	01	c	5	CwHw-Oak fern	5	3
ICHwk2	HO	01	n	6	CwHw-Oak fern	3	3
ICHwk2	HO	01	s	5	CwHw-Oak fern	5	3
ICHwk2	RD	07		4	CwHw-Devil's club-Lady fern	4	3
ICHwk2	SO	05		4	SxwCw-Oak fern	4	3
ICHwk2	ST	06		6	Sxw-Twinberry-Oak fern	2	2
ICHwk2	WD		n	3b	Willow-Red-osier dogwood floodplain	2	4

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WILDLIFE SPECIES ACCOUNT: FISHER

This model has been updated and revised for the study area and is based upon an earlier account in:

EBA Engineering Consultants Ltd. 2002. Ecosystem Mapping With Wildlife Interpretations to Support Oil and Gas Pre-Tenure Planning in the Muskwa-Kechika Management Area. Report to B.C. Ministry of Energy & Mines – Petroleum Lands Branch, Fort St. John, BC.

Species Data

Species Name: Fisher

Scientific Name*: Pekania pennanti*

Species Code: M-PEPE

Provincial Status: Blue-Listed

Identified Wildlife Status: No

COSEWIC Status: Not At Risk

Project Data

Ecoprovince: Southern Interior Mountains

Ecoregion: Columbia Highlands

Ecosection: Quesnel Highland

Biogeoclimatic Subzone Variants: ICHmk3, ICHwk2

Map Scale: 1:50,000

INTRODUCTION

The fisher is a large mustelid (weasel) that inhabits forested habitat across the province. Fishers are valued as furbearers. They are generally solitary, and feed mainly on small mammals and birds as well as vegetation such as berries. Fishers are vulnerable to overharvest and to loss of forest habitat and there are estimated to be fewer than 3800 in the province (BC Conservation Data Centre 2015).

DISTRIBUTION

Fishers are distributed throughout the forested areas of North America and most of British Columbia. Fishers are found throughout mainland British Columbia north of Kamloops although they are rare in coastal ecosystems (Nagorsen 1990; Weir and Almuedo 2010).

Distribution in the Project Area

Fishers are not common within the ICH biogeoclimatic zone (Weir and Almuedo 2010). Their presence near Mount Polley has not been confirmed but their provincial range does include the study area.

ECOLOGY AND KEY HABITAT REQUIREMENTS

General

Optimal habitats for fishers are considered mature coniferous forests and mixed conifer/hardwood stands, mostly in areas of continuous overhead cover (Allen 1983; Powell 1992; Krohn et al. 1996; Weir and Almuedo 2010). Landscape-scale fisher habitat requirements are not well understood, however their preference for diverse habitats created by multi-aged stands containing wetland or riparian habitat and their requirement for continuous overhead cover is well documented (Banci 1989; Powell and Zielinski 1994). Small forest openings created by fire and wind-throw are a natural component of fisher habitat although large, non-forested areas, such as those created by clear-cut logging, are beyond the scale of natural disturbances. Other important landscape attributes, such as stand size and shape and use of corridors, are not known (Krohn et al. 1996).

Throughout their range, fishers exhibit a strong preference for forests with high canopy closure and avoid areas with low overhead cover. In the Pacific States and the Rocky Mountains, fishers appear to use riparian areas disproportionately more than their occurrence (Powell 1992; Powell and Zielinski 1994; Jones and Garton 1994). These areas likely provide several functions including high prey abundance, abundant snags for dens/resting sites and high canopy closure which provides snow interception.

Forest structure is likely more important to fisher than specific forest types. Vertical and horizontal complexity, created by a diversity of tree sizes and shapes, light gaps, dead and downed wood and layers of overhead cover, provide good prey habitat, dens and resting sites (Powell and Zielinski 1994). Fishers infrequently use large forest openings, open hardwood forests, recent clear-cuts, grasslands, areas above timberline and other non-forested areas (Powell and Zielinski 1994). In fact, Powell (1992) states that fisher have avoided open areas 25 m across or less in the American Midwest.

Some authors have shown differences in fisher winter and summer habitat. Jones and Garton (1994), studying in the Rocky Mountains of north-central Idaho, found that fishers preferred mature and old-growth forests during summer but used young forests in winter. They hypothesized that the shift to younger stages may be due to a shift in prey use, specializing more towards snowshoe hare. Kelly (1977, as cited in Powell 1992) also found changes in seasonal habitat use. Banci (1989) reported that fishers in BC do not use different elevations in different seasons.

Fishers can travel long distances during short periods of time, about 5-6 km per day (reviewed by Powell and Zielinski 1994). Home ranges are generally exclusive by sex. Males generally have larger territories than females – an adult male's home range is generally >100 km^2 and may overlap those of several females. A female's home range is usually >25 km^2 (Weir and Almuedo 2010). Weir and Corbould (2008) noted that home ranges of fishers in the Williston region were typically larger in winter than non-winter.

Fishers have been found to be confined to or have greater density in areas with low snow accumulation (Powell 1992). Travel in deep snow is energetically costly and, compared to marten, they are less able to access the sub-nivean spaces because of their larger body size. Where snow is deep and frequent, fishers should be expected to be either absent or occur where dense overhead cover intercepts snowfall (Krohn *et al*. 1996).

Feeding Habitat

Optimum foraging habitat for fishers is provided by a mosaic of different forest types in various structural stages, together with forest floor structural complexity, which provide habitat niches for a diversity of prey species. Fishers may forage in different habitats from the ones they use for resting and denning therefore, a complete description of fisher habitat requirements must consider both foraging and resting and denning needs.Fishers will forage in areas that do not provide good year-round cover, such as younger forests and regenerating clear-cuts.

Fishers are opportunistic feeders (Banci 1989) and their prey may occur in a variety of forest types and seral stages (Powell and Zielinski 1994). Primary prey species are associated with abundant CWD and understory shrub cover. Snowshoe hares (*Lepus americanus*) and rodents form the bulk of their diet but they will eat virtually any vertebrate that they are capable of killing (Forsyth 1985; BCMWLAP 2004). Other common food items include birds, fish, snakes, toads, insects, fruit, seeds, berries, fern tips and carrion (Forsyth 1985). Habitats with high small mammal diversity, such as riparian areas, wetlands and mixed conifer-hardwood forest types, are most preferred for foraging (Kelly 1977 as cited in Powell 1992).

Foraging habitat for fishers in winter is much the same as in summer. However, in winter fishers, because of their large body size, are restricted to hunting on the snow surface (Powell 1982). Therefore, structurally complex debris (CWD), which provides subnivean access, may not be required as foraging habitat. Deep winter snow may limit the distribution of fishers (Aubry and Houston 1992). Weir and Corbould (2008) found the likelihood of activity of fishers increased with fresh snowfalls of ≥5 cm during winter.

Analysis of stomach contents by Weir et al. (2005) indicated that prey during winter is varied; however, snowshoe hares, red squirrels, and southern red-backed voles were the most common prey observed. It was also noted that in winter, females tended to exploit small mammals more than did males (Weir et al. 2005).

Thermal-Security Habitat

Security habitat conceals fishers from larger predators and modifies extremes in climate thus assisting them in maintaining a constant body temperature. Thermal habitat is more critical for fishers in winter when they may be nutritionally stressed and need to minimize energy expenditures. Security is provided by continuous overhead forest cover and in structures associated with late-successional forests. Fishers avoid wetlands, cutblocks and other open areas (Weir and Almuedo 2010).

Resting and denning sites tend to occur in structures associated with late-successional forests (Powell and Zielinski 1994; Jones and Garton 1994). This includes large trees, snags and logs greater than 55 cm dbh on average (Powell and Zielinski 1994). Weir and Corbould (2008) found that fishers rested most frequently on branch rest structures (57%); however, were more likely to use cavity rest sites than branch sites near the centre of their home ranges and were more likely to use coarse woody debris (CWD) when ambient temperatures were < -11°C. Fishers will rest in ground dens among coarse woody debris and slash piles during periods of low temperatures (below –20° C). Weir (1995) reported a greater-than-expected winter use by fishers of habitats with >50 m^3/ha of large debris (more than 20 cm diameter).

Corbould (2008) found that fishers were highly selective for patches used for resting, selecting patches of habitat with higher densities of trees with rust brooms. Other resting sites include piles of coarse woody debris, squirrel middens, tree cavities and squirrel nests. Rest sites are generally in the trees with the largest diameter available and those with the most rust brooms (Weir 1995).

Reproducing Habitat

Fishers mate in early April, and females give birth in dens in tree cavities (BC MWLAP 2004). Maternity denning habitat is the limiting habitat for fishers. This habitat includes trees with large cavities, which are generally found in late-successional forests. Maternal den site requisites are believed to be more stringent than those used for resting (Weir 1995). Natal dens are located most often in cavities of large trees and are situated 7 to 12 m above the ground (Banci 1989).

Dens are usually in live trees that have some defect (fire damage, cracks, heart rot, branch scars) that permits access to the interior of the tree. Suitable maternal den trees include black cottonwood/poplar at least 50 cm dbh, trembling aspen at least 40 cm dbh, lodgepole pine at least 35 cm dbh, and Douglas-fir at least 60 cm dbh (Weir and Almuedo 2010). In the Sub-Boreal Spruce zone, black cottonwood trees were the only trees observed to be used as reproductive dens, with cavities in large-diameter cottonwoods appearing to be a critical habitat element (Weir and Corbould 2008). Weir and Corbould (2008) concluded that these provided features and conditions beneficial to denning, including protection from weather, thermally advantageous, protection/concealment from potential hazards, and an elevated vantage point.

Females may re-use the same den tree or succession of den trees over a number of years (Weir and Almuedo 2010). Weir and Corbould (2008) observed females using between 1 and 3 trees as reproductive dens during the rearing period. It was also found that all female fishers that whelped more than once during the study period re-used den sites (Weir and Corbould 2008). At the stand level, suitable maternity den trees are most likely to be found in moist or riparian forests in mature and old structural stages.

SEASONS OF USE

For the purposes of this model, the definition of the seasons is based on that defined by RIC (1999). Table 2 presents the seasonal divisions for fishers in the Southern Interior Mountains.

Table 2: Seasons of use for fishers in the Southern Interior Mountains (RIC 1999)

Month	Season
November-April	Winter
May- June	Growing Season (Spring)
July-August	Growing Season (Summer)
September-October	Growing Season (Fall)

HABITAT USE AND ECOSYSTEM ATTRIBUTES

Ratings will be provided for Reproducing-birthing during the spring and summer. Characteristics of expected high-value habitats for reproducing-birthing habitat for fishers are summarized in Table 3.

Table 3: Key Reproducing Habitat Attributes for Fishers During Spring and Summer

Life Requisite	Primary Life Requisite	Attributes Required	Structural Stage
Reproducing – Birthing (RB)	Security /thermal cover (SH)	Presence of large-diameter *Populus*, most likely found in riparian or moist forest stands	6 to 7

Ratings

Habitat ratings were generated using the four-class rating scheme (Table 4).

Table 4: Six and Four-Class Rating Schemes Used for Habitat Ratings (RIC 1999)

% of Provincial Best*	Substantial Knowledge of Habitat Use (6-class)		Intermediate Knowledge of Habitat Use (4-class)	
	Rating	Code	Rating	Code
100 - 76%	**High**	**1**	**High**	**H**
75 - 51%	**Moderately High**	**2**	**Moderate**	**M**
50 - 26%	**Moderate**	**3**		
25 - 6%	**Low**	**4**	**Low**	**L**
5 - 1%	**Very Low**	**5**		
0%	**Nil**	**6**	**Nil**	**N**

*”Provincial Best” is the provincial benchmark habitat for a species against which all other habitats are compared.

Provincial Benchmark

The highest densities of fishers in BC have been recorded in the Sub-boreal Spruce zone in northeastern BC (Weir and Corbould 2006), which is assumed to be the provincial benchmark. The ICH is not known to be a zone with high densities of fishers. The maximum rating assigned (after adjustments) will be Moderate.

Assumptions

Forested habitats in structural stages 6 (mature forest) and 7 (old forest) represent the most likely forest types to provide suitable den trees for birthing and rearing young. These ecosystems are rated up to Low. All other structural stages, and nonvegetated and anthropogenic units, are rated Nil. A summary of the ratings applied to the ecosystems within the study area before adjustments is presented below (Table 5).

Table 5: Habitat Ratings for Fisher Reproducing-Birthing (RB) Before Adjustments

Subzone Variant	Ecosystem Code	Modifier	Structural Stage	Name	Fisher RB Rating
ICHmk3	RF		4	CwSxw-Falsebox-Knight's Plume	N
ICHmk3	RF		5	CwSxw-Falsebox-Knight's Plume	N
ICHmk3	RF		6	CwSxw-Falsebox-Knight's Plume	L
ICHmk3	RF		7	CwSxw-Falsebox-Knight's Plume	L
ICHmk3	RF	s	5	CwSxw-Falsebox-Knight's Plume	N
ICHmk3	RH	p	6	CwSxw-Devil's club-Horsetail	L
ICHmk3	SF		4	SxwCw-Oak fern	N
ICHmk3	SF		5	SxwCw-Oak fern	N
ICHmk3	SF		6	SxwCw-Oak fern	L
ICHmk3	SF		7	SxwCw-Oak fern	L
ICHmk3	SO		3	SxwCw-Oak fern	N
ICHmk3	SO		4	CwSxw-Oak fern-Cat's tail moss	N
ICHmk3	SO		5	CwSxw-Oak fern-Cat's tail moss	N
ICHmk3	SO		6	CwSxw-Oak fern-Cat's tail moss	L
ICHmk3	SO		7	CwSxw-Oak fern-Cat's tail moss	L
ICHmk3	RD		6	CwHw-Devil's club-Lady fern	L
ICHmk3	RD		7	CwHw-Devil's club-Lady fern	L
ICHmk3	BS		3a	Scrub birch-Sedge-Sphagnum	N
ICHmk3	MI			Mine	N
ICHmk3	WD		3a	Willow-Red-osier dogwood floodplain	N
ICHwk2	HM		6	HwCw-Step Moss	L

Subzone Variant	Ecosystem Code	Modifier	Structural Stage	Name	Fisher RB Rating
ICHwk2	HO		4	CwHw-Oak fern	N
ICHwk2	HO		5	CwHw-Oak fern	N
ICHwk2	HO		6	CwHw-Oak fern	L
ICHwk2	HO		7	CwHw-Oak fern	L
ICHwk2	HO	c	5	CwHw-Oak fern	N
ICHwk2	HO	n	6	CwHw-Oak fern	L
ICHwk2	HO	s	5	CwHw-Oak fern	N
ICHwk2	RD		4	CwHw-Devil's club-Lady fern	N
ICHwk2	SO		4	SxwCw-Oak fern	N
ICHwk2	ST		6	Sxw-Twinberry-Oak fern	L
ICHwk2	WD	n	3b	Willow-Red-osier dogwood floodplain	N

Map Themes and Ratings Adjustments

The map theme that can be produced is Reproducing-birthing habitat. Polygon suitability will be adjusted using information from the Vegetation Resources Inventory (VRI). Polygons with black cottonwood or aspen in age classes >3 will be adjusted upwards to a rating of Moderate.

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WILDLIFE SPECIES ACCOUNT: MYOTIS BATS

Species Data

Species Name: Little brown myotis; northern myotis

Scientific Name*: Myotis lucifugus*; *M. septentrionalis*

Species Code: M-MYOT

Provincial Status: Blue-Listed (northern myotis); Yellow-listed (little brown myotis)

Identified Wildlife Status: No

COSEWIC Status: Endangered

Project Data

Ecoprovince: Southern Interior Mountains

Ecoregion: Columbia Highlands

Ecosection: Quesnel Highland

Biogeoclimatic Subzone Variants: ICHmk3, ICHwk2

Map Scale: 1:50,000

INTRODUCTION

The little brown myotis and northern myotis are small brown bats that feed on aerial invertebrates. Both species are threatened by the fungal disease known as white-nose syndrome, which affects bats as they hibernate during the winter. White-nose syndrome is not known to be present in British Columbia but the disease is currently present in Ontario and is spreading westward. The little brown myotis and northern myotis have recently been listed as Endangered under SARA due to catastrophic die-offs of these species from white-nose syndrome in eastern North America (Government of Canada 2014).

DISTRIBUTION

The little brown myotis occupies a wide variety of habitats (BC Conservation Data Centre 2015a; Nagorsen and Brigham 1993) and is well-distributed across North America (COSEWIC 2013). It is found across the province of BC (BC Ministry of Environment 2008a).

The range of the northern myotis extends from the Atlantic provinces across eastern North America as far west as eastern BC (COSEWIC 2013). The northern myotis is associated with boreal forests in BC (Nagorsen and Brigham 1993) and is found from Revelstoke north to the Yukon border (BC Ministry of Environment. 2008b).

Distribution in the Project Area

The presence of the little brown myotis and northern myotis in the vicinity of Mount Polley has not been confirmed but the provincial range of both species does include the study area. Little brown myotis and one individual field-identified as a northern myotis were captured in 2012 near Spanish Lake (approximately 11 km northeast of the mouth of Hazeltine Creek) during surveys for Spanish Mountain Gold (survey data file at http://a100.gov.bc.ca/pub/siwe/details.do?id=5044).

ECOLOGY AND KEY HABITAT REQUIREMENTS

Both little brown myotis and northern myotis hibernate during the winter. Little brown myotis may travel up to 200 km to hibernacula in abandoned mines (Nagorsen and Brigham 1993). Hibernacula of northern myotis have not been confirmed in BC but this species hibernates in tunnels, caves and mines in other locations (COSEWIC 2013).

Myotis bats leave their hibernacula in spring when flying insects are once again available. Female northern myotis and little brown myotis give birth to a single pup annually, usually in June or July (B.C. Conservation Data Centre 2015a, b). Multiple females rear their young in communal maternity roosts, which are often re-used year to year. The pups fledge in late summer and are weaned at approximately 26 days of age (Burnett and Kunz 1982 in COSEWIC 2013). Mating takes place in the fall before or during hibernation. The females store the sperm over the winter before becoming pregnant in early spring (B.C. Conservation Data Centre 2015a, b).

Feeding

Little brown myotis emerge from their roosts at dusk and forage for insects, which they capture in flight. Primary prey species include midges, caddisflies and mayflies (Nagorsen and Brigham 1993) but many types of insect are taken as long as they are the appropriate size. Northern myotis in the eastern United States consumed primarily Lepidoptera (moths) and Coleoptera (beetles) (Dodd et al. 2012).

Little brown myotis and northern myotis forage over waterbodies, rivers, forest openings and along edges and forest trails (COSEWIC 2013). Northern myotis prefer interior forest (B.C. Conservation Data Centre 2015b) and avoid flying through open, nonforested areas (Alberta Sustainable Resource Development and Alberta Conservation Association 2009).

Thermal-Security

Maternity roost sites and hibernacula are thought to be the limiting habitat features for both species (Barclay and Brigham 1996 in COSEWIC 2013; Norquay et al. 2013 in COSEWIC 2013). Females may use several different roost sites while pregnant and nursing (Barclay and Kurta 2007). Little brown myotis day-roost in tree cavities, in rock crevices, in buildings, and in caves (Nagorsen and Brigham 1993). Warm roost sites are preferred by pregnant and nursing females in order to speed development of their pups (Alberta Sustainable Resource Development and Alberta Conservation Association 2009). Little brown myotis maternity roosts have been found in buildings but northern myotis have not been documented using buildings in BC (COSEWIC 2013; Nagorsen and Brigham 1993).

Northern myotis and little brown myotis in northeastern British Columbia were found to roost primarily in mature stands of deciduous trees (trembling aspen and balsam poplar) where large snags were present in a variety of age classes (Vonhof and Wilkinson 2000; Keystone Wildlife Research Ltd. 2009). Reproductive female northern myotis and little brown myotis typically roost in colonies while non-reproductive females and males usually roost singly (Nagorsen and Brigham 1993; Vonhof and Wilkinson 2000). Typical roost microsites include cavities created by rot or by woodpeckers, under loose bark, or within crevices or splits on the trunk (Vonhof and Wilkinson 2000). In general, myotis roosting habitat tends to be composed of older forests with tall, large-diameter snags or defect trees in early stages of decay, that are in relatively open sites where they are warmed by the sun and there is a clear flight path (B.C. Conservation Data Centre 2015a, b). Older forest stands tend to have greater numbers of potentially suitable trees and snags (Alberta Sustainable Resource Development and Alberta Conservation Association 2009; COSEWIC 2013).

SEASONS OF USE

For the purposes of this model, the definition of the seasons is based on that defined by RIC (1999). Table 2 presents the seasonal divisions for *Myotis* in the Southern Interior Mountains.

Table 2: Seasons of Use for *Myotis* in the Southern Interior Mountains (RIC 1999)

Month	Season
November-April	Winter
May- June	Growing Season (Spring)
July-August	Growing Season (Summer)
September-October	Growing Season (Fall)

HABITAT USE AND ECOSYSTEM ATTRIBUTES

Ratings will be provided for Security-Thermal (roosting) habitat during the growing season. Characteristics of expected high-value roosting habitats for Myotis bats are summarized in Table 3.

Table 3: Key Roosting Habitat Attributes for Myotis During Spring and Summer

Life Requisite	Primary Life Requisite	Attributes Required	Structural Stage
Reproducing – Birthing (RB)	Security /thermal cover (ST)	Old or mature forest stands, presence of large-diameter *Populus*, or aspen, most likely found in riparian or moist ecosystem units	5 to 7

Ratings

Habitat ratings were generated using the four-class rating scheme (Table 4). The four classes used are High (H), Moderate (M), Low (L) and Nil (N).

Table 4: Six and Four-Class Rating Schemes Used for Habitat Ratings (RIC 1999)

% of Provincial Best*	Substantial Knowledge of Habitat Use (6-class)		Intermediate Knowledge of Habitat Use (4-class)	
	Rating	Code	Rating	Code
100 - 76%	High	1	High	H
75 - 51%	Moderately High	2	Moderate	M
50 - 26%	Moderate	3		
25 - 6%	Low	4	Low	L
5 - 1%	Very Low	5		
0%	Nil	6	Nil	N

*"Provincial Best" is the provincial benchmark habitat for a species against which all other habitats are compared.

Provincial Benchmark

There are no agreed-upon provincial benchmarks for bat habitats. High ratings are assumed possible in the study area. The maximum rating assigned (after adjustments) will be High.

Assumptions

Forested habitats in structural stages 6 (mature forest) and 7 (old forest) represent the most likely forest types to provide suitable roost trees for bats. These ecosystems are rated up to Moderate. Structural stages 3-5 are rated up to Low, and all vegetated habitats in structural stage 1-2 and all nonvegetated and anthropogenic units are rated Nil. A summary of the ratings applied to the ecosystems within the study area is presented below (Table 5).

Table 5: Habitat Ratings for Myotis Security-Thermal (ST)

Subzone Variant	Ecosystem Code	Modifier	Structural Stage	Name	Myotis TS Rating
ICHmk3	RF		4	CwSxw-Falsebox-Knight's Plume	L
ICHmk3	RF		5	CwSxw-Falsebox-Knight's Plume	L
ICHmk3	RF		6	CwSxw-Falsebox-Knight's Plume	M
ICHmk3	RF		7	CwSxw-Falsebox-Knight's Plume	M
ICHmk3	RF	s	5	CwSxw-Falsebox-Knight's Plume	L
ICHmk3	RH	p	6	CwSxw-Devil's club-Horsetail	M
ICHmk3	SF		4	SxwCw-Oak fern	L
ICHmk3	SF		5	SxwCw-Oak fern	L
ICHmk3	SF		6	SxwCw-Oak fern	M
ICHmk3	SF		7	SxwCw-Oak fern	M
ICHmk3	SO		3	CwSxw-Oak fern-Cat's tail moss	L
ICHmk3	SO		4	CwSxw-Oak fern-Cat's tail moss	L
ICHmk3	SO		5	CwSxw-Oak fern-Cat's tail moss	L
ICHmk3	SO		6	CwSxw-Oak fern-Cat's tail moss	M
ICHmk3	SO		7	CwSxw-Oak fern-Cat's tail moss	M
ICHmk3	RD		6	CwHw-Devil's club-Lady fern	M
ICHmk3	RD		7	CwHw-Devil's club-Lady fern	M

Table 5 (Cont'd): Habitat Ratings for Myotis Security-Thermal (ST)

Subzone Variant	Ecosystem Code	Modifier	Structural Stage	Name	Myotis TS Rating
ICHmk3	BS		3a	Scrub birch-Sedge-Sphagnum	N
ICHmk3	MI			Mine	N
ICHmk3	WD		3a	Willow-Red-osier dogwood floodplain	N
ICHwk2	HM		6	HwCw-Step Moss	M
ICHwk2	HO		4	CwHw-Oak fern	L
ICHwk2	HO		5	CwHw-Oak fern	L
ICHwk2	HO		6	CwHw-Oak fern	M
ICHwk2	HO		7	CwHw-Oak fern	M
ICHwk2	HO	c	5	CwHw-Oak fern	L
ICHwk2	HO	n	6	CwHw-Oak fern	M
ICHwk2	HO	s	5	CwHw-Oak fern	L
ICHwk2	RD		4	CwHw-Devil's club-Lady fern	L
ICHwk2	SO		4	SxwCw-Oak fern	L
ICHwk2	ST		6	Sxw-Twinberry-Oak fern	M
ICHwk2	WD	n	3b	Willow-Red-osier dogwood floodplain	N

Map Themes and Ratings Adjustments

The map theme that can be produced is Security-Thermal (roosting) habitat. Polygon suitability will be adjusted using information from the Vegetation Resources Inventory (VRI). Polygons with *Populus* sp. in structural stages 5-7 will be adjusted upwards by one ratings class for all ecosystems originally rated M or L (e.g., an L rating is adjusted to an M rating).

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APPENDIX H: QUESNEL AND POLLEY LAKES AQUATIC PRODUCTIVITY IMPACT ASSESSMENT

Barbara Wernick, M.Sc., R.P. Bio. and Lee Nikl, M.Sc., R.P.Bio.

Golder Associates Ltd.

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June 4, 2015

MOUNT POLLEY TAILINGS STORAGE FACILITY DAM FAILURE

Quesnel and Polley Lakes Aquatic Productivity Impact Assessment

Submitted to:
Mount Polley Mining Corporation
Box 12
Likely, BC V0L 1N0

REPORT

Report Number: 1411734-038-R-Rev0

Distribution:

1 copy - Mount Polley Mining Corporation
2 copies - Golder Associates Ltd.

Golder Associates

Summary

On August 4, 2014, a failure of the Tailings Storage Facility (TSF) dam (the event) and subsequent debris flow occurred at Mount Polley Mine near the Town of Likely, British Columbia. The purpose of this Quesnel and Polley Lakes Aquatic Productivity Impact Assessment (LAPIA) is to provide a preliminary characterization of potential changes in lake productivity as a result of the event. This report also addresses potential effects on Quesnel River.

This report provides a preliminary assessment of potential effects on the aquatic environment of the lakes and Quesnel River based on information available and understanding of the event at this time; however, this understanding is expected to increase as further studies are undertaken. The objective of this report was to address the potential effects on the overall aquatic productivity of Quesnel and Polley Lakes and Quesnel River as a result of the event. It was informed per Department of Fisheries and Oceans (DFO) guidance on assessing fisheries productivity to facilitate the efforts of the Habitat Remediation Working Group that has been established.

To facilitate the assessment of potential effects on productivity a conceptual ecological model was developed for fish-habitat-food interactions. These habitat and food requirements were grouped, resulting in three general assemblages applicable to a summer condition when the event occurred. The significance of the three assemblages is how potential stressors related to the event may affect lake productivity. The three fish-habitat-food assemblages and the preliminary potential for effects identified were as follows.

Littoral Zone and Benthic Habitats - Fish associated with the littoral zone and benthic habitats are oriented to the near-shore environment and feed largely on benthic prey (e.g., amphipods, larvae and pupae of aquatic insects such as chironomids), periphyton, or in some cases crustacean zooplankton in the water column. Fish in this group include early juvenile stages of salmon (*Oncorhynchus* spp.), Burbot (*Lota lota*), and Lake Whitefish (*Coregonus clupeaformis*) and are benthivores (i.e., their food comes from benthic substrates), and forage fish such as sucker, sculpin, chub, shiner and Northern Pikeminnow (*Ptychocheilus oregonensis*). The event resulted in the alteration of littoral habitat at the mouth of Hazeltine Creek, resulting in the displacement or potential (unconfirmed) loss of fish in the area. Debris was also deposited on the lakebed in the profundal area, which resulted in a change in the benthic habitat and a potential disruption in the benthic invertebrate community. The impact on the bed of Quesnel Lake continues to be studied. Although early sampling suggests that some recovery may have begun, benthos sampling subsequent to deposition and settling of the sediments is necessary to confirm if the impact is of a transient nature. Post-event toxicity testing indicated that Quesnel Lake water did not affect survival or growth of fish or growth of plant test species and geochemical evaluations carried out have found that the tailings will be chemically stable in the lakes and are not expected to leach.

Open-Water Habitat and Fish that Feed on Emerging Insects - Fish associated with open-water habitat and feed on emerging insects (e.g., chironomids) include Mountain Whitefish (*Prosopium williamsoni*) and smaller Rainbow Trout (*Oncorhynchus mykiss)*. Larger Rainbow Trout in Quesnel Lake may consume juvenile Sockeye Salmon (*O. nerka*) and Kokanee (*O. nerka*; freshwater variant). This assemblage also applies to Polley Lake, in which the main fish species is Rainbow Trout. Although early sampling suggests that some recovery may have begun, benthos sampling subsequent to deposition and settling of the sediments is necessary to confirm if the impact is of a transient nature. Post-event toxicity testing indicated that lake water did not affect survival or

growth of fish or growth of plant test species. In Polley Lake, Rainbow Trout size did not appear to change with condition factor of the trout being within the ranges measured in prior years; however, the event likely affected reproduction through the loss of eggs in the Upper Hazeltine Creek spawning habitat in 2014 and potentially through the loss of use of that habitat in 2015.

Open-Water Habitat and Fish that Feed on Crustacean Zooplankton - The assemblage of fish associated with open-water habitat and which feed on crustacean zooplankton consists of juvenile Sockeye Salmon and Kokanee. During the summer, this assemblage may also include Lake Trout. Post-event toxicity testing indicated that Quesnel Lake water did not affect survival or growth of fish, survival or growth of daphnid zooplankton, or growth of plant test species. The literature indicates that the direction of change in primary productivity as a result of introduction of suspended sediments to a lake depends on whether the phytoplankton are light limited or nutrient limited. The preliminary information available at this time suggest that there was an influx of phosphorus into Quesnel Lake and although changes in phytoplankton and zooplankton biomass were not observed, juvenile Sockeye Salmon collected west of Cariboo Island were larger than those from the lake east of Cariboo Island.

Quesnel River experienced several pulses of turbid water during transient seiche (internal lake wave) events and lake turnover. Post-event toxicity testing indicated that Quesnel River water did not affect survival or growth of fish, development of Rainbow Trout eggs through to alevins, survival or growth of daphnid zooplankton, or growth of plant test species. Richness and measures of diversity of the benthic invertebrate community in the river near the Town of Likely were similar to the reference locations as were the relative abundance of species sensitive to metals.

Some effects are duration dependent and additional data collection is presently underway that will further inform the understanding of the effect the event had on Quesnel and Polley Lakes and Quesnel River:

- MPMC commenced water quality and zooplankton sampling in May, 2015.
- The benthic invertebrate community in Quesnel and Polley Lakes will be sampled again in summer 2015 to evaluate the abundance and diversity of benthos in the disturbed areas of the lakebed.
- The disturbed area of the lakebeds will be monitored for habitat quality in summer 2015.

Finally, a human health and ecological risk assessment will be undertaken to evaluate the potential effects of the chemical parameters of concern on the lake environments. This will include an interpretation of fish tissue chemistry collected following the event.

Study Limitations

This report was prepared for the exclusive use of Mount Polley Mining Corporation (MPMC). The inferences concerning the data, site and receiving environment conditions contained in this report are based on information obtained during investigations conducted at the site by Golder, other consultants and MPMC, and are based solely on the condition of the site at the time of the site studies and subsequent investigations and remediation and other information obtained by Golder, as described in this report. Soil, surface water and groundwater conditions may vary with location, depth, time, sampling methodology, analytical techniques and other factors.

In evaluating the subject site and water quality data, Golder has relied in good faith on information provided. The factual data, interpretations and recommendations pertain to a specific project as described in this report, based on the information obtained during the assessment by Golder on the dates cited in the report, and are not applicable to any other project or site location. Golder accepts no responsibility for any deficiency or inaccuracy contained in this report as a result of reliance on the aforementioned information.

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If new information is discovered during future work, including excavations, sampling, soil boring, predictive geochemistry or other investigations, Golder should be requested to re-evaluate the conclusions of this report and to provide amendments, as required, prior to any reliance upon the information presented herein. The validity of this report is affected by any change of site conditions, purpose, development plans or significant delay from the date of this report in initiating or completing the project.

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TABLES

FIGURES

ABBREVIATIONS AND ACRONYMS

BC MoE .... British Columbia Ministry of Environment

BLM........ Biotic Ligand Model

CRA .... commercial, Aboriginal or recreational

DFO .... Department of Fisheries and Oceans

DL .... detection limit

DO........ dissolved oxygen

EC20 .... concentration at which a 20% effect is observed

FFHIA........ Fish and Fish Habitat Impact Assessment

HHERA .... human health and ecological risk assessment

LAPIA........ Lake and Aquatic Productivity Impact Assessment

MPMC .... Mount Polley Mining Corporation

NTU........ nephelometric turbidity units

RPD .... relative percent difference

TDS........ total dissolved solids

TSF .... tailings storage facility

TSS........ total suspended solids

UNBC........ University of Northern British Columbia

WQG .... water quality guideline

WQIA .... Water Quality Impact Assessment

YOY .... young of year

UNITS

°C........ degrees Celsius

km .... kilometre

km^2........ square kilometre

m .... metre

mg/kg dw .... milligrams per kilogram as dry weight

mg/L .... milligrams per litre

µg/L........ micrograms per litre

%........ percent

1.0 INTRODUCTION

1.1 Background

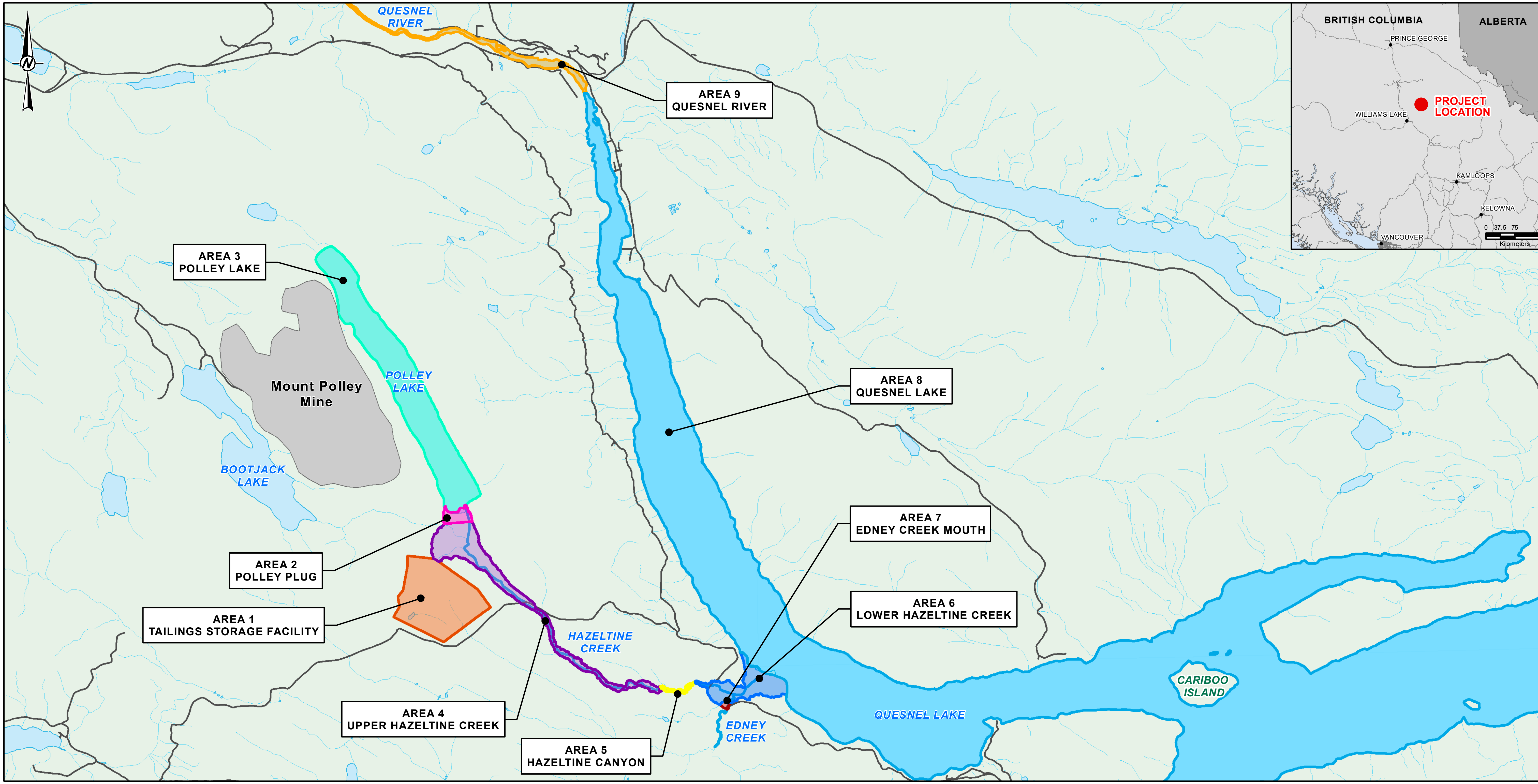
On August 4, 2014, a failure of the Tailings Storage Facility (TSF) dam (the event) and subsequent debris flow occurred at Imperial Metal's Mount Polley Mine (Figure 1). The purpose of this Quesnel and Polley Lakes Aquatic Productivity Impact Assessment (LAPIA) is to provide a preliminary characterization of potential changes in lake productivity as a result of the event. This report also addresses potential effects on Quesnel River.

This report provides a preliminary assessment of potential effects on the aquatic environment of the lakes and Quesnel River based on information available and understanding of the event at this time. The objective of this report was to address the potential effects on the overall aquatic health of Quesnel and Polley Lakes and Quesnel River as a result of the event. It has been structured per Department of Fisheries and Oceans (DFO) guidance on assessing fisheries productivity (Bradford et al. 2014) to facilitate the efforts of the Habitat Remediation Working Group that has been established.

Changes in productivity were assessed by comparing pre- and post-event data, where pre-event data were available, and by evaluating data in the context of the literature with consideration of site-specific conditions. Some effects are duration dependent and additional data collection is presently underway to inform the understanding of the event effects on Quesnel and Polley Lakes. A human health and ecological risk assessment (HHERA) is also planned that will more specifically address the potential effects of chemical parameters of concern in the environment.

The post-event data used in this report came from the following sources:

- The Water Quality Impact Assessment (WQIA; Golder 2015) presented water quality data collected by Mount Polley Mining Corporation (MPMC) staff and their consulting team (MPMC`s monitoring program is described in Appendix B of the WQIA) and identified key parameters that may have an effect on aquatic organisms in the receiving environment.
- The Fish and Fish Habitat Impact Assessment (FFHIA; SNC-Lavalin 2015c) identified fish species in Quesnel and Polley Lakes and Quesnel River and estimated the physical area affected by the TSF dam failure.
- The Bathymetry Analysis and Volume Balance (Tetra Tech EBA 2015a) evaluated the physical area of effect of the event in Quesnel Lake.
- The Sediment Quality Impact Characterization (Minnow 2015a) provided information regarding the potential for material introduced into Quesnel and Polley Lakes to affect fish food production.
- The Polley Lake Fish Assessment (Lirette 2015a) provided information on the condition of Rainbow Trout (*Oncorhynchus mykiss*).
- DFO provided length and weight data for fish collected from Quesnel Lake.
- The University of Northern British Columbia (UNBC) provided taxonomy and chemistry data for zooplankton collected from Quesnel Lake.



LEGEND

REMEDIATION AREA

- 1 - TAILINGS STORAGE FACILITY
- 2 - POLLEY PLUG
- 3 - POLLEY LAKE
- 4 - UPPER HAZELTINE CREEK
- 5 - HAZELTINE CANYON
- 6 - LOWER HAZELTINE CREEK
- 7 - EDNEY CREEK MOUTH
- 8 - QUESNEL LAKE
- 9 - QUESNEL RIVER

- MOUNT POLLEY MINE SITE
- ROAD
- WATERCOURSE
- WATERBODY

0 2 4
1:80,000 KILOMETRES

REFERENCES
1. WATERCOURSE, LAKE, ROAD, CITY AND PROVINCE DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
2. PROJECTION: NAD 1983 UTM ZONE 10

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-06-04
DESIGNED	BW
PREPARED	RH
REVIEWED	BW
APPROVED	BW

PROJECT
MOUNT POLLEY MINE
QUESNEL AND POLLEY LAKES AQUATIC PRODUCTIVITY IMPACT ASSESSMENT

TITLE
POST-EVENT ENVIRONMENTAL IMPACT ASSESSMENT STUDY AREAS

PROJECT NO.	CONTROL	REV.	FIGURE
1411734	10000 / 3000	0	1

1.2 Overview of Quesnel Lake

Quesnel Lake is a large, deep fjord lake with a surface area of 266 km^2; the lake is comprised of East, West and North Arms. It is the deepest fjord-type lake in the world with a maximum depth of 511 m in the East Arm (Laval et al. 2008). The West Basin is a shallower (113 m maximum depth) portion of the West Arm separated by a 35 m deep sill near Cariboo Island. The West Basin has vertical mixing that is typical of temperate lakes, with thermal stratification for most of the year interrupted by brief turnover periods in the spring and the fall when vertical density gradients are lowest. In the deeper portions of the lake, seasonal overturn events only occur in the upper 100 to 200 m of the water column due to changes in temperature-density relationships with increased pressure at greater depths (Laval et al. 2008). The key drivers of circulation patterns in Quesnel Lake have been studied in detail (James 2004; Laval et al. 2012; Laval et al. 2008; Potts 2004) and are described in Tetra Tech EBA (2015b). Limnological data were collected between 1985 and 1988, and in 1990 by Nidle et al. (1994), providing mean values for thermocline depth (12.4 m), epilimnetic temperature (12.4°C), and euphotic zone depth (15.5 m) (Shortreed et al. 2001). Mount Polley Mine is located near the West Basin of Quesnel Lake, which received inputs from the event via water and debris flows via Hazeltine Creek.

Nidle et al. (1994) also collected water chemistry data related to lake productivity, specifically, nutrients, pH, alkalinity, and total dissolved solids (TDS). At the time of sampling, mean annual lake-wide concentrations of total phosphorus (0.0027 mg/L), nitrate (0.104 mg/L as nitrogen [N]), and total chlorophyll *a* (1.03 µg/L) were within the range for oligotrophic lakes (Shortreed et al. 2001). Annual lake-wide summaries indicated that the lake was slightly alkaline (average pH 7.2 to 7.8 relative pH units), low in TDS (59 to 66 mg/L), with low sensitivity to acid inputs (total alkalinity from 44 to 50 mg/L as calcium carbonate [$CaCO_3$]) (Nidle et al. 1994).

1.3 Overview of Polley Lake

Polley Lake is a long (6.17 km) narrow (0.65 km) lake situated adjacent to the Mount Polley Mine within a watershed area of 17.1 km^2. Minnow (2014) estimated the hydraulic residence time of the lake as approximately 16.2 years. The lake has a mean depth of 18 m and maximum depths of 35 m in the southeast basin and 33 m in the northwest basin. The main inflow to the lake is from the Frypan Lake sub-watershed situated to the north. The present configuration of Polley Lake is not its natural form; Polley Lake was dammed and its drainage modified to provide water to hydraulic mining activities that occurred in the region during the early 1900's.

Polley Lake is dimictic and mixes from the surface to the lake bottom twice each year. Thermal stratification occurs in summer with a thermocline depth between 5 and 15 m (Minnow 2014). Hypoxic conditions generally occur at depths greater than 20 m, with dissolved oxygen (DO) concentrations less than 5 mg/L. Trophic status of the lake changed from oligotrophic/mesotrophic prior to mine development to mesotrophic/eutrophic in 2012.

