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BURNCO Rock Products Ltd.**CC** Alan Calder, Golder Associates**FROM** Paul Beddoes, Kristin Salzsauler**EMAIL** paul_beddoes@golder.com,
kristin_salzsauler@golder.com**WATER QUALITY MODELLING OF THE BURNCO AGGREGATE PROJECT, BC**

1.0 INTRODUCTION

BURNCO Rock Products Ltd. (BURNCO) and 0819042 BC Ltd. propose to construct and operate the BURNCO Aggregate Project (Project) in the McNab Valley, British Columbia. The Project is located approximately 20 kilometres (km) northeast of Gibsons, British Columbia. Aggregate resources are proposed to be mined from an area of the property located approximately 500 metres (m) from the marine foreshore and extending northward approximately 600 m toward the southern banks of McNab Creek (Figure 1-1). Sand and gravel are proposed to be extracted from an open pit over a period of 16 years. If mined, the open pit will fill with groundwater during mining, forming a pit lake.

Water quality predictions were performed in support of Project planning and permitting. The water quality model for the Project includes the pit lake and the downstream receiving environment, including two locations in McNab Creek (MCF-1 and MCF-7), a location downstream of the pit lake along a permanent watercourse (MCF-12), and a location within WC 2 downstream of the pit lake (MCF-6). This technical memorandum documents the water quality model, including a summary of the model approach, and model inputs and assumptions. The results of the water quality model are presented for two periods: operations (16 years) and closure (16 years following operations).

2.0 PROJECT DESCRIPTION

The Project is located in the McNab Valley, British Columbia. The Project will be bound to the west by a north-south aligned forest service road, to the south by a BC Hydro transmission corridor, and to the east and north by McNab Creek (Figure 1-1). A deep, steep-sided, man-made watercourse (upper segment of Watercourse 2 or WC 2) bisects the property at an approximately north-south alignment through the central portion of the valley floor. The channel bed is approximately 7 to 10 m below the adjacent valley floor. Watercourse 2 was originally intended to function as a groundwater interceptor (Figure 1-1).



A sand and gravel pit will be developed within a 70 hectare (ha) clear-cut area (Figure 1-1). Sand and gravel will be extracted from the pit using a floating dredge. The dredged aggregate will be processed on site; fines will be screened from the gravel, and then further screened to segregate aggregate by size. Oversize gravel will be crushed, and sand will be sized and dewatered to remove the fine fractions (less than or equal to 0.075 millimetres [mm]). The separated fines and organics will be placed in berms that surround the quarry. Groundwater will fill the excavation during pit development, forming a pit lake.

3.0 MODEL APPROACH

3.1 Model Overview

A mass-balance water quality model was developed using GoldSim Version 10.5. GoldSim is a graphical, object-oriented mathematical modelling program where all input parameters and functions are defined by the user and are built as individual objects or elements linked together by mathematical expressions. The object-based nature of the program is designed to facilitate an understanding of the various factors that control an engineered or natural system and predict potential changes to the system.

Simulated water qualities were determined in the pit lake and at several receiving environment assessment locations. The mass-balance model uses the site water balance to account for the magnitude of each natural flow (e.g., precipitation, stream flow) and Project-affected flow (e.g., runoff from fines, pit wall runoff) at each assessment location. Input water qualities were assigned to each source term. The inflow concentration of each modelled parameter was determined at each assessment location and at each time step in the water quality model using the following equation:

$$C = \frac{\sum_{i=1}^n C_i * V_i}{\sum_{i=1}^n V_i}$$

- where: C = predicted concentration at assessment location (milligrams per litre [mg/L]);
C_i = concentration in inflow 'i' to assessment location (mg/L);
V_i = volume of inflow 'i' to assessment location (cubic metres per day [m³/d]); and
n = number of inflows.

The inflow water quality calculated using the equation above represents the water quality at receiving environment assessment locations which are located in streams and treated as flow-through systems with no stored water volume. Pit lake water quality predictions are based on the inflow water quality calculated using the equation above mixed with the stored volume in the pit lake. Outflow and evaporation from the pit lake are treated as inflows with negative values of V_i in the equation above.

A base case scenario was developed using median water quality inputs, as discussed in Section 4.2. In addition to the base case scenario, a conservative scenario was developed using a combination of 95th percentile and probabilistic inputs. The purpose of these scenarios was to generate a range of model predictions due to changes in the input water qualities.

3.2 Model Components

3.2.1 Project Site

Following cessation of mining, a pit lake will form during operations at the Project. Pit lake water quality was modelled on a monthly time-step during the 16-year period of operation and 16 years post-closure. The pit lake will be formed by contributions from precipitation, natural surface and groundwater inflows, runoff and groundwater seepage from the separated fines and organics in the embankment to the north of the open pit, and porewater from excavated materials.

In addition, the model accounted for particulate matter from air emissions that will be deposited on water and land surfaces in the vicinity of the Project during operations (see Section 4.4).

3.2.2 Receiving Environment

Discharge from the open pit (i.e., surficial overflow) and groundwater seepage from the open pit will report to the receiving environment. To assess the impacts of the Project on the receiving surface water environment, surface water quality assessment locations were chosen adjacent to or downstream of the Project site components. The modelled receiving environment locations, as shown on Figure 1-1, are as follows:

- **MCF-1:** McNab Creek to the north and upstream of the aggregate pit, representing baseline surface water in McNab Creek affected only by air deposition from site.
- **MCF-7:** McNab Creek to the east and downstream of the aggregate pit (downstream of MCF-1), representing water in McNab Creek prior to release into Thornbrough Channel. Water quality at this location is affected by both air deposition and pit lake seepage during operations, and by pit overflow in closure.
- **MCF-12:** to the south and downstream of the aggregate pit, which will receive pit lake seepage during operations and at closure. Flow at this location will be dominated by seepage from the pit lake. Therefore, water quality at this location is assumed to be equal to pit lake water quality plus the air deposition load from the MCF-12 watershed.
- **Downstream of MCF-6:** to the south and approximately 435 m downstream of the aggregate pit. Flow at this location will be dominated by seepage from the pit lake. Therefore, water quality at this location is assumed to be equal to pit lake water quality plus the air deposition load from the MCF-6 watershed.

3.3 Modelled Parameters

The parameters included in the model are as follows:

- major ions:
 - calcium, chloride, fluoride, magnesium, potassium, sodium, sulphate;
- nutrients:
 - ammonia, nitrate, nitrite, total Kjeldhal nitrogen, orthophosphate, total phosphorus; and
- total and dissolved metals and metalloids:
 - aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silicon, silver, thallium, tin, uranium, vanadium and zinc.

The model does not predict pH in the pit lake or receiving environment. Based on the available results of geochemical testing, the fines material to be placed in the embankment north of the open pit is expected to be non-acid generating (Golder 2014a). It is assumed that pH in the pit lake and receiving environment will be within the range observed in baseline water quality (BURNCO 2014: Appendix 5.5-B).

Predicted concentrations of total dissolved solids (TDS) were calculated from results of the above parameters following the procedure of APHA (2005), using the following equation:

$$TDS = 0.6 * alkalinity + [Na] + [Mg] + [K] + [Ca] + [SO_4] + [Cl] + [NO_3] + [F] + [SiO_3]$$

Where: [Na]	=	predicted sodium concentration (mg/L)
[Mg]	=	predicted magnesium concentration (mg/L)
[K]	=	predicted potassium concentration (mg/L)
[Ca]	=	predicted calcium concentration (mg/L)
[SO ₄]	=	predicted sulphate concentration (mg/L)
[Cl]	=	predicted chloride concentration (mg/L)
[NO ₃]	=	predicted nitrate concentration (mg/L)
[F]	=	predicted fluoride concentration (mg/L)
[SiO ₃]	=	predicted silica concentration (mg/L)

Hardness was calculated from predicted concentrations of calcium and magnesium using the following equation:

$$\text{Hardness} = 2.497 * [Ca] + 4.118 * [Mg]$$

3.4 Model Assumptions and Limitations

Water quality modelling requires the use of many assumptions due to uncertainty related to determining the physical and geochemical characteristics of a complex system. Water quality predictions are based on several inputs (surface flows, groundwater flows and seepage, baseline water quality, and geochemical characterization), all of which have inherent variability and uncertainty. The water quality model has attempted to incorporate natural processes and combine them with flows to develop predictions for water quality for a Project that has not yet been developed. Given all of the inherent uncertainties associated with modelling, the results of the water quality model should be used as a tool to aid in the design of monitoring programs and mine planning, to develop mitigation strategies, and to outline potential risks rather than to indicate absolute concentrations.

The data and approach used to estimate future water quality are commensurate with industry best practices (Maest and Kuipers 2006; MEND 2009; INAP 2009) and are believed to provide a reasonable approximation of the system, as currently understood, within the context of the assumptions used in the model. Changes in the Project plan and/or design will necessarily result in changes to water quality predictions. Ultimately, even the best of models cannot compare with operational monitoring data. Water quality monitoring and periodic re-assessment of water quality predictions and/or remedial measures will be required during operations.

In addition to the assumptions that govern the model that are presented throughout Section 3 and 4, general limitations to the model include:

- **Changes to Operational Project or Site Conditions:** The Project description and inputs as discussed in this document are the basis for the model. Changes in Project scope or design details will necessarily result in changes to the water quality predictions. The model is limited in its ability to forecast operational conditions due to the dynamic nature of developments in a Project of this nature and to potential short-term changes to site conditions. As such, the purpose of the water quality modelling is to assist with planning at the environmental assessment (EA) stage of the Project.
- **Limitation of Baseline Data:** Surface water quality was monitored from 2009 to 2014 and groundwater quality was monitored from in 2010 to 2014. Based on these sampling events, a limited dataset was available for statistical analysis and comparison. It is assumed that the limited dataset is representative of the composition of each water quality input.
- **Limitation of Geochemical Testing Data:** The input water quality for surface water runoff and groundwater seepage from the stored fines fractions in the area north of the pit was derived from sequential shake flask extraction (SFE) testing of three samples of aggregate material collected from the Project site in July 2013. The three samples of the fine aggregate fraction (less than or equal to 0.075 mm) were collected from near surface; it was not possible to collect samples from the deeper zones of the deposit during the sample collection campaign. The near surface materials contain a higher content of organic material than would be expected from materials at depth. Golder (2014a) recommends collection of supplemental samples of the fine fraction from deeper in the deposit as the Project progresses to confirm the characteristics of the fine fraction.
- **Detection Limits:** For some parameters, multiple detection limits were used in monitored water quality data. Where multiple detection limits were reported for the same parameter, the lowest reported detection limit was used in statistical calculations.
- **Pit Lake Seepage:** Receiving environment locations MCF-7, MCF-6 and MCF-12 will receive pit lake water via groundwater pathways through the sediment. Locations MCF-6 and MCF-12 are assumed to receive 100% of their flow from pit lake seepage. Typically, the dissolved fraction dominates water quality in groundwater seepage rather than the particulate (i.e., total) fraction. Therefore, seepage from the pit lake is assumed to be represented by the dissolved fraction of the predicted pit lake water quality.
- **Groundwater Composition:** Groundwater inflow to the pit is assumed to contain no particulate metals or metalloids. Typically, the composition of groundwater is dominated by the dissolved metal fraction, rather than the particulate fraction. At this Project, the groundwater flow gradient is not predicted to be sufficient to transport particulate material into the pit. However, pore water from excavated material is assumed to contain particulate metals and metalloids.
- **Closure Conditions:** Water balance conditions in closure will remain relatively constant, and therefore are represented by the one year of closure flow predictions in the water balance. The water quality model creates predictions for 16 years into closure using the same predicted year of closure flows provided in the water balance.

4.0 MODEL INPUTS

Input data to the site and receiving water quality models includes:

- Pit lake and receiving environment water balance, including inflow and outflow hydrology;
- Water quality inputs, including baseline surface water quality, baseline groundwater quality, and results of geochemical leach testing of the fine aggregate fraction (less than or equal to 0.075 mm); and,
- Air deposition rates.

Table 4-1 presents a summary of the model flows and the water quality inputs assigned to each flow. These inputs are described in greater detail in the following sections.

Table 4-1: Summary of Flow and Associated Water Quality Inputs

Flow Input	Description of Flow	Water Quality Input	Description of Water Quality
Q1	Runoff from area north of pit (not containing separated fines)	C1	Baseline water quality at surface water monitoring stations MCF-2 and MCF-3
Q2	Runoff from undeveloped pit area (not containing separated fines)	C2	Baseline water quality at surface water monitoring stations MCF-4, MCF-5 and MCF-6
Q3	Runoff from area north of pit (containing separated fines)	C3a/b	Water quality from sequential SFE tests, see section 4.2.2
Q4	Precipitation/evaporation	C4	Assumed clean water
Q5	Pore water from excavated pit material	C5	Baseline water quality at groundwater water monitoring stations DH10-07S, DH10-07D, and MW05-1 (including particulate metal concentrations)
Q6	Groundwater from west of pit (not containing separated fines)	C6	Baseline water quality at groundwater water monitoring stations DH10-07S, DH10-07D, and MW05-1 (not including particulate metal concentrations)
Q7	Groundwater from north of pit (not containing separated fines)	C7	Baseline water quality at surface water monitoring stations DH10-05S, DH10-05D, and MW05-02
Q8	Groundwater from north of pit (containing separated fines)	C8a/b	Water quality from sequential SFE tests, see section 4.2.2 (same as C3a/b)
Q9	Baseline flow at MCF-1	C9	Baseline water quality at surface water quality assessment location MCF-1
Q10	Baseline flow at MCF-6	C10	Predicted pit lake water quality
Q11	Baseline flow at MCF-7	C11	Baseline water quality at surface water quality assessment location MCF-7
Q12	Groundwater seepage from pit to MCF-7	C12	Predicted pit lake water quality
Q13	Baseline flow at MCF-12	C13	Predicted pit lake water quality
Q14	Overflow from pit via weir to MCF-6	C14	Predicted pit lake water quality

SFE = shake flask extraction.

4.1 Pit Lake and Receiving Environment Water Balance

4.1.1 Base Case Scenario Water Balance

The pit lake and receiving water balances presented in Attachment 2 form the basis of the mixing volumes for the water quality model. The water balance includes monthly flow estimates for the pit lake and receiving environment over a 16-year operational period, as well as one year of closure following operations (representing Years 17 to 32).

Aggregate pit lake inflows include:

- Runoff from area north of the pit (not containing separated fines material) (Q1).
- Surface water runoff (containing separated fines material) from the area north of the pit (Q2).
 - In closure it is assumed that the fines will be remediated to prevent surface water runoff from contacting the material.
- Runoff from undeveloped pit area (not containing separated fines material) (Q3).
- Direct precipitation to the pit lake (Q4).
- Pore water draining from the excavated material (Q5).
- Groundwater inflow (not containing separated fines material) from the west of the pit (Q6).
- Groundwater inflow (not containing separated fines material) from the north of the pit (Q7).
- Groundwater inflow (containing separated fines material) from the north of the pit (Q8).

During operations and closure, pit water will seep to MCF-6, MCF-12, and MCF-7. In closure the pit will also overflow to MCF-6. Outflow from the aggregate pit reports to McNab Creek and small tributaries south of the pit and north of Howe Sound. All flow (i.e., 100% of the total flow) at MCF-6 and MCF-12 is assumed to be pit water, either through seepage during operations, or as overflow in closure. Attachment 2 presents the hydrology inputs for the pit and receiving environment locations.

4.1.2 Conservative Scenario Water Balance

The water balance used in the conservative scenario is unchanged from the base case scenario, with the exception of groundwater flow from the west into the pit lake. In the conservative scenario, this flow is split into two flows with distinct water quality inputs (discussed below): 10% of this flow is assumed to come from the vicinity of well MW05-1, while 90% is from well DH10-07; this split is based on hydrogeologic testing at these wells that indicates conductivity at well MW05-1 that is orders of magnitude lower than that at DH10-07 (See Section 6.2.2). Therefore, the water quality model assumes that 10% of the groundwater from the west can be assigned the water quality input from MW05-01, while the other 90% can be characterised by observations at DH10-07.

4.2 Base Case Scenario Water Quality Inputs

The following sections describe the derivation of inflow water quality inputs under the base case scenario using the results of baseline surface water quality monitoring, groundwater quality monitoring and geochemical characterization. For each water quality input, the available baseline water quality data were compiled for the purpose of calculating a median water quality input. Baseline concentrations below the method detection limit were assumed to be equal to one-half the detection limit for statistical calculations.

The inflow water qualities presented in the following sections were also used to derive inputs to the conservative model scenario, discussed in Section 4.3.

Table 4-2 presents the derived water quality inputs for each source compared to BCWQ Guideline for the Protection of Aquatic Life (BC MoE 2015a, BC MoE 2015b) and the CCME Guideline for the Protection of Freshwater Aquatic Life (CCME 1999) guidelines. Attachment 3 presents the baseline water quality data used to derive each water quality input.

4.2.1 Surface Runoff to the Pit Lake

Baseline water quality was determined from surface water quality monitoring conducted from 2010 to 2014 at stations in McNab Creek in the vicinity of the proposed aggregate pit. Water quality sampling locations are indicated in Figure 1-1. Water quality inputs were derived for two areas:

- **Runoff to the pit lake from the area north of the pit (not containing fines) (C1):** The input surface water quality to the pit lake from the area north of the pit was derived from baseline concentrations of surface water monitoring stations MCF-2 and MCF-3.
- **Runoff from the undeveloped pit area (C2):** The input water quality for the surface water runoff from the undeveloped pit area was derived using the results from surface water monitoring stations MCF-4, MCF-5 and MCF-6.

