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2019 Annual Environmental Report for the Mount Polley Mine

Submitted to:

BC Ministry of Environment and Climate Change Strategy
***(Environmental Management Act* Permit 11678)**

Prepared by:

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Executive Summary

In 2019, Mount Polley Mining Corporation did not conduct any productive mining. Approximately 3,591,448 t of tailings were deposited into the Tailings Storage Facility. From January to May 2019, MPMC milled 2,265,788 tonnes of stockpiled ore. The mill was shut down for the remainder of the year as part of a Care and Maintenance program. Low copper prices are cited as the reason for this action. Mining will resume once economic conditions improve. The environmental monitoring and remediation work programs will continue in 2020. The current permitted projected date of mine closure is 2022.

As permitted by the *Environmental Management Act* Permit 11678, the Water Treatment Plant operated intermittently in 2019 and discharged a total of 5,380,517 m^3 of water. The annual average discharge rate was 20,922 m^3/day and daily maximum discharge rates ranged from 0 m^3/day to 21,885 m^3/day. Reporting to Environment and Climate Change Canada under the Federal *Metal and Diamond Mining Effluent Regulations* continued accordingly.

Environmental management and monitoring in 2019 followed guidelines and procedures contained in the *Comprehensive Environmental Monitoring Plan* and was in accordance with regulations contained in *Environmental Management Act* Permit 11678 and *Mines Act* Permit M-200. Monitoring followed the updated 2018 *Comprehensive Environmental Monitoring Plan* which was approved on November 9, 2018 and immediately came into effect. Mining activities including production summaries and reclamation follow requirements contained in *Mines Act* Permit M- 200. Water chemistry results from monitoring sites were compared with appropriate permitted limits and British Columbia Water Quality Guidelines for aquatic life.

There were four instances of results triggering the *Environmental Management Act* Permit 11678 limit exceedance. However, following investigations, only the total copper exceedance at the Quesnel Lake Initial Dilution Zone in July was deemed non-compliant. Proper notification was sent to the Director and other required parties, the Water Treatment Plant was promptly shut down, an investigation was undertaken, and mitigation works completed.

In 2019, there was one unauthorized release of mine-affected water. Notification and a follow-up report were submitted to Ministry of Environment and Climate Change. There was one spill reported to Emergency Management BC.

All requirements of *Pollution Abatement Order 107461* have been met and the order was cancelled on September 12, 2019.

Certain studies were initiated in 2019 focusing on mine closure related reclamation practices:

Geomorphic Slope Guidance document will provide guidelines for site slope recontouring and stream

rehabilitation at and around the Mount Polley Mine and will also provide guidance for engineering works that would result in a natural looking slope upon closure.

Soil Cover Test Plot Design which when completed may provide guidance to determine a reclamation cover soil design that reduces infiltration of water into and mass loading of constituents from waste rock disposal sites.

As an integral component of long-term site water management, passive water treatment studies were continued in 2019 that included use of biochemical reactors (BCR), CWTS, and in situ pit lake treatment studies. The focus of these studies is to reduce constituents of concern in mine influenced water. Additional studies involve the evaluation and feasibility of other semi-passive and passive systems including sand filtration, packed bed reactors, and sulphide polishing cells. Constructed wetlands were also built in 2018 and operated in 2019 that will test whether mine water can be effectively treated through wetlands technology. For all these potential water treatment options, additional work will be carried out in 2020.

As a more active treatment option, design work and field trials for a TMT-15 dosing system was conducted on water that is treated by the Water Treatment Plant as part of the Copper Optimization Study. This study focuses on the use of reducing effluent copper levels by testing different flocculants to settle suspended solids more effectively which will reduce metal concentrations including copper.

Stakeholder engagement in 2019 included three Joint Implementation Committee meetings and five Public Liaison Committee meetings.

Table of Contents

List of Tables

List of Figures

List of Appendices

ACRONYMS AND ABBREVIATIONS

ABA	Acid-Base Accounting
ABR	Anaerobic Biological Reactor
ADSI	Annual Dam Safety Inspection
AER	*Annual Environmental Report*
AERR(s)	*Annual Environmental and Reclamation Report*
ADP	*Annual Discharge Plan*
ARD	Acid Rock Drainage
ARD/ML	Acid Rock Drainage/Metal Leaching
ARR	Annual Reclamation Report
BAT	Best Achievable Technology
BC	British Columbia
BCR	Biochemical Reactors
BC WQG	British Columbia ENV Water Quality Guideline
BC WWQG	British Columbia ENV Working Water Quality Guideline
CCS	Central Collection Sump
CEMP	*Comprehensive Environmental Monitoring Plan*
CFIA	Canadian Food Inspection Agency
CMDRC	Cariboo Mine Development Review Committee
COC	Chain of Custody
COPC	Contaminant(s) of Potential Concern
CRP	*Conceptual Remediation Plan*
CWTS(s)	Constructed Wetland Treatment System
DFO	Department of Fisheries and Oceans
DGR	Dangerous Good Regulations
DGT	Diffusive Gradient in Thin Films Device
DI	Deionized water
DQO	Data Quality Objectives
DSR	Dam Safety Review
EDC	Edney Creek
EEM	*Environmental Effects Monitoring*
ELS	Early Life Stage
EMA	*Environmental Management Act*
EMP	Environmental Management Plans
EMPR	Ministry of Energy, Mines and Petroleum Development
ENV	Ministry of Environment and Climate Change Strategy
EoR	Engineer of Record
ERA	*Ecological Risk Assessment*
GW	Groundwater
HAC	Hazeltine Creek
HHRA	*Human Health Risk Assessment*
HSRC	*Health, Safety and Reclamation Code for Mines in British Columbia*
IC	Implementation Committee
IDZ	Initial Dilution Zone

IM	Imperial Metals
KEM1/KEM2	Kemmerer water sampler
LCRS	Leachate Collection Recycle System
LD	Long Ditch
LTWMP	*Long-Term Water Management Plan*
MAC	Mining Association of Canada
MDL	Method Detection Limit
MESCP	Main Embankment Seepage Collection Pond
MDMER	*Metal and Diamond Mine Effluent Regulations*
MPMC	Mount Polley Mining Corporation
MPIC	Mount Polley Intrusive Complex
MTD	Main Toe Drain
NAG	Non-Acid Generating
NBD	North Bell Dump
NEZ	Northeast Zone
NPR	Neutralizing Potential Ratio
NW	Temporary Northwest
OMS	Operation, Maintenance and Surveillance [Manual]
PAG	Potentially Acid Generating
PAO	*Pollution Abatement Order*
PEEIAR	*Post-Event Environmental Impact Assessment Report*
PETBP	Perimeter Embankment Till Borrow Pit
PESCP	Perimeter Embankment Seepage Collection Pond
PLC	Public Liaison Committee
POI(s)	Parameter(s) Of Interest
PTD	Perimeter Toe Drain
PVR	Post Verification Review
QA/QC	Quality Assurance/Quality Control
QP	Qualified Professional
QPO	Quantitative Performance Objectives
QUL	Quesnel Lake
QUR	Quesnel River
RCP	*Reclamation and Closure Plan*
RDS	Rock Disposal Site
RO	Reverse Osmosis
RPD	Relative Percent Difference
SCIB	Soda Creek Indian Band
SERDS	Southeast Rock Disposal Site
SEZ	Southeast Zone
STD	South Toe Drain
STWMP	*Short-Term Water Management Plan*
SWE	Snow Water Equivalent
TAR	*Technical Assessment Report*
TDAR	Tailings Dam Access Road
ToR	Terms Of Reference

TRCR	Technical Research Committee on Reclamation
TRP	*Trigger Response Plan*
TSF	Tailings Storage Facility
TSM	Towards Sustainable Mining
TSS	Total Suspended Solids
WHR	Waste Haul Road
WLIB	Williams Lake Indian Band
WTP	Water Treatment Plant

List of Units

°C	degrees Celsius
Dt	dry tonnes
Ft	feet
g/t	grams per tonne
Ha	hectare(s)
Kg	kilogram(s)
Km	kilometer(s)
L	liter(s)
Lbs	pounds
M	metre(s)
masl	metres above sea level
m^3	cubic metre(s)
m^3/s	cubic metre(s) per second
mm	millimeter(s)
mg/L	milligrams per litre
Oz	ounce(s)
µS/cm	micro Siemens per centimeter
%	percent
ppm	parts per million
T	tonne(s)
Tpd	tonne(s) per day

List of Consultants and Laboratories

ALS	ALS Environmental Inc.
Contango	Contango Strategies Ltd.
Golder	Golder Associates Ltd.
Maxxam	Maxxam Analytics Inc.
Minnow	Minnow Environmental Inc.
Nautilus	Nautilus Environmental Inc.
Spectrum	Spectrum Resources Group Inc.
SRK	SRK Consulting Inc.
Tetra Tech	Tetra Tech Inc.
WaterSmith	WaterSmith Research Inc.

1 Introduction

Mount Polley Mining Corporation (MPMC) is required to submit two annual reports; one to the British Columbia (BC) Ministry of Environment and Climate Change Strategy (ENV), and a second to the BC Ministry of Energy, Mines & Petroleum Resources (EMPR) as per the *Environmental Management Act* (EMA) Permit 11678 and *Mines Act* Permit M-200, respectively. From 2000 to 2018, these two reports were combined into one comprehensive report for submission to both ministries under the title of the Annual Environmental and Reclamation Report (AERR). Starting in 2019, the *Annual Environmental Report* (*AER*) and A*nnual Reclamation Report* (*ARR*) will be submitted under separate cover.

In 1995 and 1996, an environmental monitoring program, which expanded on previous studies from 1989 and 1990, was designed and implemented to support mine planning, operations, and reclamation activities at the Mount Polley Mine. The program included baseline studies documenting the pre-development land uses and the conditions of the aquatic and terrestrial ecosystems. This information provides the foundation upon which operational environmental monitoring programs were, and continue to be, based. The November 29, 2015 *EMA* Permit 11678 amendment included a revised condition, to develop a Comprehensive Environmental Monitoring Plan (CEMP) to evaluate the effects of mining-related activities on the physical, chemical, and biological characteristics of Hazeltine Creek (HAC), Edney Creek (EDC), Bootjack Lake, Morehead Creek, Polley Lake, Quesnel Lake (QUL), Quesnel River (QUR), and associated riparian and upland areas. The original CEMP was submitted to the ENV on June 23, 2016 and an updated CEMP was submitted to the ENV on August 15, 2018 and was approved on November 9, 2018. The 2018 *CEMP* was updated in October 2019 with consultation with MPMC, Golder Associates and BC-ENV and is currently under review. Both the 2016 and 2018 *CEMP*s are provided in Appendix A along with the amended *EMA* Permit 11678 from April 7, 2017, October 2, 2018 and February 1, 2020.

On January 7, 2019, MPMC announced a decision to go on suspended operations (Care and Maintenance) on May 31, 2019 citing low metal prices. During Care and Maintenance, MPMC committed to continue environment monitoring and sampling as well as rehabilitation on Hazeltine Creek and any other commitments as required in the permits and *CEMP*. A small number of personnel remain onsite to provide but not limited to:

- Routine maintenance on infrastructure and equipment;
- Operate the Water Treatment Plant (WTP);
- Ensure water conveying systems are functioning properly;
- Environmental sampling and monitoring;
- Collect instrumentation data on the Tailings Storage Facility and provide to the Engineer of Record (EoR); and
- Ensure safety and security of the mine site.

1.1 Monitoring Objectives

Environmental monitoring according to the 2016 *CEMP* (Appendix A) was undertaken until November 9, 2018 when the 2018 *CEMP* was approved by ENV. The *CEMP* fulfills both the requirements of the *Mines Act* Permit M–200 and *EMA* Permit 11678 (Appendix A). The objective of this monitoring is to assess the environmental effects of mining activities at Mount Polley Mine on the receiving environment.

Monitoring results for 2019 are reported in subsequent sections of this report as follows:

- Stream flows and water levels;
- Meteorology (temperature, precipitation, snowpack, evaporation rates);
- Chemistry and quantity of surface, seepage, lake, and groundwater (GW);
- Hydrology of groundwater and surface water flows and levels;
- Sediment chemistry;
- Aquatic biology (toxicity testing, fish and benthic community studies, plankton, periphyton, fish and benthic tissue chemistry); and
- Terrestrial monitoring.

1.1.1 Ministry of Environment and Climate Change Strategy

As per the most recent amendments of *EMA* Permit 11678 (April 7, 2017 and October 2, 2018; Appendix A) the Annual Report must include:

- All monitoring sample quality results required under the permit.
- An evaluation of quality assurance, including collection, sampling, and data handling protocols.
- An evaluation of the treatment plant operation and control.
- An evaluation of the impacts of the mining operation on the receiving environment from the previous year.
- A summary of any non-compliance with the permit and other incidents that may have led to impacts to the receiving environment.
- An update to the water balance, and a calibration assessment of the water balance and water quality models
- An assessment of the outfall dispersion and dispersion modelling for the Quesnel Lake discharge
- An update to any modeling related to the Springer Pit groundwater seepage and its impacts on Bootjack Lake.
- A progress update with respect to the final water management plan.
- A review and update of the assessment of ARD potential and water quality impacts from mine waste management.

- A comparison of monitoring data with British Columbia water quality guidelines (BC WQG), (ENV, 2017; ENV, 2018) predictions and targets.
- An update on the progress of reclamation and any updates to the reclamation plan.
- An evaluation of the effectiveness of the Surface Runoff and Mine Drainage Control programs.
- A summary of the Public Liaison Committee meetings, and issues and concerns presented.
- An evaluation of the Outfall and Pipeline Inspection programs.
- Trend analysis (graphs) of water monitoring data at each site for the past five years.

The purpose of this document is to allow the ENV to: identify whether spills or incidents have been reported and addressed; evaluate permit compliance; identify environmental effects; verify predictions of effects; and identify whether the permit adequately protects the environment or if changes are required.

1.2 Reclamation Objectives

In accordance with the *BC Mines Act* and the *Health, Safety and Reclamation Code for Mines in British Columbia*, the primary objective of the *Reclamation and Closure Plan* (*RCP*) (MPMC, 2017a) is to:

> *"return all mine-disturbed areas to an equivalent level of capability to that which existed prior to mining on an average property basis, unless the owner, agent or manager can provide evidence which demonstrates to the satisfaction of the chief inspector the impracticality of doing so".*

To achieve these objectives, reclamation and closure prescriptions are continually being refined based on the results from the ongoing reclamation research program (Section 5.5). An updated *RCP* was submitted to the EMPR on January 15, 2017 (MPMC, 2017a).

The main objective of the reclamation program is to return all areas that have been disturbed by mining operations (except pit walls) to equivalent or greater land capability than existed prior to mining, on an average property basis. To achieve this objective, MPMC has proposed end land use objectives that are based on an ecosystem approach. The ecosystem approach considers diverse ecosystem components and the resulting ecosystem services in reclamation planning. These ecosystems can be mapped on appropriate areas of the landscape, but rather than limiting each area to one designated end land use (e.g., wildlife habitat), this approach will allow for multiple, compatible end land use objectives to be targeted. End land uses that are encompassed in the target ecosystems over time include forest cover, wildlife habitat, hunting, trapping, guide outfitting, traditional use, livestock grazing, and recreation.

An End Land Use Plan, included in the *RCP*, (MPMC, 2017a) has been developed that focusses on ecosystem rehabilitation as the main goal with a target towards ecosystems that existed prior to the development of the mine (Section 5.6). The End Land Use Plan also estimates shifts in the end land use objectives over time as the ecological trajectories of the ecosystem mature. This ensures that end land use planning is considered over the long-term and that a variety of end land uses can occur on the landscape over different temporal

scales.

The following goals are implicit in achieving these end land use objectives:

- Long-term preservation of water quality within and downstream of decommissioned operations;
- Long-term stability of engineered structures, including the waste rock dumps, Tailings Storage Facility (TSF), and open pits, as well as all exposed erodible materials;
- Removal and proper disposal of all access roads, structures, and equipment not required after the Mine closes;
- Natural integration of disturbed lands with the surrounding landscape and restoration of the natural appearance of the area after mining ceases; and
- Establishment of self-sustaining vegetation covers consistent with the end land uses.

Once these aspects are in place, flexibility exists to modify ecosystem composition, patch size, and vegetation mosaic and to provide additional structural components, as required. By reclaiming disturbed land to stable, functioning, locally appropriate ecosystems that can reasonably be expected to thrive on a specific landform or location, a variety of end land use objectives can also be met.

End land use objectives envelop a multitude of values that may exist beyond ecological conditions and are driven by what regulators, MPMC, First Nations, and local communities prefer for the landscape once the Mine is closed. End land use decisions are influenced by several factors, including:

- Permit obligations;
- Regulatory requirements;
- Landform design;
- Surface and subsurface materials at closure;
- Surface water hydrology;
- Slope;
- Aspect,
- Elevation;
- Input from First Nations, local communities and stakeholders; and
- Traditional and cultural land use.

End land use objectives may be adapted over time as interests evolve; however, once a landform is constructed, the end land uses are limited to the conditions and ecological trajectories associated with the particular ecosystem that has been rehabilitated.

Site research that was initiated at the Mine in 1998 indicates that conifer growth on reclaimed waste rock dumps is an attainable goal for parts of the Mine site. However, to create appropriate microsites for conifers

that grow in later successional stages, it is often necessary to promote early successional stage vegetation growth, allowing the process of natural succession to establish suitable vegetation cover and moisture conditions. Establishment of early successional stage communities can effectively support functioning ecosystems. Over time, as succession and native species ingress occur at reclamation sites, climax forest communities will be established.

Rehabilitation of the Mount Polley Mine site's wildlife capability will require development of self-sustaining vegetation that imitates pre-development cover. Recreation of the natural appearance and creation of suitable habitats will allow for natural integration of disturbed lands into the surrounding landscape and improve wildlife use and access over time once the Mine has reached full closure. Post-closure, as wildlife usage increases and public access to parts of the site is re-established, the government will have the opportunity to sanction the end land uses of hunting, guide outfitting, and trapping.

Similarly, livestock grazing is a compatible end land use as there is overlap in wildlife and livestock forage species and vegetative cover preferences. Other forms of outdoor recreation, including sport fishing, will be supported by maintaining appropriate water quality and aquatic habitats in receiving environment water bodies.

1.2.1 Ministry of Energy, Mines and Petroleum Resources

The *ARR* for the EMPR, as required by *Mines Act* Permit M–200, will be submitted under a separate cover.

1.3 First Nations and Stakeholders

1.3.1 First Nations Engagement

First Nations with recognized claimed traditional territory for the Mount Polley Mine are the T'exelc (Williams Lake Indian Band; WLIB) and the Xatśūll First Nation (Soda Creek Indian Band; SCIB). In 2011 and 2012, MPMC executed Participation Agreements with the WLIB and the SCIB, respectively. In August 2016 and April 2017, MPMC renewed the agreements with WLIB and SCIB (respectively). Through these respective Participation Agreements, Implementation Committees (IC) were formed to facilitate open dialogue between each of the First Nations and MPMC, providing a formalized, regular venue to discuss environmental, social and economic matters related to mine development, operation, reclamation, and closure (e.g., mine updates, permitting, environmental protection, reclamation, employment opportunities, and potential joint ventures). Meetings have taken place since March 16, 2012 with the WLIB and since July 19, 2012 with the SCIB. Effective October 18, 2012, Joint IC meetings have been held with representatives from MPMC, the WLIB, and the SCIB, replacing the previous MPMC/SCIB and MPMC/WLIB Implementation Committee meetings. Joint IC meetings are held at a minimum on a quarterly basis, but typically more frequently. These meetings and associated documentation (Terms of Reference (ToR), minutes, and action items) provide a well-defined constructive forum in which issues, reviews, and comments relating to the current and anticipated future operations of the Mount Polley Mine may be discussed. The 2019 *AER* will

be provided to the SCIB and the WLIB. Any comments or concerns will be facilitated through the Joint IC.

Three Joint IC meetings were held in 2019. Joint IC meetings were held on March 7, 2019, April 25, 2019 and November 20, 2019. MPMC provided a presentation to the IC participants on April 25, 2019. The presentation included a site update, a remediation update and a permit amendment update.

1.3.2 Regional Mine Development Review Committee

In 2014, the Regional (Cariboo) Mine Development Review Committee (CMDRC) was revived by the EMPR. The CMDRC is a regionally-based multi-agency review committee chaired by the EMPR. Participants include representatives from MPMC, local, provincial, and federal government agencies and First Nations. Members of the public are also invited to participate on a topic-specific basis.

The CMDRC also acts as a venue for communication related to permit amendment applications under the *EMA* permits, or other regulations administered by the ENV and the BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development. While communication related to *EMA* Permit 11678 amendments will be conducted as per the *EMA* Public Notification Regulation, information is presented through the CMDRC where possible to coordinate review and consultation with parallel *Mines Act* permit amendments and other updates on the Mount Polley Mine site. The goal being to make efficient use of CMDRC member's (government, First Nations, and community representatives) time.

1.3.3 Public Liaison Committee

The intention of the Public Liaison Committee (PLC) is to provide an opportunity for MPMC to share information about mine activities and monitoring results with its members. These members are comprised of public stakeholders, First Nations and government. The members are then responsible for relaying information between MPMC and the group or individuals for which they are the Designated Representative.

MPMC held five PLC meetings in 2019: February 25, 2019; April 29, 2019, May 29, 2019, October 2, 2019 and December 4, 2019. A site tour was completed during October. All minutes for the 2019 PLC meetings are included in Appendix C.

The *EMA* Permit 11678 *(*Appendix A) requires that a summary of the PLC meetings and issues and concerns be presented in this annual report. MPMC has chosen not to provide this as a summary but instead has provided the meeting minutes in full in Appendix C.

1.3.4 Communication Plan

The April 7, 2017 amended *EMA* Permit 11678 required MPMC to develop and submit an update to the Communication Plan, in consultation with stakeholders, by June 30, 2017. This plan addresses the sharing of environmental data with WLIB, SCIB, Cariboo Regional District and the community of Likely. This deadline was

extended to October 20, 2017 to allow for more consultation, and then to compensate for the interruption caused by forest fires. Ultimately, the consensus was that the plan was complete as it was originally written in 2016 and did not require updating. The Communication Plan was formally approved by ENV on January 19, 2018.

1.4 Qualified Professionals

Section 2.15 of the *EMA* Permit 11678 requires, "[a]ll documents submitted to the Director must be signed by the author and where specifically required by this permit, authored and signed by a Qualified Professional [QP]". Further to that, Section 3.9 requires, "[m]onitoring data and the analysis of that data, as it will be presented in the annual report, must be reviewed by a third party QP". The sections of this annual report that fall under these requirements are provided in Table 1.1 along with the QP that has reviewed or authored that section. Seals, where appropriate, have been provided in the applicable appendix, which are also summarized in Table 1.1.

Table 1.1.1 Annual report sections reviewed by a Qualified Professional

Section	Area	Qualified Professional	Appendix
4.8	Hydrology	Russell Smith, RPF: WaterSmith Research Inc (WaterSmith)	L
4.7; 4.10-4.12	Surface Water (including Hazeltine Creek), Lake Water Quality, Discharge Water Quality	Alicia Lalonde, P.Ag.: DWB Consulting Services Ltd. (DWB)	F
4.9	Groundwater (All)	Jacqueline Foley, Geo.L; Gizachew Demissie, E.I.T.: Golder	G
4.13-4.17	Sediment, Benthic, Fish, Periphyton, Plankton	Pierre Stecko, R.P. Bio; Katharina Batchelor, R.P. Bio: Minnow Environmental Inc. (Minnow)	K
4.18-4.22	Terrestrial Monitoring	Barbara Wernick, R.P. Bio: Golder	N

2 Mount Polley Mine Project Overview

2.1 Project History

Mount Polley Mine, operated by MPMC (a wholly owned subsidiary of Imperial Metals (IM) Corporation), is an open pit copper/gold mine with an underground component, and has the capacity to process 20,000 to 22,000 tonnes per day (tpd) of ore. The Mine is located 8 kilometres (km) southwest of Likely and 56 km (100 km by road) northeast of Williams Lake, BC (Figure 2.1). The Mount Polley Mine property covers 23,369 hectares (ha), which consist of 7 mining leases totaling 2,007 ha, and 50 mineral claims encompassing 21,362 ha. Mount Polley Mine concentrates are trucked to facilities at the Port of Vancouver, then shipped to overseas smelters or transported by rail to smelters in North America.

Clearing of the site and construction of the entire facility began in 1995, with the mill commissioned in June 1997. In May 1997, the Mine received an ENV (previously the Ministry of Water, Land and Air Protection) Effluent Permit, *EMA* Permit 11678, issued under the provisions of the provincial *EMA*. This permit authorized the discharge of concentrator tailings, mill site runoff, mine rock runoff, open pit water, and septic tank effluent to a tailings storage facility (TSF). Approval of the original Mount Polley Mine Reclamation and Closure Plan by the EMPR resulted in the issuance of *Mines Act* Permit M–200 in July 1997. The first full year of mining and milling at Mount Polley Mine took place in 1998. The Mine suspended operations in October 2001 due to low metal prices, then reopened in December 2004, with mill production commencing in March 2005.

A summary of *EMA* Permit 11678 amendments is provided in Table 2.1.

Table 2.1.1 Summary of *EMA* Permit 11678 amendments

Date	Scope of Amendment
30-May-1997	Original permit
20-Oct-1997	Amended authorized tailings discharge rate (10,000 tpd increase)
12-Jun-1998	Amended reporting requirements
8-Sep-1999	Amended monitoring requirements
1-Feb-2000	Amended authorized tailings discharge rate (4,500 tpd increase)
7-Feb-2002	Approval to discharge effluent from the Perimeter Embankment Seepage Collection Pond (PESCP) and Main Embankment Seepage Collection Pond (MESCP); approval to store TSF supernatant and Mine site contact water in the Cariboo and Bell Pits
4-May-2005	Amended authorized tailings discharge rate (5,000 tpd increase); discharge of groundwater to Polley Lake; updates to reference analytical procedures and monitoring program
17-Apr-2009	Amended monitoring, water level and supernatant characteristic requirements for the Cariboo and Bell Pits
7-Nov-2012	Approval to discharge to Hazeltine Creek
7-Jun-2013	Sulphate guidelines
9-Jul-2015	Tailings discharge to the Springer Pit
29-Nov-2015	Approval to discharge to Hazeltine Creek
4-Apr-2016	Discharge of additional tailings to the Springer Pit
9-Sep-2016	Hazeltine Creek discharge total suspended solids limit change
7-Apr-2017	Direct pipeline from water treatment plant to Quesnel Lake
2-Oct-2018	Amendment to Sections 1.2.3, 1.2.6, 2.7 of existing permit (Appendix A)
14-Mar-2019	Amendment to revisions for November 9, 2018 CEMP approval letter conditions including 3, 4, 8, 9, 11, 14 and 15
15-Jul-2019	Amendment to Section 6.14 of the approved August 15, 2018 CEMP
1-Feb-2020	Amendment to Sections 1.2, 1.2.5, 1.2.6, 2.7, 2.8, 2.8.1, 2.8.3, 2.9 2.10, 3.3, 3.5, 3.5.5, 4.1.4 of existing permit (Appendix A)

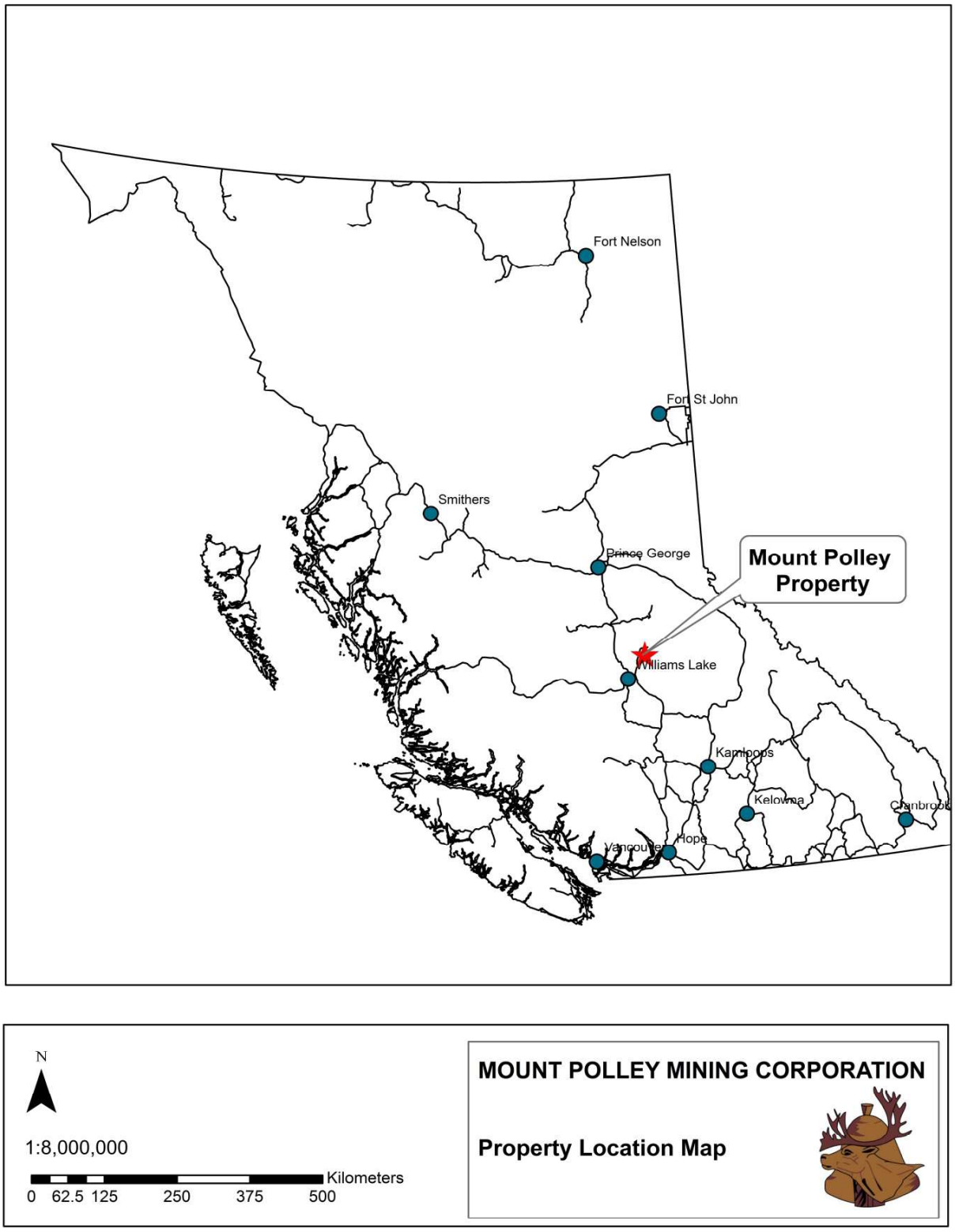

Figure 2.1 Mount Polley Mine property location

In 1995 and 1996, an environmental monitoring program, which expanded on previous studies from 1989 and 1990, was designed and implemented to support mine planning, operations, and reclamation activities at the Mount Polley Mine. The program included baseline studies documenting the pre-development land uses and the conditions of the aquatic and terrestrial ecosystems. This information provides the foundation upon which operational environmental monitoring programs were, and continue to be, based. The November 29, 2015 *EMA* Permit 11678 amendment included a revised condition, to develop a Comprehensive Environmental Monitoring Plan (CEMP) to evaluate the effects of mining-related activities on the physical, chemical, and biological characteristics of Hazeltine Creek (HAC), Edney Creek (EDC), Bootjack Lake, Morehead Creek, Polley Lake, Quesnel Lake (QUL), Quesnel River (QUR), and associated riparian and upland areas. The *CEMP* was submitted to the ENV on June 23, 2016 and an updated *CEMP* was submitted to the ENV on August 15, 2018 and was approved on November 9, 2018. The *CEMP* was updated in October 2019 with consultation with MPMC, Golder Associated and BC-ENV. *CEMP*s are provided in Appendix A along with the amended *EMA* Permit 11678 from April 7, 2017, October 2, 2018 and February 1, 2020.

2.1.1 Tailings Storage Facility Embankment Breach

On August 4, 2014, a breach occurred in the Perimeter Embankment of the TSF; this event is herein referred to as the "TSF embankment breach". The TSF embankment breach released tailings, water, and embankment construction materials to the downstream environments of Polley Lake, Hazeltine Creek and Quesnel Lake. The ENV issued MPMC *Pollution Abatement Order* (PAO) 107461, dated August 5, 2014, ordering MPMC to attend to the environmental impacts of the TSF embankment breach. The *PAO* was lifted on September 12, 2019.

Post TSF Embankment Breach Reporting

Following the TSF embankment breach, an environmental monitoring program was initiated in areas downstream of the TSF including Polley Lake and Hazeltine Creek, both of which were previously monitored under *EMA* Permit 11678 (Appendix A). Monitoring of these areas in 2014 and 2015 was carried out under the *PAO*; consequently, these monitoring results were presented in the *Post-Event Environmental Impact Assessment Report* (*PEEIAR*; MPMC, 2015a; publicly available online) and *PEEIAR* Version 2 (MPMC, 2016a; publicly available online). Results from monitoring conducted in 2016 were presented *Human Health Risk Assessment* (*HHRA*), (MPMC, 2017b; publicly available online) and *Ecological Risk Assessment (ERA)*, (MPMC, 2017c; publicly available online) which have both been approved by ENV. Monitoring results from 2017 are presented the 2017 *AERR*, (MPMC 2018a). A *CRP* was required by the PAO to address the remedial actions based on the findings, results, and conclusions on the risk assessments, and will be integrated in the updated *CEMP*. This plan was submitted on January 31, 2018 to ENV. Review comments were received from ENV and the government to government committee on December 11, 2018 just prior to consultation meetings with local communities.

2.2Post TSF Embankment Breach Project Status

2.2.1 Mine Operations

Following the TSF embankment breach, mine operations ceased. Restricted operations, with tailings being deposited in the Springer Pit, commenced on August 4, 2015. On November 6, 2015, MPMC applied for an amendment to *Mines Act* Permit M–200 to allow for the return to full operations at the Mount Polley Mine, with use of the TSF for tailings deposition. A corresponding *Mines Act* Permit M–200 amendment was received from the EMPR on June 23, 2016. Authorization to resume deposition of tailings in the TSF under *EMA* Permit 11678 was received from the ENV on June 23, 2016. MPMC resumed deposition of tailings in the TSF on June 27, 2016.

Currently authorized operations allow for: open pit mining of the Phase 4 Cariboo-Springer Pit; milling of up to a maximum of 8,200,000 t of ore per year with deposition in the TSF; and, construction and operation of the TSF up to an elevation of 970 metres above sea level (masl).

The current active project infrastructure consists of the mill site, mining in the Cariboo Pit, two rock disposal sites (RDS) (the Southeast Rock Disposal Site (SERDS), and the Temporary Northwest (NW) Potentially-Acid Generating (PAG) Stockpile), the TSF, as well as access roads, power lines, a tailings pipeline, drainage collection systems, and sediment/seepage control pond. Back-filling of the Bell Pit and Pond Zone Pit with waste rock was completed in 2012, and the SEZ Pit was backfilled in 2013. A detailed Mount Polley Mine site map is included in Appendix B.

No permits for operation beyond the Phase 4 Cariboo-Springer Pit development are in place; however, identified ore reserves indicate approximately 8 more (cumulative) years of viable mine life. Given the uncertainty around future operations and mine life, reclamation and closure planning described in this document are subject to review and updates.

On January 7, 2019, MPMC announced a decision to go on suspended operations (Care and Maintenance) on May 31, 2019 citing low metal prices. EMPR provided a Cessation of Operations Acknowledgement letter to MPMC on July 25, 2019. During Care and Maintenance, MPMC committed to continue environmental monitoring and sampling as well as rehabilitation on Hazeltine Creek and any other commitments as required in the permits and CEMP. A small number of personnel remain onsite to provide but not limited to:

- Routine maintenance on infrastructure and equipment;
- Operate the Water Treatment Plant (WTP);
- Ensure water conveying systems are functioning properly;
- Environmental sampling and monitoring;
- Collect instrumentation data on the TSF and provide to the Engineer of Record (Eor); and
- Ensure safety and security of the mine site.

2.3Site Description

2.3.1 Topography and Climate

The Mount Polley Mine property is located on the eastern edge of the Fraser Plateau physiographic sub-division, characterized by rolling topography and moderate relief. Elevations range from 920 masl at Polley Lake to 1266 masl at the summit of Mount Polley. Volcanic rocks generally underlay this part of the plateau with inclusions of intrusive rocks. Most of the area is covered by a deposit of unconsolidated till which contains fluvial, lacustrine, and colluvial deposits. Some patches of organic soils are present in poorly drained areas (i.e., wetlands). The property is located in an alkali porphyry copper-gold deposit hosted in the Central Quesnel Belt along the Intermontaine Belt of BC.

The site is located within the Interior Cedar Hemlock biogeoclimatic zone. Local forests consist of western red cedar, Douglas-fir, hybrid spruce, and subalpine fir, with a lesser presence of trembling aspen, black cottonwood, and paper birch. Much of the area was historically harvested in commercial logging operations and is also used for cattle grazing.

Average annual precipitation in the study area is 670 millimetres (mm). Precipitation typically occurs as snowfall from November through March, with an average maximum of snowpack of 178 mm snow water equivalent occurring at the end of March (Golder 2015a). Average monthly temperatures at the Mount Polley Mine range from -5.9 degrees Celsius (°C) in January to 15.5 °C in July and August (Section 4.6.2). Prevailing winds are from the north-north-east and from the south-south-west near the TSF, and from the northwest (and to a lesser extent the southeast) near the mill, with a predominance of winds designated as calm (below 3 metres per second; Golder 2015a).

2.3.2 Hydrogeology

The groundwater flow at the site occurs primarily in the bedrock units in response to recharge from precipitation in the area between Polley Lake and Bootjack Lake. Flow in the overburden is less significant due to its limited thickness and discontinuous nature. Prior to mining, the water table at the site generally followed the surface topography, but the water table was deeper below the topographic heights and shallower in the low areas. At that time, the direction of groundwater flow was inferred to be from the top of the ridge between Polley Lake and Bootjack Lake towards the low-lying areas associated with these lakes northeast and southwest from the ridge. The regional topography, water bodies, and pre-mining watersheds are shown in Figure 2.2.

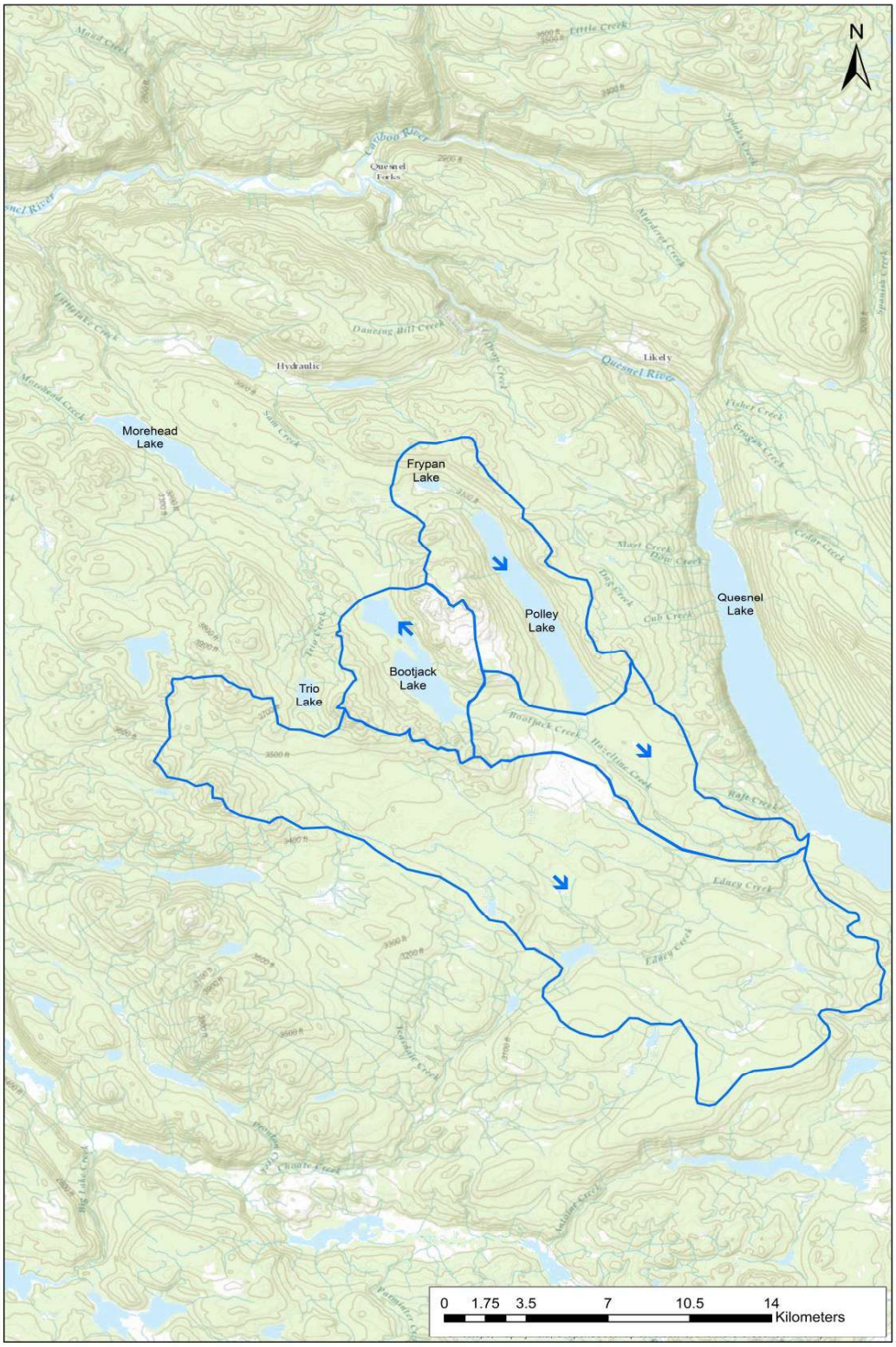

Figure 2.2 Mount Polley Mine Site and Surrounding Area Water Bodies and Topography

Mine dewatering has altered the groundwater flow pattern at the site, with the open pits and underground workings acting as sinks for groundwater flow. Mine dewatering lowered the water table elevation and created radial patterns of groundwater flow towards these facilities. In 2018, Springer Pit water levels continued to be drawn down by dredging. Near the end of 2018, when dredging operations ceased, water levels became static and remained static the rest of 2018. The currently available information suggests that some seepage from the lake towards Bootjack Lake could occur once the Springer pit lake level reaches 1020 to 1030 masl elevation (Golder 2015a).