Minnow (2014) summarized a sub-set of water quality data collected prior to the event (2009 to 2013) at two stations (P1 and P2) and two depths (surface and bottom) in Polley Lake. Based on this summary, water in Polley Lake is characterized as clear (median turbidity of 1.1 NTU), slightly alkaline (median pH 8.9 at surface and 7.7 at bottom), moderately soft in hardness (median hardness of 104 mg/L as $CaCO_3$) based on the scale described by McNeely et al. (1979), with low sensitivity to acid inputs (median total alkalinity of 79 mg/L as $CaCO_3$) based on the scale of acid sensitivity for lakes by Saffran and Trew (1996). Median concentrations of TDS at surface and bottom ranged from 132 to 135 mg/L. Median concentrations of chloride, sulphate, nitrate, nitrite, and ammonia were less than applicable British Columbia water quality guidelines (BC WQGs; BC MoE 2015) as were median concentrations of metals[1] (Minnow 2014).

[1] The term "metal" is used in this report to encompass metals, metalloids and non-metal elements.

1.4 Overview of Quesnel River

Quesnel River is a major tributary of the Fraser River located in the Cariboo District of central British Columbia. From its outflow at Quesnel Lake it flows 100 km to the northwest, descending 2,500 m, to its confluence with the Fraser River at the City of Quesnel. The river is situated in a basin with an area of approximately 11,500 km^2 and has a mean discharge rate of 230 m^3/s (Reynoldson et al. 2010).

Limited historical water quality data for Quesnel River were obtained from a BC Ministry of Environment (BC MoE) database and are restricted to near the Town of Likely. During the sampling period (1972 to 1987) the surface water was well-oxygenated (DO from 8.5 to 13.4 mg/L), clear (turbidity ranged from 0.2 to 1.4 NTU) and characterized as soft in hardness (46 to 56 mg/L as $CaCO_3$). A pH range of 6.5 to 8.1 was identified for this river with all measurements within the BC WQG pH range. Median concentrations of chloride, ammonia, nitrate, nitrite, and sulphate were less than their corresponding BC WQGs. Metals data were limited for Quesnel River; however, data for aluminum, chromium, copper, iron, lead, manganese, and zinc indicated that concentrations for these metals were less than BC WQGs.

2.0 CONCEPTUAL LAKE ECOLOGICAL MODEL

The interaction between biotic and abiotic factors in a lake is complex and in many cases it is unknown how a disruption will ultimately affect the overall productivity of a lake and its fisheries. In its most simple form, productivity begins with phytoplankton in open-water and attached algae (peri- and epiphyton) in near-shore, shallower areas harnessing energy from the sun (Figure 2). These primary producers may then be consumed by invertebrates or by fish directly and then carnivorous fish eat the invertebrates and grazing fish. Productivity may change when one or more of these linkages are affected.

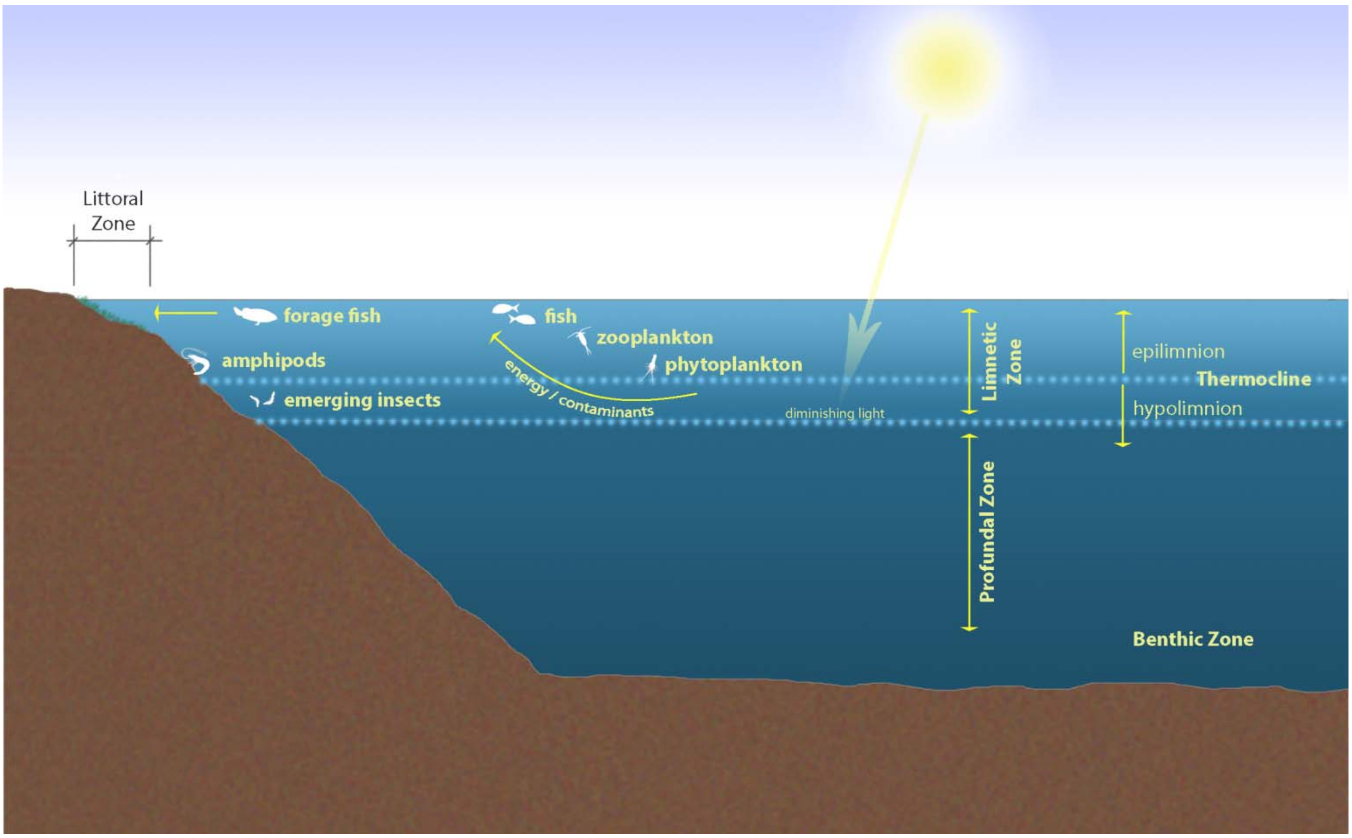


Figure 2: Generalized Conceptual Ecological Model for a Lake

Figure 2 contains several terms that are used throughout this report:

- **Benthic** – associated with the lake bottom.
- **Emerging insects** – insects that have a water-based larval stage and a flying adult stage.
- **Epilimnion** – the water column above the thermocline.
- **Hypolimnion** – the water column below the thermocline.
- **Limnetic zone** – the portion of the water column through which light penetrates.

- **Littoral zone** – the area of the lakeshore where aquatic plants grow. In Quesnel Lake, this area is 4 to 6 m deep.
- **Phytoplankton** – free-floating plants/algae and photosynthetic bacteria.
- **Profundal zone** – the portion of the water column that light does not reach and as a result does not support plant growth.
- **Thermocline** – a sharp density gradient in the water column that limits mixing of the water column which is caused by differences in temperature between the upper and lower water column. In the summer, the surface of the water column is warmer and the water at depth is cooler.
- **Zooplankton** – free-floating invertebrates.

2.1 Quesnel Lake

To facilitate the assessment of potential effects on the productivity of Quesnel Lake, a conceptual ecological model was developed for fish-habitat-food assemblages. Table 1 summarizes relevant life history and feeding habits of the 20 fish species identified in the FFHIA (SNC-Lavalin 2015c). These habitat and food requirements were grouped, resulting in three general assemblages applicable to a summer condition when the lake was stratified. This time period represents when the event occurred. When the lake is not stratified, fish usage of different parts of the lake may change. For example, Lake Trout (*Salvelinus namaycush*) are temperature sensitive and may stay below the thermocline during the summer whereas after the thermocline barrier has degraded and the lake has mixed, the fish will occupy the entire limnetic zone (McPhail 2007). Their food preference also changes from plankton during the summer to fish when the lake is not stratified.

Table 1: Summary of life history characteristics considered in conceptual ecological model

Species	Life Stage	Habitat	Food Habits	Notes
Anadromous Salmon				
Sockeye (*Oncorhynchus nerka*)	Juvenile	Littoral/pelagic	Chironomids, crustacean zooplankton initially, then crustacean zooplankton	First 5 weeks after hatching, juveniles occupy the littoral zone and after 5 weeks move off-shore and undertake diel (daily) vertical migration to 60 to 80 m during day and as shallow as 5 m at night. Some evidence that they orient to thermocline depth at night in Quesnel Lake.
	Adult	Open-water	NA	Migrate through lake to natal streams in August and September; no significant lake usage except lake spawners (lake spawning has not been observed in the West Arm of Quesnel Lake).
Coho (*O. kisutch*)	Juvenile/Adult	Open-water	Incidental	Migrate through lake to/from natal streams.
Chinook (*O. tshawytscha*)	Juvenile/Adult	Open-water	Incidental	Migrate through lake to/from natal streams.
Other Salmonids				
Kokanee (*O. nerka*, freshwater variant)	Juvenile	Littoral/open-water	Chironomids, crustacean zooplankton	YOY may forage in the littoral zone or move offshore. Juveniles undergo the same diel vertical migration as adults.
	Adult	Open-water	Crustacean zooplankton	Diel vertical migration during summer; feeding near surface at dawn and dusk, residing below the thermocline during the day and at night.
Rainbow Trout (*O. mykiss*)	Juvenile	Littoral	Benthic prey (amphipods, aquatic insects such as chironomids), plankton (crustacean zooplankton)	Inshore during winter and spring, occupying areas with cover except at night when they move over sand and gravel to feed. May move offshore in spring and summer.
	Adult	Open-water	Emerging insects, zooplankton; larger adults also eat other fish (e.g. Sockeye, Kokanee).	Diel vertical migration; more active at dawn and dusk. Spring spawning migration and summer feeding migration to Horsefly and Mitchell Rivers.

Species	Life Stage	Habitat	Food Habits	Notes
Lake Trout (*Salvelinus namaycush*)	Juvenile	Open-water	YOY – plankton; Juvenile – benthic prey	Tend to occupy deeper water than adults.
	Adult	Open-water	Fish, except in summer when they may eat plankton	During summer tend to be below the thermocline.
Bull Trout (*S. confluentus*)	Juvenile	Open-water	Aquatic insects	Rear in streams for first years; when they enter lakes they initially occupy deeper water than adults.
	Adult	Littoral (fall and spring); Open-water (summer)	Fish	Can feed under low-light conditions; shore-ward migration at night.
Lake Whitefish (*Coregonus clupeaformis*)	Juvenile	Littoral	Crustacean zooplankton	Move to deeper waters in summer and continue to descend in winter.
	Adult	Open-water	Benthic prey (chironomids, amphipods, gastropods, small fish)	Below thermocline during summer.
Mountain Whitefish (*Prosopium williamsoni*)	Juvenile	Littoral	Plankton	Remain inshore in <2 m water depth through spring and summer
	Adult	Littoral (spring/fall); Open-water (summer/winter)	Plankton, surface insects	Generally in upper 20 m of water column and found in low numbers in the limnetic zone.
Pygmy Whitefish (*P. coulterii*)	Adult	Off-shore	Benthic prey	Usually in 20 to 40 m of water; shore-ward migration at night.
Benthic Fish				
Burbot (*Lota lota*)	Juvenile	Littoral	Benthic prey – amphipods	Larvae initially limnetic, in spring become benthic. Associated with gravel, cobble and rubble substrate.
	Adult	Littoral (fall and winter); Off-shore (summer)	Fish (suckers, minnows, sculpin, trout)	Associated with gravel, cobble and rubble substrate. In summer, found offshore near the hypolimnion where they seek dark areas; vertical migration in summer; feed at night. In winter, move to shallower littoral areas. Spawn in winter.

Species	Life Stage	Habitat	Food Habits	Notes
Largescale Sucker (*Catostomus macrocheilus*)	-	Littoral/off-shore	Adults – benthic prey; Juveniles - plankton	Found above and below thermocline; horizontal migration (onshore at dawn and offshore at night).
Longnose Sucker (*C. catostomus*)	-	Littoral/off-shore	Benthic prey – chironomids	Adults forage inshore at night and remain below thermocline during the day.
Slimy Sculpin (*Cottus cogantus*)	-	Littoral/near-shore	Benthic prey – chironomids, amphipods, salmon eggs	May occur in deeper (4 to 10 m) water during summer. Feed at night. Tolerant of turbidity.
Forage Fish				
Northern Pikeminnow (*Ptychocheilus oregonensis*)	-	Littoral	Juveniles – crustacean zooplankton, chironomids; Adults – fish	Feed dusk to dawn, oriented to lake bed.
Peamouth Chub (*Mylocheilus caurinus*)	-	Littoral/near-shore	Plankton, benthic prey, aquatic insects	Adults forage in both the littoral and limnetic zone. School in shallow, vegetated areas oriented to lake bed.
Lake Chub (*Cousesius plumbeus*)	-	Littoral/near-shore	Benthic prey	Usually found at 0.5 to 10 m depth on bottom. May move to deeper water during the day in summer.
Leopard Dace (*Rhynichthys falcatus*)	-	Littoral	Periphyton, some aquatic insects.	Inhabit rocky, low gradient beaches with aquatic vegetation offshore.
Longnose Dace (*R. cataractae*)	-	Littoral/near-shore	Benthic prey	Horizontal migration between on-shore during day and off-shore at night; feed at night, oriented to lake bed.
Redside Shiner (*Richardsonius baleatus*)	-	Littoral/off-shore	Crustacean zooplankton, aquatic insects, eggs and fry of other fish	Usually found at <4 m depth in littoral zone during the day; horizontal migration offshore at night.

Notes:
Sources: Levy et al. (1991); McPhail (2007); Morton and Williams (1990); Parkinson et al. (1989); Roberge et al. (2001); Scott and Crossman (1973); Sebastian et al. (2003)
"<" - less than; m – metre; YOY – young of year

The significance of the three fish assemblages is how potential stressors related to the event may affect productivity as discussed in the framework presented in Section 3.0. The three fish/habitat assemblages identified were as follows:

Littoral Zone and Benthic Habitats

Fish associated with the littoral zone and benthic habitats (Figure 3) are oriented to the near-shore environment and feed largely on benthic prey (e.g., amphipods, larvae and pupae of aquatic insects such as chironomids, which are also known as midges), periphyton, or in some cases plankton (crustacean zooplankton) in the water column (McPhail 2007; Scott and Crossman 1973). Fish in this group include juvenile stages of salmon (*Oncorhynchus* spp.) and Burbot (*Lota lota*), Lake Whitefish (*Coregonus clupeaformis*) which preferentially inhabit the lake below the thermocline in the summer and are benthivores (i.e., their food comes from benthic substrates), and forage fish such as sucker, sculpin, chub, shiner and Northern Pikeminnow (*Ptychocheilus oregonensis*). The forage fish have a range of feeding habits and may consume primarily benthic invertebrates or periphyton, or in the case of Northern Pikeminnow, eat other fish (i.e., they are piscivorous). Other fish considered in this assemblage are adult Burbot, which are also piscivorous, and make vertical migrations in the summer to feed on trout, minnow, sucker and sculpin.

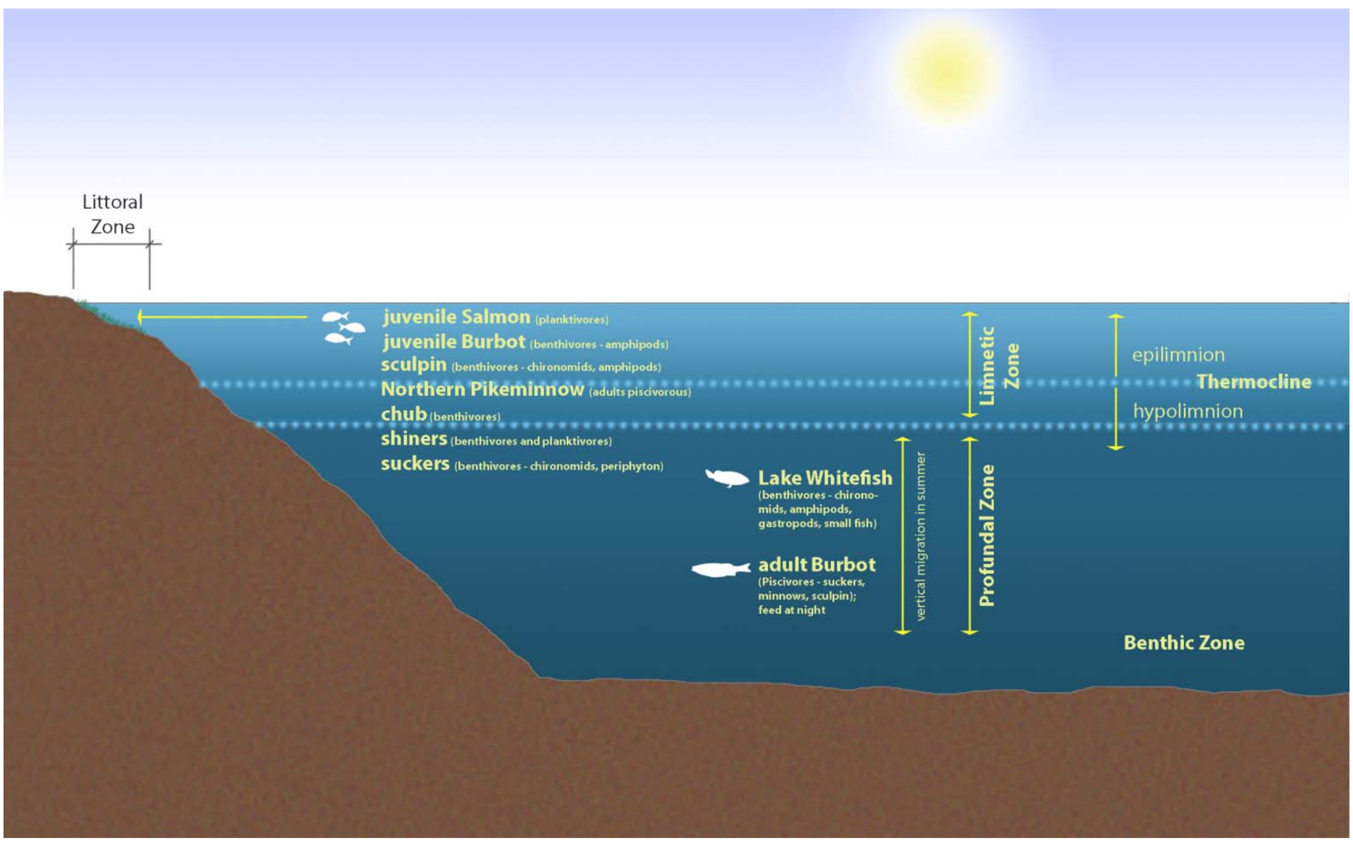


Figure 3: Conceptual Ecological Model for Littoral Zone and Benthic Habitats

Open-water Habitat and Fish that Feed on Emerging Insects

Fish associated with open-water habitat and feed on emerging insects (e.g., chironomids; Figure 4) include Mountain Whitefish (*Prosopium williamsoni*), which typically inhabit the upper 20 m of the water column, and smaller Rainbow Trout (*Oncorhynchus mykiss*), which undertake a diel (i.e., daily) vertical migration (McPhail 2007; Scott and Crossman 1973). Larger adult Rainbow Trout in Quesnel Lake may consume juvenile Sockeye Salmon (*Oncorhynchus nerka*) and Kokanee (*O. nerka*; freshwater variant; Parkinson et al. 1989).

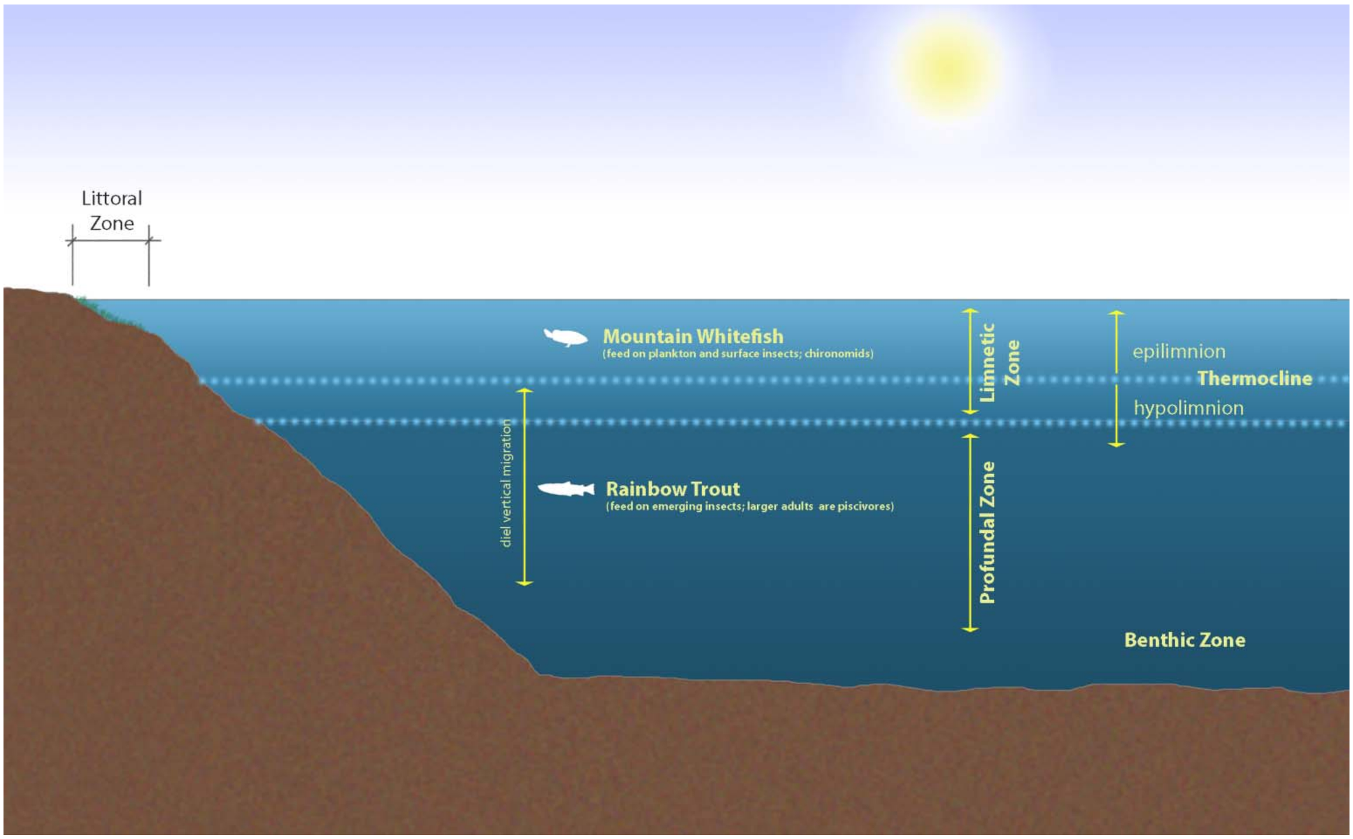


Figure 4: Conceptual Ecological Model for Open-water Habitat and Fish that Feed on Emerging Insects

Open-water Habitat and Fish that Feed on Crustacean Zooplankton

The assemblage of fish associated with open-water habitat and which feed on crustacean zooplankton (Figure 5) consists of juvenile Sockeye Salmon which undertake a diel vertical migration, orienting to the lower boundary of the thermocline at night (Levy et al. 1991) and descending to 60 to 80 m depth at night (McPhail 2007; Morton and Williams 1990; Scott and Crossman 1973). Kokanee also undertake a vertical migration, generally feeding near surface at dawn and dusk, and staying below the thermocline during the day and at night. During the summer, this assemblage may also include Lake Trout.

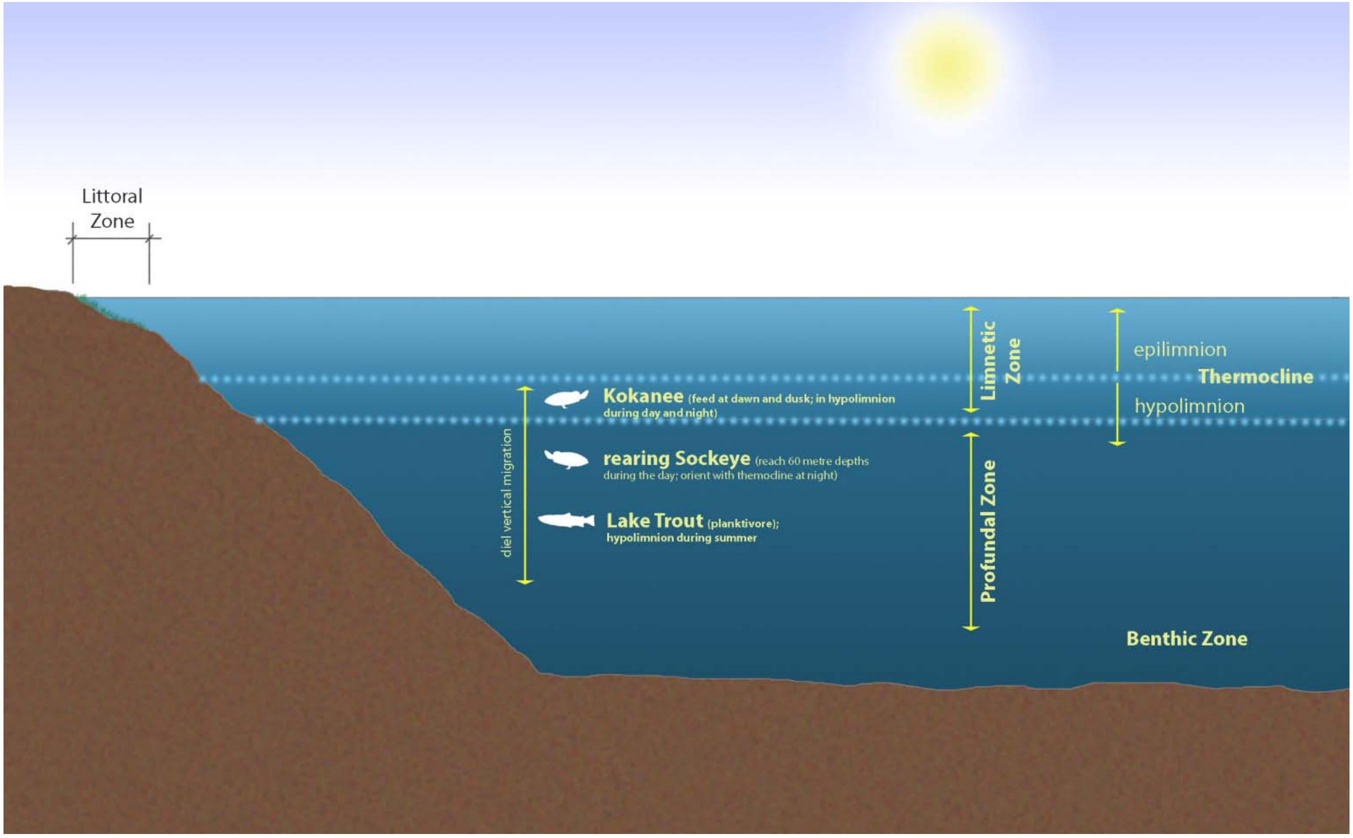


Figure 5: Conceptual Ecological Model for Open-water Habitat and Fish that Feed on Crustacean Zooplankton

2.2 Polley Lake

The conceptual ecological model for Polley Lake is a simplified version of that of Quesnel Lake. Rainbow Trout was the only CRA fish species identified by SNC-Lavalin (2015c). Other fish in the lake include Longnose Sucker and Redside Shiner. The conceptual model for open-water habitat and fish that feed on emerging insects described in Section 2.1 is applicable to Rainbow Trout.

3.0 FRAMEWORK FOR ASSESSING PRODUCTIVITY

DFO has developed a framework for assessing the potential for impacts to productivity from activities or undertakings (Bradford et al. 2014; Tupper de Kerckhove 2015). The framework starts with a generic fish life cycle and Components of Productivity (Figure 6), with the understanding that different habitats may be important for the different life stages of a fish and that different Pathways of Effect may have more or less influence on changes in those habitats. More specific life-cycle information for Quesnel and Polley Lake fish is provided in Section 2.0 (Table 1).

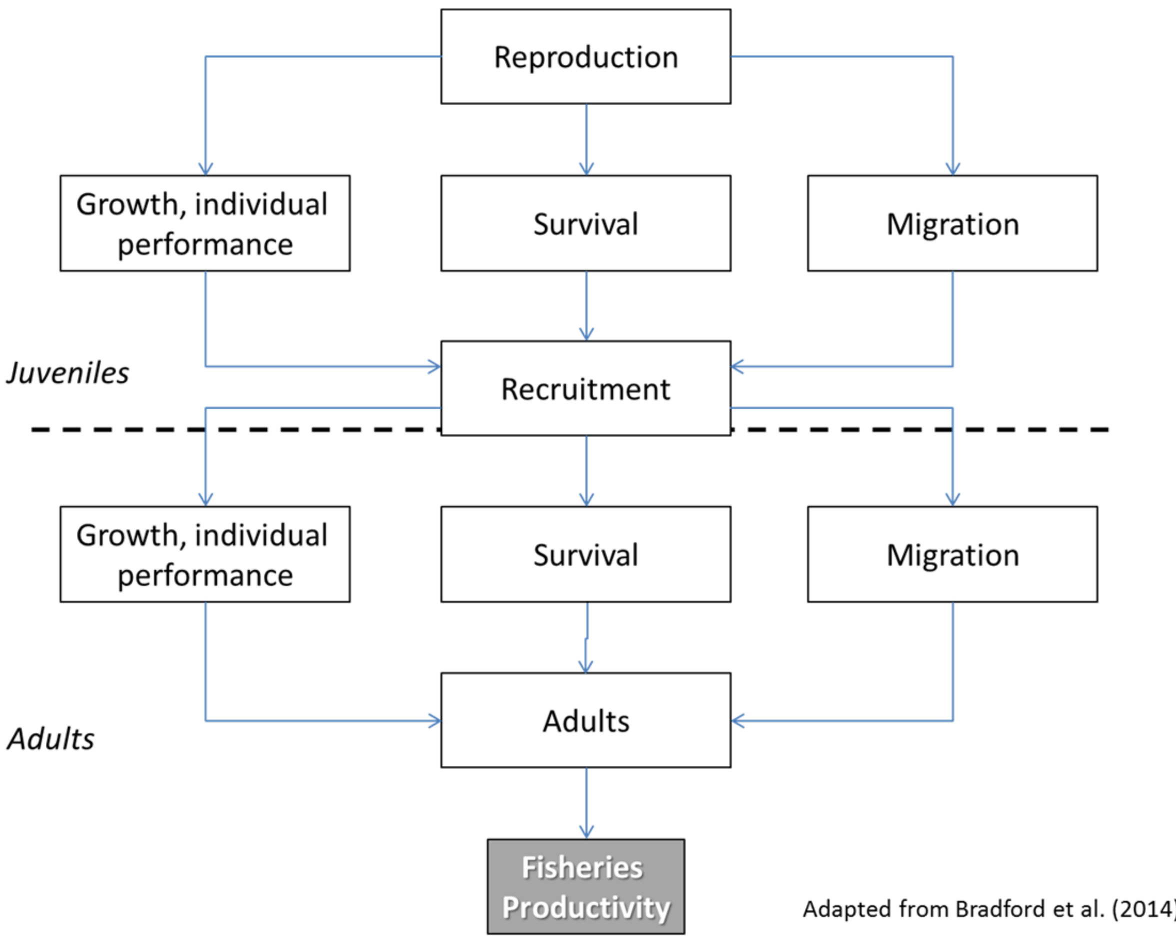


Figure 6: Generalized Fish Model with Major Components of Productivity

In the productivity framework, a **Pathway of Effects** is a specific activity or change in conditions that may affect Components of Productivity. For example, for the TSF dam failure, a Pathway of Effect was the introduction of debris from Hazeltine Creek onto the lakebed and into the water column of Quesnel Lake. A **Component of Productivity** is an aspect of fish productivity such as growth, survival, individual performance, or reproduction that may be altered by a change in conditions and a **Sub-component of Productivity** contributes to a

Component of Productivity. For example, sub-components of growth include food availability (quality and quantity) and feeding/foraging efficiency. **Indicators** are measures for predicting a change in a Component of Productivity. These may be qualitative or descriptive where there is a lack of data, or may be quantitative when sufficient information and understanding exist to accurately estimate change. Finally, **Measurements** are specific endpoints that can be used to describe changes in a given component or sub-component of productivity, for example the length and weight of a fish, or zooplankton abundance.

Table 2 summarizes the framework for assessing effects to fisheries productivity in Quesnel Lake and Table 3 summarizes the framework for Polley Lake, including the components and sub-components of productivity, the mechanisms of effect, the type of indicator that will be used (i.e., qualitative or quantitative), and information available to measure the effect. Table 2 is used in Section 4.0 to summarize the assessment for each of the three fish assemblages identified in the conceptual ecological model for Quesnel Lake (Section 2.1). Table 3 is used in Section 5.0 to summarize the assessment for each of the fish assemblage identified in the conceptual ecological model for Polley Lake (Section 2.2).

At this time, the indicators used in this preliminary assessment are qualitative and inferences are made based on the available data. No predictions or modelling of changes in overall fish populations are included in this report.

Table 2: Framework for Assessing Impact to Fisheries Productivity in Quesnel Lake

Component of Productivity	Sub-component	Mechanism	Indicator		Information Available / Measurement
			Qualitative	Quantitative	
Survival	Density independent mortality	Direct mortality	Yes	No	■ Literature information regarding potential direction of change. ■ No data on numbers of fish present or area of habitat occupied at the time of the event. ■ No data on potential mortality.
		Exceedance of environmental tolerances	Yes	No	■ Water toxicity test data. ■ Literature information regarding potential direction of change. ■ No data on numbers of fish present or area of habitat occupied at the time of the event.
	Habitat quality or quantity	Habitat supply limitation	Yes	No	■ Area of littoral and benthic habitat affected.
Growth	Fish Growth	-	Yes	No	■ Water toxicity test data. ■ Length and weight data for Sockeye Salmon juveniles; comparison between reference and exposed stations and historical data.
	Food supply	Quantity	Yes	No	■ Water column measurements: ▪ Nutrient concentrations. ▪ Chlorophyll *a* measurements. ▪ Water toxicity test data. ■ Sediment/benthic habitat measurements: ▪ Sediment toxicity test data. ▪ *In situ* benthic invertebrate community data. ■ Zooplankton community abundance and composition. ■ Comparison between reference and exposed stations. ■ Comparison with historical data where available.

Component of Productivity	Sub-component	Mechanism	Indicator		Information Available / Measurement
			Qualitative	Quantitative	
Growth cont.	Food supply cont.	Quality	Yes	No	■ Zooplankton tissue chemistry; comparison between reference and exposed stations. ■ No information on benthic invertebrate tissue chemistry.
	Efficiency	Foraging	Yes	No	■ Literature information regarding potential direction of change in feeding based on turbidity measurements. ■ Length and weight data for Sockeye Salmon juveniles; comparison between reference and exposed stations and historical data.
		Bioenergetics	Yes	No	■ Literature information regarding potential direction of change in feeding based on turbidity measurements. ■ Length and weight data for Sockeye Salmon juveniles; comparison between reference and exposed stations and historical data.
	Stress	Suboptimal environmental conditions	Yes	No	■ Water toxicity test data. ■ Literature information regarding direction of change based on turbidity measurements.
	Olfactory effects	Suboptimal environmental conditions	Yes	No	■ Literature information regarding direction of changed based on copper concentrations. ■ Data on adult Sockeye Salmon returns.
	Disease	Infection	Yes	No	■ Literature information regarding potential direction of change. ■ No data on potential infection.
Migration	-	Disruption of normal behaviour	NA	NA	■ Event did not block migratory routes through Quesnel Lake.

Component of Productivity	Sub-component	Mechanism	Indicator		Information Available / Measurement
			Qualitative	Quantitative	
Reproduction	Adult maturation	Suboptimal environmental conditions	Yes	No	■ Literature information regarding potential direction of change.
	Density-independent reproductive success	Spawning habitat quality	Yes	No	■ Water toxicity test data ■ Condition of spawning habitat following the event.
	Density-dependent reproductive success	Spawning habitat quantity	Yes	No	■ Area of spawning habitat altered.

Notes:
Based on Bradford et al. (2014)
NA – not applicable

Table 3: Framework for Assessing Impact to Fisheries Productivity in Polley Lake

Component of Productivity	Sub-component	Mechanism	Indicator		Measurement
			Qualitative	Quantitative	
Survival	Density independent mortality	Direct mortality	Yes	No	■ Literature information regarding potential direction of change. ■ No direct data on numbers of fish present at the time of the event. ■ No direct data on potential mortality.
		Exceedance of environmental tolerances	Yes	No	■ Literature information regarding potential direction of change ■ Water toxicity test data. ■ No direct data on numbers of fish present or area of habitat occupied at the time of the event.
	Habitat quality or quantity	Habitat supply limitation	Yes	No	■ No estimate available for the area of littoral or benthic habitat altered at this time.
Growth	Fish growth	-	Yes	No	■ Water toxicity test data. ■ Length and weight measurements of Rainbow Trout in September 2014.
	Food supply	Quantity	Yes	No	■ Water column measurements: ▪ Nutrient concentrations. ▪ Limited chlorophyll *a* measurements. ▪ Water toxicity test data. ■ Sediment/benthic habitat measurements: ▪ Sediment toxicity test data. ▪ Benthic invertebrate community structure. ■ Comparison between reference and exposed stations. ■ Comparison with historical data where available. ■ No information on zooplankton abundance and community composition.

Component of Productivity	Sub-component	Mechanism	Indicator		Measurement
			Qualitative	Quantitative	
Growth cont.	Food supply cont.	Quality	No	No	■ No information on zooplankton tissue chemistry. ■ No information on benthic invertebrate tissue chemistry.
	Efficiency	Foraging	Yes	No	■ Literature information regarding potential direction of change in feeding based on turbidity measurements. ■ Length and weight measurements of Rainbow Trout in September 2014. ■ Comparison to historical data.
		Bioenergetics	Yes	No	■ Literature information regarding potential direction of change in feeding based on turbidity measurements.
Individual performance	Stress	Suboptimal environmental conditions	Yes	Yes	■ Literature information regarding direction of change based on turbidity measurements. ■ Water toxicity test data. ■ No data on fish condition other than length and weight.
	Olfactory effects	Suboptimal environmental conditions	NA	NA	■ Not assessed - rainbow trout are a resident population.
	Disease	Infection	Yes	No	■ Literature information regarding potential direction of change. ■ No data on potential infection.
Migration	-	Disruption of normal behaviour	Yes	No	■ Post-event rehabilitation activities restricted fish access to Hazeltine Creek to prevent loss of fish from population.

Component of Productivity	Sub-component	Mechanism	Indicator		Measurement
			Qualitative	Quantitative	
Reproduction	Adult maturation	Suboptimal environmental conditions	Yes	No	■ Observations of spawning behaviour. ■ Literature information regarding potential direction of change.
	Density-independent reproductive success	Spawning habitat quality	Yes	No	■ Water toxicity test data. ■ Condition of spawning habitat post-breach.
	Density-dependent reproductive success	Spawning habitat quantity	Yes	No	■ Area of spawning habitat lost.

Notes:
Based on Bradford et al. (2014)
NA – not applicable

An additional factor that is important to the assessment of effects on fisheries productivity is the timing of the event and associated changes to water quality and habitat relative to the general cycle in rate of productivity. For example, Figure 7 illustrates a conceptual model of productivity in an unaffected generic lake environment which is directly related to the Component of Productivity growth. In the spring, the biomass of phytoplankton increases rapidly as light intensity increases and in response zooplankton biomass will increase after a lag period (Wetzel 2001). This is then followed by increasing biomass in fish such as Sockeye Salmon that consume those zooplankton. The event occurred during the late summer and a substantial degree of plankton and fish biomass may already have been accumulated. Thus, the potential for effects to productivity of fish would be relative to the incremental change that would have occurred after the event. Similarly, during lake turnover and the increase in turbidity observed through the water column of Quesnel Lake (Golder 2015), productivity would naturally be declining and the effect would again be incremental.

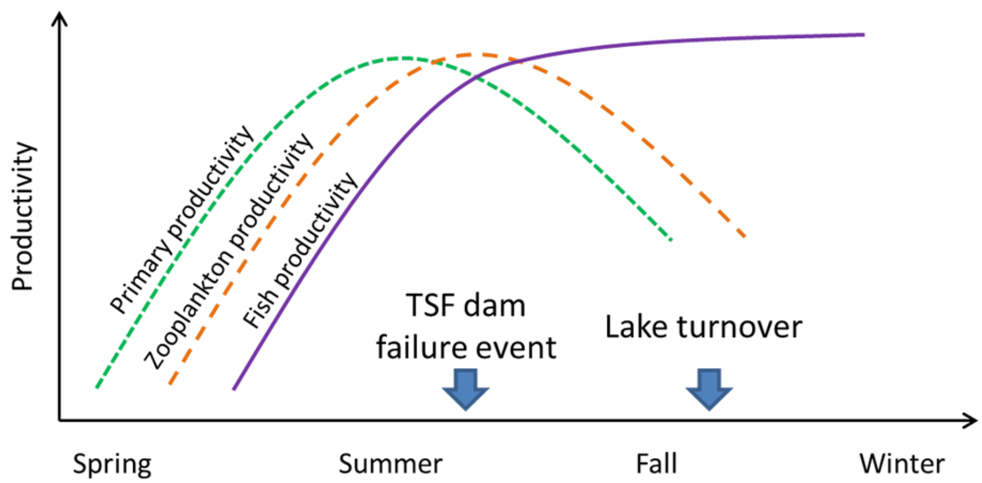


Figure 7: Conceptual Lake Productivity Model Under Natural Conditions (Not Actual Data from Quesnel Lake)

4.0 QUESNEL LAKE IMPACT ASSESSMENT

This section addresses the Components of Productivity summarized in Table 2 for Quesnel Lake.

4.1 Survival

4.1.1 Direct Mortality of Fish

It is possible that fish occupying the littoral zone at the mouth of Hazeltine Creek were entrained in the debris or they may have been displaced in advance of the debris reaching the lake. However, dead fish were not observed and this potential effect on productivity cannot be quantified.

4.1.2 Exceedance of Environmental Tolerances

Servizi and Gordon (1990) and Servizi and Martens (1987) undertook studies on the acute lethality of suspended Fraser River sediments on juvenile Chinook (*Oncorhynchus tshawytscha*) and Sockeye Salmon, respectively. Juvenile Chinook Salmon were almost twice as tolerant as juvenile Sockeye with 96-h LC_{50} values of 31,000 mg/L and 17,600 mg/L, respectively. Servizi and Martens (1991) found that smaller fish were more susceptible to suspended solids-induced mortality than larger fish. Data were not available in the period immediately (e.g., hours to days) after the event. However, the on-going monitoring program reported TSS levels less than 50 mg/L (Figure 8). No dead fish were observed and this potential effect on productivity cannot be quantified with available data.

Minnow (2015b) reported on a total of 53 toxicity tests (acute and chronic) using six different species that were carried out on water samples collected between August and September 2014 from Polley Lake, the discharge from Polley Lake into Hazeltine Creek, Quesnel Lake, and the Quesnel River. Quesnel Lake water samples were taken from the monitoring station closest to the source of event-related inputs at the mouth of Hazeltine Creek. Additional water samples were collected from November 2014 to February 2015 with a focus on sublethal toxicity testing. The fish tests included the following:

- 96-h acute lethality to Rainbow Trout (first sampling event); and
- 7-d survival and growth of Fathead Minnow (*Pimephales promelas*; representative of forage fish that may occupy the littoral zone) (first and second sampling events).

The water collected from Quesnel Lake was not acutely toxic to Rainbow Trout, and survival of Fathead Minnow in the 7-day test was not affected.