Concentrations of total and dissolved silicon were not available from surface water quality monitoring; median values from groundwater quality were used in place of this missing data.

Surface runoff inputs were compared to the BCWQ and CCME guidelines for the purpose of identifying key parameters that occur at elevated concentrations baseline conditions. The following input concentrations exceeded both the BCWQ and/or CCME the guideline criteria (median concentrations used for model input presented in parentheses):

Surface Water from North of Pit (C1):

- total metals: aluminum (0.09 mg/L), beryllium (0.0005 mg/L), mercury (0.000005 mg/L); and
- dissolved metals: aluminum (0.07 mg/L), beryllium (0.0005 mg/L), mercury (0.000005 mg/L).

Surface Water from Undeveloped Pit Area (C2):

- total metals: aluminum (0.043 mg/L) , beryllium (0.00015 mg/L), mercury (0.000005 mg/L); and
- dissolved metals: aluminum (0.021 mg/L), beryllium (0.0005 mg/L), mercury (0.000005 mg/L).

4.2.2 Groundwater Inflows to the Pit Lake

The results of groundwater quality monitoring (2010 to 2014) from monitoring wells in the vicinity of the proposed aggregate pit were used to derive input water qualities for the groundwater inflows into the pit. Groundwater monitoring well locations are indicated in Figure 1-1.

Groundwater qualities were assigned to two sources of groundwater inflow:

- **West of the Pit Area (C6):** The input water quality for the groundwater inflow from the area west of the pit was derived from baseline concentrations of groundwater water monitoring stations DH10-07S, DH10-07D, and MW05-1.
- **North of the Pit Area (C7):** The input water quality for the groundwater inflow from the area north of the pit was derived from baseline concentrations of groundwater monitoring stations DH10-05S, DH10-05D, and MW05-02.

It was assumed that groundwater inflow to the open pit will not contain a particulate fraction, based on the low groundwater flow rates. Therefore, the dissolved metal concentrations were assumed to equal the total metal concentration inputs to the model.

Baseline concentrations below the method detection limit were assumed to be equal to one-half the detection limit. Median concentrations were calculated for each of the groundwater water quality inputs. Where multiple detection limits were reported for the same parameter, the lowest reported detection limit was used in statistical calculations.

Groundwater quality inputs were compared to the BCWQ and CCME guidelines for the purpose of identifying key parameters that occur at elevated concentrations in baseline conditions.

The following input concentrations exceeded both the BCWQ and/or CCME the guideline criteria (median concentrations used for model input presented in parentheses):

Groundwater from West of Pit (C6):

- dissolved metals: beryllium (0.0005 mg/L), mercury (0.000005 mg/L).

Groundwater from North of Pit (C7):

- dissolved metals: beryllium (0.0005 mg/L), mercury (0.000005 mg/L).

4.2.3 Pore Water from Excavated Pit Material (C5)

As aggregate is excavated, pore water held within the material will drain back into the pit. The input water quality for this flow was developed using the same source data as the groundwater from the west of the pit area. The monitoring locations used to derive the groundwater from the west input water quality are within the pit boundary (Figure 1-1). It is assumed that this pore water will contain particulate metals and metalloids. It is assumed that groundwater from these locations would be representative of the pore water quality from the extracted material. Inputs were developed using total metal concentrations. The input water qualities are presented in Table 4-2, and complete analytical data are available in Attachment 3.

Pore water quality inputs were compared to the BCWQ and CCME guidelines for the purpose of identifying key parameters that occur at elevated concentrations in pore water seeping from the fines stockpiles to the open pit. The following input concentrations exceeded both the BCWQ and/or CCME the guideline criteria (median concentrations used for model input presented in parentheses):

BCWQ Guideline:

- total metals: aluminum (0.031 mg/L), beryllium (0.0005 mg/L), mercury (0.000005 mg/L); and, dissolved metals: beryllium (0.0005 mg/L), mercury (0.000005 mg/L).

CCME Guideline:

- total metals: aluminum (0.031 mg/L).

4.2.4 Stored Fines Runoff and Seepage

The input water quality for surface water runoff and groundwater seepage from the stored fines material in the area north of the pit was derived from sequential shake flask extraction (SFE) testing of three samples of aggregate material collected from the Project site in July 2013 (Golder 2014a). A series of five sequential SFE tests were used to determine the mass of soluble constituents that would be released from the sample material and the timing of these releases. Each of the five SFE tests was completed using a 3:1 water to solid ratio and agitated for 24 hours. Following each SFE test, the leachate from each test was separated from the solid sample and analyzed for dissolved metals and major parameters. The solid sample was then used to carry out the next SFE test.

Two water quality inputs were developed using the sequential SFE to represent the expected change in water quality from this facility over time:

- **“First flush” water quality (C3a and C8a)** represents contact water from newly placed material. As discussed in Golder (2014a), concentrations of many parameters were the greatest in the first leach cycle of the repetitive leach tests. The first flush scenario was calculated as the maximum concentration measured in the first leach of the three samples.
- **“Steady state” water quality (C3b and C8b)** represents water from material that has been stored over time. Golder (2014a) indicated that concentrations of some parameters, such as aluminum and sulphate, peaked in the third leach test. The water quality input for the longer-term steady state scenario was calculated as the maximum concentration measured in the second through the fifth leach of each sample, to capture the long-term variability in leachate concentrations.

Table 4-2 presents the surface runoff and groundwater seepage water quality input. The detailed results of geochemical testing used to derive this input are presented in Attachment 3.

Concentrations of nitrogen species (ammonia, nitrate, nitrite, total Kjeldhal nitrogen) were not available in the SFE test results. The groundwater quality data were used to assign nitrogen species concentrations to the water from the stored fines. For the base case scenario, the 95th percentile concentration from all groundwater samples in the baseline dataset was used as input for these parameters. The 95th percentile concentration was chosen as input to ensure a conservative approach.

In closure it is assumed that the fines storage area will be progressively reclaimed and closed as a fines berm to prevent surface runoff from contacting the fines material. As such, the runoff to the pit lake from the area north of the pit (not containing fines) (C1) water quality is used to represent surface runoff from this facility for the 16 years of closure modelled. Seepage from the stored fines in closure is assigned the “steady state” water quality (C3b).

The water quality input for surface runoff and groundwater seepage from stored fines was compared to the BCWQ and CCME guidelines to identify parameters that occur at elevated concentrations in stored fines contact water. The following input concentrations exceeded both the BCWQ and CCME the guideline criteria (median concentrations used for model input presented in parentheses):

BCWQ Guideline:

- First-Flush Water Quality (C3a and C8a):
 - dissolved metals: aluminum (0.15 mg/L), beryllium (0.00052 mg/L), cadmium (0.00093 mg/L), chromium (0.0019 mg/L), cobalt (0.013 mg/L), copper (0.074 mg/L), manganese(1.2 mg/L), mercury (0.000005 mg/L), silver (0.00044 mg/L), thallium (0.00081 mg/L), and zinc (0.067 mg/L); and
 - total metals: aluminum (1.1 mg/L), arsenic (0.0059 mg/L), beryllium (0.00053 mg/L), cadmium (0.000093 mg/L), chromium (0.0025 mg/L), cobalt (0.013 mg/L), copper (0.08 mg/L), manganese (1.2 mg/L), mercury (0.000005 mg/L), silver (0.00046 mg/L), thallium (0.00081 mg/L), and zinc (0.069 mg/L).
- Steady State Water Quality (C3b and C8b):
 - dissolved metals: dissolved aluminum (0.13 mg/L), cadmium (0.00011 mg/L), cobalt (0.0045 mg/L), copper (0.029 mg/L), mercury (0.0000088 mg/L), and zinc (0.023 mg/L); and
 - total metals: dissolved aluminum (1.1 mg/L), cadmium (0.00011 mg/L), chromium 0.001 mg/L, cobalt (0.0048 mg/L), copper (0.035 mg/L), mercury (0.0000088 mg/L), and zinc (0.025 mg/L).

CCME Guideline:

- First-Flush Water Quality (C3a and C8a):
 - dissolved metals: aluminum (0.15 mg/L), cadmium (0.00093 mg/L), chromium (0.0019 mg/L), copper (0.074 mg/L), lead (0.0016 mg/L), selenium (0.0014 mg/L), silver (0.00044 mg/L), thallium (0.0081 mg/L), and zinc (0.067 mg/L); and

- total metals: aluminum (1.1 mg/L), arsenic (0.0059 mg/L), cadmium (0.00093 mg/L), chromium (0.0025 mg/L), copper (0.08 mg/L), iron (0.64 mg/L), lead (0.002 mg/L), selenium (0.0014 mg/L), silver (0.00046 mg/L), thallium (0.0081 mg/L), and zinc (0.069 mg/L).
- Steady State Water Quality (C3b and C8b):
 - dissolved metals: aluminum (0.13 mg/L), cadmium (0.00011 mg/L), copper (0.029 mg/L), lead (0.0013 mg/L), and selenium (0.0012 mg/L); and
 - total metals: aluminum (1.1 mg/L), cadmium (0.00011 mg/L), chromium (0.001 mg/L), copper (0.035 mg/L), iron (0.55 mg/L), lead (0.0017 mg/L), and selenium (0.0012 mg/L).

The proportion of runoff from newly deposited fines versus existing fines was derived from estimates of fines tonnage based on the current extraction plan (Table 4-3). The cumulative tonnage of fines deposited in Years 1, 2, 3, 4, 5, 7, 10, 12, 15, and 16 was provided. The cumulative tonnage of fines was estimated by assuming that 40% of the aggregate material is washed and that the fines represent 5% of the washed aggregate (Holmes 2014, pers. comm.). The tonnages of new fines deposited in each year and previously deposited fines were calculated by difference.

Total metal concentrations were not analyzed in sequential SFE leachates; however, it is assumed that runoff from the vicinity of the fines embankment will contain particulate material that will contribute to the total metal concentrations. The particulate component was calculated based on the average elemental composition measured in the three samples and an assumed total suspended solids concentration of 15 mg/L, which corresponds to the Maximum Authorized Monthly Mean Concentration in Schedule 4 of the Metal Mining Effluent Regulations (MMER 2014). Total concentrations were calculated by adding the calculated particulate concentrations to the measured dissolved concentrations. The average elemental composition is presented in Table 4-4, and the calculated total concentrations are presented in Table 4-2. The elemental compositions of parameters for which there was no corresponding water quality analysis (either an input source or a receiving water body) were not considered.

4.2.5 Precipitation and Evaporation (C4)

Precipitation and evaporation from the pit lake are assumed to be clean water and to affect only the volume of water in the pit lake, not the mass of modelled parameters in the pit lake water. Therefore, no water quality input was developed for precipitation.

4.2.6 Receiving Environment Water Quality

Baseline water quality for receiving environment assessment locations MCF-1 and MCF-7 was determined from surface water quality monitoring conducted from 2010 to 2014. Baseline surface water quality inputs for each of the receiving environment assessment locations are presented in Table 4-2, and complete analytical data is presented in Attachment 3.

Median concentrations were calculated for each of the baseline receiving environment water quality inputs. Receiving environment water quality inputs were compared to the BCWQ and CCME guidelines for the

purpose of identifying key parameters that occur at elevated concentrations in baseline conditions. The following input concentrations exceeded both the BCWQ and/or CCME the guideline criteria (median concentrations used for model input presented in parentheses):

MCF-1 (C9):

- dissolved metals: aluminum (0.074 mg/L), beryllium (0.0005 mg/L), mercury (0.000005 mg/L); and
- total metals: aluminum (0.14 mg/L), beryllium (0.0005 mg/L), mercury (0.000005 mg/L).

MCF-7 (C11):

- dissolved metals: aluminum (0.074 mg/L), beryllium (0.00015 mg/L), mercury (0.00001 mg/L); and
- total metals: aluminum (0.087 mg/L), beryllium (0.00015 mg/L), mercury (0.00001 mg/L).

4.3 Conservative Scenario Water Quality Inputs

Water quality inputs under the conservative scenario were developed using the 95th percentile or probability distributions based on the available monitoring data. Water quality input from the stored fines remained the same as the base case simulation. Where insufficient data were available (i.e., less than three observations) a maximum concentration was used in place of the 95th percentile. These 95th percentile concentrations are presented in Table 4-2. The following parameters exceed CCME and/or BCWQ guidelines in at least one of the 95th percentile inputs:

- major ions: fluoride;
- dissolved metals: aluminum, beryllium, cadmium, cobalt, copper, mercury, and silver; and
- total metals: aluminum, arsenic, cadmium, cobalt, copper, iron, lead, mercury, silver, and zinc.

The use of 95th percentile input water qualities for all sources (except the stored fines) throughout the modelling period is considered overly conservative. This approach assumes all inputs will be simultaneously at concentrations that have individual likelihoods of 5%, and will remain so throughout operations and closure. While this provides a very conservative prediction, it is not a reasonably expected simulation because each 5% likelihood is independent of each other. However, should assessment of the 95th percentile simulation show no significant changes in the receiving environment, further refinement of conservative inputs and simulations is not required.

In this case, assessment of the 95th percentile simulation led to refinement of inputs for total dissolved solids (calculated from major ions) and total phosphorus. In order to generate a reasonably expected conservative prediction for these parameters, a statistical distribution was developed for each inflow water quality to the pit lake for each of these parameters.

Lognormal probability distributions were considered for water quality data, except where all observed data were consistent (i.e., all below analytical detection). In these cases a constant value was assigned equal to the detection limit. Where a range of data was available, a lognormal distribution was fit to the data, using the detection limit as

a lower bound (where applicable). Where insufficient data was available to develop a distribution (i.e., two data points), a maximum concentration was used.

All input water qualities fit the lognormal or constant distributions, except for groundwater from the west (C5). The input data for this source exhibited a bimodal distribution for each parameter; high concentrations were reported at well MW05-01, while comparatively low concentrations were reported at DH10-07 (See Attachment 3). As the data indicated two distinct water quality signatures in groundwater from the west, it was not possible to fit this to a single distribution. Instead, the data from DH10-07 was fit to a lognormal distribution, while a maximum concentration was used as input from MW05-1.

4.4 Air Deposition

The Project is expected to release particulate matter into the air from on-site activities such as aggregate handling and processing, and land clearing. An air deposition model (BURNCO 2014: Section 5.7) was developed for the site to estimate the mass of particulate that would be deposited on the land and water surface surrounding the Project. This model estimated the deposition rate for each modeled metal for each month of operations. Only particulate matter will be deposited from the air; therefore, air deposition is assumed to influence only the total fraction for each modeled parameter in the water quality model.

The air deposition model results were incorporated into the water quality model by calculating the total deposition rate for each constituent to the watershed area of the pit lake and the receiving environment assessment locations. Each watershed area was separated into land area and water area. All deposition onto the water area of each watershed was assumed to mix with the existing water quality. Further, 90% of the deposition load onto land area was assumed to be retained on the land surface, meaning only 10% of this deposition could contribute to the total metal concentrations at each assessment location. This assumption is thought to be conservative based on studies that have examined the transport of aeri ally deposited metals and metalloids (e.g., Harris 2009). Air deposition in each watershed was assumed to report instantaneously to the assessment location. The air deposition inputs were not altered between the base case and conservative scenarios.

The deposition rates used for each of the model watersheds are presented in Table 4-5.

5.0 RESULTS

A summary of predicted water qualities are presented in Tables 5-1 and 5-2 for the base case and conservative scenarios respectively. Base case scenario results are discussed in Section 5.1; conservative scenario results are discussed in Section 5.2. Detailed results for both scenarios are presented in Attachment 4. A complete assessment of the predicted water quality, including a comparison to baseline conditions, is presented in the aquatic health assessment (BURNCO 2014, Section 5.2.2).

5.1 Base Case Scenario Results

5.1.1 Pit Lake

Under base case conditions, the following parameters were predicted to exceed CCME and/or BCWQ guidelines in the pit lake (range of predicted concentrations is provided in brackets, Table 5-1):

- Dissolved Metals:
 - aluminum (0.003 - 0.012 mg/L), beryllium (0.00032 – 0.0005 mg/L), mercury (0.0000032 – 0.000005 mg/L);
- Total Metals:
 - aluminum (0.0086 – 0.028 mg/L), beryllium (0.00032 – 0.0005 mg/L), mercury (0.0000033 – 0.0000051 mg/L).

Mercury exceedances were due to the method detection limit (0.000005 mg/L) for groundwater, surface water, and geochemical testing being above the minimum guideline (BCWQ 30 day average guideline, 0.00000125 mg/L). This detection limit and exceedance also occurred in the baseline inputs (Table 4-2).

Time series plots are presented for select parameters, including sulphate, total phosphorus, and aluminum, to demonstrate concentration trends during operations and closure. Predicted concentrations of all parameters peak during operations, and reach steady state concentrations in closure (Figures 5-1, 5-2, 5-3). Predicted major ion (e.g., sulphate) and nutrient concentrations (e.g., phosphorous) in the pit lake were a function of the rate of groundwater inflow into the pit. Major ion and nutrient concentrations tended to fluctuate throughout operations, and reach stable, steady state concentrations in closure (Figures 5-1, 5-2). Alternatively, predicted metal concentrations (e.g., aluminum) in the pit lake were a function of the contribution of runoff and seepage from the stored fines in the berms surrounding the excavation (Figure 5-3). Metal concentrations tended to peak in the first years of operations, and stabilize to steady state concentrations after about 10 years of operations (Figure 5-3).