2.3.3 Deposit Geology

The Mount Polley Intrusive Complex (MPIC) hosts the Mount Polley copper-gold porphyry deposit (Figure 2.3). It is a Late Triassic magmatic center approximately 6 km by 4 km, elongate in a NNW direction. It consists of alkalic, marginally silica-undersaturated intrusions, and magmatic-hydrothermal breccias. The age of the deposit is approximately 205 million years, based on uranium-lead isotopic dating; there is close agreement between age determinations from MPIC intrusions and minerals associated with sulfide mineralization. Mineralization occurs in almost all constituent rock types of the MPIC, and thus occurred late in its formation. Nearly all economic mineralization is in breccias, or in mineralized stockwork veins in adjacent wall rock intrusion. Country rocks of the Nicola Group closest to the MPIC are mafic to intermediate volcanic and subvolcanic coherent rocks, and related breccias, and may form components of mineralized hydrothermal breccias in the periphery of the MPIC.

As is typical of alkalic porphyry copper systems, mineralization at Mount Polley formed in a number of distinct zones rather than as a simple zoned deposit. The most important (remaining) ore zones can be divided into two main groups: the Springer-Cariboo area and the Northeast-Boundary area.

The Springer-Cariboo area represents the largest volume of mineralization in the MPIC, and the most intense alteration, and likely formed on the main feeder or conduit from the parent magma source at depth. The smaller but copper and gold-enriched Northeast-Boundary area of brecciation was caused by a different, probably more focused magma-fluid feeder, 1 to 2 km away to the north.

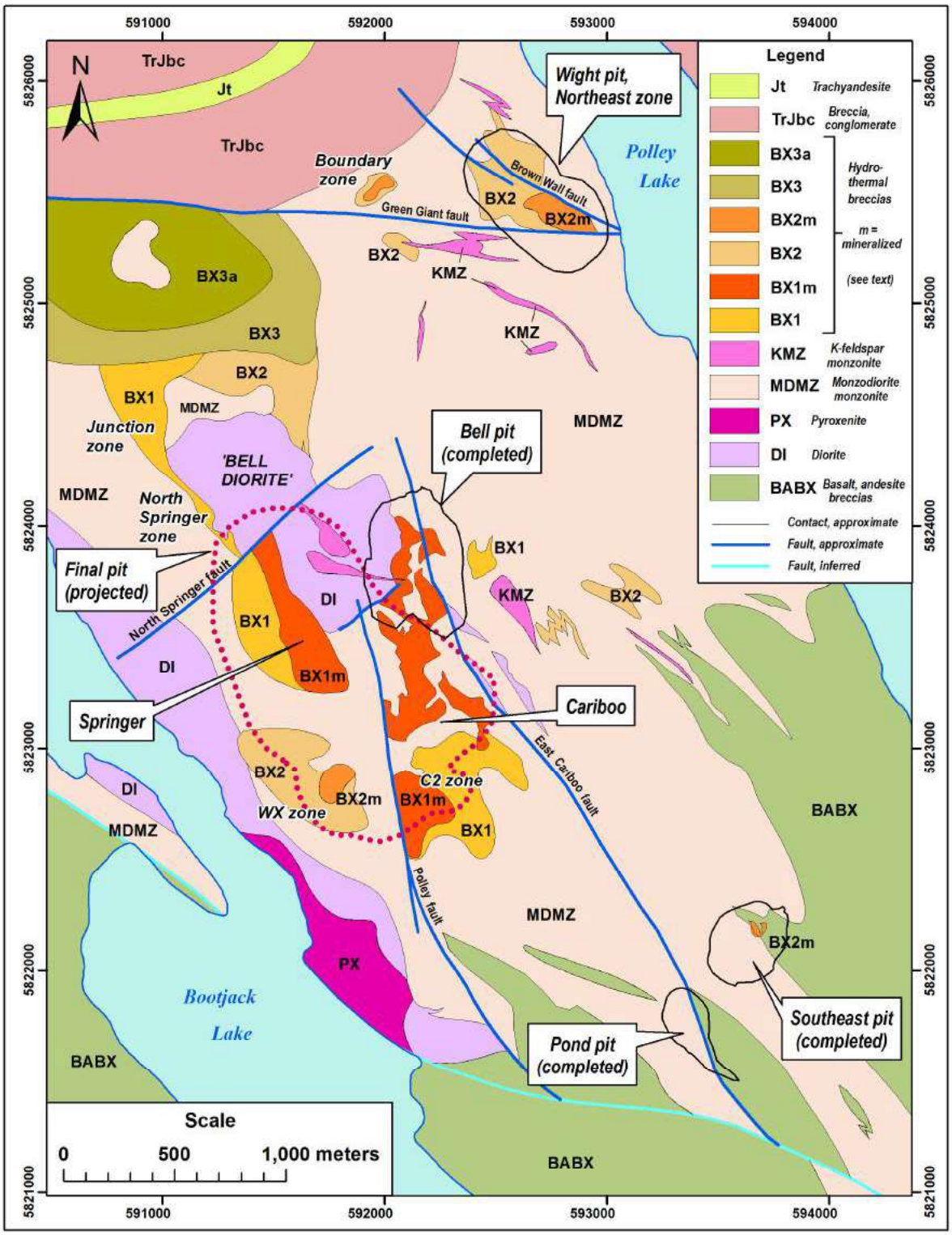

Figure 2.3 Simplified Geology of the Mount Polley Intrusive Complex

3 Environmental Protection Program

3.1 Environmental Management Systems

An Environmental Management System (EMS) is a framework that helps an organization achieve their environmental targets through regular review, evaluation and improvement of its environmental performance (EPA, 2017). Regular review and evaluation of environmental practices reduces the risk of non-compliance and allows opportunities for improvement to be identified and implemented. MPMC's EMS consists of procedures and processes for training of staff, monitoring, documenting and reporting environmental performance information, and their environmental targets are based on requirements outlined in *EMA* Permit 11678 and *Mines Act* Permit M-200.

The following Environmental Management Plans (EMP) are part of MPMC's EMS:

- Annual Discharge Plan
- CEMP (most updated version was submitted to ENV on October 31, 2019 and is currently under review)
- Dust Management Plan
- Environmental Emergency Response Plan
- Hazeltine Creek Fish Exclusion Plan
- Invasive Plant Management Plan
- Sediment and Erosion Control Plan
- Soil Management Plan

MPMC also maintains a QAQC Manual that consists of Standard Operating Procedures and Work Methods including but not limited to: water chemistry and toxicity monitoring and sampling (groundwater, surface water, lake water and seep water), periphyton sampling, phytoplankton sampling, vegetation sampling, soil sampling, hydrological sampling, meteorological sampling, snowpack measurements and the associated sample preservation and shipping and field sample record keeping as well as safety protocols including safe boating and check-in and check-out procedures.

Periodic inspections of infrastructure on the Mount Polley Mine site are also conducted and documented as part of MPMC's EMS. The following inspections and their corresponding frequencies were conducted in 2019:

- Waste Inspections – Monthly
- Sump/Ditch Inspections – Bi-annually (in the spring and fall)
- Hazeltine Creek Fish Inspections – Monthly (when creek is snow and ice free)
- Quesnel Lake Pipeline Inspections – Monthly

3.2 Environmental System Audits

EMPs are scheduled for updating and submitting according to the requirements set out by the *EMA* Permit 11678 and *Mines Act* Permit M–200. The following EMPs were reviewed and updated for 2019:

- Annual Discharge Plan
- CEMP (most updated version was submitted to ENV on October 31, 2019 and is currently under review)
- Dust Management Plan
- Environmental Emergency Response Plan
- Hazeltine Creek Fish Exclusion Plan
- Invasive Plant Management Plan
- Sediment and Erosion Control Plan

MPMC also maintains a QAQC Manual that consists of the aforementioned Standard Operating Procedures and Work Methods that is updated annually. The most recent update occurred in October 2019 in conjunction with the CEMP update. In addition, one sampling audit was conducted by MPMC on April 30, 2019. Sampling audits consist of an observer supervising sample collection and completing the Sampler Evaluation Check List included in the 2013 BC Field Sampling Manual. MPMC sampling procedures were found to be adequate following the April 30, 2019 audit.

3.3 Water Management

A map of all drainages and watersheds around the Mount Polley Mine site is shown in Figure 2.2 in Section 2.3.2 Further information regarding pre-mining drainage and watershed can be found in the *RCP* (MPMC, 2017a). The water management system allows all flow up to a 1 in 10 year 24 hour storm event, and withstand all flows up to a 1 in 200 year 24-hour storm event, without significant damage.

3.3.1 Evaluation of Effectiveness of Water Management

MPMC continually evaluates water management infrastructure through routine inspections to ensure that it performs as expected. In 2019, all water management infrastructure performed as intended. Ditches and pipelines are inspected by Environmental personnel monthly and a QP bi-annually.

3.3.2 Water Management System Update

A map of the water management system as of the December 31, 2019 is presented in Appendix B. There were no updates to the water management system in 2019.

3.3.3 Water Discharge Background

The Mount Polley Mine site has a positive water balance, which means that there is more yearly rainfall at

the site than there is evaporation. This means that water discharge is needed regardless of whether or not the Mount Polley Mine operates or manages the site on Care and Maintenance; however, a greater discharge volume is needed when the Mine is not in operation as water is not retained within the tailings production and storage process.

The water surplus was forecast before the Mine started operation and was discussed with neighboring communities during the original consultations that were carried out, along with the Environmental Assessment process, during the 1990s. At that time, the authorized plan was to settle the surplus water in sedimentation ponds and discharge to the local lakes and creeks near the Mine.

During the development and operation phases of the Mine, MPMC continued to assess and plan for water management at the Mine, obtaining and utilizing effluent discharge permits during the Mine's construction and operating period between 1997 and 2000, Care and Maintenance period between 2001 and 2005, and during operations between 2005 and 2014. Effluent was permitted to discharge into Edney Creek during Care and Maintenance until 2005. In years following 2005 the Mine site operated at an annual water balance surplus in excess of water recycling, dust suppression and evaporation. The excess water inventory was stored in mined-out pits and the TSF.

The effluent discharge permit of 2012 authorized 1.4 million cubic meters (Mm3) per annum into Hazeltine Creek of which 12% could be discharged due to constraining discharge volumes. In 2013, MPMC sought authorization for an additional interim measure to alleviate the critical need to discharge surplus water accumulating on the Mine site.

A reverse osmosis (RO) system was pursued as a short-term solution in 2014; however, MPMC did so knowing that RO would not be a suitable technology for the long-term management of site contact water. In fact, the RO system was proposed as an "interim" discharge strategy, to be employed to address the site water surplus inventory existing at the time, while allowing a sustainable long-term water management plan to be developed. The preferred long-term water management strategy continued to envision passive treatment and distributed discharge. Notably, at the time, MPMC had already been researching, trialing and operating passive treatment systems in partnership with the University of British Columbia and Genome BC since 2009 and had recently started a partnership with Thompson Rivers University for research into wetland treatment systems.

Following the failure of the TSF foundation in 2014, all water management planning was essentially 'reset', as the existing effluent authorizations were no longer practicable, and the site conditions for what was then the "interim" (RO) water management planning work was significantly advanced in 2014 were no longer applicable. MPMC had no permitted discharge, and all contact water was being stored in the Springer Pit. However, the Mine site continued to have a positive water balance (Golder 2015a) and the Springer Pit has a finite capacity. Golder estimated that once the pit water elevation reaches approximately 1,030 masl, the water will exfiltrate to the groundwater and discharge towards Bootjack Lake (Golder, 2015a). At 1,050 masl the Springer Pit will overflow.

With this new paradigm for water management planning, MPMC worked in collaboration with the ENV, the

EMPR, First Nations, local communities and stakeholders to develop a "roadmap" towards future water management. This "roadmap" recognized that a phased approach to water management planning (and corresponding *EMA* Permit 11678 amendments) would be required for the Mine, and contemplated an initial phase (the authorized *Short-term Water Management Plan* (*STWMP*)), an operating phase (the current authorized *Long-term Water Management Plan* (*LTWMP*)), and a series of future phases (transitioning into the closure and post-closure water management plan).

The effluent discharge strategy commonly referred to as the *STWMP*, was authorized on November 29, 2015, and reflects the effluent discharge authorized by *EMA* Permit 11678 to November 30, 2017. The *STWMP* includes discharge of treated effluent to Quesnel Lake via the Hazeltine Channel, and the key objective in its development and authorization was to manage contact water that had accumulated at the Mine site following the TSF foundation failure, while allowing time to develop the *LTWMP*.

MPMC have continued to follow the approach of this "roadmap" diligently, in accordance with the process established in collaboration with the aforementioned parties to ultimately return water flows to their original watersheds, to the extent practical.

Table 3.1 provides a summary of water discharge authorizations from the Mount Polley Mine. The current authorized discharge is discussed in further detail in Section 4.12.

Table 3.1 Summary of *EMA* Permit 11678 authorizations for water discharge from the Mount Polley Mine

Date	Discharge Source Permitted	Discharge Location	Comments
7-Feb-2002	MESCP	Edney Creek	Discharge discontinued in 2005; no longer permitted.
7-Nov-2012	Dam filtered	Hazeltine Creek	Discharge discontinued in 2014; no longer permitted.
29-Nov-2015	Springer Pit, and site runoff and seepage collection water management systems	Quesnel Lake via Hazeltine Creek	Discharge discontinued in 2017; see Section 4.12.
30-Nov-2017	TSF, and site runoff and seepage collection water management systems	Quesnel Lake via direct pipeline	Active in 2019; see Section 4.12

3.3.4 Long-Term Water Management Plan Development

MPMC retained qualified environmental professionals to review and modernize the previous water management plans and make sure that MPMC were applying best practices to manage surplus site water. This work resulted in a detailed *LTWMP Technical Assessment Report* (*TAR*) submitted on October 17, 2016 in support of the currently authorized *EMA* Permit 11679 of April 7, 2017. The *TAR* incorporated feedback from and comments by ENV, EMPR, and First Nations (and their respective consultants).

The current *LTWMP EMA* Permit 11678 allows MPMC to manage site contact water in accordance with the expectations laid out in the *EMA* and Ministry policy pertaining to effluents. The Veolia Actiflo® water

treatment system, was commissioned in 2015 by MPMC has met the site water management needs for the *STWMP* and remains in use today for the *LTWMP* with the addition of a pipeline and diffuser system into Quesnel Lake in 2017. The use of the Quesnel Lake outfall is authorized until December 31, 2022.

As contemplated by the "roadmap", the *LTWMP TAR* recommends that MPMC approach water discharge in phases: firstly, remove suspended particulates with a water treatment plant using modern technology, and then discharge the treated water at depth into Quesnel Lake (the current authorized discharge); and, secondly, continue to undertake a Best Achievable Technology (BAT) water treatment assessment, water treatment plant optimization, source control optimization, and a receiving environment discharge assessment of water bodies and creeks around the Mine site, with a goal of determining whether distribution of the treated water to the local watersheds is appropriate.

These assessment and optimization studies will continue in parallel to the currently authorized first phase of water treatment and discharge to Quesnel Lake, with transition into the second phase being completed after the site is reclaimed. MPMC is not ruling out the possibility that the transition would occur earlier (during care and maintenance or operations) if the investigations demonstrate that it is appropriate to do so. The *EMA* Permit 11678 authorized annual discharge is 10.5 Mm3 when discharging to Quesnel Lake, sufficient to manage the 1:200-year wet annual rainfall while the Mine is in operation (*LTWMP TAR*).

No changes to the *LTWMP* occurred in 2019 with the exception of the development, submittal, and ultimate approval of the *Annual Discharge Plan* (*ADP*) required under Section 2.7 of *EMA* Permit 11678. The *ADP* was approved by the ENV on September 6, 2018. An amendment to the *EMA* Permit 11678 was granted by ENV on October 2, 2018 to reflect the *ADP* (Appendix A). Since no changes were made to *EMA* Permit 11678, the 2018 *ADP* was carried over into 2019.

The 2019 *ADP* is meant to outline, among other items, the expected volume, timing, and quality of effluent released to Quesnel Lake, and plan the discharge in such a manner that avoids "pollution", as defined in the *EMA* and as determined by the evaluation of parameter concentrations at the edge of the Initial Dilution Zone (IDZ) in Quesnel Lake. Parameter concentrations at the edge of the IDZ will be monitored using a new, model-based approach as part of a Trigger Response Plan (TRP) (Section 4.12.2.6; Appendix I).

As part of closure planning and long-term water management, MPMC's objectives are to provide systems with long-term resilience and effectiveness so that water leaving the Mine site is the best alternative for the receiving environment. Moreover, MPMC are also seeking to distribute treated waters into the pre-mining catchments, to the extent that is practical.

Even though these systems are intended to treat closure flows, they may be implemented at full-scale before closure if testing proves successful and necessary permits can be obtained. Economic factors forced the mine into Care and Maintenance on May 31, 2019. The operating period will be extended beyond December 31, 2022, by the months or years the mine will be under Care and Maintenance. MPMC will be required to amend *EMA* Permit 11678 for any site water discharge scenario beyond December 31, 2022.

3.3.5 Water Balance

MPMC retains Golder to maintain a predictive water balance model for the Mount Polley Mine site using GoldSim™ software. This model generates probabilistic flow and water balance forecasts for site water management system components, and has been adapted to model conditions during operations, closure, and post-closure following reclamation work.

The GoldSim™ water balance model is used for planning purposes such as water discharge planning, with calibration and revised projections made based on actual observed site conditions (i.e., water levels and storage volumes). The model also undergoes routine validation through comparison of predicted and observed accumulations, based on actual climate conditions and water management data recorded from site. Model validation was most recently carried out in March 2020 for data covering the period January 2019 to December 2019. Golder provided a *Site Wide Water Balance Model Update and Calibration Technical Memorandum* and it is included in Appendix P.

In addition to the GoldSim™ model developed by Golder, MPMC has an operational spreadsheet that is used to record, and track components of the onsite water balance for operational purposes. Water storage conditions on site for 2019 are summarized in Table 3.2. Under conditions of *Mines Act* Permit M–200 authorizing the return to full operations and use of the TSF, Quantitative Performance Objectives (QPOs) were established. Some of the QPOs are specific to free water storage in the TSF. Under current authorizations, the TSF is operated with a normal operation free water surplus between 1,000,000 m^3 and 1,500,000 m^3 and is authorized for temporary detention of water for contingency (e.g., freshet) storage provided that a minimum freeboard of 1.1 m is maintained.

Under the *EMA* Permit 11678, monthly elevations of the Springer Pit must be recorded on a monthly basis for water balance purposes. Monthly elevations are provided in Table 3.3.

A summary of the water storage conditions is presented in Table 3.2.

Table 3.2 Water storage conditions at end of 2019

Item	2019 Year End	Change from 2018 to Year End
Springer Pit Elevation (masl)	982.87 [(a)]	-4.03
Springer Pit Volume (m^3) - Total	2,447,925	-406,918
Springer Pit Volume (m^3) - Tailings + Interstitial Water	2,037,104	-501,195
Cariboo Pit Water Elevation (masl)	980.0 [(a)]	- [(b)]
Cariboo Pit Water Volume (m^3)	1,174,691 [(a)]	1,174,691
TSF Elevation (masl)	962.01	0.32
TSF Volume (m^3) - Total	17,683,495	2,964,768

TSF Volume (m^3) – Tailings + Interstitial Water	15,726,999	2,660,332
Total Free Water Volume (Springer + Cariboo + TSF)	3,542,008	2,370,861
Total Water Discharged (m^3)	3,480,268	-1,785,454

(a) Due to safety, last elevation for the year was November 6, 2019.

(b) At 2018-year end, the Cariboo Pit was an active pit with minimal water stored

Table 3.3 Monthly Springer Pit elevations in 2019

Springer Pit elevations (masl)	
1-Jan-19	986.96
1-Feb-19	987.30
1-Mar-19	987.60
1-Apr-19	987.96
1-May-19	988.69
1-Jun-19	989.19
1-Jul-19	987.95
1-Aug-19	986.22
1-Sep-19	984.71
1-Oct-19	982.10
1-Nov-19	980.61
1-Dec-19	- (a)

(a) Due to safety and loss of GPS communication from power outages, last elevation for the year was November 6, 2019.

3.3.6 Water Management System Upgrades

MPMC completed and submitted a *Water Management Plan and System Review* to the EMPR on March 31, 2016, as required under conditions of *Mines Act* Permit M–200. This *Water Management Plan and System Review* provided an overview of water management planning at the Mount Polley Mine; an update on site works completed since the issuance of the July 9, 2015 *Mines Act* Permit M–200 amendment requiring its development; a review of the design criteria and operational requirements of the water management system, as completed by third party QPs; a summary of the outcomes of the third party review; and, planned work.

Bi-annual sump and ditch inspections (required under *EMA* Permit 11678*)* were completed in 2019, as well as daily water management infrastructure inspections, environmental monitoring, and other observational activities as per MPMC's *Operation, Maintenance and Surveillance (OMS) Manual* (as well as part of MPMC's *Sediment and Erosion Control Plan*, Section 3.5). Minor upgrades to the water management system conducted in 2019 include:

- Two electric pumps installed to pump from the PETBP to the TSF;
- Secondary 8" HDPE installed from Main Seepage pond to TSF; and
- Replaced diesel generator with an electric substation at the NEZ sump

3.4ML/ARD Characterization and Mine Waste Management

3.4.1 Waste Rock Characterization and Disposal

Active monitoring of ARD/ML potential in the Mount Polley waste rock continued in 2019 as part of the established protocol which encompasses two stand-alone acid-base accounting (ABA) procedures: ARD analysis of diamond drill core pulps to model a preliminary PAG body; and ongoing ABA determination of individual blast hole samples during mining operations to enhance the segregation of PAG from non-acid generating (NAG) waste (RCP, 2017a). The program characterizes all material types that will be handled during the Mine life. Analysis is completed on site by Mount Polley's LECO™ analytical machine which allows the Mine to characterize waste and direct it to suitable storage sites or designate it for construction usage when required and if deemed suitable. Acid-base accounting procedures were not conducted in 2019 as no active mining occurred.

On each bench, a sample of cuttings is collected from each blast hole and analyzed for total copper, non-sulphide copper, iron, and gold. Areas of ore and waste are identified by indicator kriging and assigning assay values, mill head value, etc. using an inverse distance calculation. The ore control staff member then establishes ore/waste boundaries based on the calculated mill head values. Mill feed ore areas are excluded from ABA analysis, as this material is processed through the mill. Only waste rock is submitted for ABA analysis. Waste rock material was not sampled in 2019 as no active mining was conducted at the mine site.

Samples with both a Neutralizing Potential Ratio (NPR) greater than 2 and a sulphur content less than 0.1% are considered NAG, and samples with both an NPR less than 2 and a sulphur content greater than 0.1% are considered PAG. PAG is currently stored in the Temporary NW PAG Stockpile to the northwest of the Springer Pit and will be relocated to the bottom of the Springer Pit and submerged upon Mine closure.

A summary of quantities of waste rock, tailings, and other Mine waste added to site storage areas in 2019 and the total quantities on site as of December 31, 2019 is provided in Table 3.4.

Table 3.4 Quantities of waste rock, tailings, low grade ore, and other mine waste as of December 31, 2019.

Name of Waste Pile or Pond	Acid Generating Waste		Potentially Acid Generating Waste		Non-Acid Generating Waste	
Waste Dumps						
	2019	Total	2019	Total	2019	Total
1. South East Rock Dump	0	0	0	0	410	55,651,883
2. NAG/PAG Dump	0	0	0	25,204,828	0	3,983,050
Total	0	0	0	25,204,828	20,796	63,547,565
Tailings Ponds						
1. Tailings Storage Facility	0	0	9,813,233	29,523,411	0	0
2. Springer Pit	0	0	0	3,110,758	0	0
Total	0	0	9,813,233	32,634,169	0	0
Low Grade Ore/Coarse Reject/Other Mine Waste						
1. Belt Cleanup Stockpile	0	0	23,155	104,709	0	0
2. #3 Ore Stockpile (LG)	0	0	0	1,590,426	0	0
3. Leach Stockpile (LG)	0	0	0	2,564,475	0	0
4. South East Rock Dump	0	0	2,178	17,921	0	0
Total	0	0	25,333	4,277,531	0	0

Springer Pit

No productive mining occurred in the Springer Pit in 2019. Note that any material from the Springer Pit mining zone refers to any cleanup that may have been needed for the dredging project.

Cariboo Pit

No productive mining occurred in the Cariboo Pit in 2019.

Wight Pit/Underground

No mining occurred in the Wight Pit in 2019. It has been in Care and Maintenance since May 2017.

ABA Data

No ABA samples were collected or analyzed in 2019.

Field Grab Samples

No field grab samples were collected in 2019.

Tailings Storage Facility

There was no construction on the TSF during 2019.

Tailings

Representative composite tailings samples were collected and analyzed for ABA every month when processing of ore occurred to represent the tonnage of tailings. From January 1 to December 31, 2019, approximately 3,591,448 t of tailings were deposited into the TSF. Table 3.5 displays the ABA data for each of the tailing's composite samples for 2019. Note that there is no data from June to December due to the mine operating in Care and Maintenance. The composite tailings samples had an average NPR value of 8.94 and range NPR values from 8.27 to 9.60.

Table 3.5 ABA results from 2019 monthly tailings composite samples

Month	Tailings Composite NPR
January	-
February	-
March	-
April	8.27
May	9.6
June	-
July	-
August	-
September	-
October	-
November	-
December	-
2019 Average	**8.94**

Monthly Milling Rates

The total amount of ore sent to the crusher in 2019 was 2,265,788 t. All mill feed was mined from the ore stockpiles. From late May to December, no mining occurred as the mine was operating in Care and Maintenance. A monthly summary of the various ore feeds is provided in is provided in Table 3.6 and monthly custom milling production in Table 3.7.

Table 3.6 Summary of monthly milling rates in 2019

Crusher Mill Feed Summary				
	Source			
Month	**Cariboo Pit Crusher Feed (t)**	**Stockpiles to Crusher Feed (t)**	**Total Crusher Feed (t)**	**Cariboo Ore to Stockpiles (t)**
January	0	542,774	542,774	0
February	0	313,845	313,845	0
March	0	507,350	507,350	0
April	0	583,571	583,571	0
May	0	318,248	318,248	0
June	0	0	0	0
July	0	0	0	0
August	0	0	0	0
September	0	0	0	0
October	0	0	0	0
November	0	0	0	0
December	0	0	0	0
Total	0	**2,265,788**	**2,265,788**	**0**

The total ore milled in 2019 was 2,231,119 t. A summary is provided in Table 3.7. The 0.98% tonnage discrepancy of total crusher feed from Table 3.6 and total mill feed from Table 3.7 comes from error in the haul truck counts of material delivered to the crusher, as mine operations assumes a constant tonnage for every haul truck coming out of the pit. The mill receives crushed ore from the crusher by conveyor belts, which measure the actual tonnage of material feeding the mill.

Table 3.7 2019 mill production summary

Mill Production Summary								
Month	Feed Tonnage (tonnes)	Tail Tonnage (tonnes)	Feed Grades			Metal Produced		
			Copper (%)	Gold (g/t)	Oxide Ratio	Cu (lbs)	Au (oz)	Ag (oz)
Jan	455,619	454,247	0.235	0.294	44.314	827,320	2,541	2,402
Feb	273,401	272,159	0.225	0.332	32.765	709,086	1,939	1,582
Mar	499,747	498,186	0.208	0.216	42.142	768,783	1,666	2,526
Apr	554,075	552,412	0.211	0.228	46.200	881,940	2,105	2,289
May	448,277	447,142	0.278	0.399	53.900	708,647	2,582	2,575
Jun	0	0	0	0	0	0	0	0
Jul	0	0	0	0	0	0	0	0
Aug	0	0	0	0	0	0	0	0
Sep	0	0	0	0	0	0	0	0
Oct	0	0	0	0	0	0	0	0
Nov	0	0	0	0	0	0	0	0
Dec	0	0	0	0	0	0	0	0
Total	**2,231,119**	**2,224,146**	**0.231**	**0.294**	**43.864**	**3,895,777**	**10,834**	**11,376**

Rock Borrow Pit

No rock was extracted from the rock borrow in 2019.

3.5 Sediment and Erosion Control

MPMC maintains a *Surface Erosion and Sediment Control Plan.* As required by the *Mines Act* Permit M-200, the plan was reviewed (but not edited) in 2019. The last revision of the plan was completed in 2016. The plan was submitted to the EMPR in January 2017 as an appendix to the updated *RCP* (MPMC, 2017a).

3.6 Waste Management

3.6.1 Storage

In its mining operations, Mount Polley utilizes a variety of chemicals, reagents, and other products. At any one time, the approximate volumes of materials in Table 3.8 could be on site. Due to the mine going into a care and maintenance phase in May of 2019, the actual volumes of the materials on site are less than reported in Table 3.8.

Table 3.8 Approximate volumes of chemicals and reagents stored at the Mount Polley Mine site

Materials	On Hand on Jan 1, 2019
PAX (Mill Reagent)	21,000 kg
Lime	61,849 kg
Polyclear 3180M	1,814 kg
Polyfroth W22C	21,848 kg
NaHS	27,000 kg
Methanol	13,615 L
Vanpress (Coagulant)	29,353

Previous blasting activities at Mount Polley Mine were carried out by Orica Ltd. In preparation for the pending care and maintenance phase all blasting ceased at the mine in the fall of 2018. As such, all blasting related materials were removed from the site by the summer of 2019 by Orica Ltd.

3.6.2 Chemical, Reagent, and Contaminated Waste Disposal

Mount Polley Mine operations utilizes potentially hazardous chemicals, reagents, and other products that are subject to waste disposal procedures. In 2019, Sumas Environmental Services Ltd. routinely removed and disposed of these waste products in an environmentally safe manner compliant with all relevant waste management legislation. Products removed include aerosol cans; contaminated gasoline and diesel; waste oil (in drums); waste oil filters; waste grease fuel or oil-soaked rags, debris, and floor dry; and leachable liquid toxic waste, such as glycol/anti-freeze mix. The site bulk waste oil tanks are emptied, and the oil removed from site by GFL Environmental. MPMC is registered with ENV under the *Hazardous Waste Regulation* (Ministry of Attorney General, 2017) for generation and temporary storage of these materials.

3.6.3 Recycling

MPMC recognizes the value of responsible waste management and recycling plays a big role in site waste management practices. Mount Polley continues to recycle used materials including waste oil, scrap steel, batteries, plastic pails, electronic waste, light bulbs and associated fixtures, paper, cardboard, and beverage containers. In 2019, Mount Polley donated the funds generated by its beverage container recycling program to the Big Brothers and Big Sisters of Williams Lake.

In 2019, 4,684.3 t of scrap steel were removed from the site.

Recycling and waste management educational presentations are routinely given to Mount Polley employees, contractors and visitors with the required site orientation.

3.7Incidents

3.7.1 Spills of Hydrocarbon or Dangerous Goods

All spills of hydrocarbons, coolant, and chemicals are reported to the MPMC Environmental Department. In 2019, there were two coolant spills and three hydrocarbon spills reported. Of these spills, one was reportable to Emergency Management BC as outlined in the Spill Reporting Legislation (Table 3.9). This spill was given a Dangerous Goods Regulation (DGR) number and recorded in the government database. All spills were cleaned up and the materials were removed from site in environmentally safe barrels by Sumas Environmental Services Ltd.

Table 3.9 Hydrocarbon and Dangerous Goods Spills reported to the Environmental Department in 2019

Date & Time Reported	DGR#	Source	Volume (L) (estimated)	Material	Location
01/Jan/2019 9:12		15-055 Haul Truck	25	Diesel Fuel	Finning/Shovel Laydown
05/Feb/2019 13:33	18-4079	15-037 Haul Truck	200	Hydraulic Fluid	Ramp to #3 stockpile
07/Mar/2019 20:20		20-022 Excavator		Hydraulic Oil	#3 Stockpile
11/Jun/2019 16:00		15-053 Wiggly	8	Coolant	TSF Corner 2 toe
20/Jun/2019 8:45		15-053 Wiggly		Coolant	HAC Reach 3 construction area

3.7.2 Water Releases

In 2019, there was one release of mine-affected water. Notifications and follow up reports were submitted to ENV and a summary is provided in Table 3.10.

Table 3.10 Release of mine influenced water reported to the ENV in 2019

Date Reported	DGIR#	Source	Volume (m^3)	Material	Location
18-July-2019	191314	MDG Tailings Line	200L	Tailings/Water	Within a mine contact water collection ditch (West Ditch)

3.8Archaeological Resources

First Nations with recognized claimed traditional territory for the Mount Polley Mine are the WLIB and the SCIB. Pre-mining studies noted that the area had low heritage resource potential due to the extensive disturbance in the area from logging and earlier mining projects (Points West Heritage Consulting, 1989).

There were no archaeological or historic sites identified at Mount Polley in 2019.

4 Environmental Monitoring

4.1 Data Quality Assurance/ Quality Control

The purpose of the data quality assurance/quality control (QA/QC) program is to verify the reliability of monitoring data through the implementation of procedures for controlling and monitoring the measurement and analysis process. The QA/QC program provides information for evaluation of the analytical and monitoring procedures, and identification of issues pertaining to possible contamination, both in the field and in the analytical laboratory. The QA/QC program includes:

- Quality assurance (QA): management and technical practices designed to confirm that data were consistent with the objectives of the water quality program.
- Quality control (QC): specific data quality objectives (DQOs), statistical assessment of data quality, and corrective measures taken whenever the DQOs were not met.

The QA/QC program is conducted at all stages of the sampling program: sample collection, transport, and analysis for all sites including contact water quality sites, surface water quality sites, lakes, and groundwater wells.

MPMC maintains a *Quality Assurance/Quality Control Manual* (most recent version: MPMC, 2017d; herein referred to as the "*MPMC QA/QC Manual*" that is reviewed and audited annually. This manual oversees all the standard operating procedures and work methods pertaining to monitoring and sampling activities on the Mount Polley Mine site.

4.2 Scheduling

To coordinate sampling and schedule all planned monitoring, as per the *CEMP* and to be compliant with all applicable regulations MPMC prepares internal monthly sampling schedules.

4.3 Field Methods

4.3.1 Sample Collection

Sample collection was consistent with the procedures described in the current *British Columbia Field Sampling Manual: 2013 – For Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples* (ENV, 2013) and MPMC *QA/QC Manual* (MPMC, 2019). Monitoring procedures for the discharge locations (see Section 4.12) were consistent with the Metal Mining and Diamond Effluent Regulations (MDMER) (Environment Canada, 2019), as appropriate.

4.3.2 Sample Suites

Each full sampling suite for water chemistry analysis consists of a variety of bottles. As outlined in Table 4.1, the type and volume of bottle will depend on the analysis and is determined by the *BC Field Sampling Manual* (ENV, 2013) and laboratory criteria (Section 4.4). In 2019, the full sampling suite for surface and lake water chemistry consisted of six bottles: Nutrients-1, TSS, total ammonia and nitrogen, dissolved organic carbon, total metals and dissolved metals bottles. The full sampling suite for groundwater chemistry consisted of three bottles: Nutrients-2, total ammonia and nitrogen and dissolved metals (Table 4.1).

Table 4.1 MPMC full sampling suite

Type and volume of bottle	Name of analysis	Type of analysis
500 mL clear plastic bottle	Nutrients-1 (surface and lake water)	pH, conductivity, turbidity, total dissolved, solids, hardness, alkalinity, chloride, fluoride, sulphate, phosphorus total and dissolved, and ortho-phosphorus
	Nutrients-2 (groundwater only)	pH, conductivity, hardness, alkalinity, chloride, fluoride, sulphate, phosphorus total and dissolved
	TSS	Whole bottle TSS
120 mL amber bottle	Total ammonia and nitrogen	Total nitrogen, nitrate, nitrite, ammonia
	Dissolved organic carbon	Dissolved organic carbon
60 mL plastic bottle	Total metals Dissolved metals	See CEMP (Appendix A) See CEMP (Appendix A)

4.3.3 Field Meters and Monitoring Equipment

Field meters were used to measure dissolved oxygen, conductivity, pH, temperature, turbidity, and water flow. Meters and other field equipment were operated and calibrated following the manufacturers' instructions and the MPMC *QA/QC Manual*, which includes specific work methods for the equipment discussed below.

The conductivity and pH meters used for field analysis of surface water and groundwater were the WTW pH/Conductivity 340i and 3430 handheld multimeters. In situ turbidity was measured with LaMotte 2020e and 2020we turbidity meters. For measuring field parameters in lakes, YSI EXO multimeters were used. Calibration records were recorded in the calibration logbook, as outlined in the MPMC *QA/QC Manual* (MPMC, 2019). The YSI EXO multimeter was operated based on the equipment manual and guidance from the supplier (Hoskin Scientific), with general MPMC calibration practices being followed.

Flow measurements were taken using a Sontek FlowTracker Acoustic Doppler Velocimeter. The user measures flow rates across a creek or ditch cross section using the FlowTracker handheld device and the device then calculates the discharge rate based on these measurements and input parameters. The meter

has QA/QC standards programed into it, and the device provides error notifications if these standards are not met. An International Organization for Standardization and statistical U.S. Geology Survey percent error are calculated for each discharge reading based on depth, velocity, width, method, number of stations, and calibration accuracy to evaluate accuracy of the discharge measurement. The dry salt slug injection tracer method was used by WaterSmith during benchmarking surveys and station assessments in August 2017 and was subject to WaterSmith's QA/QC procedures.

The staff gauge benchmarking (calibrating) and hydrology station calibrating program occurs annually as required by Section 3.4 of *EMA* Permit 11678 and as per protocol in the MPMC *QA/QC Manual* (MPMC, 2019). Station specific details are provided in Sections 4.8 and Appendix L.

Field Secchi disk monitoring was undertaken in the lakes (Section 4.15.2; Appendix M).

Chlorophyll *a*, phytoplankton and zooplankton samples were collected as per the protocol in the MPMC *QA/QC Manual* (MPMC, 2019). Chlorophyll *a* and zooplankton tissue metals analysis were sent to ALS (see Section 4.4). Enumeration and species identification of phytoplankton community and zooplankton taxonomy samples were sent to specialized labs (Section 4.4) as described in the *CEMP* (Appendix A).

4.4 Quality Control and Data Quality Objectives

Analytical processing of samples collected by MPMC is conducted by ALS Environmental (ALS) in Burnaby, BC. ALS is a Canadian Association for Laboratory Accreditation Inc. accredited laboratory for the analyses requested. The Laboratory DQOs provided to MPMC by ALS are included in Appendix D.

Bioassay (toxicity) testing is carried out by Nautilus Environmental (Nautilus) in Burnaby, BC. Nautilus is Canadian Association for Laboratory Accreditation Inc. accredited laboratory for the analyses requested. Acute and chronic bioassays methods are conducted as outlined in the MDMER Environmental Effects Monitoring (EEM) studies and *EMA* Permit 11678 requirements. The toxicity tests are scheduled 30 days prior to sampling as required by MDMER (see Section 4.12.3). The laboratory QA/QC measures provided to MPMC by Nautilus are included in Appendix D.

Phytoplankton and periphyton community samples from Hazeltine and Edney creeks and Quesnel and Bootjack lakes were sent to Biologica Environmental Services Ltd. in Victoria, BC. Zooplankton taxonomy samples from Hazeltine, Edney and Frypan creeks were sent to Cordillera Consulting Inc. in Summerland, BC. Previous samples from Quesnel Lake were sent to Mary-Jane Hudson in Nanaimo, BC to align with the Department of Fisheries and Oceans (DFO)'s operating procedures; however, Ms. Hudson has since retired.

Samples submitted were tracked to verify that laboratory sampling and analysis protocols were followed, including hold times, sample containers, preservatives, detection limits, and approved methodology. Instances in which these protocols were not followed were recorded in the sample tracking spreadsheet.