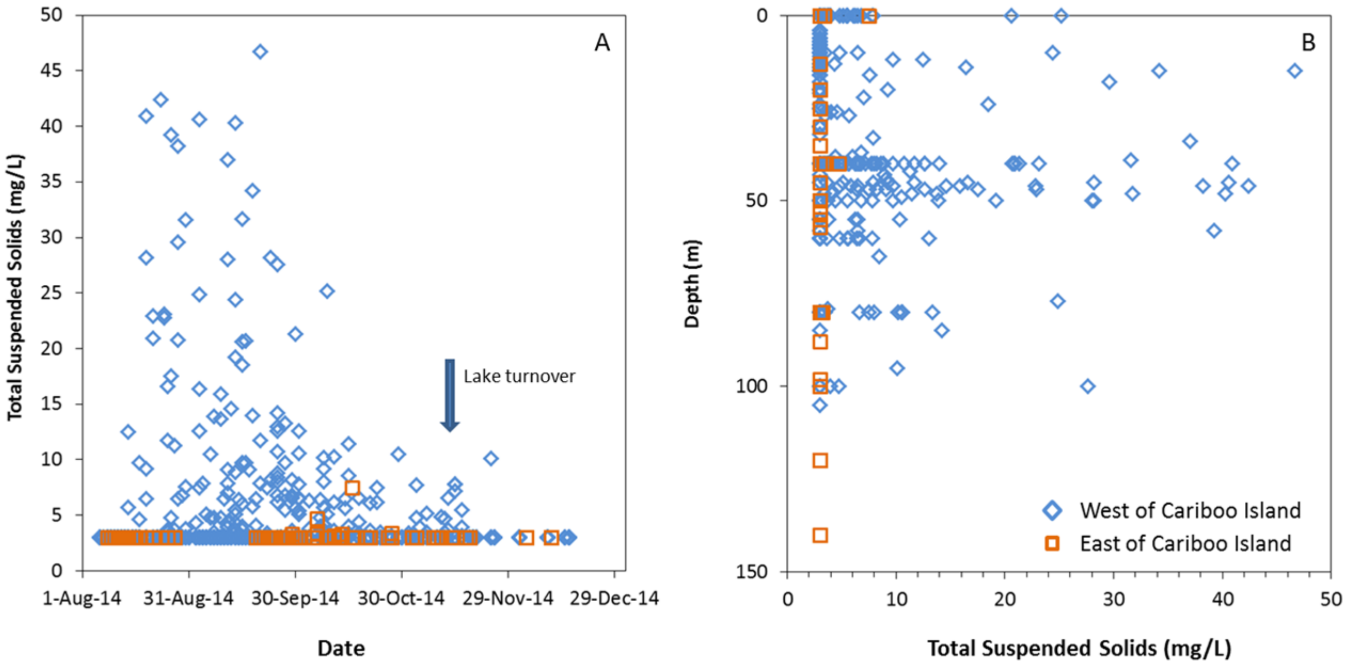


Figure 8: Spatial and Temporal Variability in Total Suspended Solids Concentration in the West Arm of the West Basin (West of Cariboo Island; 23 stations) Compared to the Middle Arm (East of Cariboo Island; 10 stations) of Quesnel Lake by Sampling Date (A) and Depth (B)

4.1.3 Habitat Quantity or Quality

The littoral zone at the mouth of Hazeltine Creek was altered as a result of the event, estimated to be 0.094 km^2 in area (SNC-Lavalin 2015c). This is approximately 6.5% of the West Basin littoral zone. Approximately 1.81 km^2 of the lake bed below the 100 m contour was covered by debris from Hazeltine Creek (Tetra Tech EBA 2015a).

The physico-chemical quality and toxicity of lake sediments were addressed by Minnow (2015a). The particle-size distribution of sediment immediately to the east of Hazeltine Creek consisted of a higher proportion of silt (mean of 85%) than other littoral sampling locations (mean of 30 to 54%) whereas on the lakebed (i.e., in the profundal zone) immediately off-shore from Hazeltine Creek had a similar grainsize distribution as several reference areas. Total organic carbon content was lower in the immediately affected area when compared to the reference areas.

Standard toxicity test organisms were evaluated under laboratory conditions using established protocols to determine if benthic-dwelling organisms could survive and grow normally (Minnow 2015a). In several samples, these organisms did not survive or grow as successfully as those exposed to reference sediment. The specific cause of toxicity was difficult to determine because the composition of newly deposited tailings-influenced sediments differs from natural sediment. For example, the organic carbon in the sediment, which is a food source to the test organisms, was low in many samples. When poor performance was observed in growth or survival, samples also contained much less organic carbon than recommended in test protocols for normal performance of the tests. It is therefore possible that apparent effects in some samples was due to food limitations, chemical influence, or both factors acting together. However, the study also provided indications of normal growth and survival in sediments that were collected distant from the areas of greatest tailings influence (i.e., Quesnel Lake locations distant from Hazeltine Creek).

4.2 Growth

4.2.1 Fish Growth

The growth of fish themselves is a time-integrated measure of the cumulative influence of the number of factors that contribute to their wellness or productivity, such as food supply and exposure to contaminants and other potential stressors like turbidity (Rand and Petrocelli 1985). Organism growth and development also requires the simultaneous function of numerous cellular and sub-cellular processes, each of which could be potential targets for toxicants. Successful growth is therefore an indication that such toxic effects are not occurring. As it relates to the post-event impacts, information regarding growth is available from test organisms used in laboratory-based water toxicity tests and from fish collected from the receiving environment.

Growth of Fathead Minnow was not affected in the 7-day survival and growth tests conducted in water from Quesnel Lake between August and September 2014 and November 2014 and February 2015 (Minnow 2015b).

DFO collected Sockeye Salmon juveniles from mid-net depths of approximately 20 m from four locations in Quesnel Lake between September 23 and 27, 2014, and measured length and weight (D. Selbie, DFO, pers. comm.). The fish collected from the West Arm west of Cariboo Island were larger than the fish collected from east of Cariboo Island (Figure 9). Fish collected from the West Arm in 2014 were also notably larger than fish collected from the same location in 2013 (Figure 10). These data suggest that a change in foraging efficiency by juvenile Sockeye Salmon may not have occurred, perhaps because *Daphnia* have been found to occupy the upper 10 m of the water column during the summer (Levy 1990; Morton and Williams 1990) where turbidity was relatively low. Another possible explanation is that a change in foraging efficiency did occur but was offset by a larger food supply that may have resulted from the influx of phosphorus into the lake (Section 4.2.2.1). Data regarding the growth of other fish species was not available.

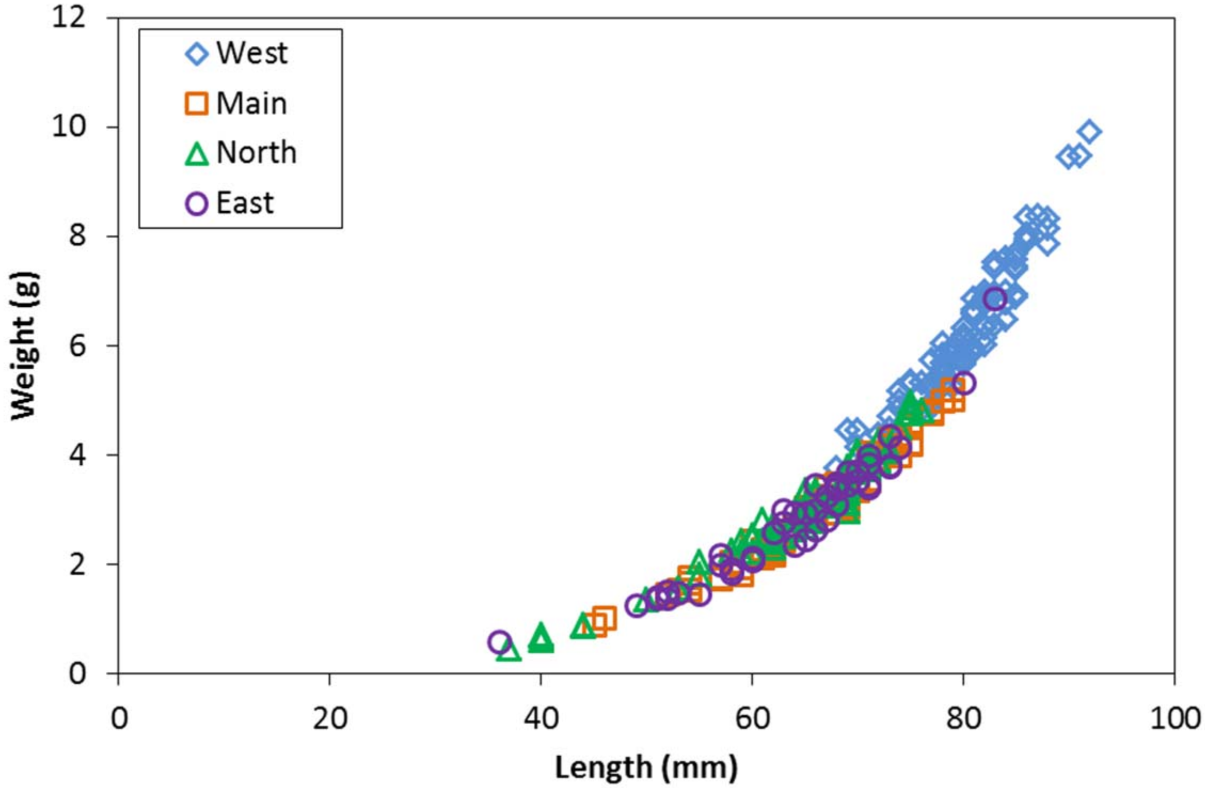


Figure 9: Length and Weight of Age 0+ Sockeye Salmon Collected from Exposed (West) and Reference (Main, North, East) Areas of Quesnel Lake Between September 23 and 27, 2014 (Data Courtesy of DFO)

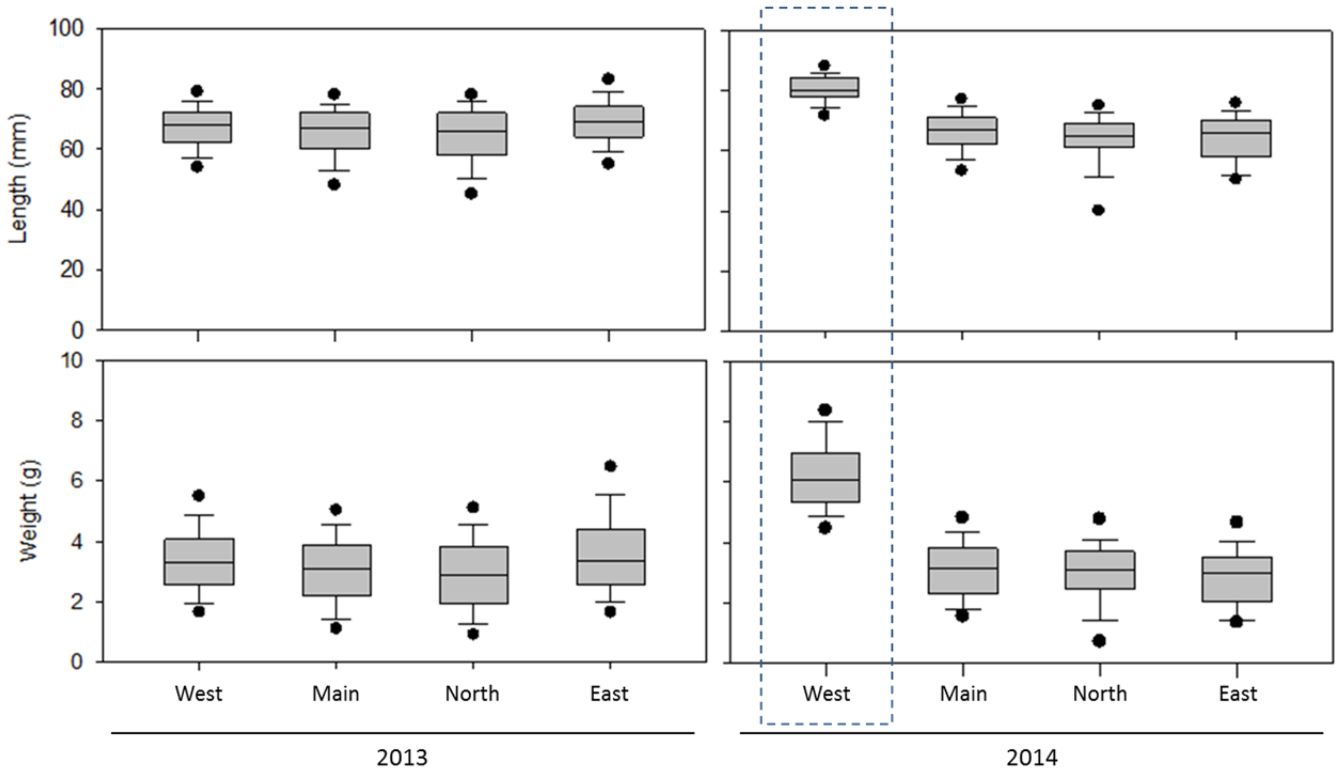


Figure 10: Comparison of Age 0+ Sockeye Salmon Length and Weight Between Exposed (West) and Reference (Main, North, East) Areas of Quesnel Lake and Pre- (2013) and Post-event (2014) (Box-plots Courtesy of D. Selbie, DFO)

4.2.2 Food Supply - Quantity

4.2.2.1 Nutrient Inputs

Introduction of suspended sediments can release nutrients and result in increased productivity (Schallenberg and Burns 1998) and mean total phosphorus concentrations have been correlated with fish production (Downing et al. 1990). As illustrated in Figure 11, there was an initial influx of phosphorus and possibly dissolved organic carbon in August. Total phosphorus concentrations were higher than pre-event conditions as well as those measured outside the West Basin, at depth (>20 m) in particular, but also in shallower water (<20 m). The dissolved phosphorus fraction was relatively lower and thus it was inferred that the phosphorus was associated with suspended particles deeper in the water column. There is some uncertainty about the type of phosphorus that may have been introduced to Quesnel Lake by the event. The phosphorus associated with the TSF is presumed to be in the mineral apatite form, which is not readily soluble. However, there is some evidence of partial dissolution of apatite to biologically-available orthophosphate at pH levels similar to those observed in Quesnel Lake (Smith et al. 1997). There appeared to be an increase in dissolved organic carbon in the top 20 m of the water column and thus it is also possible that the natural sediment and debris scoured from Hazeltine Creek contained biologically available phosphorus. Regardless of the source, given that Quesnel Lake is oligotrophic, even a relatively small increase in phosphorus could result in a rapid increase in primary productivity followed by an increase in productivity at higher trophic levels. This process is relatively efficient (i.e., utilization of phosphorus may be rapid) in oligotrophic lakes (Downing et al. 1990).

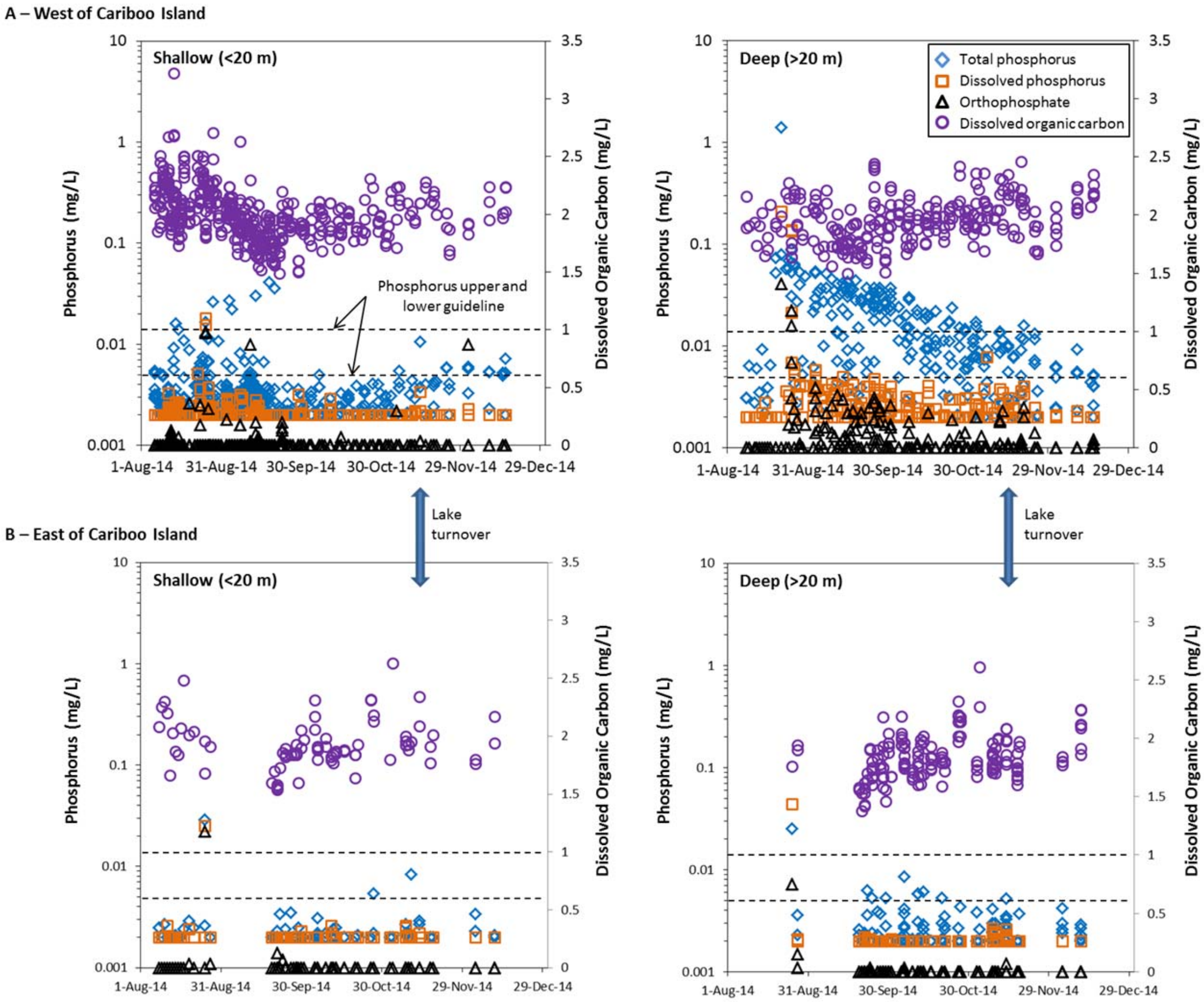


Figure 11: Temporal and Spatial Variability in Phosphorus and Dissolved Organic Carbon in Shallow (<20 m) and Deep (>20 m) Waters in (A) the West Arm of the West Basin (West of Cariboo Island; 23 stations) Compared to (B) the Middle Arm (East of Cariboo Island; 10 stations) of Quesnel Lake

4.2.2.2 Primary Productivity

Minnow (2015b) reported the findings of two plant tests conducted on water from Quesnel Lake:

- 7-d growth inhibition in the vascular aquatic plant *Lemna minor;* and
- 72-h growth inhibition in the alga *Pseudokirchneriella subcapitata* (formerly named *Selenastrum capricornutum*).

There was no impairment of growth of either test species, including in turbid water from a deeper sampling location in Quesnel Lake.

The direction of change in primary productivity as a result of introduction of suspended sediments to a lake depends on whether the phytoplankton are light limited or nutrient limited (Northcote et al. 2005; Schallenberg and Burns 2004; Schallenberg et al. 2001). Suspended sediment can inhibit photosynthesis by changing the depth to which light penetrates or can contribute nutrients that may be used by phytoplankton in an oligotrophic system as discussed in Section 4.2.2.1.

Data that provide an indication of the potential change in light penetration into the lake surface were available in the form of Secchi depth readings collected by MPMC, and historic Secchi depths presented in Nidle et al. (1994). Secchi depth is the depth at which a black and white disc lowered into the water column can no longer be seen (Figure 12), and can be correlated with the euphotic zone depth which is the depth to which light intensity is extinguished to 1% of its original intensity (French et al. 1982). Based on paired measurements collected in Quesnel Lake, Secchi depth ranges from similar to or half the euphotic zone depth as determined using a light meter (Nidle et al. 1994).

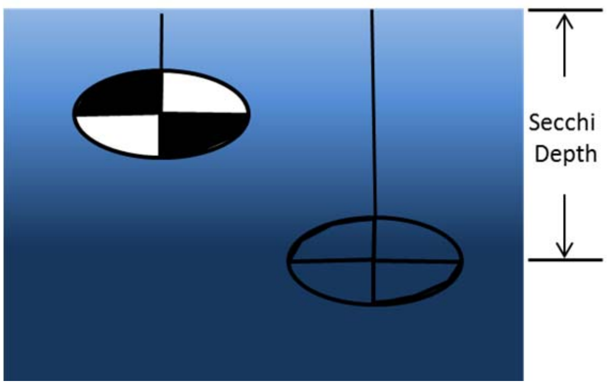


Figure 12: Illustration of Secchi Depth

Secchi depth was variable in the West Arm between sampling events but did not appear to be directly correlated with turbidity except during lake-turnover in the fall (Figure 13). Moreover, the relationship between Secchi depth and turbidity appeared to be similar between the West Arm of the West Basin (exposed) and the lake east of Cariboo Island (reference) where Secchi depth varied from between 3 and 11 m when turbidity was <1 NTU. Transient seiche[2] events resulted in the flow of water from the West Arm eastward over the sill at Cariboo Island into the main body of lake and the introduction of suspended sediment (Tetra Tech EBA 2015b) which could have influenced the Secchi depth in the main body of the lake. However, turbidity east of Cariboo Island was observed to be <1 NTU and most stations and sampling depths based on the MPMC dataset. Secchi depth at some stations was shallower during some sampling events than observed in 1985 to 1990, 2003 and 2004 in which whole-lake averages ranged from 8.8 to 10.2 m (Hume et al. 2005; Nidle et al. 1994).

[2] A seiche is a type of long-wavelength wave that occurs as a result of some disturbance within waterbody that is relatively closed-off from the outside environment.

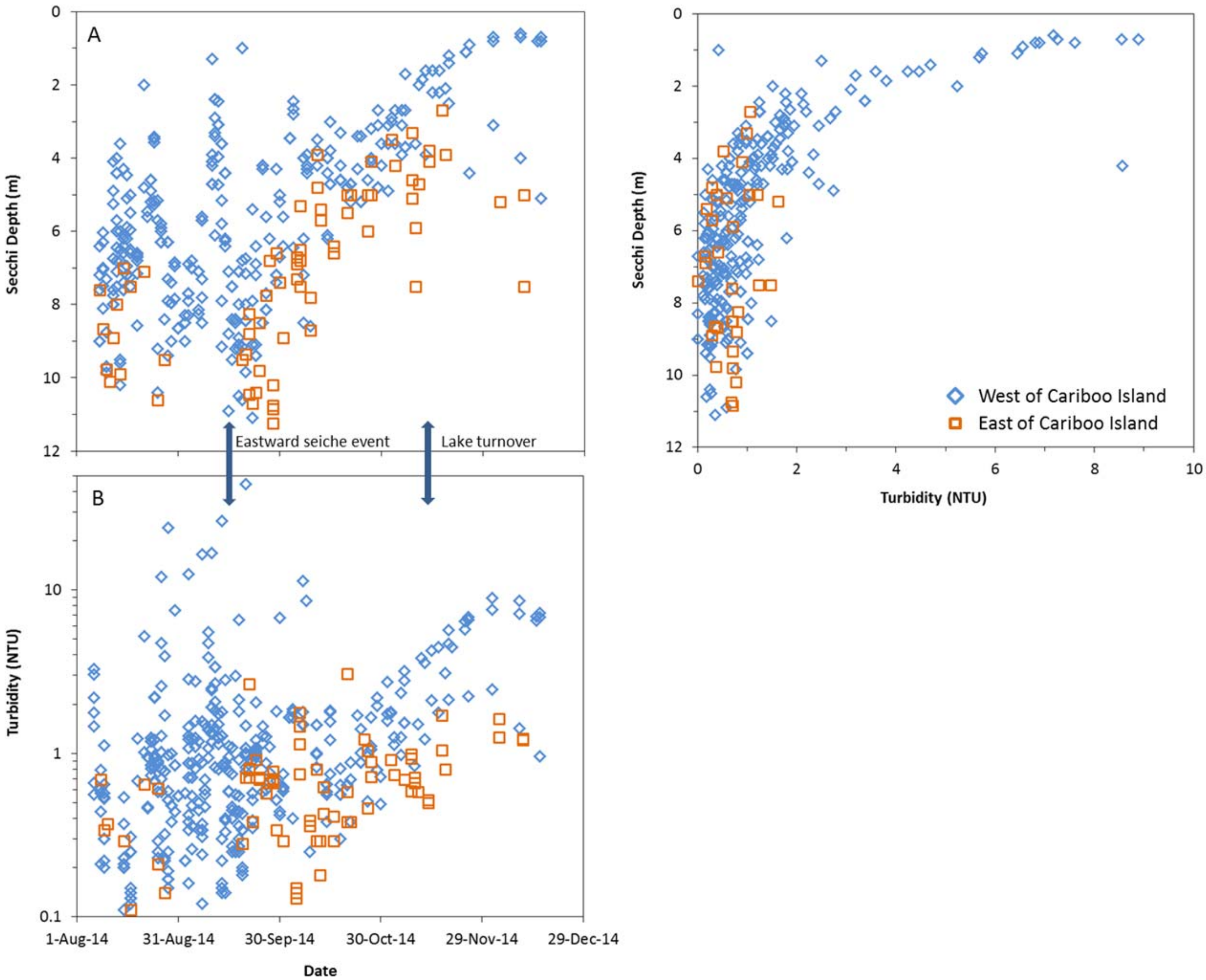


Figure 13: Temporal and spatial variability in Secchi depth (A) and turbidity in the upper 20 m of the water column (B), and Secchi Depth versus Turbidity (C) in the West Arm of the West Basin (West of Cariboo Island; 16 stations) compared to the Middle Arm (East of Cariboo Island; 10 stations) of Quesnel Lake

Lloyd et al. (1987) found that the depth of light penetration (as euphotic zone depth) could be correlated with fish production, thus a potential tool to quantify lost productivity is to compare the euphotic zone volume of the water column before and after the event. Euphotic zone depth was not measured directly in the post-event monitoring program. As discussed above, paired Secchi and euphotic zone depth data were collected by Nidle et al. (1994); however, the relationship between the two measures of light penetration is variable and estimating euphotic zone depth from the post-event Secchi depth data could result in a ±100% error and thus an unreliable prediction of change. Moreover, Lloyd et al. (1987) also observed that an increase in turbidity won't necessarily affect productivity through decreased light penetration if there is a nutrient limitation, which there is in Quesnel

Lake. Thus, it is preferable to assess direct measures of productivity such as chlorophyll *a*, a photosynthetic pigment in attached algae and phytoplankton that can be used as a surrogate for biomass or primary productivity.

Chlorophyll *a* concentrations were available for samples collected from the open-water zone of Quesnel Lake in early and mid-September following the event (Figure 14). Chlorophyll *a* in September 2004 (Hume et al. 2005) was similar to that observed post-event, and in September of 1985 to 1990 (Nidle et al. 1994) was higher than observed post-event. This natural variability in chlorophyll *a* concentration confounds the ability to use historical data to assess the potential for effect and a same-season comparison to reference conditions is preferable. Based on a visual assessment of the chlorophyll *a* time and depth series, biomass in the West Arm was similar to that in the lake east of Cariboo Island. This is not unexpected because of the lag time between the input of phosphorus and the measurement of chlorophyll *a* concentrations. The net growth of phytoplankton is controlled by zooplankton grazing (Huovinen et al. 1999) and the conversion of phytoplankton into fish production is relatively efficient in oligotrophic lakes (Downing et al. 1990). Phytoplankton biomass resulting from the phosphorus input may therefore have been rapidly converted into zooplankton and then fish biomass. The potential change in juvenile Sockeye Salmon biomass is discussed in Section 4.2.4.

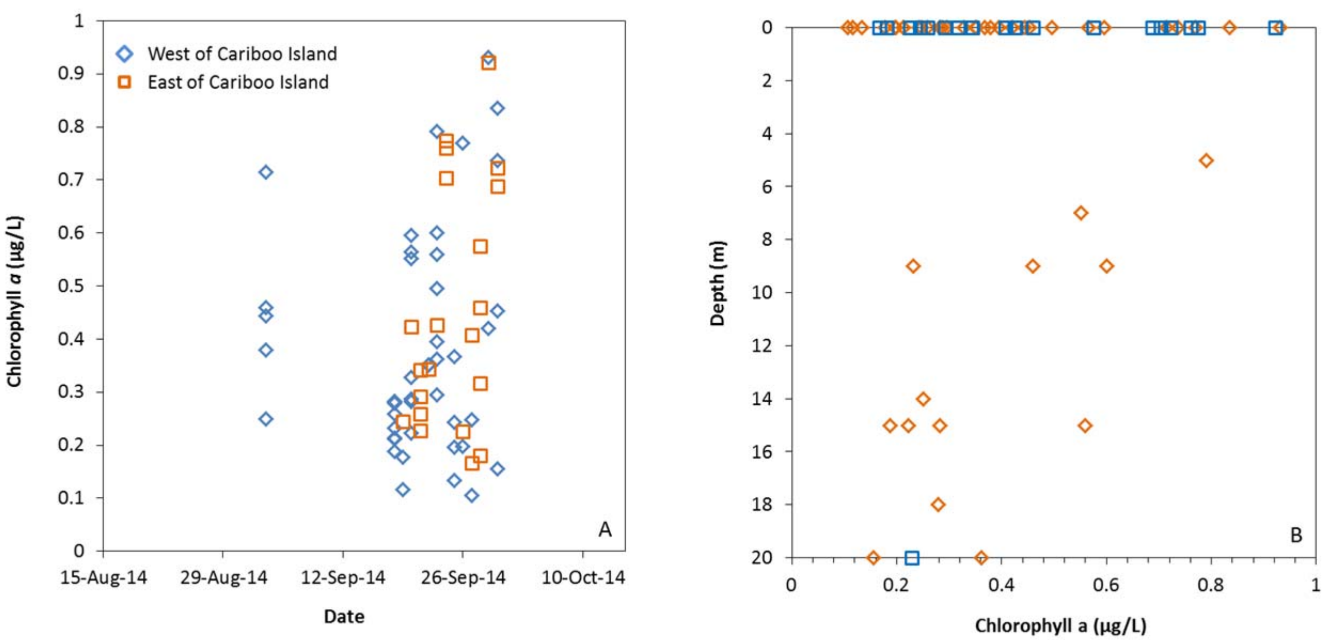


Figure 14: Temporal and Spatial Variability in Chlorophyll a Concentration in Shallow (0 to 20 m) Water in the West Arm of the West Basin (West of Cariboo Island; 11 stations) Compared to the Middle Arm (East of Cariboo Island; 7 Stations) of Quesnel Lake by (A) Sampling Date and (B) Depth

4.2.2.3 Zooplankton Productivity

Minnow (2015b) reported the findings of toxicity testing using two daphnid zooplankton species:

- 48-h acute lethality to *Daphnia magna*; and
- 7-d survival and reproduction of *Ceriodaphnia dubia*.

Water from Quesnel Lake was not acutely toxic to *Daphnia magna* and survival of *Ceriodaphnia dubia* was also not impaired. There were observations of impaired reproduction in *C. dubia* exposed to a small number of turbid deep water samples from Quesnel Lake. The observed effects were not considered by Minnow to be related to metal concentrations (the *Ceriodaphnia* test is known to exhibit false positive results [USEPA 2002]); Minnow (2015b) recommended confirmatory resampling and retesting to verify the observed responses and examine potential causes. The re-testing in samples collected by MPMC indicated that reproductive effects occurred in unfiltered samples whereas no toxicity was observed for the corresponding filtered samples (discussed further in Golder 2015). This suggested that exposure to suspended particulate matter in the samples may have resulted in a reproductive test response in this sensitive invertebrate.

Levy (1990) found that the zooplankton community in Quesnel Lake were non-migratory and located throughout the top 25 to 30 m of the water column. Morton and Williams (1990) further delineated seasonal zooplankton distribution to 75% standing biomass in the top 10 m of the water column when a well-established thermocline was in place (e.g., in August), and 75% standing biomass in the top 25 m of the water column after the thermocline started to weaken (i.e., in October). This zooplankton distribution is an important consideration in the evaluation of the potential reduction in zooplankton productivity as a result of the event.

A further consideration in the assessment of zooplankton productivity is which part of the community is important to CRA fisheries. Based on an evaluation of stomach contents, juvenile Sockeye Salmon preferentially consumed the calanoid copepod *Leptodiaptomus* during the early (May-June) shore-oriented migration of the fish from their natal streams (Morton and Williams 1990). In June, the fish migrate offshore and their prey consumption shifted to the cladoceran *Daphnia*. Other fish that may have been consuming crustacean zooplankton at the time of the event were Rainbow Trout, Lake Trout, and some forage fish species.

Depth-integrated (surface to 30 m) samples of zooplankton were collected by the University of Northern British Columbia (UNBC) approximately weekly between 5 September and 6 November, 2014 (S. Albers, pers. comm.) and a taxonomy dataset (identification of species and enumeration) was provided for use in this report. Methods regarding taxonomic identification and data processing were not provided. Due to differences in resolution of taxonomic identification as well as units[3], the zooplankton abundance and biomass data were not compared to pre-event data presented in Hume et al. (2005) and MacLellan et al. (1993). The samples were collected at one exposed area called Hazeltine (in the West Arm west of Cariboo Island) and at two reference areas, Horsefly (near the Horsefly River) and Junction (in the Main Basin where the east and north arms meet).

[3] For example, areal [value/m^2] versus volumetric [value/m^3] units and presentation on a dry- versus wet-weight basis used for the 2014 samples versus pre-event sampling. Insufficient information regarding methods was available to convert data to a common unit.

Total zooplankton abundance and biomass was lower at Hazeltine than at Junction for all sampling events undertaken by UNBC and declined at a similar rate among stations between mid-September and October of 2014 (Figure 15), as would be expected for the generalized model of productivity shown in Figure 7. Conversely, total abundance and biomass were higher at Hazeltine than at Horsefly (east of Cariboo Island) until mid-October and then lower than at Horsefly at the end of October. At all three stations, the zooplankton community was comprised of a relatively higher proportion of copepods than cladocerans. When cladocerans (e.g., *Daphnia*) are considered separately, abundance and biomass were similar among the three stations except for the first sampling event at the beginning of September at which time *Daphnia* abundance was notably higher at Junction than Hazeltine.

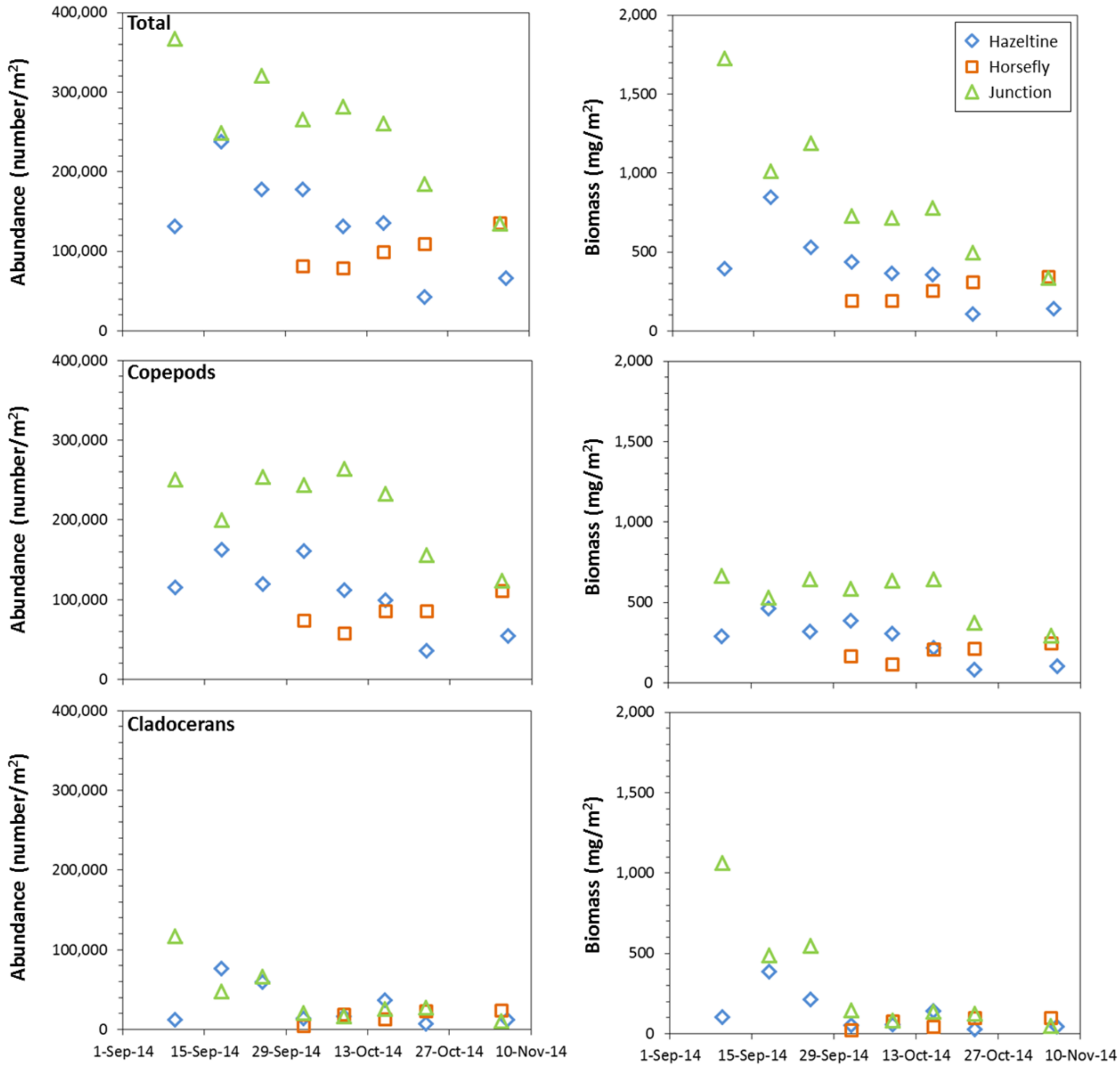


Figure 15: Spatial and Temporal Variability in Zooplankton Abundance and Biomass from Composite, Depth-integrated Samples Collected in the Exposed (Hazeltine) and Reference (Horsefly, Junction) Areas of Quesnel Lake Following the Tailings Dam Failure (Data Courtesy of UNBC)

Turbidity has been observed to affect the ability of zooplankton to consume/utilize phytoplankton, survive and reproduce (Edmundson and Koenings 1986; Levine et al. 2005). For example, Levine et al. (2005) found that induced turbidity levels of 2 to 10 NTU reduced clearance of phytoplankton by 70 to 100% and resulted in reduction in the growth and abundance of *Daphnia* and a calanoid copepod. Turbidity in the top 10 m of the water column that *Daphnia* tend to occupy in summer was in the range of 2 to 10 NTU, thus it was possible that zooplankton feeding rates were affected. However, as noted in Section 4.2.2.2 the conversion of phytoplankton into fish production is relatively efficient in oligotrophic lakes (Downing et al. 1990) and therefore, a higher zooplankton biomass resulting from the phosphorus input discussed in Section 4.2.2.1 would likely have been rapidly converted into fish biomass (the potential change in juvenile Sockeye Salmon biomass is discussed in Section 4.2.4).

Edmundson and Koenings (1986) observed that the *Daphnia* component of a glacial lake zooplankton community was less tolerant of induced turbidity (at 45 NTU) and had higher rates of mortality and lower rates of reproduction than did copepods and rotifers. A shift in cladocerans versus copepods was not observed in the zooplankton data for Quesnel Lake collected post-event; however, the zooplankton samples were collected commencing one month after the event, and changes in zooplankton abundance in either direction would not necessarily have been detected.

4.2.2.4 Benthic Invertebrates/Emerging Insects

Production of benthic invertebrates and emerging insects was disrupted at the mouth of Hazeltine Creek in the littoral zone and immediately adjacent lakebed due to the alteration of the habitat; the area of alteration is presented in Section 4.1.3. Acute mortality of benthic invertebrates also occurs at similar TSS concentrations reported to affect fish (720-51,000 mg/L; CCME 1999). Thus, it is possible that elevated TSS immediately following the TSF dam affected nearby areas not in the immediate area of alteration; however, data are unavailable to quantify this effect.

Based on the findings of Minnow (2015a), the disruption in production of benthic invertebrates was likely temporary. In both the littoral and profundal zone of the West Arm, the sediments collected one month post-event contained benthic invertebrates, including chironomids which are a preferred food item for several CRA fish species (e.g., Rainbow Trout). The abundance and diversity of organisms in the West Arm sediments was typically lower than that of reference areas at the time of sampling; however, the community is expected to continue to re-establish. Although early sampling suggests that some recovery may have begun, benthos sampling subsequent to deposition and settling of the sediments is necessary to confirm if the impact is of a transient nature.

4.2.3 Food Supply – Quality

UNBC collected zooplankton samples from three locations on Quesnel Lake concurrent with the taxonomy and had them analyzed for a suite of metals (S. Albers, pers. comm.). The samples were collected at one exposed area called Hazeltine (in the West Arm west of Cariboo Island) and at two reference areas, Horsefly (near the Horsefly River) and Junction (in the Main Basin where the east and north arms meet). Depth-integrated (surface to 30 m) samples were collected approximately weekly between 5 September and 6 November, 2014. Multiple tows were collected to generate a composite with sufficient biomass for analysis. One replicate sample was collected from Junction on 2 October 2014 for quality control purposes. The *BC Field Sampling Manual* (BC MoE 2013) recommends that the relative percent difference (RPD) between replicate samples be calculated where concentrations are greater than five times the detection limit (DL)[4]. An RPD of >20% indicates a notable difference between samples. Where the RPD could be calculated (i.e., values were >five times DL), all the parameters analyzed had results <20%, except for lead and chromium which exhibited higher variability, and overall the zooplankton tissue chemistry were considered reliable for the purposes of this assessment.

Figure 16 illustrates the temporal and spatial variability in copper, which was considered a parameter of concern based on water column concentrations, and selenium, mercury and arsenic, parameters of potential concern because their primary mode of toxicity is via dietary uptake versus direct toxicity from a water exposure, or can biomagnify (e.g., mercury) in the food chain.

- **Copper** concentrations appeared to increase over time at Hazeltine (exposed) and were higher than at the other two stations (reference) between October and December. However, copper does not biomagnify and concentrations of copper are lower than those that had no adverse effect on Rainbow Trout (Miller et al. 1993).
- **Selenium** concentrations were below the BC dietary guideline for tissue consumption by fish (BC MoE 2014) for all samples collected from Hazeltine and Horsefly. The highest concentrations were observed at Junction and exceeded the BC dietary tissue guideline.
- **Mercury** concentrations were variable at all three stations, ranging from non-detectable to less than 0.1 mg/kg dw. The highest concentrations were observed in zooplankton from Junction.
- **Arsenic** concentrations appear to increase between September and November 2014 at Hazeltine; however, they were all lower than the highest concentrations observed at Junction in September and were similar to concentrations observed at Horsefly and Junction in October through November.

Overall, the event did not appear to result in a biologically significant change in arsenic, mercury or selenium concentrations in zooplankton from the West Arm of the West Basin of Quesnel Lake relative to concentrations observed in the lake east of Cariboo Island. The change in copper concentrations at Hazeltine may have been in response to copper associated with increasing suspended solids in the water column during lake turn over as small particulates may have been attached to phytoplankton biomass and consumed incidentally. When aquatic invertebrates have ingested sediment particles and gut contents are not cleared prior to whole tissue analysis, actual uptake by the organism can be overestimated (Gillis et al. 2005; Sibley et al. 1997). Nevertheless, and even if the observed concentrations of copper in zooplankton in the West Basin were in the tissue and not just in the gut, these concentrations are lower than dietary no-effect levels for Rainbow Trout (e.g., Miller et al. 1993). As discussed in Section 4.2.1, growth of juvenile Sockeye in the West Basin was higher than that of fish collected in reference areas of the lake and thus consumption of zooplankton from the West Arm does not appear to have affected growth.

[4] Within five times the DL, laboratory results are considered too variable to be representative of the true concentration (BCMoE 2013).