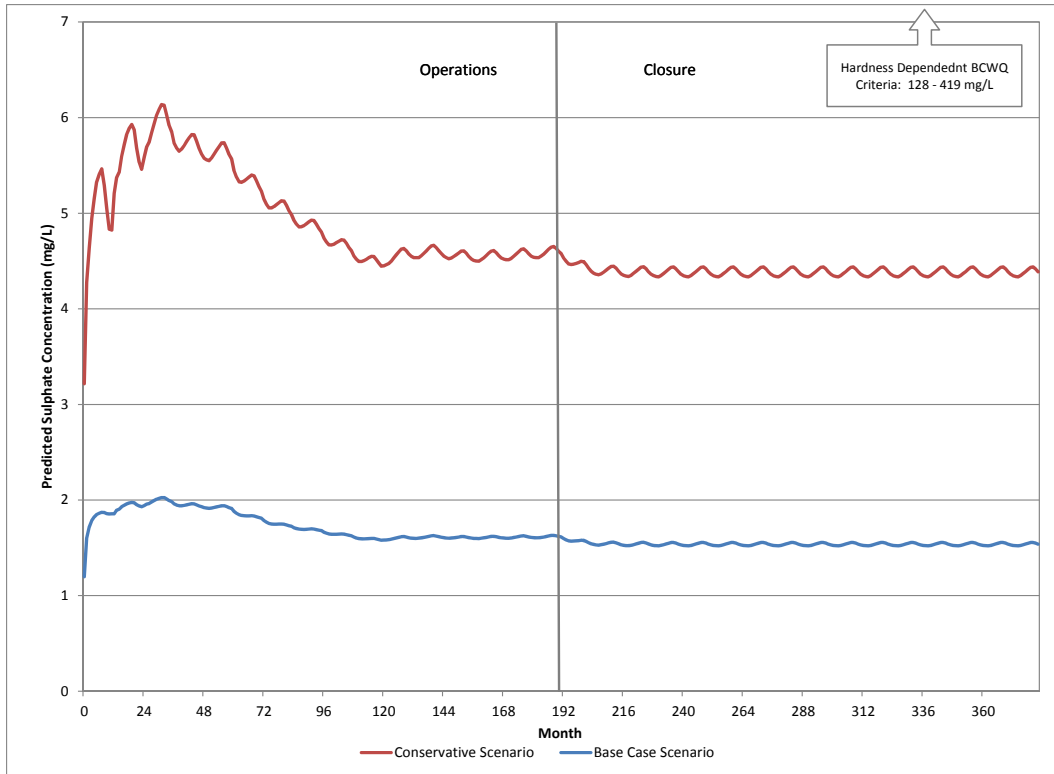


Figure 5-1: Time series of predicted sulphate concentration in the pit lake.

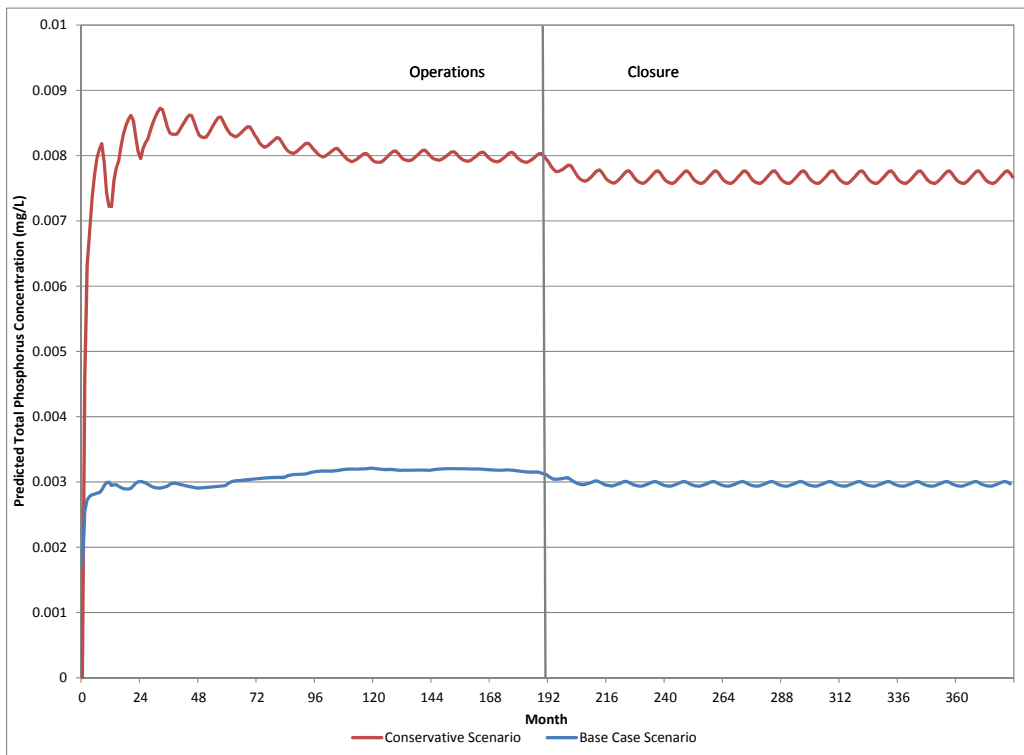


Figure 5-2: Time series of predicted total phosphorus concentration in the pit lake.

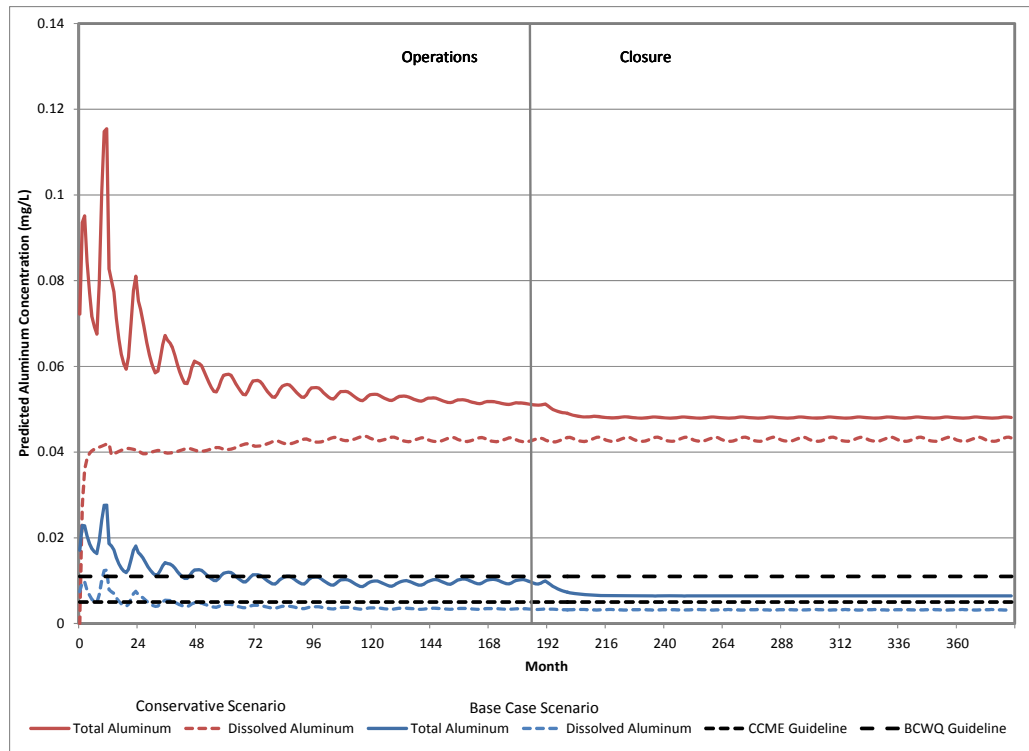


Figure 5-3: Time series of predicted aluminum concentration in the pit lake.

5.1.2 Receiving Environment

Under base case conditions, the following parameters were predicted to exceed CCME and/or BCWQ guidelines in receiving environment locations (MCF-1, MCF-7, MCF-12, MCF-6) (range of predicted concentrations is provided in brackets, Table 5-1):

- Dissolved Metals:
 - aluminum (0.003 – 0.074 mg/L), beryllium (0.00015 – 0.0005 mg/L), mercury (0.0000032 – 0.000010 mg/L);
- Total Metals:
 - aluminum (0.0033 – 0.014 mg/L), beryllium (0.00015 – 0.0005 mg/L), mercury (0.0000032 – 0.000010 mg/L).

Mercury exceedances were due to the method detection limit (0.000005 mg/L) being above the minimum guideline (BCWQ 30 day average guideline, 0.00000125 mg/L). This detection limit and exceedance also occurred in the baseline inputs (Table 4-2).

Predicted concentrations of all modelled parameters at MCF-1 and MCF-7 were a function of baseline concentrations in McNab Creek. There was little Project influence on these locations. The only additional source of chemical load from the Project at MCF-1 was air deposition from the Project. Air deposition and pit lake seepage were additional sources of chemical load from the Project at MCF-7

Predicted concentrations at MCF-6 and MCF-12 were driven by the predictions for the pit lake. Flow at these locations was assumed to be 100% from the pit lake, either through seepage (operations), or overflow (closure). The predicted concentrations at these locations were similar to the pit lake concentrations.

5.2 Conservative Scenario Results

5.2.1 Pit Lake

Under conservative conditions, the following parameters were predicted to exceed CCME and/or BCWQ guidelines in the pit lake (range of predicted concentrations is provided in brackets, Table 5-1):

- Dissolved Metals:
 - aluminum (0.027 – 0.044 mg/L), beryllium (0.00032 – 0.0005 mg/L), mercury (0.0000032 – 0.000005 mg/L);
- Total Metals:
 - aluminum (0.048 – 0.12 mg/L), beryllium (0.00032 – 0.0005 mg/L), mercury (0.0000033 – 0.0000051 mg/L).

A complete assessment of the predicted water quality, including a comparison to baseline conditions, is presented in the aquatic health assessment (BURNCO 2014, Section 5.5.2). Mercury exceedances were due to the method detection limit (0.000005 mg/L) being above the minimum guideline (BCWQ 30 day average guideline, 0.0000125 mg/L). This detection limit and exceedance also occurred in the baseline inputs (Table 4-2).

Time series plots of sulphate, total phosphorus, and aluminum showed similar trends under conservative conditions as seen under base case conditions (Figures 5-1, 5-2, and 5-3); however, concentrations were higher under the conservative conditions.

5.2.2 Receiving Environment

Under base case conditions, the following parameters were predicted to exceed CCME and/or BCWQ guidelines in receiving environment locations (MCF-1, MCF-7, MCF-12, MCF-6) (Table 5-1):

- Dissolved Metals:
 - aluminum (0.027 – 0.12 mg/L), beryllium (0.00032 – 0.0005 mg/L), cadmium (0.000009 – 0.000027 mg/L), mercury (0.000032 – 0.000010 mg/L);
- Total Metals:
 - aluminum (0.03 – 0.17 mg/L), beryllium (0.00032 – 0.0005 mg/L), cadmium (0.000009 – 0.000034 mg/L), copper (0.00032 – 0.0024 mg/L), mercury (0.0000032 – 0.000014 mg/L), silver (0.000006 – 0.00010 mg/L).

Mercury exceedances were due to the method detection limit (0.000005 mg/L) being above the minimum guideline (BCWQ 30 day average guideline, 0.00000125 mg/L). This detection limit and exceedance also occurred in the baseline inputs (Table 4-2).

Predicted concentrations at MCF-1 and MCF-7 were driven by baseline concentrations in McNab Creek, as seen in the base case condition. Predicted concentrations at MCF-6 and MCF-12 were driven by the predictions for the pit lake, as seen in the base case condition.

6.0 SUMMARY

A mass-balance water quality model was developed using GoldSim 10.5 to predict water quality in the pit lake and changes to water quality in the receiving environment during operations at the BURNCO McNab Aggregate Project. The model estimates concentrations of select parameters in the pit lake and receiving environment over the base case 16 years of operations at the Project. Water quality was assessed under two conditions: the base case condition, using median concentrations for groundwater and surface water inputs; and a conservative condition using a combination of 95th percentile and probabilistic inputs.

Pit lake and receiving environment water quality predictions were compared to the BCWQ Guidelines for the Protection of Aquatic Life (BC MoE 2015a, BC MoE 2015b) and the CCME Guidelines for the Protection of Freshwater Aquatic Life (CCME 1999) to identify parameters that could cause impacts in the environment. Modelling identified exceedances of the following parameters in the pit lake and/or receiving environment (Tables 5-1 and 5-2):

Pit Lake:

- Dissolved Metals:
 - aluminum (0.003 – 0.044 mg/L), beryllium (0.00032 – 0.0005 mg/L), mercury (0.0000032 – 0.000005 mg/L);
- Total Metals:
 - aluminum (0.0086 – 0.12 mg/L), beryllium (0.00032 – 0.0005 mg/L), mercury (0.0000033 – 0.0000051 mg/L).

Receiving Environment (Locations: MCF-1, MCF-7, MCF-12, MCF-6):

- Dissolved Metals:
 - aluminum (0.003 – 0.12 mg/L), beryllium (0.00032 – 0.0005 mg/L), cadmium (0.000009 – 0.000027 mg/L), mercury (0.000032 – 0.000010 mg/L);
- Total Metals:
 - aluminum (0.0033 – 0.17 mg/L), beryllium (0.00032 – 0.0005 mg/L), cadmium (0.000009 – 0.000034 mg/L), copper (0.00032 – 0.0024 mg/L), mercury (0.0000032 – 0.000014 mg/L), silver (0.000006 – 0.00010 mg/L).

Mercury exceedances were due to the method detection limit (0.000005 mg/L) for groundwater, surface water, and geochemical testing being above the minimum guideline (BCWQ 30 day average guideline, 0.00000125 mg/L). This detection limit and exceedance also occurs in the baseline inputs (Table 4-2).

The predicted water quality is discussed more detail, including a comparison to baseline conditions, in the aquatic health assessment report (BURNCO 2014: Section 5.5.2).

Natural processes and Project components were incorporated into the model as best as possible. However, water quality models are intended as a tool to aid in the design of monitoring programs and mine planning, to develop mitigation strategies, and to outline potential risks rather than to indicate absolute concentrations. Therefore, continued water quality monitoring and periodic re-assessment of water quality predictions and/or remedial measures will be required during operations. Collection of additional surface water and groundwater samples, and fines samples for geochemical characterization is recommended to confirm and refine inputs if necessary.

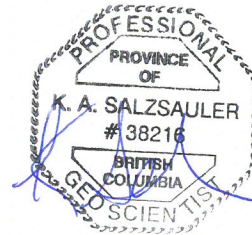
7.0 CLOSURE

We trust that this memo provides the information required at this time. Please do not hesitate to contact the undersigned should you have any questions or comments regarding the above.

GOLDER ASSOCIATES LTD.



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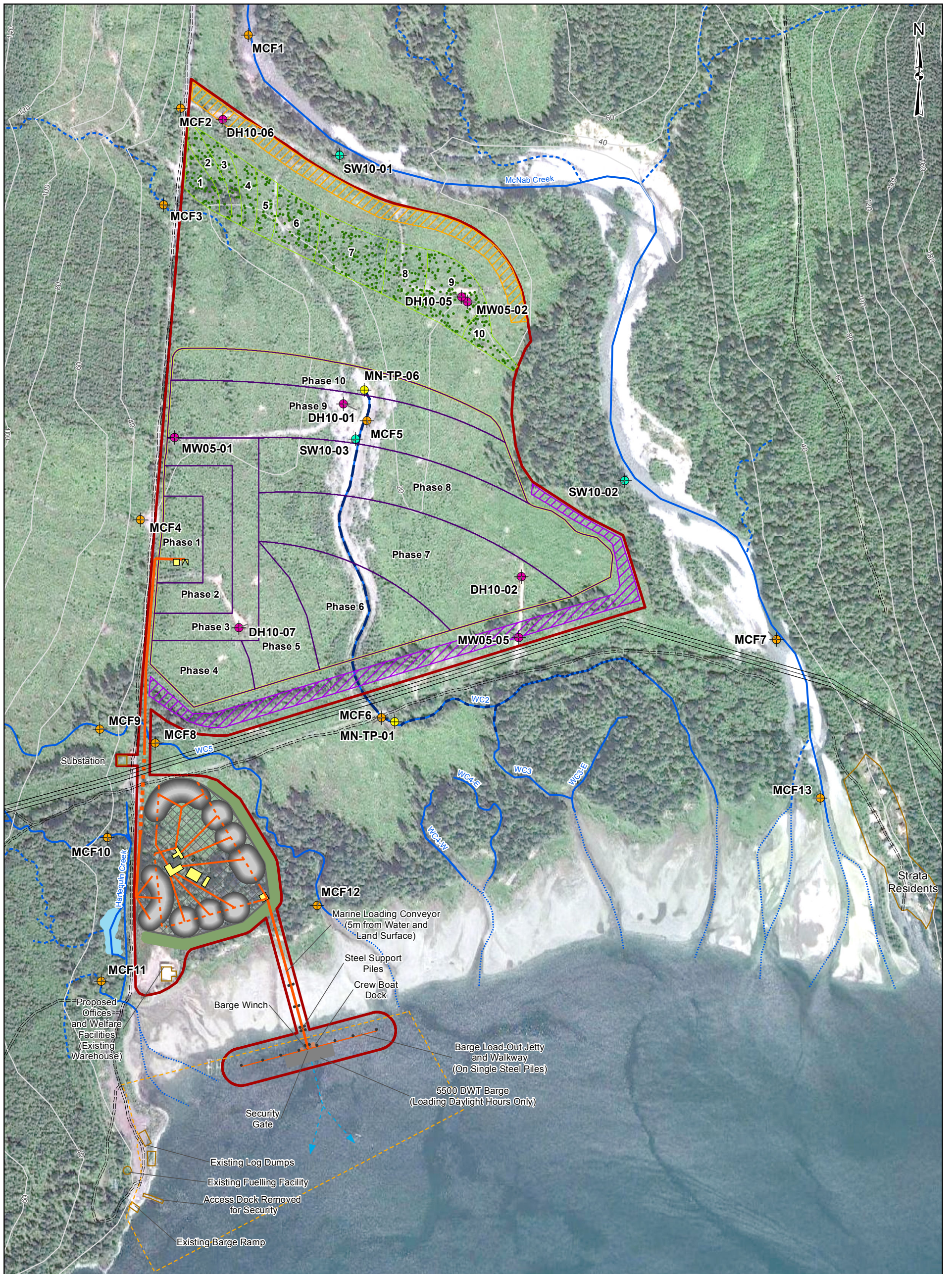
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- Attachments: Figure 1-1: Sampling Locations
Attachment 1: Tables
Attachment 2: Water Balance
Attachment 3: Input Water Quality
Attachment 4: Detailed Model Results