This spreadsheet tracked individual samples and recorded the locations of samples, along with the date, duplicate and blank sample information, sample shipping information, laboratory correspondence, analytical results, and potential data integrity issues.

4.4.1 Replicates and Blanks

For water chemistry, QC samples were collected as a component of the monitoring program as per the MPMC *QA/QC Manual*. The recommended minimum number of replicates and blanks is 10% of the overall samples as set out by the current *BC Field Sampling Manual* (ENV, 2013). In 2019, MPMC achieved 16% of total QC samples. A combined QC schedule across the various MPMC monitoring programs as described in the *CEMP* is summarized in Table 4.2.

Table 4.2 Water chemistry QC sample frequencies for MPMC monitoring programs

QC Samples	Minimum Frequency
Duplicate samples	2 per month/10% of samples
Equipment blanks	Monthly/Quarterly per piece of equipment (when used)
Trip blanks	2 per month
Field blanks	2 per month
Filter blanks	Quarterly
Deionized (DI) water blanks	Annually
Inter-laboratory replicate	Annually

Field Replicates

The semi-blind replicates are intended to evaluate the QA/QC surrounding the sampling methods. Replicates are prepared by collecting two full sample suites from one location at the same time, one after the other, labelling one with the sampling location name (e.g., E4, HAC-13) and labelling the second sample suite with a replicate name (e.g., ED, HAC-M). When the results are reported back from the analytical laboratory, all parameters from the replicate and the actual sample are screened to confirm likeness, or potential of sampling error or contamination. The screening process also considers accuracy of the analytical procedures and small-scale natural variations in water quality which may occur over the timescale of collection (approximately 10 minutes). In particular, there is considerable potential for variations in water quality over short-time scales during periods of high sediment loads.

Semi-blind field replicates were compared to evaluate the precision of the methods used (i.e. Combined precision of field methods, laboratory methods and the environmental variability between the side-by-side samples). A relative percent difference (RPD) is calculated to identify significant differences between the replicate and sample, where the RPD (as %) can be defined as:

$$\text{RPD } (\%) = \frac{|X_x - X_y|}{\bar{X}} \times 100$$

Where X_x= the concentration of the original sample
X_y= the concentration of the blind field duplicate sample
$\bar{X}$ = the average of the original and duplicate samples

The acceptance criteria for RPDs for water chemistry are defined as 1.5x the laboratory RPD criteria, which is summarized in Table 4.3. For results less than five times the detection limit, significant differences are identified if the difference of the two results is greater than twice the detection limit. When either sample is less than detection limit, differences are not calculated.

Table 4.3 Duplicate Sample RPD acceptance criteria

Analyte Group	RPD Acceptance Criterion
Metals	30%
Inorganics	30%
Organics	45%
Other parameters	1.5 x Laboratory RPD

4.4.1.1 Field QA Results and Discussion

There were 97 field replicate samples collected in 2019, as shown in Table 4.4. The raw data are available in Appendix D. Note the prefixes refer to location areas (ie. 'W' refers to non-contact water site, 'EDC-01', refers to Edney Creek); additional information on naming conventions are found in the CEMP (Appendix A). There were no results for total metals analysis for the groundwater duplicates (e.g. GW15-2a) as total metals are not analyzed for groundwater samples. In addition, the BAC samples (eg. BAC-01) are only analyzed for E-coli and total bacteria coliform. All results above the respected RPDs were rechecked by ALS.

Table 4.4 Field replicate sample locations collected in 2019.

Date Sampled	Location	Name
7-Jan-19	W5	WE
8-Jan-19	HAC-10	HAC-J
8-Jan-19	HAD-3	HAD-C
16-Jan-19	US NEZ Seep LD	2110 NEZ Seep LD
5-Feb-19	E4	ED
5-Feb-19	East MTD	East 12204
5-Feb-19	HAC-01c	HAC-Ac
7-Feb-19	W1	WA
7-Feb-19	W12	WL
11-Feb-19	P2-B	PB-B

Date Sampled	Location	Name
12-Feb-19	GW95R-1	GWIER-A
14-Feb-19	NEZ Seep 1	NEZ Seep A
25-Feb-19	GW12-2A	GWL-BA
4-Mar-19	HAC-13	HAC-M
5-Mar-19	QUL-58-B	QUL-EH-B
5-Mar-19	BAC-01	BAC-A
19-Mar-19	E19	ES
21-Mar-19	E23	EW
28-Mar-19	W4a	WDa
2-Apr-19	HAD-08	HAC-H
3-Apr-19	W5	WE
4-Apr-19	NEZ Seep 2	NEZ Seep B
17-Apr-19	NEZ Seep 2a	NEZ Seep Ba
25-Apr-19	QUL-58-S	QUL-EH-S
1-May-19	W8z	WHz
6-May-19	PAG Seep 15	PAG Seep O
6-May-19	SERD Seep 13	SERD Seep M
6-May-19	W20	WT
8-May-19	QUL-18-100m	QUL-R-100m
8-May-19	QUL-59-BT	QUL-EI-BT
9-May-19	E1a	EAa
14-May-19	HAC-14	HAC-N
15-May-19	QUL-57-BT	QUL-EG-BT
16-May-19	E23	EW
16-May-19	P1-S	PA-S
21-May-19	HAD-3	HAD-C
22-May-19	B2-AT	BB-AT
29-May-19	GW96-4b	GWIF-Db
29-May-19	GW00-3b	GWXX-Cb
29-May-19	GW16-5a	GWP-Ea
2-Jun-19	GW11-1a	GWK-Aa
2-Jun-19	GW12-3a	GWL-Ca
4-Jun-19	W10	WJ
4-Jun-19	EDC-01	EDC-A
6-Jun-19	P1-BT	PA-BT
11-Jun-19	BAC-02	BAC-B
11-Jun-19	NEZ Seep 1	NEZ Seep A
18-Jun-19	QUL-2a-40m	QUL-Ba-40m

Date Sampled	Location	Name
19-Jun-19	QUL-120a-80m	QUL-ATa-80m
2-Jul-19	HAC-05a	HAC-Ea
2-Jul-19	W4a	WDa
9-Jul-19	E19	ES
9-Jul-19	NEZ Seep 2	NEZ Seep B
15-Jul-19	P2-B	PB-B
30-Jul-19	QUL-ZOO-1-S	QUL-ZOO-A-S
30-Jul-19	QUL-ZOO-7-DI	QUL-ZOO-G-DI
1-Aug-19	HAC-14	HAC-N
7-Aug-19	STD	19204
7-Aug-19	W5	WE
13-Aug-19	P2-S	PB-S
15-Aug-19	NEZ Seep 1	NEZ Seep A
15-Aug-19	GW05-01	GWE-A
19-Aug-19	QUL-18-20m	QUL-R-20m
20-Aug-19	QUL-58-BT	QUL-EH-BT
20-Aug-19	QUL-2a-60m	QUL-Ba-60m
21-Aug-19	GW15-2a	GWO-Ba
28-Aug-19	P2-S	PB-S
29-Aug-19	B2-BT	BB-BT
3-Sep-19	HAC-13	HAC-M
4-Sep-19	GW16-2a	GWP-BA
9-Sep-19	E10	EJ
10-Sep-19	HAD-3	HAD-C
11-Sep-19	P1-AT	PA-AT
12-Sep-19	NEZ Seep 2a	NEZ Seep Ba
16-Sep-19	B1-S	BA-S
17-Sep-19	BAC-03	BAC-C
1-Oct-19	HAC-08	HAC-H
1-Oct-19	EDC-01	EDC-A
1-Oct-19	W10	WJ
9-Oct-19	P2-B	PB-B
17-Oct-19	US NEZ Seep LD	2119 NEZ Seep LD
23-Oct-19	B2-B	BB-B
30-Oct-19	QUL-58-S	QUL-EH-S
4-Nov-19	E22	EV
4-Nov-19	W8z	WHz
4-Nov-19	HAC-05a	HAC-0EA
5-Nov-19	E19a	ESa
13-Nov-19	E19	ES

Date Sampled	Location	Name
13-Nov-19	W1b	WAb
14-Nov-19	E23	EW
18-Nov-19	GW16-5a	GWP-Ea
18-Nov-19	GW11-1a	GWK-Aa
20-Nov-19	P2-Mid	PB-Mid
20-Nov-19	GW12-2a	GWL-Ba
20-Nov-19	GW12-4b	GWL-Db
2-Dec-19	HAC-13	HAC-M
9-Dec-19	E1a	EAa

Total and Dissolved Metals

For total metal analyses, the applicable replicate criterion was exceeded on by:

- Five occasions for aluminum (five RPDs ranging from 47.7% to 148.1% and one significant difference of 0.011 mg/L).
- One occasion for cadmium (significant difference of 0.0000163 mg/L).
- Three occasions for copper (three RPDs ranging from 35.9% to 119.2%).
- Three occasions for iron (RPD= 48.2% and two significant differences of 0.093 mg/L and 0.130 mg/L).

Total metal comparisons are available in Table 1 of Appendix D. There are 12 exceedances of the applicate replicate criterion for total metals in 2019. This is a substantial decrease compared to the 22 from 2018. In 2019 there were 12% of results that did not meet the replicate criteria. Comparatively, 2016 and 2018 have the same 22% percent of results that did not meet the replicate criteria, while 2017 retained only 10%. Note that there is some degree of variability that can be expected in replicate samples for parameters such as total metals, which are influenced by total suspended solids (TSS).

For dissolved metals analyses, the applicable replicate criterion was exceeded on by:

- Eight occasions for cadmium (eight RPDs ranging from 30.3% to 58.4%).
- Two occasions for copper (RPD=34.8% and RPD=34.2%).
- Three occasions for manganese (three RPDs ranging from 30.8% and 146.2%).
- Six occasions for selenium (six RPDs ranging from 33.3% and 59.3%).

All dissolved metal comparisons are available in Table 2 of Appendix D. In 2019 there were 20% of results that did not meet the replicate criteria. Comparatively, 2017 and 2018 have the same 9% while 2016 has 16% of its replicates that did not meet the replicate criteria.

General Parameters

For general parameters (ammonia, total nitrogen, total phosphorus, TDS and turbidity), the applicable replicate criterion was exceeded on one occasion for ammonia (significant difference of 0.0115 mg/L), five occasions for total nitrogen (five RPDs ranging from 31.1% to 73.2%), four occasions for total phosphorus (significant differences of 0.011 mg/L, 0.0116 mg/L, 0.0129 mg/L and 0.0103 mg/L), one occasion for TDS (RPD=35.7%) and seven occasions for turbidity (seven RPDs ranging from 30.3% to 84.4%) (Table 3, Appendix D).

For E-coli and total coliform analysis, no differences were identified between samples. All results were below detection limit (Table 4, Appendix D).

No inter-laboratory replicate was collected in 2019.

Blanks

Trip/travel blanks and field blanks, prepared by the analytical laboratory, do not contain the variables to be analyzed. The blanks are exposed to the same conditions and treatments as the water samples collected and are intended to monitor contamination that may occur during sampling or shipping. Field blanks are opened and preserved at a sample location to expose them to the natural environment and trip blanks remain closed at all times. Trip blanks are not opened and are pre-preserved and are submitted to the laboratory with sample sets for total suspended solids, total metals, and nutrient and anion analysis, as well as dissolved organic carbon analysis for field blanks.

Trip Blanks

In 2019, 35 trip blanks were submitted to ALS, as listed in Table 4.5

Table 4.5 Trip blanks sent for analysis in 2019

Date Sampled	Area
2-Jan-19	Mine Site
16-Jan-19	Mine Site
5-Feb-19	Mine Site
5-Feb-19	Hazeltine Creek
27-Feb-19	Mine Site
5-Mar-19	Mine Site
21-Mar-19	Mine Site
3-Apr-19	Mine Site
1-May-19	Mine Site
16-May-19	Mine Site

Date Sampled	Area
22-May-19	Bootjack Lake
3-Jun-19	Mine Site
3-Jun-19	Mine Site
6-Jun-19	Polley Lake
18-Jun-19	Quesnel Lake
2-Jul-19	Mine Site
9-Jul-19	Mine Site
30-Jul-19	Mine Site
7-Aug-19	Mine Site
7-Aug-19	Mine Site
13-Aug-19	Polley Lake
15-Aug-19	Mine Site
29-Aug-19	Quesnel Lake
9-Sep-19	Mine Site
12-Sep-19	Mine Site
16-Sep-19	Bootjack Lake
8-Oct-19	Mine Site
9-Oct-19	Polley Lake
30-Oct-19	Quesnel Lake
4-Nov-19	Hazeltine Creek
14-Nov-19	Mine Site
19-Nov-19	Mine Site
20-Nov-19	Mine Site
9-Dec-19	Mine Site
18-Dec-19	Mine Site

Ammonia, total barium, total chromium, total lead, total phosphorus, total tin and total suspended solids (TSS) were above detection limits in one or more of the trip blanks (Table 6, Appendix D). Total phosphorus and total lead were greater than five times the detection limit; results are provided in Table 4.6.

Table 4.6. Summary of trip blank results that are 5x detection limit

Date Sampled	Parameter	Detection Limit	Result
27-Feb-19	Total Phosphorus (mg/L)	0.0020	0.0110
22-May-19	Total Lead (mg/L)	0.000050	0.000291

The trip blank parameters that are above detection limit were rechecked by ALS laboratory. A code is associated with the parameters in the ALS results spreadsheet to indicate that the result was rechecked and verified.

Field Blanks

Thirty-six field blanks listed in Table 4.8 were submitted to ALS in 2019. Dissolved organic carbon (DOC), total aluminum, total phosphorus, total manganese, total selenium, dissolved cadmium and dissolved tin were above detection limits in one or more of the field blanks. These results were within five times the reported detection limit so was determined not to affect the reliability of the data except for total phosphorus, which was greater than five times the detection limit in one instance (Table 4.7) (Table 7, Appendix D).

Table 4.7 Summary of field blank results that are 5x detection limit

Date Sampled	Parameter	Detection Limit	Result
2-Jul-19	Total Phosphorus (mg/L)	0.0020	0.0115

The field blank parameters that are above detection limit are rechecked by ALS laboratory. A code is associated with the parameters in the ALS results spreadsheet to indicate that the result was rechecked and verified. Investigations for the parameters above detection limit are on-going.

Table 4.8 Field blanks sent for analysis in 2019

Date Sampled	Area
2-Jan-19	Mine Site
8-Jan-19	Hazeltine Creek
5-Feb-19	Mine Site
14-Feb-19	Mine Site
27-Feb-19	Mine Site
4-Mar-19	Hazeltine Creek
6-Mar-19	Mine Site
2-Apr-19	Hazeltine Creek
3-Apr-19	Mine Site
17-Apr-19	Mine Site
1-May-19	Mine Site
14-May-19	Hazeltine Creek
16-May-19	Polley Lake
3-Jun-19	Mine Site
3-Jun-19	Mine Site
11-Jun-19	Mine Site
25-Jun-19	Bootjack Lake
2-Jul-19	Hazeltine Creek
2-Jul-19	Mine Site
30-Jul-19	Polley Lake
7-Aug-19	Mine Site
7-Aug-19	Mine Site
19-Aug-19	Quesnel Lake
29-Aug-19	Quesnel Lake
9-Sep-19	Mine Site
10-Sep-19	Hazeltine Creek
1-Oct-19	Edney Creek
8-Oct-19	Mine Site
23-Oct-19	Bootjack Lake
4-Nov-19	Mine Site
20-Nov-19	Mine Site
26-Nov-19	Mine Site
26-Nov-19	Mine Site
2-Dec-19	Hazeltine Creek
12-Dec-19	Mine Site
18-Dec-19	Mine Site

Filter Blanks

Filter blanks are prepared by filtering deionized water and submitting it for dissolved metals analysis. This tests for potential sample contamination during in-field filtering of dissolved metals samples. Two filter blanks were submitted in 2019. All parameters analyzed in the filter blanks were below reported detection limits (Table 8, Appendix D).

De-ionized Water Blanks

Deionized water blanks are prepared by submitting a full sample suite (minus dissolved metals since filter blanks are prepared) of deionized water. One deionized water blank was submitted in 2019; all parameters were below reported detection limit except for turbidity (Table 9, Appendix D).

Equipment Blanks

Equipment blanks are collected to test for potential sample contamination being introduced from sampling equipment. When conducting lake water quality sampling, an equipment blank sample is taken with the Kemmerer (KEM1 or KEM 2) sampler monthly during each sampling program. When groundwater samples are collected within the quarter according to the 2018 *CEMP*, an equipment blank is collected. MPMC has two groundwater pumps: Grundfos (GW-Grundfos) and Low-flow (GW Low-Flow). Equipment blanks (KEM 1 or KEM 2) are submitted to the laboratory for full sample suites for lake quality sampling (minus dissolved metals since filter blanks using syringes are also prepared); while groundwater equipment blanks (GW-Grundfos and/or GW Low-Flow) are submitted for physical tests, anions and nutrients and dissolved metals.

Five Kemmerer equipment blanks were taken in 2019, as shown in Table 4.9.

Table 4.9 Equipment blanks taken in 2019

Date Sampled	Equipment
12-Feb-19	KEM2
5-Mar-19	KEM2
25-Apr-19	KEM2
21-Aug-19	KEM2
21-Nov-19	KEM2

Ammonia, total nitrogen, total phosphorus and DOC were above detection limits in one or more of the equipment blanks (Table 10, Appendix D). A summary of results for the KEM blanks that are greater than five times the detection limit is provided Table 4.10.

Table 4.10 Summary of KEM2 blank results that are 5x detection limit

Date Sampled	Parameter	Detection Limit	Result
21-Aug-19	DOC (mg/L)	0.50	15.4
21-Nov-19	Total Phosphorus (mg/L)	0.0020	0.0110

The equipment blank parameters that are above detection limit are rechecked by ALS laboratory. A code is associated with the parameters in the results spreadsheet to indicate that the result was rechecked and verified.

Six groundwater equipment blanks were taken in 2019, as shown in Table 4.11. Both groundwater pumps were used in the last quarter of 2019.

Table 4.11 Summary of groundwater equipment blanks

Date Sampled	Equipment
3-Apr-19	GW-Grundfos
3-Jun-19	GW-Low Flow
4-Jun-19	GW-Grundfos
21-Aug-19	GW-Low Flow
21-Aug-19	GW-Grundfos
20-Nov-19	GW-Low Flow
20-Nov-19	GW-Grundfos

Conductivity, alkalinity, ammonia, total barium, total calcium, total manganese, total molybdenum, total phosphorus, nitrate and nitrite, nitrate, total nitrogen, turbidity, sulfate, dissolved cadmium, dissolved calcium, dissolved manganese, dissolved molybdenum, dissolved sodium, dissolved silicon, dissolved strontium and dissolved zinc were all above detection limits in one or more of the equipment blanks (Table 10, Appendix D). A summary of results for the GW-Grundfos blanks that are greater than five times the detection limit is provided in Table 4.12.

Table 4.12 Summary of GW-Grundfos blank results that are 5x detection limit

Date Sampled	Parameter	Detection Limit	Result
3-Apr-19	Total Manganese (mg/L)	0.00010	0.00073
4-Jun-19	Turbidity (NTU)	0.10	9.30
4-Jun-19	Alkalinity (mg/L))	1.0	1.7
4-Jun-19	Total Phosphorus (mg/L)	0.0020	0.0120
20-Nov-19	Dissolved Calcium (mg/L)	0.050	0.418

The equipment blank parameters that are above detection limit are rechecked by ALS laboratory. A

code is associated with the parameters in the results spreadsheet to indicate that the result was rechecked and verified.

4.5Data Quality Review and Data Management

A data quality review was conducted for results, including screening of laboratory QA/QC data, sample integrity issues, detection limits achieved, and metadata accuracy, as well as potential outliers/extreme values. This information was catalogued in the MPMC sample tracking spreadsheet described in Section 4.4.

MPMC uses the MonitorPro (MP-5 database) by EHS Data Limited for data management: soil, sediment, and tissue chemistry data were uploaded to separate MP-5 databases prior to the cyberattack and the data are now currently managed via spreadsheets and filed on the MPMC network. After the cyberattack, the MP-5 database responsible for water chemistry samples and in situ parameters was rebooted and water chemistry data using files generated by the analytical laboratory, as well as weather station downloads were uploaded into the MP-5 database. Accompanying field data were manually entered and uploaded into the MP-5 database. Original laboratory-produced results files are filed on the MPMC network according to location, and date, and are linked to the data stored in the MP-5 database. Sample names, dates, and times are cross-referenced with the MPMC sample tracking sheet before final upload to the database and field data undergo a QC screening prior to upload. Parameter restrictions are in place in the MP-5 database to reduce the likelihood of a typographical or laboratory reporting error being uploaded. Any errors identified by the MP-5 database underwent further audit before final acceptance.

Non-chemistry data, including toxicity testing results, benthic invertebrate and plankton taxonomy data, and hydrology data (logger downloads and FlowTracker exports) are filed according to year and sample location on the MPMC network.

4.5.1 Rating Curve Development

Stage-discharge rating curves were developed for the hydrometric stations by relating manual water level and stream discharge measurements acquired by MPMC (velocity-based measurements using a SonTek FlowTracker) and WaterSmith (dry salt slug injection tracer method [Hudson and Fraser, 2005]). The rating curves were fit statistically [R Development Core Team, 2010] using a nonlinear least-squares regression model of the following generic form:

$$Q = 10^{(a + b \log 10(H - c))}$$

where

Q is discharge, m^3/s,

H is stage (m),

a, b, and c are regression coefficients.

Vented pressure transducers (model INW PT2x) were installed at various sites to continuously monitor water level at 10-minute intervals during non-freezing months. According to the manuals, INW PT2x sensors maintain a sensor accuracy of ±0.25% (Seametrics 2016). A linear relation was developed between the automatically recorded pressure and the manual staff gauge readings at each station. Stage values estimated from the pressure readings using the stage-pressure relation were then be substituted into the rating curve equation to estimate stage-discharge at a 10-minute interval throughout the monitoring season. Any estimation above the highest measured discharge is considered an extrapolation.

Statistical analyses of the manual gauge readings are reported in Section 4.8 and in Appendix L.

As required by Section 3.4 of the *EMA* Permit 11678, calibration measurements (taken by a dry salt slug injection tracer method) and benchmarking surveys of hydrological stations were conducted by a QP, in this instance, WaterSmith, on July 12, 2019. Details of the site visit are reported in Sections 4.8 and Appendix L.

Routine monitoring incorporates inspections of equipment, including stilling wells and loggers (*e.g.*, to identify sedimentation inside the stilling well, debris build up in logger ports). QA/QC of all collected data were completed to identify potential station changes or issues like spurious errors and drifts in the automated data. This process included comparisons with previously collected data.

4.6 Climate

EMA Permit 11678 Section 3.6 (Appendix A) requires the collection of detailed meteorology data. The objective of this data collection program is to provide site-specific precipitation, temperature, and evaporation data for use in water balance calculations and hydrological predictions. Mount Polley Mine maintains two automated HOBO weather stations. These stations monitor temperature, rainfall, solar radiation, relative humidity, wind direction, wind speed, and wind gust speed. Weather Station #1 is located approximately one km southeast of Polley Mountain and was installed in September 2012. Due to battery issues, only partial data were retrievable from Station #1 in July. Weather Station #2 is located northeast of the TSF (between the Rock Quarry and Biosolids Storage Facility) and was installed in November 2012. Due to equipment and battery issues, only partial data were retrievable from Station #2 in January, March, May, June and August, and no data were retrievable in February and September to December. MPMC is actively working to repair Station #2. A summary of the monthly site precipitation, evaporation, and temperature data collected in 2019 is provided in Table 4.13.

Evaporation is calculated by using the Penman-Monteith equation using the WaSIM software developed by Cranfield University. Snowfall measurements are based on monthly snowpack testing done at multiple locations across the site. These measurements are taken at the end of every month, as well as between melting and snowfall events, if forecasted. The snow course method aligned with the Snow Survey Sampling Guide (ENV, 1981).

Table 4.13 Mount Polley 2019 monthly precipitation, evaporation, and temperature data

Month	Monthly Precipitation as Rain (mm)	Monthly Snowpack (mm Snow Water Equivalent)	Evaporation (mm)	Average Temperature (°C)	Maximum Temperature (°C)	Minimum Temperature (°C)
January	0.0	196	5.1	-2.74	3.54	-13.31
February	0.0	230	14.1	-2.51	0.25	-31.12
March	0.0	98	43.3	-2.58	17.95	-14.9
April	13.7	0	203	12.09	23.55	-2.62
May	19.2	0	121.5	11.57	25.11	-1.5
June	37.5	0	125.4	11.85	24.32	2.32
July	78.6	0	26	23.36	36.99	12.73
August	27.1	0	109.1	14.39	26.52	6.51
September	59.4	0	46	9.44	24.2	-3.3
October	3.6	0	22.9	1.53	10.54	-8.83
November	0.2	0	11.2	-2.17	8.30	-16.28
December	0.2	67.5	12.5	0.46	1.0	-8.0

4.6.1 Wind Monitoring

During an audit by WaterSmith in January 2019, it was found that the wind sensor was directed incorrectly at Weather Station #1. The wind sensor was rotated 180° and data have been adjusted accordingly. Wind data for 2019 shows high speed winds are typically observed from the northwest which is consistent with previous years' data except for 2018 where winds were observed from a southeast direction.

4.6.2 Temperature

In 2019, the lowest monthly mean temperature was -2.74 °C recorded in January, and the highest monthly mean temperature was 23.36 °C recorded in July. Temperatures were colder than average in June and August to November but were warmer than average for the rest of the year when compared to site data collected since 1995. Figure 4.1 presents a comparison of 2019 maximum, mean, and minimum monthly temperatures with average monthly temperature data (based on data collected at Mount Polley since 1995). This data is shown in tabular form in Table 4.13.

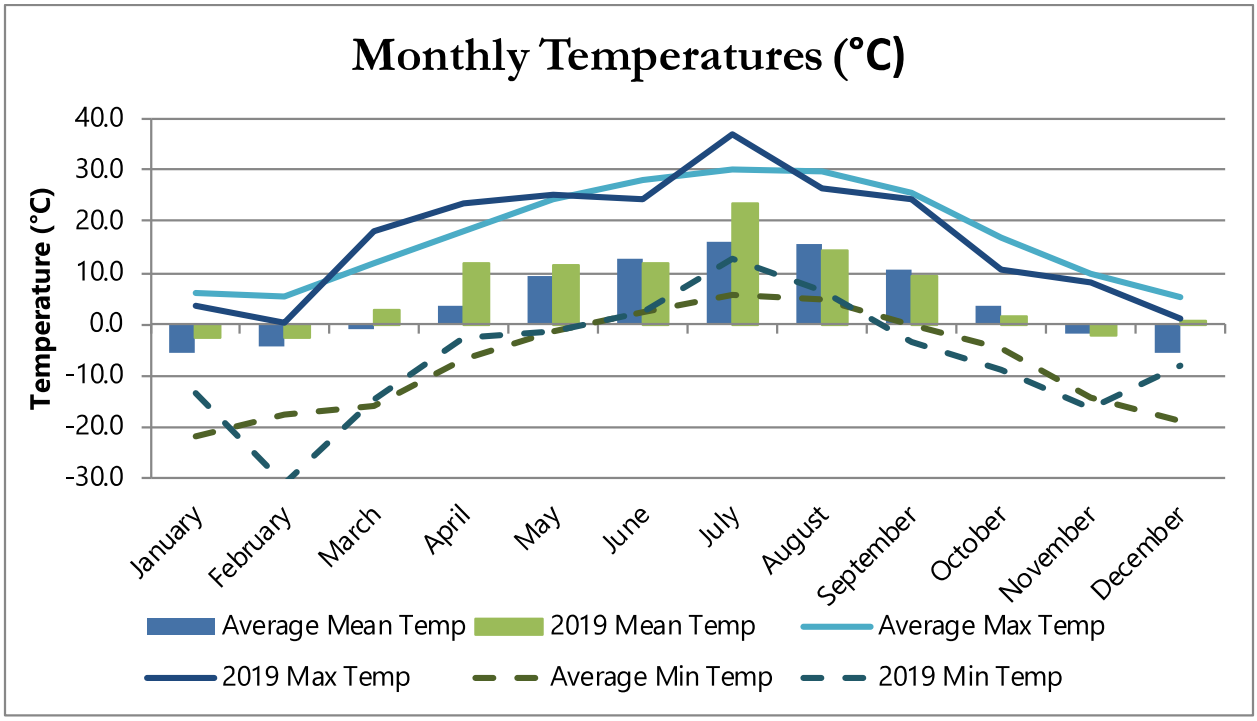

Figure 4.1 Maximum, mean and minimum monthly temperature data for Mount Polley (2019 versus average)

4.6.3 Precipitation

In 2019, 472 millimetres (mm) of precipitation were recorded: 240 mm as rain and 232 mm as snow water equivalent (SWE). This is below the average annual precipitation of 627 mm, with rainfall below its respective annual average but with snowfall above its respective annual average. The 2019 snowpack peaked in March at 232 mm SWE, above the annual average of 176 mm SWE. Total rainfall was lower compared to monthly averages for all months, except in July (79 mm) and September (59 mm). The driest non-freezing month was May, with 19 mm of rain recorded. Precipitation data by month are presented in Table 4.13, Figure 4.2 and Figure 4.3. All precipitation averages are calculated based on data collected at the Mount Polley Mine site since 1995.

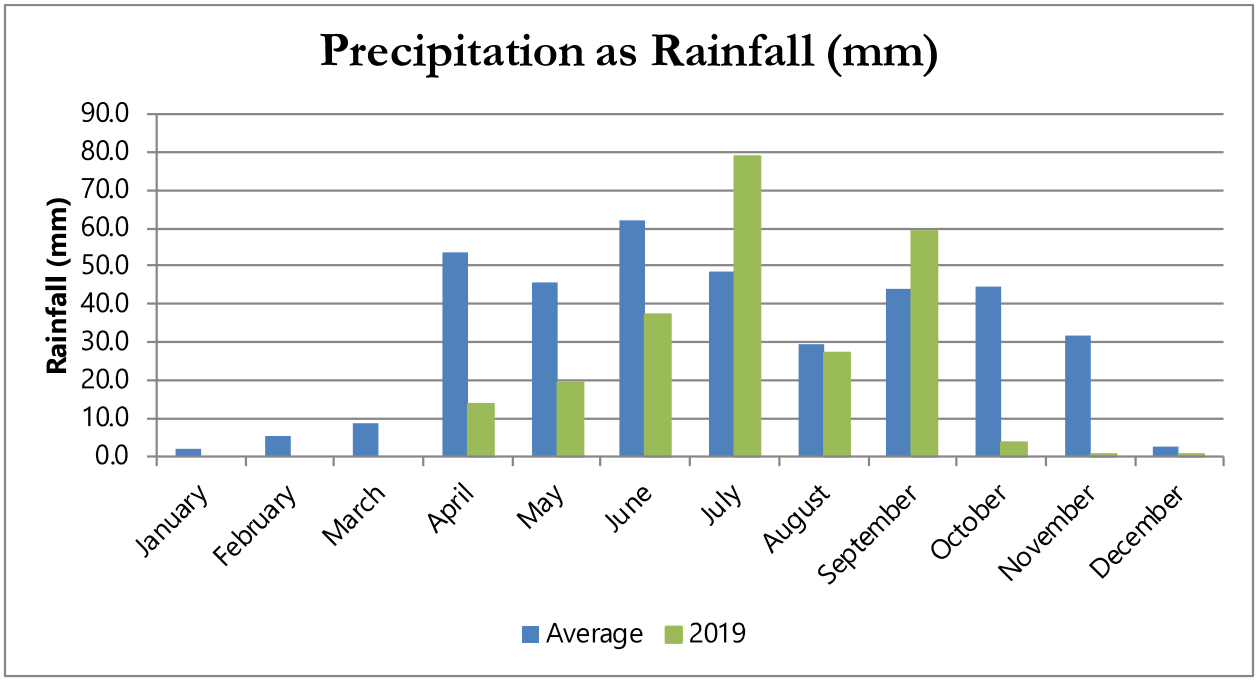

Figure 4.2 Monthly rainfall at Mount Polley (2019 versus average)

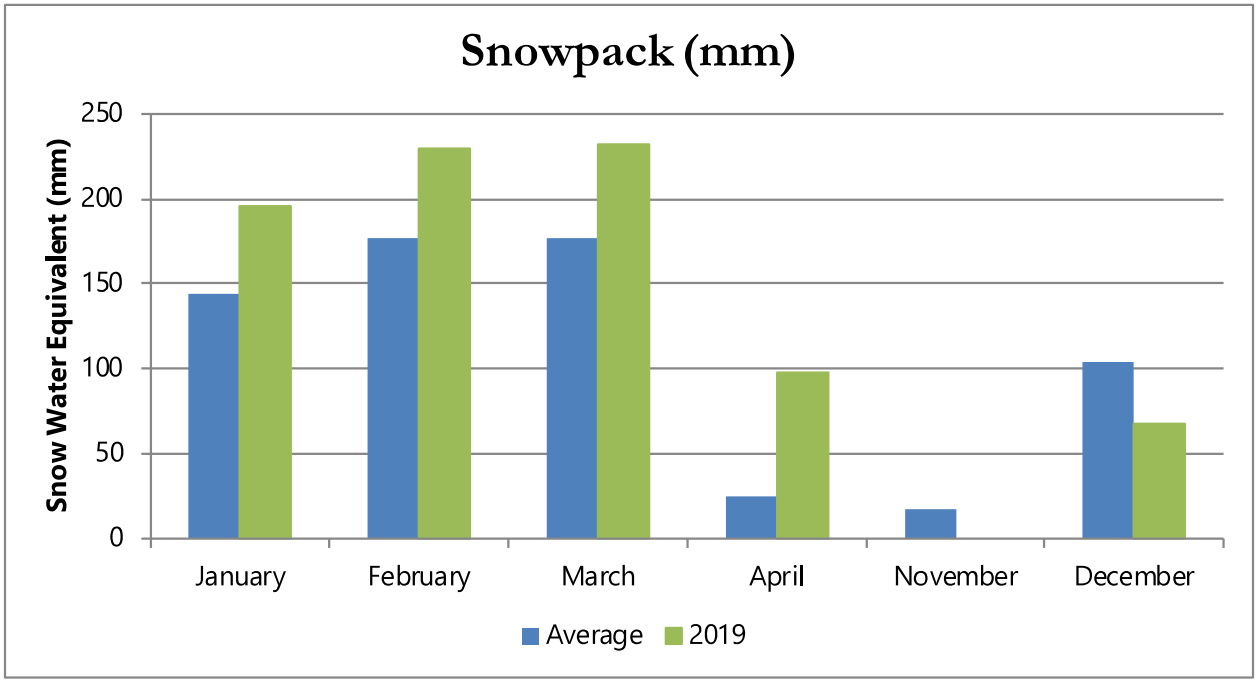

Figure 4.3 Monthly snowpack at Mount Polley (2019 versus average)

4.6.4 Evaporation

Total open water evaporation in 2019 was calculated to be 740 mm. June experienced the greatest amount

of evaporation at 125 mm. Monthly evaporation data are presented in Table 4.13. Figure 4.4 presents monthly comparisons of precipitation and evaporation for 2019.

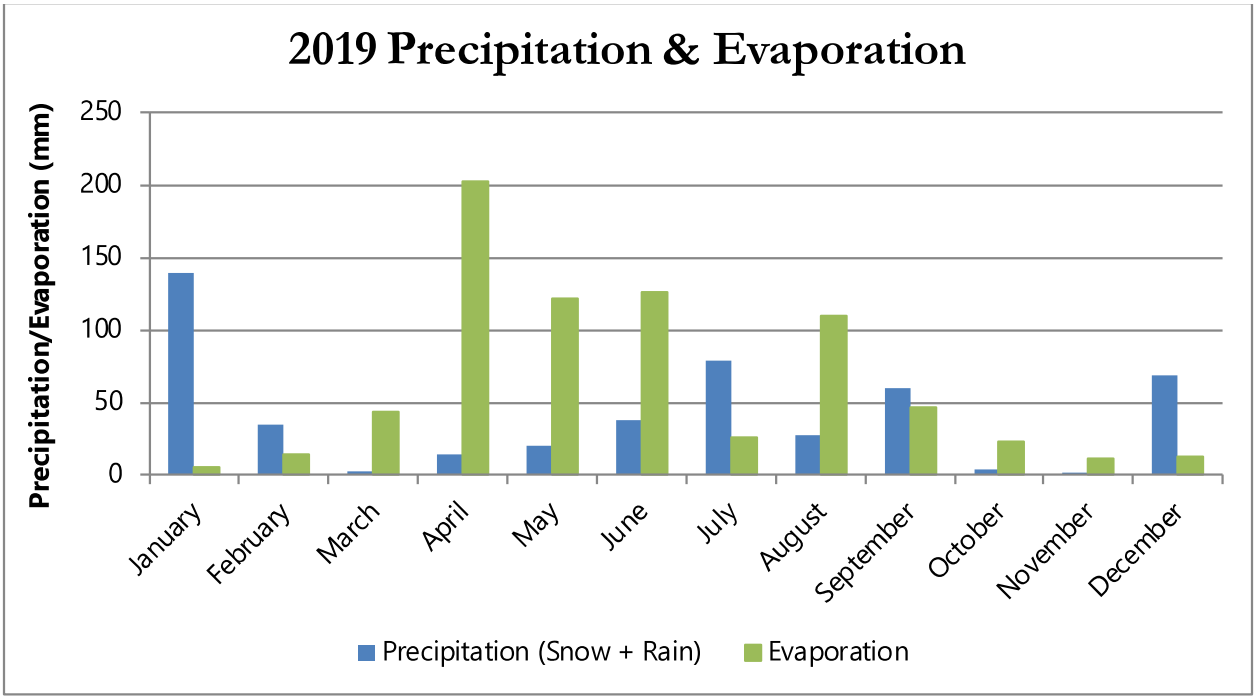

Figure 4.4 Mount Polley 2019 monthly precipitation and evaporation

4.7 Surface Water Monitoring

4.7.1 Hazeltine Creek

Water quality was monitored weekly and monthly at various sites throughout Hazeltine Creek in accordance with the 2016 and 2018 *CEMP* in 2019 (see Table 4.14). Flows in the creek are regulated by the Polley Lake weir structure.

Discharge from the WTP into Hazeltine Creek ceased in 2017; therefore, no comparisons from the previous years' data will be made as the conditions have changed since 2018.

Hazeltine Creek water quality is provided in Appendix F.

Table 4.14 2019 sampling events in Hazeltine Creek

Site Name	Site Identifier (EMS No.)	Full Sample Suite Frequency 2016 *CEMP*	Full Sample Suite Frequency 2018 *CEMP*	Actual Sampling Events
HAC-01c	E303953	Weekly	Monthly	12
HAC-05a	E304510	Monthly	Monthly	12
HAC-08	E303013	Monthly	Monthly	12
HAC-10	E303010	Monthly	Monthly	12
HAC-14		N/A	Monthly[a]	10
HAC-13	E304810	Weekly	Monthly	12

[a] Monthly only from March to November - not accessible during winter months; was sampled twice in April.

4.7.1.1 BC WQG at HAC-10

HAC-10 is located immediately downstream of the Polley Lake weir. The weir was opened and closed from January to end of April to facilitate flows and freshet. As stated above, for the rest of 2019, the weir remained open for fish. Samples were collected monthly; therefore, chronic BC WQG for aquatic life are not applicable. No exceedances in acute BC WQGs for aquatic life occurred at HAC-10 in 2019.

4.7.1.2 BC WQG at HAC-13

HAC-13 is located midway in Reach 1 in Upper Hazeltine Creek. Samples were collected monthly at this site, therefore the chronic BC WQG for aquatic life are not applicable. No exceedances in acute BC WQGs for aquatic life occurred at HAC-13 in 2019.

4.7.1.3 BC WQG at HAC-05a

HAC-05a is located upstream of the Gavin Lake road bridge. Samples were collected monthly; therefore, chronic BC WQG for aquatic life are not applicable. No exceedances in acute BC WQG for aquatic life occurred at HAC-05a in 2019.

4.7.1.4 BC WQG at HAC-08

HAC-08 is located upstream of the Ditch Road bridge (on the Likely-Horsefly forest service road) at Lower Hazeltine Creek. Samples were collected monthly; therefore, chronic BC WQG for aquatic life are not applicable.

Table 4.15 Summary of acute BC WQG for aquatic life exceedances at HAC-08

Site	Parameter	Results	Acute BC WQG (mg/L)
HAC-08	Total copper	2 exceedances	0.006 [a], 0.0275 [b]
	Total iron	2 exceedances	1.0
	Turbidity	3 exceedances	Change from background 2 NTU at any one time for a duration of 30 d in all waters during clear flows or in clear waters

[a] Hardness dependent copper guideline.
[b] Copper guideline calculated with BLM software.

Total copper: There were two acute BC WQG for aquatic life exceedances in 2019. Two exceedances occurred in July and October during periods of heavy rain. The maximum concentration was 0.141 mg/L in October, with an annual average hardness of 151 mg/L, and an annual total copper average of 0.0285 mg/L.

Total iron: There were two acute BC WQG for aquatic life exceedances in 2019. Two exceedances occurred in July and October during periods of heavy rain. The maximum result was 4.74 mg/L in October; the annual average of total iron was 0.887 mg/L.