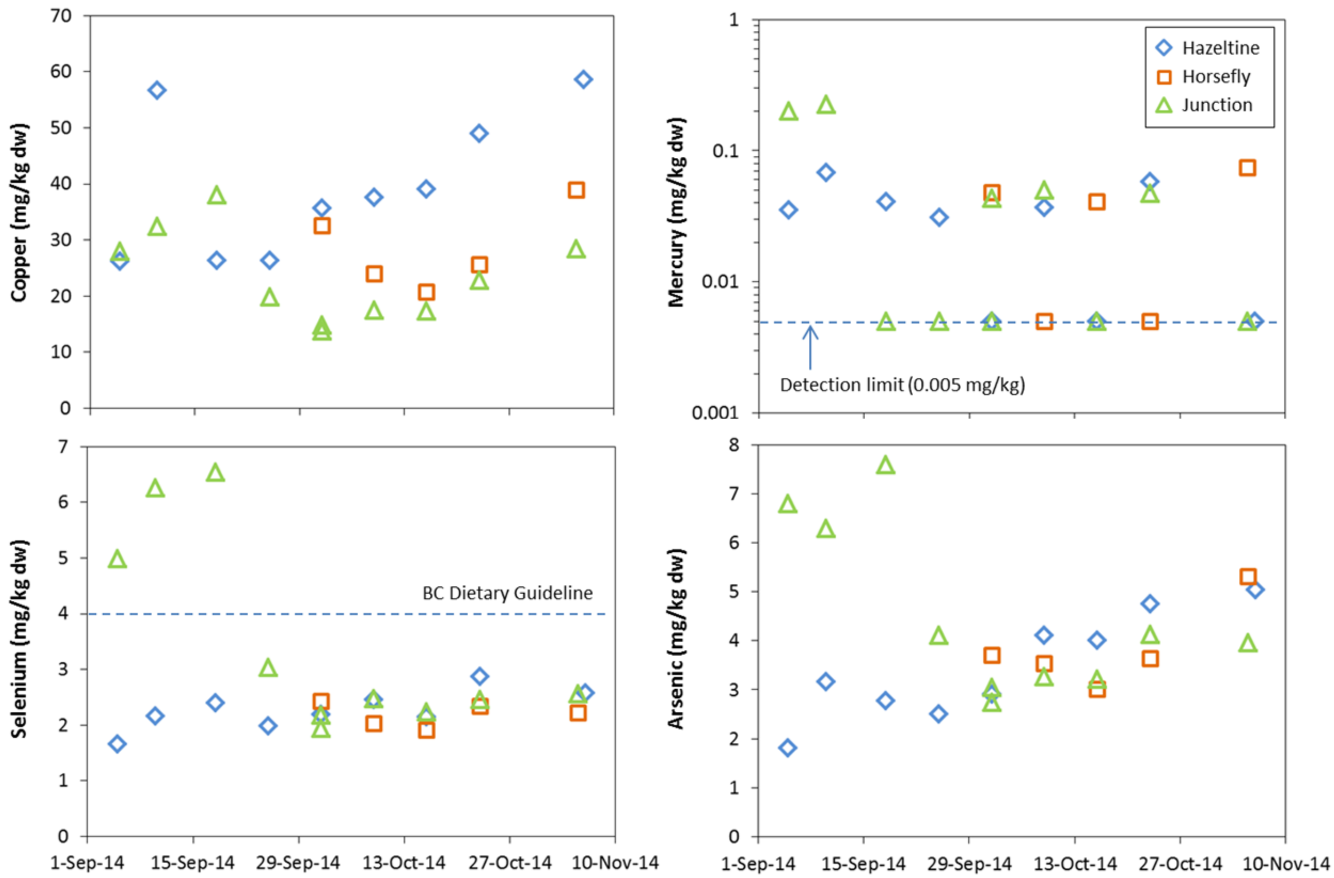


Figure 16: Spatial and Temporal Variability in Zooplankton Tissue Chemistry from Composite, Depth-integrated Samples Collected in the Exposed (Hazeltine) and Reference (Horsefly, Junction) Areas of Quesnel Lake Following the Tailings Dam Failure (Data Courtesy of UNBC)

4.2.4 Food Supply - Efficiency

Foraging efficiency can be affected by increased turbidity via change in feeding rates, reaction distance, prey selection and prey abundance (Bash et al. 2001; Muck 2010; Sigler et al. 1984). The potential for effects on foraging efficiency and food capture is dependent on the species and habitat being occupied, and the ultimate influence on productivity is balanced among food availability, prey capture success, and predator avoidance (De Robertis et al. 2003; Levy 1990; Roberge et al. 2001; Robertson et al. 2006).

Littoral/Nearshore Area

Fish feeding in littoral (i.e., the area less than 6 m deep along the shoreline) and nearshore zones may not have been affected because turbidity was less than 5 to 10 NTU in the top 5 to 10 m of the water column. Moreover, several fish species occupying the littoral zone feed at night or are benthic feeders and therefore do not rely on sight to capture prey (e.g., Northern Pikeminnow; sucker), or are not sensitive to turbidity (e.g., sculpin) (McPhail 2007).

Open-water Area

Shaw and Richardson (2001) found that following pulsed inputs of fine sediments to experimental channels, Rainbow Trout juveniles grew less than control fish, possibly due to increased physiological stress and inability to capture drifting invertebrates. However, these were artificial mesocosms with trout confined to small areas and it appears that these findings cannot be extrapolated to juvenile Sockeye in Quesnel Lake, given that length and weight data collected from Quesnel Lake following the event (Section 4.2.1) show that this species grew considerably.

Rainbow Trout migrate out of the open-water area of Quesnel Lake into the Horsefly and Mitchell Rivers twice a year (Sebastian et al. 2003). The first migration is in spring either to spawn, or to feed on newly emerged Sockeye fry (pre-spawner and non-spawner Rainbow Trout). The second is a “feeding” migration to the same rivers from July to September when age 3 to 5+ and some larger fish preferentially feed on aquatic invertebrates, Sockeye eggs and adult Sockeye carcasses. The TSF dam failure occurred during the timing of the “feeding” migration which may have reduced the number of Rainbow Trout in the West Arm and thus the potential effect of the event on feeding success with the exception of Lower Hazeltine Creek.

In deeper areas of the lake, turbidity was higher, increasing from 10 NTU at the thermocline to >200 NTU at the lakebed (Golder 2015; Petticrew et al. 2015). However, the thermocline was at or below the expected euphotic depth of the lake. Therefore, fish feeding/foraging at these depths would not necessarily be expected to rely on visual cues (for example, adult Burbot feed at night; McPhail 2007) and their efficiency at prey capture may not have been affected although prey density may have.

Benthic Area

Fish species occupying the benthic zone feed at night or are benthic feeders and would not necessarily rely on sight to capture prey (e.g., Burbot, sucker; McPhail 2007). Feeding efficiency may thus not have been affected by increased turbidity. However, in those benthic zones at the bottom of Quesnel Lake, a reduction in food supply would have been expected.

4.2.5 Bioenergetics

Length and weigh data collected by DFO indicated that juvenile Sockeye Salmon captured from the West Arm of the West Basin in September 2014 were larger than Sockeye capture in reference areas of the lake, and were also larger than Sockeye collected from the West Arm in 2013 (Section 4.2.1). Data for other fish species were not available.

4.3 Individual Performance

4.3.1 Stress

Suspended sediment can cause changes in behaviour such as avoidance (Bisson and Bilby 1982; Robertson et al. 2006) and physiological trauma such as gill damage (Birtwell 1999; Muck 2010; Servizi and Martens 1987):

- Avoidance can occur at turbidity levels on the order of 35 to 70 NTU, measured in a laboratory (Bisson and Bilby 1982). In that study, this level of turbidity occurred below the thermocline and thus diel vertical migrations could have been disrupted. Petticrew et al. (2015) reported that fish aggregated in the West

Arm of Quesnel Lake following the TSF dam failure, thus it appears that fish did not necessarily migrate out of the area as Robertson et al. (2006) suggest may occur in response to an increase in turbidity.

- Gill abrasions have been observed at TSS concentrations on the order of hundreds to thousands of mg/L (Birtwell 1999; Servizi and Martens 1987). It is possible that TSS concentrations of this magnitude occurred immediately after the TSF dam failure and immediately adjacent to the mouth of Hazeltine Creek; however, at the stations from which MPMC collected water quality data, TSS concentrations were below 50 mg/L (Figure 8) which is a level at which gill abrasions would not be expected. DFO has submitted preserved samples of juvenile Sockeye for histological analysis. As of the date of this report, results from these analyses were not available.

As discussed in Section 4.2.1, Fathead Minnow and Rainbow Trout exposed to Quesnel Lake water in laboratory toxicity testing and juvenile Sockeye Salmon collected from Quesnel Lake did not fail to grow, which is a potential outcome of the stressors identified above.

Samples of several fish species were collected for analytical chemistry, sampling dates and locations in Quesnel Lake. The data are provided in SNC-Lavalin (2015a) and will be assessed in the future ecological risk assessment.

4.3.2 Olfactory Effects

In natural waters, copper is known to be complexed with a variety of organic and inorganic ligands and thus free copper (Cu^{2+}) is typically present in minor amounts (Allen and Hansen 1996; Bazzi et al. 2002). It is this Cu^{2+} form that is the more toxic form of copper and has greater effect on olfactory organs, which play a role in predator avoidance and homing ability. Table 4 summarizes commonly cited studies on the effects of copper on homing ability of adult salmonids. At hardness levels similar to that observed in Quesnel Lake, field observations of effects on homing occurred at copper concentrations of 10 to 25 µg/L.

Table 4: Studies on Copper and Olfactory Impacts That are Most Commonly Cited

Copper Conc. (µg/L)	Hardness (mg/L)	Exposure Duration	Effect	Source
20	20	Indefinite	Atlantic salmon spawning migrations in the wild interrupted	Sprague et al. (1965) cited in Hecht et al. (2007)
10-25	40	Indefinite	Chinook salmon spawning migrations in the wild apparently disrupted	Mebane (2000)
44	n/a	n/a	90% reduction in selection of home stream by Atlantic salmon	Sutterlin and Gray (1973), cited in Mebane (1994)

Note: n/a - not available

In comparison, dissolved copper concentrations on the order of 2 µg/L or less have been demonstrated in some laboratory behavioural studies to reduce the ability of juvenile salmon to avoid prey (Sandahl et al. 2007). However, there is some disagreement in the scientific community about these findings as other researchers have not been able to reproduce the results at these low levels (Bailey et al. 2015). Moreover, dissolved organic carbon concentrations are often not reported in such studies. Dissolved organic carbon reduces copper effects on olfactory sensory organs, as it reduces copper toxicity. DeForest et al. (2011) indicate that Biotic Ligand Model (BLM)-based water quality criteria for dissolved copper (USEPA 2007) would be protective against olfactory effects in juvenile salmon. This was based on an evaluation of water chemistry data from some 113 watercourses. As an example, DeForest et al. (2011) estimated a BLM-based 20% olfactory effect level concentration (EC20) of 13.1 µg/L for a creek with water chemistry that has similarities to the chemistry of Quesnel Lake (i.e., the creek had the following characteristics: pH = 8.2, hardness = 80 mg/L, dissolved organic carbon = 1.1 mg/L). This estimated concentration is higher than both the acute (8.1 µg/L) and chronic (5.0 µg/L) BLM-based USEPA water quality criteria, suggesting that the BLM-based criteria protect against olfactory impacts.

The highest concentration of dissolved copper measured in MPMC's monitoring program was 9.1 µg/L, from a sample location near the outlet of Hazeltine Creek and at 50 m depth; the maximum dissolved copper concentration in water to 20 m depth was 3.9 µg/L. This is a conservative characterization of the concentration that salmon would be exposed to because the average concentrations, representing the majority of the water chemistry, are lower. The average concentration at depth (>20 m) was 4.7 µg/L and in shallower water (<20 m) was 1.3 µg/L. In Quesnel Lake near the Town of Likely, the average dissolved copper concentration was 0.76 µg/L and in the Quesnel River was 1.1 µg/L. More recent water chemistry data indicate that copper concentrations have since decreased over time (Golder 2015).

When compared to the literature thresholds for olfactory impairment, these concentrations are below the thresholds at which olfactory effects in salmon would be expected. This is also true for the maximum measured concentration of dissolved copper (9.1 µg/L) which is below the reported olfactory thresholds for similar hardness and dissolved carbon concentrations. Therefore, based on the water chemistry data from Quesnel Lake and Quesnel River, impacts on fish migration through olfactory impairment and lost "homing" ability were unlikely. This is supported by the 2014 Sockeye Salmon escapement summary by the Pacific Salmon Commission for Quesnel Lake which indicates that Sockeye returned to spawning areas at relatively high numbers. These returns do not reflect the potential for effects on juvenile salmon; however, based on what is known about copper bioavailability as a result of the event (as summarized in Golder 2015), and the effects thresholds discussed above, effects on juveniles are not expected.

4.3.3 Disease

The physiological stress associated with exposure to elevated concentrations of TSS may reduce the ability of a fish to resist disease at TSS concentrations of 100 to 300 mg/L (citations in Lloyd 1987) or to tolerate exposure to pentachlorophenol at TSS concentrations > 100 mg/L (Birtwell 1999; McLeay et al. 1987). It is possible that TSS concentrations of this magnitude occurred immediately after the TSF dam failure, and immediately adjacent to the mouth of Hazeltine Creek; however, at the stations from which MPMC collected water quality data, TSS concentrations were below 50 mg/L and thus an increased incidence of disease would not be expected (Figure

8). Incidence of disease, such as that induced by gill abrasions would be identifiable in the historological study being carried out by DFO.

As discussed in Section 4.2.1, Fathead Minnow and Rainbow Trout exposed to Quesnel Lake water in laboratory toxicity testing and juvenile Sockeye Salmon collected from Quesnel Lake did not fail to grow, which is a potential outcome of the stressors identified above.

4.4 Migration

Changes in migration were not considered a potential effect to productivity. The only migratory corridor blocked was into Hazeltine Creek for which habitat alteration has been accounted in SNC-Lavalin (2015c).

4.5 Reproduction

4.5.1 Adult Maturation and Reproduction

A full reproductive cycle has not yet occurred for several fish such as Sockeye Salmon and therefore cannot be assessed at this time. However, water quality conditions and toxicity testing results do not indicate that such effects would be likely on sockeye or other species.

4.5.2 Density-independent Reproductive Success (Spawning Habitat Quality)

A change in spawning habitat quality for Sockeye Salmon is unlikely to have occurred in the lake as lake spawning has not been observed in the West Arm west of Cariboo Island. For fish species that spawn in the littoral zone, there may have been a temporary loss of use of the area, depending on the timing of spawning. Fish species that migrate to streams and rivers (including the seasonal channel in the Hazeltine fan area) to spawn are addressed in the FFHIA (SNC-Lavalin 2015c). Sockeye spawning has been recorded in Lower Hazeltine Creek; however, the brood year returning in 2014 was expected to be minimal (T. Whitehouse, DFO, pers. comm.).

4.5.3 Density-dependent Reproductive Success (Spawning Habitat Quantity)

A change in spawning habitat quantity for Sockeye Salmon is unlikely to have occurred in the lake as lake spawning has not been observed in the West Arm east of Cariboo Island. For fish species that spawn in the littoral zone, there may have been a temporary loss of use of the area, depending on the timing of spawning. Fish species that migrate to streams and rivers (including the seasonal channel in the Hazeltine fan area) to spawn are addressed in the FFHIA (SNC-Lavalin 2015c). Sockeye spawning has been recorded in Lower Hazeltine Creek; however, the brood year returning in 2014 was expected to be minimal (T. Whitehouse, DFO, pers. comm.).

4.6 Summary of Effects on Fish Productivity

4.6.1 Productivity of Fish Associated with the Littoral Zone and Benthic Habitat

The event resulted in the alteration of littoral habitat at the mouth of Hazeltine Creek, resulting in the displacement or potential (unconfirmed) loss of fish in the area (Table 5). Debris was also deposited on the lakebed in the profundal area, which resulted in a change in the benthic habitat and a potential disruption in the benthic invertebrate community. The impact on the bed of Quesnel Lake continues to be studied. Although early sampling suggests that some recovery may have begun, benthos sampling subsequent to deposition and settling of the sediments is necessary to confirm if the impact is of a transient nature. Post-event toxicity testing indicated that Quesnel Lake water did not affect survival or growth of fish or growth of plant test species.

4.6.2 Productivity of Fish Associated with Open-water Habitat that Feed on Emerging Insects

Production of emerging insects was disrupted on the lakebed in a way similar to that discussed in Section 4.6.1 as a result of the disruption to benthic habitat (Table 6). Although early sampling suggests that some recovery may have begun, benthos sampling subsequent to deposition and settling of the sediments is necessary to confirm if the impact is of a transient nature. Post-event toxicity testing indicated that Quesnel Lake water did not affect survival or growth of fish or growth of plant test species.

4.6.3 Productivity of Fish Associated with Open-water Habitat that Feed on Crustacean Zooplankton

Post-event toxicity testing indicated that Quesnel Lake water did not affect survival or growth of fish, survival or growth of daphnid zooplankton, or growth of plant test species. The literature indicates that the direction of change in primary productivity as a result of introduction of suspended sediments to a lake depends on whether the phytoplankton are light limited or nutrient limited. The preliminary information available at this time suggest that there was an influx of phosphorus into Quesnel Lake and although changes in phytoplankton and zooplankton biomass were not observed, juvenile Sockeye Salmon collected west of Cariboo Island were larger than those from the lake east of Cariboo Island (Table 7). The absence of an observed increase in either phytoplankton or zooplankton abundance may reflect grazing/predation, which may in turn be reflected in the larger and possibly more numerous juvenile Sockeye observed in DFO's data compared to previous years.

Table 5 Summary of Effects on Productivity of Littoral Zone and Benthic Habitat

Component of Productivity	Sub-component	Mechanism	Potential Effect on Productivity
Survival	Density independent mortality	Direct mortality	■ Possible, but not quantifiable as no dead fish were observed. Fish may also have been displaced.
		Exceedance of environmental tolerances	■ TSS concentrations could have been high enough in the littoral and benthic zones during and immediately following the event to cause lethal conditions; however, the post-event water quality monitoring program did not identify concentrations above 50 mg/L. ■ Post-event toxicity testing indicated that Quesnel Lake water did not affect survival of juvenile Rainbow Trout or to Fathead Minnow (representative of forage fish that may occupy the littoral zone).
	Reduced habitat quality or quantity	Habitat supply limitation	■ A littoral area of approximately 94,400 m^2 was altered. ■ A benthic area of approximately 1.81 km^2 below the 100 m contour was altered.
Growth	Fish Growth	-	■ Growth of Fathead Minnow was not affected in laboratory water toxicity tests. ■ No information was available regarding growth of fish occupying the littoral or benthic zones.
	Food supply	Quantity	■ Post-event toxicity testing indicated that the growth of aquatic vascular plant and algal test organisms was not impaired. ■ The literature indicates that the response of productivity as a result of an introduction of suspended solids can be offset by a concurrent input of nutrients. The event resulted in a pulse of phosphorus and organic carbon to the lake; however, no data were available to evaluate the overall potential change to quantity of planktonic food in the littoral zone. ■ In sediment toxicity tests, organic carbon was low in many samples and was associated with poor performance in growth or survival of test organisms. ■ Production of benthic invertebrates and emerging insects was disrupted at the mouth of Hazeltine Creek in the littoral zone and the adjacent lakebed due to the alteration of the habitat. One month following the event, these areas were being recolonized.
		Quality	■ No data were available regarding the potential uptake of metals in food organisms.

Component of Productivity	Sub-component	Mechanism	Potential Effect on Productivity
Growth cont.	Efficiency	Foraging	■ It is possible that foraging ability was affected for species reliant on sight. Several fish species occupying the littoral and benthic zones are not visual feeders or are tolerant of turbidity.
		Bioenergetics	■ No data were available regarding a potential change in energy conversion.
Individual performance	Stress	Suboptimal environmental conditions	■ Suspended sediments can cause change in behaviour; however, turbidity in the upper water column was lower than turbidity observed to cause such effects.
	Olfactory effects	Suboptimal environmental conditions	■ Copper concentrations were lower than those observed to cause effects.
	Disease	Infection	■ TSS concentrations were lower than those reported in the literature to reduce the ability of a fish to resist disease.
Migration	-	Disruption of normal behaviour	■ NA
Reproduction	Adult maturation	Suboptimal environmental conditions	■ No information available.
	Density-independent reproductive success	Spawning habitat quality	■ There may have been a temporary loss of use of littoral and benthic habitat altered as a result of the event.
	Density-dependent reproductive success	Spawning habitat quantity	■ There may have been a temporary loss of use of littoral and benthic habitat altered as a result of the event.

Notes:
NA – not applicable; TSS – total suspended solids

Table 6 Summary of Effects on Productivity of Open-water Habitat and Fish that Feed on Emerging Insects

Component of Productivity	Sub-component	Mechanism	Potential Effect on Productivity
Survival	Density independent mortality	Direct mortality	■ Possible, but not quantifiable as no dead fish were observed. Fish may also have been displaced.
		Exceedance of environmental tolerances	■ TSS concentrations could have been high enough in limnetic zone adjacent to the Hazeltine delta during and immediately following the event to cause lethal conditions; however, the post-event water quality monitoring program did not identify concentrations above 50 mg/L. ■ Post-event toxicity testing indicated that Quesnel Lake water was not toxic to juvenile Rainbow Trout
	Reduced habitat quality or quantity	Habitat supply limitation	■ NA
Growth	Fish growth	-	■ No information was available for Rainbow Trout or Mountain Whitefish
	Food supply	Quantity	■ In sediment toxicity tests, organic carbon was low in many samples and was associated with poor performance in growth or survival of test organisms. ■ Production of emerging insects was disrupted on lakebed due to the alteration of the habitat. One month following the event, these areas were being recolonized.
		Quality	■ No information was available regarding potential change in food quality.
	Efficiency	Foraging	■ It is possible that foraging ability was affected for species reliant on sight. Rainbow Trout undergo a feeding migration to rivers from July to September and thus may not have been present during the event.
		Bioenergetics	■ No data were available to evaluate energy conversion.

Component of Productivity	Sub-component	Mechanism	Potential Effect on Productivity
Individual performance	Stress	Suboptimal environmental conditions	■ Suspended sediments can cause change in behaviour; however, turbidity in the upper water column was lower than turbidity observed to cause such effects. ■ Post-event toxicity testing indicated that Rainbow Trout did not fail to grow, which is a potential outcome of stress.
	Olfactory effects	Suboptimal environmental conditions	■ Copper concentrations were lower than those observed to cause effects.
	Disease	Infection	■ TSS concentrations were lower than those reported in the literature to reduce the ability of a fish to resist disease. ■ Post-event toxicity testing indicated that Rainbow Trout did not fail to grow, which is a potential outcome of stress.
Migration	-	Disruption of normal behaviour	■ NA
Reproduction	Adult maturation	Suboptimal environmental conditions	■ No information available.
	Density-independent reproductive success	Spawning habitat quality	■ NA; spawning occurs in streams and rivers.
	Density-dependent reproductive success	Spawning habitat quantity	■ NA; spawning occurs in streams and rivers.

Notes:
NA – not applicable; TSS – total suspended solids

Table 7 Summary of Effects on Productivity of Open-water Habitat and Fish that Feed on Crustacean Zooplankton

Component of Productivity	Sub-component	Mechanism	Potential Effect on Productivity
Survival	Density independent mortality	Direct mortality	■ Possible, but not quantifiable as no dead fish were observed. Fish may also have been displaced.
		Exceedance of environmental tolerances	■ TSS concentrations could have been high enough in limnetic zone adjacent to the Hazeltine delta during and immediately following the event to cause lethal conditions; however, the post-event water quality monitoring program did not identify concentrations above 50 mg/L. ■ Post-event toxicity testing indicated that Quesnel Lake water was not toxic to juvenile Rainbow Trout
	Reduced habitat quality or quantity	Habitat supply limitation	■ NA
Growth	Fish growth	-	■ Post-event toxicity testing indicated that Rainbow Trout did not fail to grow in Quesnel Lake water. ■ Juvenile Sockeye Salmon captured from the West Arm of the West Basin in September 2014 were larger than Sockeye capture in reference areas of the lake, and were also larger than Sockeye collected from the West Arm in 2013.
	Food supply	Quantity	■ Post-event toxicity testing indicated there was no impairment in growth of an algal test organism. ■ Lake water was not toxic to daphnid zooplankton and did not affect reproduction ■ The literature indicates that the response of productivity as a result of an introduction of suspended solids can be offset by a concurrent input of nutrients. The event resulted in a pulse of phosphorus to the lake. A resulting increase in primary and zooplankton productivity was not observed; however, the conversion of phytoplankton into fish production is relatively efficient in oligotrophic lakes.
		Quality	■ The event did not appear to result in a change in arsenic, mercury or selenium concentrations in zooplankton from the West Arm. Conversely, copper concentrations increased, but this may have been related to the ingestion of suspended particles, which can result in an overestimate of uptake into tissues. Moreover, the tissue concentrations were lower than no-effects concentrations for Rainbow Trout.

Component of Productivity	Sub-component	Mechanism	Potential Effect on Productivity
Growth cont.	Efficiency	Foraging	■ Inputs of suspended sediment can affect the prey capture success of visual feeders; however, this is not supported by juvenile Sockeye length and weight data.
		Bioenergetics	■ Juvenile Sockeye Salmon growth data indicate efficient conversion of energy from zooplankton.
Individual performance	Stress	Suboptimal environmental conditions	■ Suspended sediments can cause change in behaviour; however, turbidity in the upper water column was lower than turbidity observed to cause such effects. ■ Rainbow Trout exposed to Quesnel Lake water in laboratory toxicity testing and juvenile Sockeye Salmon collected from Quesnel Lake did not fail to grow, which is a potential outcome of stress.
	Olfactory effects	Suboptimal environmental conditions	■ Copper concentrations were lower than those observed to cause effects. ■ Adult Sockeye Salmon were observed to return at relatively high numbers in September 2014.
	Disease	Infection	■ TSS concentrations were lower than those reported in the literature to reduce the ability of a fish to resist disease. ■ Rainbow Trout exposed to Quesnel Lake water in laboratory toxicity testing and juvenile Sockeye Salmon collected from Quesnel Lake did not fail to grow, which is a potential outcome of stress.
Migration	-	Disruption of normal behaviour	■ NA
Reproduction	Adult maturation	Suboptimal environmental conditions	■ No information available at the time of writing.
	Density-independent reproductive success	Spawning habitat quality	■ NA; potential spawning in the Hazeltine fan area addressed in SNC-Lavalin (2015c) ■ Primary spawning areas are in other streams and rivers or lakeshore areas in the eastern part of the lake.

Component of Productivity	Sub-component	Mechanism	Potential Effect on Productivity
Reproduction cont.	Density-dependent reproductive success	Spawning habitat quantity	■ NA; potential spawning in the Hazeltine fan area addressed in SNC-Lavalin (2015c) ■ Primary spawning areas are in other streams and rivers or lakeshore areas in the eastern part of the lake.

Notes:
NA – not applicable; TSS – total suspended solids

5.0 POLLEY LAKE IMPACT ASSESSMENT

5.1 Survival

5.1.1 Direct Mortality of Fish

It is possible that fish occupying the littoral zone at the outlet to Hazeltine Creek were entrained in the debris or they may have been displaced in advance of the debris reaching the lake. However, dead fish were not observed and this potential effect on productivity cannot be quantified.

5.1.2 Exceedance of Environmental Tolerances

The on-going monitoring program reported TSS levels less than those observed to cause acute lethality (Figure 17) and laboratory toxicity testing with Rainbow Trout (96-h LC50) and Fathead Minnow (7-day survival and growth) indicated that water from Polley Lake was not lethal to these fish species (Minnow 2015b). No dead fish were observed and this potential effect on productivity cannot be quantified.

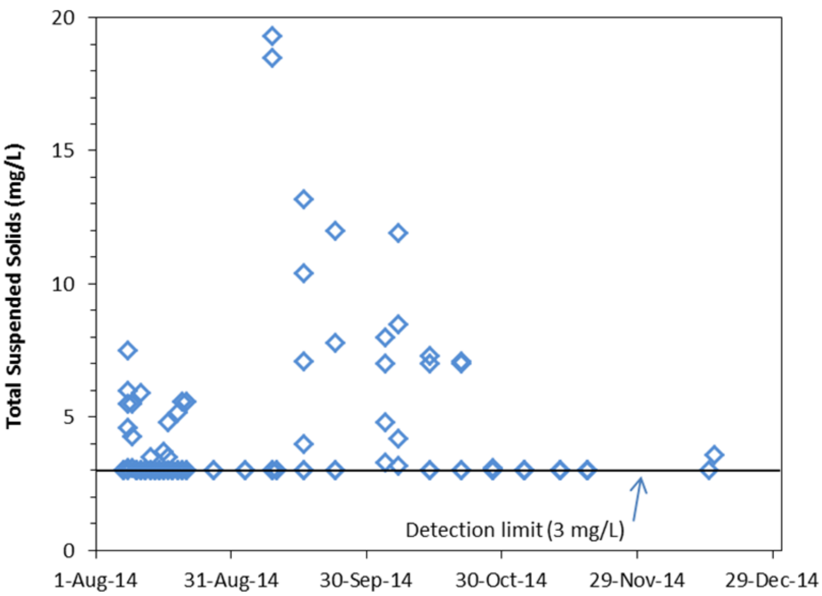


Figure 17: Temporal Variability in Total Suspended Solids Concentration in Polley Lake

5.1.3 Habitat Quantity or Quality

A portion of the south end of Polley Lake near the outflow to Hazeltine Creek was filled with a mixture of tailings, embankment material, and eroded native material from the breach that plugged the outlet of Polley Lake (SNC-Lavalin 2015b). There has been no quantitative estimate of the spatial extent of this material coverage and the change in bathymetry cannot be reliably estimated because of a lack of reliable pre-event data. The effect to productivity is expected to be temporary as the littoral area will become established.

The physico-chemical quality and toxicity of lake sediments were addressed by Minnow (2015a). As observed for Quesnel Lake (Section 4.1.3), the area affected by the event had a lower total organic carbon content, which may have contributed to a modest effect on growth in the midge (*Chironomus dilutus*) test observed in toxicity testing. Low organic carbon can be expected to result in decreased growth because it reflects lower food supply.

5.2 Growth

5.2.1 Fish Growth

Growth of Fathead Minnow was not affected in the 7-day survival and growth tests conducted in water from Polley Lake (Minnow 2015b).

Lirette (2015a) surveyed the age structure and body condition of Rainbow Trout and Longnose Sucker in Polley Lake on September 23-24, 2014 using sinking and floating gill nets set at maximum depths of 7.6 and 9.5 m in the littoral zone at the north end of the lake. The study design was based on earlier studies carried out so that comparisons could be made. A total of 144 Rainbow Trout, 140 Longnose Suckers, and one Redside Shiner were captured in the nets. Mean condition factor (CF or *K*; calculated based on length and weight) for rainbow trout was higher in 2014 than in 2012 and slightly lower for Longnose Sucker in 2014 than in 2012 (Table 8). Lirette (2015a) noted that higher condition factors in the past (i.e., 1973 and 1995) may have been due to increased harvesting of Rainbow Trout, which reduces fish density and competition for resources. The condition of these fish species did not appear to have been affected within seven weeks of the event, which corresponded to the period of highest turbidity at depth.

Table 8: Summary of Fish Age and Condition for Polley Lake

Species	Year	Age range	Mean condition factor [(a)]
Rainbow trout	1973	-	1.341
	1990	2^+ to 6^+	-
	1995	3^+ to 4^+	1.253
	2009/2010	3^+ to 6^+	-
	2012	-	0.993
	2014	1^+ to 6^+	1.103
Longnose sucker	1995	-	1.454
	2009/2010	5^+ to 10^+	-
	2012	-	1.354
	2014	1^+ to 13^+	1.239

Notes:
Source: Lirette (2015a)
(a) Condition factor (CF or '*K*') is calculated from the relationship between fish length and weight. Lirette (2015a) used the following equation: $100\ x\ \frac{(weight\ [g])}{(fork\ length\ [cm])^3}$

5.2.2 Food Supply - Quantity

5.2.2.1 Nutrient Inputs

Following the event, surface measurements of total phosphorus were higher than applicable WQGs, but the trophic status of Polley Lake did not change and remained mesotrophic/eutrophic post-event (Figure 11). At depth, mean total phosphorus concentrations were higher; however, a large proportion of the total phosphorus was associated with the particulate fraction, and mean dissolved phosphorus concentrations were similar to pre-event concentrations. Although there was a change in total phosphorus concentrations in Polley Lake, overall there did not appear to be a discernable change in the concentration of phosphorus available to plant life, due to the event. There appeared to be an influx of dissolved organic carbon followed by a decrease to pre-event concentrations which may have been associated with debris introduced to the lake as a result of the TSF dam failure.

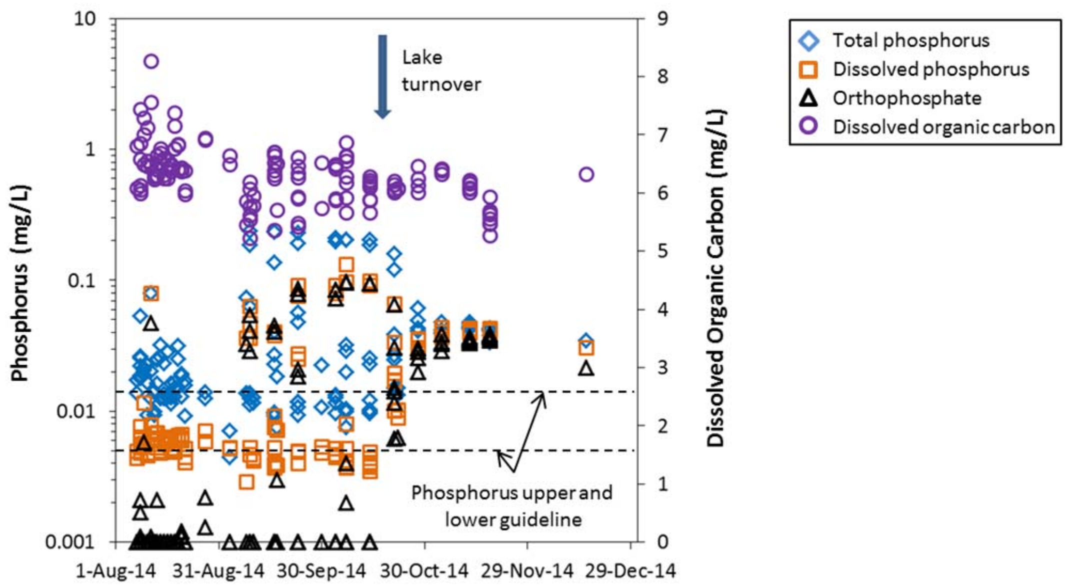


Figure 18: Temporal Variability in Phosphorus and Dissolved Organic Carbon in Polley Lake (18 stations)

5.2.2.2 Primary Productivity

There was no impairment of growth of either *Lemna minor* (vascular aquatic plan) or *Pseudokirchneriella subcapitata* (alga) in laboratory toxicity tests on water from Polley Lake (Minnow 2015b).

Measurement of Secchi depth commenced in early September once the lake was considered safe for boat access. The Secchi depths measured in Polley Lake post-event in September and October 2014 were similar to pre-event conditions in June and July 2014 and were within historical ranges (Figure 19). There was no indication of a reduction in light penetration into the lake surface based on Secchi depth measured post event, during the period of measurement.

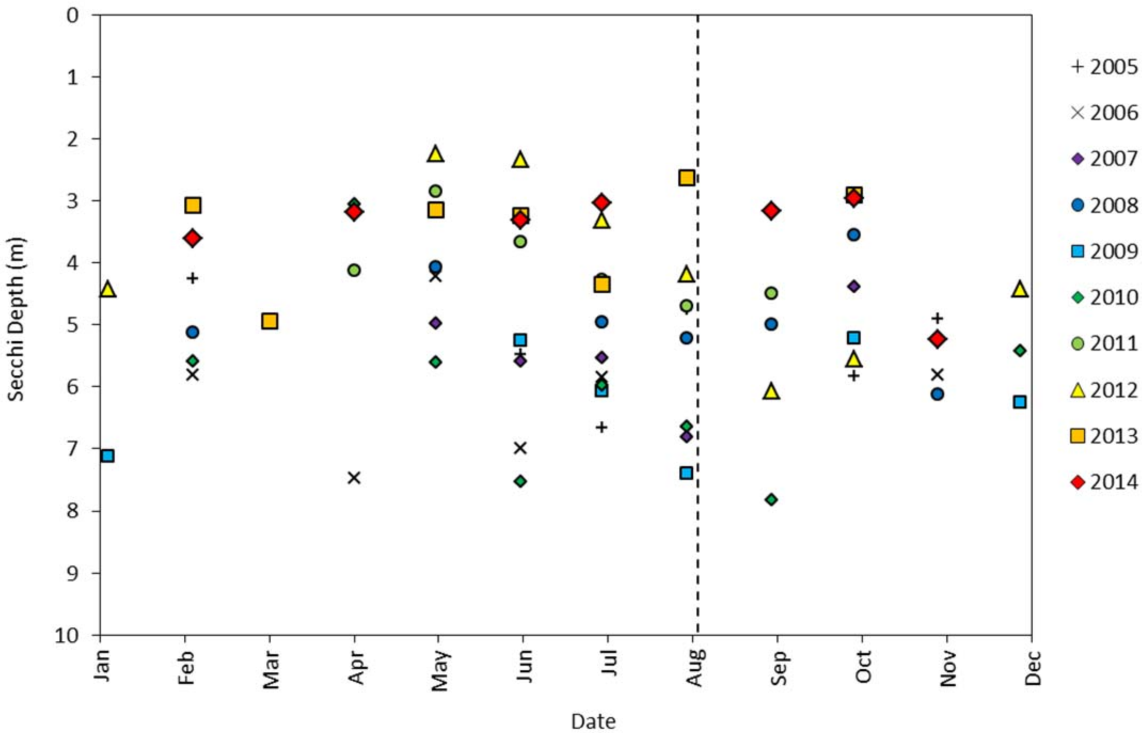


Figure 19: Secchi depth (monthly average) measured in Polley Lake from 2005 to 2014. Dashed line indicates date of TSF breach August 4, 2014.

The most recent pre-event data for chlorophyll *a* measured in Polley Lake is from baseline studies conducted in 1995 and 1996, in which mean chlorophyll *a* concentrations were reported to range from 0.4 to 1.0 µg/L (Minnow 2014). A change in nutrient concentrations and trophic status of the lake in 2010-2012 corresponded with observations of phytoplankton blooms. Post-event measurement of chlorophyll *a* was limited to three samples taken on September 9, 2014, with concentrations ranging from 5.2 to 6.6 µg/L. It is not known if the post-event chlorophyll *a* concentrations are different than immediately prior to the event.

5.2.2.3 Zooplankton Productivity

Water from Polley Lake was not acutely toxic to *Daphnia magna* or *Ceriodaphnia dubia* and did not affect reproduction in *Ceriodaphnia dubia* (Minnow 2015b).

As of the time of writing, zooplankton community data were not available to assess zooplankton productivity. However, recent sampling of zooplankton has been undertaken by MPMC. Condition factor of Rainbow Trout approximately seven weeks after the event was comparable to pre-impact condition factor, which suggests that the food supply for trout was within the range that might have been encountered previous to the event.

5.2.2.4 Benthic Invertebrates/Emerging Insects

Production of benthic invertebrates and emerging insects was disrupted in the littoral zone and immediately adjacent lakebed. Based on the findings of Minnow (2015a), this effect was temporary as invertebrates were found in most sediment samples collected in Polley Lake between August and October 2014.

5.2.3 Food Supply – Quality

No information is available regarding metal concentrations in the tissues of food items for Rainbow Trout. However, those data may be available in the future. Metal concentrations in Rainbow Trout collected shortly after the event were comparable to pre-event concentrations (SNC-Lavalin 2015a). Additional fish tissue collection is being planned.

5.2.4 Efficiency

The potential for effects on foraging efficiency and food capture is dependent on the species and habitat being occupied. Fish feeding in littoral and nearshore zones was likely not affected because turbidity was low (i.e., ≤ 3 NTU) in the top 7 m of the water column. Rainbow Trout length and weight data do not suggest that foraging efficiency was affected (Section 5.2.1).

5.2.5 Bioenergetics

Rainbow Trout condition factor data do not suggest that efficiency in conversion of energy was affected (Section 5.2.1).

5.3 Individual Performance

5.3.1 Stress

As discussed in Section 5.2.1, Fathead Minnow and Rainbow Trout exposed to Polley Lake water in laboratory toxicity testing and Rainbow Trout and Longnose Sucker collected from Polley Lake did not fail to grow, which is a potential outcome of stressors.

Fish tissue samples were collected for analytical chemistry for several sampling dates and locations. The data are provided in SNC-Lavalin (2015a) and will be assessed in the future ecological risk assessment.

5.3.2 Olfactory Effects

Olfactory effects were not assessed for Polley Lake because the rainbow trout in Polley Lake are a resident population. A migration barrier between Polley Lake and Quesnel Lake exists at Hazeltine Canyon.

5.3.3 Disease

TSS concentrations observed were not high enough to reduce the ability of fish to resist disease and thus an increase in the incidence of disease as a result of increased turbidity would not be expected (Figure 17). As discussed in Section 5.2.1, Fathead Minnow and Rainbow Trout exposed to Polley Lake water in laboratory toxicity testing and Rainbow Trout and Longnose Sucker collected from Polley Lake did not fail to grow, which is a potential outcome of disease.

5.4 Migration

Adult Rainbow Trout migrate into upper Hazeltine Creek from Polley Lake after ice-out in the spring (mid-April to mid-May) to spawn, returning to the lake by mid-June near the end of freshet and prior to the 2014 spawning period (SNC-Lavalin 2015b). The 2015 spawning migration to Hazeltine Creek was blocked by a fish fence because physical works associated with the rehabilitation of Hazeltine Creek were being undertaken.

5.5 Reproduction

5.5.1 Adult Maturation

Trout were observed gathering at the fish fence in spring 2015, suggesting normal maturation by trout in Polley Lake (Figure 20).

Figure 20: Photograph of Rainbow Trout Gathering at the Fish Fence at the Outlet from Polley Lake to Hazeltine Creek in Spring 2015.

5.5.2 Density-independent Reproductive Success (Spawning Habitat Quality)

Rainbow Trout were unable to access Hazeltine Creek in spring 2015 to spawn, which will likely reduce recruitment to the young-of-year age class in the lake.

5.5.3 Density-dependent Reproductive Success (Spawning Habitat Quantity

Rainbow Trout were unable to access Hazeltine Creek in spring 2015 to spawn, which will likely reduce recruitment to the young-of-year age class in the lake. Five drainages enter Polley Lake from the west side, and an evaluation of the suitability of these for rainbow trout spawning and rearing found that rearing habitat existed in two of these drainages (North and East Dump Creeks), although the habitat was characterized as poor (Sigma 2004, cited in Minnow 2014). Frypan Creek, the major inlet to Polley Lake, was observed to contain juvenile Rainbow Trout in September 2014 (Lirette 2015b); however it is unknown as to whether this represents usable spawning and rearing habitat relative to what had previously been accessible in Hazeltine Creek. A further consideration is the potential for interspecific competition between age 0 to 1+ Rainbow Trout which use the same food source as Redside Shiner, which Rainbow Trout avoid by rearing initially in Hazeltine (L. Williston, Ministry of Forests, Lands, and Natural Resource Operations [MFLNRO], pers. comm.). It is unknown at this time what effect loss of Hazeltine Creek as rearing habitat will have on the success of the 2015 year class.

5.6 Summary of Effects on Fish Productivity

The primary effect of the event on the Rainbow Trout of Polley Lake was the disruption to rearing habitat in Hazeltine Creek and the potential loss of a year-class of Rainbow Trout and the blockage of access to Hazeltine Creek for spawning in 2015 (Table 9). Post-event toxicity testing indicated that Polley Lake water did not affect survival or growth of fish, survival or growth of daphnid zooplankton, or growth of plant test species. Rainbow Trout and Longnose Sucker length and weight data suggest that feeding efficiency was not affected.