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8.0 REFERENCES

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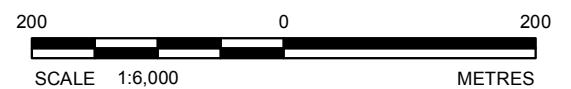
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LEGEND

- | | | |
|--|---|---|
| <ul style="list-style-type: none"> Test Pit Location (Golder 2013) Freshwater Quality Sampling Location (Golder 2012) Monitoring Well (Golder 2012) Surface Water Monitoring Station (Golder 2010) Project Area Proposed Aggregate Pit Phase Final Pit Lake Outline Product Stockpile Fines Storage Area | <ul style="list-style-type: none"> Processing Area Existing Feature Existing Log Tenure Area Possible Processing Plant Configuration McNab Creek Flood Protection Dyke Pit Lake Containment Berm Processing Area Berm Elevated Conveyor Underground Conveyor Barge Load-out Transmission Line | <ul style="list-style-type: none"> Road (Existing) Contour (20m) Permanent / Perennial Watercourse Intermittent Watercourse Intertidal Watercourse Constructed Watercourse Phase 1 (1985) Phase 2 (1998) Phase 3 (2001 - 2003) Barge Route Pile |
|--|---|---|

REFERENCE

Watercourses from the Province of British Columbia and field data. Base data from the Province of British Columbia. Contours from TRIM positional data. Base Imagery from Google Maps 20100807. Projection: UTM Zone 10 Datum: NAD 83



PROJECT		BURNCO ROCK PRODUCTS LTD. BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.	
TITLE		SAMPLING LOCATIONS	
PROJECT NO. 11-1422-0046		PHASE No.	
DESIGN	PB	27 May. 2014	SCALE AS SHOWN
GIS	DL	10 Mar. 2016	REV. 2
CHECK	PAB	24 Oct. 2014	FIGURE 1-1
REVIEW	KAS	24 Oct. 2014	



ATTACHMENT 1

Tables

Table 4-2b: Inflow Water Quality, McNab Aggregate Project, BC

Table with 22 columns: Parameter, Units, BC Water Quality Guidelines for the Protection of Freshwater Aquatic Life, Surface Water Runoff from North of Pit (C1), Surface Water Runoff from Undeveloped Pit Area (C2), Runoff and Groundwater Seepage from Stored Fines (C3 and C8), Porewater from Excavated Material (C5), Groundwater Inflow from West of Pit (C6), Groundwater Inflow from North of Pit (C7), Baseline Surface Water at MCF-1 (C9), Baseline Surface Water at MCF-7 (C11). Rows are categorized into Conventional, Major Ions, Nutrients, Dissolved Metals, and Total Metals.

Notes:

- A = approved guideline, W = working guideline
a) BC Water Quality (BCWQ) guidelines for the protection of freshwater aquatic life
b) calculated value: calculated TDS based on standard methods (APHA, 2005)
c) assumed alkalinity based on mean of shake flask extraction test, used for calculation of TDS
d) calculated hardness based on concentrations of calcium and magnesium
e) hardness dependent F guideline: BC Max WQG (mg/L) = (.51.73 + 92.57 * log[hardness]) * 0.01; equation was only applied when the hardness was > 10, otherwise 0.4 was used.
f) hardness dependent sulphate guideline: BC 30-d WQG (mg/L) = 128 at hardness <30 mg/L; at hardness 31-75 mg/L = 218; at hardness 76-180 mg/L = 309; at hardness 181-250 mg/L = 429; at hardness >250 mg/L, determine base on site water
g) pH and temperature dependent ammonia guideline: values selected from Tables 3 and 4 in BC WQG based on maximum baseline temperature of 18°C and pH 8.0
h) chloride dependent nitrite guideline: BC Max WQG (mg/L) = 0.06 at Cl < 2 mg/L, at Cl 2-4 mg/L = 0.12, at Cl 4-6 mg/L = 0.18, at Cl 6-8 mg/L = 0.24, at Cl 8-10 = 0.30, at Cl >10 = 0.6
BC 30-d WQG (mg/L) = 0.02 mg/L at Cl < 2 mg/L, at Cl 2-4 mg/L = 0.04, at Cl 4-6 mg/L = 0.06, at Cl 6-8 mg/L = 0.08, at Cl 8-10 mg/L = 0.1, at Cl >10 = 0.2
i) pH dependent dissolved Al guideline: BC Max WQG (mg/L) = 0.1 at pH >6.5, at pH <6.5 = EXP(1.209-2.426*(pH)+0.286*(pH^2)); BC 30-d WQG (mg/L) = 0.05 at pH >6.5, at pH <6.5 = EXP(1.6-3.327*(median pH)+0.402*(median pH^2)); minimum baseline surface water pH = 5.57
j) hardness dependent dissolved Cd guideline: BC WQG Long-term average (ug/L) = 2.718[0.736*ln(hardness)+4.943]; BC WQG short-term max (ug/L) = 2.718[1.03*ln(hardness)+5.274]. For the purpose of guideline comparison, the dissolved Cd guideline was used for total Cd guideline is for Cr(VI)
k) hardness dependent Cu guideline: BC Max WQG (mg/L) = (0.094(hardness+2))/1000; BC 30-d WQG (mg/L) = 0.002 at hardness <= 50 mg/L, at hardness >= 50 mg/L = 0.04*hardness/1000
m) hardness dependent Pb guideline: BC Max WQG (mg/L) = 0.003 at hardness <= 8 mg/L, at hardness > 8 mg/L = (EXP(1.273*ln(hardness))-1.46)/1000; BC 30-d WQG (mg/L) = (3.31+EXP(1.273*(ln(hardness))-4.704))/1000 at hardness >= 8 mg/L, no guideline at hardness <= 8 mg/L
n) hardness dependent Mn guideline: BC Max WQG (mg/L) = 0.01102*(hardness)+0.54; BC 30-d WQG (mg/L) = 0.0044*hardness+0.605
o) BC 30-d WQG (mg/L) = 0.00002 when methylmercury (MeHg) is 0.5% of total Hg, = 0.00001 at 1% MeHg, = 0.0000125 at 8% MeHg; applied most conservative guideline
p) hardness dependent Ni guideline: BC Max WQG = 0.025 at hardness <= 60 mg/L, at hardness 60-120 mg/L = 0.065, at hardness 120-180 mg/L = 0.11, at hardness >180 mg/L = 0.15
q) hardness dependent Ag guideline: BC Max WQG (mg/L) = 0.0001 at hardness <= 100 mg/L, at hardness >100 mg/L = 0.003; BC 30-d WQG (mg/L) = 0.00005 at hardness <= 100 mg/L, at hardness > 100 mg/L = 0.0015
r) hardness dependent Zn guideline: BC Max WQG (mg/L) = (33+0.75(hardness-90))/1000; BC 30-d WQG (mg/L) = (7.5+0.75(hardness-90))/1000
s) up to 10 - highly sensitive to acid inputs; 10 to 20 - moderately sensitive; over 20 - low sensitivity. Refer to calcium regarding sensitivity to acid inputs, the more restrictive of calcium or alkalinity is applicable.
t) up to 4 - highly sensitive to acid inputs; 4 to 8 - moderately sensitive; over 8 - low sensitivity. Refer to alkalinity, the more restrictive of calcium or alkalinity applies.

123 Indicates concentration exceeding the BC Max WQ Guideline and baseline.
123 Indicates concentration exceeding the BC 30-d WQ Guideline and baseline.

Table 4-3: Tonnage of Fines Extracted by Mine Year

Year	Cumulative Tonnage of Fines (tonnes)	New Fines Deposited (tonnes)	Previously Deposited Fines (tonnes)
1	1960	1960	0
2	14761	12801	1960
3	39005	24244	14761
4	51520	12515	39005
5	76788	25268	51520
7	107488	30700	76788
10	179813	72325	107488
12	263206	83393	179813
15	337066	73860	263206
16	370237	33171	337066

Table 4-4: Elemental Composition of Fine Aggregate Material Samples

Element	Units	MN-TP-01 S1-S3	MN-TP-01 S4-S9	MN-TP-06 S1-S6	Average
Aluminum	mg/kg	64900	65100	63400	64467
Boron	mg/kg	30	40	40	37
Barium	mg/kg	125	131	128	128
Calcium	mg/kg	4400	4300	4500	4400
Chromium	mg/kg	42	43	43	43
Copper	mg/kg	484	421	318	408
Iron	mg/kg	34600	35000	32700	34100
Potassium	mg/kg	1800	1900	2200	1967
Lithium	mg/kg	16	18	21	18
Magnesium	mg/kg	5500	5500	6100	5700
Manganese	mg/kg	485	496	364	448
Sodium	mg/kg	800	900	800	833
Nickel	mg/kg	27	27	32	29
Phosphorus	mg/kg	15500000	17200000	14400000	15700000
Strontium	mg/kg	36	36	36	36
Titanium	mg/kg	900	900	1100	967
Vanadium	mg/kg	74	79	91	81
Zinc	mg/kg	156	146	128	143
Silver	mg/kg	1.4	1.6	0.48	1.2
Arsenic	mg/kg	66	66	82	71
Beryllium	mg/kg	1.0	1.0	0.90	0.97
Bismuth	mg/kg	0.44	0.42	0.39	0.42
Cadmium	mg/kg	0.35	0.38	0.22	0.32
Cobalt	mg/kg	18	20	14	17
Mercury	mg/kg	0.19	0.17	0.090	0.15
Molybdenum	mg/kg	2.7	3.0	3.1	2.95
Lead	mg/kg	21	32	22	25
Antimony	mg/kg	0.81	0.84	0.57	0.74
Selenium	mg/kg	2.0	2.0	1.0	1.67
Thallium	mg/kg	0.27	0.27	0.22	0.25
Uranium	mg/kg	25	26	22	25

Table 4-5: Air Deposition Rates for Model Watersheds

Parameter	MCF-6-LAND	MCF-6-WATER	MCF-6-TOTAL	MCF1-LAND	MCF1-WATER	MCF1-TOTAL	MCF7-LAND	MCF7-WATER	MCF7-TOTAL	MCF12-LAND	PIT_LAKE
	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr
TSP	116925	1308658	1425583	467852	42275	510127	644322	272220	916542	39080	1308658
Aluminum	1272	13726	14997	4376	511	4887	6277	2821	9098	183	13726
Antimony	0.071	0.78	0.85	0.26	0.027	0.29	0.37	0.16	0.53	0.016	0.78
Arsenic	1.3	14	15	4.7	0.48	5.2	6.6	2.9	9.4	0.31	14
Barium	9.5	108	117	39	3.3	42	53	22	76	3.6	108
Beryllium	0.021	0.24	0.26	0.083	0.0077	0.091	0.11	0.049	0.16	0.0066	0.24
Bismuth	0.026	0.28	0.31	0.094	0.0099	0.1	0.13	0.058	0.19	0.0057	0.28
Cadmium	0.014	0.15	0.16	0.051	0.0053	0.056	0.071	0.031	0.1	0.0031	0.15
Calcium	504	5728	6231	2118	172	2290	2877	1191	4068	207	5728
Chromium	4.7	54	59	21	1.5	22	28	11	39	2.3	54
Cobalt	0.87	9.7	11	3.5	0.31	3.8	4.8	2.0	6.8	0.29	9.7
Copper	2.8	31	34	11	1.0	12	15	6.4	21	0.86	31
Iron	2325	26215	28540	9460	820	10280	12961	5440	18401	842	26215
Lead	3.5	38	41	12	1.4	14	17	7.8	25	0.57	38
Lithium	1.7	20	21	7.2	0.6	7.8	9.8	4.1	14	0.67	20
Magnesium	572	6450	7023	2329	202	2531	3191	1339	4530	208	6450
Manganese	31	344	374	123	11	134	169	71	240	10	344
Mercury	0.023	0.25	0.27	0.081	0.0093	0.09	0.12	0.052	0.17	0.0036	0.25
Molybdenum	0.098	1.1	1.2	0.4	0.034	0.44	0.55	0.23	0.78	0.037	1.1
Nickel	2.1	23	25	8.5	0.73	9.2	12	4.9	16	0.76	23
Phosphorus	67	739	805	255	25	279	355	153	507	18	739
Potassium	219	2494	2712	929	74	1003	1259	519	1778	93	2494
Selenium	0.052	0.57	0.62	0.2	0.019	0.22	0.27	0.12	0.39	0.014	0.57
Silver	0.012	0.13	0.15	0.045	0.0047	0.049	0.063	0.028	0.091	0.0026	0.13
Sodium	94	1093	1187	425	30	455	567	228	796	49	1093
Strontium	3.6	41	45	15	1.2	17	21	8.6	30	1.5	41
Thallium	0.014	0.16	0.18	0.059	0.0049	0.064	0.08	0.033	0.11	0.0056	0.16
Tin	0.17	1.8	2.0	0.59	0.065	0.65	0.84	0.37	1.2	0.03	1.8
Titanium	90	1020	1110	374	31	405	509	212	721	35	1020
Uranium	0.21	2.3	2.5	0.79	0.079	0.87	1.1	0.48	1.6	0.052	2.3
Vanadium	6.6	74	80	26	2.3	29	36	15	52	2.3	74
Zinc	4.6	52	57	18	1.7	20	25	11	36	1.5	52

Table 5-1a: Predicted Quality under the Base Case Scenario, McNab Aggregate Project, BC.

Table with columns for Parameter, Units, CCME Guidelines, Pit Lake, MCF-1, MCF-7, MCF-6, and MCF-12. Rows include Conventional parameters (Total Dissolved Solids, Alkalinity, Hardness), Major Ions (Calcium, Chloride, Fluoride, Magnesium, Potassium, Sodium, Sulphate), Nutrients (Ammonia, Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus), Dissolved Metals (Aluminum, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lithium, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silicon, Silver, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc), and Total Metals.

- Notes:
1) Interim guideline
2) Canadian Council of Ministers of the Environment (CCME), Guidelines for the protection of freshwater aquatic life.
3) Calculated value: calculated TDS based on standard methods (APHA, 2005)
4) Assumed alkalinity based on mean of shake flask extraction test, used for calculation of TDS
5) Calculated hardness based on concentrations of calcium and magnesium
6) pH and temperature dependent ammonia guideline: based on maximum baseline temperature of 18°C and pH of 8.0
7) pH dependent Al guideline: CCME Al (mg/L) = 0.005 at pH<6.5, CCME Al (mg/L) = 0.1 at pH >6.5 (minimum observed baseline surface water pH = 5.57)
8) Hardness dependent Cd guideline: CCME Short-term Guideline (mg/L) = 0.00011 at hardness <5.3 mg/L, at hardness >5.3 to <360 mg/L = (10^(-1.016*log(hardness)-1.71))/1000, at hardness >360 mg/L = 0.0077
9) Hardness dependent Cu guideline: CCME (mg/L) = 0.002 at hardness <82 mg/L, at hardness >82 to <180 mg/L = (0.2*EXP(0.8545*(ln(hardness)-1.465)))/1000
10) Hardness dependent Pb guideline: CCME (mg/L) = 0.001 at hardness <60 mg/L, at hardness >60 to <180 mg/L = (EXP(1.273*(ln(hardness)-4.705)))/1000, at hardness >180 mg/L = 0.007
11) Hardness dependent Ni guideline: CCME (mg/L) = 0.025 at hardness <60 mg/L, at hardness >60 to <180 mg/L = (EXP(0.76*(ln(hardness)-1.06)))/1000, at hardness >180 mg/L = 0.15
12) CCME guidance framework trigger values (mg/L): ultra-oligotrophic <0.004, oligotrophic 0.004-0.01, meso-eutrophic 0.02-0.035, eutrophic 0.035-0.1, hyper-eutrophic >0.1

123 Indicates concentration exceeding the CCME short-term guideline and baseline.
123 Indicates concentration exceeding the CCME long-term guideline and baseline.