Turbidity: There were three acute BC WQG for aquatic life exceedances in 2019. Change from background of 2 NTU at any one time for a duration of 30 days occurred in July (47.6 NTU), October (89.4 NTU) and November (11.5 NTU), during high rainfall events. The annual average was 15.1 NTU with a maximum result of 89.4 NTU in October.

4.7.1.5 BC WQG at HAC-01c

HAC-01c replaced HAC-12 in late 2017 and is located approximately 150 m downstream of HAC-12. HAC-01c represents the outlet of Hazeltine Creek to Quesnel Lake without the influence of discharge from the WTP. The previous outlet location, HAC-12, was influenced by the WTP discharge and therefore, the previous years' water quality results were not comparable with those from 2018 or 2019. Samples were collected monthly in 2019; therefore, chronic BC WQG for aquatic life are not applicable.

Table 4.16 Summary of acute BC WQG for aquatic life exceedances at HAC-01c

Site	Parameter	Results	Acute BC WQG (mg/L)
HAC-01c	Total copper	1 exceedance	0.003-0.040[a]
	Total iron	1 exceedance	1.0
	Turbidity	1 exceedance	Change from background 2 NTU at any one time for a duration of 30 d in all

			waters during clear flows or in clear waters

Total copper: There was one acute BC WQG for aquatic life exceedance in 2019. The exceedance occurred in May during the freshet period. The maximum concentration was 0.0205 mg/L in April, with an annual average hardness of 160 mg/L, and an annual total copper average of 0.013 mg/L.

Total iron: There was one acute BC WQG for aquatic life exceedance in 2019. The exceedance occurred in May during the freshet period. The maximum result was 1.45 mg/L in May; the annual average of total iron was 0.0298 mg/L.

Turbidity: There was one acute BC WQG for aquatic life exceedance in 2019. Change from background of 2 NTU at any one time for a duration of 30 days occurred in May (21.7 NTU), during the freshet period. The annual average was 5.0 NTU with a maximum result of 21.7 NTU in May.

4.7.1.6 Supplemental Sites: POF-1 and POF-5

Additional monitoring was continued in the Polley Flats to identify any potential influential sources seeping into Hazeltine Creek. Site POF-1 was established in 2016 and was sampled 12 times in 2019. An addition source, POF-5, was established in summer 2017 and was sampled 7 times in 2019 and was dry the rest of the year and therefore, could not be sampled. Influence from these sites will be monitored by upstream and downstream samples of established sites in Hazeltine Creek in 2020. Sampling details are provided in Section 4.3 and the water quality is provided in Appendix F.

4.7.2 Aquatic Receiving Environment

Surface water monitoring and analysis was conducted as outlined in the *CEMP* (Appendix A). Refer to Section 4.3 for a discussion of field sampling equipment and methodology. Sampling stations and frequency are summarized in Table 4.17 and locations are shown in Appendix B.

Table 4.17 Sampling events in 2019 at surface water quality sites

Site	Site Identifier (EMS No.)	Frequency			
		2016 *CEMP*	2018 *CEMP*	Actual	Total
W1	E225084	Monthly	Quarterly	4	4
W4a	E298551	Monthly	Monthly	12	20
		Weekly [a]		8	
W5	E208039	Monthly	Monthly	11 [b]	19
		Weekly [a]		7	
W8	E216743	Quarterly	Quarterly	6 [c,d]	13
		Weekly [a]		7	
W8z	E223292	Quarterly	Quarterly	4	4
W10	E291209	Monthly	Semi-annually	4	4
EDC-01	E303014	Monthly	Semi-annually	4	4
W12	E216744	Quarterly	Quarterly	4	4
W20	E297070	Quarterly	Semi-annually	2	2

[a] Weekly TSS and turbidity sampling for five (5) weeks during spring freshet and autumn low flows.

[b] Frozen in February 2019.

[c] Frozen in March 2019.

[d] Frozen in January 2019.

Samples were submitted to ALS for analysis of:

- Physical parameters (pH, turbidity, TSS, total dissolved solids, and hardness);
- Anions and nutrients (alkalinity, chloride, fluoride, sulphate, total nitrogen, nitrate, nitrite, ammonia, phosphorus total and dissolved, and ortho-phosphorus);
- Organics (dissolved organic carbon); and
- Total and dissolved metals (metals suite as listed in *CEMP* Appendix A).

Water chemistry results from the surface sites were compared with the BC WQG for aquatic life for both short-term (maximum or acute) and long-term (chronic) exposures. In 2019, there were 23 exceedances of the acute BC WQG for aquatic life at the permitted surface water monitoring sites (Table 4.18). Note that the list of analytes with concentrations greater than BC WQG is similar to baseline.

At sites W4a, W5, and W8 weekly intensive sampling of TSS and turbidity occurred during spring (freshet) and fall (low flow period); and a 30-day average could be calculated; these were therefore appropriately compared to chronic TSS and turbidity BC WQG as summarized in Table 4.19. Additional details for each site are provided in the following sections and Appendix F (which includes tables of results for the past five years and graphs of select parameters). Note that only parameters with trends and/or exceedances are discussed the sections below. Note that results below method detection limit (MDL) are represented as half (0.5x) the MDL in statistical calculations and graphs.

Table 4.18 Summary of acute BC WQG exceedances for aquatic life at surface water monitoring sites

Site	Parameter	Results	Acute BC WQG (mg/L)
W5	Dissolved aluminum	6 exceedances - see Section 4.7.2.3; 0.113 mg/L, 0.183 mg/L, 0.116 mg/L, 0.148 mg/L, 0.195 mg/L, 0.107 mg/L	0.1
	Total copper	5 exceedances - see Section 4.7.2.3; 0.0101 mg/L, 0.0702 mg/L, 0.0133 mg/L, 0.0103 mg/L, 0.0136 mg/L	0.0003-0.0040 [(a)]
W8	Dissolved aluminum	2 exceedances – see Section 8.1.5 for details; 0.128 mg/L, 0.180 mg/L	0.1
W8z	Dissolved aluminum	3 exceedances - see Section 4.7.2.5 for details; 0.201 mg/L, 0.252 mg/L, 0.257 mg/L	0.1
	Total copper	0.00503 mg/L	0.0040 [(a)]
W20	Dissolved aluminum	0.208 mg/L; 0.171 mg/L	0.1
W10	Dissolved aluminum	0.159 mg/L	0.1
EDC-01	Dissolved aluminum	0.103 mg/L	0.1

(a) Hardness dependent copper guideline; range given is based on hardness range at each site, when available.

Table 4.19 Summary of chronic BC WQG exceedances for aquatic life at surface water monitoring sites. This only applies to sites where five samples were collected in 30 days.

Site	Parameter	Results	Chronic BC WQG (mg/L)
W5	TSS	1 exceedance; 24.1 mg/L	5 mg/L change from background in 30 days
	Turbidity	1 exceedance; 2.56 NTU	2 NTU change from background in 30 days

4.7.2.1 Site W1 – Morehead Creek (E225084)

This site has been monitored since 1990. It was sampled 4 times in 2019 and has been sampled 44 times over the past 4 years. There is no notable increasing or decreasing trend in water quality at this location. Graphs for a subset of parameters are provided in Appendix F.

Total copper: Though no monitoring results showed exceedances of acute BC WQG for copper in 2019, these types of exceedances have been observed since monitoring began in 1990 (before mining began). From 2016 to 2019 the minimum recorded value for copper was 0.00273 mg/L, the maximum was 0.0243 mg/L, and the mean was 0.00652 mg/L. The mean value for copper in 2019 was 0.00521 mg/L.

Dissolved aluminum: No exceedances of acute BC WQGs for dissolved aluminum occurred in 2019. In 2018, monitoring results in November showed one exceedance of the BC WQG for dissolved aluminum. This result appears to be an outlier (potentially a sampler or lab error) as it is the only observed exceedance for dissolved aluminum at this location, and there were no other elevated parameters observed in this

sample. With the 2018 outlier of 0.24 mg/L removed the mean value for dissolved aluminum at W1 between 2016 and 2019 was 0.0442 mg/L and the mean value since monitoring began is 0.043 mg/L.

Sulphate: A slight increase in sulphate levels has been recorded at W1 since 2005, though the levels remain well below any guidelines. From 2016 to 2019 the minimum recorded sulphate value was 4.32 mg/L and the maximum was 30 mg/L with a mean of 8.71 mg/L. The mean for 2019 was 6.3 mg/L and the mean value since monitoring began is 6.39 mg/L.

Chloride: From 2016 to 2019 the minimum recorded chloride value was 0.84 mg/L, the maximum was 73.9 mg/L and the mean was 4.98 mg/L. The mean value for 2019 was 1.37 mg/L and the mean since monitoring began is 3.39 mg/L.

4.7.2.2 Site W4a – North Dump Creek below Wight Pit Road (E298551)

This site has been monitored since 2014. W4a was sampled 12 times in 2019 for full metals suites and 8 times for turbidity and TSS only. Between 2016 and 2019 W4a has been sampled 48 times for full metals suites and 30 times for turbidity and TSS only. Graphs are provided in Appendix F. There were no acute or chronic exceedances at this location in 2019. In comparison with previous years, there was one exceedance in November 2014, two in April and November 2015, one in April 2016, and three in April, May, and November 2017. Most exceedances have occurred during freshet in spring, however, during random periods of heavy rains in summer and fall, it is not uncommon to see spikes. There is no notable increasing or decreasing trend in water quality at this location.

Total copper: There were no exceedances in acute BC WQG at this site in 2019. Between 2016 and 2018 there were three acute exceedances for total copper in 2018: 0.0172 mg/L in April, 0.0104 mg/L in May, and 0.0164 mg/L in November. In 2016 there was one acute WQG exceedance and in 2017 there were three. Generally, these exceedances correspond to elevated TSS in the sample. The elevated TSS is a result of a rainfall or run-off event. Between 2016 and 2019 the minimum concentration of copper recorded at W4a is 0.0033 and the maximum concentration is 0.0724 mg/L. The mean concentration between 2016 and 2019 is 0.0095 mg/L and the mean for 2019 is 0.0072 mg/L.

Dissolved aluminum: From 2016 to 2019 the minimum recorded dissolved aluminum is 0.003 mg/L, the maximum is 0.1 mg/L and the mean is 0.019 mg/L. In 2019 the mean is 0.017 mg/L.

TSS: Between 2016 and 2019 there were 12 exceedances generally related to rainfall and runoff events. Between 2016 and 2019 the minimum value is <1.0 mg/L, the maximum is 138 mg/L and the mean is 8.91mg/L. In 2019 the mean value is 3.49 mg/L.

Turbidity: Between 2016 and 2019 there were four exceedances generally related to rainfall and runoff

events. Between 2016 and 2019 the minimum value is 0.18 NTU, the maximum is 145 NTU and the mean is 4.31 NTU. In 2019 the mean value is 1.55 NTU.

Total iron: Between 2016 and 2019 there was one acute exceedance for total iron (in 2017). This exceedance may have had road runoff influence as the field notes express that the water was cloudy at the time of sampling. Between 2016 and 2019 the minimum value is 0.033 mg/L, the maximum is 1.49 mg/L and the mean is 0.216 mg/L. In 2019 the mean value is 0.162 mg/L.

Total selenium: From 2016 to 2019 the minimum recorded total selenium is 0.0005 mg/L, the maximum is 0.0098 mg/L and the mean is 0.0016 mg/L. In 2019 the mean is 0.0015 mg/L.

4.7.2.3 Site W5 – Bootjack Creek (E208039)

This site has been monitored since 1990. It was sampled 11 times in 2019 for full metals suite and 7 times for TSS and turbidity only and has been sampled 43 times for full metals suite and 29 times for TSS and turbidity only over the past four years. There was no flow observed at this site in July and December 2017, February and August of 2018 and February of 2019. There is no notable increasing or decreasing trend in water quality at this location. Graphs for a subset of parameters are provided in Appendix F.

Due to the TSF breach in August 2014, Bootjack Creek no longer flows directly to Hazeltine Creek resulting in a disconnection in fish habitat. In October 2014, fish were salvaged and are excluded from Bootjack Creek.

Sulphate: From 2016 to 2019 the minimum recorded sulphate was 1.22 mg/L and the maximum was 106 mg/L with a mean of 13.62 mg/L. The mean for 2019 was 8.62 mg/L and the mean value since monitoring began is 15.12 mg/L.

Dissolved aluminum: In 2019 there were 6 exceedances of the acute BC WQG for dissolved aluminum at this location. Between 2016 and 2019 there have been 20 exceedances of the acute guideline for dissolved aluminum at this location. Dissolved aluminum has been elevated at this monitoring location since before the mine was established and there is no observed increasing trend. Between 2016 and 2019 the minimum value recorded is 0.0079 mg/L, the maximum is 0.309 mg/L and the mean is 0.109 mg/L. The mean for 2019 is 0.111 mg/L.

Total copper: There were 5 acute BC WQG exceedances of total copper in 2019. Between 2016 and 2019 there were 22 exceedances of the acute BC WQG at this location. As with dissolved aluminum, this site had elevated copper since before the mine was established and there is no observed increasing trend. Between 2016 and 2019 the minimum value recorded is 0.0026 mg/L, the maximum is 0.0702 mg/L and the mean is 0.0113 mg/L. The mean for 2019 is 0.0156 mg/L.

TSS: In 2019 there was one exceedance of the acute BC WQG. Between 2016 and 2019 the minimum value

recorded is <1.0 mg/L, the maximum is 102 mg/L and the mean is 6.009 mg/L. The mean for 2019 is 16.887 mg/L.

Turbidity: In 2019 there was one exceedance of the acute BC WQG. Between 2016 and 2019 the minimum value is 0.18 NTU, the maximum is 21.2 NTU and the mean is 2.172 NTU. In 2019 the mean value is 2.476 NTU.

4.7.2.4 Site W8 – Northeast Edney Creek Tributary (E216743)

This site has been monitored since 1995. It was sampled 6 times in 2019 for full metals suite and 7 times for TSS and turbidity only and has been sampled 20 times for full metals suite and 31 times for TSS and turbidity only over the past four years.

Dissolved aluminum: There were two acute exceedances at this location in 2019. Between 2016 and 2019 there have been 8 exceedances of the acute guideline for dissolved aluminum at this location. Dissolved aluminum has been elevated at this monitoring location since before the mine was established and there is no observed increasing trend. Between 2016 and 2019 the minimum value recorded is 0.0039 mg/L, the maximum is 0.231 mg/L and the mean is 0.0877 mg/L. The mean for 2019 is 0.0982 mg/L.

Total copper: Between 2016 and 2019 the minimum value recorded is 0.0007 mg/L, the maximum is 0.0087 mg/L and the mean is 0.0032 mg/L. The mean for 2019 is 0.0031 mg/L.

Total chromium: Between 2016 and 2019 the minimum value recorded is 0.0005 mg/L, the maximum is 0.0015 mg/L and the mean is 0.0009 mg/L. The mean for 2019 is 0.0008 mg/L.

TSS: Between 2016 and 2019 the minimum value recorded is 1.1 mg/L, the maximum is 26.5 mg/L and the mean is 3.67 mg/L. The mean for 2019 is 3.26 mg/L.

Turbidity: Between 2016 and 2019 the minimum value recorded is 0.22 NTU, the maximum is 3.12 NTU and the mean is 1.18 NTU. The mean for 2019 is 1.26 NTU.

4.7.2.5 Site W8z – Southwest Edney Creek Tributary (E223292)

This site has been monitored since 1997. It was sampled four times in 2019 and has been sampled 13 times over the past four years.

Dissolved aluminum: There were three acute BC WQG exceedances at this location in 2019. All samples collected at this location since 1997 except for one have exceeded the BC WQG for dissolved aluminum. Between 2016 and 2019 the minimum value recorded is 0.187 mg/L, the maximum is 0.406 mg/L and the mean is 0.257 mg/L. The mean for 2019 is 0.248mg/L.

Total copper: There was one acute BC WQG exceedance at this location in 2019. Between 2016 and 2019 there have been five exceedances of the acute guideline for total copper at this location. As with dissolved aluminum, this site had elevated copper since before the mine was established and there is no observed increasing trend. Between 2016 and 2019 the minimum value recorded is 0.0032 mg/L, the maximum is 0.0067 mg/L and the mean is 0.0049 mg/L. The mean for 2019 is 0.0043 mg/L.

Dissolved iron: There were no acute BC WQG exceedances at this site in 2019. Between 2016 and 2019 there have been four exceedances of the acute guideline for dissolved iron at this location. As with dissolved aluminum, this site had elevated dissolved iron since before the mine was established and there is no observed increasing trend. Between 2016 and 2019 the minimum value recorded is 0.187 mg/L, the maximum is 0.643 mg/L and the mean is 0.365 mg/L. The mean for 2019 is 0.293 mg/L.

Total chromium: Though there were no acute BC WQG exceedances in chromium at this site in 2019, as with many sites and many parameters the water at this site is naturally elevated with chromium and almost always exceeds the BC WQG. Between 2016 and 2019 the minimum value recorded is 0.0009 mg/L, the maximum is 0.0018 mg/L and the mean is 0.0014 mg/L. The mean for 2019 is 0.0014 mg/L.

TSS: Between 2016 and 2019 the minimum value recorded is <1.0 mg/L, the maximum is 1.0 mg/L and the mean is 1.0 mg/L. The mean for 2019 is 1.0 mg/L.

Turbidity: Between 2016 and 2019 the minimum value recorded is 0.50 NTU, the maximum is 2.65 NTU and the mean is 1.25 NTU. The mean for 2019 is 0.79 NTU.

4.7.2.6 Site W10 – Edney Creek (E291209)

Prior to this becoming a permitted site there were only a few samples collected here since 1995. This site is a reference site, selected for comparisons to the sites downstream from the mine disturbance, including a site in the re-engineered channel of Edney Creek. Graphs are provided in Appendix F. This site was sampled four times in 2019.

Dissolved aluminum: There was one acute BC WQG exceedance at this site in 2019 and 13 exceedances of BCWQG between 2016 and 2019. This site has had elevated dissolved aluminum since before the mine was established and there is no observed increasing trend. Between 2016 and 2019 the minimum value recorded is 0.0033 mg/L, the maximum is 0.202 mg/L and the mean is 0.059 mg/L. The mean for 2019 is 0.0715 mg/L.

Total copper: There were no acute BC WQG exceedances at this site in 2019. Between 2016 and 2019 the minimum value recorded is 0.0009 mg/L, the maximum is 0.0047 mg/L and the mean is 0.0026 mg/L. The mean for 2019 is 0.0028 mg/L.

Total chromium: Between 2016 and 2019 the minimum value recorded is 0.0006 mg/L, the maximum is 0.0016 mg/L and the mean is 0.0010 mg/L. The mean for 2019 is 0.0009 mg/L.

TSS: Between 2016 and 2019 the minimum value recorded is <1.0 mg/L, the maximum is 27.1 mg/L and the mean is 5.40 mg/L. The mean for 2019 is 2.35 mg/L.

Turbidity: Between 2016 and 2019 the minimum value recorded is 0.1 NTU, the maximum is 7.38 NTU and the mean is 1.76 NTU. The mean for 2019 is 1.54 NTU.

4.7.2.7 Site EDC-01 – Edney Creek below constructed channel (E303014)

Located just upstream of the mouth of the creek near Quesnel Lake, this site was established in February 2015 after the newly constructed Edney Channel was completed and opened to fish passage. This site is used to monitor any potential impacts on Edney Creek from the new construction. This site was sampled four times in 2019. Considering W10 as the background site for Edney Creek, the following observations are noted:

Dissolved aluminum: There was one acute BC WQG exceedance at this site in 2019 and 7 exceedances between 2016 and 2019. Between 2016 and 2019 the minimum value recorded is 0.003 mg/L, the maximum is 0.172 mg/L and the mean is 0.053 mg/L. The mean for 2019 is 0.052 mg/L. Comparing these results to W10, the levels at EDC-01 were similar.

Total copper: There were no acute BC WQG exceedances at this site in 2019. One exceedance is noted at this site in 2016 and another in 2018. Between 2016 and 2019 the minimum value recorded is 0.002 mg/L, the maximum is 0.0085 mg/L and the mean is 0.0043 mg/L. The mean for 2019 is 0.0035 mg/L. Comparing these results to W10, the levels at EDC-01 were similar.

Total iron: There were no acute BC WQG exceedances at this site in 2019, however, one exceedance is noted in 2018. Between 2016 and 2019 the minimum value recorded is 0.044 mg/L, the maximum is 1.11 mg/L and the mean is 0.286 mg/L. The mean for 2019 is 0.202 mg/L. Comparing these results to W10, the levels at EDC-01 were similar.

Total chromium: Between 2016 and 2019 the minimum value recorded is 0.00054 mg/L, the maximum is 0.002 mg/L and the mean is 0.0010 mg/L. The mean for 2019 is 0.0079 mg/L. Comparing these results to W10, the levels of chromium at EDC-01 were similar.

Sulphate: Between 2016 and 2019 the minimum value recorded is 1.33 mg/L, the maximum is 65.4 mg/L and the mean is 15.40 mg/L. The mean for 2019 is 4.49 mg/L. Comparing these results to W10, the levels at EDC-01 were similar.

TSS: Between 2016 and 2019 the minimum value recorded is <1.0 mg/L, the maximum is 26.7 mg/L and the mean is 6.00 mg/L. The mean for 2019 is 2.7 mg/L. Comparing these results to W10, the levels at EDC-01 were similar.

Turbidity: Between 2016 and 2019 the minimum value recorded is 0.17 NTU, the maximum is 10.9 NTU and the mean is 2.16 NTU. The mean for 2019 is 1.03 NTU. Comparing these results to W10, the levels at EDC-01 were similar.

4.7.2.8 Site W12 – 6K Creek at Road (E216744)

This site has been monitored since 1990. It was sampled four times in 2019 and has been sampled 15 times over the past four years. There is no notable increasing or decreasing trend in water quality at this location. Graphs for a subset of parameters are provided in Appendix F.

Total copper: Between 2016 and 2019 the minimum value recorded is 0.0024 mg/L, the maximum is 0.0137 mg/L and the mean is 0.0060 mg/L. The mean for 2019 is 0.0058 mg/L. This site had elevated copper since before the mine was established.

Dissolved aluminum: Between 2016 and 2019 the minimum value recorded is 0.0041 mg/L, the maximum is 0.0957 mg/L and the mean is 0.0292 mg/L. The mean for 2019 is 0.0272 mg/L.

Sulphate: A slight increase in sulphate levels has been recorded at W12 since 2005, though the levels remain well below any guidelines. From 2016 to 2019 the minimum recorded sulphate was 3.73 mg/L and the maximum was 61.6 mg/L with a mean of 19.79 mg/L. The mean for 2019 was 14.39 mg/L and the mean value since monitoring began is 9.73 mg/L.

TSS: Between 2016 and 2019 the minimum value recorded is <1.0 mg/L, the maximum is 10.0 mg/L and the mean is 3.4 mg/L. The mean for 2019 is < 1.0 mg/L.

Turbidity: Between 2016 and 2019 the minimum value recorded is 0.33 NTU, the maximum is 2.63 NTU and the mean is 1.06 NTU. The mean for 2019 is 0.56 NTU.

4.7.2.9 Site W20 – W20 Creek (E297070)

This site has been monitored since 2013 when the West Ditch was constructed. In 2019 four samples were collected. There have been no trends or notable changes in water quality at this location. Graphs for a subset of parameters are provided in Appendix F.

Dissolved aluminum: Though there were no acute BC WQG exceedances in 2019, most samples at this location have high dissolved results. Between 2016 and 2019 the minimum value recorded is 0.0363 mg/L,

the maximum is 0.229 mg/L and the mean is 0.153 mg/L. The mean for 2019 is 0.138 mg/L.

Total copper: Between 2016 and 2019 the minimum value recorded is 0.00365 mg/L, the maximum is 0.00829 mg/L and the mean is 0.0060 mg/L. The mean for 2019 is 0.0052 mg/L.

4.7.3 Lake Sampling

In 2019, lake sampling was completed as outlined in the 2016 and 2018 *CEMP* in Appendix A (Table 4.20). Refer to Section 4.3 for a discussion of field sampling equipment and methodology and Appendix B for site map.

Appendix M includes tables of all results for the past five years and graphs of the parameters measured.

Table 4.20 Lake water quality sampling locations in 2019

Site	Site Identifier (EMS No.)	Profile Frequency		Sample Frequency	
		CEMP	Actual	Permit Requirement	Actual
P1	E207974	Monthly[a]	7	Spring overturn, twice in summer, fall overturn, once under ice	9
P2	E207975	Monthly[a]	8	Spring overturn, twice in summer, fall overturn, once under ice	10
B1	E207972	Monthly[a]	6	Semi-annually	4
B2	E215897	Monthly[a]	6	Semi annually	4
B4	E216744	For closure only	-	For closure only	-
QUL-ZOO-1	E306455	Semi-annually	3	Semi-annually	3
QUL-ZOO-7	E306456	Semi-annually	3	Semi-annually	3
QUL-ZOO-8	E306457	Semi-annually	1[b]	Semi-annually	1[b]
QUL-2a	E303020	Four times annually	5	Four times annually	5
QUL-18	E303019	Four times annually	4	Four times annually	4
QUL-120a	E303022	Semi-annually	2	Semi-annually	2

[a] When accessible
[b] Site was removed from the sampling program in June 2019

4.7.3.1 Bootjack Lake

In Bootjack Lake, station B1 is located at the northwest end of the lake and station B2 is located at the southeast end. It was discovered that in late 2016, the previous stations were not at the deepest locations

for the 2016 monitoring season and these sites were relocated to the deepest areas for monitoring in 2017 and continued in 2018 and 2019. Sampling occurred during spring turnover in May, in late summer in August and September and during fall turnover in October in 2019. Limnological profiles were taken monthly between spring and fall turnover at B1 and B2. Profile and chemistry data are presented in Appendix M.

In 2016, four locations (B3, B4, B5, and B6) were created near areas of potential exfiltration from the Springer Pit supernatant. Based on the 2016 results it was determined in 2017 that one location, B4, would be profiled bi-monthly, as the Springer Pit supernatant is well below the recommended 1030 masl (Golder, 2016a). This monitoring was discontinued in 2019.

In Situ Data

In 2019, MPMC recorded profile data at B1 and B2 six times. Limnological profiles of pH, conductivity, dissolved oxygen, turbidity, and temperature as well as Secchi depth were measured at B1 and B2 from May to October 2019. During the lake turnover events in spring and fall 2019 as well as throughout the year, field parameters were consistent with previous years.

Lake Water Chemistry

Water samples for analytical chemistry were collected at surface, bottom, and every 10 m when the lake is isothermal and at surface, bottom, and every 5 m when the lake is not isothermal at sites B1 and B2. Appendix M contains water chemistry data tables with results from the last five years.

Bootjack Lake has been routinely sampled for water quality twice a year during spring turnover and in late August. In 2017, total iron, total manganese, and total phosphorus levels exceeded aquatic BC WQGs for samples collected near the bottom of B1 and B2 during sampling events in September, due to conditions at the bottom becoming anoxic with the fall turnover. Historically, MPMC has not sampled during fall turnover on Bootjack Lake and therefore did not have baseline data for comparison. Late August does appear to signal the start of the anoxic conditions associated with fall turnover seen in 2017, with B1 changing earlier than B2, possibly due to its slightly shallower depth. The water quality from 2018 and 2019 is consistent with this trend, as subtle increases of total manganese (2018 and 2019), total iron (2018 and 2019) and total phosphorus (2019) were noticed in August. There are no other significant changes in water chemistry in Bootjack Lake.

4.7.3.2 Polley Lake

In Polley Lake, station P1 is located at the deepest point at the north end of Polley Lake and station P2 is located at the deepest point at the south end of Polley Lake and are shown in Appendix B. Sampling occurred monthly between spring and fall overturn; limnological profiles were conducted monthly along with the Secchi depth during the same period as per *CEMP* (Appendix A). Only one sampling event occurred

in winter 2019 at P1 and P2. Profile and chemistry data are presented in Appendix M.

Polley Lake was impacted by the TSF embankment breach that occurred in 2014 (MPMC, 2015a) and sample results for water quality show that some water chemistry results are elevated from historic and baseline levels. All results are included in Appendix M.

In Situ Data

In 2019, MPMC recorded profile data at P1 and P2 10 times. Profiles of pH, specific conductivity, dissolved oxygen, turbidity and temperature were measured at P1 and P2 twice a month in May and June 2019; only profile data was collected on June 24, 2019 as spring lake turnover had already occurred. During the lake turnover events in spring and fall 2019 as well as throughout the year, field parameters were consistent with previous post-breach years.

In Polley Lake, conductivity historically ranged from 121 to 215 µS/cm, with an average of 186 µS/cm. Following the breach, the conductivity increased to a maximum of 410 µS/cm at P1 and 396.9 µS/cm at P2 in September 2015, with an average of 284.2 µS/cm. Conductivity throughout Polley Lake appears to be decreasing slightly since the breach; however, it remains above historic levels. In 2019, the average conductivity recorded at P1 was 258 µS/cm and at P2 was 259 µS/cm, which is similar to 2018, 2017, and 2016, but lower than 2015.

In Polley Lake, pH historically ranged between 6.90 and 9.55 with an average of 8.27 at P1 and from 7.12 and 9.55 with an average of 8.34 at P2. Following the breach, pH remains similar with a range of 6.72 to 8.75 at P1 with an average of 7.77 and from 6.7 to 8.79 with an average of 7.85 at P2.

Water Chemistry

In 2018, water samples for analytical chemistry were collected at surface, bottom, and every 5 m when conditions were not isothermal and every 10 m when isothermal at sites P1 and P2. These data are presented in Appendix M.

Polley Lake has met all BC WQG for aquatic life parameters in 2019 with the exception of total phosphorus, which has been elevated since prior to mining. Some trending parameters are discussed below:

Total copper: Copper concentrations have been higher since 2014 with an average of 0.0046 mg/L compared with the average of 0.0023 mg/L pre-breach. In 2019, the maximum total copper concentration recorded was 0.010 mg/L, which was similar to 2018 with 0.0103 mg/L and 2017 with 0.0104 mg/L but higher than 2016 and 2015 (0.0079 mg/L and 0.0068 mg/L respectively).

Total selenium: Selenium concentrations have decreased to below pre-breach. The pre-breach average was 0.0009 mg/L compared to 0.0007 mg/L in the years after 2014. The maximum recorded in 2019 was

0.0006 mg/L and an average of 0.0005 mg/L. While an initial increase was noted following the breach with a maximum of 0.0012 mg/L, the downward trend was obvious, in 2015, 2016, 2017 and 2018 with maximum concentrations of 0.0011 mg/L, 0.008 mg/L, and 0.007 mg/L and 0.006 mg/L, respectively.

Minnow has installed DGTs in Polley Lake since 2015 and have provided memos that have been appended to previous years' annual reports (MPMC 2016b, 2017e, 2018f). According to Minnow, total and dissolved metals over-represent the metal fraction that is potentially available for uptake by aquatic organisms in natural surface waters. Minnow's technical memos describe the methods and results for the DGT deployments. Key findings for Polley Lake include that mean DGT-labile copper concentrations are very low, however they are higher than in Bootjack Lake (reference), and DGT labile concentrations in Polley Lake of arsenic, molybdenum, selenium and vanadium were enriched compared to Bootjack Lake. However, total concentrations of these metals were below the BC WQG.

4.7.3.3 Quesnel Lake

Quesnel Lake Zooplankton Sites

In Quesnel Lake, site QUL-ZOO-1 is located in the centre of the West Basin, QUL-ZOO-7 is located in front of Horsefly Bay, and QUL-ZOO-8 is located at the junction of the North, East and West Arms (Appendix B). Sampling and limnological profiles occurred semi-annually as per the CEMP (Appendix A). In 2019, samples were collected in June, July and August. There were no acute BC WQG exceedances at these sites in 2019. MPMC continues to collect profile and surface water quality data from these sites to be used in the analysis of plankton results (see Section 4.15).

Quesnel Lake Receiving Environment and Reference Sites

According to the 2018 *CEMP*, the far-field receiving environment in Quesnel Lake are monitored at QUL-18 (the deepest area of the West Basin, downstream far-field exposure station) and QUL-2a (West Basin upstream of the mouth of Hazeltine Creek; to monitor for potential eastward flow of effluent due to seiche events). Sampling and limnological profiles at depths occurred five times at QUL-2a and four times at QUL-18 in 2019 (Appendix A).

An upstream reference station, QUL-120a, is located east of Cariboo Island. Sampling and limnological profiles at depths outlined in the 2018 *CEMP* (Appendix A) occurred semi-annually in June and August 2019 to coincide with zooplankton sampling events.

The 2018 *ADP* identified no significant differences in water quality between QUL-2a and QUL-120a. This analysis spearheaded the change for the background water quality reference site from QUL-120a to QUL-2a. Location QUL-2a also poses less of a safety risk and is the closest up-gradient site the discharge and water quality at a depth of 40m was shown a greater representation of what would be measured at the IDZ (MPMC, 2018b; Appendix I). This change was reflected in the 2018 *CEMP*.

Lake Water Chemistry

Quesnel Lake is an oligotrophic lake, therefore, it is common to see total phosphorus concentrations lower than the BC WQG, as was observed at all sites in Quesnel Lake (Appendix M), except for certain locations discussed below. No acute BC WQG exceedances were found in any of the receiving environment sites for 2019. Since only four times annual or semi-annual sampling is conducted at QUL-18, QUL-2a, and QUL-120a, the required five samples taken in 30 days to calculate the chronic average was not met. Therefore, these comparisons are for screening purposes only and are discussed below. Additional information related to the discharge water quality are in Section 4.12.2 and discharge plume modeling in Quesnel Lake are in Appendix J.

At QUL-18 in 2019, there were no observed changes or trends in the water quality at this site. An increase in total phosphorus at the surface, 20m, and 50m depths (0.141 mg/L, 0.097 mg/L, and 0.046 mg/L respectively) in late August of 2018 was noted. This may have been due to remnants of spawning and debris from the wildfires; the total phosphorus limit is only applicable during spring overturn at the epilimnetic water if residence time exceeds 6 months (according the BC WQG for total phosphorus – nutrients and algae), therefore, total phosphorus remained in compliance with the BC WQG. Total phosphorus concentrations at the surface, 20m and 50m depths decreased in August 2019. The average of total phosphorus in 2019 at QUL-18 was 0.0036 mg/L and the maximum concentration was 0.0055 mg/L throughout the water column (Figure 4.5). There was one instance of total copper exceeding the chronic BC WQG at 100 m depth in August 2019. Concentrations have exceeded chronic limits at a 100 depth once in August 2018, once in April 2017 and three times in 2016 (May, June, and November); and once at 20 m depth in November 2016 (Figure 4.6). The average of total copper in 2019 at QUL-18 was 0.0010 mg/L and the maximum concentration was 0.0025 mg/L throughout the water column.

At QUL-2a, there were no observed changes or trends in the water quality at this site in 2019. One higher total phosphorus concentration (0.0488 mg/L) occurred at the surface in May in 2018 but decreased (0.0041 mg/L) in 2019. Observations collected during the 2018 sample event noted an abundance of pollen on the surface (Figure 4.8). The working BC WQG for total chromium was exceeded at QUL-2a-60m in September 2018 with a result of 0.0019 mg/L (note this sample result appears to be an outlier, potentially from a contaminated sample vessel or sampling error as all other sample results for this site are below the detection limit of 0.0005 mg/L); however, a decrease in total chromium was observed in August and October 2019 (<0.00050 mg/L). There were two instances of total copper exceeding the chronic BC WQG at surface and at 40 m depth in July 2018. The only other time a result exceeded the chronic limit occurred at 60 m depth in May 2016 (Figure 4.8). The average of total copper in 2019 at QUL-2a was 0.0008 mg/L and the maximum concentration was 0.0012 mg/L throughout the water column.

At QUL-120a, there were no observed changes or trends in the water quality at this site. However, an increase in total phosphorus at 120m and 140m depth in late August 2018 (0.0436 mg/L and 0.077 mg/L respectively) was noted. This may be due to remnants of spawning and debris from the wildfires; the total phosphorus limit is only applicable during spring overturn at the epilimnetic water if residence time exceeds

6 months (according the BC WQG for total phosphorus – nutrients and algae), therefore, total phosphorus remains in compliance with the BC WQG (Figure 4.6). Copper results remain below BC WQG at QUL-120a (Figure 4.7). There were no trends observed and no acute or chronic exceedances were found at QUL-120a in the 2019 sampling events.

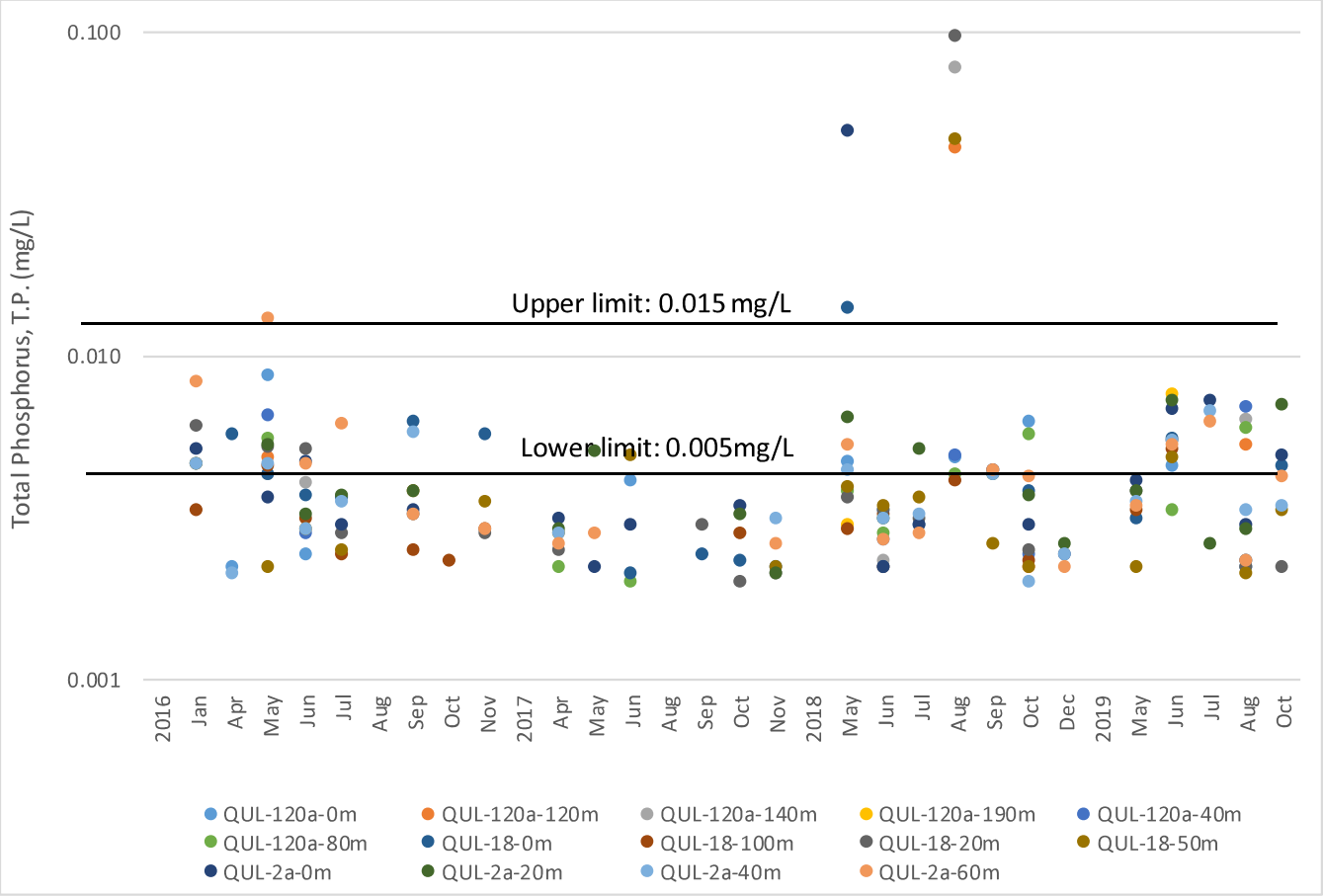

Figure 4.5 Total phosphorus concentrations at QUL-120a, QUL-2a, and QUL-18 from 2016 to 2019.