Table 9 Summary of Effects on Productivity of Fish in Polley Lake

Component of Productivity	Sub-component	Mechanism	Potential Effect on Productivity
Survival	Density independent mortality	Direct mortality	■ Possible, but not quantifiable as no dead fish were observed. Fish may also have been displaced.
		Exceedance of environmental tolerances	■ TSS concentrations could have been high enough in the south end of the lake during and immediately following the event to cause lethal conditions; however, the post-event water quality monitoring program did not identify concentrations above 50 mg/L. ■ Post-event toxicity testing indicated that Quesnel Lake water was not toxic to juvenile Rainbow Trout or Fathead Minnow
	Reduced habitat quality or quantity	Habitat supply limitation	■ There has been no quantitative estimate of the spatial extent of material covering habitat in the lake and the change in bathymetry cannot be reliably estimated because of a lack of reliable pre-event data
Growth	Fish growth	-	■ Growth of Fathead Minnow was not affected in laboratory water toxicity tests. ■ Rainbow Trout and Longnose Sucker collected post event were similar in size to those measured pre-event.
	Food supply	Quantity	■ There was no impairment in growth of an aquatic vascular plant or an algal test species. ■ Polley Lake water was not toxic to daphnid zooplankton and did not affect reproduction. ■ Production of emerging insects was disrupted on lakebed due to the alteration of the habitat. One month following the event, these areas were being recolonized. ■ In sediment toxicity tests, organic carbon was low in many samples and was associated with poor performance in growth or survival of test organisms.
		Quality	■ No information was available regarding potential change in food quality. However, metal concentrations in Rainbow Trout collected shortly after the event were comparable to pre-event concentrations
	Efficiency	Foraging	■ Rainbow Trout and Longnose Sucker length and weight data suggest that feeding efficiency was not affected.
Growth cont.	Efficiency cont.	Bioenergetics	■ Rainbow Trout and Longnose Sucker length and weight data suggest that conversion of energy was not affected.

Component of Productivity	Sub-component	Mechanism	Potential Effect on Productivity
Individual performance	Stress	Suboptimal environmental conditions	■ Rainbow Trout and Longnose Sucker length and weight data suggest that stress did not impair growth ■ Suspended sediments can cause change in behaviour; however, turbidity in the upper water column was lower than turbidity observed to cause such effects.
	Olfactory effects	Suboptimal environmental conditions	■ Copper concentrations were lower than those observed to cause effects.
	Disease	Infection	■ Rainbow Trout and Longnose Sucker length and weight data suggest that disease did not impair growth ■ TSS concentrations were lower than those reported in the literature to reduce the ability of a fish to resist disease.
Migration	-	Disruption of normal behaviour	■ Spawning migration of Rainbow Trout to Hazeltine was blocked for spring 2015.
Reproduction	Adult maturation	Suboptimal environmental conditions	■ Trout were observed gathering at the fish fence in spring 2015, suggesting normal spawning development.
	Density-independent reproductive success	Spawning habitat quality	■ Rainbow Trout were unable to access Hazeltine Creek in spring 2015 to spawn, which will likely reduce recruitment to the young-of-year age class in the lake
	Density-dependent reproductive success	Spawning habitat quantity	■ Rainbow Trout were unable to access Hazeltine Creek in spring 2015 to spawn, which will likely reduce recruitment to the young-of-year age class in the lake. Interspecific competition between age 0 to 1+ Rainbow Trout and Redside Shiner in Polley Lake; it is unknown what effect this may have on the success of the 2015 year-class.

Notes:
NA – not applicable; TSS – total suspended solids

6.0 QUESNEL RIVER IMPACT ASSESSMENT

The water quality parameters of potential concern identified for Quesnel River were turbidity and total copper (Golder 2015). Total copper was correlated with turbidity and thus inferred to not be bioavailable. This assessment therefore focussed on the potential effects associated with turbidity.

Several short-term pulses of turbidity were observed in Quesnel River in response to westward seiche events and a longer-term elevation in turbidity occurred during Quesnel Lake turnover (Figure 21). The turbidity was due to the suspension of fine particles and total suspended solids concentrations were at or below the detection limit of 3 mg/L.

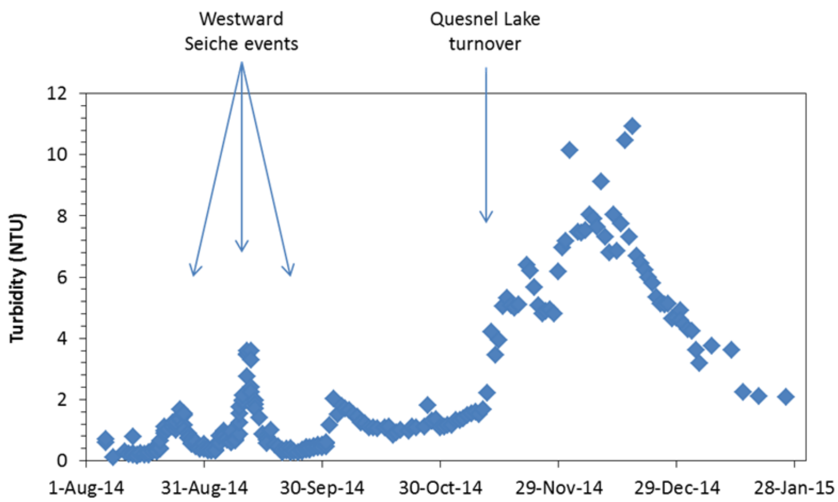


Figure 21: Temporal Variability in Turbidity in Quesnel River Near the Town of Likely

These suspended sediment levels were lower than those reported to result in changes to the following components of productivity.

6.1 Survival

Laboratory toxicity testing with Rainbow Trout (96-h LC50) and Fathead Minnow (7-day survival and growth) indicated that water from Quesnel River Lake was not lethal to these fish species (Minnow 2015b). Similarly, mortality did not occur during a an extended early life stage toxicity test using Quesnel River water when turbidity was highest.

6.2 Fish Growth

Growth of Fathead Minnow was not affected in the 7-day survival and growth tests conducted in water from Quesnel River (Minnow 2015b).

6.3 Food Supply

6.3.1 Primary Productivity

There was no impairment of growth of either *Lemna minor* (vascular aquatic plan) or *Pseudokirchneriella subcapitata* (alga) in laboratory toxicity tests on water from Quesnel River (Minnow 2015b).

Van Nieuwenhuyse (1983, cited in Birtwell 1999) calculated that an increase of 5 NTU would decrease the algal productivity of shallow clear-water streams by 3 – 13%. During the seiche events, turbidity was below this level of effect. During lake turnover, turbidity was greater than this effect level; however, primary productivity is naturally lower in fall and winter and a change in turbidity of 10 NTU would not be expected to further decrease productivity.

6.3.2 Benthic Invertebrates

Benthic drift has been observed to increase with the concentration of TSS and may occur within hours of a relatively small increase in TSS (10 mg/L). In comparison, changes in population sizes have been observed at higher TSS exposure (60 - 130 mg/L) over a period of > 50 days (Bilotta and Brazier 2008).

Minnow (2015a) collected benthic invertebrate samples from Quesnel River substrates at six locations in late October 2014, prior to Quesnel lake turnover and the increased turbidity observed through to January 2015. Benthic invertebrate abundance was higher at the three stations closest to the Quesnel Lake Outlet than the three stations further downstream and was greater than the reference stations. Richness and measures of diversity of the benthic community in the river near the Town of Likely were similar to the reference locations as were the relative abundance of larval Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies), which are often collectively referred to as EPT taxa and used as an indicator of potential exposure to contaminants as they tend to be sensitive to metals. These results suggest that the benthic invertebrate community was not significantly affected by the transient pulses of turbidity at least up to the time of lake turnover.

Minnow (2015a) also collected benthic invertebrate samples from Quesnel River for analytical chemistry. Copper was higher in whole community samples collected near the Town of Likely than in benthos from the reference area (Cariboo River); however, Minnow (2015a) did not find a correlation between tissue and water chemistry that would explain the difference. As discussed in Section 4.2.3, the observed concentrations were lower than lower than dietary no-effect levels for Rainbow Trout (e.g., Miller et al. 1993).

Additional sampling of the benthic invertebrate community in the fall of 2015 will help confirm whether or not effects to the benthic invertebrate community occurred during lake turnover.

6.4 Individual Performance of Fish

Fish behaviour such as avoidance, breakdown of normal dominance hierarchies, lack of territorial defence, and increased gill flaring has been observed at turbidity levels on the order of >50 NTU (Berg and Northcote 1985; Bisson and Bilby 1982). As discussed above, Fathead Minnow and Rainbow Trout exposed to Quesnel River water in laboratory toxicity testing did not fail to grow, which is a potential outcome of the stressors identified above.

Samples of several fish species were collected for analytical chemistry from Quesnel River; the data are provided in SNC-Lavalin (2015a) and will be assessed in the future ecological risk assessment.

6.5 Reproduction

Chapman (1988) reviewed a large number of papers investigating the effect of fine sediments on alevin emergence and survival in salmonid species. While differences between fish species and site conditions caused large variations in the actual relationship between percent fines and alevin (newly-hatched fish) emergence, a general trend of decreased alevin emergence correlated with increased percentages of fine-grained sediment in gravel. The major factor contributing to egg and alevin survival was the inter-gravel dissolved oxygen concentration; fine-grained sediment clogged the interstitial spaces, and therefore reduced the flow of oxygen-rich water to the redd.

An early life stage test with rainbow trout was carried out by MPMC using water samples regularly collected from the Quesnel River (QUR-1) between November 25 and December 22, 2014. The water samples were collected to coincide with egg availability which happened to also coincide with the period of greatest turbidity in Quesnel River. There were no reported adverse effects on the survival or normal development of Rainbow Trout eggs exposed to the water through to hatching of the alevin stage (MPMC 2015). Similar results were observed when the test was repeated with water samples collected from December 10, 2014 to January 7, 2015 (MPMC, unpublished data). These results suggest that the increase in turbidity in the Quesnel River after turnover of Quesnel Lake was unlikely to have an effect on incubating salmonid eggs in the river.

7.0 SUMMARY

This report provides a preliminary assessment of potential effects on the aquatic health of Quesnel and Polley Lakes, and Quesnel River, following the TSF dam failure at Mount Polley Mine. The assessment was structured based on DFO guidance on evaluating productivity to facilitate the ongoing efforts of the Habitat Remediation Working Group that has been established. Changes in productivity were assessed by comparing pre- and post-event data were available, and by evaluating data in the context of the literature with consideration of site-specific conditions.

To facilitate the assessment of potential effects on productivity a conceptual ecological model was developed for fish-habitat-food interactions. These habitat and food requirements were grouped, resulting in three general assemblages applicable to a summer condition when the event occurred. The three assemblages assist in identifying how potential stressors related to the event may affect lake productivity. The three fish-habitat-food assemblages and the preliminary potential for effects identified were as follows.

Littoral Zone and Benthic Habitats - Fish associated with the littoral zone and benthic habitats are oriented to the near-shore environment and feed largely on benthic prey (e.g., amphipods, larvae and pupae of aquatic insects such as chironomids), periphyton, or in some cases crustacean zooplankton in the water column. Fish in this group include early juvenile stages of salmon, Burbot, and Lake Whitefish and are benthivores (i.e., their food comes from benthic substrates), and forage fish such as sucker, sculpin, chub, shiner and Northern Pikeminnow. The event resulted in the alteration of littoral habitat at the mouth of Hazeltine Creek, resulting in the displacement or potential (unconfirmed) loss of fish in the area. Debris was also deposited on the lakebed in the profundal area, which resulted in a change in the benthic habitat and a potential disruption in the benthic invertebrate community. The impact on the bed of Quesnel Lake continues to be studied. Although early sampling suggests that some recovery may have begun, benthos sampling subsequent to deposition and settling of the sediments is necessary to confirm if the impact is of a transient nature. Post-event toxicity testing indicated that Quesnel Lake water did not affect survival or growth of fish or growth of plant test species and geochemical evaluations carried out have found that the tailings will be chemically stable in the lakes and are not expected to leach metals.

Open-Water Habitat and Fish that Feed on Emerging Insects - Fish associated with open-water habitat and feed on emerging insects (e.g., chironomids) include Mountain Whitefish and smaller Rainbow Trout. Larger Rainbow Trout in Quesnel Lake may consume juvenile Sockeye Salmon and Kokanee. This assemblage also applies to Polley Lake, in which the main fish species is Rainbow Trout. Production of emerging insects was disrupted on the bed of both Quesnel and Polley Lakes. Although early sampling suggests that some recovery may have begun, benthos sampling subsequent to deposition and settling of the sediments is necessary to confirm if the impact is of a transient nature. Post-event toxicity testing indicated that lake water did not affect survival or growth of fish or growth of plant test species. In Polley Lake, Rainbow Trout size did not appear to change; however, the event likely affected reproduction through the loss of eggs in the Upper Hazeltine Creek spawning habitat in 2014 and potentially through the loss of use of that habitat in 2015.

Open-Water Habitat and that Fish that Feed on Crustacean Zooplankton - The assemblage of fish associated with open-water habitat and which feed on crustacean zooplankton consists of juvenile Sockeye Salmon and Kokanee. During the summer, this assemblage may also include Lake Trout. Post-event toxicity testing indicated that Quesnel Lake water did not affect survival or growth of fish, survival or growth of daphnid zooplankton, or growth of plant test species. The literature indicates that the direction of change in primary productivity as a result of introduction of suspended sediments to a lake depends on whether the phytoplankton are light limited or nutrient limited. The preliminary information available at this time suggest that there was an influx of phosphorus into Quesnel Lake and although changes in phytoplankton and zooplankton biomass were not observed, juvenile Sockeye Salmon collected west of Cariboo Island were larger than those from the lake east of Cariboo Island.

Quesnel River experienced several pulses of turbidity water during transient seiche (internal lake wave) events and lake turnover. Post-event toxicity testing indicated that Quesnel River water did not affect survival or growth of fish, development of Rainbow Trout eggs through to alevins, survival or growth of daphnid zooplankton, or growth of plant test species. Richness and measures of diversity of the benthic invertebrate community in the river near the Town of Likely were similar to the reference locations as were the relative abundance of species sensitive to metals.

Some effects are duration dependent and additional data collection is presently underway that will further inform the understanding of the effect the event had on Quesnel and Polley Lakes and Quesnel River:

- MPMC commenced water quality and zooplankton sampling in May, 2015.
- The benthic invertebrate community in Quesnel and Polley Lakes will be sampled again in summer 2015 to evaluate the continuing improvement in abundance and diversity of benthos in the disturbed areas of the lakebed.
- The disturbed area of the lakebeds will be monitored for habitat quality in summer 2015.

Finally, a human health and ecological risk assessment will be undertaken to evaluate the potential effects of the chemical parameters of concern on productivity of the lake environments. This will include an interpretation of fish tissue chemistry collected following the event.

8.0 CLOSURE

We trust that this report provides sufficient information for your present needs. If you have any questions, please do not hesitate to contact the undersigned at 604-296-4200.

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10.0 GLOSSARY

Benthic	At the lake bed.
Benthivore	An animal that eats benthic prey
Bioaccumulation	The accumulation of a substance in the tissues of an aquatic organism through exposure to water and diet.
Bioavailability	The portion of a substance or chemical that is immediately available for uptake by organisms. Bioavailability of different substances can change over time.
Biomass	The mass of biological material, including plants, animals and decaying organic matter, present within a particular habitat, area or ecosystem at any one time
Chlorophyll *a*	A photosynthetic pigment found in plants responsible for the conversion of inorganic carbon and water into organic carbon. The concentration of chlorophyll *a* is an indicator of algal concentration.
Dimictic	Refers to lakes that mix from top to bottom twice a year; mixing occurs in spring and fall.
Dissolved organic carbon	The dissolved portion of organic carbon in water. It is comprised of humic substances and partly degraded plant and animal materials.
Dissolved oxygen	The amount of free oxygen dissolved in water, usually expressed in milligrams per litre (mg/L), parts per million (ppm), or percent of saturation (%). Adequate concentrations of dissolved oxygen are necessary for fish and other aquatic organisms.
Emerging insect	Insects that have a water-based larval stage and a flying adult stage.
Epilimnion/epilimnetic	The water column above the thermocline.
Epiphyton	Algae that grow on the surfaces of aquatic plants.
Euphotic zone	The depth at which light diminishes to 1%.
Forage fish	Small fish that are prey for larger fish
Hypolimnion	The water column below the thermocline.
Limnetic zone	The water column in the euphotic zone.
Littoral zone	The area of the lakeshore where aquatic plants grow.
Oligotrophic	Trophic state classification for lakes characterized by low productivity and low nutrient inputs (particularly total phosphorus).
Periphyton	Algae that grow on the surface of rocks.
Phytoplankton	Free-floating plants/algae and photosynthetic bacteria.
Piscivore	An animal that eats fish.
Planktivore	An animal that eats plankton.
Profundal zone	The water column below the euphotic zone.
Seiche	A type of long-wavelength wave that occurs as a result of some disturbance within waterbody that is relatively closed-off from the outside environment. Long waves resonate outward to the boundaries of the waterbody, and then resonate back inward.
Stratification	The process by which the water column develops layers of water separated by a density barrier.
Thermocline	The location of a sharp change in temperature of the water column that causes a density barrier and limits mixing of the water column.
Zooplankton	Free-floating invertebrates.

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APPENDIX I: MOUNT POLLEY TAILINGS DAM FAILURE - FISH AND FISH HABITAT IMPACT ASSESSMENT

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MOUNT POLLEY TAILINGS STORAGE FACILITY FAILURE – FISH AND FISH HABITAT IMPACT ASSESSMENT

Prepared For: Mount Polley Mining Corporation

SNC-LAVALIN INC.

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EXECUTIVE SUMMARY

The Fish and Fish Habitat Impact Assessment (FFHIA) describes historical or pre-event baseline fisheries resource information for water courses and water bodies affected by the TSF dam foundation failure (henceforth referred to as the TSF dam failure), and it assesses the potential effects to those resources, including describing the potential impacts to fish and fish habitat.

Specifically, the FFHIA qualitatively and where possible quantitatively, identifies the potential impact to fish species including their productivity and habitats. The focus of this assessment was on alterations to the physical properties of fish habitat, and on fish species that are part of commercial, recreational or aboriginal fisheries.

Note that in this assessment physical habitat properties include the geomorphological characteristics and biological attributes that determine habitat structure. Physical habitat does not include physiochemical attributes of stream or lake water (e.g., water chemistry, water temperature, water clarity, water quantity or light intensity). Alterations to physiochemical properties will be addressed in the Mount Polley Tailings Dam Failure – Surface Water Quality Impact Assessment (Golder Associates Ltd. 2015a) and Mount Polley Tailings Dam Failure – Quesnel and Polley Lakes Aquatic Productivity Impact Assessment. (Golder Associates Ltd. 2015b.).

The area included in the FFHIA encompasses specific fish-bearing water courses and water bodies directly and potentially affected by the TSF dam failure. This includes the Hazeltine Creek watershed consisting of Polley Lake and Hazeltine and Edney creeks. Specific areas included the entire Hazeltine Creek mainstem between Polley Lake and Quesnel Lake, as well as lower Edney Creek (i.e., lower reach near the confluence with Hazeltine Creek) and surrounding riparian habitats. The assessment area also includes the shoreline and littoral region where Hazeltine Creek enters Quesnel Lake, the West Arm of Quesnel Lake, and upper Quesnel River from the confluence of Quesnel Lake to just downstream of the UNBC Quesnel River Research Center.

The following summarizes the main findings of the FFHIA for the identified water courses and water bodies.

Hazeltine Creek

Approximately 62,616 m^2 of aquatic habitat and 717,249 m^2 of riparian habitat was estimated to have been permanently altered on Hazeltine Creek.

There is the potential for subsequent Rainbow Trout reproductive events to be inhibited, which could affect ongoing population viability and productivity. Spawning Rainbow Trout returning to upper Hazeltine Creek from Polley Lake to reproduce may seek out other nearby watercourses to undertake their reproductive cycle, but it is unknown whether sufficient quantities and quality of spawning habitat exists in the surrounding area to accommodate them. Rainbow Trout are the most abundant and widely distributed fish species in lower Hazeltine Creek relative to other fish species present in the creek. Re-establishing access to habitat in lower Hazeltine Creek will offer opportunity for spring spawning Rainbow Trout to successfully migrate and reproduce to initiate the natural recruitment process. Other fish species also utilize lower Hazeltine Creek, but in lower numbers, suggesting preferred habitat conditions in lower Hazeltine Creek quite possibly were not present.

Overall, it was generally not possible to directly account for losses of fish or production in upper and lower Hazeltine Creek due to the TSF dam failure because of a lack of baseline species population parameters and production estimates. Although static data (i.e., Catch Per Unit Effort, densities/biomass) was somewhat available, it could not be effectively applied to produce production rates estimates. It is recommended that an effectiveness and biotic response monitoring program be implemented to monitor population dynamic productivity parameters once Hazeltine Creek has been rehabilitated.

Edney Creek

Approximately 2,390 m^2 of aquatic habitat and 20,215 m^2 of riparian habitat was altered in lower Edney Creek.

The amount of habitat in Edney Creek altered by the TSF dam failure was small in comparison to habitat available in the Edney watershed, thus the current obstruction to upstream migration, caused by material from the TSF, and potential loss of reproductive events of Rainbow Trout appear to present the primary concern to Rainbow Trout population productivity. Although there is limited evidence of other fish species utilizing Edney Creek, restoring access may also contribute to the productivity of other species (i.e., Coho Salmon) utilizing or migrating out from Edney Creek. It is our understanding from Mount Polley Mining Corporation that rehabilitation of Edney Creek and its connectivity to Quesnel Lake was commissioned prior to spring 2015 with the aim to allow for upstream and downstream access (migration) for fish.

Quesnel River

No permanent physical alteration of habitat is believed to have occurred in the Quesnel River. The potential for water quality-related effects are addressed in the Golder (2015a), Mount Polley Tailings Dam Failure – Surface Water Quality Impact Assessment. The potential for settling of suspended particles is being addressed by Minnow Environmental Inc. (Minnow Environmental) through the use of sediment traps (Minnow Environmental 2015).

Quesnel Lake

It was estimated that the TSF dam failure permanently altered a 2,081 m length of West Basin shoreline at the mouth of Hazeltine Creek (about 6% of the total shoreline in the West Basin), and about 94,394 m^2 or 6.5% of the total West Arm littoral zone (0-6 m depth). Further, about 15% of ‘very high’ rated juvenile fish habitat at the mouth of Hazeltine Creek was altered. Finally, Tetra Tech (2015) determined that about 1.81 km^2 of the surface area of the lake-bed below the 100-m depth contour was permanently altered by the event.

Overall, it was generally not possible to directly account for losses of fish or production in the West Arm of Quesnel Lake due to the TSF dam failure because of a lack of baseline information about species population properties such as production estimates, densities/biomass or location and surface area of key habitats.

Polley Lake

Tailings from the TSF dam failure entered Polley Lake at the lake outlet to Hazeltine Creek; however, there are no current estimates of how much linear shoreline or surface area of lake bed was altered by the event.

The TSF dam failure resulted in blockage of upper Hazeltine Creek and hence the Polley Lake Rainbow Trout population lost access to creek spawning habitat for one season. A reduction in rainbow trout returning to Polley Lake may affect future angling results.

The TSF dam failure may have impacted habitats important to Redside Shiner and Longonse Sucker in Polley Lake. However, there is currently insufficient scientific evidence confirming the habitats or population properties of these species in Polley Lake.

Recommendations

The duration and severity of the impacts (i.e., permanent and/or temporary alterations) as a result of the TSF dam failure to fish production and habitat will ultimately depend on the nature and success of the rehabilitation (i.e., offsetting) efforts to altered riverine and lacustrine habitats as well as monitoring the affected creek and lake systems for potential long-term (chronic) effects. The characterisation of effects should be reassessed once rehabilitation efforts are complete, and should continue to be re-examined in the context of the results of any effectiveness and biotic-response monitoring. In addition, an ecological risk assessment should be completed to prioritize and focus the monitoring and rehabilitation programs.

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ACRONYMS

AHI – Aquatic Habitat Index

BC – British Columbia

BC MoE – BC Ministry of Environment

BC MoF – BC Ministry of Forests

CCLUP – Cariboo Chilcotin Land Use Plan

CDC – BC Conservation Data Centre

CMN – Community Mapping Network

COSEWIC – Committee on the Status of Endangered Wildlife in Canada

DFO – Fisheries and Oceans Canada

DO – dissolved oxygen

FFHIA – Fish and Fish Habitat Impact Assessment

FFP – Fish Protection Provisions

FIM – Foreshore Inventory Mapping

FSR – Forest Service Road

GIS – Geographic Information System

GoC – Government of Canada

HSRMP – Horsefly Sustainable Resource Management Plan

IFC – Interior Fraser Coho

Imperial Metals - Imperial Metals Corporation

LHC – Lower Hazeltine Creek

ACRONYMS (cont'd)

LWD – large woody debris

MFLNRO – BC Ministry of Forests, Lands and Natural Resource Operations

MPMC – Mount Polley Mining Corporation

MWLAP – BC Ministry of Water, Lands and Air Protection

RMA – Riparian Management Area

SARA – *Species at Risk Act*

SNC-Lavalin – SNC-Lavalin Inc.

SRMPs – Sustainable Resource Management Plans

TDS – Total Dissolved Solids

TSF – Tailings Storage Facility

UEC – Upper Edney Creek

UFFCA – Upper Fraser Fisheries Conservation Alliance

UHC – Upper Hazeltine Creek

UNBC – University of Northern British Columbia

u/s – upstream

WQIA – Water Quality Impact Assessment

YOY – young-of-the-year

SYMBOLS & UNITS

% – percent

°C – degrees Celsius

cm – centimetre(s)

CPUE – catch per unit effort

g – gram(s)

ha – hectare

kg – kilogram

km – kilometre(s)

km^2 – square kilometre(s)

km^3 – cubic kilometre(s)

m – metre(s)

m^2 – square metre(s)

m^3 – cubic metre(s)

mg – milligram

mg/l – milligram per litre

mg/ml^2 – milligram per square millilitre

mg/m^2 – milligram per square metre

mL – millilitre(s)

mm – millimetre(s)

N – total number (count)

NTU – Nephelometric Turbidity Unit

UTM – Universal Transverse Mercator

1 BACKGROUND

On August 4, 2014, a foundation failure of the Tailings Storage Facility (TSF) dam occurred at Mount Polley Mine. The purpose of this Fish and Fish Habitat Impact Assessment (FFHIA) is to describe historical or pre-event baseline fisheries resource information for watercourses and water bodies affected by the TSF dam foundation failure (henceforth referred to as the TSF dam failure), and to assess potential effects on those resources, including understanding the potential impacts to fish and fish habitat.

1.1 Fish Habitat and Productivity

Under the Canadian federal *Fisheries Act* “fish habitat” means spawning grounds and any other areas, including nursery, rearing, food supply and migration areas, on which fish depend directly or indirectly in order to carry out their life processes. Further, Fisheries and Oceans (DFO) defines a permanent alteration to fish habitat as a modification of a special scale and a duration that limits or diminishes the ability of fish to use such habitats as spawning grounds, or as nursery, rearing, or food supply areas, or as a migration corridor, or any other area in order to carry out one or more of their life processes.

Habitat necessarily includes all of the physical, chemical, and biological attributes that affect or sustain fish but the focus in this FFHIA is on alteration (permanent or temporary) of physical habitat properties of water courses and bodies that may affect fish, including species that are part of commercial, recreational or aboriginal fisheries. Physical habitat properties include the geomorphological characteristics and biological attributes that determine habitat structure. The six main attributes that are the principal determinants of the physical habitat structure provided by a watercourse include: stream size and channel dimensions, channel gradient, channel substrate, size and type, habitat complexity and cover, vegetation cover and structure of the riparian zone, and channel-riparian interactions (Kaufmann et al. 1999). In lakes, physical habitat structure refers to shoreline riparian vegetation, aquatic macrophytes, littoral fish cover, littoral bottom substrate, lake shoreline substrate, littoral depth, lake morphometry, bathymetry, and lakebed substrate (Kaufmann et al. 2014).

In the FFHIA, physical habitat does not include physiochemical attributes of stream or lake water (e.g., water chemistry, water temperature, water clarity, water quantity or light intensity). Alterations to physiochemical (i.e., water quality) properties will be addressed in the Mount Polley Tailings Dam Failure – Surface Water Quality Impact Assessment (Golder Associates Ltd. 2015a) and Mount Polley Tailings Dam Failure – Quesnel and Polley Lakes Aquatic Productivity Impact Assessment. (Golder Associates Ltd. 2015b.) Results from fish tissue sampling are addressed in the separate technical memorandum prepared by SNC-Lavalin, titled ‘*Fish Tissue Results for Samples Collected Following the Mount Polley Tailings Storage Facility Dam Failure*’.

Most relevant to the FFHIA is the potential for lost fish productivity as a result of impacts to habitat. Fisheries productivity can be defined as the sustained yield of all component populations and species and their habitats, which support and contribute to a fishery in a specified area. It is determined by the vital rates of reproduction, growth, and survival, and life history characteristics of the population (e.g., age at maturity).

Fish production has a spatial and temporal context, and the production of a fish population depends on the amount and quality of habitat required for each life stage. Any adverse change in a component of productivity is expected to have some negative effect on fish. For example, activities that cause a decrease in habitat quantity cause a decrease in supply of habitat and will potentially result in density-dependent limitation caused by a reduction in carrying capacity (Bradford et al. 2014).

The life cycle of a typical fish can be used as a template for considering the assessment of effects on habitat and fish productivity. Activities that restrict an individual fish from completing their life cycle or that diminish their vital rates (reproduction, growth, survival) will ultimately result in a reduction in yield at the population level (Bradford et al. 2014); such activities will interfere with the sustainability of fish productivity. Table 1-1 briefly summarizes some of the key components and mechanisms typically considered in assessments of fish productivity, and the location of the assessment within the impact assessment documents.

Table 1-1: Summary of Fish Productivity Components and Mechanisms

Productivity Component	Mechanism	Impact Assessment Document
Growth	Reduction of food quality Reduction in food quantity	Considered in the Golder Associates Ltd. (2015a) Mount Polley Tailings Dam Failure – Surface Water Quality Impact Assessment and Golder Associates Ltd. (2015b) Mount Polley Tailings Dam Failure – Quesnel and Polley Lakes Aquatic Productivity Impact Assessment.
Individual Performance	Increase in infection, disease, bioaccumulation	Considered in the Golder Associates Ltd. (2015a) Mount Polley Tailings Dam Failure – Surface Water Quality Impact Assessment and Golder Associates Ltd. (2015b) Mount Polley Tailings Dam Failure – Quesnel and Polley Lakes Aquatic Productivity Impact Assessment.
Survival	Direct mortality	Considered in this FFHIA
	Loss or alteration of rearing & overwintering habitat (quantity and quality)	Considered in this FFHIA

Productivity Component	Mechanism	Impact Assessment Document
	Exceedance of environmental tolerances (e.g., turbidity, contamination)	Considered in the Golder Associates Ltd. (2015a) Mount Polley Tailings Dam Failure – Surface Water Quality Impact Assessment and Golder Associates Ltd. (2015b) Mount Polley Tailings Dam Failure – Quesnel and Polley Lakes Aquatic Productivity Impact Assessment.
Migration	Blocking of passage	Considered in this FFHIA
	Deterioration of migrations conditions	Considered in this FFHIA
	Loss of shallow water corridors	Considered in this FFHIA
Reproduction	Sub-optimal environmental conditions	Considered in the Golder Associates Ltd. (2015a) Mount Polley Tailings Dam Failure – Surface Water Quality Impact Assessment and Golder Associates Ltd. (2015b) Mount Polley Tailings Dam Failure – Quesnel and Polley Lakes Aquatic Productivity Impact Assessment.
	Loss or alteration of spawning habitat (quantity and quality)	Considered in this FFHIA
	Loss of access to spawning habitat	Considered in this FFHIA

Koops et al. (2013); Bradford et al. (2014)

Link to Comprehensive Environmental Impact Assessment Workplan (CEIA)

A number of aquatic components described in the Aquatic Impact Assessment section of the CEIA workplan (dated August 29, 2014), such as primary productivity, are addressed in the technical reports summarized in Table 1-1.

1.2 Objective

The objective of the FFHIA was to qualitatively and/or quantitatively identify the potential impact to fish species including their productivity and habitats. The focus of this assessment was on alterations to the physical properties of fish habitat, and on fish species that are part of commercial, recreational or aboriginal fisheries.

1.3 Acknowledgements

Cameron Wallace, B.Sc. (GIS Analyst) managed the preparation all key maps. Natalie Neufeld assisted in data management and in preparation of data summary tables.

Raw fisheries data for Hazeltine and Edney creeks as well as Polley and Quesnel lakes was provided by both Mount Polley Mining Corporation (MPMC) and Minnow Environmental Inc. (Minnow Environmental) personnel. The Project Sponsor was Gordon Johnson, M.Sc., P.Eng.

2 IMPACT ASSESSMENT AREA

The areas included as part of the FFHIA encompass specific fish-bearing watercourses and waterbodies directly and potentially affected by the TSF dam failure. This includes the Hazeltine Creek watershed consisting of Polley Lake and Hazeltine and Edney creeks. Specific areas included the entire Hazeltine Creek mainstem between Polley Lake and Quesnel Lake, as well as lower Edney Creek (i.e., lower reach near the confluence with Hazeltine Creek) and surrounding riparian habitats. The assessment area also includes the shoreline and littoral region of where Hazeltine Creek enters Quesnel Lake, the West Arm of Quesnel Lake, and upper Quesnel River from the confluence of Quesnel Lake to just downstream of the UNBC Quesnel River Research Center.

Bootjack Creek (a tributary to upper Hazeltine Creek) has not been included in the scope of this assessment. Bootjack Creek was historically impacted by mine development in 1913. It is our understanding from MPMC that emergency measures commenced post TSF dam failure to salvage/remove fish from the watercourse as fish had been cut off from accessing Polley Lake via Hazeltine Creek. Prior to the TSF dam failure a plan was being considered to decommission the creek due to encroaching mine disturbance on the remaining Bootjack Creek catchment. In October 2013, discussions commenced between MPMC, DFO, the Ministry of Forests, Lands and Natural Resource Operations, First Nations representatives, and various local stakeholders with respect to potential offsetting options to address the permanent removal of Bootjack Creek. Given the current situation, it is our understanding from MPMC that offsetting for impacts to Bootjack Creek incurred prior to and post TSF dam failure will be captured in the offsetting measures developed and agreed to as part of the TSF dam failure.

Figure 2-1 (Appendix I) illustrates the defined fisheries assessment areas noted above.

3 METHODOLOGY

A general approach was used to conduct the FFHIA, which included the following two steps:

i. Review and compilation of available historical information to generate pre-TSF dam failure baseline data (Section 3.1); and

ii. Assessment of potential physical effects resulting from the TSF dam failure and potential implications to fisheries productivity (Section 3.2); and

The following sections discuss each step in further detail.

3.1 Compilation of Fisheries Baseline Pre-TSF Dam Failure

Baseline information was compiled from numerous historical and more recently generated data sources (DWB 2014; Lirette 2015; MPMC 2009; Cariboo 2008a, 2009; and Minnow Environmental 2009, 2011, 2012, 2014) such as field data collected following the TSF dam failure (i.e., water quality, fish tissue residue, benthic invertebrate etc.), where appropriate and applicable.

Representatives of the following agencies and groups were contacted to inquire whether they had any pre-event data or if they could recommend other data sources for Hazeltine and Edney creeks, Quesnel River, and Polley and Quesnel lakes:

- BC Ministry of Environment (BC MoE);
- DFO;
- Local consultants who have worked in the Likely and Quesnel Lake area; and
- Regional researchers at the University of British Columbia (UBC) and University of Northern British Columbia (UNBC).

Additionally, a number of historical studies and publically available websites were reviewed and accessed to generate the pre-event fisheries baseline conditions for Hazeltine and Edney creeks, Quesnel River, and Polley and Quesnel lakes. All data sources have been listed in the Reference Section (Section 7).

3.2 Assessment of Potential Physical Effects Resulting from the TSF Dam Failure

For the purpose of the FFHIA, aquatic habitat is defined as the permanently or temporarily wetted riverine or lacustrine habitat that supports one or more life history phases (rearing, overwintering, spawning, etc.) of an aquatic organism (Lewis et al. 2013). Riparian habitat is defined as the area of the streambank, including any side channels and associated banks, which contain upland areas not normally inundated during high water conditions (Chilibeck et al. 1992).

Direct and indirect effects were evaluated and quantified (where applicable) for both (1) aquatic and riparian habitat, and, where feasible, (2) fish 'productivity' for those watercourses with adequate fish-specific data. Direct effects are referred to as "footprint" effects because they typically alter or disturb habitat within the footprint of a 'project'. In the case of the TSF dam failure, the "footprint" effects are comprised of those habitats altered in Hazeltine and Edney creeks and the shorelines and lakebeds (where applicable) of Polley and Quesnel lakes. Indirect effects are generally secondary effects from footprint effects, such as deposition of sediment. Note that this FFHIA does not address indirect (secondary) effects with respect to water quality or sediment deposition as they will be covered in the Water Quality Impact Assessment and the Quesnel and Polley Lakes Aquatic Productivity Impact Assessment (Golder 2015a,b).

The methods applied to evaluate alterations to applicable watercourses and waterbodies affected by the TSF dam failure are described below.

3.2.1 Hazeltine Creek and Edney Creek

Quantification of Aquatic Habitat Footprints

The extent of aquatic footprints in Hazeltine and Edney creeks were calculated based on the following protocol:

- Satellite images of the watercourses, after the TSF dam failure, were overlayed on top of images prior to the release to visually establish the extent of effects to aquatic and riparian areas in affected watercourses. For Hazeltine Creek this included the length between the outlet at Polley Lake and the inlet at Quesnel Lake. For Edney Creek, the upstream extent of tailings were determined with UTM coordinates;
- The aquatic area of affected watercourses was calculated using the average channel (bankfull) width of the watercourse multiplied by the length that was affected. Different calculations were performed for each of the two watercourses (Hazeltine and Edney creeks);
- Hazeltine Creek – the average channel (bankfull) width multiplied by the length of each of nine reaches assessed in 2006 (Minnow Environmental 2007). As no channel width data was available for the section of the watercourse upstream of the nine reaches, the average channel width of the nine reaches was used as an estimate for this remaining section; and
- Edney Creek – the average channel (bankfull) width multiplied by the length of affected channel. The channel width was obtained from a site assessment conducted in 1997 (Hallam Knight Piésold 1997).

Aquatic habitat affected by the TSF dam failure was also compared to the total fish-bearing aquatic area of the watershed (i.e., for Edney Creek) and reported as a percentage of the watershed affected by the TSF dam failure.

Quantification of Riparian Habitat Footprints

Alteration of riparian habitat was calculated based on the application of the Riparian Management Area (RMA) of each watercourse, obtained from the BC Ministry of Forests' *Riparian Management Area Guidebook* (BC MoF 1995), and measuring the distance from the watercourse top of bank and away from the channel at a perpendicular angle for a set distance. Given that the exact top of bank was not known, the distance was measured from the edge of the channel. These RMAs include a reserve zone and a management zone and are ultimately based on the stream riparian class and average channel width (Table 3-1). The stream riparian class is based on fish presence in the watercourse; S1 to S4 classes are fish-bearing whereas S5 and S6 classes are non-fish-bearing. A number of calculations were performed for each of the two watercourses (Hazeltine and Edney creeks):

- Hazeltine Creek – as all of the riparian vegetation on both banks (riverbank left and right) were affected by the TSF dam failure, the areal extent was estimated by multiplying the RMA on both sides of the watercourse by the channel length in each reach using Geographic Information System (GIS) software. In some sections of the creek, the RMA did not extend past the affected area of the creek. Sections of Hazeltine Creek riparian areas that overlapped other watercourse riparian areas (i.e., Edney Creek) were not included so as not to double-count total effect estimates.
- Edney Creek – although there were sections of riparian vegetation that appeared to be still intact, we applied a conservative approach and assumed that all riparian vegetation within the zone of influence was affected. Thus, the areal extent of the riparian footprint was estimated by multiplying the RMA on both sides of the watercourse by channel length using a GIS.

Table 3-1: Specified Minimum RMA Slope Distances for Stream Riparian Classes

Riparian Class	Average Channel Width (m)	Reserve Zone Width (m)	Management Zone Width (m)	Total RMA Width (m)
S1 large rivers	≥100	0	100	100
S1 (except large rivers)	>20	50	20	70
S2	>5≤20	30	20	50
S3	1.5≤5	20	20	40
S4	<1.5	0	30	30
S5	>3	0	30	30
S6	≤3	0	20	20

Gray cells - Fish stream or community watershed. White cells - Not fish stream and not in community watershed.
(BC MoF 1995)

A fish habitat survey conducted in 2006 found no surface water tributaries to Hazeltine Creek with the exception of Edney Creek (Minnow Environmental 2007). As such, Hazeltine and Edney creeks were the only watercourses considered in the impact assessment.

3.2.2 Hazeltine Creek and Edney Creek: Effects to Fish Productivity

The estimated loss of fish productivity to Hazeltine and Edney creeks was evaluated using three approaches: 1) the quantification and value (quality) of altered aquatic and riparian habitats; 2) fish abundance information (i.e., catch per unit effort [CPUE]) was highlighted for those species with readily available data; and 3) a crude estimate of life stages potentially displaced as a result of the TSF dam failure were compiled and described. All three measures have been identified as surrogates of productivity (Bradford et al. 2013).

3.2.3 Quesnel Lake and Polley Lake: Effects to Fish Productivity

The lake impact assessment considers the interactions between three main components: 1) physical properties of each lake zone; 2) fish groups; and 3) fish productivity properties. Each component is briefly discussed below.

3.2.3.1 Lake Zones

To facilitate an understanding of the potential effects of the TSF dam failure on fish habitat and productivity of the lakes, four major zones were identified based on standard limnological categorizations (e.g., Wetzel 2001). These included:

Littoral Zone: A zone from the natural shoreline moving lake-ward including the maximum depth of aquatic plants.

Limnetic Zone: The open water area adjacent to the littoral zone where the main photosynthetic activity from phytoplankton takes place. The depth of the limnetic zone extends through the thermocline to the limit of one-percent light penetration (i.e., euphotic zone).

Profundal Zone: Deep open water area of no light penetration beneath the limnetic zone extending to just above the lake-bed.

Benthic Zone: Includes the lakebed sediment surface and sub-surface layers extending from the littoral zone.

3.2.3.2 Fish Groups

To facilitate the assessment of the TSF dam failure on the productivity of fish in the four zones of the lakes, the fish species thought to occur in each lake were separated into four major groups based on similar life histories and ecological function. This approach was necessary because little information is available describing the current presence/absence, distribution or abundance of each individual fish species in the two lakes.

3.2.3.3 Fish Production

The life cycle of a typical fish can be used as a template for considering the assessment of effects on fisheries productivity. Productivity results from individuals completing their life cycle and meeting five critical production components related to: growth, individual performance, survival, migration, and reproduction that will generate sufficient yield at the population level (Table 1-1).

3.2.3.4 Links between TSF Dam Failure and Fish

The potential effects of the TSF dam failure on physical habitat and productivity of fish in the lakes were considered by evaluating each of the four major lake zones.

Quesnel Lake

To determine the linear extent and surface area of littoral zone habitat altered, the region satisfying depth range requirements for the shallow-water aquatic plant *Potamogeton* sp. (0-6 m) was quantified for the pre-event shoreline.

A coarse[1] pre-event bathymetric survey (Coast Pilot 2001) was used to quantify the littoral zone. The 2001 bathymetric survey was delivered as a contour map, divided into 10 m intervals. To identify the 6-m littoral zone the coarse historical pre-breach survey data was up-sampled to 1 m intervals and the area from 0 to 6 m depth was combined to represent the littoral zone. A constant nearshore slope was assumed in up-sampling.

This methodology includes assumption of constant nearshore slope in the up-sampling and definition of the pre-TSF failure littoral areas. In addition, pre-TSF failure data offer coarse spatial resolution and are not suited to detailed analyses. These data are the only available pre-TSF failure bathymetric data and enabled estimation of littoral habitat permanently altered. However, the accuracy of resultant values is only comparable to the accuracy of the original survey and any corresponding interpolation conducted to produce contours of 10 m intervals.

[1] Scale of 1:100,000. Sounding line spacing of 1,000 m.