ATTACHMENT 2
Water Balance

Table A1-1: Pit Lake Water Balance Flow Inputs

Year #	Month	Inflows							Outflow		
		Surface Water Input			Direct Precip on Pit Lake minus Evaporation (m3)	Volume of pore water from excavated pit material (m3)	Groundwater Input			Estimated Total Seepage Outflow (m3)	Estimated Overflow (m3)
Runoff from Area North of Pit - through natural areas with no fines deposits (m3)	Runoff from Area North of Pit - through areas of deposited fines (m3)	Runoff from Undeveloped Pit Area - with no fines deposits (m3)	GW Inflows From West - infiltrating through natural areas with no fines deposit (m3)	GW Inflows From North - infiltrating through natural areas with no fines deposit (m3)			GW Inflows From North - infiltrating through natural areas with fines deposit (m3)				
11	1	10,911	3,475	10,554	72,006	24,233	179,180	1,027,143	3,297	1,250,022	-
11	2	9,431	3,004	9,122	60,613	24,233	161,840	927,742	2,978	1,118,185	-
11	3	9,211	2,934	8,910	58,020	24,233	179,180	1,027,143	3,297	1,232,151	-
11	4	5,620	1,790	5,436	29,832	24,233	173,400	994,009	3,191	1,156,734	-
11	5	4,112	1,310	3,978	15,335	24,233	179,180	1,027,143	3,297	1,177,810	-
11	6	2,796	891	2,705	5,978	24,233	173,400	994,009	3,191	1,126,426	-
11	7	2,495	795	2,413	-2,283	24,233	179,180	1,027,143	3,297	1,156,495	-
11	8	2,193	699	2,121	-5,073	24,233	179,180	1,027,143	3,297	1,153,016	-
11	9	4,441	1,415	4,296	17,765	24,233	173,400	994,009	3,191	1,141,972	-
11	10	9,650	3,074	9,334	60,288	24,233	179,180	1,027,143	3,297	1,235,422	-
11	11	12,638	4,025	12,225	83,990	24,233	173,400	994,009	3,191	1,226,934	-
11	12	12,501	3,982	12,092	83,053	24,233	179,180	1,027,143	3,297	1,264,704	-
12	1	10,216	4,170	7,717	81,779	24,753	190,960	1,077,604	3,676	1,318,366	-
12	2	8,830	3,605	6,670	68,834	24,753	172,480	973,319	3,321	1,179,301	-
12	3	8,625	3,521	6,515	65,881	24,753	190,960	1,077,604	3,676	1,299,024	-
12	4	5,262	2,148	3,975	33,846	24,753	184,800	1,042,842	3,558	1,218,674	-
12	5	3,850	1,572	2,909	17,359	24,753	190,960	1,077,604	3,676	1,240,172	-
12	6	2,618	1,069	1,978	6,729	24,753	184,800	1,042,842	3,558	1,185,837	-
12	7	2,336	954	1,765	-2,683	24,753	190,960	1,077,604	3,676	1,216,854	-
12	8	2,053	838	1,551	-5,855	24,753	190,960	1,077,604	3,676	1,213,070	-
12	9	4,158	1,698	3,141	20,121	24,753	184,800	1,042,842	3,558	1,202,560	-
12	10	9,035	3,688	6,825	68,454	24,753	190,960	1,077,604	3,676	1,302,486	-
12	11	11,833	4,831	8,939	95,392	24,753	184,800	1,042,842	3,558	1,294,437	-
12	12	11,705	4,778	8,842	94,328	24,753	190,960	1,077,604	3,676	1,334,135	-
13	1	9,174	5,213	5,987	87,742	15,055	202,740	1,128,044	4,076	1,407,846	-
13	2	7,929	4,506	5,174	73,848	15,055	183,120	1,018,879	3,681	1,262,008	-
13	3	7,744	4,401	5,054	70,680	15,055	202,740	1,128,044	4,076	1,387,611	-
13	4	4,725	2,685	3,084	36,300	15,055	196,200	1,091,656	3,944	1,303,465	-
13	5	3,457	1,965	2,256	18,601	15,055	202,740	1,128,044	4,076	1,326,011	-
13	6	2,351	1,336	1,534	7,187	15,055	196,200	1,091,656	3,944	1,269,079	-
13	7	2,097	1,192	1,369	-2,929	15,055	202,740	1,128,044	4,076	1,301,461	-
13	8	1,844	1,048	1,203	-6,335	15,055	202,740	1,128,044	4,076	1,297,492	-
13	9	3,734	2,122	2,437	21,557	15,055	196,200	1,091,656	3,944	1,286,521	-
13	10	8,113	4,610	5,295	73,435	15,055	202,740	1,128,044	4,076	1,391,185	-
13	11	10,626	6,038	6,934	102,348	15,055	196,200	1,091,656	3,944	1,382,617	-
13	12	10,510	5,973	6,859	101,206	15,055	202,740	1,128,044	4,076	1,424,280	-
14	1	9,174	5,213	4,256	93,704	15,133	214,520	1,178,465	4,495	1,474,515	-
14	2	7,929	4,506	3,678	78,862	15,133	193,760	1,064,420	4,060	1,321,904	-
14	3	7,744	4,401	3,593	75,476	15,133	214,520	1,178,465	4,495	1,453,383	-
14	4	4,725	2,685	2,192	38,748	15,133	207,600	1,140,450	4,350	1,365,440	-
14	5	3,457	1,965	1,604	19,835	15,133	214,520	1,178,465	4,495	1,389,031	-
14	6	2,351	1,336	1,091	7,652	15,133	207,600	1,140,450	4,350	1,329,519	-
14	7	2,097	1,192	973	-3,162	15,133	214,520	1,178,465	4,495	1,363,270	-
14	8	1,844	1,048	855	-6,801	15,133	214,520	1,178,465	4,495	1,359,115	-
14	9	3,734	2,122	1,732	22,992	15,133	207,600	1,140,450	4,350	1,347,670	-
14	10	8,113	4,610	3,764	78,417	15,133	214,520	1,178,465	4,495	1,457,074	-
14	11	10,626	6,038	4,929	109,304	15,133	207,600	1,140,450	4,350	1,447,987	-
14	12	10,510	5,973	4,876	108,085	15,133	214,520	1,178,465	4,495	1,491,613	-
15	1	9,174	5,213	2,525	99,666	15,211	226,300	1,228,865	4,935	1,541,185	-
15	2	7,929	4,506	2,182	83,875	15,211	204,400	1,109,942	4,458	1,381,800	-
15	3	7,744	4,401	2,132	80,271	15,211	226,300	1,228,865	4,935	1,519,156	-
15	4	4,725	2,685	1,301	41,195	15,211	219,000	1,189,224	4,776	1,427,414	-
15	5	3,457	1,965	952	21,064	15,211	226,300	1,228,865	4,935	1,452,045	-
15	6	2,351	1,336	647	8,104	15,211	219,000	1,189,224	4,776	1,389,945	-
15	7	2,097	1,192	577	-3,416	15,211	226,300	1,228,865	4,935	1,425,058	-
15	8	1,844	1,048	508	-7,289	15,211	226,300	1,228,865	4,935	1,420,718	-
15	9	3,734	2,122	1,028	24,431	15,211	219,000	1,189,224	4,776	1,408,822	-
15	10	8,113	4,610	2,233	83,400	15,211	226,300	1,228,865	4,935	1,522,964	-
15	11	10,626	6,038	2,925	116,261	15,211	219,000	1,189,224	4,776	1,513,357	-
15	12	10,510	5,973	2,893	114,963	15,211	226,300	1,228,865	4,935	1,558,946	-
16	1	8,826	5,561	-	108,388	20,324	241,800	1,318,405	5,295	1,640,852	-
16	2	7,628	4,806	-	91,224	20,324	218,400	1,190,818	4,782	1,470,239	-
16	3	7,451	4,694	-	87,311	20,324	241,800	1,318,405	5,295	1,617,537	-
16	4	4,546	2,864	-	44,849	20,324	234,000	1,275,876	5,124	1,519,836	-
16	5	3,326	2,096	-	22,990	20,324	241,800	1,318,405	5,295	1,546,490	-
16	6	2,262	1,425	-	8,896	20,324	234,000	1,275,876	5,124	1,480,160	-
16	7	2,018	1,271	-	-3,591	20,324	241,800	1,318,405	5,295	1,517,776	-
16	8	1,774	1,118	-	-7,797	20,324	241,800	1,318,405	5,295	1,513,172	-
16	9	3,592	2,263	-	26,646	20,324	234,000	1,275,876	5,124	1,500,079	-
16	10	7,806	4,918	-	90,722	20,324	241,800	1,318,405	5,295	1,621,523	-
16	11	10,223	6,441	-	126,432	20,324	234,000	1,275,876	5,124	1,610,673	-
16	12	10,510	5,973	-	114,963	20,324	226,300	1,228,865	5,295	1,558,946	-
17	1	8,826	5,560	-	108,386	-	241,800	1,317,150	5,290	1,629,653	55,376
17	2	7,629	4,806	-	91,224	-	218,400	1,189,702	4,778	1,471,903	43,693
17	3	7,451	4,694	-	87,311	-	241,800	1,318,335	5,295	1,626,888	39,011
17	4	4,546	2,864	-	44,843	-	234,000	1,277,340	5,130	1,570,834	-
17	5	3,326	2,096	-	22,984	-	241,800	1,325,168	5,322	1,610,945	-
17	6	2,262	1,425	-	8,896	-	234,000	1,288,007	5,173	1,545,944	-
17	7	2,018	1,271	-	-3,587	-	241,800	1,335,208	5,362	1,587,520	-
17	8	1,774	1,118	-	-7,792	-	241,800	1,337,787	5,373	1,581,500	-
17	9	3,593	2,263	-	26,647	-	234,000	1,287,728	5,172	1,546,595	-
17	10	7,806	4,918	-	90,720	-	241,800	1,319,451	5,299	1,624,285	32,769
17	11	10,223	6,441	-	126,431	-	234,000	1,274,970	5,120	1,576,365	81,064
17	12	10,112	6,371	-	125,021	-	241,800	1,317,569	5,291	1,628,677	76,916

Table A1-2: Receiving Environment Flow Inputs

Year	Month	MCF-1 (m ³ /s)	Downstream of MCF-6 (m ³ /s)	MCF-7		MCF-12 (m ³ /s)
				Total Flow (m ³ /s)	Flow from Groundwater (m ³ /d)	
		Q9	Q10	Q11	Q12	Q13
1	1	3.58	0.23	3.63	0	0.025
1	2	4.35	0.23	4.46	0	0.025
1	3	4.10	0.23	4.19	0	0.025
1	4	4.29	0.23	4.39	0	0.025
1	5	7.99	0.23	8.36	0	0.025
1	6	6.63	0.23	6.90	0	0.025
1	7	3.51	0.23	3.55	0	0.025
1	8	1.11	0.23	0.98	0	0.025
1	9	1.83	0.23	1.75	0	0.025
1	10	4.07	0.23	4.15	0	0.025
1	11	5.26	0.23	5.43	0	0.025
1	12	5.37	0.23	5.55	0	0.025
2	13	3.58	0.15	3.65	0	0.035
2	14	4.35	0.15	4.47	0	0.035
2	15	4.10	0.15	4.20	0	0.035
2	16	4.29	0.15	4.40	0	0.035
2	17	7.99	0.15	8.37	0	0.035
2	18	6.63	0.15	6.92	0	0.035
2	19	3.51	0.15	3.57	0	0.035
2	20	1.11	0.15	1.00	0	0.035
2	21	1.83	0.15	1.77	0	0.035
2	22	4.07	0.15	4.17	0	0.035
2	23	5.26	0.15	5.44	0	0.035
2	24	5.37	0.15	5.56	0	0.035
3	25	3.58	0.15	3.66	0	0.035
3	26	4.35	0.15	4.49	0	0.035
3	27	4.10	0.15	4.22	0	0.035
3	28	4.29	0.15	4.42	0	0.035
3	29	7.99	0.15	8.39	0	0.035
3	30	6.63	0.15	6.93	0	0.035
3	31	3.51	0.15	3.59	0	0.035
3	32	1.11	0.15	1.01	0	0.035
3	33	1.83	0.15	1.79	0	0.035
3	34	4.07	0.15	4.19	0	0.035
3	35	5.26	0.15	5.46	0	0.035
3	36	5.37	0.15	5.58	0	0.035
4	37	3.58	0.15	3.68	0	0.035
4	38	4.35	0.15	4.51	0	0.035
4	39	4.10	0.15	4.23	0	0.035
4	40	4.29	0.15	4.44	0	0.035
4	41	7.99	0.15	8.40	0	0.035
4	42	6.63	0.15	6.95	0	0.035
4	43	3.51	0.15	3.60	0	0.035
4	44	1.11	0.15	1.03	0	0.035
4	45	1.83	0.15	1.80	0	0.035
4	46	4.07	0.15	4.20	0	0.035
4	47	5.26	0.15	5.47	0	0.035
4	48	5.37	0.15	5.60	0	0.035
5	49	3.58	0.15	3.69	0	0.035
5	50	4.35	0.15	4.52	0	0.035
5	51	4.10	0.15	4.25	0	0.035
5	52	4.29	0.15	4.45	0	0.035
5	53	7.99	0.15	8.42	0	0.035
5	54	6.63	0.15	6.96	0	0.035
5	55	3.51	0.15	3.62	0	0.035
5	56	1.11	0.15	1.04	0	0.035
5	57	1.83	0.15	1.82	0	0.035
5	58	4.07	0.15	4.22	0	0.035
5	59	5.26	0.15	5.49	0	0.035
5	60	5.37	0.15	5.61	0	0.035
6	61	3.58	0.15	3.71	0	0.035
6	62	4.35	0.15	4.54	0	0.035
6	63	4.10	0.15	4.27	0	0.035
6	64	4.29	0.15	4.47	0	0.035
6	65	7.99	0.15	8.44	0	0.035
6	66	6.63	0.15	6.98	0	0.035
6	67	3.51	0.15	3.63	0	0.035
6	68	1.11	0.15	1.06	0	0.035
6	69	1.83	0.15	1.83	0	0.035
6	70	4.07	0.15	4.23	0	0.035
6	71	5.26	0.15	5.50	0	0.035
6	72	5.37	0.15	5.63	0	0.035
7	73	3.58	0.15	3.71	0	0.037
7	74	4.35	0.15	4.53	0	0.037
7	75	4.10	0.15	4.26	0	0.037
7	76	4.29	0.15	4.46	0	0.037
7	77	7.99	0.15	8.43	0	0.037
7	78	6.63	0.15	6.98	0	0.037
7	79	3.51	0.15	3.63	0	0.037
7	80	1.11	0.15	1.06	0	0.037
7	81	1.83	0.15	1.83	0	0.037
7	82	4.07	0.15	4.23	0	0.037
7	83	5.26	0.15	5.50	0	0.037
7	84	5.37	0.15	5.62	0	0.037
8	85	3.58	0.15	3.70	0	0.039
8	86	4.35	0.15	4.53	0	0.039
8	87	4.10	0.15	4.26	0	0.039
8	88	4.29	0.15	4.46	0	0.039
8	89	7.99	0.15	8.43	0	0.039
8	90	6.63	0.15	6.97	0	0.039
8	91	3.51	0.15	3.63	0	0.039
8	92	1.11	0.15	1.05	0	0.039
8	93	1.83	0.15	1.83	0	0.039
8	94	4.07	0.15	4.23	0	0.039
8	95	5.26	0.15	5.50	0	0.039
8	96	5.37	0.15	5.62	0	0.039
9	97	3.58	0.16	3.70	0	0.040
9	98	4.35	0.16	4.53	0	0.040
9	99	4.10	0.16	4.26	0	0.040
9	100	4.29	0.16	4.46	0	0.040
9	101	7.99	0.16	8.43	0	0.040
9	102	6.63	0.16	6.97	0	0.040
9	103	3.51	0.16	3.62	0	0.040
9	104	1.11	0.16	1.05	0	0.040
9	105	1.83	0.16	1.82	0	0.040
9	106	4.07	0.16	4.22	0	0.040
9	107	5.26	0.16	5.49	0	0.040
9	108	5.37	0.16	5.62	0	0.040