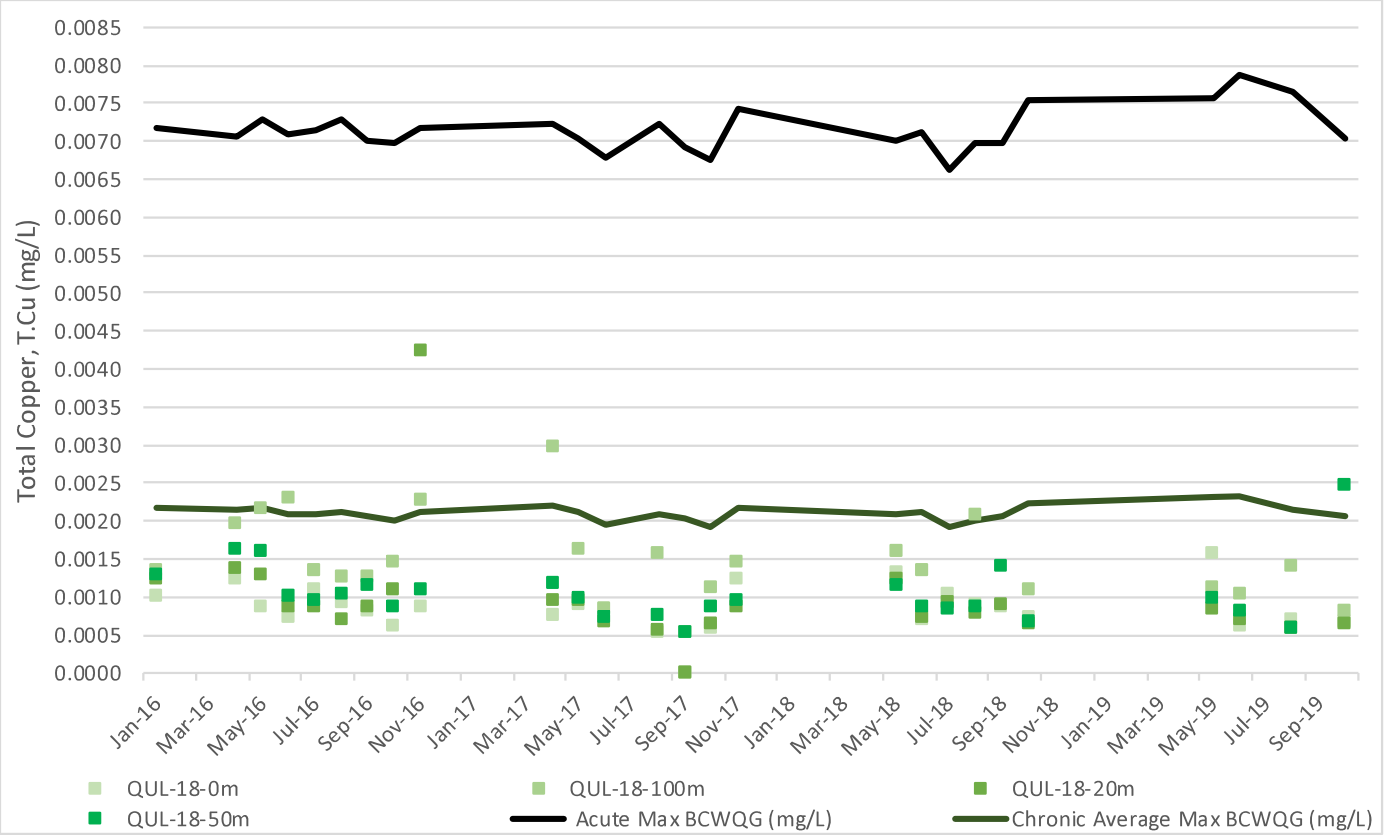

Figure 4.6 Total copper results at QUL-18 from 2016 to 2019

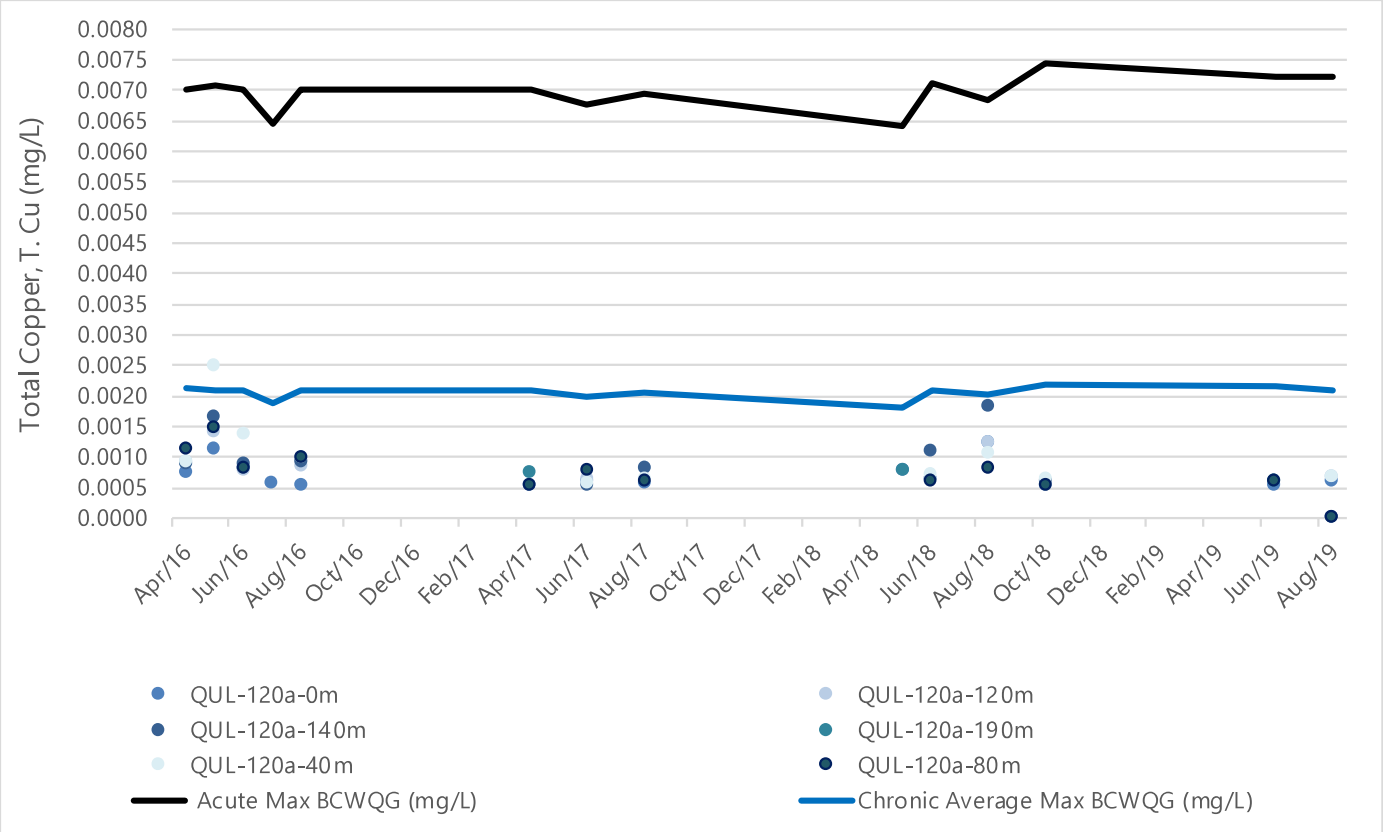

Figure 4.7 Total copper results at QUL-120a from 2016 to 2019

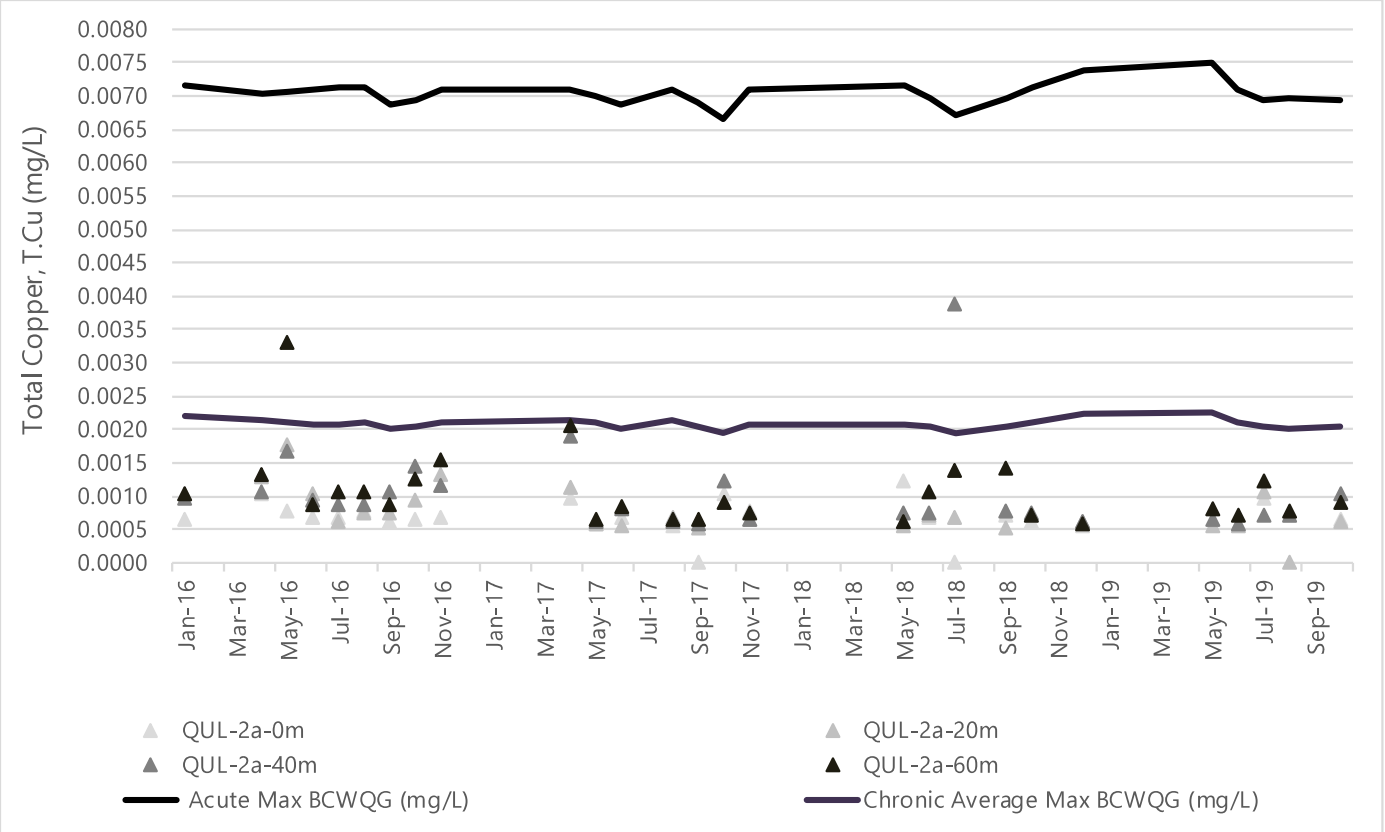

Figure 4.8 Total copper concentrations at QUL-2a from 2016 to 2019

4.8Hydrology

4.8.1 Rating Curve Development

Stage-discharge rating curves were developed for the hydrometric stations by relating manual staff gauge and stream discharge measurements acquired by MPMC (velocity-based measurements using a SonTek FlowTracker) and WaterSmith (dry salt slug injection tracer method [Hudson and Fraser, 2005]). The rating curves were fit statistically [R Development Core Team, 2010] using a least-squares regression model based on one of the following generic forms:

$$Q = a + b\,H \quad (1)$$

$$Q = 10^{(a + b\log10(H - c))} \quad (2)$$

where

Q is discharge, m^3/s,

H is stage (m),

a, b, and c are regression coefficients.

Vented pressure transducers (model INW PT2x) were installed at multiple stations to continuously monitor water pressure (i.e., relating to water level) at 10-minute intervals during non-freezing months. According to the manual, PT2x sensors maintain a sensor accuracy of ±0.25% (Seametrics 2016). For stations with automated pressure transducers, a linear relation was developed between the automatically recorded pressure and the manual staff gauge readings. Stage values estimated from the pressure recordings using the stage-pressure relations were then substituted into the stage-discharge rating curve equations to estimate discharge at a 10-minute interval throughout the monitoring season. Any estimation above or below the highest measured discharge is considered an extrapolation.

Statistical analyses of the manual staff gauge readings are reported in Section 4.8, and in Appendix L.

As required by Section 3.4 of the *EMA Permit 11678,* calibration measurements (taken by a dry salt slug injection tracer method) and benchmarking surveys of hydrological stations were conducted by a qualified professional (WaterSmith) on July 10, 2019. Details of the site visit are reported in Sections 4.8.

Routine monitoring incorporated inspections of equipment, including stilling wells and loggers (e.g., to identify sedimentation inside the stilling well, debris build up in logger ports). QA/QC of all collected data was completed to identify spurious errors and/or drifts in the manual and automated data, or potential station changes. This process included comparisons with previously collected data.

4.8.2 Hydrology – Hazeltine Creek

In 2019, hydrological monitoring in Hazeltine Creek was completed at sites H1 (Upper Hazeltine Creek), H2 (Lower Hazeltine Creek), and H4 (Polley Lake outlet), as required by Section 3.4 of *EMA* Permit 11678 and *CEMP*. Manual flow measurements were taken at these stations from April through November when flow rates were sufficient. Flow was controlled by the Polley Lake weir continuously in 2019 and not indicative of the natural flow regime. The flow was maintained due to the reintroduction of fish back into the remediated areas of upper Hazeltine Creek.

Tables and figures presenting the 2019 hydrology results are presented in Appendix L, including hydrographs, stage-discharge rating curves, pressure-stage relations, goodness of fit statistics, and photographs.

4.8.3 Site H1 - Upper Hazeltine Creek

Six staff gauge readings and manual flow measurements were taken between May 24 and November 12, 2019. The highest manually measured discharge was 0.40 m^3/s on November 12, 2019.

Pressure transducer data from a PT2x were recorded from May 21 to November 12, 2019. The PT2x was removed in November due to freezing temperatures. There are no gaps in the automated pressure record; however, only values between 0.15 m^3/s and 0.40 m^3/s were retained in the resulting automated discharge dataset, as the rating curve remains under development after reconstructing the weir in August 2018.

Moreover, automated discharge data were not generated for periods in the fall when the recorded water temperature was below 0.5ºC, due to an elevated potential for ice build-up on the weir crest. The stilling well was raised by 9.5 cm on July 9, 2019, as the weir reconstruction increased the pool depth and sediment was accumulating in the pool. The automated data were adjusted to account for raising the well. Otherwise, a benchmark survey conducted on July 10, 2019 by WaterSmith indicated the stilling well and staff gauge had been stable.

From August to October 2018, remediation work occurred below the Gavin Lake bridge causing flow to be diverted from the H1 hydrology station. A rating curve shift may have occurred; possibly due to infilling of the substrates at the weir crest due to fish habitat construction, resulting in water levels being higher for a given discharge. There were instream works in the vicinity of the H1 site in 2019. An assessment of the goodness of fit of the manual readings to the stage-discharge rating curve yielded a mean absolute difference of 2% and a standard error of 3%. Flow was steady through most of the record and increased in October and November 2019 from heavy precipitation and from opening the Polley Lake control structure to release excess water that had been impounded in Polley Lake due the discharge control regime associated with downstream construction work.

4.8.4 Site H2 - Lower Hazeltine Creek

Six staff gauge readings and manual flow measurements were taken between May 29 and November 12, 2019. The highest manually measured discharge was 0.55 m^3/s on October 24, 2019.

Pressure transducer data from a PT2x were recorded from March 18 to November 12, 2019. The PT2x was removed in November 2019 due to freezing temperatures. There are no gaps in the automated pressure record; however, automated discharge data were not generated for periods in the fall when the recorded water temperature was below 0.5ºC, due to an elevated potential for ice build-up on the weir crest. A benchmark survey conducted on July 10, 2019 by WaterSmith indicated the stilling well and staff gauge had been stable.

A stage-discharge rating curve was developed using the monitoring results from previous years and the 2019 monitoring results. The 2019 staff gauge readings were consistently slightly below the rating curve. The reason is unclear, but the rating curve was adjusted down after fitting the curvature to account for this discrepancy. An assessment of the goodness of fit of the 2019 manual readings to the stage-discharge rating curve yielded a mean absolute difference of 5% and a standard error of 3%.

The peak flow occurred in early April. Discharge receded through late April and May, and remained low until mid-September, aside from a short peak on July 17, 2019 related to rainfall. Discharge increased in the fall from heavy precipitation and from opening the Polley Lake control structure to release excess water that had been impounded in Polley Lake due the discharge control regime associated with downstream construction work. The highest calculated discharge rate was 0.80 m^3/s on April 6, 2019.

4.8.5 Site H4 - Polley Lake Weir

Nine staff gauge readings and manual flow measurements were taken between April 1 and November 12, 2019. The highest manually measured discharge rate was 0.37 m^3/s on November 12, 2019.

Pressure transducer data from a PT2x were recorded from March 18 to November 12, 2019. The PT2x was removed in November due to freezing temperatures. There are no gaps in the automated pressure record; however, automated discharge data were not generated for periods in the fall when the recorded water temperature was below 0.5ºC, due to an elevated potential for ice build-up on the weir crest. A benchmark survey conducted on July 10, 2019 by WaterSmith indicated the stilling well and staff gauge had been stable.

A stage-discharge rating curve was developed using the monitoring results from previous years and the 2019 monitoring results. An assessment of the goodness of fit of the manual readings to the stage-discharge rating curve yielded a mean absolute difference of 15% and a standard error of 21%. The error was particularly high for this station because the weir crest is relatively wide and shallow, necessitated by the low channel gradient, making water level insensitive to changing discharge.

The peak flow occurred in early April. Discharge receded through late April and May and remained low until early October. Discharge increased in the fall from heavy precipitation and from opening the Polley Lake control structure to release excess water that had been impounded in Polley Lake due the discharge control regime associated with downstream construction work. The highest calculated discharge rate was 0.43 m^3/s on April 3, 2019.

4.8.6 Hydrology – Mine Site

In 2019, hydrological monitoring was completed at sites W1b (Morehead Creek), W4a (North Dump Creek), W5 (Bootjack Creek), W12 (6km Creek), and H3 (Edney Creek), as required by Section 3.4 of *EMA* Permit 11678 and the CEMP. Supplemental monitoring was carried out at the NW Ditch, Junction Zone Ditch, Joe's Creek Pipe, South Toe Drain and the East Main and South Toe Drains at the TSF.

Tables and figures presenting 2019 hydrology results are presented in Appendix L, including hydrographs, stage-discharge rating curves, pressure-stage relations, goodness of fit statistics.

4.8.7 Site W1b – Upper Morehead Creek

Four staff gauge readings and manual flow measurements were taken between June 17 and November 13, 2019. The highest manually measured discharge rate was 0.05 m^3/s on June 17, 2019.

No pressure transducer was installed at this site in 2019. A benchmark survey conducted on July 10, 2019 by WaterSmith indicated the staff gauge had been stable.

A stage-discharge rating curve was developed using the monitoring results from previous years and the 2019 monitoring results. An assessment of the goodness of fit of the manual readings to the stage-discharge rating curve yielded a mean absolute difference of 24% and a standard error of 30%.

4.8.8 Site W4a – North Dump Creek

Six staff gauge readings and 19 bucket flow measurements were taken between January 2, 2019, and March 19, 2020. The highest manually measured discharge rate was 0.013 m^3/s on April 3, 2019. No pressure transducer was installed at this site in 2019. A stage-discharge rating curve was developed using the 2019 monitoring results. An assessment of the goodness of fit of the manual readings to the stage-discharge rating curve yielded a mean absolute difference of 39% and a standard error of 57%.

4.8.9 Site W5 – Bootjack Creek above Hazeltine Creek

Nine staff gauge readings and four manual flow measurements were taken between May 1 and November 13, 2019. The highest manually measured discharge rate was 0.02 m^3/s on November 13, 2019.

No pressure transducer was installed at this site in 2019. A benchmark survey conducted on July 10, 2019 by WaterSmith indicated the staff gauge had been stable.

A stage-discharge rating curve was developed using the monitoring results from previous years and 2019 monitoring results. An assessment of the goodness of fit of the manual readings to the stage-discharge rating curve yielded a mean absolute difference of 14% and a standard error of 19%.

4.8.10 Site W12 – 6 km Creek at Bootjack Road

Five staff gauge readings and four flow measurements were taken between June 13 and November 13, 2019. The highest manually measured discharge rate was 0.10 m^3/s on October 24, 2019.

No pressure transducer was installed at this site in 2019. A benchmark survey conducted on July 10, 2019 by WaterSmith indicated the staff gauge had been stable.

A stage-discharge rating curve was developed using the monitoring results from previous years and the 2019 monitoring results. The rating curve is not valid for staff gauge levels below 0.624 m, as the water level is below the weir crest. An assessment of the goodness of fit of the manual readings to the stage-discharge rating curve yielded a mean absolute difference of 12% and a standard error of 5%.

4.8.11 Site H3 – Lower Edney Creek

Seven staff gauge readings and manual flow measurements were taken between May 29 and November 12, 2019. The highest manually measured discharge was 0.81 m^3/s on November 12, 2019.

Pressure transducer data from a PT2x were recorded from April 1 to November 12, 2019. The PT2x was removed in November due to freezing temperatures. There are no gaps in the automated pressure record; however, automated discharge data were not generated for periods in the fall when the recorded water temperature was below 0.5ºC, due to an elevated potential for ice build-up on the weir crest. A benchmark survey conducted on July 10, 2019 by WaterSmith indicated the stilling well and staff gauge had been stable; however, the pressure transducer was found on July 10, 2019 to be slipping through the bottom of the stilling well, causing a potential upward bias in the recorded water levels of up to 3-4 cm. Notwithstanding, this potential bias was not identified in the continuous records. This hardware malfunction was repaired on July 10, 2019.

A stage-discharge rating curve was developed using the monitoring results from previous years and the 2019 monitoring results. An assessment of the goodness of fit of the 2019 manual readings to the stage-discharge rating curve yielded a mean absolute difference of 7% and a standard error of 10%.

The peak flow occurred in mid-April. Discharge receded through late April and May but peaked again in mid-July due to rainfall. Discharge increased in the fall from heavy precipitation. The highest calculated discharge rate was 4.1 m^3/s on April 20, 2019.

4.8.12 Supplemental Sites

Flow monitoring and/or staff gauge measurements were also collected at supplemental sites including the NW Ditch, Junction Zone Ditch, Joe's Creek Pipe, South Toe Drain and the East Main and South Toe Drains at the TSF. Results are presented in Appendix L. These flow measurements from site water management system components are primarily used for verifying the site water balance.

4.9 Groundwater Monitoring

4.9.1 Mine Site

Based on the results of this monitoring program, the following conclusions are provided:

- Historically, groundwater levels at GW15-1(a,b), GW15-2(a,b) and GW12-2(a,b) (located on the west side of the mine site) displayed similar trends to surface water elevations within Springer Pit. GW15-1a was appeared to be significantly influenced at a lower depth of Springer Pit (i.e., dewatering in 2019) compared to GW15-1b, GW15-2(a, b) and GW12-2(a, b). When these groundwater elevations (particularly those at GW12-2(a,b) and GW15-2(a,b) are greater than the surface water elevation within the pit, it is inferred that a groundwater divide is present between Springer Pit and Bootjack lake (in the area of these monitoring wells). This groundwater divide results in groundwater flowing from these monitoring wells towards the east, to Springer Pit, and towards the west to Bootjack Lake.
- Based on the 2019 groundwater elevations and the water level elevations in Springer Pit, it can be

inferred that groundwater leakage from Springer Pit to Bootjack Lake did not occur.
- Significant changes to groundwater quality have not been identified in 2019. Slightly increasing POI concentration trends at some locations were noted but the reasons for this are not clear.

Based on the results of the 2019 annual groundwater monitoring report, and as previously noted in Golder's August 16, 2017 technical memorandum summarizing the results of previous hydrogeological assessments conducted in association with Springer and Cariboo Pits (Golder, 2017a), the following recommendations are provided.

- Continue the groundwater level and quality monitoring program at the mine site. This includes measuring the depth to groundwater at the various on-site monitoring wells as per the requirement of the 2019 CEMP (preferably on the same day in May and November 2020).
- No water levels were measured at GW14-1 and GW05-1 due to the use of the well as a pumping well. If possible, a depth to groundwater, during both pumping and non-pumping conditions, should be measured a minimum of once per year, and specifically, during the one day when the depth to water is measured at all other wells on one given day. For historical water level comparison, GW14-1 and GW05-1 were excluded.
- When the groundwater model previously developed for the area between Springer and Cariboo Pits and Bootjack Lake (Golder 2016) is updated, it should be recalibrated using current groundwater and surface water elevations prior to mine closure.

4.9.2 Hazeltine Creek

Following the TSF embankment breach an investigation of the groundwater quality in the Hazeltine Creek riparian area was conducted in 2015 to confirm the results of the geochemistry assessment conducted by SRK Consulting Inc. (SRK, 2015a). A second groundwater assessment was completed in 2016 in support of the risk assessments, and in 2017, a third assessment was completed by Golder. The 2017 assessment recommended one more year of sampling which was completed in 2018. The Golder groundwater review included a review of the 2016 to 2018 groundwater results but did not make recommendations and no trends were found. No monitoring or sampling of groundwater wells in the vicinity of Hazeltine Creek were sampled in 2019 (Appendix G).

4.10 Contact Water Chemistry

Contact water sampling and analysis was conducted as outlined in Section 3.2 of *EMA* Permit 11678 (Appendix A). Contact water sampling is also outlined as per the 2016 *CEMP* and the 2018 *CEMP* (Appendix A). As per the 2018 *CEMP*, monitoring and changes of contact water sites fall under *Mines Act* Permit M-200. Refer to Section 4.3 of this report for a discussion of field sampling equipment and methodology.

This section contains data for the permitted effluent site with a prefix letter "E". Sample site and frequency are summarized in Table 4.21 Sampling events in 2019 at contact water quality sites. Sample location is shown

in Appendix B. As per 2016 and 2018 *CEMP* (Appendix A), legacy sites such as East and West Main Toe Drains, MESCP (E4) and Central Collection Sump (CCS) (E18) that no longer discharge into Hazeltine or Edney Creek have been removed. E11 and E11a (Springer Pit Supernatant) were sources of contact and discharge water under the 2016 *CEMP* and were sampled accordingly until the LTWMP discharge permit was approved in 2017 and dredging of the Springer Pit in January 2018, which made that location inaccessible. Note that E19- Perimeter Embankment Till Borrow Pit (PETBP) was included as a surface contact water sites in the 2016 *CEMP* but is discussed in the discharge system and monitoring section of the annual report (Section 4.12).

E1a, previously E1, is the water chemistry sampling location for the TSF supernatant. The site, E1, was established in 1997 to monitor changes as it was the primary source of discharge water before the TSF embankment breach. No water was stored, or samples collected at the site after August 4, 2014. The TSF was operational once again in November 2016 and samples were collected again. Upon receipt of the 2017 *EMA* Permit 11678 amendment, the site name was changed to E1a to reflect the water chemistry post-TSF embankment failure.

Table 4.21 Sampling events in 2019 at contact water quality sites

Site	Site Identifier (EMS No.)	Frequency	
		Permit Requirement	Actual
E1a [a]	E225309	Monthly/Quarterly [b]	13

[a] Deposition of tailings into TSF is ongoing; TSF supernatant being used as reclaim water as of November 8, 2016. E1 has been replaced by E1a.

[b] Required monthly by the 2016 *CEMP* and quarterly by the 2018 *CEMP*.

Samples were submitted to ALS for analysis of:

- Physical parameters (pH, turbidity, TSS, total dissolved solids, and hardness);
- Anions and nutrients (alkalinity, sulphate, total nitrogen, nitrate, nitrite, ammonia, chloride, fluoride, total phosphorus, dissolved phosphorus, and ortho-phosphate);
- Organics (dissolved organic carbon); and
- Total and dissolved metals (metals suite as listed in the *CEMP*, Appendix A).

Thirteen parameters of interest (POIs) were identified in the *Chemical Characterization of the Proposed Effluent for Discharge to Hazeltine Creek* (Knight Piésold Ltd. 2009) based on site geochemistry and historical characteristics, as well as existing and projected waste and water management practices. To monitor changes in the effluent surface water quality, in the subsequent sections, these POIs were reviewed for each water quality site over time:

- **Physical Parameters**: Hardness, TSS;
- **Anions**: Chloride, sulphate;

- **Nutrients**: Nitrate, total phosphorus; and
- **Metals**: Dissolved aluminum, total cadmium, total copper, total molybdenum, total and dissolved iron, total selenium.

Results for POI concentrations for the effluent sites are noted and included in tabular format in Appendix F. Note that results below method detection limit (MDL) are represented as half (0.5x) the MDL in statistical calculations and graphs.

Water quality data, including summary statistics (number, minimum, maximum, mean, standard deviations, and method detection limit) are provided in Appendix F.

4.10.1 Site E1a – Tailings Supernatant (E225309)

Water quality at this location was sampled 8 times in 2019. Graphs and results for a subset of parameters only for the post-breach years, are provided in Appendix F. Notable observations in POI results are compared with data over the last five years (pre-breach: 2012-2014, and post-breach: 2016-2019):

Hardness: A general increase in concentration occurred after tailings deposition started post-breach in 2016. However, hardness concentrations are continuing to trend downward to pre-breach levels. The 2019 annual mean was 408 mg/L (lower than 2017 at a mean of 506 mg/L and 2018 at a mean of 472 mg/L), and overall post-breach mean of 475 mg/L. The pre-breach mean was 438 mg/L. The maximum hardness in 2019 was 457 mg/L.

TSS: Concentrations have remained stable post and pre-breach. The 2019 annual mean was 4.9 mg/L, and the overall post-breach mean is 13.0 mg/L. The maximum TSS post-breach is similar to pre-breach with concentrations of 50.1 mg/L and 54.9 mg/L respectively.

Chloride: Concentrations initially decreased in 2016 but increased to and surpassed pre-breach levels in 2017 and 2018. The 2019 annual mean was 23.2 mg/L, less than the overall post-breach mean of 23.1 mg/L. The pre-breach mean was 24.3 mg/L. The maximum chloride post-breach was higher in 2018 and 2019 with concentrations of 34.2 mg/L than 2017 and pre-breach with concentrations of 25.1 mg/L and 28.0 mg/L respectively.

Sulphate: Concentrations have remained stable post and pre-breach. The 2019 annual mean was 516 mg/L, and overall post-breach mean of 576 mg/L. The pre-breach mean was 542 mg/L. The maximum sulphate post-breach is above pre-breach levels with a concentration of 684 mg/L and 596 mg/L respectively.

Nitrate: Concentrations have increased post-breach but were starting to decrease to pre-breach levels in 2018 and 2019. The maximum nitrate post-breach was 12.8 mg/L in 2017 and has steadily decreased in 2019 to its lowest concentration of 2.3 mg/L (pre-breach minimum was 4.93 mg/L). The 2019 annual mean

was 3.6 mg/L (lower than the 2017 mean of 10.5 mg/L and 2018 mean of 7.9 mg/L) and the pre-breach mean was 6.4 mg/L.

Total phosphorus: Concentrations have remained stable post and pre-breach. The 2019 annual mean was 0.021 mg/L, with an overall post-breach mean of 0.022 mg/L. The pre-breach mean was 0.015 mg/L. The maximum total phosphorus post-breach is similar to pre-breach with concentrations of 0.07 mg/L and 0.06 mg/L respectively.

Dissolved aluminum: Concentrations have remained stable post and pre-breach (note that there are no data from February 2013 to 2014). The 2019 annual mean was 0.0264 mg/L and overall post-breach mean was 0.0287 mg/L (with the removal of an outlier from March 2018). The pre-breach mean was 0.0215 mg/L. The maximum dissolved aluminum post-breach is similar to pre-breach with concentrations of 0.0505 mg/L and 0.0521 mg/L respectively.

Total cadmium: Concentrations have remained stable post and pre-breach as the majority of results were below detection limit. Only two times were results above detection limit; once in 2016 and 2017. In 2018 and 2019, all results were below detection limit.

Total copper: Concentrations have increased post-breach and were stabilizing in 2017 and 2018. The 2017 and 2018 annual means were stable at 0.019 mg/L; however, in 2019 the annual mean was 0.028, with an overall post-breach mean of 0.022 mg/L. The pre-breach mean was 0.010 mg/L. The maximum total copper post-breach of 0.083 mg/L is approximately double the pre-breach maximum of 0.041 mg/L.

Total molybdenum: Concentrations have increased post-breach and are continuing in an upward trend. The 2019 annual mean was 0.242 mg/L compared to the 2018 and 2017 annual means of 0.226 mg/L and 0.186 mg/L, respectively and the overall post-breach mean was 0.213 mg/L. The pre-breach mean was 0.184 mg/L. The maximum total molybdenum post-breach of 0.290 mg/L is similar to the pre-breach with maximum of 0.213 mg/L.

Total iron: Concentrations have remained stable post and pre-breach, but total iron is starting to trend downwards. The 2019 annual mean of 0.101 mg/L is lower than the 2018 annual mean of 0.184 mg/L, 2017 annual mean of 0.307 mg/L, overall post-breach mean of 0.228 mg/L and the pre-breach mean of 0.272 mg/L. The maximum total iron in 2019 was 0.167 mg/L which is also lower than the post-breach maximum of 0.814 mg/L.

Dissolved iron: Concentrations have remained below detection limits in pre- and post-breach results, except for one instance in March 2018, with a result of 0.086 mg/L.

Total selenium: Concentrations have remained stable post and pre-breach. The 2019 annual mean was 0.0372 mg/L, with an overall post-breach mean of 0.0377 mg/L. The pre-breach mean was 0.0260 mg/L.

The maximum total selenium post-breach of 0.0453 mg/L is higher than the pre-breach maximum of 0.0346 mg/L.

Only two parameters have shown a continuous increasing trend in concentration after post-breach deposition of tailings commenced. Total molybdenum and chloride have shown a general increasing trend, with total copper almost doubling in concentrations in post-breach era but remaining stable. Monthly monitoring was scheduled for E1a under the 2016 *CEMP*. Under the 2018 *CEMP*, the frequency has moved to quarterly, and tailings water is discharged through the WTP via the PETBP.

4.10.2 Long-Term Predictions

Kinetic rate information is an important component of drainage chemistry prediction that provides a measure of the dynamic performance or "reactivity" of the material being tested. Stephen Day, MSc, PGeo, of SRK has been retained to interpret results of the ongoing kinetic-testing program and recommend additional testing, if required. Stephen Day, MSc, PGeo of SRK provided a report titled *Status of Kinetic Tests on Rock and Tailings Samples, Mount Polley Mine* is included in Appendix R. Additionally, SRK completed a report describing the derivation and use of the source terms (SRK, 2016) for the *TAR* submitted to ENV for the long-term water management application (Golder, 2016b).

4.10.3 Heap Leach Research

In 2006, Mount Polley applied for an amendment to the *Mines Act* M-200 Permit allowing them to build a Heap Leach Pad and Copper Recovery facility. The amendment was granted on March 29, 2007. The *Mines Act* M-200 Permit requires that all monitoring data from the facility be included in this report.

In 2014, Mount Polley participated in a research project with Kemetco Research who has been developing a sulphur oxidation bioreactor system for potential use in generating sulphuric acid for copper oxide heap leaching. The heap leach at Mount Polley has been decommissioned until the research is complete. Three batch tests were started at Kemetco Research, but the project has been postponed since the TSF embankment breach. No samples were collected in 2019. Table 4.22 shows the sump levels in 2019.

Table 4.22 Heap leach sump level in 2019

Month	Heap Leach Sump Level (ft)
January	-
February	-
March	9.98
April	10.75
May	9.64
June	-
July	-
August	-
September	-
October	-
November	-
December	-

4.10.4 Sulphur Pile

Approximately 10,259 t of sulphur were acquired by MPMC from 2006-2008 to facilitate the production of sulphuric acid at the Heap Leach Pad. In 2018, elevated copper concentrations were discovered in the LD and, through an extensive investigation, traced back to NEZ Seep 1 and 2. Further investigations identified the sulphur pile as being a source of sulphuric acid which has leached into the underlying waste rock. The rock has neutralized the acid, but potentially it has resulted in elevated metal concentrations in the seepage. Research is ongoing into the geochemical characteristics of the affected rock. To prevent ongoing leaching, the sulphur pile was moved to the LCRS in October 2018. A sump was constructed at the base of the NEZ waste rock pile to collect the affected NEZ seeps; the sump is pumped to the mill except during freezing periods when it is piped to the Wight Pit. Monitoring of the affected NEZ seeps will continue as part of the Source Control optimizations in *EMA* Permit 11678 Section 2.8.3.

4.11 Seepage Water Chemistry

An important component in determining and monitoring long-term chemical stability of drainage from the pits and waste rock dumps is water quality monitoring. Locations monitored by MPMC (in addition to sampling required under the *Mines Act* Permit M-200 and *EMA* Permit 11678 [refer to the *CEMP* in Appendix A]), sampling periods, and sampling frequencies are provided in Table 4.23.

These water collection facilities and drainage monitoring locations are shown in Appendix B. MPMC continued the bi-annual seep survey program of all rock waste dumps on site in 2019, with representative seeps being monitored monthly or quarterly when possible (numerous seeps stop flowing during dry periods). Seep monitoring locations are shown in Appendix B. Note that when field parameters of adjacent seeps are consistent, typically only the seep with larger flow is sampled. Results are reported in Appendix F. Collection of this data are used in long-term water quality predictions.

Table 4.23 Site drainage water quality monitoring locations, and sampling periods and frequencies

Sample Location	Drainage Area	Sampling Period	2016 *CEMP* Sampling Frequency	2018 *CEMP* Sampling Frequency
Cariboo Pit Sump (E8)	-	1997 – current	Bi-annually[1]	Bi-annually[1]
Wight Pit (E10)	-	2006 – current	Bi-annually	Bi-annually
Pond Zone Pit Sump (E12)	-	2010 – 2012	N/A	N/A
Springer Pit Sump (E11)[2]	-	2011 – current	Monthly[1]	Bi-annually[1]
Boundary Pit	-	2012 – current	Bi-annually	Bi-annually
Joe's Creek Pipe	NBD Seep	2010 – current	Monthly	Quarterly
Long Ditch	East RDS, NEZ Dump, SERDS, Wight Pit dewatering	2008 – current	Quarterly	Quarterly
SERDS Ditch	SERDS, West Ditch, MDC Sump	2012 – current	Quarterly	Quarterly
NW Sump (E13)	Temporary NW PAG Stockpile, NW Ditch	2012 – current	Quarterly	Quarterly
Mine Drainage Creek Sump (E14)	Upper Mine Drainage Creek, West Ditch	2013 – current	Quarterly	Quarterly
Bootjack Creek Culvert Sump (E15)	TSF Access Road, Upper Bootjack Creek	2013 – current	Quarterly	Quarterly
9km Sump (E17)	Temporary NW PAG Stockpile, Junction Zone Ditch	2014 – current	Quarterly	Quarterly
TSF Supernatant (E1a)	Tailings slurry, seepage collection ponds	1997 – 2014, 2016 – current	Monthly[3]	Quarterly[3]
MESCP (E4)	MTD, STD, Main Embankment foundation drains	2001 – current	Quarterly	Quarterly
PESCP (E7)	Long Ditch, SERDS Ditch, PTD	2001 – 2014	N/A	N/A
Central Collection Sump (E18)	Long Ditch, SERDS, Ditch, PTD, MESCP, South Embankment Seepage Collection Pond, TSF (as of 2016)	2014 – current	Quarterly	Quarterly
East/West Main Toe Drains (MTDs)	TSF Main Embankment toe drains	1998 – current	Quarterly	Quarterly
Perimeter Toe Drain (PTD)	TSF Perimeter Embankment toe drain	2009 – 2014	N/A	N/A
South Toe Drain (STD)	TSF South Embankment toe drain	2011 – current	Quarterly	Quarterly

[1] when pit is not storing water from other sources on site
[2] Not accessible due to ongoing dredging operations
[3] when barge in TSF is supplying reclaim water to mill; started sampling November 2016

No obvious trends in the water quality at the drainage location sampling sites have been observed. This is consistent with SRK ore characterization and geochemical source term reports (SRK 2015b; 2016).

4.12 Discharge System and Monitoring

The WTP is a Veolia ACTIFLO® system, which was commissioned in October 2015. Discharge began on December 1, 2015 and continued throughout 2019. The total water discharged in 2019 was 5,380,517 m^3.

The 2018 *ADP* (MPMC, 2018b; Appendix I) was prepared and submitted to ENV on July 30, 2018 and was approved on September 6, 2018. Since there were no changes needed for the ADP in 2019, the 2018 was rolled forward to be used in 2019.

4.12.1 Discharge System

Based on site water management objectives, site contact water can be conveyed to multiple locations around site to either discharge treated water via the WTP into the pipeline or store water as needed. Discharging treated water would be the main priority for water management. Site contact water reports to the gravity-driven sections of the West Ditch or Long Ditch, which both ultimately flow to the CCS. Water in the CCS flows to the PETBP which is the source of the WTP influent. Pumping infrastructure also exists at the CCS and the PETBP such that it can be directed to the TSF. Water from the TSF is primarily pumped to the mill via the Booster Station to meet process requirements (fire suppression during Care and Maintenance), pumped to Springer Pit for dredging operation (summer season) and can also be diverted to the CCS to increase the influent flow in the WTP.

Storage of water in the TSF or pits can be used for:

- Process Plant milling requirements (Not needed for Care and Maintenance);
- Maintaining water for dredging operation in Springer Pit;
- Maintaining pond volume in the TSF for dust management;
- Pit storage as contingency for large water events (freshet) or failures in the water management systems (power or equipment failure);
- Research studies (Pit Lakes);
- Etc.

4.12.1.1 Treatment Works and Source Control Optimization

MPMC was required to assess and optimise the existing treatment process and works on a regular basis under Section 2.9 of *EMA* Permit 11678.