The length of shoreline in the West Arm of Quesnel Lake and the length of shoreline affected by the TSF dam failure were compared to determine the proportion of shoreline affected by the TSF dam failure. Shoreline data used to define the shoreline position within the West Arm of Quesnel Lake was derived from Coast Pilot (2001). The length of shoreline affected was defined by the length adjacent to identified regions of tailing deposits at the terminus of Hazeltine Creek. This extent was defined by the Hazeltine Creek Hydrotechnical and Geomorphological Impact Assessment (SNC-Lavalin 2015b).

Polley Lake

At the time of preparing this FFHIA There was no information that identified the Polley Lake shoreline or lake bed pre- or post-TSF dam failure. Therefore, only a qualitative review of potential changes in physical properties of fish habitat was completed.

3.3 Assumption

One key assumption used throughout this assessment is that observable or inferred changes in the vital rates (e.g., survival or reproduction) of species are ultimately related to population viability and fishery sustainability (Randall et al. 2013; Koops et al. 2013). For example, the observation of restricted access to spawning habitat was considered evidence to suggest a future reduction in population productivity, and thus some negative effect on fish production.

4 FISHERIES BASELINE CONDITIONS

The fisheries baseline information was compiled during a desk-top study of best available scientific information and professional opinion and draws where necessary on available information and/or findings from the Water Quality Impact Assessment (WQIA; Golder 2015a), Sediment Impact Assessment (Minnow Environmental 2015), Hydrotechnical and Geomorphological Impact Assessment (SNC-Lavalin 2015b) and the Bathymetry Analysis and Volume Balance (Tetra Tech, Inc. [Tetra Tech] 2015).

For each of the sections below the pertinent baseline information has been summarized for each watercourse and waterbody. This includes: characterization of fish habitat, description of fish species assemblage including the identification of federal and provincial at-risk fish species. For a summary of life histories for select fish species that inhabit Hazeltine and Edney creeks refer to Appendix II.

4.1 Hazeltine Creek

Hazeltine Creek is a 10.3 km-long, third-order (describes the relative size and topology of a stream in a network; RISC 2001) watercourse that flows southeast from Frypan Lake to Polley Lake and eventually draining to the West Arm of Quesnel Lake (BC MoE 2014). Hazeltine Creek has at least 14 tributaries including Edney and Bootjack creeks, and drains an area of approximately 112 km^2 in the Cariboo region of BC (Minnow Environmental 2014).

4.1.1 Biophysical and Fish Habitat Characteristics

Minnow Environmental (2007) conducted the most detailed fish and fish habitat study available for Hazeltine Creek. The study area consisted of nine surveyed reaches, which extended from a point approximately 1.75 km downstream of the Polley Lake outlet to the confluence of Quesnel Lake and provided a summary of the biophysical assessment and habitat characteristics of each designated reach (Minnow Environmental 2007).

The following general summary of the biophysical assessment is from the Minnow Environmental Aquatic Environmental Description Report (Minnow Environmental 2014):

Most of Hazeltine Creek has a moderate gradient (less than 2%) with the exception of a steep section (7.3% gradient) approximately 5.8 to 7.0 km downstream of Polley Lake. Stream morphology is mostly riffle-run with flow typically confined within a well-defined meandering channel with predominantly gravel-cobble substrate and bordered by relatively steep banks. Morphology of the steep section is step-pool, with a dominance of cobble to bedrock substrate. A few depositional locations typically associated with beaver activity have been identified within Hazeltine Creek. The steep section located in reaches 5 and 6 presents a barrier to fish passage. Due to the fish barrier fish from Quesnel Lake cannot access the upstream areas of Hazeltine Creek and Polley Lake.

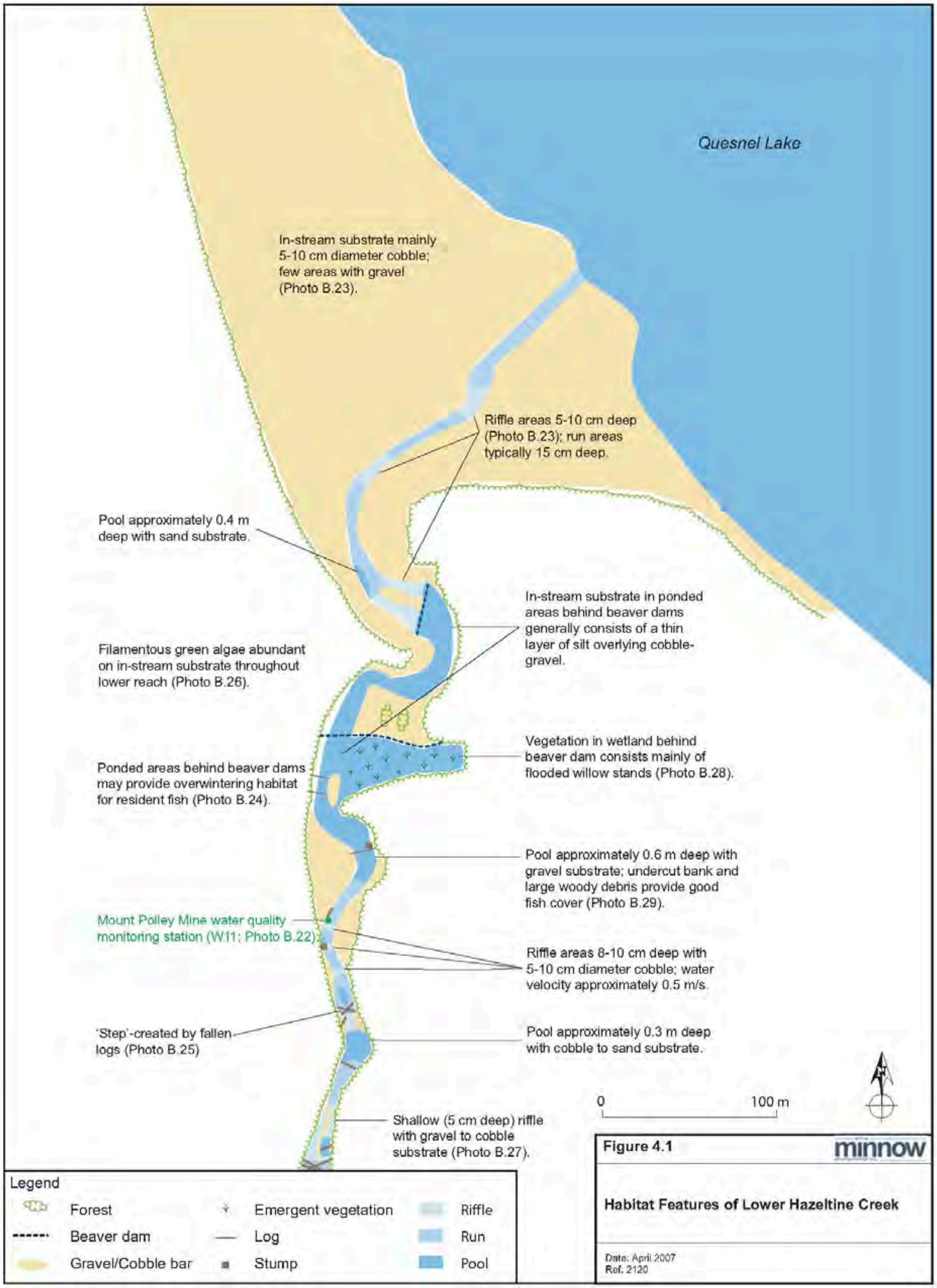
Delineation of the reaches identified for Hazeltine Creek are shown in Figure 3.2 (taken from Minnow Environmental 2014).

Overall, Hazeltine Creek was dominated by shallow riffle/run mesohabitat with some limited pool habitat (Minnow Environmental 2007). Functional aquatic cover was provided mainly by large woody debris (LWD), overhanging vegetation, and pool depth. The proportion of functional aquatic cover, particularly deep pool habitat, was relatively low in Hazeltine Creek (Minnow Environmental 2007). As such, suitable overwintering habitat for sub-adult/adult salmonids was limited. Some pools identified as suitable overwintering habitat were associated with the presence of beaver dams (Minnow Environmental 2007).

Hazeltine Creek from Quesnel Lake upstream to the confluence with Edney Creek has been identified in the Horsefly Sustainable Regional Management Plan (HSRMP) as critical habitat (BC MFLNRO 2005). The HSRMP is one of seven plans covering the Cariboo-Chilcotin Region, including the previously endorsed South Chilcotin and Anahim Round Table plans. SRMPs are a spatial application of the Cariboo Chilcotin Land Use Plan (CCLUP) direction at the sub-regional planning level. The assessment area lies within the boundaries of this plan; the FFHIA was informed by the fisheries management information presented in this plan.

Figure 3.2: Hazeltine Creek Habitat Survey

Although species considered in the HSRMP included Salmon, Bull Trout, Rainbow Trout (*O. mykiss*), and Kokanee (*O. nerka*), the Plan did not specifically identify which species the critical habitat of Hazeltine applied to (BC MFLNRO 2005). Minnow Environmental (2007) also characterized fish habitat in Hazeltine Creek near the confluence of Quesnel Lake (Figure 4-1, on the following page). And more recently, as part of a foreshore inventory and mapping assessment, the mouth of Hazeltine Creek was assigned a 'Very High' aquatic habitat index rating by Ecoscape Environmental Consultants (Ecoscape 2012). The rating was based on four parameters (biophysical, fisheries, shoreline vegetation and habitat modification), which were integrated into a scoring system based on data collected during the assessment, and each of the four parameters was given a score based on the physical properties of the assessed area. The aquatic habitat index ratings range from 'Very Low' to 'Very High' based on fish and wildlife habitat values (e.g., presence of aquatic vegetation) (Ecoscape 2012).



Fiigure 4-1: Habitat Feature of Lower Hazeltine Creek

4.1.1.1 Riparian Habitat

Riparian habitat along Hazeltine Creek consisted of conifers (western redcedar, fir, sitka spruce, western hemlock), deciduous (alder, black cottonwood, Pacific willow) and shrubs (hardhack, red-osier dogwood) (Minnow Environmental 2007). Approximately 22% of the overhead canopy cover throughout the nine surveyed reaches was considered dense (greater than 70% of stream surface area shaded), 27% was partially open (10-70% of stream shaded), and 48% open (less than 10% of stream shaded) (Minnow Environmental 2007).

No specific characteristics with respect to aquatic or riparian habitat were available for the uppermost-segment of Hazeltine Creek (from the outlet of Polley Lake downstream to a distance of 1.75 km).

4.1.2 Fish Assemblage

With the presence of a barrier that prevents upstream migration of fish on Hazeltine Creek (approximately 2.6 km upstream of Quesnel Lake), there were two unique fish assemblages: Upper Hazeltine Creek and Lower Hazeltine Creek.

4.1.2.1 Upper Hazeltine Creek

Rainbow Trout appear to be the only commercial, recreational or Aboriginal fishery species to inhabit upper Hazeltine Creek (Minnow Environmental 2014).

Upper Hazeltine Creek provided important spawning habitat for Rainbow Trout from Polley Lake, with adults migrating to spawn in the creek between early May and early June (MPMC 2004; Minnow Environmental 2014). Typically, after freshet when flows have subsided, adults, along with parr from the previous spawning season, return to Polley Lake. The emigration of larger fish shortly after freshet is reflected in data collected by Bruce and Slaney (1991) and Minnow Environmental (2009), as the vast majority of Rainbow Trout collected in upper Hazeltine Creek consisted of young-of-the-year (YOY). A summary of capture results for Rainbow Trout from upper Hazeltine Creek are provided in Table 4-1.

Table 4-1: Summary of Rainbow Trout Capture Data from Upper Hazeltine Creek

Watercourse	Year	Species	Age	Number Captured	Mean Fork Length (mm)	Mean Weight (g)
Upper Hazeltine Creek	1989[1]	Rainbow Trout	-	48	-	-
	1990[2]		0^+	612	41	0.90
			1^+	3	91	8.43
			2^+	1	143	36.05
	2007[3]		0-1	198	48.4[5]	1.49[5]
	2012[4]		-	20	281	241

[1] data from Imperial Metals (1990); MPMC (2009).
[2] data from Bruce and Slaney (1991).
[3] data from Minnow Environmental (2009) (data combined for three sites); Cariboo Envirotech (2008a).
[4] data from Minnow Environmental (2012).

Estimates of Rainbow Trout relative abundance in upper Hazeltine Creek ranged from 3.64 to 7.04 fish/60 electrofishing seconds (Minnow Environmental 2009; Table 4-2). Potential recruitment of Rainbow Trout from upper Hazeltine Creek to Polley Lake has been estimated to be approximately 54,500 individuals annually (Bruce and Slaney 1991).

Table 4-2: Estimated Rainbow Trout Relative Abundance from Upper Hazeltine Creek

Location	Year	Station	Relative Abundance Catch Per Unit Effort (# of fish / 60 EF seconds)
Upper Hazeltine Creek	2007[1]	UHC-1	3.90
		UHC-2	7.04
		UHC-3	3.64

[1] data from Minnow Environmental 2009. UHC=Upper Hazeltine Creek.

4.1.2.2 Lower Hazeltine Creek

Fish species diversity in lower Hazeltine Creek (i.e., downstream of the cascade barriers) is considerably more diverse, likely due to accessibility from Quesnel Lake. Table 4-3 summarizes the documented species in lower Hazeltine Creek.

Table 4-3: Fish Species Documented in Lower Hazeltine Creek

Species Groupings	Common Name	Latin Name
Salmonids	Sockeye Salmon	*O. nerka*
	Coho Salmon	*O. kisutch*
	Chinook Salmon	*O. tshawytscha*
	Kokanee	*O. nerka*
	Rainbow Trout	*O. mykiss*
	Mountain Whitefish	*P. williamsoni*
Non-Salmonids	Burbot	*Lota lota*
	Largescale Sucker	*C. macrocheilus*
	Longnose Sucker	*C. catostomus*
	Longnose Dace	*Rhynichthys cataractae*
	Peamouth	*Mylocheilus caurinus*
	Redside Shiner	*Richardsonius balteatus*

Few studies have been conducted on lower Hazeltine Creek. Rainbow Trout and Burbot appear to be the most common species of fish inhabiting this section of the creek, as the remaining species, have been caught in relatively low numbers (Imperial Metals 1990; MPMC 2009; Minnow Environmental 2009; Cariboo Envirotech 2008a) (Table 4-4).

Table 4-4: Summary of Fish Capture Data in Lower Hazeltine Creek

Year	Species	Number Captured
1989[1]	Chinook Salmon	9
	Longnose Sucker	8
	Rainbow Trout	142
	Sockeye Salmon	8
	Mountain Whitefish	2
2007[1,2]	Bridgelip Sucker	6
	Burbot	158
	Chinook Salmon	38
	Coho Salmon	9
	Largescale Sucker	9
	Longnose Dace	24
	Peamouth	18
	Redside Shiner	6
	Rainbow Trout	96
	White Sucker	1

[1] data from Imperial Metals (1990); MPMC (2009).
[2] data from Minnow Environmental (2009) (data combined for three sites); Cariboo Envirotech (2008a).

Relative abundance data for fish was sparse for lower Hazeltine Creek (Table 4-5).

Table 4-5: Summary of Relative Fish Abundance in Lower Hazeltine Creek

Location	Year	Station	Relative Abundance Catch Per Unit Effort (# of fish/60 electrofishing seconds)						
			Rainbow Trout	Burbot	Chinook Salmon	Coho Salmon	White Sucker	Longnose Dace	Bridgelip Sucker
Lower Hazeltine Creek[1]	2007[1]	LHC-1	0.83	1.53	0.30	0.07	-	0.08	0.05
		LHC-2	0.55	0.55	0.18	-	-	-	-
		LHC-3	0.56	1.21	0.36	0.02	0.02	0.02	-

[1] data from Minnow Environmental 2009. LHC=Lower Hazeltine Creek.

A small escapement data set was available for Sockeye and Coho Salmon for lower Hazeltine Creek. Mean annual escapement from Hazeltine Creek between 1989 and 2013 was 280 adult Sockeye, with a high of 1,616 observed in 1989 (DFO 2015). In 2006 (Minnow Environmental 2007) and in 2010 (DFO 2015), no Sockeye were observed, whereas 79 were documented in 2011.

Coho Salmon have also been documented in Hazeltine Creek; however, limited numbers have been observed. Four adult Coho were observed within 125 m of Edney Creek confluence in November 2007, while none were documented in 2008 (Cariboo Envirotech 2008a; 2009). Fish life history summaries for species that are present in Hazeltine Creek are presented in Appendix II.

4.2 Edney Creek

Edney Creek is a 13.16 km-long, third-order (describes the relative size and topology of a stream in a network; RISC 2001) watercourse that flows southeast from Edney Lake to Hazeltine Creek, which drains to Quesnel Lake (BC MoE 2014; Minnow 2007). Edney Creek has approximately 12 tributaries and drains an area of approximately 86 km2 in the Cariboo region of BC (Pederson 1998).

4.2.1 Biophysical and Fish Habitat Characteristics

A habitat impact study conducted at a site on lower Edney Creek (F1) at the Horsefly-Likely Forest Service Road (FSR) crossing in 1995 found usable Rainbow Trout fry habitat (49% of total area) as well as juvenile habitat (39% of total area), based on the discharge at the time of the survey (Hallam Knight Piésold 1996a).

A fisheries monitoring program conducted in 1997 reported that the site (F1) consisted of a variety of substrates, with run mesohabitat predominant (50%); however, riffle (30%) and pools (20%) were also present (Hallam Knight Piésold 1997). Aquatic cover types were well mixed, with the total aquatic cover in the channel at approximately 25%.

Pederson (1998) classified lower reaches of Edney Creek as having a cascade-pool morphology dominated by cobble substrates, with functioning LWD as the most prevalent aquatic cover type. Fish habitat value was rated as high.

In 2006, Edney Creek was observed to be ponded just upstream from its confluence with Hazeltine Creek due to the presence of a beaver dam, which resulted in Edney Creek splitting into two channels that both flowed into Hazeltine Creek (Minnow Environmental 2007). This same assessment concluded that Edney Creek contributed approximately 60% of the flow into lower Hazeltine Creek below the Edney/Hazeltine Creek confluence.

In 2007, a salmon spawning assessment was completed for the first 600 m of Edney Creek from the Hazeltine Creek confluence (shown on Map 1, Cariboo 2009). Results characterized spawning habitat quality as high due to deep pools, abundant aquatic cover, and presence of suitable spawning gravels (Cariboo Envirotech 2008a).

4.2.2 Fish Assemblage

At least nine fish species have been documented in Edney Creek (BC MoE 2014; Cariboo Envirotech 2008a; Hallam Knight Piésold 1997). Table 4-6 summarizes the documented species in Edney Creek.

Table 4-6: Fish Species Documented in Edney Creek

Species Groupings	Common Name	Latin Name
Salmonids	Sockeye Salmon	*O. nerka*
	Coho Salmon	*O. kisutch*
	Chinook Salmon	*O. tshawytscha*
	Rainbow Trout	*O. mykiss*
	Mountain Whitefish	*P. williamsoni*
Non Salmonids	Burbot	*L. lota*
	Longnose Sucker	*C. catostomus*
	Longnose Dace	*R. cataractae*
	Redside Shiner	*R. balteatus*

Table 4-7 summarizes fish capture data from historical sampling programs for Edney Creek.

Table 4-7: Summary of Historical Fish Capture Data in Edney Creek

Watercourse	Site	Year	Species	Number Captured	Mean Fork Length (mm)	Mean Weight (g)
Lower Edney Creek	-	1989[1]	Burbot	12	-	-
	-		Chinook Salmon	16	-	-
	-		Longnose Sucker	7	-	-
	-		Mountain Whitefish	3	-	-
	-		Rainbow Trout	24	-	-
	-		Sockeye Salmon	869	-	-
	F1 (at Horsefly-Likely FSR crossing[2]	1995	Rainbow Trout	11	79	6.3
		1996		158	-	-
		1997		111	68	4.5
	-	1998[1]	Rainbow Trout	111	-	-
	-	2007[5]	Coho Salmon	12	-	-
	Upstream of confluence with Hazeltine Creek[3]	2014	Rainbow Trout	52	-	-

Table 4-7 (Cont'd): Summary of Historical Fish Capture Data in Edney Creek

Watercourse	Site	Year	Species	Number Captured	Mean Fork Length (mm)	Mean Weight (g)
Upper Edney Creek1	-	1989	Rainbow Trout	9	-	-
	-	1995		199	-	-
	-	1996		299	-	-
	-	1997		98	-	-
	-	1998		126	-	-
	UER[4]	2007		136	53.3[6]	2.08[6]
	-	1997	Longnose Sucker	1	-	-
Upper Edney Creek tributary 1[1]	-	1995	Rainbow Trout	47	-	-
	-	1996		48	-	-
	-	1997		14	-	-
	-	1998		2	-	-
	UEC[4]	2007		19	108	17.1
Upper Edney Creek tributary 2[1]	-	1995	Rainbow Trout	49	-	-
	-	1996		88	-	-
	-	1997		88	-	-
	-	1998		28	-	-

[1] data from MPMC (2009).
[2] data from Hallam Knight Piésold (1996a, 1997).
[3] data from DWB (2014).
[4] data from Minnow Environmental (2009).
[5] data from Cariboo Envirotech (2008a).
[6] data only from 100 Rainbow Trout.
'-' = data not available.

Although Sockeye, Coho, and Chinook Salmon have been documented in Edney Creek, spawner escapement data is not available. The number of Coho Salmon observed in Edney Creek is small and has ranged from 0 individuals recorded in 2008 (Cariboo Envirotech 2009) to a maximum of 12 individuals in 2007 (Cariboo Envirotech 2008a). No juvenile Coho Salmon have been documented (Hallam Knight Piésold 1997; Minnow Environmental 2009). Sockeye Salmon have also been observed; however, their only documented presence was in 1989.

Of the fish species present in Edney Creek, only Rainbow Trout and Longnose Sucker have been captured in the upper section of the watercourse (i.e., near Edney Lake and in tributaries). The upper limit of fish distribution in Edney Creek is likely a falls barrier of unknown height located upstream of Edney Lake (Hallam Knight Piésold 1997; BC MoE 2014). Rainbow Trout and Redside Shiner are documented to be present in Edney Lake (BC MoE 2014). Adult Rainbow Trout and Longnose Sucker likely utilize Edney Lake for rearing and spawn in the creek, with juveniles utilizing the Edney Creek mainstem as rearing habitat (MPMC 2009). Redside Shiner may also spawn in Edney Creek, but some populations also spawn in lakes (McPhail 2007).

Data from a study conducted in lower Edney Creek indicated that ages for Rainbow Trout ranged from YOY to three-year-olds (Hallam Knight Piésold 1997). Rainbow Trout age from studies in 1997 and 2007 in upper Edney Creek and two of its tributaries were similar to those in the lower section (YOY to three-year-olds) (Hallam Knight Piésold 1997; Minnow Environmental 2009).

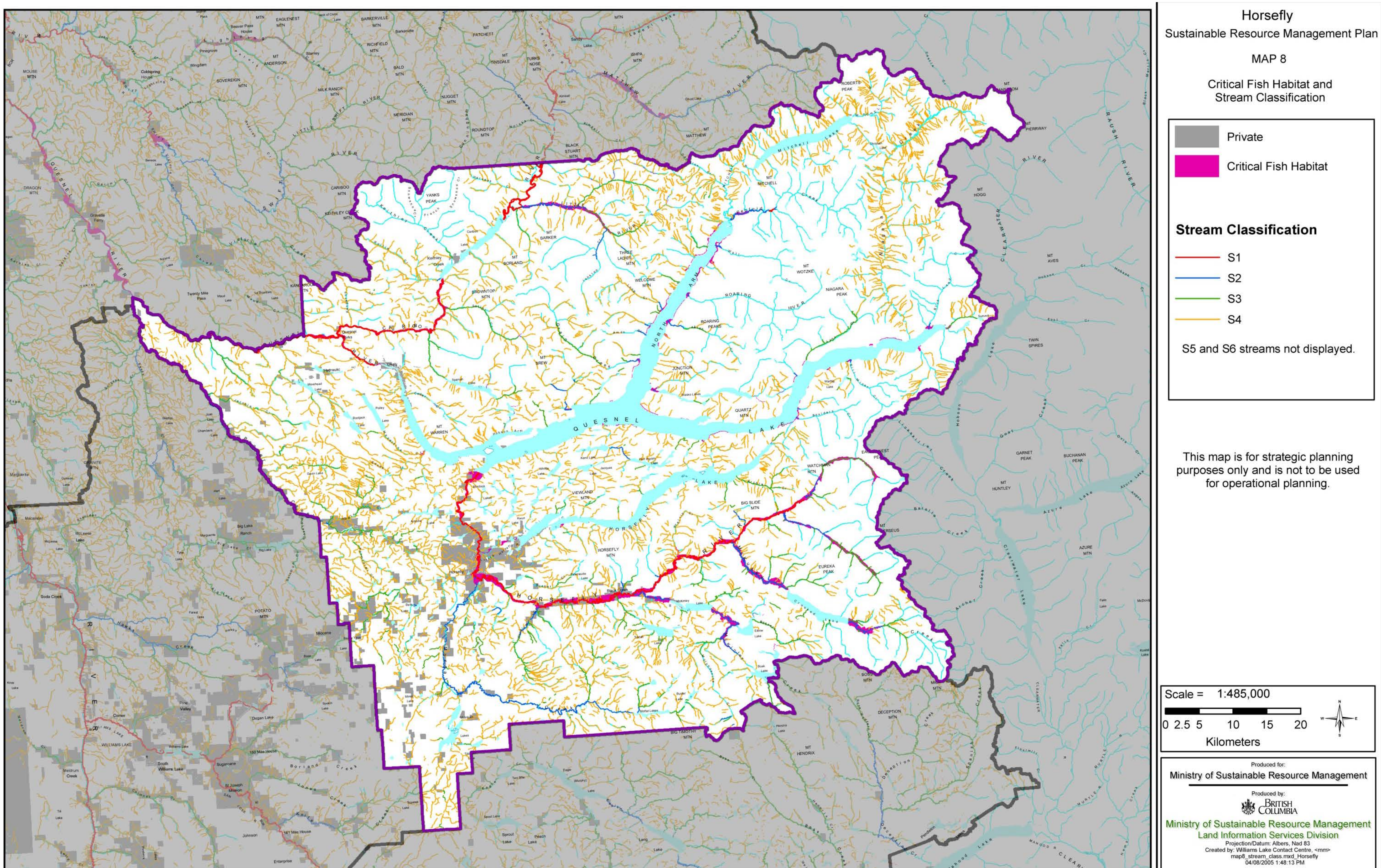
Based on 2007 data, the majority of Rainbow Trout captured in upper Edney Creek (79%) were YOY (Minnow Environmental 2009). Fish life history summaries for species that are present in Edney Creek are presented in Appendix II.

4.3 Quesnel River

Quesnel River is a fifth-order (describes the relative size and topology of a stream in a network; RISC 2001) watercourse that flows from Quesnel Lake at the town of Likely, approximately 100 km northwest toward the city of Quesnel, where it discharges into the Fraser River. Quesnel River is the only discharge channel of Quesnel Lake and has a mean annual outflow of approximately 131 m^3/s (Orbis 2009). The Quesnel watershed occupies 225,751 hectares (ha) in south central BC and provides migration, rearing and spawning habitat for several salmonid and non-salmonid species (Pederson 1998). The Quesnel watershed consists of four smaller watersheds including the Cariboo River, Cottonwood River, Quesnel River and Horsefly River (Orbis 2009).

4.3.1 Biophysical and Fish Habitat Characteristics

The mainstem of the Quesnel River provides valuable habitat for numerous life stages for a number of salmonid and non-salmonid species (Pederson 1998). The HSRMP (BC MFLNRO 2005) identified critical fish habitat on Quesnel River, Figure 4-3 (Map 8). Specifically, Quesnel River is considered critical habitat for Quesnel Lake Rainbow Trout, a river resident stock (Sebastian et al. 2003) believed to use the Quesnel River for spawning. The West Arm of Quesnel Lake has important salmonid habitat areas, which have experienced anthropogenic impacts prior to the TSF dam failure, particularly near the Quesnel River confluence (Ecoscape 2012).



Map 8: Horsefly Sustainable Resource Management Plan

Limited detailed fish habitat information has been documented for the upper section of Quesnel River near Quesnel Lake. However, mesohabitats in the Quesnel River were generally described by Cariboo Envirotech (2007; 2008b), and included:

- Non-turbulent glides at the outlet of Quesnel Lake (referred to as the 'Narrows') and low gradient pools as the river widens near the town of Likely.
- Faster water with riffles and cascades throughout the area between the Likely bridge and the UNBC Quesnel River Research Centre.
- Fast moving water with steep gradients and high canyon walls in the section of river between the UNBC Quesnel River Research Centre to the Bullion Pool (approximately 4.4 km downstream from the Likely bridge).
- Wide, fast flowing water downstream of the Bullion Pool is the Quesnel Forks where the Cariboo and Quesnel rivers converge.

4.3.2 Fish Assemblage

Numerous fish species have been documented in Quesnel River (BC MoE 2014). Table 4-8 summarizes the documented species.

Table 4-8: Fish Species Documented in Quesnel River

Species Groupings	Common Name	Latin Name
Salmonids	Sockeye Salmon	*O. nerka*
	Coho Salmon (IFC)	*O. kisutch*
	Chinook Salmon	*O. tshawytscha*
	Pink Salmon	*O. gorbuscha*
	Rainbow Trout	*O. mykiss*
	Mountain Whitefish	*P. williamsoni*
	Dolly Varden	*S. malma*
	Bull Trout	*S. confluentus*
	Lake Trout	*S. namaycush*
	Kokanee	*O. nerka*

Table 4-8 (Cont'd): Fish Species Documented in Quesnel River

Species Groupings	Common Name	Latin Name
Non Salmonids	Burbot	*L. lota*
	Longnose Sucker	*C. catostomus*
	Longnose Dace	*R. cataractae*
	Leopard Dace	*Rhinichthys falcatus*
	Largescale Sucker	*C. macrocheilus*
	Northern Pikeminnow	*Ptychocheilus oregonensis*
	Redside Shiner	*R. balteatus*
	Slimy Sculpin	*Cottus cognatus*
	Sculpin (general)	-
	Sucker (general)	-
	Sturgeon (general)	-
	Lamprey (general)	-
	Minnow (general)	-

Sport fish in Quesnel River include Chinook and Coho Salmon as well as resident Kokanee, Rainbow Trout, Lake Trout, Dolly Varden, Whitefish, and several pelagic non-salmonid species (Imperial Metals 1990). Below is a summary of fish species that utilize the upper Quesnel River as part of their life history.

Sockeye Salmon utilize Quesnel River during migration to/from Quesnel Lake.

Kokanee also utilize the narrows of Quesnel River near the town of Likely for spawning (Pederson 1998). The Horsefly River and Quesnel River Kokanee spawning runs are nearly a month earlier than Quesnel Lake shore spawning Kokanee but 10 days later than Sockeye (Sebastian et al. 2003).

Rainbow Trout are the most common species inhabiting the upper Quesnel River (UFFCA & DFO 2010) and spawn downstream of Quesnel Lake to the UNBC Quesnel River Research Centre (Previously Likely Fish Hatchery) (Pederson 1998). The Quesnel River Rainbow Trout are a river resident stock (Sebastian et al. 2003).

Interior Fraser Coho Salmon are part of a population that are listed as "endangered" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and are under consideration for listing under the federal *Species at Risk Act* (SARA 2002). A small subset of the population spawns in Quesnel River downstream of Quesnel Lake to the UNBC Quesnel River

Research Centre (Pederson 1998). Although no historical Coho Salmon stocking or spawner escapement data is available (DFO 2015), twenty-seven percent of the 530 Coho observed during a 2007 adult Coho survey were observed in Quesnel River (n=131) and Quesnel River narrows (n=13) (Cariboo Envirotech 2008a). No Coho (live or deceased) were observed in any of the watercourses surveyed in 2008 (Cariboo Envirotech 2009); however, this may be attributed to the surveys being conducted later in the season than previous years.

Chinook Salmon spawn in the narrows of Quesnel River and at the bridge near Likely (Pederson 1998). Chinook Salmon spawner escapement data have been collected in Quesnel River since 1951 (DFO 2015). Mean annual escapement over 63 sampling periods between 1951 and 2013 was 2,084 adult Chinook, with a high of 9,000 observed in 1986 (DFO 2015).

Pink Salmon are limited to the lower section of the Quesnel River as the canyon upstream of the Barlow Creek and Quesnel River confluence is a gradient barrier for this species (Pederson 1998). Pink Salmon spawner escapement data have been collected intermittently in Quesnel River since 1965 (DFO 2015). Mean annual escapement over 11 sampling periods between 1985 and 2013 was 1,449 adult Pink, with a high of 4,000 observed in 1971 (DFO 2015).

Dolly Varden spawn in Quesnel River from the Likely bridge downstream to the UNBC Quesnel River Research Centre (Pederson 1998).

4.4 Quesnel Lake

Quesnel Lake, BC's deepest lake and one of the deepest fjord lakes in the world, is a glacial lake with a reported maximum depth of 610 m (Cariboo Envirotech 2008a), with an estimated maximum depth of 116 m recorded for the West Arm (Coast Pilot 2001). The approximate surface area of West Arm is about 21.5 km^2 with a volume of approximately 1 km^3. The lake is dimictic and oligotrophic. Occasionally the lake freezes over during winter while summer surface water temperature seldom exceeds 18ºC. The lake is fed by several tributaries, with primary influence being from Horsefly River, Mitchell River, and Niagara Creek, and drains via Quesnel River to the Fraser River (MPMC 2009). Portions of the Cariboo Mountains Provincial Park are adjacent to the eastern section of the lake along the north and east arms; the town of Likely, BC is present near the outlet at the west arm.

4.4.1 Fish Assemblage

At least 20 fish species have been documented in Quesnel Lake including several migratory salmonids, resident salmonids, benthic and pelagic non-salmonid species (Bryant et al. 1996, Hatfiled 1996, McPhail 2007; Table 4-9).

Table 4-9: Fish Species Documented in Quesnel Lake

Species Groupings	Common Name	Latin Name
Migratory salmonids	Sockeye Salmon	*O. nerka*
	Coho Salmon	*O. kisutch*
	Chinook Salmon	*O. tshawytscha*
Resident salmonids	Kokanee	*O. nerka*
	Rainbow Trout	*O. mykiss*
	Bull Trout	*S. confluentus*
	Lake Trout	*S. namaycush*
	Pygmy Whitefish	*Prosopium coulteri*
	Mountain Whitefish	*P. williamsoni*
	Lake Whitefish	*Coregonus clupeaformis*
Benthic species	Burbot	*L. lota*
	Largescale Sucker	*C. macrocheilus*
	Longnose Sucker	*C. catostomus*
	Slimy Sculpin	*C. cognatus*
Pelagic non-salmonid species	Northern Pikeminnow	*P. oregonensis*
	Peamouth Chub	*M. caurinus*
	Leopard Dace	*R. falcatus*
	Longnose Dace	*R. cataractae*
	Redside Shiner	*Richardsonius balteatus*
	Lake Chub	*Couesius plumbeus*

The main emphasis of studies conducted on Quesnel Lake has been on the food web interactions between Sockeye Salmon/Kokanee and Rainbow Trout (Sebastian et al. 2003; Parkinson et al. 1989; Selbie 2014), as well as DFO trawl surveys specifically targeting juvenile Sockeye and Kokanee in the limnetic zone of the lake. Other limited information for Quesnel Lake fisheries was obtained through multiple fish creel surveys conducted between 1950s and 1970s. As such, the majority of assessments in Quesnel Lake pertain to species of fish of commercial, Aboriginal and/or recreational value. Based on the available information, relatively little is known about the specific distribution of fish species within Quesnel Lake, particularly benthic and pelagic, non-salmonid species. These species are typically caught as by-catch and are rarely targeted by fishery or research programs.

The descriptions provided below provide some general information for species of fish considered to be a part of a commercial, recreational or Aboriginal fishery for which studies have been conducted.

Sockeye Salmon are an important fishery, migrating from the Fraser River up the Quesnel River, and into Quesnel Lake and tributaries. Over 80 Sockeye Salmon populations have been identified in Quesnel Lake with spawning primarily occurring in the Horsefly and Mitchell river systems, as well as in several other smaller tributaries and along the shoreline in parts of Quesnel Lake (UFFCA & DFO 2010). Sockeye Salmon spawner escapement data have been collected intermittently from numerous tributaries and lake shore areas of Quesnel Lake between 1950 and 2013 (DFO 2015) (Table 4-10). None of the specific shore spawning locations identified in Table 4-10 are in proximity to Hazeltine Creek, as they are primarily located in the North Arm of Quesnel Lake.

Table 4-10: Documented Sockeye Salmon Shoreline Spawning Areas in Quesnel Lake

Location on Quesnel Lake	Mean Escapement Estimate (and Range)	Number of Sampling Years (Year Range)
Deception Point	11,656 (0-123,709)	19 (1990-2013)
North Arm – unnamed cove	1,651 (0-7,184)	8 (2001-2011)
Goose Point	1,613 (0-16,202)	12 (1999-2013)
Long Creek – lake shore	1,454 (0-5,920)	10 (1999-2013)
Blue Lead Creek – lake shore	1,271 (0-11,173)	13 (1999-2013)
Grain Creek – lake shore	1,214 (0-7,371)	12 (1999-2013)
Bear Beach – lake shore	1,156 (0-8,797)	8 (1999-2013)
Bowling Point	1,135 (0-11,160)	11 (1999-2013)
Roaring River – lake shore	1,008 (0-7,632)	14 (1999-2013)

Coho Salmon present in Quesnel Lake are part of the IFC population that is listed as "endangered" by COSEWIC and are under consideration for addition to the SARA (GoC 2014). A small subset of the population spawns in Quesnel River and several other tributaries to Quesnel Lake (Cariboo Envirotech 2008a). Although few individuals have been documented in Edney and Hazeltine Creek, these watercourses do provide some suitable spawning habitat.

Kokanee in Quesnel Lake have two distinct populations; tributary spawners and shoreline spawners (Sebastian et al. 2003). The estimated Kokanee spawning population of Quesnel Lake was between 75,000 and 150,000 individuals, with the majority being shoreline spawners (Sebastian et al. 2003). Although few known shore spawning locations have been identified in Quesnel Lake, several locations have been documented in the north and east arms (Deception Point, Blue Lead Creek, and Goose Point) (Sebastian et al. 2003). Limited information is available for shore spawning locations in the West Arm and it is unknown whether Kokanee utilize Hazeltine Creek or the lake shore area in the vicinity of the Hazeltine Creek-Quesnel Lake confluence.

Rainbow Trout in Quesnel Lake can attain 7-10 kilogram (kg) in size and are part of a renowned recreational fishery. Few Rainbow Trout studies have been conducted on the lake itself (most pertain to food web implications with Kokanee/Sockeye Salmon), but rather have focused on spawning surveys in some of the major tributaries: Mitchell and Horsefly rivers. These two rivers have been identified as the major spawning locations for Quesnel Lake Rainbow Trout (Sebastian et al. 2003). Rainbow Trout are widespread in Quesnel Lake and often inhabit numerous smaller tributaries such as lower Hazeltine and Edney creeks (Lirette 2014).

4.5 Polley Lake

Polley Lake is located between Frypan Lake and Quesnel Lake in the Cariboo region of BC and is connected to these waterbodies by Hazeltine Creek. The lake is approximately 453 ha in size, with a maximum depth of 35 m and a mean depth of 18 m, with the deepest sections at either ends of the lake (BC MoE 2014; Minnow Environmental 2014). Total lake volume is estimated at 62.1 million m^3, and total watershed area (including lake area) is about 21.4 km^2 (Golder 2015c); however, the watershed was historically larger (21.63 km^2) prior to Mount Polley Mining Corporation diverting portions of the watershed for mine operations (Minnow Environmental 2014). Polley Lake's main inlet and outlet is Hazeltine Creek (BC MoE 2014); there are no other tributaries with year-round flow, but there are at least five other unnamed, seasonally-flowing tributaries that may be utilized by fish (i.e. Rainbow Trout) if conditions are suitable (MPMC 2004).

4.5.1 Biophysical and Fish Habitat Characteristics

Polley Lake is dimictic, with well-developed thermal stratification in summer that occurs at approximately 5 to 15 m (Minnow Environmental 2014). Although well-mixed in winter, water temperatures gradually increase with depth; whereas dissolved oxygen (DO) levels gradually decrease with depth, year-round. DO concentrations below 5.0 mg/L are typically observed at depths greater than 20 m during spring, summer and fall. An increase in the number of phytoplankton blooms supports a probable change in trophic status from oligotrophic/mesotrophic to mesotrophic/eutrophic based on recent (2012) observations.

No specific information was found describing fish habitat in Polley Lake; this represents a gap in the FFHIA.

4.5.2 Fish Assemblage

Polley Lake is a fish-bearing waterbody (BC MoE 2014; Minnow Environmental 2012); however, anadromous salmon are prevented from accessing the lake by a cascade barrier downstream on Hazeltine Creek. As such, there are no salmon spawner escapement data for Polley Lake. Resident species include Longnose Sucker and Rainbow Trout, which have been captured in Polley Lake during numerous fish surveys conducted for Mount Polley Mining Corporation between 1999 and 2012. Redside Shiners have been captured on occasion and most recently during field studies in 2014 after the tailings dam release (Lirette 2014). Table 4-11 summarizes the documented species in Polley Lake.

Table 4-11: Fish Species Documented in Polley Lake

Species Groupings	Common Name	Latin Name
Salmonids	Rainbow Trout	*O. mykiss*
Non Salmonids	Longnose Sucker	*C. catostomus*
	Redside Shiner	*R. balteatus*

Creel surveys conducted on Polley Lake in 1990 and 1995 estimated that 15,412 and 9,009 trout, respectively, were caught between May 1 and September 30; however, 1995 numbers may not be accurate due to the low number of surveys (n=2) (Lirette and Tredger 1991; Hallam Knight Piésold 1996b).

Adult Rainbow Trout migrate from Polley Lake to Hazeltine Creek after ice-out in the spring (mid-April to mid-May) to spawn, returning to the lake by mid-June near the end of freshet (MPMC 2004). The majority of Rainbow Trout fry present in Hazeltine Creek migrate to Polley Lake within their first year after hatching (i.e., as YOY) (Bruce and Slaney 1991). This is further substantiated by scale analysis of adult Rainbow Trout captured by anglers from the lake, which indicated that 82% were recruited to the lake as yearlings from their nursery stream (assumed to be Hazeltine Creek) (Lirette and Tredger 1991).

Bruce and Slaney (1991) estimated that approximately 54,500 Rainbow Trout fry and parr migrate to Polley Lake from Hazeltine Creek after hatching. Results suggest that Rainbow Trout from Hazeltine Creek contribute considerably to the overall Polley Lake recreational fishery.

Table 4-12 summarizes recent and historical catch results for fish captured in Polley Lake.

Table 4-12: Summary of Historical Fish Capture Data from Polley Lake

Site	Species	Year Sampled	Number Captured / Analyzed	Fork Length (mm)	Weight (g)	CPUE seine net (fish/ft^2/hour)
Polley Lake	Rainbow Trout	1973[1]	65	-	-	0.0008
		1990[1]	77	145 – 357	-	-
		1995[2]	16	230 – 300	213 – 303	0.0006
		2009/2010[3]	44	213 – 357	111 – 580	-
		2012[4]	30	280 – 399	105 – 650	0.0006
		2014[5]	144	163 – 397	45 – 950	0.0029
	Longnose Sucker	1973	26	-	-	0.0003
		1995	37	315 – 395	452 – 893	0.0014
		2009/2010	12	297 – 360	350 – 620	-
		2012	68	207 – 453	120 – 1,470	0.0013
		2014	140	152 – 430	45 – 1,060	0.0028
	Redside Shiner	1973	1,211	-	-	0.015
		2014	1	140	40.2	0.00002

[1] data from Lirette and Tredger (1991) and Lirette (2015). 1990 fork lengths collected from a subset during a creel survey of fish harvested by anglers.
[2] data from Hallam Knight Piésold (1996b); Minnow Environmental (2014). Fork length and weight only collected from fish analyzed for metals (n=9 Rainbow Trout, n=10 Longnose Sucker).
[3] data from Minnow Environmental (2011).
[4] data from Minnow Environmental (2012).
[5] field data collected post-TSF dam failure (Lirette 2015).

Table 4-13 summarizes fish age and condition results from historical sampling programs for Polley Lake.

