APPENDIX 14-F
MINE SITE WATER MODEL REPORT

Seabridge Gold Inc.

KSM PROJECT
Mine Site Water Model Report

SEABRIDGE GOLD

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July 2013

Mine Site Water Model Report

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1 Introduction

The objective of this report is to present the model developed for predictions of water quantity and quality at the Mine Site water storage facility (WSF) and the receiving waters of the Sulphurets-Unuk watershed downstream of the WSF.

1.1 Project Proponent

Seabridge Gold Inc. (Seabridge) is the proponent for the proposed KSM Project (the Project), a gold, copper, silver, molybdenum mine.

1.2 Project Location

The Project is located in the coastal mountains of northwestern British Columbia. It is approximately 950 km northwest of Vancouver and 65 km northwest of Stewart, within 30 km of the British Columbia–Alaska border (Figure 1.2-1).

1.3 Project Overview

The Project is located in two geographical areas: the Mine Site and Processing and Tailing Management Area (PTMA), connected by twin 23-km tunnels, the Mitchell-Treaty Twinned Tunnels (Figure 1.3-1). The Mine Site is located south of the closed Eskay Creek Mine, within the Mitchell, McTagg, and Sulphurets Creek valleys. Sulphurets Creek is a main tributary of the Unuk River, which flows to the Pacific Ocean. The PTMA is located in the upper tributaries of Teigen and Treaty creeks. Both creeks are tributaries of the Bell-Irving River, which flows to the Nass River and into the Pacific Ocean. The PTMA is located about 19 km southwest of Bell II on Highway 37.

The Mine Site will be accessed by a new road, the Coulter Creek Access Road, which will be built from km 70 on the Eskay Creek Mine Road. This road will follow Coulter and Sulphurets creeks to the Mine Site. The PTMA will also be accessed by a new road, the Treaty Creek Access Road, the first 3-km segment of which is a forest service road off of Highway 37. The Treaty Creek Access Road will parallel Treaty Creek.

Four deposits will be mined at the KSM Project—Kerr, Sulphurets, Mitchell, and Iron Cap—using a combination of open pit and underground mining methods. Waste rock will be stored in engineered rock storage facilities located in the Mitchell and McTagg valleys at the Mine Site. Ore will be crushed and transported through one of the Mitchell-Treaty Twinned Tunnels to the PTMA. This tunnel will also be used to route the electrical power transmission lines. The second tunnel will be used to transport personnel, fuel, and bulk materials. The Process Plant will process an average of 130,000 tpd of ore to produce a daily average of 1,200 t of concentrate. Tailing will be pumped to the Tailing Management Facility from the Process Plant. Copper concentrate will be trucked from the PTMA along highways 37 and 37A to the Port of Stewart, which is approximately 170 km away via road.

The mine operating life is estimated at 51.5 years. Approximately 1,800 people will be employed annually during the Operation Phase. Project Construction will take about five years, and the capital cost of the Project is approximately US$5.3 billion.