Veolia, the original equipment manufacturer of the Actiflo© water treatment plant visited the Mount Polley WTP twice in the first half of 2019. The first visit focused on programming the Programmable Logic Controller (PLC) and Human Machine Interface (HMI) with modifications to accept the TSS and conductivity probes. Automation and recording capabilities were upgraded. Two new dosing pumps were added for the TMT field trials to be conducted by Golder during the 2019 freshet.

The second visit by Veolia was an audit to optimize the quality of the clarified effluent, maximize plant throughput and provide additional training to operators. Veolia recommended an operating range for dosage of sand, polymer and coagulant based on influent clarity and flow rates. A daily and weekly schedule of visual checks and maintenance was recommended.

In 2019, Golder carried out concept design and field trials for a TMT-15 dosing system that can be used to optimize copper removal from the WTP. The field trials were carried out on site from April 2 to 4, 2019 and the results were summarized in a technical memorandum (TM) submitted by Golder to MPMC on May 29, 2019 and subsequently provided to BC ENV on May 30, 2019. Following the field trials Golder recommended continued improvement of the performance of the Actiflo treatment system, and regular maintenance and close monitoring of process control of the existing WTP (Golder, 2019a). Following the Veolia Audit Report of April 2019, MPMC conducted annual maintenance on the WTP to ensure it continues to operate properly. Annual maintenance works include calibration of cyclones and pump maintenance. The building was boarded to prevent heat loss for winter conditions. In addition, MPMC conducted works to seal the WTP to ensure a process water temperature of 12°C. Slurry pumps were installed in the sludge ponds to redirect sludge to the TSF. This prevents the possible recirculation of sludge to the WTP influent ponds. Reagent usage and dosage rates were optimized.

A source control action plan was developed and implemented in 2018 to isolate the NEZ Seeps and direct the water to a collection sump (NEZ Sump) for source control management. A generator, level controls and pump were installed at the NEZ sump and water was conveyed via pipeline to the processing plant during the 2019 freshet. The result was reduced COC loading in the WTP effluent during the 2019 freshet.

4.12.1.2 WTP Operations

During treatment, the feed water of the WTP undergoes suspended solids removal using Veolia ACTIFLO® water treatment technology prior to discharge. The WTP doses the raw water with coagulant to a tank where a polymer is injected to create floc particles. Microsand is added to ballast the flocculants, which move on to another tank that allows them to swell and mature. The water flows to the next stage, which uses lamella to clarify the water and promote fast settling of the microsand ballasted sludge. The clarified water is discharged, and the sludge is separated from the microsand, which is reused. An on-line turbidity meter measures the turbidity every ten seconds and calculates the TSS using a calibrated factor based on a site-specific correlation between turbidity and TSS. If an on-line TSS measurement is above 11 mg/L for 10 minutes, or over 12 mg/L instantaneously, an alarm sounds to alert the operator and the WTP automatically goes into recirculation mode and ceases discharge.

The WTP started discharging to Quesnel Lake via the direct pipeline on January 8, 2018. There were periodic times when the WTP was put into recirculation mode due to various issues described in Table 4.24. The annual average discharge rate was 20,922 m^3/day and daily maximum discharge rates ranged from 0 m^3/day to 21,885 m^3/day. According to the *EMA* Permit 11678, the authorized annual average discharge rate is 29,000 m^3/day and a daily maximum discharge rate of 52,000 m^3/day. Daily maximum rates are provided in Appendix H.

Table 4.24 Reasons for discharge stoppages in 2019

Date	Discharge Action	Reason
30-Dec-18	Ceased	Precaution for preliminary results that exceeded permit limit
2-Jan-19	Restarted	Subsequent sampling showed no permit limit exceedances
26-Feb-19	Ceased	Power outage
27-Feb-19	Recirculation	Bay door could not be closed due to extreme temperatures
28-Feb-19	Recirculation	Maintenance issue
28-Feb-19	Restarted	Maintenance issue resolved
5-Mar-19	Recirculation	QUL-58-S sample exceeded total phosphorus permit limit
7-Mar-19	Restarted	Subsequent sampling showed no permit limit exceedances
20-Mar-19	Ceased	Power outage, polymer mixing plugged at 17:31
20-Mar-19	Restarted	Issues resolved at 20:43
3-Apr-19	Recirculation	TMT trials began at 09:15
3-Apr-19	Restarted	TMT trials ceased at 17:35
4-Apr-19	Recirculation	TMT trials began at 09:15
4-Apr-19	Restarted	TMT trials ceased at 14:35
4-Apr-19	Recirculation	Power outage at 19:00, recirculation at 22:45
5-Apr-19	Restarted	Issues resolved and discharge resumes at 01:23
5-Apr-19	Ceased	Power outage at 19:55
6-Apr-19	Restarted	Issue resolved and discharge resumes at 08:04
5-Jun-19	Ceased	WTP shut down during night shift until further notice due to low water
17-Jun-19	Recirculation	HAD-3 sample collected on June 4 exceeded permit limit for total chromium
18-Jun-19	Restarted	HAD-3 sample did not exceed permit limit, elevated value was due to a laboratory error
18-Jun-19	Ceased	WTP shut down at 15:00 due to low water level in influent pond (PETBP)
8-Jul-19	Restarted	Issues resolved
10-Jul-19	Ceased	QUL-58-AT sample exceeded permit limit for total copper
13-Jul-19	Restarted	Following approval from the ENV Director
25-Jul-19	Ceased	QUL-58-BT sample exceeded permit limit for total copper
26-Jul-19	Restarted	QUL-58-BT sample did not exceed permit limit, elevated value was due to a laboratory error; however, approval from the ENV Director was received before the WTP was restarted
6-Aug-19	Ceased	WTP shut down for nightshift due to absent operator
7-Aug-19	Restarted	Day shift operator arrived on site
13-Aug-19	Ceased	Pipe repair required
14-Aug-19	Restarted	Pipe repaired
4-Sept-19 – 2-Oct-19	Ceased/Restarted	WTP shutdown at night as night shift operators were not available
23-Dec-19 – Dec-31-19	Ceased/Restarted	Prolonged power outages

4.12.1.3 Outfall and Pipeline Commissioning and Inspection

As required by in Section 3.5 of *EMA* Permit 11678 (Appendix A), routine visual inspection of the outfall into Quesnel Lake, along with the pipeline, must be conducted. MPMC conducts routine inspections and maintains records of these routine inspections.

A comprehensive inspection and testing program of the outfall must be conducted (which includes an annual leak and pressure testing of the pipeline), and an underwater inspection of the diffuser every 2 years. As the pipeline is gravity fed and buried, the leak and pressure testing is not possible. The inspection at the Quesnel Lake diffusers has been conducted annually from 2015 to 2018 by a QP. A comprehensive inspection of the diffusers was conducted on September 5, 2018 and on the pipeline on November 5, 2019. Recommended frequency of the diffuser inspection has changed to every 5 years (starting with 2023), but pipeline inspections by a QP remain annual. The final report was submitted to ENV.

Recommendations from the inspection are planned to be completed in the summer of 2020. The recommendations include:

- Replace the flange bolt on the WTP-HDPE pipe interfacing flange with stud bolts with a nut at each end.
- Drain or pump out the standing water pond at STN 0+500 and contour and grade the area to allow drainage into Hazeltine Creek. Once drained, grading and proper ditching/drainage should be completed to prevent re-accumulation of standing water.
- Drain or pump out the standing water between 2+000 and 2+600. Once drained, grading and proper ditching/drainage should be completed to prevent re-accumulation of standing water.
- Shoring and drainage for ephemeral streams located between STN 1+000 and 5+470 be implemented before freshet in 2020 to prevent further erosion in the area.
- Rehabilitate and restore the areas eroded and cracked by freshet in 2019. Monitoring of these areas as well as implementation of preventative measures should also be conducted.
- Relocate stockpiled topsoil or debris from pipeline ROW construction to areas in need of re-vegetation. The pipeline ROW should also be monitored for re-vegetation where the roots may affect the pipeline; any trees growing over the pipeline should be removed and grasses thatched to keep out tree seeds.
- Replacement of vent heads from the existing gooseneck type to a mushroom cap type to prevent blockage of the vents.
- Replacement of metals tags on the pipeline marker posts with a more durable alternative.

4.12.2 Discharge Monitoring

This section provides an assessment of the compliance with the amended *EMA* Permit 11678 limits with respect to the data collected at the WTP discharge end-of-pipe site (HAD-03) and at the edge of the initial dilution zone (IDZ) site (QUL-58) in Quesnel Lake. These data were collected in accordance with the approved 2016

and 2018 *CEMP* (Appendix A) and the *ADP* (Appendix I). This compliance is primarily based on the permit conditions stipulated in the *EMA* Permit 11678 dated April 7, 2017 and October 2, 2018. This section addresses the *EMA* Permit 11678 Section 3.9 requirements:

- *(e) a summary of any non-compliance with the permit and other incidents that may have led to impacts to the receiving environment;*
- *(k) a comparison of monitoring data with water quality guidelines, predictions, and targets.*

This discharge triggered the *MDMER* and reporting to Environment and Climate Change Canada continued in 2019 as outlined in the *MDMER*. All requirements were met. Table 4.25 outlines the number of sampling events at each site in 2019 (a map of these locations is provided in Appendix B).

Table 4.25 Sampling events in 2019 at discharge monitoring sites

Site Name	Site Identifier (EMS No.)	Full Sample Suite Frequency 2016 *CEMP*	Full Sample Suite Frequency 2018 *CEMP*	Actual Sampling Events
E19	E305050	Weekly [(a)]	Weekly [(a)]	59
HAD-03	E304230	Weekly [(a)]	Weekly [(a)]	55
QUL-57	E304874	Weekly/Monthly [(b)]	4 times per year	7
QUL-58	E304876	Weekly/Monthly [(c)]	4 times per year	12
QUL-59	E304875	Weekly/Monthly [(b)]	4 times per year	6
QUL-2a	E303020	Monthly	4 times per year	5
QUL-18	E303019	Monthly	4 times per year	4
QUL-120a	E303022	Seasonally	Bi-annually	2
QUR-11	E306454	Monthly	Removed [(d)]	0

[(a)] When discharging.

[(b)] Limnological profiles occur weekly for 5 weeks during spring and fall turnover; monthly all other times of the year.

[(c)] Samples and limnological profiles occur weekly for 5 weeks during spring and fall turnover; monthly all other times of the year.

[(d)] Effective as of on November 9, 2018 with the acceptance of the 2018 *CEMP*.

4.12.2.1 Permit Compliance

The *EMA* Permit 11678 requires the following regulatory compliance be met:

1. Effluent chemistry data from end-of-pipe at HAD-03 (WTP outflow) must be equivalent to or less than specified values in Section 1.2.3 of the Permit (Appendix A). In addition, the trigger and response plan required under Section 2.7 (5) must show how the concentrations of the parameters meet the objectives for the "Edge of Quesnel Lake Initial Dilution Zone (IDZ)" in Quesnel Lake specified in Section 1.2.3 of the Permit.
2. Effluent must meet the acute toxicity requirement of less than 50% mortality in 100% effluent in 96-hour rainbow trout (*Oncorhynchus mykiss*) and *48-hour Daphnia magna* toxicity tests (*EMA*

Permit 11678 Section 3.3 and 3.10). These results are presented in Section 4.12.3.

4.12.2.2 Influent Chemistry – E19

In accordance with the 2016 and 2018 *CEMP*, E19 (WTP feed) water samples were collected weekly and concurrently with HAD-03 samples during effluent discharge. E19 represents the water entering (influent) into the WTP; the influent is pumped from the PETBP which collects the contact water from the Mount Polley Mine site. Fifty-nine samples were collected from E19 in 2019. The influent results are compared with the effluent results to gauge treatment efficiency. The WTP monitors the influent flow rate, turbidity and temperature.

4.12.2.3 Effluent Chemistry – HAD-03

To meet the requirements of the *EMA* Permit 11678 and *MDMER* requirements, water chemistry samples were collected weekly at the end-of-pipe site at the WTP outlet (site HAD-03) when discharging. Note that there were periodic times when there was no discharge; see Table 4.24 for details. This requirement was met by the collection of 55 samples at HAD-03 in 2019. All parameters were met or were below the concentrations limits in Section 1.2.3 of the Permit except for a few instances (Section 4.12.2.4).

The permit limit for total copper according to Section 1.2.3 of the *EMA* Permit 11678 is 0.033 mg/L. There were no sampling events where total copper exceeded the permit limit (Section 4.12.2.4). The maximum result for total copper at HAD-03 in 2019 was 0.019 mg/L on December 18, 2019; the annual average was 0.009 mg/L. Results for the influent and effluent are shown below in Figure 4.9.

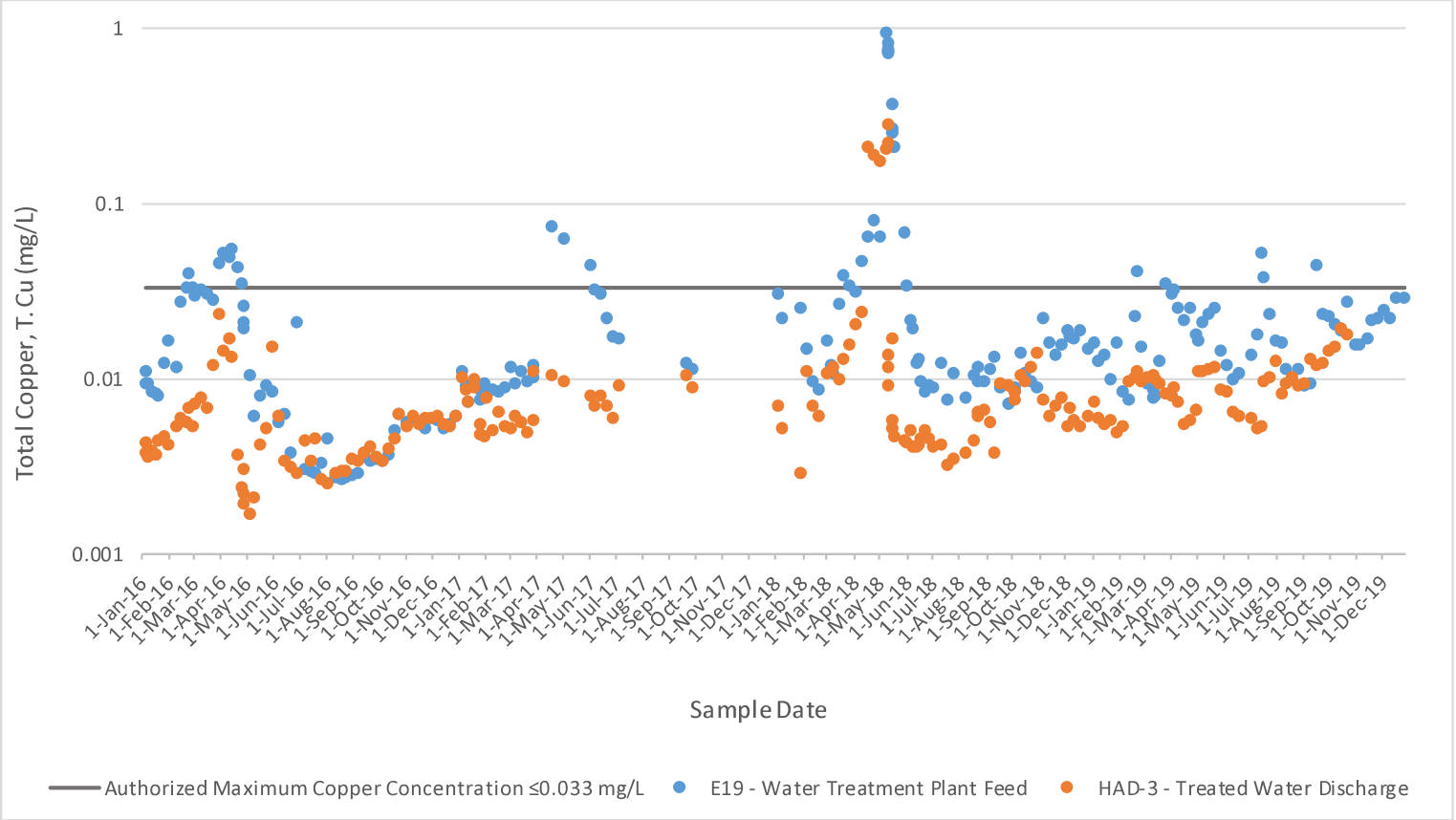

Figure 4.9 Total copper concentrations in influent (E19) and effluent (HAD-03) in from 2016-2019.

There were no exceedances of TSS in 2019. The maximum total TSS limit must be equivalent to or less than 30 mg/L with a monthly average equivalent to or less than 15 mg/L. The maximum result for TSS at HAD-03 in 2019 was 17.4 mg/L in October; the annual average was 6.53 mg/L. The maximum 30-day average TSS was 10.1 mg/L in October 2019. Results for influent and effluent are shown in Figure 4.10.

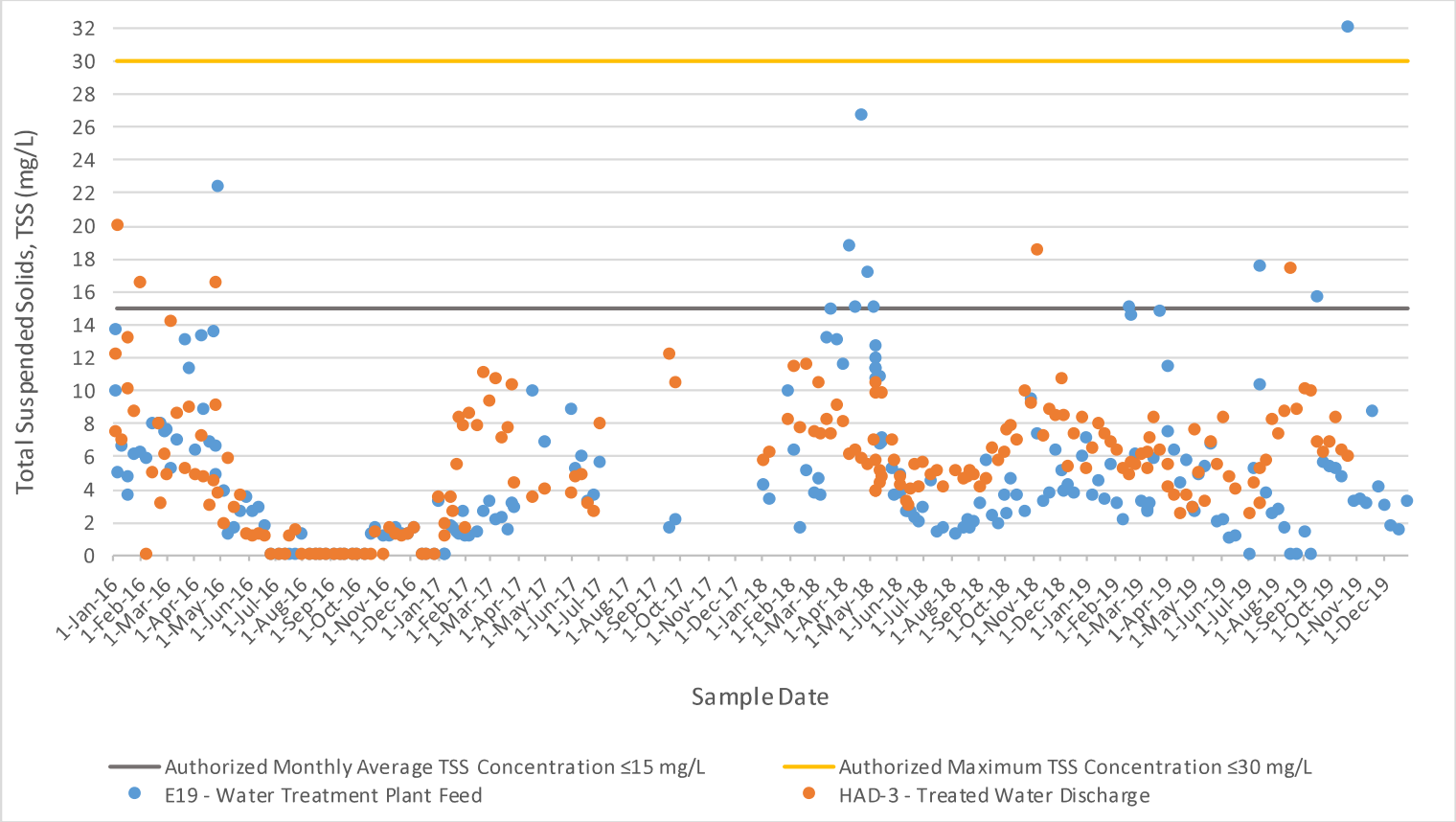

Figure 4.10 Total suspended solids concentrations in influent (E19) and effluent (HAD-03) in 2016-2019.

4.12.2.4 HAD-03 Permit Limit Exceedance Events

In 2019, there was one instance where ALS results from HAD-03 samples were above the permit limits. MPMC notified the required parties and an investigation was undertaken. Below is a list of the exceedances in 2019:

- Total chromium on June 17, 2019*

* Not considered to be true exceedance; see below for further explanation.

Total Chromium

Total chromium from June 17, 2019 was initially reported to have a concentration of 0.0101 mg/L which was above the permit limit of 0.004 mg/L. The WTP was promptly shut down, required parties notified, and recheck and reanalysis requested. The elevated initial total chromium concentration was the result of laboratory error and was confirmed by ALS as a sample mix-up, and the actual result was below the permit limit at <0.00050 mg/L. MPMC emailed ENV, retracting the total chromium exceedance, and the WTP resumed discharging.

4.12.2.5 Plume Dispersion Model

Tetra Tech Inc. (Tetra Tech) was retained by MPMC to assess the long-term and far-field fate of effluent discharged from the diffusers in Quesnel Lake (see Appendix J). Tetra Tech applied the existing hydrodynamic model of Quesnel Lake to simulate effluent concentrations throughout the lake as a result of the discharge. After the simulations were completed, MPMC requested advice with respect to the likely position of the effluent plume by month, to support monitoring in the field (Tetra Tech, 2016). In 2017, Tetra Tech was retained to determine the relationship between the volumetric dilution by a dilution test and dilution calculated from observed specific conductivity from limnological profiles in Quesnel Lake. The results improved the confidence of the estimated dilution factor applied to the profiles. Tetra Tech ran the near-field model to discuss the plume width and dilution and concluded that there was only a 3% chance of detecting the plume at the IDZ. In addition, the field models suggest the plume concentrations are generally less than 1% at the IDZ (MPMC, 2018a). In 2018 and 2019, Tetra Tech was requested to conduct analyses of the limnological profiles and data from Quesnel Lake and provide conclusions and recommendations in order to better understand the lake circulation, and the interaction of the lake with the effluent discharge. Tetra Tech's 2018 and 2019 reviews identified some of the specific conductivity spikes observed at shallower depths stemmed from surrounding creek sources. Other observations noted that the effluent's density during certain periods of the year may be greater than originally modeled. This may be contributing to a gradual increase of dilute effluent under the thermocline and is expected to flush out during the spring and fall overturns (Tetra Tech, 2018; Tetra Tech, 2019).

4.12.2.6 Receiving Environment Chemistry – Quesnel Lake

The receiving environment for the water discharge plan is Quesnel Lake and further downstream Quesnel River. In accordance with the 2018 *CEMP*, (see Table 4.25), monitoring at the edge of the initial dilution zone (IDZ), site QUL-58, in Quesnel Lake occurred 4 times per year, with intensive sampling during overturn periods, when treated effluent was discharging in 2019.

In situ limnological profiles, Secchi measurement (see Section 4.15.2) and grab samples were collected for water chemistry at the inferred centerline of the effluent plume (when discharging) at the compliance site QUL-58 (when weather conditions were safe). A reasonable amount of effort was spent looking for the discharge plume by observing any increases in specific conductivity. If the plume was detected, grab samples were taken at surface (QUL-58-S), 5 m above the plume (QUL-58-AP), middle of plume (QUL-58-MP), 5m below the plume (QUL-58-BP), and at bottom (QUL-58-B), with additional profiling at supplemental stations, QUL-57 and QUL-59, located at the edge of the IDZ, 25 m on either side of QUL-58 (plume centerline). If the plume could not be detected, then sampling occurred at the default QUL-58 site at the surface (QUL-58-S), bottom (QUL-58-B), mid-depth (QUL-58-MID) (if no thermocline) or 1 m above (QUL-58-AT) and below (QUL-58-BT) the thermocline (if present).

In 2019, there were 12 sampling events at edge of the IDZ (QUL-58). Three of those events occurred when the treated effluent was not discharging (Table 4.26). The plume may have been detected during the field

investigations along the IDZ on May 8, 15 and 21, 2019, August 20, 2019 and October 30, 2019 when the WTP was discharging treated effluent.

Table 4.26 Effluent discharge condition during IDZ sampling at QUL-58

Date sampled	Treated effluent condition
26-Feb-19	Not discharging
4-Mar-19	Discharging
25-Apr-19	Discharging
2-May-19	Discharging
8-May-19	Discharging
15-May-19	Discharging
21-May-19	Discharging
19-Jun-19	Not discharging
11-Jul-19	Not discharging
25-Jul-19	Not discharging
20-Aug-19	Discharging
30-Oct-19	Discharging

In addition to the field investigation, MPMC retained Tetra Tech to develop near-field models to predict the plume direction and depth using the conductivity from the limnological profiles from Quesnel Lake (Section 4.12.2.5). The results from the Tetra Tech's memo in Appendix J indicate that the detection of conductivity 'spikes' at shallower depths are from higher conductivity Hazeltine and/or Edney creek water; while at bottom waters in the West Basin, slightly elevated conductivity measurements stem from dilute effluent trapped beneath the thermocline and the sill near Cariboo Island (Appendix J).

Permit Limits at the edge of Quesnel Lake IDZ

The amended *EMA* Permit 11678 (April 7, 2017) included compliance limits at the edge of the Quesnel Lake IDZ. All parameters met or were below the concentrations limits in Section 1.2.3 of the Permit except for three instances where ALS results were above the permit limits (Appendix H). MPMC notified the required parties and an investigation was undertaken. Below is a list of the exceedances in 2019:

- Total phosphorus at QUL-58-S on March 5, 2019, 2019*
- Total phosphorus at QUL-58-AT on July 10, 2019
- Total copper at QUL-58-BT on July 25, 2019*

* Not considered to be true exceedances; see below for further explanations.

Total Phosphorus

Total phosphorus at QUL-58-S from March 5, 2019 was reported to have a concentration of 0.0156 mg/L which was above the permit limit of 0.010 mg/L. Subsequent samples from the WTP in recirculation mode and at QUL-58 were below the permitted limits, and as a result the WTP began discharging again on March 7, 2019. A follow-up report was sent to ENV on April 3, 2019. It was noted that the samples collected from the surface of Quesnel Lake are not considered compliance points as there are many factors that may be influencing them.

Total Copper

Total copper from the July 10, 2019 sampling event at QUL-58-AT resulted in a concentration of 0.00266 mg/L which was above the permit limit of 0.0022 mg/L. Dilution modelling of water quality results for the most recent HAD-3 (WTP) samples and subsequent QUL-58 samples were below permitted limits and the WTP began discharging again on July 13, 2019 at 08:36.

Total copper at QUL-58-BT from July 25, 2019 was initially reported to have a concentration of 0.0101 mg/L which was above the permit limit of 0.022 mg/L. The WTP was promptly shut down, required parties notified, and recheck and reanalysis requested. The elevated initial total copper concentration was the result of laboratory error and was confirmed by ALS as a sample mix-up, and the actual result was below the permit limit at 0.00064 mg/L. MPMC emailed ENV, received approval from the Director and the WTP resumed discharging on July 26, 2019 at 09:00.

Total copper results for the edge of the Quesnel Lake IDZ (site location QUL-58) are shown below (Figure 4.11). The annual total average of total copper at the IDZ in 2019 was 0.0010 mg/L. Reviewing non-surficial sample data, the maximum total copper concentration was 0.0014 mg/L at mid depth at QUL-58 in May when the WTP was discharging; the maximum total copper concentration (when the WTP was not discharging) was 0.0012 mg/L in June at the bottom at QUL-58. Note that the maximum results were similar when the WTP was discharging and not discharging. As there are many inputs into Quesnel Lake, it is hard to pinpoint exactly which sources are contributing to the total copper results, but these results indicate that the discharge is not the sole contributing factor.

ADP – Trigger Response Plan

The *ADP* was submitted to ENV on July 30, 2018 as required per Section 2.7 of *EMA* Permit 11678 and accepted on September 6, 2018 (Appendix I). The permit was amended on October 2, 2018 to reflect the changes brought forth with the updated *ADP* (Appendix A). The major requirement of the *ADP* was to include a TRP, which outlines the steps in the event that the water quality results are within 80% of the permit limits at HAD-03 and/or exceed permit limits at HAD-03 and/or QUL-58.

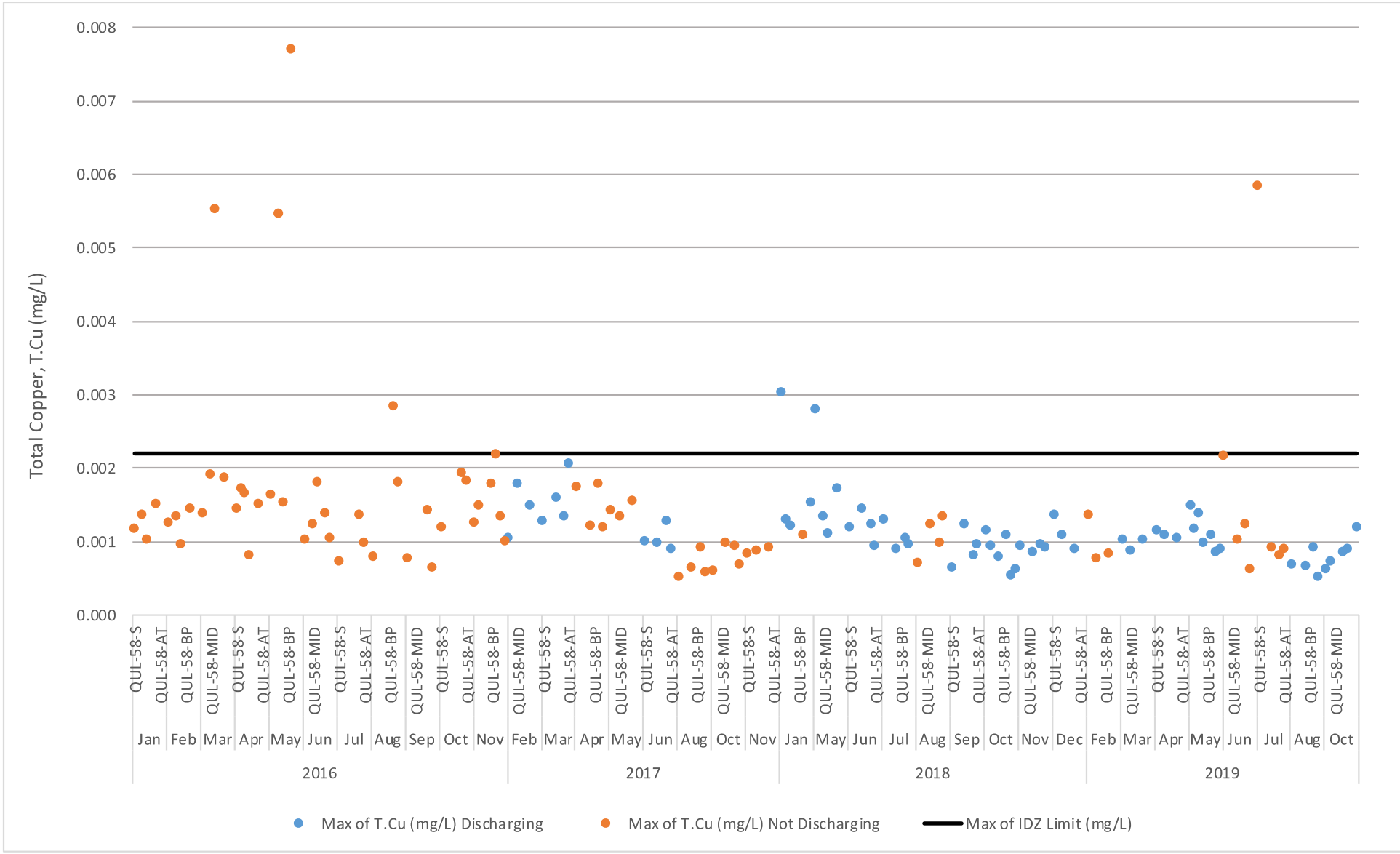

Figure 4.11 Total copper results at the IDZ (QUL-58) from 2016-2019

In addition, the *ADP* contains an analysis of the remaining capacity of Quesnel Lake using the dispersion model and background concentrations (Figure 4.12). MPMC maintains this tool to check if permit limits and water quality guidelines are being met at the IDZ without monitoring on the lake during unsafe conditions (Appendix I).

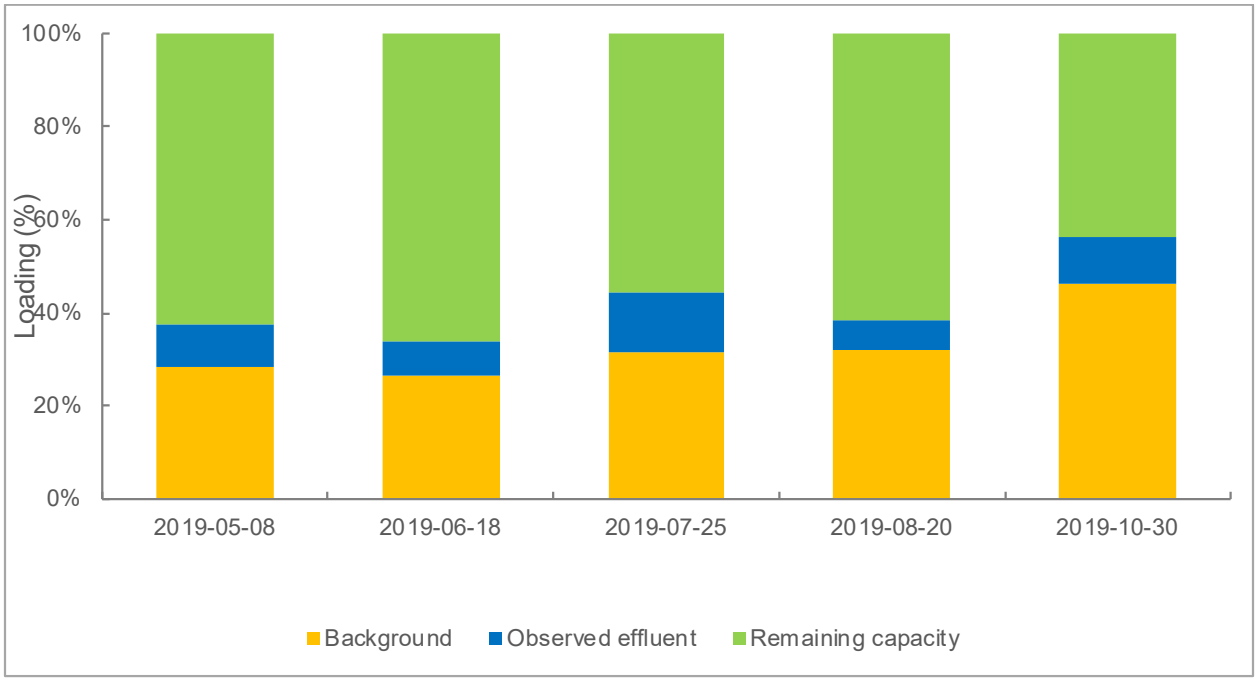

Figure 4.12 Calculated assimilative capacity of total copper on a daily basis in 2019.

Further to the *ADP,* Golder completed two memos: 2019 Verification of Near-Field Modelling in Quesnel Lake and a Comparison of Water Quality Model Predictions and 2019 Measured Concentrations-Mount Polley Mine (Appendix J). These documents provided updates to the previous near field dispersion modelling validation and water quality models at the discharge with 2019 data. The first memo involved calculating the dilution factors in Quesnel Lake during periods of discharge and no discharge from the WTP. The calculated dilution factors ranged from 40 to over 100 when the discharge was active. These results confirm the conservative model predictions and effluent mixing in the lake tends to higher than expected (Appendix J). The second memo compares the 2019 data with predictions described in the *LTWMP TAR* (Golder, 2016b). The comparison indicates the measured concentrations are below model predictions and *EMA* Permit 11678 limits with some exceptions (Appendix J).

BC WQG at the edge of Quesnel Lake IDZ

Short-term maximum and long-term average BC WQG for aquatic life concentrations were compared with the water chemistry data from QUL-58. These limits are not considered compliance limits as MPMC is regulated with *EMA* Permit 11678 requirements at the IDZ. Total copper (Figure 4.16) (except in 2016) and other parameters for the BC WQG for aquatic life guidelines were met (with the exception of total

phosphorus).

Note that samples were taken monthly at QUL-58, with bi-annual intensive sampling during spring and fall turnover (dependent on weather conditions and safety). As summarized in Table 4.25, spring intensive sampling occurred during June and early July and fall intensive sampling occurred in October and early November (i.e. five samples in 30 days) in 2019, which can compared to the long term average total copper guideline (Figure 4.16). The data in Figure 4.16 are depth integrated average concentrations for simplicity. All other data points are presented for screening purposes only. Note that all concentrations from QUL-58 were below the short-term maximum BC WQG for total copper in 2016 through 2019. All concentration from QUL-58 were below the long-term average BC WQG for total copper except during two sampling events in 2016 during the spring intensive sampling. Figure 4.13, Figure 4.14 and Figure 4.15 show the data for 2016, 2017 and 2018, respectively.

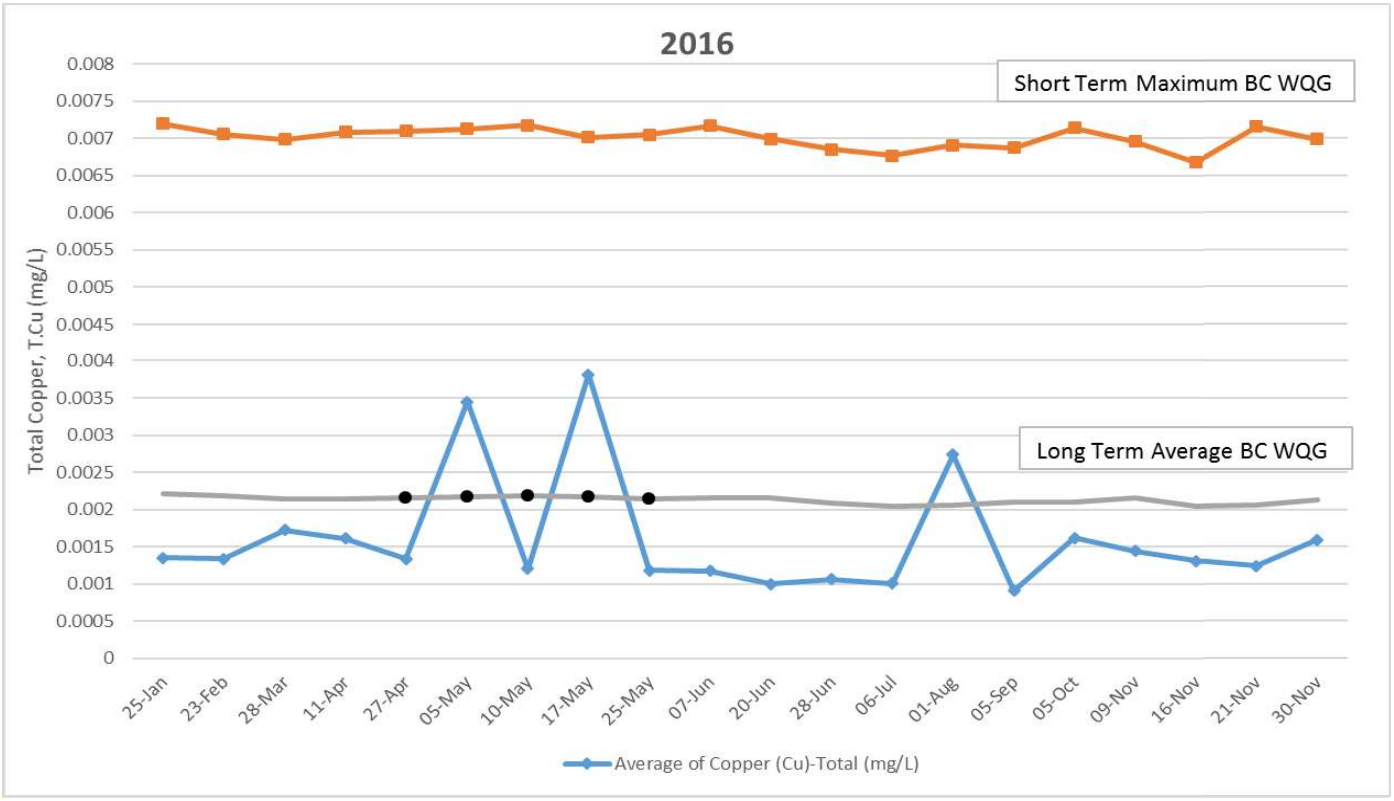

Figure 4.13 Short and long-term BC WQG for aquatic life total copper concentrations at QUL-58 in 2016. The black dots discern applicable long-term average BC WQG for aquatic life (5 samples in 30 days).