Table 4-13: Summary of Fish Age and Condition for Polley Lake

Watercourse	Species	Year	Age Range	Mean Condition
Polley Lake	Rainbow Trout	1973[1]	-	1.341
		1990[2]	2^+ to 6^+	-
		1995[1,3]	3^+ to 4^+	1.253
		2009/2010[4]	3^+ to 6^+	-
		2012[1]	-	0.993
		2014[1]	1^+ to 6^+	1.103
	Longnose Sucker	1995[1,3]	-	1.454
		2009/2010[4]	5^+ to 10^+	-
		2012[1]	-	1.354
		2014[1]	1^+ to 13^+	1.239

[1] data from Lirette (2015).
[2] data from Lirette and Tredger (1991).
[3] data from Hallam Knight Piésold (1996b).
[4] data from Minnow Environmental (2009).

4.6 At-Risk Species

There are no fish species documented in Hazeltine Creek, Edney Creek, Quesnel River, Quesnel Lake, nor Polley Lake, that are currently protected under the Government of Canada SARA (GoC 2014).

While there are no fish species considered ‘at risk’, local populations of Coho Salmon (IFC population) have been identified by COSEWIC as endangered. This particular Coho Salmon stock has periodically been observed in Hazeltine Creek and Edney Creek, and are known to be present in Quesnel Lake. However, the species is not currently listed on any Schedule under SARA and are therefore not protected under legislation (GoC 2014).

The BC MoE’s Species and Ecosystems Explorer was also accessed to obtain information on the presence of fish species at risk. The search results identified that Bull Trout are blue-listed (Special Concern) in the Cariboo Region, in which Quesnel Lake is located (BC CDC 2014). No other red- or blue-listed species were identified for the Cariboo Region. Bull trout are also listed by COSEWIC as a Species of Special Concern and under consideration for SARA designation.

5 IMPACT ASSESSMENT

5.1 *Hazeltine Creek*

5.1.1 Quantification of Habitat Footprints

5.1.1.1 Aquatic Habitat

Table 5-1 and Figure 5-1 (Appendix I) summarize the estimated aquatic habitat footprint on Hazeltine Creek (calculated as described in Section 3.2.1) that resulted from the TSF dam failure. Estimated areas are for each of the nine surveyed reaches of the creek, as well as for the unsurveyed section upstream of the nine reaches.

Table 5-1: Estimated Aquatic Habitat Altered in Hazeltine Creek

Watercourse	Reach	Channel (Bankfull) Width (m)[1,2,3]	Channel Length (m)	Aquatic Footprint (m^2)
Hazeltine Creek	u/s of Reach 1	6.2	1,900	11,765
	1	7.0	499	3,488
	2	45.0	231	10,186
	3	7.9	166	1,312
	4	4.7	2,488	11,690
	5	4.5	1,380	6,209
	6	3.7	1,120	4,133
	7	5.3	305	1,617
	8	5.0	703	3,509
	9	11.3	771	8,707
	Total	-	**9,563**	**62,616**

1 data from Minnow Environmental (2007).
2 reach 2 consisted of a ponded beaver dam area resulting in a larger channel (bankfull) width for this reach.
3 'u/s of Reach 1' channel width is the average width of Reaches 1 and 3-9. Reach 2 was not included as it consisted of a ponded beaver dam and considered an anomaly/outlier.

Approximately 62,616 m^2 of aquatic habitat were altered in Hazeltine Creek (from the outlet of Polley Lake to the inlet of Quesnel Lake) as a result of the TSF dam failure.

Table 5-2 summarizes the estimated aquatic habitat permanently altered by mesohabitat type (e.g., pool, riffle, run) and aquatic cover type (e.g., boulder, deep pool), as well as substrate class (e.g., sand, gravel) of the nine surveyed reaches of Hazeltine Creek.

Table 5-2: Estimates of Aquatic Habitat Type Altered in the Nine Surveyed Reaches of Hazeltine Creek by Habitat, Cover, and Substrate Type[1]

Watercourse	Mesohabitat Type	Area (m^2) of Mesohabitat Type and % of Total	Aquatic Cover Type	Area (m^2) of Aquatic Cover Type % of Total	Substrate Class	Area (m^2) of Substrate Type and % of Total
Hazeltine Creek	Pool	19,732 (39%)	Deep Pool	13,447 (60%)	Cobble	18,256 (45%)
	Run	16,871 (33%)	Large Woody Debris	4,413 (20%)	Gravel	14,227 (35%)
	Riffle	14,319 (28%)	Overhanging Vegetation	3,829 (17%)	Sand	5,675 (14%)
	-	-	Boulder	572 (3%)	Boulder	1,175 (3%)
	-	-	Other	174 (1%)	Fines	843 (2%)
	-	-	-	-	Bedrock	413 (1%)
	Total[2,3,4]	**50,851**	**-**	**22,435**	**-**	**40,589**

[1] data from Minnow Environmental (2007). Does not include section of Hazeltine Creek upstream of Reach 1.
[2] aquatic mesohabitat and substrate type totals do not equal, as Reach 2 did not have a substrate class recorded.
[3] aquatic cover type does not equal mesohabitat type or substrate class due to different analysis methods.
[4] totals may not equal due to rounding

Pool habitat comprised the largest (39%) mesohabitat type that was altered in the nine surveyed reaches of Hazeltine Creek. Of the available aquatic cover for fish, deep pools consisted of the greatest amount affected (60%), followed by LWD (20%) and overhanging vegetation (17%). Cobble (45%) and gravel (35%) were the two most dominant substrate types. No information is available for the impacted section of the creek upstream of the nine surveyed reaches (1.90 km). The mesohabitats comprising the uppermost reach of Hazeltine Creek between Reach 1 and Polley Lake outlet have not been accounted for in total areas/percentages summarized in Table 5-2 as detailed habitat data was not readily available in historical reports. However, given the reach's short linear distance, the numbers presented in Table 5-2 would not be expected to change substantially.

5.1.1.2 Riparian Habitat

Riparian habitat on both banks of Hazeltine Creek was permanently altered. Table 5-3 and Figure 5-1 (Appendix I) provide a summary of the estimated total riparian area (calculated as described in Section 3.2.1) that was affected along the nine surveyed reaches of the creek, including the unsurveyed section upstream of Reach 1 (Reach 1 to Polley Lake outlet).

Table 5-3: Estimated Riparian Habitat Altered Adjacent to Hazeltine Creek

Watercourse	Reach	Channel (Bankfull) Width (m)[1,2,3]	Riparian Management Area (m)[3,4]	Channel Length (m)[1]	Altered Riparian Area (m^2)[5]
Hazeltine Creek	u/s of Reach 1	6.2	50	1,900	179,804
	1	7.0	50	499	47,847
	2	45	70	231	23,061
	3	7.9	50	166	16,460
	4	4.7	40	2,488	168,731
	5	4.5	40	1,380	94,191
	6	3.7	40	1,120	51,988
	7	5.3	50	305	24,946
	8	5	40	703	50,244
	9	11.3	50	771	59,977
	Total[6]	-	-	**9,563**	**717,249**

1 data from Minnow Environmental (2007).
2 'u/s of Reach 1' channel width is the average width of Reaches 1 and 3 to 9. Reach 2 was not included as it consisted of a ponded beaver dam.
3 reach 2 consists of a ponded beaver dam area resulting in a larger bankfull (channel) width and RMA for this reach.
4 from edge of channel.
5 includes affected riparian area on both sides of Hazeltine Creek.
6 total affected riparian area does not include overlap on Edney Creek, so as not to double-count areas.

The total affected riparian area of Hazeltine Creek permanently altered as a result of the TSF dam failure was 717,249 m^2.

5.1.2 Potential Effects to Fish Productivity

Rainbow Trout was the only species known to utilize upper Hazeltine Creek, whereas Rainbow Trout and Burbot dominated fish catches in lower Hazeltine Creek. Although other species of fish have been documented in lower Hazeltine Creek, their presence is rare compared to that observed in other relatively nearby watercourses (e.g., Horsefly and Mitchell rivers), suggesting their contribution to overall productivity to each of those species in the Quesnel Lake system is expected to be limited. As such, the static values of relative abundance tabulated for lower Hazeltine Creek Rainbow Trout and Burbot are coarse estimates of overall productivity loss. Ideally, more dynamic parameters such as population estimates coupled with calculated production rates (e.g., Kwak 1992) would provide a more practical account of the affected productivity.

Rainbow Trout relative abundance in upper Hazeltine Creek typically ranged between 3.64 and 7.04 fish/60 electrofishing seconds (Table 5-4). Rainbow Trout relative abundance was considerably lower below the known fish barrier (i.e., lower Hazeltine) ranging between 0.55 to 0.83 fish / 60 electrofishing seconds. Relative abundance data for Burbot in lower Hazeltine Creek ranged from 0.55 to 1.53 fish/60 electrofishing seconds; Table 5-4).

Table 5-4: Estimated Fish Relative Abundance for Most Common Species Documented in Hazeltine Creek[1]

Watercourse	Year	Station	Fish Species	Relative Abundance (CPUE (# of fish/60 electrofsihing seconds)
Upper Hazeltine Creek	2007	UHC–1	Rainbow Trout	3.90
		UHC–2		7.04
		UHC–3		3.64
Lower Hazeltine Creek	2007	LHC-1	Rainbow Trout	0.83
		LHC-2		0.55
		LHC–3		0.56
		LHC–1	Burbot	1.53
		LHC–2		0.55
		LHC–3		1.21

[1] data from Minnow Environmental (2009).

Reaches 4 and 5 of Hazeltine Creek are historical identified spawning areas for Rainbow Trout from Polley Lake and is also considered important rearing habitat for juvenile Rainbow Trout (MPMC 2004). Bruce and Slaney (1991) estimated an annual recruitment of approximately 54,000 Rainbow Trout in upper Hazeltine Creek to Polley Lake using a theoretical density model developed by Ptolemy et al. (1991). Given this number was estimated prior to mine development it is unknown whether this estimate is indicative of upper Hazeltine Creek's production rate (productivity) at the time of the TSF dam failure.

5.1.2.1 Species and Life Stages Potentially Affected

5.1.2.1.1 Rainbow Trout

Rainbow Trout aging data from upper and lower Hazeltine Creek indicated that only YOY (0^+) and a few older fish (1^+) rear in Hazeltine Creek outside of the spawning window of April to late/May/early June (Minnow Environmental 2009; Bruce and Slaney 1991). Given that the TSF dam failure occurred in the month of August, it is believed that all YOY and juvenile Rainbow Trout were likely displaced as eggs typically hatch in late June after spring freshet (MPMC 2004). Considering adult Rainbow Trout return to their respective lake shortly after spawning in May/June, it is assumed that adults were likely not present in upper or lower Hazeltine Creek during the TSF dam failure, and thus were likely unaffected.

5.1.2.1.2 Pacific Salmon and Kokanee

Given the presence of a fish barrier in Hazeltine Creek, occurrences of Pacific Salmon and Kokanee are restricted to lower Hazeltine Creek. Three species of salmon have been documented in lower Hazeltine Creek and include Chinook, Coho, and Sockeye/Kokanee Salmon.

Adult Chinook return to their natal streams in the Quesnel Lake watershed as early as late July with the peak occurring in August (McPhail 2007). The displacement of juvenile Chinook Salmon is unknown but believed to be small given the low escapement numbers of the species in Hazeltine Creek.

Coho adults have been observed in Hazeltine Creek in November (Cariboo Envirotech 2008a), and due to their fall spawning time, were most likely not present during the TSF dam failure. The displacement of juvenile Coho Salmon, however, is unknown but believed to be small due to the low escapement numbers observed in Hazeltine Creek.

Sockeye Salmon and Kokanee have been documented in Hazeltine Creek and typically spawn in September/October. The spawning time of these species is considerably later than when the TSF dam failure occurred suggesting that adults were likely not present in Hazeltine Creek during the release. Potential displacement to juvenile Sockeye/Kokanee is also believed to be negligible given that fry migrate to their nursery lake shortly after emerging from the gravels.

5.1.2.1.3 Burbot & Mountain Whitefish

Burbot appeared to be one of the most abundant species of fish that was known to inhabit lower Hazeltine Creek. It is likely that only juvenile Burbot were displaced, as adults occupy deeper water during the summer months (i.e., Quesnel Lake) and 84% of captured fish in lower Hazeltine Creek were YOY (Minnow Environmental 2009).

Limited records document Mountain Whitefish in lower Hazeltine Creek, suggesting they account for a small percentage of the lower Hazeltine Creek fish assemblage. Based on the limited data, it is assumed that both juvenile and adult life stages, albeit few individuals, could have been displaced by the TSF dam failure.

5.1.2.1.4 Other Fish Species

Other than known presence and distribution information, abundance, and age data was not available for other fish species (see list in Table 4-3). However, all other species present in lower Hazeltine Creek (e.g., Redside Shiner, Longnose Dace, etc.) at the time of the TSF dam failure would have been displaced.

5.1.2.2 Potential Long-Term Implications

Table 5-5 summarizes the productivity components that were estimated to be as a result of the TSF dam failure. The TSF dam failure resulted in the temporary disruption to several productivity components; however, the long-term implications and overall disruption to productivity cannot be confirmed until rehabilitation efforts on Hazeltine Creek are complete.

Table 5-5: Summary of Productivity Components and Mechanisms for Reduced Productivity in Hazeltine Creek

Productivity Component	Mechanism for Reduced Productivity
Production	Disruption to production (e.g., habitat, fish abundance, diversity)
Growth	*Physiochemical water properties considered in Golder (2015)*
Individual performance	*Physiochemical water properties considered in Golder (2015).* Potential bioaccumulation considered in fish tissue memorandum '*Fish Tissue Results for Samples Collected Following the Mount Polley Tailings Storage Facility Dam Failure*' (SNC-Lavalin 2015a)
Survival	Displacement of fish *Physiochemical water properties considered in Golder (2015)*
Migration	Loss of access to key habitats
Reproduction	Loss of spawning events

Both the aquatic and riparian habitats of Hazeltine Creek were permanently altered. However, the duration and severity of the permanent alteration on overall fish production (including habitat) will depend on the nature and success of the rehabilitation (i.e., offsetting) efforts to altered riverine and riparian habitats. The level of permanent alteration should be re-evaluated once offsetting efforts in the immediately affected areas are complete and should be re-examined in the context of the results of any effectiveness and biotic-response monitoring.

Depending on when the affected segment of upper Hazeltine Creek is rehabilitated and migration access to/from Polley Lake re-established (i.e. after spring season), there is the potential for subsequent Rainbow Trout reproductive events to be inhibited, which could affect ongoing population viability and sustainability. Spawning Rainbow Trout looking to return to upper Hazeltine Creek to reproduce may seek out other nearby watercourses to undertake their reproductive cycle. Quinn (2005) suggested that if the conditions of a natal watercourse are sufficiently degraded, salmon(ids) may move elsewhere to spawn. However, the carrying capacity of other nearby watercourses may not entirely accommodate additional spawning recruits, native spawners may be displaced, or physical conditions in these other nearby watercourses may not be ideal due to homing imprinting (Quinn 2005). It is unknown whether any of these three conditions are actively ‘in play’ within Polley Lake, thus the magnitude of effect on the productivity (as a result of lost reproductive events) of Polley Lake Rainbow Trout cannot be reasonably estimated at this time.

Similarly, Rainbow Trout are the most abundant and widely distributed fish in lower Hazeltine Creek. Access to habitat in the lower reaches of Hazeltine Creek will offer opportunity for spring spawning Rainbow Trout to successfully migrate and reproduce to initiate the natural recruitment process. It is our understanding from MPMC (K. McMahon, pers. comm.) that rehabilitation efforts on Edney Creek have since re-opened migratory access between Edney Creek and Quesnel Lake providing the prospect for potential spring spawning Rainbow Trout. This may pose as an opportunity for spawning Rainbow Trout destined for Hazeltine Creek to complete their reproductive cycle. Furthermore, other species also utilized lower Hazeltine Creek, but in lower numbers suggesting lower Hazeltine Creek quite possibly did not offer preferred habitat conditions for these species.

5.2 Edney Creek

5.2.1 Quantification of Habitat Footprints

5.2.1.1 Aquatic Habitat

Edney Creek was assessed for habitat loss and mitigation options on September 19, 2014 after the TSF dam failure. There was evidence that when the tailings material in Hazeltine Creek reached the lower bridge, it flowed down the Horsefly-Likely FSR and into Edney Creek, reaching as far as approximately 55 m upstream of the Edney Creek bridge. The tailings reached as high as 1.5 m against the opposite bank (on the road side) of the creek.

Table 5-6 and Figure 5-2 (Appendix I) summarize the estimated aquatic footprint in lower Edney Creek as a result of the TSF dam failure. Mean channel (bankfull) width was obtained from previous site assessments on Edney Creek (Hallam Knight Piésold 1997).

In total, approximately 2,390 m^2 of aquatic habitat in Edney Creek was altered. Although fish distribution throughout the entire Edney Creek watershed (i.e., in the mainstem, tributaries, and associated lakes) is not completely known, based on data from previous habitat assessments (Hallam Knight Piésold 1996a; 1997) the total aquatic habitat area of the watershed has been estimated at 623,089 m^2. Thus, aquatic habitat affected by the TSF dam failure represents approximately 0.4% of the total aquatic habitat in the watershed. Further, the magnitude of physical alteration to lower Edney Creek is considered temporary given the small area and rehabilitation efforts to the watercourse that have been completed and recently commissioned.

Table 5-6: Estimated Aquatic Footprint of Edney Creek

Watercourse	Reach	Mean (Channel (Bankfull) Width (m)[1]	Affected Channel Length (m)	Affected Aquatic Area (m^2)
Edney Creek	-	6.0	398	2,390

[1] data from Hallam Knight Piésold (1997) (Site F1 at Edney Creek bridge).

5.2.1.2 Riparian Habitat

The total riparian area footprint of Edney Creek from its confluence with Hazeltine Creek to the upstream extent of tailings was estimated to be 20,215 m^2.

Table 5-7 and Figure 5-2 (Appendix I) provide a summary of the total riparian footprint that was altered on Edney Creek as a result of the TSF dam failure. Mean channel (bankfull) width was estimated from a site assessment conducted on Edney Creek in 1997 (Hallam Knight Piésold 1997).

Table 5-7: Estimated Affected Riparian Habitat of Edney Creek

Watercourse	Reach	Mean Channel (Bankfull) Width (m)[1]	Riparian Management Area (m)[2]	Affected Channel Length (m)	Affected Riparian Area (m^2)[3]
Edney Creek	-	6.0	40	398	20,215

[1] data from Hallam Knight Piésold (1997); (Site F1 at Edney Creek bridge).
[2] from edge of channel.
[3] includes affected riparian area on both sides of Edney Creek.

5.2.2 Potential Effects on Fish Productivity

Although Edney Creek contains a relatively diverse fish assemblage, historical fish relative abundance data were not available. As such, estimated loss of fish productivity due to the TSF dam failure could not be calculated.

5.2.2.1 *Species and Life Stages Potentially Affected*

5.2.2.1.1 Rainbow Trout

Rainbow Trout aging data from historical fisheries assessments (Hallam Knight Piésold 1997; Minnow Environmental 2009) indicate that adult Rainbow Trout are only present in Edney Creek during the spawning window (e.g., April/May). As such, it is assumed that adults were likely not present in Edney Creek during the TSF dam failure, and given the short segment of lower Edney Creek that was affected, it is likely only small proportion of adults would have been displaced if present. Fisheries assessments have also indicated that juvenile Rainbow Trout will remain in Edney Creek for up to three years. Thus, it is expected that some YOY and/or juvenile life stages of Rainbow Trout were likely displaced by the TSF dam failure. It is also believed that the effects to Rainbow Trout eggs were likely negligible, as eggs typically hatch in late June/early July (MPMC 2004) and hatching would have occurred in 2014 prior to the TSF dam failure.

5.2.2.1.2 Salmon Species

Although Chinook, Coho, and Sockeye Salmon have historically been captured or observed in Edney Creek, abundance numbers have been low. As such, effects to the recruitment of these species from Edney Creek to Quesnel Lake is likely negligible.

Adult Chinook return to their natal streams in the Quesnel Lake watershed as early as late July with the peak occurring in August (McPhail 2007). The likelihood of adults present in Edney Creek during the TSF dam failure is low considering the run timing of the species. The displacement to juvenile Chinook Salmon, however, is unknown but believed to be small due to the low historical escapement numbers of Chinook in Edney Creek.

Coho adults have been observed in Edney Creek in fall and due to their spawning time, were likely not present during the TSF dam failure. The displacement of juvenile Coho Salmon, however, is unknown but believed to be small due to the low historical escapement numbers observed in Edney Creek.

Sockeye Salmon/Kokanee have been documented in Edney Creek and typically spawn in September/October. The spawning time of the species is considerably later than when the TSF dam failure occurred suggesting that adults were likely not present in Edney Creek during the TSF dam failure. Potential displacement of juvenile Sockeye/Kokanee is also believed to be negligible given that fry migrate to their nursery lake shortly after emerging from the gravels.

5.2.2.1.3 Other Fish Species

Other fish species present in Edney Creek (e.g., Redside Shiner, Longnose Dace) would likely have had certain life stages displaced by the TSF dam failure, as some life history requirements are fulfilled in the stream environment.

5.2.2.2 Potential Long-Term Implications

Provided below is a summary of productivity components that were estimated to be altered/affected/interrupted as a result of the TSF dam failure (Table 5-8). Although the long-term implications of these outcomes cannot be confirmed, given the small area affected (4% of total watershed), it is believed that the long-term implications to overall productivity in Edney Creek will be relatively low.

Table 5-8: Productivity Components and Mechanisms for Reduced Productivity in Edney Creek

Productivity Component	Mechanism for Reduced Productivity
Production	Loss of production (e.g., habitat, fish abundance, diversity)
Growth	Physiochemical water properties considered in Golder (2015)
Individual performance	Physiochemical water properties considered in Golder (2015)
Survival	Direct mortalities Physiochemical water properties considered in Golder (2015)
Migration	Loss of access to key habitats
Reproduction	Loss of spawning events

The amount of habitat in Edney Creek affected by the TSF dam failure was small in comparison to that available in the Edney system, so obstruction to upstream migration and potential loss of reproductive events of Rainbow Trout appear to present the primary concern to Rainbow Trout population sustainability. It is our understanding that connectivity between Edney Creek and Quesnel Lake was restored prior to spring spawning (K. McMahen, pers. comm.). If so the case, then the risk to potential loss of reproductive events may be reduced. Although there is limited evidence of other fish species utilizing Edney Creek, restoring access may also contribute to the productivity of other species (i.e., Coho Salmon) looking to utilize or migrate out from Edney Creek.

5.3 Quesnel River

No permanent physical alteration of habitat is believed to have occurred in the Quesnel River. The potential for water quality-related effects are addressed in the Quesnel and Polley Lakes Impact Assessment (Golder 2015). The potential for settling of suspended particles is its outlet addressed by Minnow Environmental through the use of sediment traps (Minnow Environmental 2015).

5.4 Quesnel Lake

The objective of this section of the FFHIA is to discuss the potential effects of the TSF dam failure and to estimate the alteration to physical components of habitat and potential effects on the productivity of fish found in the West Arm of Quesnel Lake.

5.4.1 Fish Groups

Table 5-9 below summarizes the fish species groups identified for Quesnel Lake and their association with commercial, recreational and Aboriginal fisheries.

Table 5-9: Summary of Each Species Group indicating whether part of a commercial, recreational or Aboriginal fishery

Fish Group	Quesnel Lake Fish Species	Commercially Fished	Recreationally Fished	Aboriginal Fish
Migratory salmonids	Sockeye Salmon	X	X	X
	Coho Salmon*	X	X	X
	Chinook Salmon	X	X	X
Resident salmonids	Kokanee		X	X
	Rainbow Trout		X	X
	Bull Trout+		X	X
	Lake Trout		X	X
	Mountain Whitefish		X	X
	Pygmy Whitefish		X	X
	Lake Whitefish		X	X
Benthic species	Burbot		X	X

*Endangered (COSEWIC)
+Species of special concern (COSEWIC)

Other pelagic non salmonid and non fishery species that may occur in the West Arm include: Longonse Sucker, Largescale Sucker, Slimy Sculpin, Redside Shiner, Longnose Dace, Leopard Dace, Northern Pikeminnow, Peamouth Chub, and Lake Chub.

5.4.1.1 Littoral Zone

The littoral zone of Quesnel Lake is defined by the likely maximum growing depth of the dominant native aquatic plants in the West Arm of Quesnel Lake, namely *Potamageton* spp (Ecoscape 2012).

5.4.1.1.1 Littoral Zone Fish Assemblage

About 20 species of fish inhabit the littoral zone of Quesnel Lake and include species groupings such as migratory salmonids, resident salmonids, benthic species, and pelagic, non-salmonid species (Table 5-10). Migratory salmonids will typically use the littoral zone as rearing and foraging habitat during the YOY and juvenile life history stage. Unlike the migratory salmonids documented in Quesnel Lake, resident salmonids rely on littoral habitat for rearing (YOY and juvenile), foraging (juvenile and adult) and spawning (with the exception of Bull Trout)(Bryant et al. 1996, Hatfield 1996, McPhail 2007). The remaining species groupings consisting of benthic and potential pelagic, non-salmonid species will utilize the littoral zone for rearing (YOY and juvenile), foraging (juvenile and adult) and spawning (adult).

Table 5-10: Life History Stages of Fish Species Inhabiting Quesnel Lake Littoral Zone

Species Grouping	Species	YOY	Juvenile	Adult
Migratory Salmonids	Sockeye Salmon	Rearing	Rearing, Foraging	Spawning
	Coho Salmon	Rearing	Rearing, Foraging	
	Chinook Salmon	Rearing	Rearing, Foraging	
Resident Salmonids	Bull Trout		Rearing, Foraging	Foraging
	Rainbow Trout	Rearing	Rearing, Foraging	Spawning, Foraging
	Kokanee	Rearing	Rearing, Foraging	Spawning, Foraging
	Lake Trout	Rearing	Rearing, Foraging	Spawning, Foraging
	Mountain Whitefish	Rearing	Rearing, Foraging	Spawning, Foraging
	Pygmy Whitefish	Rearing	Rearing, Foraging	Spawning, Foraging
	Lake Whitefish	Rearing	Rearing, Foraging	Spawning, Foraging
Benthic Species	Burbot	Rearing	Rearing, Foraging	Spawning, Foraging
	Largescale Sucker	Rearing	Rearing, Foraging	Spawning, Foraging
	Longnose Sucker	Rearing	Rearing, Foraging	Spawning, Foraging
	Slimy Sculpin	Rearing	Rearing, Foraging	Spawning, Foraging
Pelagic, Non-Salmonid Species	Redside Shiner	Rearing	Rearing, Foraging	Spawning, Foraging
	Longnose Dace	Rearing	Rearing, Foraging	Spawning, Foraging
	Leopard Dace	Rearing	Rearing, Foraging	Spawning, Foraging
	Northern Pikeminnow	Rearing	Rearing, Foraging	Spawning, Foraging
	Peamouth Chub	Rearing	Rearing, Foraging	Spawning, Foraging
	Lake Chub	Rearing	Rearing, Foraging	Spawning, Foraging

5.4.1.1.2 Alterations to Physical Habitat Properties in Littoral Zone

The littoral zone surrounding the Hazeltine Creek mouth was scoured and/or buried as a result of the TSF dam failure (SNC-Lavalin 2015b). *Potamogeton* was identified as the most common and abundant aquatic plant in the littoral zone of the West Arm of Quesnel Lake (Ecoscape 2012). The extent of littoral habitat altered was defined by the length of littoral zone adjacent to identified regions of tailing deposits at the terminus of Hazeltine Creek. This extent was defined by the Hazeltine Creek Hydrotechnical and Geomorphological Impact Assessment (SNC-Lavalin 2015b) (Figure 5-1).

Fiiigure 5-1: Tailings extent and extent of affected littoral zone

The length of shoreline in the West Arm (October 2001) is estimated at 35,330 m and the length of shoreline affected by the TSF dam failure is estimated at 2,081 m.

The total littoral area (0-6m) of the West Arm (October 2001) was estimated to be 1,458,051 m^2 and the littoral area affected by the TSF dam failure is estimated at 94,394 m^2 or 6.5% of the total West Arm littoral zone (Figure 5-4).

Fivgure 5-4: Littoral area in the West Arm of Quesnel Lake and affected area

5.4.1.1.3 Quality of Lost Littoral Zone Habitat

The importance of the littoral zone adjacent of Hazeltine Creek to the productivity of fish is described in Ecoscape (2012). The authors undertook FIM of about 70 km of shoreline in the West Arm of Quesnel Lake. The study area included the portion of the West Arm of the lake, into which Hazeltine Creek drains, with the easternmost boundary of the study area located approximately 2 km west of the mouth of Whiffle Creek.

Using the inventory data, field reviews and other data sources the authors also developed an aquatic habitat index (AHI) to characterize and rank the estimated value and sensitivity of different shorelines of the West Arm. The AHI is used to analyze the habitat value of a shoreline segment relative to those from different parts of the lake or different lakes. Three categories are used to derive AHI scores: biophysical (e.g., shoretype, substrate), fisheries (e.g., juvenile rearing suitability) and shoreline vegetation.

Results of the foreshore mapping completed by Ecoscape (2012) indicate that:

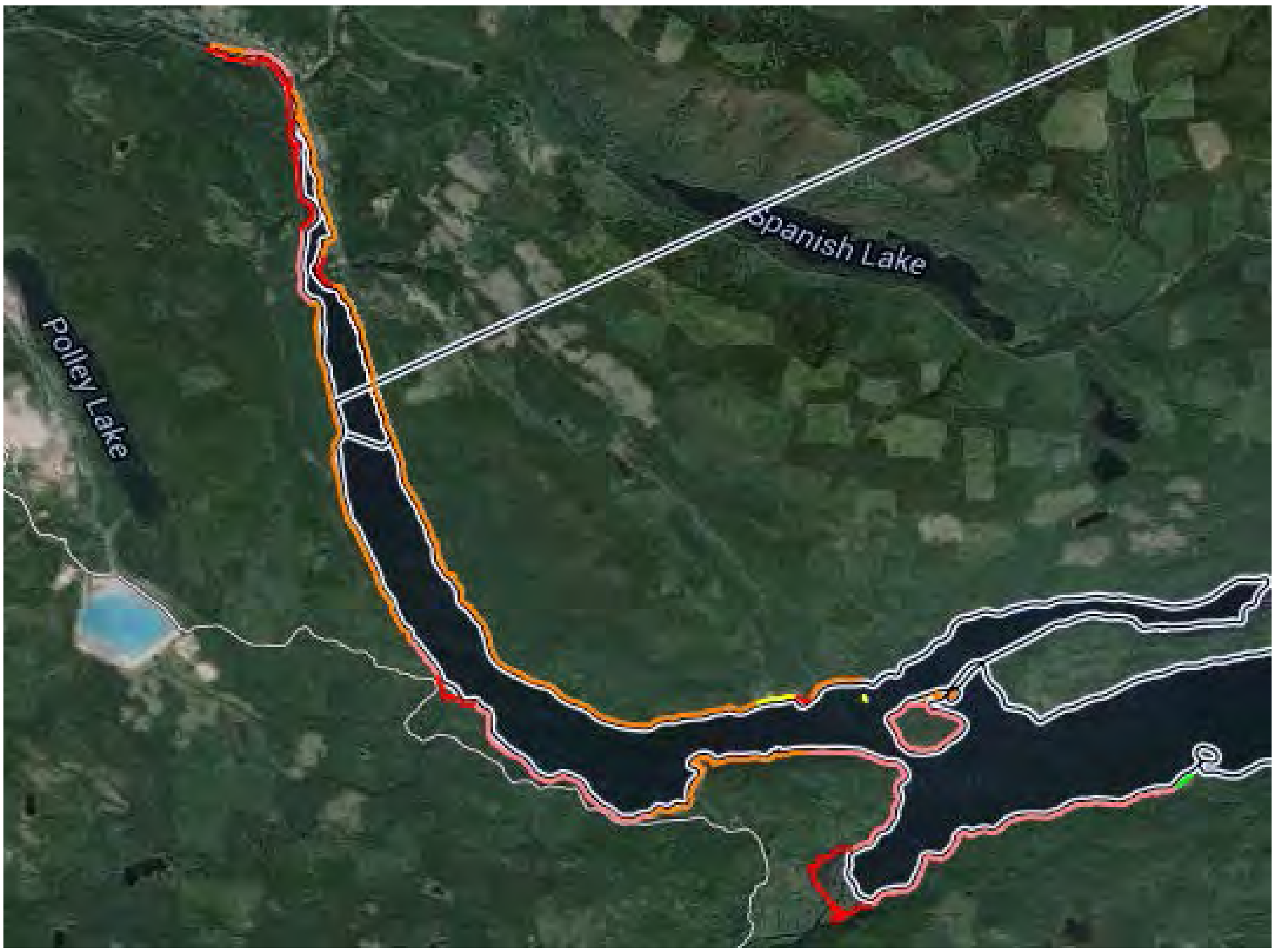
- The most predominant shore types observed around the West Arm of Quesnel Lake were gravel beach, accounting for 49% (or 34 km) of the study area, and rocky shore, accounting for over 35% (or 24.2 km).
- 36% (25 km) of shoreline in the study area had aquatic vegetation, predominantly emergent vegetation (including grasses and herbaceous vegetation) located below the high water level.
- Approximately 77% (54 km) of the shoreline in the study area showed low level (less than 10%) impact from shoreline modification (e.g., retaining walls, roads).
- High juvenile rearing value was identified to occur along 14 km of the shoreline in the study area, with land use disturbance noted along 2% (322 m). Note that at the time of this assessment, maps showing the location of high juvenile habitat rearing value along the shoreline of the West Arm were not obtained or available, but it was estimated that 14 of 70 km or 20% of the shoreline was high value.

Results of the aquatic habitat inventory completed by Ecoscape (2012) indicated that:

- Approximately 51% of the shoreline is ranked as ‘Very High’ and ‘High’ value, 48% of the shoreline length is moderate value, and the remaining 2% is ranked ‘Low’ and ‘Very Low’ value.
- ‘Very High’ value shorelines occurred primarily adjacent to stream mouths and gravel shores, with a reduced representation of ‘Very High’ value habitat occurring along rocky, cliff/bluff and sand shores. The West Arm of Quesnel Lake exhibited limited ‘Very Low’ AHI ratings.

- Within those areas ranked as ‘Very High’, the shoreline was 96% natural in terms of land use; in ‘High’ value areas, the shoreline was 95% natural; and within ‘Moderate’ value areas the shoreline was 80% natural. Areas of ‘Low’ value were around 48% natural, while areas with ‘Very Low’ value areas had 5% of the shoreline remaining natural.
- Examination of the AHI rating maps (CMN 2015) indicated that the shoreline adjacent to the Hazeltine Creek mouth was considered to have a ‘Very High’ AHI (Figure 5-5 and Figure 5-6).

It is estimated form the CMN mapping data that approximately 15% of the ‘Very High’ rated juvenile habitat in the West Arm occurred at the mouth of Hazeltine Creek and was altered by the TSF event.



Fvgure 5-5: Locations in the west arm of Quesnel Lake with Moderate (orange), High (pink), or ‘Very High’ (red) AHI ratings (CMN 2015)

Fvigure 5-6: The mouth of Hazeltine Creek is rated as 'Very High' (red) AHI, with an approximate shoreline length of 1200 m (CMN 2015).

5.4.1.1.4 Littoral Zone Effect Assessment

An assessment of lost productivity of fish in the littoral zone during the event or after then event was not possible because no information was available describing the use of littoral zone habitats by fish.

5.4.1.2 Limnetic Zone

5.4.1.2.1 Limnetic Zone Fish Assemblage

Approximately 18 species of fish are expected to inhabit the limnetic zone (MOE Habitat wizard, Table 5-11). Similar to the littoral zone, four species groupings are present. Migratory salmonids utilize the limnetic zone for rearing and foraging until they undergo smoltification and migrate downstream towards the marine environment. Resident salmonids will also typically use the zone for rearing and foraging during various life history phases. Benthic species are usually only present in the limnetic zone for a short period of time after hatching and consequently rear in the pelagic column until settling on the lake bed (Bryant et al. 1996, Hatfield 1996, McPhail 2007). Adult Burbot, however, will also make vertical migrations to the open water column in search of food. The presence of pelagic, non-salmonid species in the limnetic zone are likely foraging.

Table 5-11: Life History Stages of Fish Species Inhabiting Quesnel Lake Limnetic Zone

Species Grouping	Species	YOY	Juvenile	Adult
Migratory Salmonids	Sockeye Salmon	Rearing	Rearing, Foraging	
	Coho Salmon		Rearing, Foraging	
	Chinook Salmon		Rearing, Foraging	
Resident Salmonids	Bull Trout		Rearing, Foraging	Foraging
	Rainbow Trout		Rearing, Foraging	Foraging
	Kokanee	Rearing	Rearing, Foraging	Foraging
	Lake Trout	Rearing	Rearing, Foraging	Foraging
	Mountain Whitefish	Rearing	Rearing, Foraging	Foraging
	Pygmy Whitefish	Rearing	Rearing, Foraging	Foraging
	Lake Whitefish	Rearing	Rearing, Foraging	Foraging
Benthic Species	Burbot	Rearing		Foraging
	Largescale Sucker	Rearing		
	Longnose Sucker	Rearing		
Potential Pelagic, Non-Salmonid Species	Redside Shiner			Foraging
	Longnose Dace			Foraging
	Northern Pikeminnow			Foraging
	Peamouth Chub			Foraging
	Lake Chub			Foraging

5.4.1.2.2 Limnetic Zone Effect Assessment

No physical alteration of habitat occurred in the limnetic zone of Quesnel Lake. The potential for physiochemical related effects (e.g., turbidity, water temperature) are addressed in the Golder (Golder Associates Ltd.). 2015a. Mount Polley Tailings Dam Failure – Surface Water Quality Impact Assessment.

5.4.1.3 Profundal Zone

5.4.1.3.1 Profundal Zone Fish Assemblage

The profundal zone of Quesnel Lake is likely used by seven fish species and three species groups, namely migratory and resident salmonids, and benthic species (MOE Habitat wizard, Bryant et al. 1996, Hatfield 1996, McPhail 2007; Table 5-12). Of the migratory species, only Sockeye Salmon (YOY and juvenile) are likely rearing and feeding in the upper profundal zone as demonstrated by historical DFO hydroacoustic surveys (e.g., Morton and Williams 1990); the young salmon were apparently avoiding warm (greater than 17°C) waters above the thermocline. The resident salmonid grouping consists of Bull Trout, Kokanee, Lake Trout, Pygmy Whitefish, and Lake Whitefish. Bull Trout and Lake Trout are only typically present during the adult stage as they forage the depths for prey. Both species of whitefish and Kokanee will utilize the profundal zone for rearing and foraging opportunities (Bryant et al. 1996, Hatfield 1996, McPhail 2007).

Table 5-12: Life History Stages of Fish Species Inhabiting Quesnel Lake Profundal Zone

Species Grouping	Species	YOY	Juvenile	Adult
Migratory Salmonids	Sockeye Salmon	Rearing	Rearing, Foraging	
Resident Salmonids	Kokanee	Rearing	Rearing, Foraging	Foraging
	Bull Trout			Foraging
	Lake Trout			Foraging
	Pygmy Whitefish		Rearing, Foraging	Foraging
	Lake Whitefish		Rearing, Foraging	Foraging
Benthic Species	Burbot			Foraging

5.4.1.3.2 Profundal Zone Effect Assessment

No physical alteration of habitat likely occurred in the profundal zone of Quesnel Lake. The potential for physiochemical related effects (e.g., turbidity, water temperature) are addressed in the Golder (Golder Associates Ltd.). 2015a. Mount Polley Tailings Dam Failure – Surface Water Quality Impact Assessment.

5.4.1.4 Benthic Zone

5.4.1.4.1 Benthic Zone Fish Assemblage

The benthic zone fish assemblage includes species that associate with the lake bed in order to fulfill any of their life history requirements (Table 5-13). Resident salmonids (both juvenile and adult stage) will use the benthic zone to rear and forage (juveniles), while adults will rely on the lake bed for food as well as potential spawning habitat. All benthic species and respective life history stages will utilize the lake bed for rearing (YOY, juveniles), foraging (juvenile, adult) and spawning (adult). For the three potential pelagic, non-salmonid fish species, both the juvenile and adult phases may be present on the lake bed for rearing, foraging and spawning.

Table 5-13: Life History Stages of Fish Species Inhabiting Quesnel Lake Benthic Zone

Species Grouping	Species	YOY	Juvenile	Adult
Resident Salmonids	Rainbow Trout		Rearing, Foraging	Spawning, Foraging
	Bull Trout		Rearing, Foraging	Spawning, Foraging
	Lake Trout		Rearing, Foraging	Spawning, Foraging
	Mountain Whitefish		Rearing, Foraging	Spawning, Foraging
	Pygmy Whitefish		Rearing, Foraging	Spawning, Foraging
	Lake Whitefish		Rearing, Foraging	Spawning, Foraging
Benthic Species	Burbot	Rearing	Rearing, Foraging	Spawning, Foraging
	Largescale Sucker	Rearing	Rearing, Foraging	Spawning, Foraging
	Longnose Sucker	Rearing	Rearing, Foraging	Spawning, Foraging
	Slimy Sculpin	Rearing	Rearing, Foraging	Spawning, Foraging
Potential Pelagic, Non-Salmonid Species	Northern Pikeminnow		Rearing, Foraging	Foraging
	Peamouth Chub		Rearing, Foraging	Spawning, Foraging
	Lake Chub		Rearing Foraging	Foraging

5.4.1.4.2 Benthic Zone Physical Habitat Properties

Tetra Tech (2015; Bathymetry Analysis and Volume Balance) determined that the surface area of lake-bed below the 100-m depth contour covered after the event was about 1.81 km^2. Lake bed benthic habitats that were covered would result in loss of any productive habitat values to benthic fish species such as Burbot and Slimy Sculpin.

The potential for physiochemical related effects (e.g., turbidity, water temperature) are addressed in the Golder (Golder Associates Ltd.). 2015a. Mount Polley Tailings Dam Failure – Surface Water Quality Impact Assessment.

5.4.2 Quesnel Lake Assessment Summary

Table 5-14 summarizes the potential effects of the TSF dam failure on physical alterations to Quesnel Lake fish habitat in four major lake zones.

Table 5-14: Summary of Physical Alterations to Fish Habitat in Quesnel Lake

Lake Zone	Estimated amount of lake zone habitat physically altered
Littoral	2,081 m of lake shoreline permanently altered 94, 394 m2 of littoral zone permanently altered 15% of very high rated juvenile fish habitat at the mouth of Hazeltine Creek permanently altered
Limnetic	No physical habitat properties altered; physiochemical water properties considered in Golder (2015).
Profundal	No physical habitat properties altered; physiochemical water properties considered in Golder (2015).
Benthic (lakebed)	Permanent alteration to physical habitat of the West Arm lakebed below the 100 m contour is estimated at 1.8 km^2 Tetra Tech (2015).

5.5 Polley Lake

5.5.1 Fish Impact Assessment

Tailings from the TSF dam failure entered Polley Lake at the lake outlet to Hazeltine Creek; however, there are no current estimates of how much linear shoreline or surface area of lake bed was physically altered by the event.

The TSF dam failure resulted in blockage of the upper Hazeltine Creek and hence the Polley Lake Rainbow Trout population lost access to creek spawning habitat for one season. One cohort of production was lost. A reduction in rainbow trout returning to Polley Lake is likely to affect both the density and growth rates of fish in the lake. This in turn may affect future angling results (Lirette 2015).

The TSF dam failure may have impacted habitats important to Redside Shiner and Longonse Sucker in Polley Lake. However, there is currently insufficient scientific evidence confirming the habitats or population properties of these species in Polley Lake.

6 RECOMMENDATIONS FOR ADDITIONAL WORK

The duration and severity of the impacts as a result of the TSF dam failure on fish production and habitat will depend on the nature and success of the rehabilitation (i.e., offsetting) efforts to altered riverine and lacustrine habitats as well as monitoring the affected creek and lake systems for potential long-term (chronic) effects. The characterization of effects should be reassessed once rehabilitation efforts in the immediately affected areas are complete, and should continue to be re-examined in the context of the results of any effectiveness and biotic-response monitoring.