Table A1-2: Receiving Environment Flow Inputs

Year	Month	MCF-1 (m ³ /s)	Downstream of MCF-6 (m ³ /s)	MCF-7		MCF-12 (m ³ /s)
				Total Flow (m ³ /s)	Flow from Groundwater (m ³ /d)	
10	109	3.58	0.16	3.69	0	0.042
10	110	4.35	0.16	4.52	0	0.042
10	111	4.10	0.16	4.25	0	0.042
10	112	4.29	0.16	4.45	0	0.042
10	113	7.99	0.16	8.42	0	0.042
10	114	6.63	0.16	6.96	0	0.042
10	115	3.51	0.16	3.62	0	0.042
10	116	1.11	0.16	1.05	0	0.042
10	117	1.83	0.16	1.82	0	0.042
10	118	4.07	0.16	4.22	0	0.042
10	119	5.26	0.16	5.49	0	0.042
10	120	5.37	0.16	5.61	0	0.042
11	121	3.58	0.16	3.69	0.0	0.034
11	122	4.35	0.16	4.52	0.0	0.034
11	123	4.10	0.16	4.25	0.0	0.034
11	124	4.29	0.16	4.45	0.0	0.034
11	125	7.99	0.16	8.42	0.0	0.034
11	126	6.63	0.16	6.96	0.0	0.034
11	127	3.51	0.16	3.62	0.0	0.034
11	128	1.11	0.16	1.04	0.0	0.034
11	129	1.83	0.16	1.82	0.0	0.034
11	130	4.07	0.16	4.22	0.0	0.034
11	131	5.26	0.16	5.49	0.0	0.034
11	132	5.37	0.16	5.61	0.0	0.034
12	133	3.58	0.17	3.68	6.7	0.037
12	134	4.35	0.17	4.51	6.7	0.037
12	135	4.10	0.17	4.24	6.7	0.037
12	136	4.29	0.17	4.44	6.7	0.037
12	137	7.99	0.17	8.41	6.7	0.037
12	138	6.63	0.17	6.95	6.7	0.037
12	139	3.51	0.17	3.61	6.7	0.037
12	140	1.11	0.17	1.03	6.7	0.037
12	141	1.83	0.17	1.80	6.7	0.037
12	142	4.07	0.17	4.21	6.7	0.037
12	143	5.26	0.17	5.48	6.7	0.037
12	144	5.37	0.17	5.60	6.7	0.037
13	145	3.58	0.17	3.67	13.3	0.040
13	146	4.35	0.17	4.50	13.3	0.040
13	147	4.10	0.17	4.23	13.3	0.040
13	148	4.29	0.17	4.43	13.3	0.040
13	149	7.99	0.17	8.40	13.3	0.040
13	150	6.63	0.17	6.94	13.3	0.040
13	151	3.51	0.17	3.60	13.3	0.040
13	152	1.11	0.17	1.02	13.3	0.040
13	153	1.83	0.17	1.79	13.3	0.040
13	154	4.07	0.17	4.20	13.3	0.040
13	155	5.26	0.17	5.47	13.3	0.040
13	156	5.37	0.17	5.59	13.3	0.040
14	157	3.58	0.18	3.66	20.0	0.042
14	158	4.35	0.18	4.49	20.0	0.042
14	159	4.10	0.18	4.22	20.0	0.042
14	160	4.29	0.18	4.42	20.0	0.042
14	161	7.99	0.18	8.39	20.0	0.042
14	162	6.63	0.18	6.93	20.0	0.042
14	163	3.51	0.18	3.59	20.0	0.042
14	164	1.11	0.18	1.01	20.0	0.042
14	165	1.83	0.18	1.78	20.0	0.042
14	166	4.07	0.18	4.18	20.0	0.042
14	167	5.26	0.18	5.46	20.0	0.042
14	168	5.37	0.18	5.58	20.0	0.042
15	169	3.58	0.18	3.65	26.7	0.045
15	170	4.35	0.18	4.48	26.7	0.045
15	171	4.10	0.18	4.21	26.7	0.045
15	172	4.29	0.18	4.41	26.7	0.045
15	173	7.99	0.18	8.38	26.7	0.045
15	174	6.63	0.18	6.92	26.7	0.045
15	175	3.51	0.18	3.57	26.7	0.045
15	176	1.11	0.18	1.00	26.7	0.045
15	177	1.83	0.18	1.77	26.7	0.045
15	178	4.07	0.18	4.17	26.7	0.045
15	179	5.26	0.18	5.45	26.7	0.045
15	180	5.37	0.18	5.57	26.7	0.045
16	181	3.58	0.18	3.64	33.3	0.037
16	182	4.35	0.18	4.47	33.3	0.037
16	183	4.10	0.18	4.20	33.3	0.037
16	184	4.29	0.18	4.40	33.3	0.037
16	185	7.99	0.18	8.37	33.3	0.037
16	186	6.63	0.18	6.91	33.3	0.037
16	187	3.51	0.18	3.56	33.3	0.037
16	188	1.11	0.18	0.99	33.3	0.037
16	189	1.83	0.18	1.76	33.3	0.037
16	190	4.07	0.18	4.16	33.3	0.037
16	191	5.26	0.18	5.44	33.3	0.037
16	192	5.37	0.18	5.56	33.3	0.037
17	193	3.58	0.19	3.63	41.7	0.037
17	194	4.35	0.19	4.46	41.7	0.037
17	195	4.10	0.19	4.19	41.7	0.037
17	196	4.29	0.19	4.39	41.7	0.037
17	197	7.99	0.19	8.36	41.7	0.037
17	198	6.63	0.19	6.90	41.7	0.037
17	199	3.51	0.19	3.56	41.7	0.037
17	200	1.11	0.19	0.98	41.7	0.037
17	201	1.83	0.19	1.76	41.7	0.037
17	202	4.07	0.19	4.16	41.7	0.037
17	203	5.26	0.19	5.43	41.7	0.037
17	204	5.37	0.19	5.55	41.7	0.037

ATTACHMENT 3
Input Water Quality

Table 4-2a: Inflow Water Quality, McNab Aggregate Project, BC

Parameter	Units	CCME Guidelines ^a			Surface Water Runoff from North of Pit (C1)					Surface Water Runoff from the Undeveloped Pit Area (C2)							Median (mg/L)	95 th Percentile (mg/L)	
					MCF-2	MCF-3		Median (mg/L)	Maximum (mg/L)	MCF-4		MCF-5		MCF-6					
						16-Oct-12	16-Oct-12			25-Mar-14	16-Oct-12	25-Mar-14	10-Sep-12	16-Oct-12	25-Mar-14	12-Sep-12			17-Oct-12
Short-term	Long-term	notes	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
Conventional																			
Total Dissolved Solids ^b	mg/L	-	-	-	12	10	9.4	8.3	11	17	13	14	13	11	13	13	11	10	15
Alkalinity ^c	mg/L	-	-	-	4.8	3.1	2.9	3.1	4.8	2.8	3.1	4.4	6.6	5.7	4.8	6.0	5.9	4.0	5.0
Hardness ^d	mg/L	-	-	-	6.5	4.6	3.5	4.6	6.5	8.7	6.6	7.4	6.8	5.1	6.4	6.9	5.5	2.4	3.8
Major Ions																			
Calcium	mg/L	-	-	-	2.1	1.5	1.1	1.5	2.1	3.0	2.3	2.5	2.3	1.7	2.2	2.3	1.9	0.77	1.3
Chloride	mg/L	640	120	-	0.97	0.86	0.57	0.86	0.97	1.2	0.68	0.73	0.83	0.67	0.79	0.79	0.7	0.57	1.7
Fluoride	mg/L	0.12	-	l	<0.020	<0.020	<0.020	0.01	0.01	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.02	0.027
Magnesium	mg/L	-	-	-	0.31	0.21	0.18	0.21	0.31	0.3	0.23	0.29	0.27	0.21	0.24	0.27	0.21	0.11	0.16
Potassium	mg/L	-	-	-	<2.0	<2.0	<2.0	1.0	1.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0.11	1.0
Sodium	mg/L	-	-	-	<2.0	<2.0	<2.0	1.0	1.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0.61	1.1
Sulphate	mg/L	-	-	-	1.1	1.8	1.7	1.7	1.8	6.4	3.0	2.1	1.5	1.6	1.8	1.7	2.1	0.72	3.3
Nutrients																			
Ammonia	mg/L (as N)	0.41	-	e	<0.0050	<0.0050	<0.0050	0.0025	0.0025	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.01	0.035
Nitrate	mg/L (as N)	550	13	-	0.52	0.17	0.071	0.17	0.52	<0.0050	0.009	0.16	0.34	0.23	0.12	0.31	0.23	0.05	0.33
Nitrite	mg/L (as N)	0.06	-	-	<0.0010	<0.0010	<0.0010	0.0005	0.0005	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0018	0.0025
Total Kjeldhal Nitrogen	mg/L (as N)	-	-	-	0.14	0.076	0.051	0.076	0.14	<0.050	0.05	<0.050	<0.050	<0.050	0.056	<0.050	0.07	0.1	0.38
Total Phosphorus	mg/L	-	see notes	l	0.012	0.0046	0.0028	0.0046	0.012	0.0036	0.0024	0.0025	<0.0020	<0.0020	0.0053	<0.0020	<0.0020	0.0025	0.011
Dissolved Metals																			
Aluminum	mg/L	0.005	-	f	0.072	0.07	0.023	0.07	0.072	0.041	0.024	0.014	0.028	0.022	0.01	0.019	0.02	0.074	0.099
Antimony	mg/L	-	-	-	<0.00050	<0.00050	<0.00050	0.00025	0.00025	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00025	0.00025
Arsenic	mg/L	0.005	-	-	<0.00050	<0.00050	<0.00050	0.00025	0.00025	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00023	0.0005
Barium	mg/L	-	-	-	<0.020	<0.020	<0.020	0.01	0.01	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.0015	0.01
Beryllium	mg/L	-	-	-	<0.0010	<0.0010	<0.0010	0.0005	0.0005	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.00015	0.0005
Boron	mg/L	29	1.5	-	<0.10	<0.10	<0.10	0.05	0.05	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.025	0.05
Cadmium	mg/L	0.000011	0.00004	g	<0.000017	0.000021	0.000011	0.000011	0.000021	0.000027	0.000017	<0.000017	<0.000017	0.000011	<0.000017	<0.000017	0.000012	0.00001	0.000027
Chromium	mg/L	0.001	-	h	<0.0010	<0.0010	<0.0010	0.0005	0.0005	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0005	0.0005
Cobalt	mg/L	-	-	-	<0.00030	<0.00030	<0.00030	0.00015	0.00015	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	0.00025	0.00025
Copper	mg/L	0.002	-	i	<0.0010	<0.0010	<0.0010	0.0005	0.0005	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.00045	0.00074
Iron	mg/L	0.3	-	-	<0.030	<0.030	<0.030	0.015	0.015	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0.015	0.025
Lead	mg/L	0.001	-	j	<0.00050	<0.00050	<0.00050	0.00025	0.00025	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00011	0.00025
Lithium	mg/L	-	-	-	<0.0050	<0.0050	<0.0050	0.0025	0.0025	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0025	0.0025
Manganese	mg/L	-	-	-	0.0048	0.0029	0.00034	0.0029	0.0048	0.0063	<0.00030	0.0091	0.0094	0.0064	0.0069	0.0069	0.0029	0.0005	0.0011
Mercury	mg/L	0.000026	-	-	<0.000010	<0.000010	<0.000010	0.000005	0.000005	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.00001	0.00001
Molybdenum	mg/L	0.073	-	l	<0.0010	<0.0010	<0.0010	0.0005	0.0005	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0005	0.0005
Nickel	mg/L	0.025	-	k	<0.0010	<0.0010	<0.0010	0.0005	0.0005	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0005	0.00068
Selenium	mg/L	0.001	-	-	<0.0010	<0.0010	<0.0010	0.0005	0.0005	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.00005	0.0005
Silver	mg/L	0.0001	-	-	<0.000020	<0.000020	<0.000020	0.00001	0.00001	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	0.00001	0.0001
Thallium	mg/L	0.0008	-	-	<0.00020	<0.00020	<0.00020	0.0001	0.0001	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	0.000038	0.0001
Tin	mg/L	-	-	-	<0.00050	<0.00050	<0.00050	0.00025	0.00025	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.0016	0.0025
Titanium	mg/L	-	-	-	<0.010	<0.010	<0.010	0.005	0.005	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.0025	0.005
Uranium	mg/L	0.033	0.015	-	<0.00020	<0.00020	<0.00020	0.0001	0.0001	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	0.00013	0.0002
Vanadium	mg/L	-	-	-	<0.0010	<0.0010	<0.0010	0.0005	0.0005	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0015	0.0025
Zinc	mg/L	0.03	-	-	<0.0050	<0.0050	<0.0050	0.0025	0.0025	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0025	0.0025
Total Metals																			
Aluminum	mg/L	0.005	-	f	0.41	0.09	0.075	0.09	0.41	0.047	0.052	0.16	0.039	0.031	0.23	0.028	0.024	0.087	0.13
Antimony	mg/L	-	-	-	<0.00050	<0.00050	<0.00050	0.00025	0.00025	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00023	0.0005
Arsenic	mg/L	0.005	-	-	<0.00050	<0.00050	<0.00050	0.00025	0.00025	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00023	0.0005
Barium	mg/L	-	-	-	<0.020	<0.020	<0.020	0.01	0.01	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.002	0.01
Beryllium	mg/L	-	-	-	<0.0010	<0.0010	<0.0010	0.0005	0.0005	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.00015	0.0005
Boron	mg/L	29	1.5	-	<0.10	<0.10	<0.10	0.05	0.05	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.025	0.05
Cadmium	mg/L	0.000011	0.00004	g	0.000031	0.000026	0.000012	0.000026	0.000031	0.00003	0.000015	<0.000017	<0.000017	<0.000010	<0.000017	<0.000017	0.000013	0.000015	0.000034
Chromium	mg/L	0.001	-	h	<0.0010	<0.0010	<0.0010	0.0005	0.0005	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0005	0.0005
Cobalt	mg/L	-	-	-	<0.00030	<0.00030	<0.00030	0.00015	0.00015	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	0.00025	0.00025
Copper	mg/L	0.002	-	i															

Table 4-2a: Inflow Water Quality, McNab Aggregate Project, BC

Table with columns for Parameter, Units, CCME Guidelines (Short-term, Long-term, notes), and various monitoring locations (DH10-055, DH10-05D, MW05-02, Groundwater from North (C7), DH10-075, DH10-07D, MW05-1, Groundwater from West (C6), Pore water from Excavated Material (C5)). Rows include Conventional parameters (Total Dissolved Solids, Alkalinity, Hardness), Major Ions (Calcium, Chloride, Fluoride, Magnesium, Potassium, Sodium, Sulphate), Nutrients (Ammonia, Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus), Dissolved Metals (Aluminum, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silicon, Silver, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc), and Total Metals.

- Notes:
I = Interim guideline
a) Canadian Council of Ministers of the Environment (CCME). Guidelines for the protection of freshwater aquatic life.
b) calculated value: calculated TDS based on standard methods (APHA, 2005)
c) Measured alkalinity, not used as model input.
d) calculated hardness based on concentrations of calcium and magnesium
e) pH and temperature dependent ammonia guideline: based on maximum baseline temperature of 18°C and pH of 8.0
f) pH dependent Al guideline: CCME Al (mg/L) = 0.005 at pH<=5, CCME Al (mg/L) = 0.1 at pH >=5 (minimum observed baseline surface water pH = 5.57)
g) hardness dependent Cd guideline: CCME Short-term Guideline (mg/L) = 0.00011 at hardness <= 3 mg/L, at hardness >= 3 to <= 360 mg/L = [10*(1.016*log(hardness)-1.71)]/1000, at hardness >360 mg/L = 0.0077
CCME Long-term Guideline (mg/L) = 0.00004 at hardness <17 mg/L, at hardness >=17 to <=280 mg/L = 10*(0.83*log(hardness)-2.46)/1000, at hardness >280 mg/L = 0.00037
h) guideline is for Cr(VI)
i) hardness dependent Cu guideline: CCME (mg/L) = 0.002 at hardness <=82 mg/L, at hardness >82 to <=180 mg/L = (0.2*EXP(0.8545*(ln(hardness)-1.465)))/1000
j) hardness dependent Pb guideline: CCME (mg/L) = 0.001 at hardness <=60 mg/L, at hardness >60 to <=180 mg/L = (EXP(1.273*(ln(hardness)-4.705)))/1000, at hardness >180 mg/L = 0.007
k) hardness dependent Ni guideline: CCME (mg/L) = 0.025 at hardness <=60 mg/L, at hardness >60 to <=180 mg/L = EXP(0.76*(ln(hardness)+1.06))/1000, at hardness >180 mg/L = 0.15
l) CCME guidance framework trigger values (mg/L): ultra-oligotrophic <0.004, oligotrophic 0.004-0.01, mesotrophic 0.01-0.02, meso-eutrophic 0.02-0.035, eutrophic 0.035-0.1, hyper-eutrophic >0.1

123 Indicates concentration exceeding the CCME short-term guideline and baseline.

123 Indicates concentration exceeding the CCME long-term guideline and baseline.

Table 4-2b: Inflow Water Quality, McNab Aggregate Project, BC

Table with columns for Parameter, Units, BC Water Quality Guidelines, and various monitoring points (DH10-055, DH10-05D, MW05-02, etc.) and rows for Conventional, Major Ions, Nutrients, Dissolved Metals, and Total Metals.

Notes:

- A = approved guideline, W = working guideline
a) BC Water Quality (BCWQ) guidelines for the protection of freshwater aquatic life
b) calculated value: calculated TDS based on standard methods (APHA, 2005)
c) Measured alkalinity, not used as model input.
d) calculated hardness based on concentrations of calcium and magnesium
e) hardness dependent F guideline: BC Max WQG (mg/L) = (-51.73 + 92.57 *log(hardness))^0.01; equation was only applied when the hardness was >= 10, otherwise 0.4 was used.
f) hardness dependent sulphate guideline: BC 30-d WQG (mg/L) = 128 at hardness <30 mg/L, at hardness 31-75 mg/L = 218, at hardness 76-180 mg/L = 309, at hardness 181-250 mg/L = 429, at hardness >250 mg/L determine base on site water
g) pH and temperature dependent ammonia guideline: values selected from Tables 3 and 4 in BC WQG based on maximum baseline temperature of 18°C and pH 8.0
h) chloride dependent nitrite guideline: BC Max WQG (mg/L) = 0.06 at Cl <2 mg/L, at Cl 2-4 mg/L = 0.12, at Cl 4-6 mg/L = 0.18, at Cl 6-8 mg/L = 0.24, at Cl 8-10 = 0.30, at Cl >10 = 0.6
BC 30-d WQG (mg/L) = 0.02 mg/L at Cl <2 mg/L, at Cl 2-4 mg/L = 0.04, at Cl 4-6 mg/L = 0.06, at Cl 6-8 mg/L = 0.08, at Cl 8-10 mg/L = 0.1, at Cl >10 = 0.2
i) pH dependent dissolved Al guideline: BC Max WQG (mg/L) = 0.1 at pH >= 6.5, at pH < 6.5 = EXP[1.209-2.426*(pH)+0.286*(pH^2)]; BC 30-d WQG (mg/L) = 0.05 at pH >= 6.5, at pH < 6.5 = EXP[1.6-3.327*(median pH)+0.402*(median pH^2)]; minimum baseline surface water pH = 5.57
j) hardness dependent dissolved Cd guideline: BC WQG Long-term average (ug/L) = 2.718[0.736*ln(hardness)-4.943]; BC WQG short-term max (ug/L) = 2.718[1.03* ln(hardness)-5.274]. For the purpose of guideline comparison, the dissolved Cd guideline was used for total Cd.
k) guideline is for Cr(VI)
l) hardness dependent Cu guideline: BC Max WQG (mg/L) = (0.094(hardness)+2)/1000; BC 30-d WQG (mg/L) = 0.002 at hardness <= 50 mg/L, at hardness >= 50 mg/L = 0.04*hardness/1000
m) hardness dependent Pb guideline: BC Max WQG (mg/L) = 0.003 at hardness <= 8 mg/L, at hardness > 8 mg/L = (EXP[(1.273*ln(hardness))-1.46])/1000; BC 30-d WQG (mg/L) = (3.31+EXP(1.273*ln(hardness))-4.704)/1000 at hardness > 8 mg/L, no guideline at hardness <= 8 mg/L
n) hardness dependent Mn guideline: BC Max WQG (mg/L) = 0.01102*(hardness)+0.54; BC 30-d WQG (mg/L) = 0.0044*(hardness)+0.605
o) BC 30-d WQG (mg/L) = 0.00002 when methylmercury (MeHg) is 0.5% of total Hg = 0.00001 at 1% MeHg = 0.0000125 at 8% MeHg; applied most conservative guideline
p) hardness dependent Ni guideline: BC Max WQG = 0.025 at hardness <= 60 mg/L, at hardness > 60-120 mg/L = 0.065, at hardness 120-180 mg/L = 0.11, at hardness > 180 mg/L = 0.15
q) hardness dependent Ag guideline: BC Max WQG (mg/L) = 0.0001 at hardness <= 100 mg/L, at hardness > 100 mg/L = 0.003; BC 30-d WQG (mg/L) = 0.00005 at hardness <= 100 mg/L, at hardness > 100 mg/L = 0.0015
r) hardness dependent Zn guideline: BC Max WQG (mg/L) = (33+0.75(hardness-90))/1000; BC 30-d WQG (mg/L) = (7.5+0.75(hardness-90))/1000
s) up to 10 - highly sensitive to acid inputs; 10 to 20 - moderately sensitive; over 20 - low sensitivity. Refer to calcium regarding sensitivity to acid inputs, the more restrictive of calcium or alkalinity is applicable.
t) up to 4 - highly sensitive to acid inputs; 4 to 8 - moderately sensitive; over 8 - low sensitivity. Refer to alkalinity, the more restrictive of calcium or alkalinity applies.