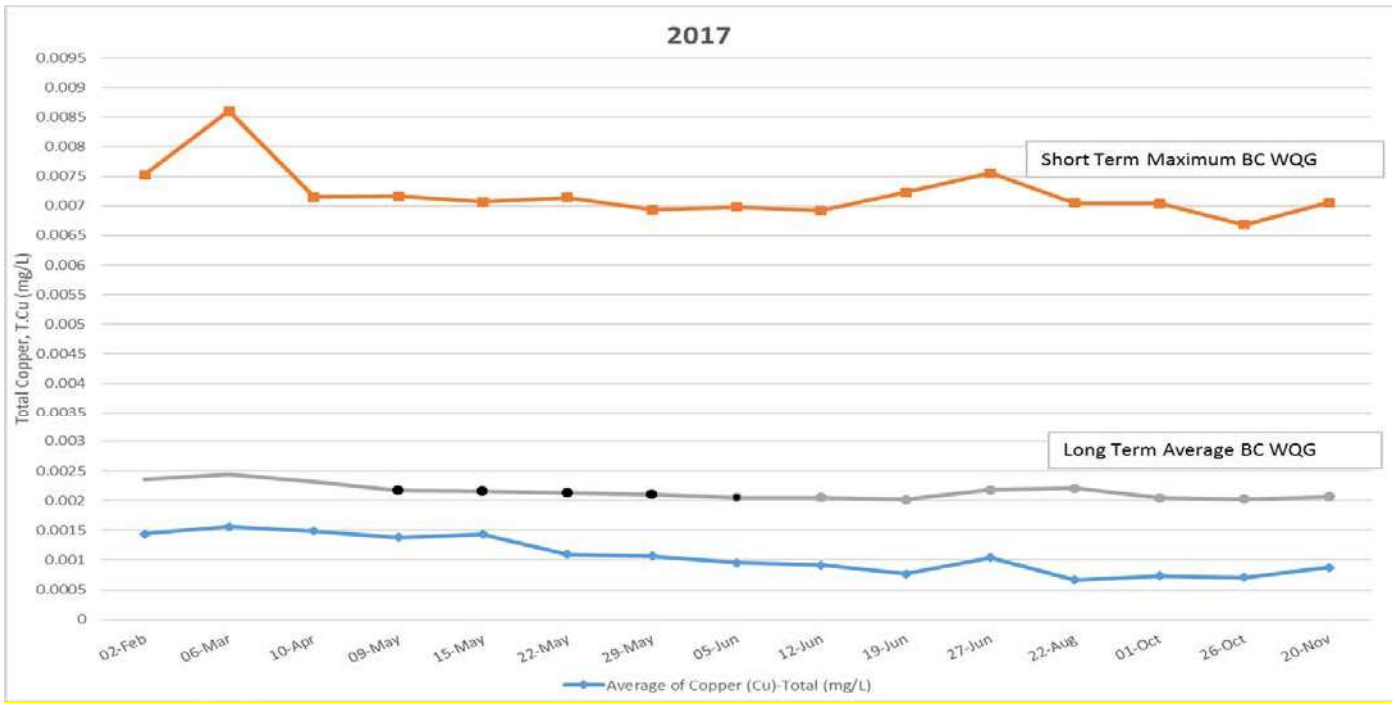

Figure 4.14 Short and long-term BC WQG for aquatic life total copper concentrations at QUL-58 in 2017. The black dots discern applicable long-term average BC WQG for aquatic life (5 samples in 30 days).

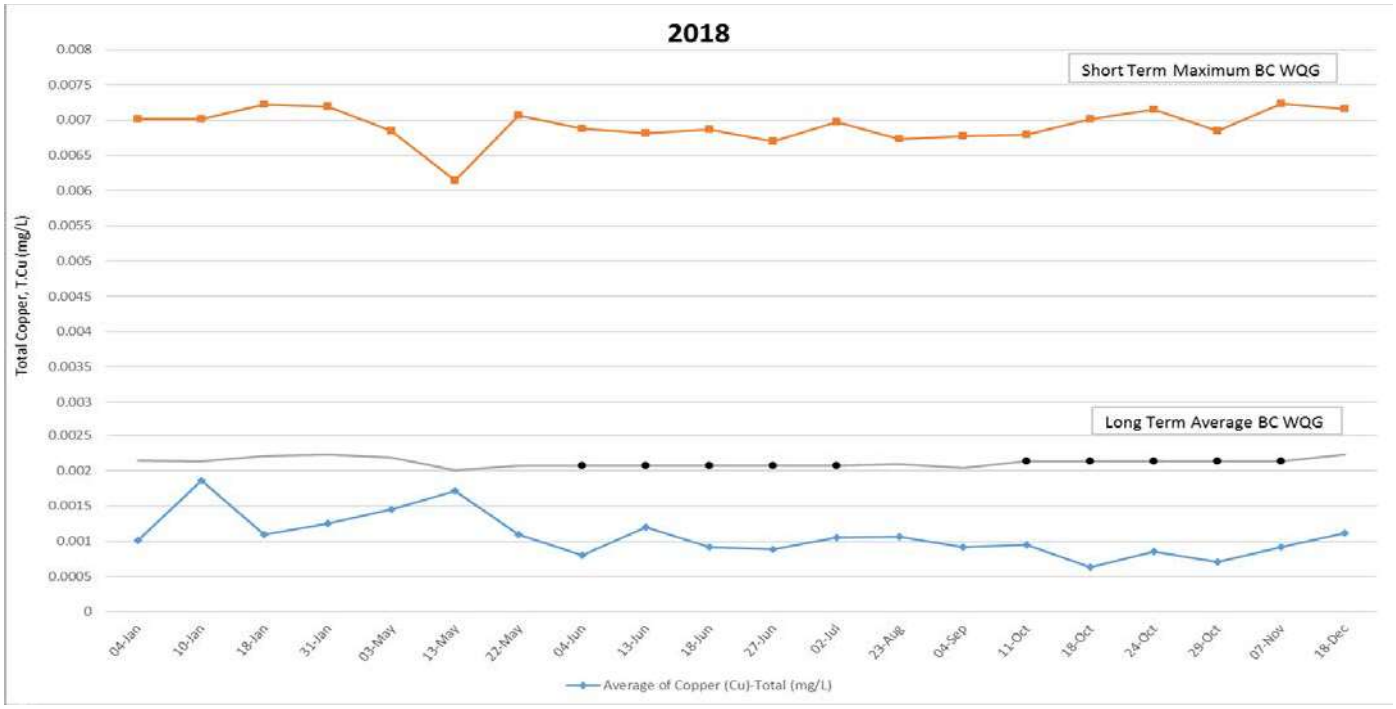

Figure 4.15 Short and long-term BC WQG for aquatic life total copper concentrations at QUL-58 in 2018. The black dots discern applicable long-term average BC WQG for aquatic life (5 samples in 30 days).

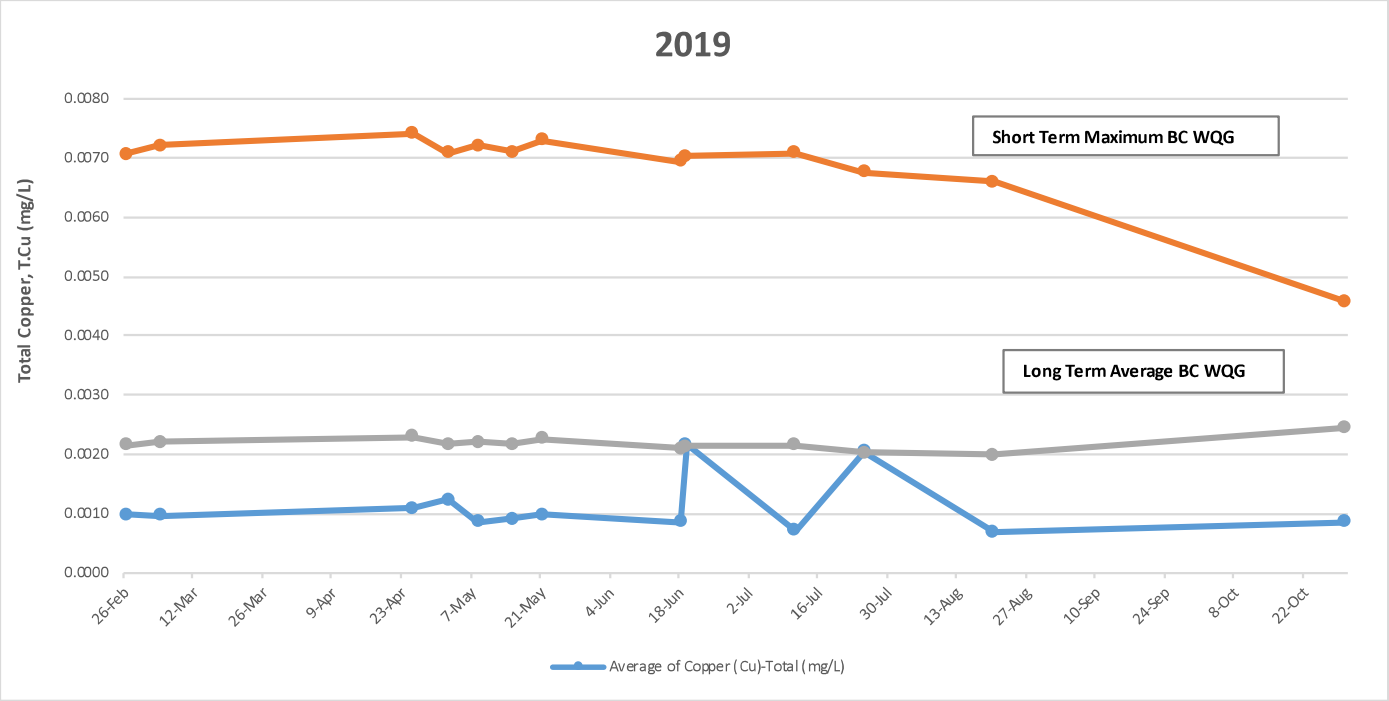

Figure 4.16 Short and long-term average BC WQG for aquatic life total copper concentrations at QUL-58 in 2019

Historically, total phosphorus in Quesnel Lake and at QUL-58 has rarely met the BC WQG for aquatic life in lakes (where salmonids are the predominant fish species). The BC WQG limit ranges from 0.0050 mg/L to 0.0150 mg/L (ENV, 2018) and in 2019, the monthly mean results range from 0.0030 mg/L to 0.0104 mg/L at QUL-58. While it has met the BC WQG during some sampling events, the total phosphorus limit is only applicable during spring overturn at the epilimnetic water if residence time exceeds 6 months (according to the BC WQG for total phosphorus– nutrients and algae [ENV, 2018]), therefore, total phosphorus remains below the BC WQG at an average of 0.0061 mg/L. This is expected as Quesnel Lake is an oligotrophic water body.

4.12.2.7 Receiving Environment Chemistry – Quesnel River

Quesnel River, site QUR-11, was sampled monthly by MPMC as a downstream site in the receiving environment according to the 2016 *CEMP*. Grab samples and in situ parameters were collected off the Likely Bridge using the Kemmerer sampler. The water chemistry results were compared to the BC WQG for aquatic life and all guidelines were met at QUR-11 in 2018. A total copper result from September 20, 2018 was elevated compared to previous results and was deemed as an outlier.

MPMC provides payment for a joint federal and provincial water quality monitoring site that is monitored at this same location. This sample is currently collected monthly and the data from the government sample are available on-line. Due to the ongoing sampling from this program, QUR-11 was removed as a monitoring site in the 2018 *CEMP*, therefore, no samples were collected in 2019.

4.12.3 Discharge Toxicity Testing Results

As per Section 3.3 of the *EMA* Permit 11678 issued on April 7, 2017 (amended October 2018), monthly acute toxicity testing is required at the discharge, location HAD-03. Further toxicity test sampling occurred as required by the 2018 *CEMP* and MDMER; testing was completed at Nautilus. No toxicity testing was completed at HAC-12 as the site no longer exists.

Table 4.27 Toxicity sampling events in 2019

Site Name	Site Identifier (EMS No.)	Test Type	Frequency	Actual Sampling Events
HAD-03	E304230	96-h rainbow trout LC50	Monthly	12
		48-h *D. magna* LC50	Monthly	12
		7-d *C. dubia* survival and reproduction	Semi-annually	2
		7-d rainbow trout embryo-alevin	Semi annually	2
		72-h *P. subcapitata* growth inhibition	Quarterly	2[(b)]
		7-d *L. minor* growth inhibition	Quarterly	4

[(a)] Sample frequency changed from semi-annual to quarterly in 2019 and were missed in the first and second quarters.

4.12.3.1 Acute toxicity testing

Monthly acute toxicity testing occurred at HAD-03 throughout 2019, when the WTP was discharging (see Table 4.27). These tests were conducted on 100% (i.e. full strength) treated effluent in accordance with the following standard methods as required by *EMA* Permit 11678 and *MDMER*:

- 96-hour acute lethality to juvenile rainbow trout (procedures described by Environment Canada (2000a))
- 48-hour acute lethality to the water flea *D. magna* (procedures described by Environment Canada (2000b))

Acute toxicity tests of rainbow trout and *D. magna* both met the *EMA* Permit 11678 requirement of no acute toxicity by determining that the mortality was less than 50% in 100% effluent (results are provided in Appendix H).

4.12.3.2 Chronic toxicity testing

Chronic toxicity tests at HAD-03 (see Table 4.27) were conducted on 100% treated effluent according to the following standard methods as required by *EMA* and *MDMER* requirements:

- 7-day survival and reproduction of the water flea *C. dubia* (procedures described by Environment Canada (2000c))

- 7-day early life stage with salmonid (rainbow trout embryo-alevin) (procedures described by Environment Canada (1998))
- 7-day growth inhibition in the aquatic plant *Lemna minor* (procedures described by Environment Canada (2007b))
- 72-hour growth inhibition in the alga *Pseudokirchneriella subcapitata* (procedures described by Environment Canada (2007c)).

C.dubia and rainbow trout early life stage met the permit requirement of no chronic toxicity by determining that the inhibition of both tests was less than 25% (results are provided in Appendix H).

Effects were noted for *L. minor* during the chronic toxicity testing in 2019. Inhibitory effects on frond growth and/or dry weight of *L. minor* were observed with an IC25 and IC50 (%v/v) for frond growth and dry weight.

4.13 Sediment Quality

Sediment quality and toxicity samples were collected in Bootjack, Polley and Quesnel Lake at various periods in 2019 by Minnow. Samples were collected Bootjack, Polley and Quesnel Lake using diffusive gradient in thin film technique (DGT) to study the sediment-water interface layer. These results are presented in the Minnow report provided in Appendix K.

Bulk sediment sampling was conducted by Minnow in one area in upper Hazeltine Creek, one area in lower Hazeltine Creek and areas in upper and lower Edney Creek in 2019 as part of the fish habitat survey. The purpose of the sampling was to evaluate the substrate chemistry as it relates to rainbow trout spawning in the remediated areas of upper Hazeltine Creek. These results are presented in the Minnow report provided in Appendix K.

4.14 Benthic Invertebrates

Benthic invertebrate community samples were collected in Bootjack, Polley, and Quesnel Lakes in 2019 by Minnow. These results are presented in the Minnow report provided in Appendix K.

Benthic invertebrate sampling was conducted by Minnow in Hazeltine, Frypan and Edney Creeks to meet the CEMP requirements (Appendix A). Benthic invertebrate total biomass, tissue quality, and community samples as well as composite taxa and single taxon (caddisfly) tissue samples were collected in upper Hazeltine, Edney, and Frypan Creeks in 2019. These results are presented in the Minnow report provided in Appendix K.

4.15 Plankton, Chlorophyll *a*, and Secchi Disk

4.15.1 Plankton and Chlorophyll *a*

Chlorophyll *a* samples in Polley and Quesnel Lakes were generally collected two times (i.e. June and August) per growing season (Table 4.28). In 2016, chlorophyll *a* was collected three times at QUL-58, P1, and P2 for additional data. In 2017, an additional sample was collected at QUL-58; no samples were collected at QUL-ZOO-8 due to unsafe conditions from wildfires. In 2018, some chlorophyll *a* samples were collected in July and September as samples were missed at QUL-58 and QUL-2a in June, and QUL-ZOO-1, -7, and -8 and QUL-2a in August due to the proximity of forest fires limiting visibility and deteriorating air quality. An additional sample was collected at QUL-18 in May 2018. In 2019, only one sample was collected from QUL-ZOO-8 as it was removed from the sampling program later in the year. Chlorophyll *a* results from Polley Lake since 2011 are included in Figure 4.17. Chlorophyll *a* results from Quesnel Lake since 2014 are included in Figure 4.18.

Results from 2019 are in Appendix M and discussion for 2016 to 2019 results are in Minnow's report in Appendix K.

Table 4.28 Chlorophyll a sample events from 2016-2019

Site Name	2016 Sample Dates			2017 Sample Dates			2018 Sample Dates			2019 Sample Dates	
QUL-2a	28-Jun-16	15-Aug-16		19-Jun-17			25-Jul-18	5-Sep-18		19-Jun-19	20-Aug-19
QUL-18	28-Jun-16	15-Aug-16		19-Jun-17			23-May-18	19-Jun-18	27-Aug-18	19-Jun-19	19-Aug-19
QUL-120a	27-Jun-16	24-Aug-16		31-Aug-17			19-Jun-18	27-Aug-18		19-Jun-19	19-Aug-19
QUL-58	20-Jun-16	28-Jun-16	1-Aug-18	15-May-17	29-May-17	19-Jun-17	4-Sep-18			19-Jun-19	20-Aug-19
QUL-ZOO-1	27-Jun-16	24-Aug-16		21-Jun-17	21-Aug-17		20-Jun-18	5-Sep-18		25-Jun-19	29-Aug-19
QUL-ZOO-7	27-Jun-16	24-Aug-16		21-Jun-17	21-Aug-17		20-Jun-18	5-Sep-18		25-Jun-19	29-Aug-19
QUL-ZOO-8	27-Jun-16	24-Aug-16					20-Jun-18	5-Sep-18		25-Jun-19	
P1	6-Jun-16	4-Jul-16	23-Aug-16	28-Jun-17	23-Aug-17		12-Jun-18	21-Aug-18		24-Jun-19	
P2	6-Jun-16	4-Jul-16	23-Aug-16	28-Jun-17	23-Aug-17		12-Jun-18	21-Aug-18		24-Jun-19	28-Aug-19

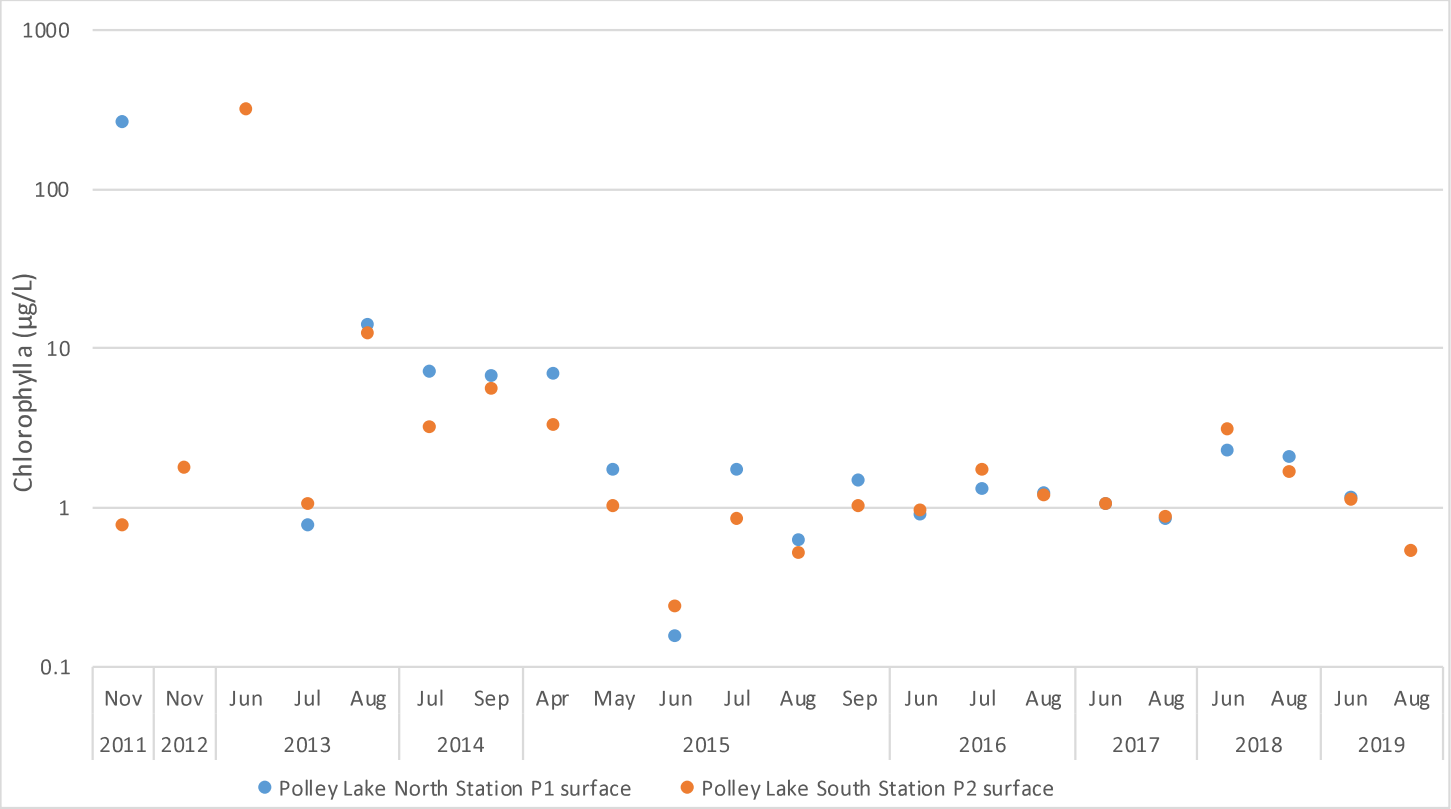

Figure 4.17 Chlorophyll a results from Polley Lake

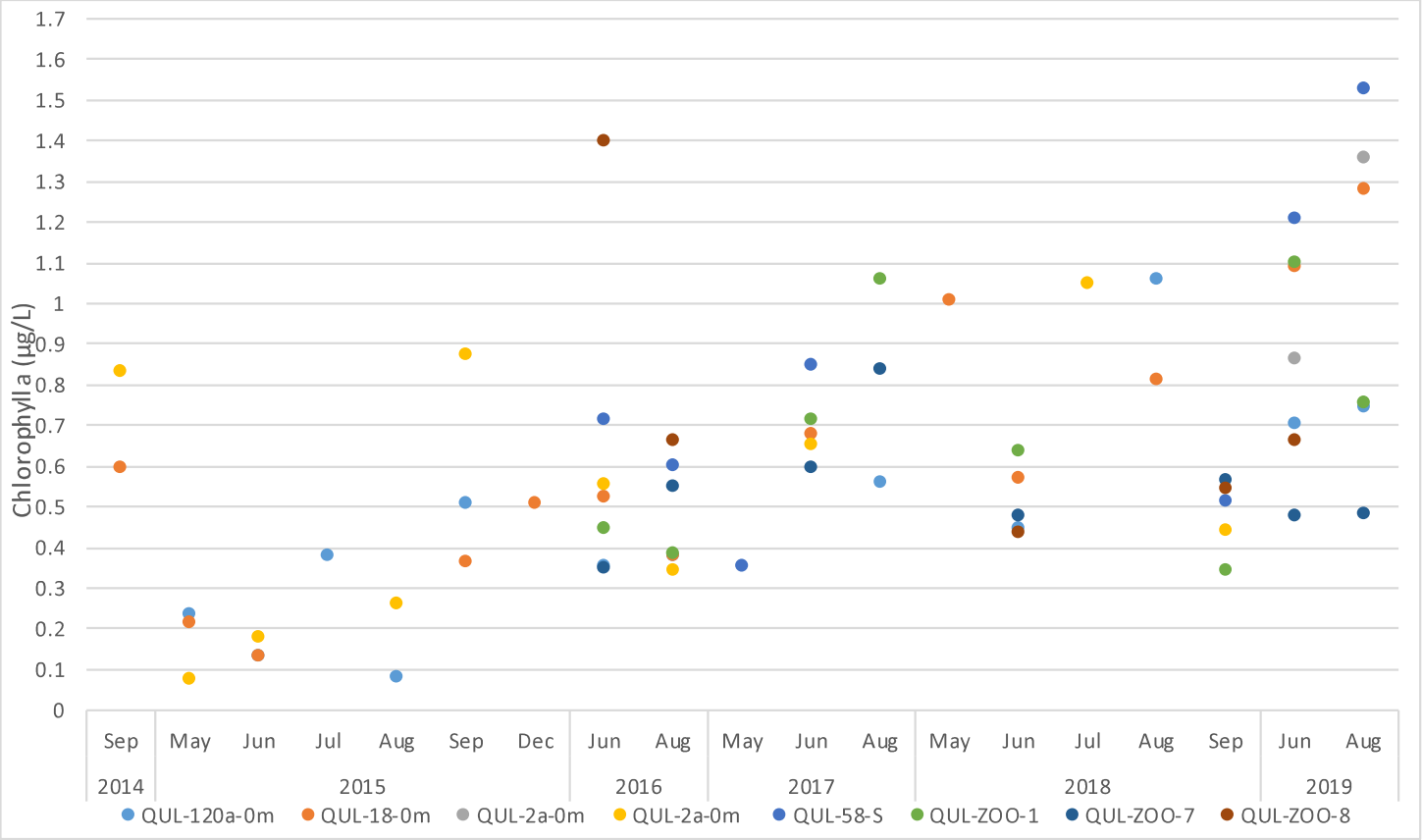

Figure 4.18 Chlorophyll a results from Quesnel Lake

Zooplankton and phytoplankton samples were also collected at surface depth, twice per growing season (June and August) at the same water quality monitoring stations in Polley Lake (P1 and P2). Samples were collected on June 24, 2019 at P1 and P2, and August 28, 2019 at P2. Quesnel Lake monitoring is conducted at three stations historically sampled by Department of Fisheries and Oceans (DFO), so pre- and post-TSF embankment breach results can be compared for both spatial and temporal trends. However, MPMC does not have access to the historic and current DFO data. Station 1 (QUL-ZOO-1) is located in the centre of the West Basin, station 7 (QUL-ZOO-7) is located in front of Horsefly Bay, and station 8 (QUL-ZOO-8) is located at the junction of the North, East, and West Arms (Appendix B). In 2019, zooplankton and phytoplankton samples were collected by in June, July and/or August. Results are in Appendix M.

Additional review of phytoplankton, and zooplankton are presented in the Minnow's report in Appendix K. The raw Quesnel Lake zooplankton taxonomy are included in Appendix M.

4.15.2 Secchi Disk

During each sampling and profiling event, a Secchi depth measurement (Table 4.29) was collected (except if conditions were too windy/wavy) as per 2016 and 2018 *CEMP* (Appendix A). Secchi depth data are included in Appendix M.

Table 4.29 Secchi depth measurement events in 2019

Site	Site Identifier (EMS No.)	Secchi Depth Measurement Events
P1	E207974	5
P2	E207975	6
B1	E207972	3
B2	E215897	5
B4	E216744	0
QUL-ZOO-1	E306455	3
QUL-ZOO-7	E306456	3
QUL-ZOO-8	E306457	1
QUL-120a	E303022	2
QUL-18	E303019	3
QUL-58	E304876	9
QUL-57	E304874	8
QUL-59	E304875	7
QUL-2a	E303020	4

All Secchi depths measured were within the range of measurements from previous years.

4.16 Periphyton

Periphyton sampling was conducted by Minnow Environmental Inc. (Minnow) in Hazeltine, Frypan and Edney Creeks to meet the *CEMP* requirements (Appendix A). Periphyton biomass (ash-free-dry-mass), productivity (chlorophyll *a*), community samples, and tissue chemistry were collected for analysis in 2019. These results are presented in the Minnow report provided in Appendix K.

4.17 Fish

Several fish studies were conducted by Minnow in 2019. In Edney Creek, fish usage and habitat characterization studies and spawning surveys were completed. Fish tissue quality sampling was conducted in Polley and Bootjack Lake. Ongoing fish community surveys were also completed in Polley and Bootjack Lake. Discussion of these results will be presented in the Minnow report provided in Appendix K.

4.17.1 Fish and Habitat Surveys

Habitat assessments, habitat usage/density, and fish growth assessments were completed in remediated and upstream areas of Edney Creek and Reach 1 and Reach 2 of Hazeltine Creek from June to October. Fry trapping was completed for collection of whole-body rainbow trout tissue quality samples. Additional fry trapping was completed in Hazeltine and Frypan for collection of non-lethal meristics data. Discussion of

these results will be presented in the Minnow report provided in Appendix K.

On April 27, 2018 after detailed studies and analysis, MPMC was authorized to move the fish exclusion fences from upstream of the Polley Lake weir to just above the Gavin Lake Road Bridge. This allowed the Polley Lake rainbow trout to return to the newly constructed spawning and rearing habitat in the approximately 2.6 kms of upper Hazeltine Creek. A *2019 Hazeltine Creek Monitoring Report* was issued under separate cover in March 2020 and is provided in Appendix O.

4.17.2 Fish Exclusion

In accordance with Section 2.6 of *EMA* Permit 11678 and the Hazeltine Creek Fish Exclusion and Response Plan (MPMC, 2016b), monthly visual inspections were conducted in 2019 (Table 4.30). Inspections included the length of Hazeltine Creek from the fish exclusion fences to the Lower Settling Pond near Quesnel Lake, with the exception of the lower canyon during winter months due to safety concerns. Inspections were not completed in ice and snow covered conditions. Fry were observed downstream of the fish exclusion fences in June, July, August and September. No trapping was conducted as none of the fry were identified as Rainbow Trout.

Table 4.30 Results of monthly visual fish inspections of Hazeltine Creek in 2019

Date of Inspection	Time	Inspector	Inspection Results/Comments
8-Jan-19	13:50	GH, MK	Creek covered in ice and snow, no inspection
5-Feb-19	14:35	GH	Creek covered in ice and snow, no inspection
4-Mar-19	13:58	GH	Creek covered in ice and snow, no inspection
10-Apr-19	9:17	GH	No fish observed, water somewhat turbid and brown in color, did not inspect canyon
23-May-19	10:24	GH	Cleaned lower fish fence, no fish observed
12-Jun-19	9:50	GH	~40 Redside Shiner fry observed in 2 pools immediately D/S of fences, no RBT observed
24-Jul-19	12:29	GH	7 LNS fry observed ~50m D/S of fence, ~65 LNS fry observed ~170m D/S of Gavin Bridge, 13 LNS fry observed ~300m D/S of Gavin Bridge, 8 LNS fry observed ~400m D/S of Gavin Bridge, turbid water below R1 @ worksite- no visibility, all fish appeared to be LNS of the same age class - YOY- no par marks observed
14-Aug-19	11:51	GH	Large mats of algae in some pools limiting visibility, 20 LNS 150-200m D/S bridge, turb. signature from failure in canyon
17-Sep-19	11:59	GH	2 fry ~50m D/S of fence - unknown species, water quite turbid below construction
16-Oct-19	12:00	GH	No fish observed
5-Nov-19	12:30	GH	No fish observed, light rain, overcast
10-Dec-19	13:06	GH	10-20% ice covered, 50-60% ice covered for portions of reach 3, no fish observed, canyon not inspected

4.18 Terrestrial Monitoring

In 2018, extensive terrestrial monitoring, under the supervision of QP's from Golder, continued in the Hazeltine Creek corridor. The data collected from this monitoring program was used to address some of the uncertainties from the *ERA* (MPMC 2017c). The data and analysis found that risks to wildlife associate with copper and vanadium in soils are low. Details of the terrestrial monitoring including the *Update to Wildlife Food Chain Model* are included in Appendix N.

Wildlife monitoring was the only terrestrial monitoring completed on the mine site in 2019.

4.18.1 Wildlife Monitoring

The Mount Polley site and surrounding area is home to a wide variety of wildlife including ungulates, carnivores, raptors, waterfowl, songbirds, mustelids, amphibians and a host of aquatic organisms. With extensive wildlife activity on the mine site, MPMC provides training to all employees regarding management of food waste and bear awareness. This training and information is intended to help keep MPMC employees and the wildlife safe.

To meet requests by the ENV and various stakeholders, to provide valuable data for evaluating the effects of the mine on wildlife, and to monitor wildlife habitat creation through reclamation, the MPMC Environmental Department records wildlife observations and incidents on the mine site. In addition, MPMC maintains three motion triggered wildlife cameras which are staged in various locations on-site. The cameras collect photo-data from approximately April to November each year and enable MPMC to capture around the clock wildlife activities. This information is considered valuable for future redamation and land use planning.

Following the TSF embankment breach, MPMC submitted the *Post Event Environmental Impact Assessment Report* (PEEIAR) (MPMC, 2015a) that included an investigation of the impacts to wildlife. The findings stated that there was no evidence of direct impacts to local populations of larger mammals such as deer, moose or bear, but impacts due to bioavailability of metals was yet unknown. The *ERA* (MPMC, 2017c) evaluated the possible risks of metal bioaccumulation in various animals. The findings showed that metals were likely to have low bioavailability and a low risk of bioaccumulation. The *ERA* also compared the frequency of wildlife observations in 2015 to 2016, and noted that the observation of deer, small mammals and birds increased, likely due to increased forage ability. Ongoing remediation of the impacted areas are providing habitat and food for a variety of mammals and birds, which is an important step to rebuilding the ecosystems.

In 2017, there were 734, in 2018, there were 399, and in 2019 there were 420 recorded wildlife observations. The observation data from January to May 2018 were affected by the cyberattack discussed earlier. Observation numbers were also affected by the union strike in 2018. The observation data in 2019 was affected by the transition into Care and Maintenance on May 31, 2019 due to the low number of employees

on site. The observations include actual sightings, and observations of scat and tracks (Table 4.31). Observations comprise a wide range of different birds, carnivores, moose, and deer. It is assumed that the number of reported observations is only a fraction of the actual observations but suggests regular use of the site by wildlife. Table 4.31 indicates some generic observations such as "Deer", these entries refer to sightings with no positive species identification.

In 2017 and 2019 there were no wildlife incidents reported. In 2018, there was one wildlife incident reported. A young black bear was found dead below a power pole. The bear had likely climbed up the power pole and electrocuted itself. This incident was reported to the Conservation Officer Service and the bear was disposed of away from active work areas.

Table 4.31 2019 wildlife observations at Mount Polley Mine

2019 Wildlife Observations

Onsite		
Wildlife Observed	# Observed	Scat/Tracks
Bald Eagle	1	
Black Bear	155	
Beaver	1	
Canada Goose	4	
Coyote	8	
Duck	6	
Golden Eagle	1	
Spruce Grouse	3	
Lynx	4	
Moose	22	
Mountain Blue Bird	1	
Mule Deer	41	
Northern Harrier Hawk	1	
Red Tailed Hawk	2	
Sandhill Crane	3	
Stellars Jay	2	
Swallow	1	
Western Toad	3	

Offsite		
Wildlife Observed	# Observed	Scat/Tracks
Black Bear	23	
Bull Moose	9	
Coyote	8	
Fox	1	
Grouse	1	
Lynx	3	
Mule Deer	1	
Snowshoe Hare	5	
Squirrell	1	
Wolf	2	

Breach Affected		
Wildlife Observed	# Observed	Scat/Tracks
American Kestrel	1	
Bald Eagle	11	
Barrow's Goldeneye	11	
Beaver	1	
Black Bear	12	
Blue Heron	2	
Canada Goose	22	
Coyote	1	
Golden Eagle	1	
Grouse	4	
Killdeer	2	
Lynx	2	
Mallard	5	
Mule Deer	1	
Otter	3	2
Rainbow Trout	20+	
Red Tailed Hawk	2	
Sand piper	2	
Wolf	2	

4.19 Amphibian Hazard Assessment

Federal risk assessment guidance (FSCAP 2016) acknowledges there are gaps in the scientific literature and available assessment techniques that create a challenge for the meaningful risk evaluation of amphibians. In 2018, ENV accepted a proposal from MPMC for a tiered approach for evaluating risks to amphibians around Hazeltine Creek that builds on the existing ecological risk assessment. The first two tiers were completed in 2018 and recommendations were made regarding next steps. The findings and recommendations are detailed in Amphibian Hazard Assessment Report prepared by Golder which can be found in Appendix N and is summarized below.

4.19.1 Magnitude of Hazard

The work completed in 2018 provides a hazard evaluation for amphibians exposed to surface water and soils at the Mount Polley site. There are no readily available amphibian-specific toxicity reference values that have been endorsed by BC ENV or other relevant regulatory agencies, and therefore, it is not possible

to conduct data screening in a routine manner like what can be done for other ecosystem components such as plants, soil invertebrates or aquatic organisms. Both federal and provincial risk assessment guidance allow for the derivation of a toxicity reference value using the available and applicable scientific literature under these circumstances. Golder derived a toxicity reference value of 0.018 mg/L dissolved copper for evaluating hazards associated with surface water, and 800 mg/kg copper for evaluating hazards associated with hydric soils or sediment. The available surface water and soil data for the Mount Polley site were compared to these conservative screening values, and overall, there was no evidence that environmental concentrations were routinely or notably higher than those screening value on a site-wide basis. Hazards to amphibians as a result of exposure to soil or surface water are considered to be low under these circumstances.

4.19.2 Implications for Monitoring

A hazard assessment does not typically lead to a "no further action required" unless all hazard quotients are less than 1. There are some areas where the hazard quotients appear to be consistently greater than 1 where additional monitoring specific to amphibians is warranted. The seepage zones and non-rehabilitated soil in the Polley Flats area are two specific areas for further monitoring. Conversely, the magnitude of the hazard elsewhere at the site was relatively low (i.e., less than a factor of 2) even though site-specific copper bioavailability was not considered.

The *ERA* had multiple lines of evidence that indicated that the bioavailability of copper from tailings was relatively low. It is not expected that copper bioavailability to amphibians would be substantially different in magnitude than that previously measured for soil invertebrates, plants, aquatic organism or wildlife receptors. Rather, the *ERA* indicated that impacts to those receptor populations and communities had occurred because of the habitat alteration implicit in the physical scouring and deposition of tailings. The nature of the tailings itself (i.e., low organic carbon; low water holding capacity; limited grain size diversity) was often a confounding factor in evaluating the risk associated with residual metals. The risk assessment identified that ecological succession would likely result in amelioration of those non-chemical stressors over time. Amphibians are expected to share a similar profile in that physical stressors and habitat alteration are present and likely more of an influence than residual metals associated with the tailings. The nature and level of effort for future monitoring or evaluation should be proportional to the magnitude of hazard described in this report in light of these overall risk assessment findings.

4.19.3 Recommended Next Steps

The focus of the terrestrial CEMP (which includes habitat used by adult amphibians) is to monitor natural ecological succession over time. Amphibians also utilize aquatic environments that are being monitored by CEMP components authored by other QPs. A tiered strategy for evaluating risks to amphibians was originally described in the 2018 *CEMP*. The following recommendations are provided to assist MPMC integrate amphibian-specific monitoring activities into the overall CEMP:

- Most concentrations were either less than the screening value or within a factor of 2x. The next step according to the proposed tiered approach (see Appendix N) was to refine how the screening values are applied by measuring water and hydric soil copper concentrations in the specific areas that provide valued amphibian habitat. Golder concludes that this preliminary decision criteria is still relevant and recommends that a habitat survey be completed by a qualified biologist, followed by targeted soil, water and sediment sampling for any areas that are identified as providing valued habitat for amphibians.
- Additional evaluation of literature to refine the screening values is not recommended. The literature search summarized in this document was robust, and the applicable data were summarized and used as appropriate.
- Toxicity testing with amphibians is not recommended at this time. Separating the influence of chemical and non-chemical stressors was a challenge in both the plant and sediment invertebrate toxicity testing and this challenge is expected to be more problematic for amphibians. There is no approved Environment Canada protocol for toxicity testing with representative Canadian amphibian species. Protocols from other jurisdictions focus on the African clawed toad which is not meaningful for managing this site.

Golder recommends that a structured approach could be used to measure population-level metrics (e.g., number of egg masses per unit area or abundance of amphibians per unit catch effort in the specific valued habitats identified on site). Biological monitoring may not be necessary if supplemental soil / sediment and surface water sampling shows that copper concentrations in valued amphibian habitat are less than the screening values. The tiered approach (Appendix A) deferred field-based effects assessment until the screening values were refined. Challenges associated with conducting "control-impact'" style measurements were described and continue to be a concern because there does not appear to be any "control" ponds that would have the same characteristics of on-site ponds in terms of habitat complexity, size, depth or other relevant factors. However, targeted monitoring of a few key metrics over time for on-site waterbodies would provide structure to the important site observation that amphibians appear to be successfully breeding on a year over year basis despite the presence of tailings and physical alteration of habitat.

4.20 Soil

No soil works were completed in 2019.

4.21 Soil Invertebrates

No soil invertebrate works were completed in 2019.

4.22 Vegetation

No vegetation works were completed in 2019.