7 SUMMARY OF FINDINGS

The following is a summary of the key findings generated from the FFHIA.

Hazeltine Creek

The quantity of aquatic and riparian habitat permanently physically altered as a result of the TSF dam failure was estimated and is summarized in Table 7-1.

Table 7-1: Summary of Physical Alterations to Fish Habitat in Hazeltine Creek

Physical Habitat Type	Estimated Amount of Habitat Physically Altered
Aquatic	62,616 m^2 of aquatic habitat was permanently altered.
Riparian	717,249 m^2 of riparian habitat was permanently altered.

There is the potential for subsequent Rainbow Trout reproductive events to be inhibited, which could affect ongoing population viability and productivity. Spawning Rainbow Trout looking to return to upper Hazeltine Creek to reproduce may seek out other nearby watercourses to undertake their reproductive cycle, but it is unknown whether sufficient quantities and quality of spawning habitat exists to accommodate any Hazeltine Rainbow Trout. Rainbow Trout are the most abundant and widely distributed in lower Hazeltine Creek. Providing access to habitat in the lower reaches of Hazeltine Creek will offer opportunity for spring spawning Rainbow Trout to successfully migrate and reproduce to initiate the natural recruitment process. Other fish species also utilize lower Hazeltine Creek, but in lower numbers suggesting lower Hazeltine Creek quite possibly did not offer preferred habitat conditions. It is our understanding from MPMC (K. McMahen, pers. comm.) that rehabilitation efforts and connectivity with Quesnel Lake were commissioned prior to spring, thus it is possible that any spawning Rainbow Trout naturally destined for lower Hazeltine Creek may now access and utilize Edney Creek to complete their reproductive cycle. Monitoring of adult Rainbow Trout accessing the rehabilitated channel during the spring spawning window will confirm some degree of the channel's effectiveness.

Edney Creek

The quantity of aquatic and riparian habitat temporarily physically altered as a result of the TSF dam failure was estimated and is summarized in Table 7-2.

Table 7-2: Summary of Physical Alterations to Fish Habitat in Edney Creek

Physical Habitat Type	Estimated Amount of Habitat Physically Altered
Aquatic	2,390 m^2 of aquatic habitat was temporarily altered.
Riparian	20,215 m^2 of riparian habitat was temporarily altered.

The amount of habitat in Edney Creek altered by the TSF dam failure was small in comparison to that available in the Edney watershed, thus the obstruction to upstream migration and potential loss of reproductive events of Rainbow Trout appear to present the primary concern to Rainbow Trout population productivity. Although there is limited evidence of other fish species utilizing Edney Creek, restoring access may also contribute to the productivity of other species (i.e., Coho Salmon) looking to utilize or migrate out from Edney Creek. It is our understanding from MPMC (K. McMahen, pers. comm.) that rehabilitation of Edney Creek and its connectivity to Quesnel Lake was commissioned prior to this past spring (2015) with the aim to allow for unfettered upstream/downstream access (migration) for fish. Monitoring of adult Rainbow Trout accessing the rehabilitated channel during the spring spawning window will confirm some degree of the channel's effectiveness.

Quesnel River

No physical alteration of habitat is believed to have occurred in the Quesnel River. The potential for water quality-related effects are addressed in the Quesnel and Polley Lakes Impact Assessment (Golder 2015). The potential for settling of suspended particles is addressed by Minnow Environmental through the use of sediment traps (Minnow Environmental 2015).

Quesnel Lake

It was determined that the TSF dam failure impacted a 2,081 m length of West Basin shoreline at the mouth of Hazeltine Creek (about 6% of the total shoreline in the West Basin). The littoral area (0-6 m) affected by the TSF dam failure was estimated to be 94,394 m^2 or 6.5% of the total West Arm littoral zone. The amount of West Arm lakebed below 100 m depth impacted by the TSF dam failure was estimated by Tetra Tech (2015) to be about 1.8km^2. The summary of physical alterations of fish habitat as a result of the TSF dam failure was estimated and is summarized in Table 7-3.

Table 7-3: Summary of Physical Alterations to Fish Habitat in Quesnel Lake

Lake Zone	Estimated Amount of Lake Zone Habitat Physically Altered
Littoral	2,081 m of lake shoreline was permanently altered. 94,394 m^2 of littoral zone was permanently altered. 15% of very high rated juvenile fish habitat at the mouth of Hazeltine Creek was permanently altered.
Limnetic	No physical habitat properties altered; physiochemical water properties are being considered in Golder (2015a,b).
Profundal	No physical habitat properties were altered; physiochemical water properties are being considered in Golder (2015a,b).
Benthic (lakebed)	Permanent alteration to physical habitat of the West Arm lakebed below the 100 m contour is estimated at 1.8 km^2 Tetra Tech (2015).

Polley Lake

The TSF dam failure resulted in blockage of upper Hazeltine Creek and hence the Polley Lake Rainbow Trout population lost access to creek spawning habitat for one season. A reduction in rainbow trout returning to Polley Lake may affect future angling results.

The TSF dam failure may have impacted habitats important to Redside Shiner and Longonse Sucker in Polley Lake. However, there is currently insufficient scientific evidence confirming the habitats or population properties of these species in Polley Lake.

8 UNCERTAINTY ASSESSMENT

The FFHIA included the compilation and assessment of available fish and fish habitat data to evaluate for potential effects of the TSF dam failure on the species productivity in the main ecological units identified in the WQIA (Golder 2015). Table 8-1 lists some of the key uncertainties professionally determined by SNC Lavalin in the FFHIA data for each ecological unit that need to be understood to better understand the effects of the TSF dam failure on fish productivity.

Table 8-1: Summary of Key FFHIA Data Uncertainties for Each Ecological Unit to Better Understand the Effects of the TSF Dam Failure on Fish Productivity

Ecological Unit	Source of Uncertainty	Degree of Uncertainty	Comment
Polley Lake and upper Hazeltine Creek	• Pre and post fish population estimates and distribution within the littoral and limnetic zone of Polley Lake. • Pre and post event fish benthic habitat in Polley Lake. • Upper Hazeltine Creek fish population and production estimates with emphasis on Rainbow Trout.	• High • High • Moderate	Rainbow Trout in upper Hazeltine Creek is an important contributing population/stock to overall Rainbow Trout recreational fishery in Polley Lake (Lirette 2015).
Lower Hazeltine Creek	• Fish population and production rate estimates with emphasis on Rainbow Trout.	• Moderate	Historically, Rainbow Trout is the most abundant species observed. Production rates unable to be calculated with existing baseline data.
Edney Creek	• Post event fish population and production estimates with emphasis on Rainbow Trout.	• Low	Small proportion of Edney Creek was affected by the TSF dam failure, but number of fish utilizing lower Edney Cr at time of TSF dam failure is unknown.
Quesnel Lake Littoral Zone	• Fish species and densities present in the littoral zone at time of event.	• High	Future monitoring will be required to document fish use of the littoral zone.
Quesnel Lake Limnetic Zone	• Horizontal and vertical distribution of juvenile salmon and other pelagic species post event.	• Moderate	Monitoring of juvenile salmon vertical and horizontal distribution in the limnetic zone will reduce uncertainty.
Quesnel Lake Benthic Zone	• Pre and post event fish species and densities present on lake bed and habitats covered by the debris flow from Hazeltine Creek.	• High	Monitoring will reduce the uncertainty of re-colonization of benthic lake habitats and benthic species.

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10 CLOSURE

This report was prepared based on objectives and available information at the time of writing.

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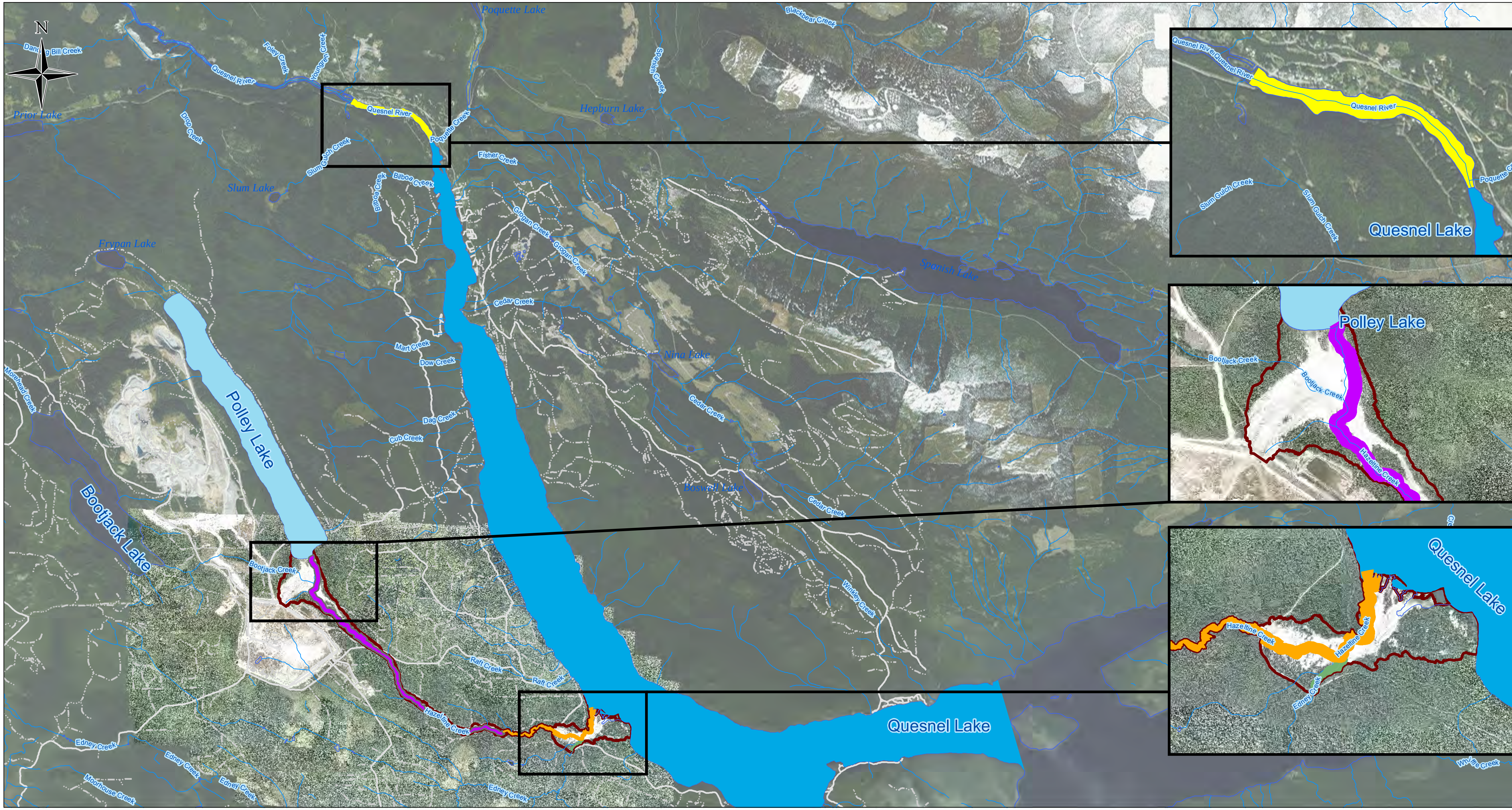
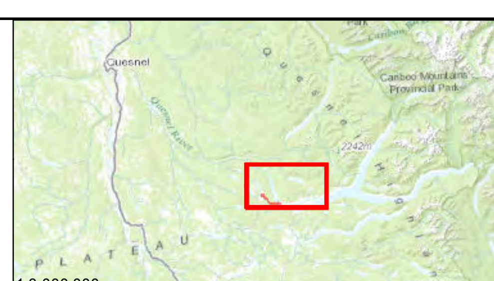
APPENDIX I



LEGEND

- Quesnel River Assessment Area
- Quesnel Lake Assessment Area
- Polley Lake Assessment Area
- Upper Hazeltine Creek Assessment Area
- Lower Hazeltine Creek Assessment Area
- Edney Creek Assessment Area
- Affected Area
- Gravel Roads
- Rough Roads



NOTES

1. Original in colour.
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3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.
4. Privileged and Confidential: Subject to Solicitor-Client Privilege and Prepared in Contemplation of Litigation.
5. Roads are not complete and extent is based on extent of TRIM data available.

REFERENCES

0 550 1,100 2,200 3,300 4,400 Meters

1. Stream and Road Data: BCGOV ILMB Crown Registry and Geographic Base Branch (CRGB)
(data accessed through www.GeoBC.gov.bc.ca)

2. Orthophoto collected by McElhanney on August 5, 2014

3.Service Layer Credits: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User

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CLIENT NAME: Mount Polley Mining Corporation	PROJECT LOCATION: Mount Polley Mine, Likely, BC

Fisheries Assessment Area in Response to the Mount Polley TSF Breach

BY: LH	SCALE: 1:82,684	DATE: 2015/05/08	REF No:	REV: 0
CHK'D: SJ	PROJ COORD SYS: NAD 1983 UTM Zone 10N		Figure 2-1	

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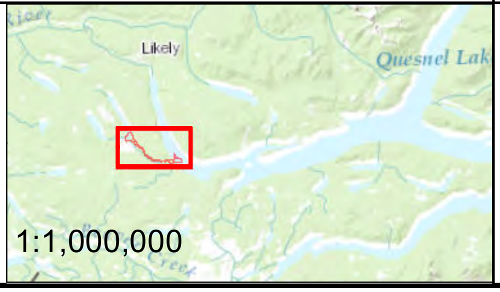
LEGEND

- Riparian Overlap with Bootjack Creek
- Riparian Overlap with Edney Creek
- Impacted Aquatic Area
- Impacted Riparian Area
- Streams
- Affected Area
- Gravel Roads
- Rough Roads



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REFERENCES

0 125 250 500 750 1,000 Meters

1. Stream and Road Data: BCGOV ILMB Crown Registry and Geographic Base Branch (CRGB) (data accessed through www.GeoBC.gov.bc.ca)

2. Orthophoto collected by McElhanney on August 5, 2014

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Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User

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CLIENT NAME: Mount Polley Mining Corporation	PROJECT LOCATION: Mount Polley Mine, Likely, BC

Hazeltine Creek Aquatic and Riparian Area Impacts

BY: LH	SCALE: 1:25,000	DATE: 2015/05/01	REF No: REV: 0
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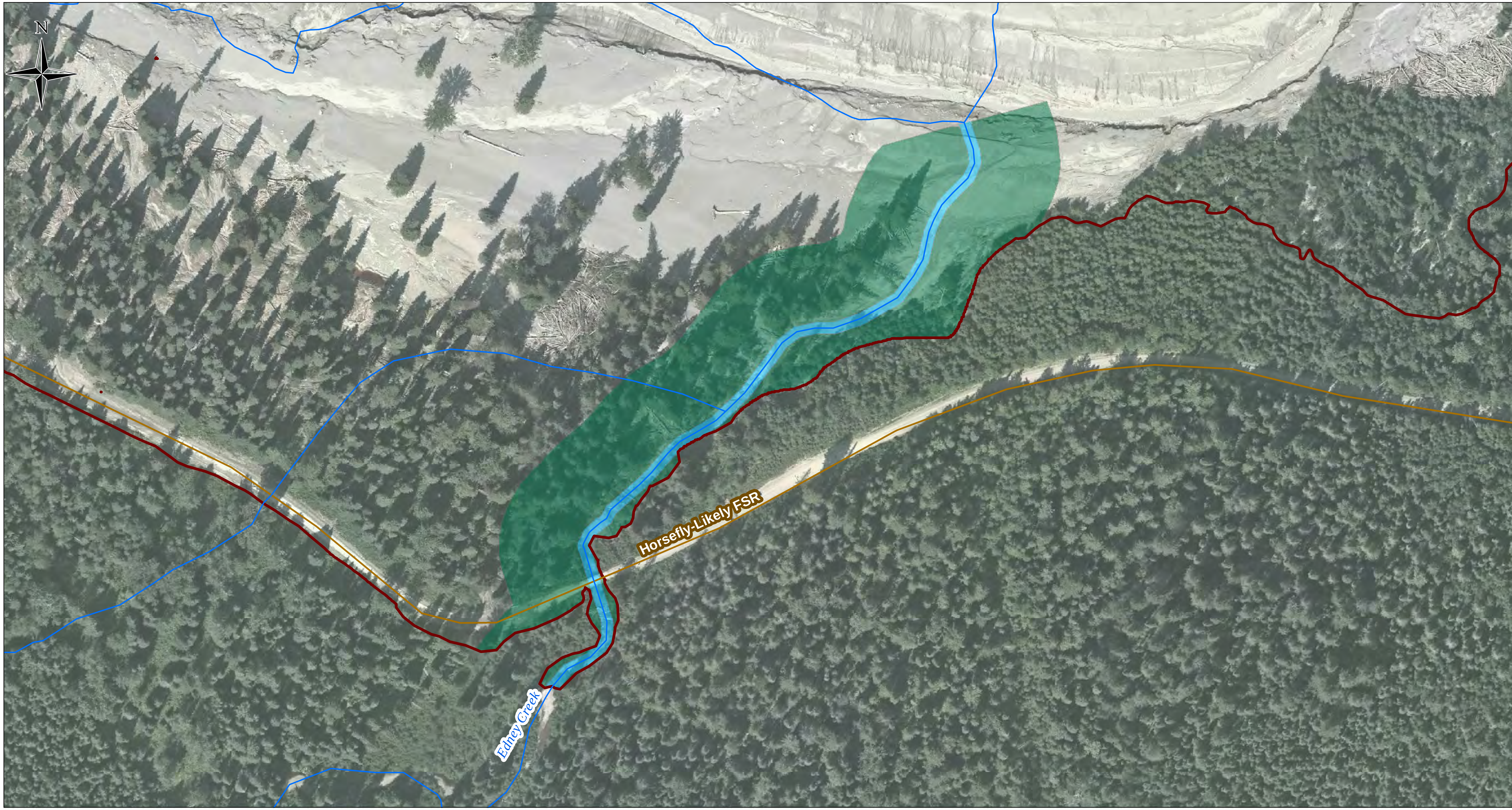

LEGEND

- Streams
- Forest Tenure Road
- Affected Area
- Impacted Aquatic Area
- Impacted Riparian Area

NOTES

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REFERENCES

0 10 20 40 60 80 Meters

1. Stream and Road Data: BCGOV ILMB Crown Registry and Geographic Base Branch (CRGB)
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2. Orthophoto collected by McElhanney on August 5, 2014

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SNC·LAVALIN

CLIENT NAME: Mount Polley Mining Corporation

PROJECT LOCATION: Mount Polley Mine, Likely, BC

Edney Creek Aquatic and Riparian Area Impacts

BY: LH	SCALE: 1:2,000	DATE: 2015/05/01	REF No: REV: 0
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APPENDIX II

Hazeltine and Edney Creeks Fish Life History Summaries

HAZELTINE, BOOTJACK AND EDNEY CREEKS FISH LIFE HISTORY SUMMARIES

This document provides a summary the life histories of impacted fish (as defined under the *Fisheries Act*) that were known to have been displaced, presented in their general order of sampled abundance.

Burbot *(Lota lota)*

The burbot is the only member of the Gadidae (cods) family that inhabits the freshwaters of British Columbia (BC). This fish usually spends its time on the bottom in the deep, cool areas of lakes and rivers (BC Ministry of Environment [MoE] 2015). Lacustrine, adfluvial and fluvial populations can occur in the same river systems (McPhail 1997).

Spawning

The age at maturity varies between systems and life histories but they typically mature between 2 to 8 years (Roberge et al. 2002). McPhail (1997) noted the age at first maturity varies by latitude and males usually reach sexual maturity a year or two before females.

Burbot spawn at night in mid-winter under the ice, typically from January through March (BC MoE 2015), but spawning has been recorded to range between November and May (Roberge et al. 2002). Spawning occurs in lakes (over shallows) and in rivers (side channels behind deposition bars) at temperatures ranging from 0° to 4°C (McPhail 1997; Roberge et al. 2002; BC MoE 2015).

Burbot aggregate and up to 12 adult burbot spawn together in a ball approximately 60 cm in diameter which moves over the bottom shedding milt and eggs (BC MoE 2015; McPhail 1997). Female burbot have very high fecundity with average individual egg release of over 900,000 eggs in some populations though not all adult burbot spawn every year (McPhail 1997). Eggs are released into the water column, and sink slowly to the substrates below (Scott and Crossman 1973; Roberge et al. 2002). Spawning in lakes occurs over fine to gravel substrates in shallow bays, or shoals, typically in shallow water up to 1.25 m deep, but can range to 10 m depth (BC MoE 2015; Roberge et al. 2002; McPhail 1997). In rivers they spawn over clean sand, gravel or cobble and rubble substrate (McPhail 1997).

The eggs hatch after about 30 days, with a larval stage occurring before growing into fry (BC MoE 2015).

Rearing

Larvae are pelagic in lakes appearing shortly after ice-out forming small schools and drifting passively for about a month, or in rivers getting swept downstream as drift (McPhail 1997). The mortality in the larval stage is high. During the larval drifting and schooling period, burbot feed on rotifers, copepods, and cladocerans (McPhail 1997). By early summer, at a size range of 15 mm to 50 mm, larvae shift to a primarily benthic form and take up a demersal life (McPhail 1997). This habitat shift is accompanied by a transition from crepuscular to nocturnal activity, and a change in diet. Young of the year burbot (YOY) feed on larger items such as amphipods, insects, etc. until they are large enough to forage on fish (McPhail and Paragamian 2000, as cited in Roberge et al. 2002). Juvenile burbot remain inshore in relatively shallow water and feed and grow throughout the winter. In streams, young burbot associate with undercut banks, submerged logs and weeds preferably near rocky areas, but will use sandy areas (Roberge et al. 2002; BC MoE 2015). Juvenile burbot, up to 500 mm, are known to feed heavily on M*ysis relicta* (mysis shrimp) (Scott and Crossman 1973, cited by Roberge, 2002).

Subadult Burbot occupy similar habitat as YOY: shallow littoral environments with rocks, weeds or debris as cover (McPhail and Paragamian 2000 as cited in Roberge et al. 2002). With increased size burbot move to deeper water of lakes and recruit to the adult population at about the time of sexual maturity (McPhail 1997; Roberge *et al.* 2002). In lakes, burbot seek deeper cooler waters during the summer and adult burbot have been caught as deep as 210 m (BC MoE 2015). Burbot also inhabit cool, large rivers (Scott and Crossman 1973; Tallman 1996, cited by Roberge *et al.* 2002). Adult burbot forage almost exclusively on fish (Scott and Crossman, 1973; McPhail, 1997; Roberge *et al.* 2002). Adult burbot are nocturnal ambush predators, locating their prey first by smell, then by vibrations as the prey nears (BC MoE 2015).

Both subadults and adults are temperature sensitive and usually avoid temperatures above 12°C (McPhail, 1997). Above 12°C there is an avoidance response with burbot shifting their distribution to below the thermocline (e.g. Edsall et al. 1993; McPhail, 1997). If this is not possible, summer kills may occur (Lafferty et al. 1992, as cited in McPhail 1997).

In Canada, burbot live to a maximum age of approximately 22 years, dependant on water temperatures, with southern populations tending to have shorter lifespans (McPhail and Paragamian 2000, cited in Roberge et al. 2002).

Local Population

Burbot were the most common fish species captured in lower Hazeltine Creek, primarily in areas close to the confluence with Quesnel Lake. The age and population type (i.e., fluvial, lacustrine, adfluvial) of burbot captured in lower Hazeltine Creek was not confirmed during historical studies.

However, as adult burbot spawn in winter or early spring, capture results in lower Hazeltine Creek suggest that most (84%) were YOY (Minnow Environmental 2009), suggesting these are likely adfluvial fish from Quesnel Lake utilizing lower Hazeltine Creek for spawning.

The presence of beaver dams near the confluence with Quesnel Lake may pose an occasional upstream migration barrier to fish (Minnow Environmental 2007), but when passable, the pools associated with the beaver dams may have provided important nursery habitat characteristics in a stream smaller in size than typically identified for the species in the literature.

Rainbow Trout *(Oncorhynchus mykiss)* – Freshwater resident

Rainbow trout occupy many different habitat types over their range. Stream-dwelling rainbow trout are typically found in habitat with gravel substrate and riffle-pool morphology, while lake-resident rainbow trout are usually found in deeper, cool lakes with adequate shallows and vegetation for food production (BC MoE 2015). Lake dwelling rainbow trout are found in a variety of lake types, but are most commonly found in deep, cold oligotrophic lakes that have inlet and outlet streams with adequate spawning habitat (Ford et al. 1995, cited in Roberge et al. 2002). Water temperatures greater than 24°C are lethal to adult rainbow trout (Roberge et al. 2002).

Spawning

Rainbow trout typically spawn in flowing water; however, a few introduced populations spawn on gravel beaches in lakes (McPhail 2007).

Rainbow trout usually spawn for the first time in their third or fourth year. In the larger piscivorous fish, maturity is delayed (BC MoE 2015). If food and other factors are suitable, most mature individuals spawn every year.

In BC, freshwater resident Rainbow Trout spawning is triggered by rising water levels and water temperatures (above 5°C) and typically occurs from April to July (depending on latitude and altitude) (McPhail 2007). Spawning typically occurs at temperatures ranging from 8°C to 15°C (Scott and Crossman 1973, cited in Roberge et al. 2002).

Redds are built in clear, silt-free cold water near vegetated banks over fine gravel in riffles above pools (McPhail 2007), and in clean gravel in riffle habitat at the tail of pools (BC MoE 2015). Preferred small gravel substrate size ranges from 6mm to 52 mm (Whyte et al. 1997). Typical water velocities in spawning sites range from 0.3 m/s to 0.9 m/s and water depths range from 0.15 m to 2.5 m, with site selection dependent on body size (McPhail 2007; Whyte et al. 1997). As such, most, if not all, native, lake populations of rainbow trout migrate to associated lake tributaries to spawn (McPhail 2007).

Access to spawning areas in streams is limited by channel gradient, elevation drops (e.g. cascades or falls), water depths and velocities. Stream gradients in excess of 20% (BC MoF, 1998), water velocities exceeding adult burst swim speed of 4.3 m/s, jump heights over 1.5 m or jump height to plunge-pool depth ratios above 1:1.25 can all function as barriers to adult rainbow trout migration to spawning areas (Whyte et al. 1997). Bjornn and Reiser (1991) indicated maximum water velocities for prolonged swimming of 1.22 m/s (small fish) to 2.44 m/s (large fish), while Whyte et al. (1997) reported 1.8 m/s as an adult rainbow trout prolonged swim speed.

Rearing

Eggs hatch into alevins after four to seven weeks, depending on water temperature (BC MoE 2015). It takes three to seven days after hatching for the alevins to absorb the remaining yolk to become fry (BC MoE 2015). Free-swimming fry emerge from the gravel during the summer. The fry of lake-resident spawners may move into the lake immediately, or, when there is sufficient stream flow, they may spend up to three years in the stream to avoid lake predators (BC MoE 2015).

Juveniles remain inshore during winter and early spring (Beauchamp 1990b, as cited in McPhail 2007) and by day are associated with cover (cobble and boulders or woody debris) (McPhail 2007). At night, they leave cover and forage over sand and gravel substrates (Tabor and Wurtsbaugh 1991, as cited in McPhail 2007). Lake populations of Rainbow Trout fry typically migrate to their lake from rearing streams in late summer or early fall (McPhail 2007).

Adult rainbow trout from large lakes are primarily piscivores, and grow to a large size (Roberge et al. 2002). In streams, the average size of rainbow trout has been shown to vary depending on elevation, with size decreasing with increasing elevation (McMichael and Pearsons 1998 as cited in Roberge et al. 2002). Rainbow trout in streams primarily feed on crustaceans, molluscs, and insects such as caddis flies and black flies, but they also eat salmon eggs when available (BC MoE 2015).

Local Population

The Quesnel Lake rainbow trout population spawns primarily in the Horsefly and Mitchell Rivers which support rearing juveniles for at least one and possibly two winters (Tredger 1989; as cited in Sebastian et al. 2003).

Polley Lake contains a population of rainbow trout which were isolated from downstream populations due to documented migration barriers on Hazeltine Creek between Polley Lake and Quesnel Lake. No historical fish stocking has been recorded to have occurred in Polley Lake. Polley Lake is di-mictic, with well-developed thermal stratification in summer that occurs at approximately 5 m to 15 m (Minnow Environmental 2014). Although well-mixed in winter, water temperatures gradually increase with depth; dissolved oxygen levels gradually decrease with depth, which has been observed year-round. Levels of dissolved oxygen below the BC MoE water quality guidelines for the protection of aquatic life (i.e., < 5mg/L) have been observed at depths starting at 20 m year-round.

Rainbow Trout from Polley Lake likely migrate to upper Hazeltine Creek and into Bootjack Creek to spawn in the spring as a result of rising water temperatures (above 5ºC) and levels, typically after ice-out (mid-April to mid-May), with spawning occurring from early May to early June (MPMC 2004). Adults, along with juveniles from the previous spawning season, return to Polley Lake after freshet (mid-May to mid-June), with fry emerging from the gravel and beginning to actively feed in late June or early July in upper Hazeltine Creek and Bootjack Creek (MPMC 2004).

Young-of-the-year Rainbow Trout were almost exclusively captured in upper Hazeltine and Bootjack Creeks (over 98% of catch) during a fish and fish habitat assessment conducted in 1990, with the remainder comprised of one and two year olds (Bruce and Slaney 1991). This indicates the majority of Rainbow Trout fry present in Hazeltine and Bootjack Creeks migrate to Polley Lake within their first year after hatching (i.e., as young-of-the-year). This is further substantiated by scale analysis of adult rainbow trout present in the lake, which indicated that 80% were recruited to the lake as yearlings (Bruce and Slaney 1991).

Lower Hazeltine Creek from the mouth upstream to the confluence with Edney Creek, has been identified in the Horsefly Sustainable Resource Management Plan as critical habitat (BC Ministry of Forest, Lands, Natural Resource Operations [MFLNRO] 2005). Species considered in the plan included Salmon, Bull Trout, Rainbow Trout, and Kokanee; however, it did not specifically state which of these species the critical habitat in lower Hazeltine applied to (BC MFLNRO 2005).

Length-frequency analysis of the rainbow trout capture data from both upper and lower Hazeltine Creek from two separate studies (Minnow Environmental 2009; Bruce and Slaney 1991) indicated the almost exclusive presence of YOY fish, with few older fish present (likely juveniles). This suggests that adult rainbow trout migrate from Polley and Quesnel Lakes to spawn in the creek in the spring, returning to the lakes post-spawning.

Suitable spawning gravels for rainbow trout were not common within the section from the confluence with Quesnel Lake upstream approximately 525 m, as it was dominated by cobble and larger gravel mixes (Minnow Environmental 2009).

Edney Creek was observed to be ponded just upstream from the confluence with Hazeltine Creek due to a beaver dam (Minnow Environmental 2007). This ponded area likely provided overwintering habitat for fish in the creek. Fish aging data from historical fisheries assessments (Hallam Knight Piesold 1997; Minnow Environmental 2009) suggest that a subset of adults from Quesnel Lake likely migrate annually to Edney Creek to spawn in the spring, returning to the lake afterwards. The majority of their offspring (fry) spend up to three seasons in Edney Creek before migrating to Quesnel Lake to continue rearing.

The highest density of rainbow trout in the Edney Creek watershed was consistently observed in the upper section of the drainage at a site downstream of Edney Lake (F2) (Hallam Knight Piesold 1996a, 1997). Adult rainbow trout likely utilize Edney Lake for rearing and spawn in the creek itself, with juveniles utilizing the Edney Creek as rearing habitat (MPMC 2009).

Sockeye Salmon *(Oncorhynchus nerka)*

Sockeye salmon occur in two forms, the anadromous sockeye salmon and the freshwater lake-resident kokanee. The life cycle of juvenile sockeye salmon is different from other Pacific salmon in that they typically rear in lakes rather than streams, although some river mainstem rearing populations do occur (Woods et al. 1987 as cited in Roberge et al. 2002).

Spawning

Sockeye salmon age of maturity varies, but all sockeye return from the ocean to spawn by their maximum age of eight years, most typically after two to three years at sea (Burgner 1991, as cited in Roberge et al. 2002). In the Fraser River, migration to the spawning grounds begins in July and continues to late-August or early September (Gilhousen 1960, as cited in Roberge et al. 2002). Spawning occurs at temperatures ranging between 3 - 7°C (Scott and Crossman 1973, as cited in Roberge et al. 2002).

Sockeye salmon typically spawn in tributaries or outlets of lakes, and unlike the other Pacific salmon that tend to only spawn in fluvial habitats, they also spawn on littoral area beaches of lakes themselves (Whyte et al. 1997; Foerster 1968, as cited in Quinn 2005). Sockeye prefer spawning sites with sub-gravel flow, in shallow riffles, the outlet of lakes, or on beaches in lakes where there is upwelling (Parsons and Hubert 1988 as cited in McPhail 2007).

Female sockeye salmon select the redd site, and will defend the redd until near death (Burgner 1991, as cited in Roberge et al. 2002). Gravel diameters range from 10 mm to 25 mm, depending on water velocity and female size (McPhail 2007), but suitable substrate can range from 13 mm to 102 mm (Whyte et al. 1997). Preferred water depths range from 6 cm to 37 cm and water velocities range from 0.15 m/s to 0.85 m/s (McPhail 2007).

Access to spawning areas in streams can be limited by channel gradient, elevation drops (e.g., cascades or falls), water depths and velocities. Adult sockeye burst swim speed is 6.3 m/s (prolonged swim speed is 3.1 m/s) and maximum jump heights are 2.1 m with a jump height to plunge-pool depth ratios of 1:1.25 (Whyte et al. 1997).

Rearing

Juvenile sockeye salmon typically rear in lakes rather than streams, although some stream rearing populations do occur (Woods et al. 1987, as cited in Roberge et al. 2002). Most juvenile sockeye rear in lakes for the first year or two of their lives before migrating to sea (Quinn 2005; Whyte et al. 1997). However, three years of freshwater residency (Ricker 1941; Burgner 1991 as cited in Roberge et al. 2002) also occurs.

Sockeye YOY and older feed on plankton (Roberge et al. 2002). Vertical distribution of juvenile Sockeye Salmon can be quite variable within and among lakes throughout the year due to changes in water clarity and depth and the stability of the thermocline (Roberge et al. 2002). Diel vertical migration is thought to be a predatory response, so in turbid lakes, juvenile Sockeye Salmon may not undergo diel vertical migrations (Roberge et al. 2002).

Local Population

The lake is noted as being one of the largest sockeye salmon producing lakes in the Fraser River system (Nidle et al. 1994). Spawning adult salmon migrate up the Quesnel River into the west end of Quesnel Lake, with the majority of sockeye returning to Horsefly River and Mitchell River (Nidle et al. 1994; Hume et al. 2005) as well as Summit Creek (Hillaby 2011) and various small streams in the east arm or along the shores of the lake (Nidle et al. 1994; Hume et al. 2005). The majority of sockeye spawning in Quesnel Lake is east of Hazeltine Creek.

Past impacts have limited the Horsefly River to one dominant run of sockeye, which spawns on a four-year cycle and one subdominant run also on a four-year cycle. The Salmonid Enhancement Program of Department of Fisheries and Oceans (DFO) has a spawning channel on Horsefly River, with capacity for approximately 22,000 adult sockeye the channel was built in 1988-89 to enhance the sockeye salmon run in the sub-dominant years (Hillaby 2011). Recently hatched sockeye fry would be expected to migrate downstream to Quesnel Lake to rear immediately after emergence in the spring (McPhail 2007; MPMC, 1990).

Lower Hazeltine Creek from the mouth upstream to the confluence with Edney Creek, has been identified in the Horsefly Sustainable Resource Management Plan as critical habitat (BC MFLNRO 2005). Species considered in the plan included Salmon, Bull Trout, Rainbow Trout, and Kokanee; however, it did not specifically state which of these species the critical habitat in lower Hazeltine applied to (BC MFLNRO 2005).

Sockeye salmon spawner escapement data have been collected intermittently in Hazeltine Creek since 1989 (DFO 2014). Mean annual escapement over 15 sampling periods between 1989 and 2013 was 280 adult, summer-run sockeye, with a high of 1,616 observed in 1989 (DFO 2014). The escapement data suggest that sockeye primarily used Hazeltine Creek for spawning only during dominant years of their four year lifecycle (1989, 1993, 1997, 2001, 2005). However, while 2009 would have been considered a dominant year; no sockeye were enumerated, whereas 79 were documented in 2011. Recent data (from 2001, 2005 and 2011) suggested that more females were present in the creek than males (DFO 2014). No Kokanee have been captured or observed in lower Hazeltine Creek; however, they apparently use this section for spawning (Minnow Environmental 2007).

During a November 2007 salmon spawner assessment of the first 1000 m of Edney Creek upstream from the confluence with Hazeltine Creek, spawning habitat quality was considered high due to deep pools, abundant instream cover, and presence of spawning gravels (Cariboo Envirotech 2008). Rainbow Trout and sockeye salmon were the most abundant fish species captured in sampling of Edney Creek; however, sockeye were only captured in 1989. However, the presence of beaver dams near the confluence with Quesnel Lake may have prevented adult salmon from migrating upstream of this point in some years.

Chinook Salmon *(Oncorhynchus tshawytscha)*

There are two main forms of Chinook Salmon, stream-type and ocean-type, as well as many intermediates (Healey 1991, as cited in Roberge et al. 2002). Stream-type Chinook salmon spend a larger portion of their life within freshwater, both before migration to the ocean (one to three years) and during migration to spawning grounds (several months), and are more frequent in the northern range (above the 56th parallel). Ocean-type Chinook salmon spend less than a year rearing in freshwater and will enter freshwater only days or weeks before spawning, and are dominant in the southern range (below the 56th parallel) (Healey 1991, as cited in Roberge et al. 2002).

Spawning

Chinook salmon age of maturity varies, with two to three years spent at sea the most common, but all chinook return from the ocean to spawn by their maximum age of nine years (Roberge et al. 2002). In BC, migration timing to the spawning grounds is variable between stocks. Chinook salmon spawn in May or June in the most northern part of their range, between July to September in BC and as late as November or January in the most southern locations (Healey 1991, as cited in Roberge et al. 2002).

Chinook salmon typically inhabit large, low gradient (approximately 1%) river systems (Healey 1991, as cited in Roberge et al. 2002). Less commonly, Chinook can spawn on gravel shoals of lake shores or within small lake tributaries streams (Scott and Crossman 1973, as cited in Roberge et al. 2002).

Female Chinook salmon select the redd site. Redds are built in riffle-pool habitat on gravel and cobble substrates (Roberge et al. 2002). Gravel diameters range from 13 mm to 102 mm (Whyte et al. 1997).

Preferred water depths are a minimum 0.3 m and water velocities range from 0.32 m/s to 1.09 m/s (Whyte et al. 1997). Spawning has been recorded for depths up to 5 m (Roberge et al. 2002).

Access to spawning areas in streams can be limited by channel gradient, elevation drops (e.g., cascades or falls), water depths and velocities. Adult Chinook burst swim speed is 6.6 m/s (prolonged swim speed is 3.2 m/s) and maximum jump heights are 2.4 m with a jump height to plunge-pool depth ratios of 1:1.25 (Whyte et al. 1997).

Rearing

It is common for newly emergent ocean-type Chinook salmon young-of-the-year to migrate directly to the ocean where they remain in the estuary or nearshore areas for several months to reach smolt size before moving to the open ocean (Healey 1991, as cited in Roberge et al. 2002).

The YOY that remain in streams and rivers associate with cobble and boulder substrates, in fairly fast flowing water up to 1.0 m deep (Roberge et al. 2002). Preferred water temperature ranges between 12°C 14°C (Scott and Crossman 1973, as cited in Roberge et al. 2002). Chinook YOY feed on zooplankton and aquatic invertebrates in drift (Sommer et al. 2001, as cited in Roberge et al. 2002), juveniles feed on invertebrates and adults feed on fish (Scott and Crossman 1973, as cited in Roberge et al. 2002).

Local Population

Lower Hazeltine Creek from the mouth upstream to the confluence with Edney Creek, has been identified in the Horsefly Sustainable Resource Management Plan as critical habitat (BC MFLNRO 2005). Species considered in the plan included Salmon, Bull Trout, Rainbow Trout, and Kokanee; however, it did not specifically state which of these species the critical habitat in lower Hazeltine applied to (BC MFLNRO 2005).

There was no spawner escapement data for Chinook or Coho Salmon (DFO 2014). Chinook and Coho likely utilized the stream habitat for juvenile rearing habitat, with Chinook fry last captured in Hazeltine Creek in 2007 (n=38) (Minnow Environmental, 2009).

Historical information indicates lower Hazeltine Creek was not an important spawning location for Chinook (Minnow Environmental, 2007). Minnow Environmental (2007) indicated limitations to salmon productivity in Hazeltine Creek included the absence of deep water habitat during low flow conditions and the low pool-to-riffle ratio.

Coho Salmon *(Oncorhynchus kisutch)*

Coho Salmon spawn and rear in streams; however, lake-rearing (Swain and Holtby 1989, as cited in Roberge et al. 2002), pond-rearing (Dolloff 1993, as cited in Roberge et al. 2002) and lake-resident (Foerster and Ricker 1953, as cited in Roberge et al. 2002) populations occur in BC.

Spawning

Coho salmon age of maturity varies, with two years spent at sea the most common, but maximum age for coho is five years (Roberge et al. 2002). In BC, migration to the spawning grounds is usually between September or October (Fraser et al. 1983, as cited in Roberge et al. 2002). Spawning occurs between October and March, with some coho spawning shortly after arriving in the stream, others wait several months to spawn (Roberge et al. 2002).

Females select the redd sites. Redds are usually built in areas of medium to small gravel (Scott and Crossman 1973, as cited in Roberge et al. 2002). Gravel diameters range from 13 mm to 102 mm (Whyte et al. 1997). Preferred water depths are a minimum 0.18 m and water velocities range from 0.30 m/s to 0.91 m/s (Whyte et al. 1997). Spawning has been recorded for depths up to 5 m (Roberge et al. 2002). Coho salmon typically spawn in channels that are characterized by riffle-pool habitat with a gradient of 1-3% (Montgomery et al. 1999, as cited in Roberge et al. 2002)

Access to spawning areas in streams can be limited by channel gradient, elevation drops (e.g., cascades or falls), water depths and velocities. Adult chinook burst swim speed is 6.6 m/s (prolonged swim speed is 3.2 m/s) and maximum jump heights are 2.4 m with a jump height to plunge-pool depth ratios of 1:1.25 (Whyte et al. 1997).

Rearing

Coho salmon stream residency time varies. Coho typically remain in streams and rivers for up to two years (Whyte et al. 1997), but some migrate to sea as YOY fry, or spend all or a portion of their lives in freshwater (Quinn, 2005).

Newly emergent coho salmon young-of-the-year move to slower areas within the stream, such as side channels, near cover structures and stream banks (Tschaplinski and Hartman 1983; Bisson et al. 1988, as cited in Roberge et al. 2002).

Young-of-the-year and more so juvenile coho salmon feed on insects and young fish (Scott and Crossman 1973, as cited in Roberge et al. 2002).

Lethal water temperature for coho salmon is 25.1°C (Roberge et al. 2002).

Local Population

Lower Hazeltine Creek from the mouth upstream to the confluence with Edney Creek, has been identified in the Horsefly Sustainable Resource Management Plan as critical habitat (BC MFLNRO 2005). Species considered in the plan included Salmon, Bull Trout, Rainbow Trout, and Kokanee; however, it did not specifically state which of these species the critical habitat in lower Hazeltine applied to (BC MFLNRO 2005).

Local populations of coho salmon (Interior Fraser River stock), which have historically been observed in Hazeltine Creek, are identified by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as endangered; however, the species is not currently listed on any Schedule under Species at Risk Act (SARA) and are therefore not protected under legislation (GoC 2014).

Coho salmon have historically been captured or observed in low numbers in lower Hazeltine Creek (n=9 in 2007). There was no spawner escapement data for Chinook or Coho Salmon (DFO 2014); however, a number of spawner surveys conducted in the 2000's recorded the presence of 12 Coho in Edney Creek in 2007. In a spawner survey of Hazeltine Creek conducted in November 2007, four Coho were observed, all within 125 m of the confluence with Edney Creek; however, no adult Coho were observed in 2008, although this may have been due to the timing of the survey (Cariboo Envirotech 2008; 2009).

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