123 Indicates concentration exceeding the BC Max WQ Guideline and baseline.
123 Indicates concentration exceeding the BC 30-d WQ Guideline and baseline.

Table 4-2b: Inflow Water Quality, McNab Aggregate Project, BC

Table with columns: Parameter, Units, BC Water Quality Guidelines for the Protection of Freshwater Aquatic Life (Maximum, notes, 30-Day Average, notes), MCF-1 (10-Sep-12, 16-Oct-12, 25-Mar-14), MCF-1 (C9) (Median (mg/L), Maximum (mg/L)), MCF-7 (C11) (24-Nov-09, 7-Jan-10, 18-Feb-10, 31-Mar-10, 13-May-10, 15-Jun-10, 13-Jul-10, 23-Aug-10, 23-Sep-10, 28-Oct-10, 2-Dec-10, 10-Sep-12, 17-Oct-12, 27-Mar-14), MCF-7 (C11) (Median (mg/L), 95th Percentile (mg/L)).

Notes:
A = approved guideline, W = working guideline
a) BC Water Quality (BCWQ) guidelines for the protection of freshwater aquatic life
b) calculated value: calculated TDS based on standard methods (APHA, 2005)
c) Measured alkalinity, not used as model input.
d) calculated hardness based on concentrations of calcium and magnesium
e) hardness dependent F guideline: BC Max WQG (mg/L) = (-51.73 + 92.57 *log(hardness))*0.01; equation was only applied when the hardness was ≥ 10,
f) hardness dependent sulphate guideline: BC 30-d WQG (mg/L) = 128 at hardness <30 mg/L, at hardness 31-75 mg/L = 218, at hardness 76-180 mg/L = 309, at hardness 181-250 mg/L = 429, at hardness >250 mg/L determine base on site water
g) pH and temperature dependent ammonia guideline: values selected from Tables 3 and 4 in BC WQG based on maximum baseline temperature of 18°C and pH 8.0
h) chloride dependent nitrite guideline: BC Max WQG (mg/L) = 0.06 at Cl <2 mg/L, at Cl 2-4 mg/L = 0.12, at Cl 4-6 mg/L = 0.18, at Cl 6-8 mg/L = 0.24, at Cl 8-10 = 0.30, at Cl >10 = 0.6
BC 30-d WQG (mg/L) = 0.02 mg/L at Cl <2 mg/L, at Cl 2-4 mg/L = 0.04, at Cl 4-6 mg/L = 0.06, at Cl 6-8 mg/L = 0.08, at Cl 8-10 mg/L = 0.1, at Cl >10 = 0.2
i) pH dependent dissolved Al guideline: BC Max WQG (mg/L) = 0.1 at pH ≥ 6.5, at pH <6.5 = EXP(1.209-2.426*(pH)+0.286*(pH²)); BC 30-d WQG (mg/L) = 0.05 at pH ≥ 6.5, at pH <6.5 = EXP(1.6-3.327*(median pH)+0.402*(median pH²)); minimum baseline surface water pH = 5.57
j) hardness dependent dissolved Cd guideline: BC WQG Long-term average (µg/L) = 2.718[0.736*ln(hardness)-4.943]; BC WQG short-term max (µg/L) = 2.7
k) guideline is for Cr(VI)
l) hardness dependent Cu guideline: BC Max WQG (mg/L) = (0.094(hardness+2))/1000; BC 30-d WQG (mg/L) = 0.002 at hardness ≤50 mg/L, at hardness >50 mg/L = 0.04*hardness/1000
m) hardness dependent Pb guideline: BC Max WQG (mg/L) = 0.003 at hardness ≤8 mg/L, at hardness >8 mg/L = EXP((1.273*ln(hardness))-1.46)/1000; BC 30-d WQG (mg/L) = (3.31+EXP(1.273*ln(hardness))-4.704)/1000 at hardness >8 mg/L, no guideline at hardness ≤8 mg/L
n) hardness dependent Mn guideline: BC Max WQG (mg/L) = 0.01102*(hardness)+0.54; BC 30-d WQG (mg/L) = 0.0044*hardness+0.605
o) BC 30-d WQG (mg/L) = 0.00002 when methylmercury (MeHg) is 0.5% of total Hg = 0.00001 at 1% MeHg, = 0.00000125 at 8% MeHg; applied most conservative guideline
p) hardness dependent Ni guideline: BC Max WQG = 0.025 at hardness <60 mg/L, at hardness 60-120 mg/L = 0.065, at hardness 120-180 mg/L = 0.11, at hardness >180 mg/L = 0.15
q) hardness dependent Ag guideline: BC Max WQG (mg/L) = 0.0001 at hardness ≤100 mg/L, at hardness >100 mg/L = 0.003; BC 30-d WQG (mg/L) = 0.00005 at hardness ≤100 mg/L, at hardness >100 mg/L = 0.0015
r) hardness dependent Zn guideline: BC Max WQG (mg/L) = (33+0.75(hardness-90))/1000; BC 30-d WQG (mg/L) = (7.5+0.75(hardness-90))/1000
s) up to 10 - highly sensitive to acid inputs; 10 to 20 - moderately sensitive; over 20 - low sensitivity. Refer to alkalinity regarding sensitivity to acid inputs, the more restrictive of calcium or alkalinity is applicable.
t) up to 4 - highly sensitive to acid inputs; 4 to 8 - moderately sensitive; over 8 - low sensitivity. Refer to calcium, the more restrictive of calcium or alkalinity applies.

123 Indicates concentration exceeding the BC Max WQ Guideline and baseline.
123 Indicates concentration exceeding the BC 30-d WQ Guideline and baseline.

ATTACHMENT 4
Detailed Model Results

TableA3-1a: Predicted Pit Lake Water Quality under the Base Case Scenario, McHabs Aggregate Project, BC

Table with columns for Parameter, Units, Year 1 (Jan-Dec), Year 2 (Jan-Dec), Year 3 (Jan-Dec), and Year 4 (Jan-Dec). Rows include Conventional parameters (Total Dissolved Solids, Alkalinity, Hardness), Major Ions (Calcium, Chloride, Fluoride, Magnesium, Potassium, Sodium, Sulfate), Nutrients (Ammonia, Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus), Dissolved Metals (Aluminum, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc), and Total Metals.

Notes:
a) Calculated value. Calculated TDS based on standard methods (APHA, 2005).
b) Assumed alkalinity based on mean of SFE test, used for calculation of TDS.
c) Calculated hardness based on concentrations of Calcium and Magnesium.

Table 3-1a: Predicted Pit Lake Water Quality under the Base Case Scenario, Michab Aggregate F

Table with columns for Parameter, Units, and monthly data from Year 17 to Year 20. Rows are categorized into Conventional, Major Ions, Nutrients, Dissolved Metals, and Total Metals.

Note:
a) Calculated value. Calculated TDS based on standard methods (APHA, 2005).
b) Assumed alkalinity based on mean of SFE test, used for calculation of TDS.
c) Calculated hardness based on concentrations of Calcium and Magnesium.

TableA3-1a: Predicted Pit Lake Water Quality under the Base Case Scenario, Michab Aggregate P

Table with 132 columns (Parameter, Units, and months from Jan to Dec for Years 25, 26, 27, and 28). Rows include categories: Conventional (Total Dissolved Solids, Alkalinity, Hardness), Major Ions (Calcium, Chloride, Fluoride, Magnesium, Potassium, Sodium, Sulphate), Nutrients (Ammonia, Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus), and Dissolved Metals (Aluminum, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc). Each cell contains a numerical value representing the predicted water quality parameter for that month and year.

Note:
a) Calculated value. Calculated TDS based on standard methods (APHA, 2005).
b) Assumed alkalinity based on mean of SFE test, used for calculation of TDS.
c) Calculated hardness based on concentrations of Calcium and Magnesium.

Table A3-15: Predicted Pit Lake Water Quality under the Conserv

Table with columns for Parameter, Units, Year 13 (Jan-Dec), Year 14 (Jan-Dec), Year 15 (Jan-Dec), and Year 16 (Jan-Dec). Rows include Conventional parameters (Total Dissolved Solids, Alkalinity, Hardness), Major Ions (Calcium, Chloride, Fluoride, Magnesium, Potassium, Sodium, Sulfate), Nutrients (Ammonia, Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus), Dissolved Metals (Aluminum, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lithium, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc), and Total Metals.

Notes:
a) Calculated value: Calculated TDS based on standard methods
b) Assumed alkalinity based on mean of SFE test, used for calculati
c) Calculated hardness based on concentrations of Calcium and M

Table A3-2a: Predicted MCF-1 Water Quality under the Base Case

Table with columns for Parameter, Units, and 120 monthly data points from Jan to Dec for Years 13, 14, 15, and 16. Rows include Conventional parameters (Total Dissolved Solids, Alkalinity, Hardness, Major Ions like Calcium, Chloride, Fluoride, Magnesium, Nitrate, Potassium, Sodium, Sulfate), Nutrients (Ammonia, Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus), Dissolved Metals (Aluminum, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Lead, Lithium, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc), and Total Metals.

Note:
a) Calculated value. Calculated TDS based on standard methods (A)
b) Assumed alkalinity based on mean of SFE test, used for calcium
c) Calculated hardness based on concentrations of Calcium and Mg

Table A3-2a: Predicted MCF-1 Water Quality under the Base Case

Parameter	Units	Year 25												Year 26												Year 27												Year 28											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Conventional																																																	
Total Dissolved Solids*	mg/L	17																																															
Alkalinity ^a	mg/L	1.0																																															
Hardness ^b	mg/L	2.7																																															
Major Ions																																																	
Calcium	mg/L	0.88																																															
Chloride	mg/L	0.57																																															
Fluoride	mg/L	0.01																																															
Magnesium	mg/L	0.11																																															
Potassium	mg/L	1.0																																															
Sodium	mg/L	1.0																																															
Sulfate	mg/L	0.89																																															
Nutrients																																																	
Ammonia	mg/L (as N)	0.0025																																															
Nitrate	mg/L (as N)	0.15																																															
Nitrite	mg/L (as N)	0.0005																																															
Total Kjeldahl Nitrogen	mg/L (as N)	0.069																																															
Total Phosphorus	mg/L	0.0037																																															
Dissolved Metals																																																	
Aluminum	mg/L	0.074																																															
Arsenic	mg/L	0.00025																																															
Barium	mg/L	0.01																																															
Beryllium	mg/L	0.0005																																															
Boron	mg/L	0.05																																															
Cadmium	mg/L	0.0000085																																															
Chromium	mg/L	0.0005																																															
Cobalt	mg/L	0.00015																																															
Copper	mg/L	0.0005																																															
Iron	mg/L	0.015																																															
Lead	mg/L	0.00025																																															
Lithium	mg/L	0.0025																																															
Manganese	mg/L	0.0017																																															
Mercury	mg/L	0.000005																																															
Molybdenum	mg/L	0.0005																																															
Nickel	mg/L	0.0005																																															
Selenium	mg/L	0.0005																																															
Silicon	mg/L	2.5																																															
Silver	mg/L	0.00001																																															
Thallium	mg/L	0.0001																																															
Tin	mg/L	0.00025																																															
Titanium	mg/L	0.005																																															
Uranium	mg/L	0.0002																																															
Vanadium	mg/L	0.0005																																															
Zinc	mg/L	0.0025																																															
Total Metals																																																	
Aluminum	mg/L	0.14																																															
Arsenic	mg/L	0.00025																																															
Barium	mg/L	0.01																																															
Beryllium	mg/L	0.0005																																															
Boron	mg/L	0.05																																															
Cadmium	mg/L	0.000009																																															
Chromium	mg/L	0.0005																																															
Copper	mg/L	0.0005																																															
Iron	mg/L	0.034																																															
Lead	mg/L	0.00025																																															
Lithium	mg/L	0.0025																																															
Manganese	mg/L	0.0023																																															
Mercury	mg/L	0.000005																																															
Molybdenum	mg/L	0.0005																																															
Nickel	mg/L	0.0005																																															
Selenium	mg/L	0.0005																																															
Silver	mg/L	0.00001																																															
Thallium	mg/L	0.0001																																															
Tin	mg/L	0.00025																																															
Titanium	mg/L	0.005																																															
Uranium	mg/L	0.0002																																															
Vanadium	mg/L	0.0005																																															
Zinc	mg/L	0.0025																																															

^a Calculated value: Calculated TDS based on standard methods (A)
^b Assumed alkalinity based on mean of SFE test, used for calcium
^c Calculated hardness based on concentrations of Calcium and Magnesium

Table A3-2b: Predicted MCF-1 Water Quality under the Conservat

Parameter	Units	Year 5												Year 6												Year 7												Year 8											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Conventional		...																																													
Total Dissolved Solids*	mg/L	...																																															
Alkalinity	mg/L	...																																															
Hardness*	mg/L	...																																															
Major Ions		...																																															
Calcium	mg/L	...																																															
Chloride	mg/L	...																																															
Fluoride	mg/L	...																																															
Magnesium	mg/L	...																																															
Potassium	mg/L	...																																															
Sodium	mg/L	...																																															
Sulfate	mg/L	...																																															
Nutrients		...																																															
Ammonia	mg/L (as N)	...																																															
Nitrate	mg/L (as N)	...																																															
Nitrite	mg/L (as N)	...																																															
Total Kjeldahl Nitrogen	mg/L (as N)	...																																															
Total Phosphorus	mg/L	...																																															
Dissolved Metals		...																																															
Aluminum	mg/L	...																																															
Arsenic	mg/L	...																																															
Barium	mg/L	...																																															
Beryllium	mg/L	...																																															
Boron	mg/L	...																																															
Cadmium	mg/L	...																																															
Chromium	mg/L	...																																															
Cobalt	mg/L	...																																															
Copper	mg/L	...																																															
Iron	mg/L	...																																															
Lithium	mg/L	...																																															
Manganese	mg/L	...																																															
Mercury	mg/L	...																																															
Molybdenum	mg/L	...																																															
Nickel	mg/L	...																																															
Selenium	mg/L	...																																															
Silicon	mg/L	...																																															
Silver	mg/L	...																																															
Thallium	mg/L	...																																															
Tin	mg/L	...																																															
Titanium	mg/L	...																																															
Uranium	mg/L	...																																															
Vanadium	mg/L	...																																															
Zinc	mg/L	...																																															
Total Metals		...																																															
Aluminum	mg/L	...																																															
Arsenic	mg/L	...																																															
Barium	mg/L	...																																															
Beryllium	mg/L	...																																															
Boron	mg/L	...																																															
Cadmium	mg/L	...																																															
Chromium	mg/L	...																																															
Cobalt	mg/L	...																																															
Copper	mg/L	...																																															
Iron	mg/L	...																																															
Lead	mg/L	...																																															
Lithium	mg/L	...																																															
Manganese	mg/L	...																																															
Mercury	mg/L	...																																															
Molybdenum	mg/L	...																																															
Nickel	mg/L	...																																															
Selenium	mg/L	...																																															
Silver	mg/L	...																																															
Thallium	mg/L	...																																															
Tin	mg/L	...																																															
Titanium	mg/L	...																																															
Uranium	mg/L	...																																															
Vanadium	mg/L	...																																															
Zinc	mg/L	...																																															

Notes:
a) Calculated value; Calculated TDS based on standard methods
b) Assumed alkalinity based on mean of SFE test, used for calcium
c) Calculated hardness based on concentrations of Calcium and Mg

Table A3-2b: Predicted MCF-1 Water Quality under the Conservat

Table with columns for Parameter, Units, and 12 months (Jan-Dec) for each of four years (Year 13, Year 14, Year 15, Year 16). Rows include Conventional parameters (Total Dissolved Solids, Alkalinity, Hardness), Major Ions (Calcium, Chloride, Fluoride, Magnesium, Potassium, Sodium, Sulfate), Nutrients (Ammonia, Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus), Dissolved Metals (Aluminum, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lithium, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc), and Total Metals. Data values are provided for each parameter across the 48-month period.