5 Reclamation Program

The objectives of the reclamation program are outlined in Section 1.2. To achieve these objectives, as outlined in the most recent *RCP* (MPMC, 2017a), MPMC has established projects at the site to research reclamation and closure methods, including soil amendments and application methods, re-vegetation, vegetation metal uptake, and passive/semi-passive water treatment. Based on the results of these research projects, larger scale progressive reclamation has been ongoing at Mount Polley since 2010, with two primary benefits:

1. Conducting reclamation during the operating life of the Mine reduces the size of disturbed area requiring reclamation at closure and minimizes liabilities.
2. Sites undergoing progressive reclamation can be continually monitored, and reclamation prescriptions modified based on findings. Using this approach, it is anticipated that a refined prescription for meeting reclamation objectives will be developed and can be applied site-wide at Mine closure.

An update on 2019 progressive reclamation activities within the mine site and research projects is included in this section, as well as an updated five-year reclamation plan. Progressive reclamation in 2018 does not include reclamation and revegetation activities associated with the breach. Further reclamation information can be found in the *RCP* (MPMC, 2017a) updated in January of 2017.

5.1 Reclamation Cost Update

No significant new disturbance occurred in 2019.

5.2 Stability of Works

5.2.1 Rock Disposal Sites (RDS)

Examinations of RDSs are made in accordance with Section 6.10.1 of the *Health, Safety and Reclamation Code for Mines in British Columbia (HSRC),* (EMPR, 2017). Monitoring of RDSs occurs according to the terms and conditions of a variance granted by the EMPR on February 9, 2001. A report on the 2019 RDS inspection, prepared by a QP will be submitted to the EMPR by March 31, 2020.

5.2.2 Pit Walls

Pit walls are monitored for stability using high-precision 3-D surveys, radar monitoring, and surface inspections. Pit wall stability is reviewed annually by a third party QP from an engineering services firm. A report on the 2019 pit slope inspection, prepared by a QP and will be submitted to the EMPR by March 31, 2020.

5.2.3 Tailings Storage Facility and Associated Works

MPMC received authorization to proceed with construction activities at the TSF to a maximum elevation of 970 m under the *Mines Act* Permit M-200 June 23, 2016 amendment. Construction of the Main Embankment and Perimeter Embankment Buttresses for the 970 m approved design were deemed completed by the Engineer of Record (EoR) in 2016.

MPMC conducted the following TSF related construction activities in 2019:

- No construction conducted in 2019.

The following inspections occurred at the TSF in 2019:

- Annual Dam Safety Inspection (DSI), conducted by the EoR on October 1, 2019 as required by Section 4.2 of the *HSRC* (EMPR, 2017).

In addition to the physical activities, MPMC also submitted the following reports:

- The 2019 DSI report, as required under the *HSRC* (EMPR, 2017) to be submitted to EMPR by March 31, 2020.

There were no unusual or dam safety related occurrences in 2019. Pond water volume fluctuated between 2.0M and 3.3M m^3, with excess water available for discharge through the WTP.

5.32019 Reclamation Activities

5.3.1 Reclamation Inspection

On September 4, 2019, EMPR conducted a site visit to review changes in site conditions since the last inspection and to carry out a *Mines Act* environmental and reclamation compliance inspection. An inspection report was issued including recommendations related to Permit M-200 the *HSRC* (EMPR, 2017) and established best practices in environmental management and Mine reclamation.

The report included three advisories that required responses from the Mine manager. All advisories and information requests have been considered, and a summary is provided in Table 5.1.

Table 5.1 Summary of EMPR reclamation inspection recommendations

EMPR Inspection Report September 4, 2019	
Advisory	**MPMC Response**
1. A small soil stockpile located adjacent to the headwater tank was observed. A vegetative cover consisting of a mix of native and agronomic species had been established on the pile. Oxeye daisy was also present on the stockpile. Oxeye daisy is considered to be a regionally noxious weed under the BC Weed Control Act in the Cariboo region. Mr. Holmes indicated that Spectrum Resources Group was on site in 2018 to treat invasive plants; however, treatment did not occur in 2019. It was discussed that use of the material would result in a transfer of weed species to other areas of the mine. Similar discussions resulted during the 2018 inspection with regard to the biosolids stockpile. As these materials will be used for onsite reclamation in future, infestation of stockpiled reclamation materials may result in the spread of invasive species to reclamation areas. MPMC is advised that treatment of invasive plant species should be continued to ensure that further spread of invasive species does not occur.	*The treatment of invasive plant species will be continued.*
2. The previous inspection included an advisory that the materials be vegetated, or other erosion control measures be employed. In the response to the inspection MPMC indicated that the materials would be seeded. During the inspection, establishment of some native species was observed along the peripheries of the stockpile; however, the majority of the stockpile remained un-vegetated. Mr. Holmes indicated that seeding of the stockpile may have been missed or the seed didn't take. MPMC is advised that this material be protected by vegetating with suitable plant species for	*This area will be re-seeded in the spring.*

erosion control purposes or other effective means. The area should be inspected to determine if contouring is also required to ensure that materials aren't exposed to standing or uncontrolled water sources.	
3. The need for ongoing monitoring of reclamation trials was discussed during the inspection. It is important that monitoring of reclamation research trials continue in the future to ensure that MPMC is able to evaluate the success of trial applications, update Reclamation and Closure Plan with learnings from trials and progressive reclamation and demonstrate reclamation success. Please ensure that reclamation monitoring continues on an appropriate schedule and that findings are reported in the Annual reclamation Report.	*Reclamation monitoring will continue on schedule and included in the Annual Reclamation Report.*

5.3.2 Progressive Reclamation

Further information on progressive reclamation at Mount Polley Mine is summarized in the following sections. Table 5.2 details the progressive reclamation completed up to date and summarizes the area disturbed and reclaimed in 2019 and fulfills the EMPR requirements for Table 1.

Table 5.2 Progressive reclamation completed at Mount Polley Mine as of December 31, 2019

Area	Parcel	Re-contoured (ha)		Soil/Till Applied (ha)		Seeded (ha)		Fertilizer/Biosolids (ha)		Tree-Planted (ha)	
		2018	Total	2018	Total	2018	Total	2018	Total	2018	Total
NEZ Dump	2a, 2b1, 2b2	0.00	5.13	0.00	5.13	0.00	5.13	0.00	5.13	0.00	5.13
	Beside 2a/2b	0.00	2.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NBD	Parcels 1 - 10	0.00	9.45	0.00	11.59	0.00	11.59	0.00	11.59	0.00	11.59
	South Triangle	0.00	1.30	0.00	1.30	0.00	1.30	0.00	1.30	0.00	1.30
	Phase 1	0.00	2.21	0.00	2.21	0.00	2.21	0.00	2.21	2.21	2.21
	Phase 2	0.00	2.87	0.00	2.87	0.00	2.87	0.00	2.87	2.87	2.87
	Metro Van Research 1	0.00	2.81	0.00	2.81	0.00	1.87	0.00	2.34	0.00	2.34
	Wrap Around Toe	0.00	0.00	0.00	2.20	0.00	2.20	0.00	0.00	0.00	0.00
	Beside Research 1	0.00	4.76	0.00	1.99	0.00	0.00	0.00	0.00	0.00	0.00
	Metro Van Research 2	0.00	2.00	0.00	2.00	0.00	1.33	0.00	1.66	0.00	2.00
	Beside Research 2	0.00	2.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	Beside BJ FSR	0.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Boundary Zone	Dump	0.00	4.70	0.00	4.70	0.00	0.00	0.00	0.00	4.70	4.70
East RDS	Above Access Road	0.00	3.42	0.00	4.06	0.00	4.06	0.00	0.00	2.75	2.75
	Highway to Heaven	0.00	11.53	2.89	9.47	0.00	6.58	0.00	0.00	9.47	9.47
	Tree Plots	0.00	2.31	0.00	2.31	0.00	2.31	0.00	1.20	0.00	2.31
Waste Haul Road	Above WHR	0.00	1.81	0.00	1.81	0.00	1.81	0.00	0.00	0.00	0.00
	Below Helipad	0.00	1.53	0.00	1.53	0.00	1.53	0.00	1.53	0.00	1.53
South Till Borrow		0.00	23.25	0.00	0.00	0.00	14.75	0.00	12.00	0.00	0.00
	TOTAL	0.00	85.18	2.89	55.98	0.00	59.54	0.00	41.83	22.00	48.20

Waste Dumps: North Bell Dump

No new reclamation work was completed on the North Bell Dump in 2019. Monitoring of past reclamation work is ongoing.

Waste Dumps: NEZ Dump

No new reclamation work was completed on the North East Zone Dump in 2019. Monitoring of past reclamation is ongoing.

Waste Dumps: Boundary Dump

No new reclamation work was completed on the Boundary Dump in 2019. Monitoring of past reclamation is ongoing.

Waste Dumps: East RDS

No new reclamation work was completed on the East Rock Disposal Site in 2019. Monitoring of past reclamation is ongoing.

Watercourse Reclamation

No watercourse reclamation was conducted in 2019.

Pit Reclamation

No pit reclamation was conducted in 2019. The Bell Pit, Pond Zone Pit, and Southeast Zone (SEZ) Pit have been backfilled by waste dumps and will not require reclamation.

TSF Reclamation

No reclamation was conducted at the TSF in 2019.

Road Reclamation

No road reclamation was conducted in 2019.

Treatment of Structures and Equipment

No site structures or equipment were salvaged or disposed of in 2019.

Securing of Mine Openings

There was no sealing or securing of any Mine entrances in 2019.

5.3.3 Re-vegetation

MPMC recognizes re-vegetation as a critical aspect of site maintenance and reclamation. Disturbed areas are grass seeded on an ongoing basis to prevent erosion and invasive species establishment. Soil stockpiles and areas that are unlikely to be disturbed are typically prescribed a native seed mix (Table 5.3). Sites that may be re-disturbed (or where preventing establishment of native species is the primary goal) are typically prescribed an aggressive seed mix (Table 5.3). This mixture grows rapidly in the short term but dies off allowing the ingress of native species from surrounding areas.

All non-active soil stockpiles on site are routinely inspected for erosion and vegetative cover and any non-active stockpiles requiring additional vegetative cover and/or showing signs of erosion are added to the bi-annual (spring and fall) seeding list. This seeding list serves to track areas that require seeding, their size, description and type of seed.

Ground cover seeding took place in 2019 on soil stockpiles, the NEZ Sump and associated ditches and some additional area near the CWTS. MPMC maintains an active Seeding List that serves to track areas that require seeding, their size, description and type of seed.

In addition to seeding ground cover (herbaceous) vegetation, the primary re-vegetation objectives at the Mine include the establishment of woody shrubs and trees (coniferous and deciduous). MPMC recognizes the importance of appropriate seed source and selection for long-term success and endeavors to use local seed sources. All of the conifer management at the Mine is consistent with provincial forest management practices as governed by the *Forest and Range Practices Act* (ENV, 2002). This includes participation in regional silviculture strategies, stocking standards, tree species selection, and seed planning and registration. Additional erosion control is provided through re-vegetation associated with site progressive reclamation.

Table 5.3 Aggressive and native seed mixes for reclamation

Species	% by Weight
Aggressive Seed Mix	
Dahurian Wildrye	25
Slender Wheatgrass	30
Perennial Ryegrass	15
Timothy	5
Native Seed Mix	
Mountain Brome	25
Native Red Fescue	10
Rocky Mountain Fescue	14.31
Bluebunch Wheatgrass	25
Blue Wildrye	25
Fireweed	0.014
Big Leaf Lupine	0.68

5.4 Invasive Plant Management

Invasive plant species are managed under MPMC *Invasive Plant Management Plan*. This plan was reviewed in 2019 (as required by *Mines Act* Permit M-200). Invasive species management activities in 2019 included:

- Seeding of soil stockpiles that are not active and new disturbed areas as well as new reclamation sites (unless they are covered with freshly stripped soil that is expected to re-vegetate without seeding) to promote establishment of native species.
- Use of only high-quality grade seed, currently sourced from Premier Pacific Seed (Table 5.3). At a minimum, seed used is of the grade Common No.1 Forage Mixture (or better) or Canada No. 1 Ground Cover Mixture. All seed used meets or exceeds Canadian Food Inspection Agency (CFIA) and regional standards for presence of noxious weeds.
- Monitoring of soil stockpiles to evaluate presence of invasive species

The invasive species currently known to be present at Mount Polley Mine that are listed in the *2018 Regional Strategic Plan for Invasive Plant Management* and *Executive Summary* (the most recent regional plan) by the Cariboo Chilcotin Coast Invasive Plant Committee (CCCIPC, 2018) are oxeye daisy, Canada thistle, orange hawkweed, yellow hawkweeds (non-native), and scentless chamomile. All of these plants have the priority ranking "3 – Established", and are common and widespread, with widespread control not currently possible. As such, MPMC's approach is to manage invasive species at this site such that they do not inhibit reclamation activities, with recognition that all outside sources (for example, cattle, wildlife, wind and water) pose challenges to eradicating invasive plants at the Mine site that are widespread in the surrounding areas.

5.52019 Reclamation and Closure Research Update

No new reclamation research was conducted in 2019.

Information on ongoing and past reclamation research can be found in MPMC *AERR*s from 2010 to 2018. Further information can be found in MPMC *RCP* Update January 2017 (MPMC, 2017a).

5.5.1 Biosolids

In 1999, the ENV issued MPMC a permit to import biosolids from the Greater Vancouver Regional District (now Metro Vancouver) for the purpose of mine site reclamation (*EMA* Permit 15968). After initial receipt and stockpiling of the biosolids shipments in 2000, the program was suspended due to the temporary closure of the Mine; biosolids shipment recommenced in 2007. In 2014, *EMA* Permit 15968 was amended to include:

- An increase in the maximum rate of land application from 150 dry tonnes (dt)/ha to 165 dt/ha;
- An increase in the maximum cumulative discharge from 90,000 dt to 99,000 dt;
- Revised references to MPMC land claims and an updated site plan; and
- The allowance of two designated storage facilities.

Currently there is only one biosolids stockpile on site, located near the TSF. Table 5.4 provided by Metro Vancouver, summarizes biosolids deliveries and applications at Mount Polley from 2000 to 2014. No biosolids were used on site in 2019 and no changes to stockpiled volumes have been made since 2014. As no deliveries were made in 2019, no Metro Vancouver biosolids were assessed for compliance with *EMA* Permit 15968 requirements or compared to the Organic Matter Recycling Regulation criteria for Class A biosolids.

Table 5.4 Metro Vancouver biosolids deliveries and applications at Mount Polley (2000 – Present)

Mt Polley Inventory, Updated: Mar. 7, 2018					
Stockpile Location	Delivery Date	Biosolids Delivered			
		Annacis	Lulu	Total (wt)	Total (*dt*)
Tailings Storage Facility Stockpile (Area 1)	2000/01 inventory		10,754	10,754	*2581*
	Feb 7 - Nov 2, 2007		4,641	4,641	*1114*
	Aug 5 - Nov 1, 2009	7,101	124	7,225	*2160*
	Jan 1 - Nov. 12, 2010	16,136	42	16,178	*4367*
	Apr 4 - 14; July 4, 2011	1,206		1,206	*338*
	Apr 25 - Sept. 4, 2013	9,664		9,664	*2706*
NEZ	Sep 28 - Nov 19, 2008	3,875		3,875	*1163*
	Apr 15 - May 29, 2011	5,058		5,058	*1416*
North Bell					

	2012 deliveries: MPMC "Area 2" (May 30 - June 17)			1,060		1,060	*297*
	2012 deliveries: MPMC "Area 1" (June 18 - July 31)			1,482		1,482	*415*
	2013 Deliveries: Tree Trial Plots (Sept. 28 - Oct. 6)			960		960	*269*
	2014 Deliveries : Tree Trial Plots (May 21 - 27)			706		706	*198*
	Delivered 2000-to-present			**47,247**	**15,561**	**62,808**	***17022***
	Site ID	**ha**	**rate (dt/ha)**	**Biosolids Utilized**			
				Annacis	Lulu	Total (wt)	Total (*dt*)
Applications	tree research plots (circa 2000/01)				234	234	*56*
	NEZ - **2008**			3,875		3,875	*1,163*
	North Bell Roadside Slopes (Areas 1 - 10) - **2011**	11.6	122	5,058		5,058	*1,416*
	North Bell (Areas 11 - 19) - **2012**	5.1	140	2,542		2,542	*712*
	North Bell Tree Trial Plots (Plots 2-6) - **2013**	2.3	104	960		960	*269*
	North Bell Tree Trial Plots (Plots 8-12) - **2014**	1.7	118	706		706	*198*
						-	
	CONFIRMED - APPLIED/USED to date			**13,141**	**234**	**13,375**	***3,813***
	Carry Over (at TSF)			**34,106**	**15,327**	**49,433**	***13,209***

5.5.2 Passive Treatment

The Anaerobic Biological Reactor (ABR) was a pilot passive water treatment system constructed at the Mount Polley site in 2009 in partnership with the University of British Columbia and Genome BC. In 2015, the ABR was decommissioned in preparation for buttressing of the TSF Main Embankment. The objective of the ABR was to reduce elevated parameters in Mine effluent through microbial activity to concentrations appropriate for discharge into the receiving environment.

Monitoring results (refer to pervious *AERR*s) indicate that the ABR was capable of reducing metal concentrations in TSF toe drain water to below BC WQGs for protection of aquatic life for all parameters except sulphate. Research indicated the primary causes for the low levels of sulphate reduction to be a lack of dissolved metals for sulphate to bind to and insufficiently anaerobic conditions during summer months.

In 2016, MPMC engaged Contango Strategies Ltd. (Contango) and Golder, to initiate further research work into the feasibility of passive and semi-passive water treatment at the Mount Polley Mine site. As stated in the *RCP* 2017 Update (MPMC, 2017a), "a passive or semi-passive system is the preferred option for water treatment during closure/post-closure; however, optimization through bench- and pilot-scale testing is required to address uncertainties and to optimize the design of a full-scale system" or systems. Where technically achievable, the Mine intends to initiate passive and/or semi-passive treatment during operations.

The work initiated in 2016 identified and characterized the feed water chemistry and flows of various locations on site that would be most suitable for passive treatment and identified sites that could be (a) discharged directly with little or no treatment, (b) suitable pilot sites for simple passive treatment systems,

and (c) potential pilot sites for semi-passive treatment. Individual flows for various Mine water sources were individually assessed in order to tailor treatment technologies to specific sources and their characteristic chemistry. Also, wherever possible, passive treatment systems (if shown to be feasible) are to be designed to make use of materials available on site or from the local area (MPMC, 2017a).

Currently passive treatment research is being advanced in parallel across multiple fronts. Key passive treatment initiatives being investigated indude use of biochemical reactors (BCR), CWTS, and in situ pit lake treatment. Summaries of the work completed to date and future plans are provided below, with further detail provided in the Treatment Works and Source Control Optimization: Progress Reports submitted to ENV under Section 2.9 of *EMA* Permit 11678.

BCRs

Work is ongoing with Golder to explore the potential for use of BCRs at the Mount Polley site. This work compliments the previous ABR research and includes evaluation of a potential passive treatment 'train' configuration (and the role of a BCR within it). As summarized in the *LTWMP TAR* (Golder, 2016b) and *RCP* (MPMC, 2017a) work conducted in completing the site selection screening, contaminants of potential concern (COPC) identification and technology assessment and preliminary implementation scheduling supports advancing the concept of BCRs to the bench-scale phase. In 2018 bench-scale testing of various combinations of BCR substrate, inoculums and influent water was completed. All previous BCR work that has been conducted has been incorporated into the LTWMP for the mine.

CWTSs

Work is ongoing with Contango to explore the potential for use of CWTSs at the Mount Polley site. Following initial site visits in 2016 and initial review of the information contained in the *RCP* 2017 Update, Contango completed a *CWTS Feasibility Assessment Report* (Contango, 2017). Findings of the assessment determined, among other things, that the water chemistry at the Mount Polley site is relatively benign and that passive treatment is conceptually and theoretically possible.

Contango proposed a 5-phase approach to assessing the feasibility of passive water treatment through the use of CWTSs. Part of Phase 1 included design work for the construction of CWTS's both on-site at Mount Polley and off-site at Contango's research facility in Saskatchewan. Phase 2 tested, through bench-scale testing, different substrates to be used in the CWTS as well as testing the treatability of Mine site water. Phases 2 and 3 were initiated in 2018 including the off-site CWTS which was constructed and commissioned in September 2018 and the on-site CWTS with construction finished in late November 2018.

The on-site CWTS was operated throughout the non-freezing months in 2019 (April-December) with regular monitoring taking place. Details of the CTWS operation can be found in Appendix Q.

In situ Pit Lake Treatment

Work is ongoing with Golder to explore the potential for use of in situ pit lake treatment at the Mount

Polley site. Informed by the results of the water quality modelling included in the *LTWMP TAR* (Golder, 2016b), the primary target of the in situ pit treatment investigation is selenium reduction. This treatment technology relies on the same anaerobic microbial reduction process as some active and passive biological treatment and involves amending surface water to promote this anaerobic reduction.

A desktop study conducted in 2017 (MPMC, 2017a) supported the feasibility of the treatment methodology, and recommended advancing to bench-scale testing. Work in 2018 included bench-scale testing of various combinations of carbon amendments, inoculums and influent water.

Saturated Rock Fill and In Situ TSF Treatment for Selenium/Nitrate Removal

In 2019 work was done to evaluate the potential to convert existing site infrastructure (i.e., the Wight Pit and the tailings storage facility) into water treatment facilities to independently meet centralized post-closure treatment requirements at the mine (Golder, 2019b). Under the hypothetical scenario being evaluated the Wight Pit would be converted into a saturated rock fill (SRF) reactor and the TSF would be used as an in situ treatment system.

A previous conceptual design study (Golder 2016a) predicted that treatment will be required for selenium and nitrate. The conceptual design study was developed based on centralized treatment. Treatment targets were proposed for closure and post-closure based on the *Reclamation and Closure Plan Water Quality Modelling Report* (Golder 2017b). It was assumed, for present purposes, that effluent from the SRF treatment system will be discharged to Polley Lake and that effluent from the TSF treatment system will be discharged to Edney Creek and/or Hazeltine Creek (depending on the final effluent discharge locations from the TSF system).

Geomorphic Slope Guidance

A Geomorphic Slope Guidance (Golder, 2017c) document was developed to provide guidelines for site slope recontouring and stream rehabilitation at and around the Mount Polley Mine and will also provide guidance for engineering works that would result in a natural looking slope upon closure. This guidance document will aid in long-term water management.

Soil Cover Test Plot Design

The Soil Cover Test Plot (Golder, 2018a) work, when completed may provide guidance to determine a reclamation cover soil design that reduces infiltration of water into and mass loading of constituents from waste rock disposal sites. This work may also become part of long-term water management.

5.6Five Year Reclamation Plan

Table 5.5 outlines Mount Polley's previous five-year progressive reclamation plan. This table has been updated to summarize reclamation prescriptions to date. MPMC currently has no plans for Mine site reclamation for the next five years and as such no projected five-year reclamation summary is included in

this report. It should be noted that several areas have been identified as candidates for progressive reclamation but there are no immediate plans for completing the work. Work in the next five years will focus on monitoring of progressive reclamation and research projects.

Table 5.5 Previous five year progressive reclamation plan

Site Specifications				Soil				Revegetation			Schedule						
Site	Parcel(s)	Area	End Land Use Objectives	Soil Stockpile Source	Volume (m³)	Application Depth (cm)	Ammendments	Grass Seed Mix[1]	Shrub & Deciduous Tree Planting	Conifer Tree Planting	Re-Contour	Soil Application	Soil Ammendment Application	Coarse Woody Debris Applicaiton	Grass Seeding	Shrub & Deciduous Tree Planting	Conifer Planting
North Bell Dump	Parcels 1-10	11.59	Wildlife, forestry	Wight Till	10,600	20	Biosolids (122 dt/ha)	Native grasses (30 kg/ha) (hydroseeded with fibre mulch, except southern-most Parcel 10 hand seeded at 35 kg/ha)	Black cottonwood - 60 sph Paper birch - 34 sph Trembling aspen - 34 sph Sitka alder - 172 sph Saskatoon - 34 sph Prickly rose - 34 sph Scoulers willow - 79 sph Soopolalie - 100 stem trial plot	Lodgepole pine - 1075 sph Douglas fir - 451 sph Western red cedar - 54 sph Hybrid spruce - 54 sph Consider underplanting with later successional species in future.	2011	2011	2011	2011	2011	2013 - poor survival 2014 - re-plant	2014
	South Triangle	1.30	Wildlife, forestry	North Bell Dump Till	1,733	30	18-19-18 Fertilizer (75 kg/ha)	Native grasses (35 kg/ha) (hydroseeded with fibre mulch)	2013 Black cottonwood - 1000 sph Sitka alder - 800 sph 2014 Soopolalie - 100 stem trial plot	Lodgepole pine - 1400 sph Douglas fir - 600 sph Consider underplanting with later successional species in future.	2011	2011	2011	-	2011/2012	2013/2014	2014
	Phase 1	2.21	Wildlife, forestry	North Bell Dump Till	3,920	20	Biosolids (138 dt/ha)	Native grasses/forbes (35 kg/ha) (hand seeded)			2012	2012	2012	-	2012		
	Phase 2	2.87	Wildlife, forestry	North Bell Dump Top	4,680	20	Biosolids (135 kg/ha)	Native grasses + lupine (35 kg/ha) (hand seeded)			2012	2012	2012	-	2012		
	Metro Van Research Parcel 1	2.81	Wildlife, forestry	North Bell Dump Till	4,680	20	Biosolids (107 dt/ha) (on 2.34 ha)	1) No seed 2) Forbes mixture (75 g/ha fireweed, 1 kg/ha lupine, 113 g/ha Dryas drummondii, 4.9 kg/ha june grass, yarrow, pearly everlasting mix) 3) Fireweed (75 g/ha) 4) No seed 5) Native grasses/forbes (5kg/ha) 6) Native grasses/forbes (10 hg/ha)	Black cottonwood - 200 sph Paper birch - 50 sph Trembling aspen - 50 sph Sitka alder - 200 sph Saskatoon - 50 sph Prickly rose - 50 sph Scoulers willow - 50 sph Huckleberry - 50 sph	Lodgepole pine - 1120 sph Douglas fir - 480 sph Consider underplanting with later successional species in future.	2012	2013	2013	-	2014	2014	2014
	Wrap Around Toe	2.20	Wildlife	North Bell Dump Till	14,418	6	None	Native grasses (~15 kg/ha) (hand seeded)	Monitor natural vegetation ingress		-	2012	-	-	2012	TBD - monitor ingress	
	Beside Research	2.00	Wildlife, forestry	Direct Placement: SEZ Stripping	4,000	20	None	Monitor natural growth from direct placement			2012	2013	-	TBD - monitor ingress			
	Metro Van Research Parcel 2 (in Beside Phase 2 parcel 4.79 ha area)	2.00	Wildlife, forestry	North Bell Dump Top	4,000	20	Biosolids (107 dt/ha)	1) No seed 2) Forbes mixture (75 g/ha fireweed, 1 kg/ha lupine, 113 g/ha Dryas drummondii, 4.9 kg/ha june grass, yarrow, pearly everlasting mix) 3) Fireweed (75 g/ha) 4) No seed 5) Native grasses/forbes (5kg/ha) 6) Native grasses/forbes (10 hg/ha)	Black cottonwood - 200 sph Paper birch - 50 sph Trembling aspen - 50 sph Sitka alder - 200 sph Saskatoon - 50 sph Prickly rose - 50 sph Scoulers willow - 50 sph Huckleberry - 50 sph	Lodgepole pine - 1190 sph Douglas fir - 510 sphh Consider underplanting with later successional species in future.	2012	2014	2014	-	2014	2015	2015
Waste Haul Road	Heli Pad Area	1.53	Wildlife, forestry	Old Cariboo Stockpile/ Springer Pit	3,825	28	18-19-18 Fertilizer (170 kg/ha)	Aggressive seed mix (26 kg/ha) (hydroseeded)	Monitor natural vegetation ingress	Douglas fir - 216 sph	-	2013	-	TBD - monitor ingress	2014		2015
	Above WHR (Pond Zone)	1.81	Wildlife, forestry	Old Cariboo Stockpile/ Springer Pit	5,456	30	None	Native grasses/forbes (22 kg/ha)	Monitor natural vegetation ingress		-	2013	-	TBD - monitor ingress	2013		
East RDS	Highway to Heaven	11.52	Wildlife, forestry	2014: Direct Placement: Caribou Ore Stockpile, WX Zone Stripping 2016: Highway to Heaven	2014 - 26,700 2015 - 8,200	40	None	Native grasses/forbes (30 kg/ha)			2014 - 9.47 ha	2014 - 6.58 ha	-	TBD - monitor ingress	2014		
	Tree Plots[2]	2.13	Wildlife, forestry	Bell Pit Stockpile	Not Calculated	0 - 65	Amendment Tested: Fertilizer (RTI Bio Pack's, 10g/bag) Biosolids (50 - dt/ha) Tailings (20cm)	Domistic grasses (20kg/ha - 40 kg/ha) Native grasses/forbes (40 kg/ha) - two different mixtures	-	Lodgepole pine - 1400 sph Douglas fir - 600 sph	2000	1998 - 2000	1998 - 2000	-	1998 - 2000	-	1998 - 2000
	Above Access Road	3.78	Wildlife, forestry	Direct Placement: TSF Rd Stripping (Bootjack Creek), Caribou Ore Stockpile, WX Zone	9,000	25	None	~ 0.75 kg/ha lupine ~ 2 kg/ha june grass, yarrow, pearly everlasting mix ~35 g/ha Fireweed (~ 1 ha on eastern side only)			2011	2014	-	TBD - monitor ingress	2014		

								Remaining area: Native grasses/forbes (30 kg/ha)									
TSF		23.95	Wildlife, forestry, livestock	South Till Borrow	N/A	N/A	Biolids - 12.00 ha	Unknown			Unknown	N/A	Unknown	-	Unknown		
NEZ Dump	Parcel 2 (a/b)	5.13	Wildlife, forestry	Wight Till	20,000	40	2a: fertilizer (238 kg/ha) 2b1: biosolids 2b2: fertilizer (71 kg/ha), biosolids	Native grasses/forbes (handseeded) 2a: 45 kg/ha 2b: 34 kg/ha	Paper birch - 100 sph Trembling aspen - 100 sph Black cottonwood - 200 sph Sitka alder - 100 sph saskatoon - 100 sph wood rose - 100 sph Willow live stakes - 40 sph	Lodgepole pine - 1300 sph Douglas fir - 700 sph	2010	2010	2010	-	2011	2012	2012
Boundary Zone	Boundary Dump	4.70	Wildlife, forestry	PAG Dump Stripping	12,000	28	None	Monitor growth from direct placement and natural ingress (monitor invasive species establishment)			2011	2014	-	TBD - monitor ingress	Monitor growth from direct placement and natural ingress		

Notes:
1) Native grasses/forbes: mountain brome, native red fescue, Rocky Mountain fescue, wheat grass - blue bunch, blue wild rye, june grass, tickle grass, fireweed.
Native grasses: mountain brome, native red fescue, Rocky Mountain fescue, wheat grass - blue bunch, blue wild rye.
Aqgressive seed mix: dahurian wildrye, slender wheatgrass, perennial ryegrass, timothy
2) Refer to summary reports on the tree plots for detailed information on the treatment units and research design

6 Air Discharge Permit

In 1997, MPMC was issued an Air Discharge permit, (under the former *Waste Management Act)* by ENV. There are no reporting requirements for this *EMA* Permit 15087.

7 Refuse Permit

In 1997, MPMC was issued a Refuse permit, (under the former *Waste Management Act)* by ENV. There are no reporting requirements for this *EMA* Permit 14590.

8 Biosolids Permit

In 1999, MPMC was issued a Biosolids permit, (under the former *Waste Management Act)* by ENV. All reporting requirements are presented in Section 5.5.1.

9 Summary and Conclusions

The 2019 monitoring program achieved the objectives as outlined in the 2018 *CEMP*. The *CEMP* is designed to integrate environmental monitoring programs currently being carried out at the mine to meet multiple ENV requirements. In addition to presenting data and review from 2019, the *EMA* Permit 11678 requires a three-year detailed monitoring program interpretive report. As a detailed monitoring review was completed in 2019 and submitted with the 2018 AERR, the next is not required until March 31, 2022.

Environmental monitoring in 2019, and discussion related to data from 2016 to 2019 included:

- Stream flows and water levels;
- Meteorology (temperature, precipitation, snowpack, evaporation rates);
- Chemistry and quantity of surface, seepage, lake and groundwater;
- Hydrology of groundwater and surface water flows and levels;
- Sediment chemistry;
- Aquatic biology (toxicity testing, fish and benthic community studies, plankton, periphyton, fish, and benthic tissue chemistry); and
- Terrestrial monitoring.

From 2016 to 2019, monitoring of effluent discharge showed compliance with all parameters with some exceptions. In 2019, there were four instances of results triggering the *EMA* Permit 11678 limit exceedances at compliance locations, only one of which was determined to be an actual exceedance (Sections 4.12.2.4; 4.12.2.6). There were no toxic effects on the environment. The WTP operated intermittently in 2019 and discharged a total of 5,380,517 m^3 of treated water.

The technical memo provided by Tetra Tech (Appendix J) suggests a gradual increase of dilute effluent under the thermocline that is expected to flush out during the spring and fall overturns. Continued efforts will be made to locate the plume when sampling (only during periods of discharge). Monitoring at the IDZ remains a safety challenge that MPMC continues to discuss with ENV.

In 2018, ENV approved the *ADP* which includes a *TRP*. MPMC updated the ADP in 2019 though, its submission to ENV was not required. This plan is used as a guidance document for MPMC for monitoring the discharge and for reviewing and responding to current water quality results. As noted in 2016, 2017 and 2018 the maximum results for total copper at the IDZ were similar when the WTP was discharging and not discharging. It is worth noting that there are many inputs into Quesnel Lake, which are contributing to the total copper in the lake, and that MPMC's discharge is not the sole contributing factor (Section 4.12.2.6).

Lake water quality data from Bootjack, Polley, and Quesnel Lake spanning 2016 to 2019 continue to meet BC WQG with some exceptions described in Sections 4.7.3.1, 4.7.3.2 and 4.7.3.3. Secchi disk readings continue to be similar or better than background readings (prior to 2014) (Section 4.15.2).

A detailed review of sediment, periphyton, fish community and tissue, plankton, and benthic invertebrate's data from 2016 to 2019 in breach affected and reference areas was completed by Minnow and is included in Appendix K.

Mine site surface water and groundwater monitoring results were consistent with previous years monitoring and no significant changes to groundwater quality have been identified in 2019. In 2016, 2017 and 2018, Springer groundwater wells displayed similar trends to surface water elevations within Springer Pit. In 2018 and 2019, as the Springer Pit was being dredged, groundwater elevations continued to decrease and no groundwater leakage from Springer Pit to Bootjack Lake occurred. A detailed review from Golder is included in Appendix G and summarized in Section 4.9.

In 2019, no terrestrial monitoring with the exception of wildlife monitoring was conducted on the Mine site. Wildlife continued to be monitored in 2019 and observations were higher than in 2018 despite the mine being in Care and Maintenance from May to December 2019. There was were no wildlife incidents in 2019 (Section 4.18.1).

Certain studies were initiated in 2019 focusing on mine closure related reclamation practices: Geomorphic Slope Guidance document will provide guidelines for site slope recontouring and stream rehabilitation at and around the Mount Polley Mine and will also provide guidance for engineering works that would result in a natural looking slope upon closure. Soil Cover Test Plot Design which when completed may provide guidance to determine a reclamation cover soil design that reduces infiltration of water into and mass loading of constituents from waste rock disposal sites. As an integral component of long-term site water management, passive water treatment studies were continued in 2019 that included use of biochemical reactors (BCR), CWTS, and in situ pit lake treatment studies. The focus of these studies is to reduce constituents of concern in mine influenced water. Additional studies involve the evaluation and feasibility of other semi-passive and passive systems including sand filtration, packed bed reactors, and sulphide polishing cells. Constructed wetlands were also built in 2018 and operated in 2019 that will test whether mine water can be effectively treated through wetlands technology. For all these potential water treatment options, additional work will be carried out in 2020.

In 2019, Mount Polley Mining Corporation did not conduct any productive mining. Approximately 3,591,448 t of tailings were deposited into the TSF. From January to May 2019, MPMC milled 2,265,788 tonnes of stockpiled ore. The mill was shut down for the remainder of the year as part of a Care and Maintenance program.

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10 References

Cariboo Chilcotin Coast Invasive Plant Committee [CCCIPC]. (2018). *2018 Regional Strategic Plan for Invasive Plant Management* and *Executive Summary*. Retrieved from the CCCIPC website: http://cccipc.ca/index.php/S=0/resources/regional-strategic-plans

Contango Strategies Ltd [Contango]. (2017). *CWTS Feasibility Assessment Report for Mount Polley Mining Corporation*. Prepared for Mount Polley Mining Corporation, July 2017.

Environment and Climate Change Canada [ECCC], (2018). *Metal and Diamond Mining Effluent Regulations*. Fisheries Act SOR/2002-22. Retrieved from Justice Laws website: https://laws-lois.justice.gc.ca/PDF/SOR-2002-222.pdf

Ministry of Energy, Mines, and Petroleum Resources [EMPR]. (2017). *Health, Safety and Reclamation Code for Mines in British Columbia*. Retrieved from the BC government website: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/mineral-exploration-mining/documents/health-and-safety/code-review/health_safety_and_reclamation_code_2017_rev.pdf

Ministry of Environment and Climate Change [ENV]. (1981). *Snow Survey Sampling Guide*. Surface Water Section, Water Management Branch, Province of British Columbia. Retrieved from the BC government website: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/snow/snow_survey_sampling_guide.pdf

ENV. (2002). *Forest and Range Practices Act*. Retrieved from the BC government website: http://www.bclaws.ca/civix/document/id/complete/statreg/02069_01

ENV. (2013). *British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples*. Retrieved from the BC government website: https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance/bc-field-sampling-manual

ENV. (2018). *British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture Summary Report*. Water Protection & Sustainability Branch. Retrieved from the BC government website: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/wqgs-wqos/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf

FCSAP (Federal Contaminated Sites Action Plan). 2016 Draft. *Ecological Risk Assessment Guidance, Module 6: Ecological Risk Assessment for Amphibians on Federal Contaminated Sites*. 127 pages.

Golder Associates Ltd., [Golder]. (2015a). *Mount Polley Mine: Short Term Effluent Discharge Technical Assessment Report in Support of an Effluent Permit Amendment*. Report prepared for MPMC. May 29, 2015.

Golder. (2016a). *Mount Polley Mine – Prediction of Water Level and Seepage from the Springer Pit and Bootjack Lake Water Quality Technical Memorandum*. Prepared for MPMC, March 7, 2016.

Golder. (2016b). *Mount Polley Mine: Long-Term Water Management Plan Permit Amendment Application under the Environmental Management Act Technical Assessment Report.* Prepared for MPMC, October 17, 2016.

Golder. (2017a). *Summary of Hydrogeological Assessments Conducted Until March 2017 Springer and Cariboo Open Pits – Mount Polley Mine Technical Memorandum.* Prepared for MPMC, August 16, 2017.

Golder. (2017b). *Reclamation and Closure Plan Water Quality Modelling Report*. Prepared for MPMC, 2017.

Golder. (2017c). *Geomorphic Slope Guidance Document*. Prepared for MPMC, December 15, 2017.

Golder. (2018a). *Soil Cover Test Plots Design, Construction, and Performance Monitoring*. Prepared for MPMC, June 1, 2018.

Golder. (2019a). *Technical Memorandum: TMT Dosing System Field Trials for Dissolved Copper Removal During Freshet*. Prepared for MPMC, May 29, 2019.

Golder. (2019b). *Passive Water Treatment for Closure Work Plan for 2019 – Mount Polley Mine*. Prepared for MPMC, June 13, 2019.

Hudson, R., and J. Fraser, (2005). *Introduction to salt dilution gauging for streamflow measurement, part IV: the mass balance (or dry injection) method.* Streamline Watershed Management Bulletin, 9(1), 6-12.

Knight Piésold Ltd, (2009). *Chemical Characterization of the Proposed Effluent for Discharge to Hazeltine Creek*. Letter to Mr. Ron Martel, Mount Polley Mining Corporation from Amanda Strouth, Greg Smythe and Ken Brouwer. May 11, 2009.

Ministry of Attorney General. (2017). *Hazardous Waste Regulations.* Environmental Management Act. Retrieved from the BC government website: https://www2.gov.bc.ca/gov/content/environment/waste-management/hazardous-waste/legislation-regulations

MPMC. (2014). *2013 Annual Environmental and Reclamation Report*. Submitted to Ministry of Environment and Ministry of Energy and Mines, March 31, 2014.

MPMC. (2015a). *Post-Event Environmental Impact Assessment Report – Key Findings Report*. Prepared for MPMC by Golder Associates. Submitted to Ministry of Environment, June 5, 2015.

MPMC. (2016a). *Update Report: Post-Event Environmental Impact Assessment Report*. Submitted to Ministry of Environment, June 3, 2016.

MPMC. (2016b). *Hazeltine Creek Fish Exclusion and Response Plan Rev1*. Submitted to Ministry of Environment, May 5, 2016.

MPMC. (2017a). *Mine Reclamation and Closure Plan Update January 2017*. Submitted to Ministry of Energy and Mines, March 15, 2017.