Notes:
a) Calculated value: Calculated TDS based on standard methods
b) Assumed alkalinity based on mean of SFE test, used for calculation
c) Calculated hardness based on concentrations of Calcium and Mg

Table A3-2b: Predicted MCF-1 Water Quality under the Conservat

Table with 28 columns (Year 21-24) and multiple rows for various water quality parameters such as Calcium, Magnesium, Sodium, and various metals. Includes a 'Notes' section at the bottom.

a) Calculated value; Calculated TDS based on standard methods
b) Assumed alkalinity based on mean of SFE test, used for calculation
c) Calculated hardness based on concentrations of Calcium and Magnesium

Table A3-3a: Predicted MCF-7 Water Quality under the Base Case Scenario, MCLab Aggregate Project, BC

Table with 48 columns (Year 1-4, Jan-Dec) and multiple rows for parameters like Total Dissolved Solids, Alkalinity, Hardness, Major Ions, Nutrients, and Dissolved Metals. Values are numerical and consistent across years for each parameter.

Notes:
a) Calculated value: Calculated TDS based on standard methods (APHA, 2005).
b) Assumed alkalinity based on mean of SFE test, used for calculation of TDS.
c) Calculated hardness based on concentrations of Calcium and Magnesium.

Table A3-3a: Predicted MCF-7 Water Quality under the Base Case

Parameter	Units	Year 29												Year 30												Year 31												Year 32											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Conventional		[Data for conventional parameters]																																													
Major Ions		[Data for major ions]																																															
Nutrients		[Data for nutrients]																																															
Dissolved Metals		[Data for dissolved metals]																																															
Total Metals		[Data for total metals]																																															

Notes:
a) Calculated value: Calculated TDS based on standard methods (A)
b) Assumed alkalinity based on mean of SFE test, used for calcium
c) Calculated hardness based on concentrations of Calcium and Mg

Table A3-3b: Predicted MCF 7 Water Quality under the Conservat

Parameter	Units	Year 5												Year 6												Year 7												Year 8											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Conventional																																																	
Total Dissolved Solids*	mg/L	33																																															
Alkalinity	mg/L	5.4																																															
Hardness*	mg/L	4																																															
Major Ions																																																	
Calcium	mg/L	1.3																																															
Chloride	mg/L	1.7																																															
Fluoride	mg/L	0.027																																															
Magnesium	mg/L	0.16																																															
Potassium	mg/L	1.0																																															
Sodium	mg/L	1.1																																															
Sulfate	mg/L	3.3																																															
Nutrients																																																	
Ammonia	mg/L (as N)	0.013																																															
Nitrate	mg/L (as N)	0.33																																															
Nitrite	mg/L (as N)	0.00048																																															
Total Kjeldahl Nitrogen	mg/L (as N)	0.057																																															
Total Phosphorus	mg/L	0.011																																															
Dissolved Metals																																																	
Aluminum	mg/L	0.0403																																															
Antimony	mg/L	0.00024																																															
Arsenic	mg/L	0.0007																																															
Barium	mg/L	0.012																																															
Beryllium	mg/L	0.00048																																															
Boron	mg/L	0.048																																															
Cadmium	mg/L	0.000014																																															
Chromium	mg/L	0.00049																																															
Cobalt	mg/L	0.00017																																															
Copper	mg/L	0.00054																																															
Iron	mg/L	0.039																																															
Lithium	mg/L	0.0024																																															
Manganese	mg/L	0.045																																															
Mercury	mg/L	0.000048																																															
Molybdenum	mg/L	0.00084																																															
Nickel	mg/L	0.00049																																															
Selenium	mg/L	0.00049																																															
Silicon	mg/L	6.0																																															
Silver	mg/L	0.00001																																															
Thallium	mg/L	0.000098																																															
Tin	mg/L	0.00024																																															
Titanium	mg/L	0.00048																																															
Uranium	mg/L	0.0001																																															
Vanadium	mg/L	0.00069																																															
Zinc	mg/L	0.0025																																															
Total Metals																																																	
Aluminum	mg/L	0.061																																															
Antimony	mg/L	0.00024																																															
Arsenic	mg/L	0.00071																																															
Barium	mg/L	0.012																																															
Beryllium	mg/L	0.00048																																															
Boron	mg/L	0.048																																															
Cadmium	mg/L	0.000014																																															
Chromium	mg/L	0.00049																																															
Cobalt	mg/L	0.00017																																															
Copper	mg/L	0.00054																																															
Iron	mg/L	0.039																																															
Lithium	mg/L	0.0024																																															
Manganese	mg/L	0.045																																															
Mercury	mg/L	0.000048																																															
Molybdenum	mg/L	0.00084																																															
Nickel	mg/L	0.00049																																															
Selenium	mg/L	0.00049																																															
Silicon	mg/L	6.0																																															
Silver	mg/L	0.00001																																															
Thallium	mg/L	0.000098																																															
Tin	mg/L	0.00024																																															
Titanium	mg/L	0.00048																																															
Uranium	mg/L	0.0001																																															
Vanadium	mg/L	0.00069																																															
Zinc	mg/L	0.0025																																															

Notes:
 a) Calculated value; Calculated TDS based on standard methods
 b) Assumed alkalinity based on mean of SFE test, used for calculation
 c) Calculated hardness based on concentrations of Calcium and Mg

Table A3-3b: Predicted MCF-7 Water Quality under the Conservat

Table with columns for Parameter, Units, and months (Jan-Dec) for years 13, 14, 15, and 16. Rows include categories like Conventional, Major Ions, Nutrients, Dissolved Metals, and Total Metals, with specific chemical parameters and their predicted values.

Notes:
a) Calculated value: Calculated TDS based on standard methods
b) Assumed alkalinity based on mean of SFE test, used for calculati
c) Calculated hardness based on concentrations of Calcium and Mg

Table A3-4a: Predicted MCF-6 Water Quality under the Base Case Scenario, McHabitat Aggregate Project, BC

Table with columns for Parameter, Units, and 48 months (Year 1-4) for 12 months each. Rows include Total Dissolved Solids, Alkalinity, Hardness, Major Ions (Calcium, Chloride, Fluoride, Magnesium, Potassium, Sodium, Sulphate), Nutrients (Ammonia, Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus), Dissolved Metals (Aluminum, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc), and Total Metals.

Note:
a) Calculated value. Calculated TDS based on standard methods (APHA, 2005).
b) Assumed alkalinity based on mean of SFE test, used for calculation of TDS.
c) Calculated hardness based on concentrations of Calcium and Magnesium.

Table A3-4a: Predicted MCF-6 Water Quality under the Base Case

Table with columns for Parameter, Units, and monthly data for Years 5, 6, 7, and 8. Rows include various chemical species such as Chloride, Fluoride, Calcium, Magnesium, Potassium, Sodium, Sulfate, Ammonia, Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphate, Dissolved Metals (Aluminum, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc), and Total Metals.

Note:
a) Calculated value. Calculated TDS based on standard methods
b) Assumed alkalinity based on mean of SFE test, used for calculation
c) Calculated hardness based on concentrations of Calcium and Mg

Table A3-4b: Predicted MCF-6 Water Quality under the Conservat

Table with columns for Parameter, Units, and months (Jan-Dec) for years 13, 14, 15, and 16. Rows include Conventional parameters (Total Dissolved Solids, Alkalinity, Hardness), Major Ions (Calcium, Chloride, Fluoride, Magnesium, Potassium, Sodium, Sulfate), Nutrients (Ammonia, Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus), Dissolved Metals (Aluminum, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lithium, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc), and Total Metals.

Notes:
a) Calculated value: Calculated TDS based on standard methods
b) Assumed alkalinity based on mean of SFE test, used for calc
c) Calculated hardness based on concentrations of Calcium and Mg

Table A3-4b: Predicted MCF-6 Water Quality under the Conservat

Table with columns for Parameter, Units, and months for years 21, 22, 23, and 24. Rows include Conventional parameters (Total Dissolved Solids, Alkalinity, Hardness), Major Ions (Calcium, Chloride, Fluoride, Magnesium, Potassium, Sodium, Sulphate), Nutrients (Ammonia, Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus), Dissolved Metals (Aluminum, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lithium, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc), and Total Metals.

Notes:
a) Calculated value: Calculated TDS based on standard methods
b) Assumed alkalinity based on mean of SFE test, used for calculat
c) Calculated hardness based on concentrations of Calcium and Mg

Table A3-4b: Predicted MCF-6 Water Quality under the Conservat

Table with columns: Parameter, Units, Year 29 (Jan-Dec), Year 30 (Jan-Dec), Year 31 (Jan-Dec), Year 32 (Jan-Dec). Rows include Conventional (Total Dissolved Solids, Alkalinity, Hardness), Major Ions (Calcium, Chloride, Fluoride, Magnesium, Potassium, Sodium, Sulfate), Nutrients (Ammonia, Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphate), Dissolved Metals (Aluminum, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lithium, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc), and Total Metals (Aluminum, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Manganese, Mercury, Molybdenum, Nickel, Nickel, Selenium, Silver, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc).

Notes:
a) Calculated value; Calculated TDS based on standard methods
b) Assumed alkalinity based on mean of SFE test, used for calculati
c) Calculated hardness based on concentrations of Calcium and Mg

Table A3-5a: Predicted MCF-12 Water Quality under the Base Case

Table with columns for Parameter, Units, and 48 months (Year 13-16). Rows include Conventional parameters (Total Dissolved Solids, Alkalinity, Hardness), Major Ions (Calcium, Chloride, Fluoride, Magnesium, Potassium, Sodium, Sulphate), Nutrients (Ammonia, Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus), Dissolved Metals (Aluminum, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc), and Total Metals. Values are provided for each month from Jan to Dec across four years.

Note:
a) Calculated value. Calculated TDS based on standard methods
b) Assumed alkalinity based on mean of SFE test, used for calculation
c) Calculated hardness based on concentrations of Calcium and Mg

Table A3-5a: Predicted MCF-12 Water Quality under the Base Cas

Table with columns: Parameter, Units, Year 21 (Jan-Dec), Year 22 (Jan-Dec), Year 23 (Jan-Dec), Year 24 (Jan-Dec). Rows include various chemical parameters like Calcium, Chloride, Fluoride, Magnesium, Potassium, Sodium, Sulphate, Ammonia, Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus, Dissolved Metals, and Total Metals. Values are presented in a grid format for each month of each year.

a) Calculated value. Calculated TDS based on standard methods
b) Assumed alkalinity based on mean of SFE test, used for calcium
c) Calculated hardness based on concentrations of Calcium and Mg

Table A3-5b: Predicted MCF-12 Water Quality under the Conserv

Table with columns for Parameter, Units, and months for years 9, 10, 11, and 12. Rows include Conventional (Total Dissolved Solids, Alkalinity, Hardness), Major Ions (Calcium, Chloride, Fluoride, Magnesium, Potassium, Sodium, Sulfate), Nutrients (Ammonia, Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus), Dissolved Metals (Aluminum, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lithium, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc), and Total Metals.

Notes:
a) Calculated value; Calculated TDS based on standard methods
b) Assumed alkalinity based on mean of SFE test, used for calcium
c) Calculated hardness based on concentrations of Calcium and Mg

Table A3-5b: Predicted MCF-22 Water Quality under the Conserv...

Table with columns for Parameter, Units, Year 13 (Jan-Dec), Year 14 (Jan-Dec), Year 15 (Jan-Dec), and Year 16 (Jan-Dec). Rows include categories like Conventional, Major Ions, Nutrients, Dissolved Metals, and Total Metals, with numerous chemical and physical parameters listed.

Notes:
a) Calculated value; Calculated TDS based on standard methods
b) Assumed alkalinity based on mean of SFE test, used for calcium
c) Calculated hardness based on concentrations of Calcium and Mg

Table A3-5b: Predicted MCF-12 Water Quality under the Conserv

Table with columns for Parameter, Units, and months (Jan-Dec) for years 21, 22, 23, and 24. Rows include Conventional parameters (Total Dissolved Solids, Alkalinity, Hardness), Major Ions (Calcium, Chloride, Fluoride, Magnesium, Potassium, Sodium, Sulfate), Nutrients (Ammonia, Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus), Dissolved Metals (Aluminum, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lithium, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc), and Total Metals.

Notes:
a) Calculated value: Calculated TDS based on standard methods
b) Assumed alkalinity based on mean of SFE test, used for calculati
c) Calculated hardness based on concentrations of Calcium and Mg

Table A3-5b: Predicted MCF-12 Water Quality under the Conserv

Parameter	Units	Year 25												Year 26												Year 27												Year 28																																																																																																											
		Jan												Feb												Mar												Apr												May												Jun												Jul												Aug												Sep												Oct												Nov												Dec											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec																																																																																																
Conventional																																																																																																																																																	
Total Dissolved Solids ^a	mg/L	22																																																																																																																																															
Alkalinity ^b	mg/L	5.4																																																																																																																																															
Hardness ^c	mg/L	20																																																																																																																																															
Major Ions																																																																																																																																																	
Calcium	mg/L	6.7																																																																																																																																															
Chloride	mg/L	1.2																																																																																																																																															
Fluoride	mg/L	0.024																																																																																																																																															
Magnesium	mg/L	0.83																																																																																																																																															
Potassium	mg/L	1.6																																																																																																																																															
Sodium	mg/L	2.6																																																																																																																																															
Sulfate	mg/L	4.4																																																																																																																																															
Nutrients																																																																																																																																																	
Ammonia	mg/L (as N)	0.01																																																																																																																																															
Nitrate	mg/L (as N)	0.15																																																																																																																																															
Nitrite	mg/L (as N)	0.00048																																																																																																																																															
Total Kjeldahl Nitrogen	mg/L (as N)	0.051																																																																																																																																															
Total Phosphorus	mg/L	0.0076																																																																																																																																															
Dissolved Metals																																																																																																																																																	
Aluminum	mg/L	0.0428																																																																																																																																															
Antimony	mg/L	0.00024																																																																																																																																															
Arsenic	mg/L	0.00054																																																																																																																																															
Barium	mg/L	0.011																																																																																																																																															
Beryllium	mg/L	0.00048																																																																																																																																															
Boron	mg/L	0.048																																																																																																																																															
Cadmium	mg/L	0.000011																																																																																																																																															
Chromium	mg/L	0.00048																																																																																																																																															
Cobalt	mg/L	0.00016																																																																																																																																															
Copper	mg/L	0.00057																																																																																																																																															
Iron	mg/L	0.03																																																																																																																																															
Lithium	mg/L	0.0024																																																																																																																																															
Manganese	mg/L	0.029																																																																																																																																															
Mercury	mg/L	0.000048																																																																																																																																															
Molybdenum	mg/L	0.0007																																																																																																																																															
Nickel	mg/L	0.00048																																																																																																																																															
Selenium	mg/L	0.00048																																																																																																																																															
Silicon	mg/L	0.14																																																																																																																																															
Silver	mg/L	0.000096																																																																																																																																															
Thallium	mg/L	0.000096																																																																																																																																															
Tin	mg/L	0.00024																																																																																																																																															
Titanium	mg/L	0.0048																																																																																																																																															
Uranium	mg/L	0.00099																																																																																																																																															
Vanadium	mg/L	0.00072																																																																																																																																															
Zinc	mg/L	0.0025																																																																																																																																															
Total Metals																																																																																																																																																	
Aluminum	mg/L	0.048																																																																																																																																															
Antimony	mg/L	0.00024																																																																																																																																															
Arsenic	mg/L	0.00054																																																																																																																																															
Barium	mg/L	0.011																																																																																																																																															
Beryllium	mg/L	0.00048																																																																																																																																															
Boron	mg/L	0.048																																																																																																																																															
Cadmium	mg/L	0.000011																																																																																																																																															
Chromium	mg/L	0.00048																																																																																																																																															
Cobalt	mg/L	0.00016																																																																																																																																															
Copper	mg/L	0.00057																																																																																																																																															
Iron	mg/L	0.033																																																																																																																																															
Lead	mg/L	0.00024																																																																																																																																															
Lithium	mg/L	0.0024																																																																																																																																															
Manganese	mg/L	0.029																																																																																																																																															
Mercury	mg/L	0.000048																																																																																																																																															
Molybdenum	mg/L	0.00072																																																																																																																																															
Nickel	mg/L	0.00048																																																																																																																																															
Selenium	mg/L	0.00048																																																																																																																																															
Silver	mg/L	0.000096																																																																																																																																															
Thallium	mg/L	0.000096																																																																																																																																															
Tin	mg/L	0.00024																																																																																																																																															
Titanium	mg/L	0.0048																																																																																																																																															
Uranium	mg/L	0.00099																																																																																																																																															
Vanadium	mg/L	0.00072																																																																																																																																															
Zinc	mg/L	0.0025																																																																																																																																															

Notes:
 a) Calculated value; Calculated TDS based on standard methods
 b) Assumed alkalinity based on mean of SFE test, used for calculation
 c) Calculated hardness based on concentrations of Calcium and Magnesium

Table A3-5b: Predicted MCF-12 Water Quality under the Conserv

Table with 42 columns representing months from Jan to Dec for years 29, 30, 31, and 32. Rows include parameters such as Total Dissolved Solids, Major Ions (Calcium, Magnesium, Potassium, Sodium, Sulfate), Nutrients (Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus), Dissolved Metals (Aluminum, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lithium, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc), and Total Metals. Each cell contains a numerical value representing the predicted quality metric.

Notes:
a) Calculated value: Calculated TDS based on standard methods
b) Assumed alkalinity based on mean of SFE test, used for calculat
c) Calculated hardness based on concentrations of Calcium and M