Figure 1.2-1

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KSM Project Location

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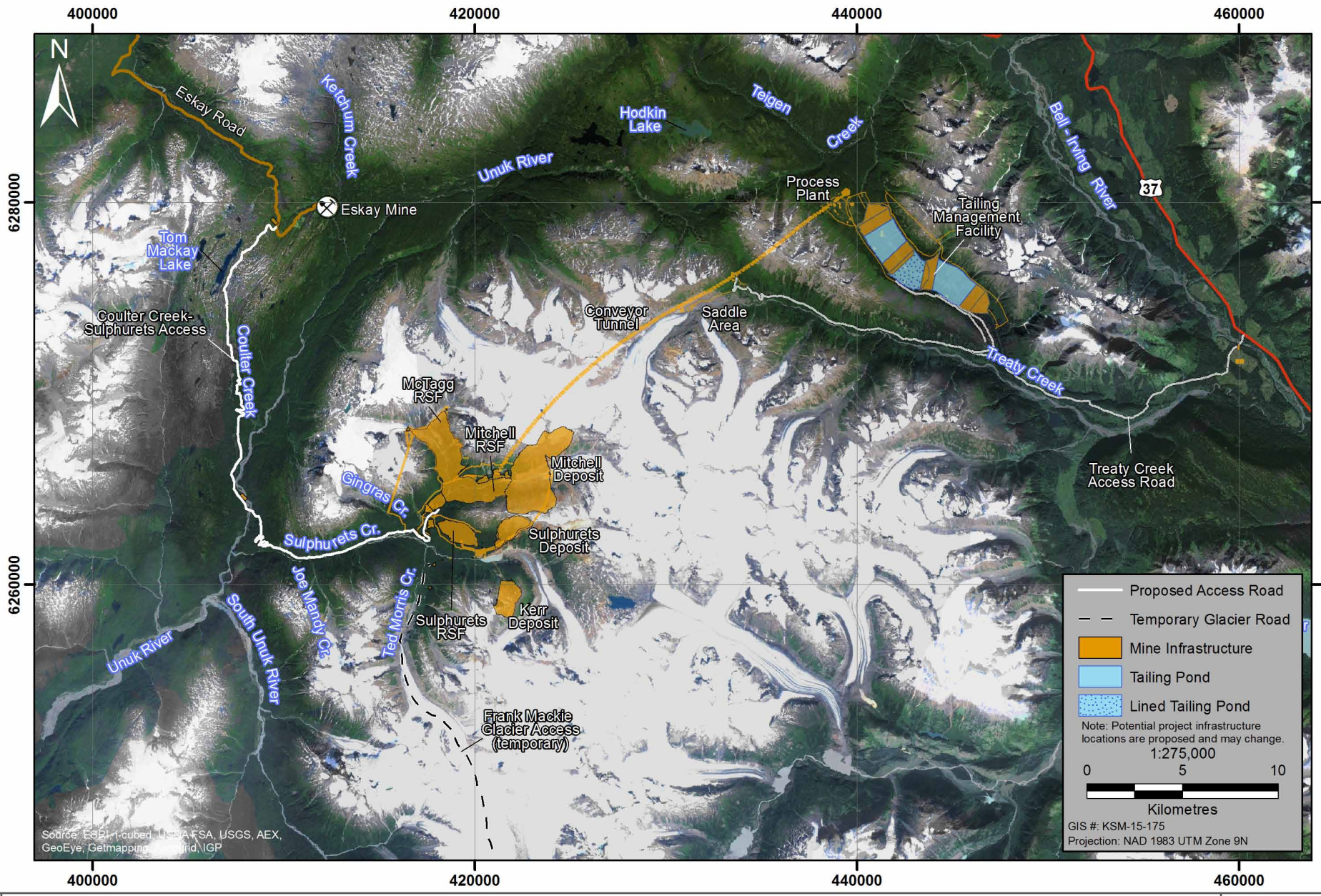

Figure 1.3-1

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KSM Project Layout

Figure 1.3-1

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2 Objectives and Scope of Work

The objective of this report is to present the model developed for predictions of water quantity and quality at the Mine Site water storage facility (WSF) and the receiving waters of the Sulphurets-Unuk watershed downstream of the WSF.

This report is divided into six sections:

- Description of the model setup and fundamental assumptions;
- Description of the water balance and predictive water quantity modelling;
- Presentation and discussion of water quantity model results;
- Description of the geochemical source loadings and predictive water quality modelling;
- Presentation and discussion of water quality model results; and
- Summary.

3 Model Setup

The predictive water quantity and water quality model developed the Project is based on the principle of water and chemical mass balance (Figure 3-1). The model accounts for flows and chemical loadings entering and leaving any bodies of water and calculates water quantity and water quality (i.e., the concentrations of chemical species).

3.1 GoldSim

GoldSim—a dynamic and probabilistic simulation software—was used to model the volume and flow of water and the concentrations and transport of the concerned chemical species within the boundary of the Project as well as its downstream receiving environments as a function of time. A daily time step was applied in the water quantity and water quality simulation of the Project.

GoldSim was developed to model complex environmental systems and has been extensively and successfully applied to simulate water resource management, mining operation, contaminant transport, and radioactive waste management. It is a standard modelling tool in the water resources and mining industries.

GoldSim is based on the principle of mass balance. A body of water is modelled by the "reservoir" element in the model. Water quantity mass balance is always maintained: the change in mass or volume of the body of water is equal to the difference between the sum of the inflows to the body of water and the sum of the outflows from it. Water quality is modelled by linking chemical loadings to the water balance. In GoldSim, the concentrations and transport of the concerned chemical species are modelled by the contaminant transport "cell" elements, which are linked with the corresponding water balance "reservoir" elements. Mass balance is always maintained for the "cell": the change in the mass of any chemical species is equal to the sum of mass fluxes to and from the "cell". Transport of chemical species between "cells" is calculated as the product of water flow between the corresponding "reservoirs" and the concentration of the chemical species in the source "cell".

The generalized mass balance equations applied in the model are:

$$C_{A+B\,i} = \frac{(C_{A\,i} \times Q_A + C_{B\,i} \times Q_B)}{(Q_A + Q_B)}$$

where:
C_{Ai} and C_{Bi} are the concentrations of chemical species *i* in streams A and B, respectively; Q_A and Q_B are the flow rates or volumes of water in streams A and B, respectively; and $C_{A+B\,i}$ is the concentration of chemical species *i* in the mixed body of water of streams A and B;

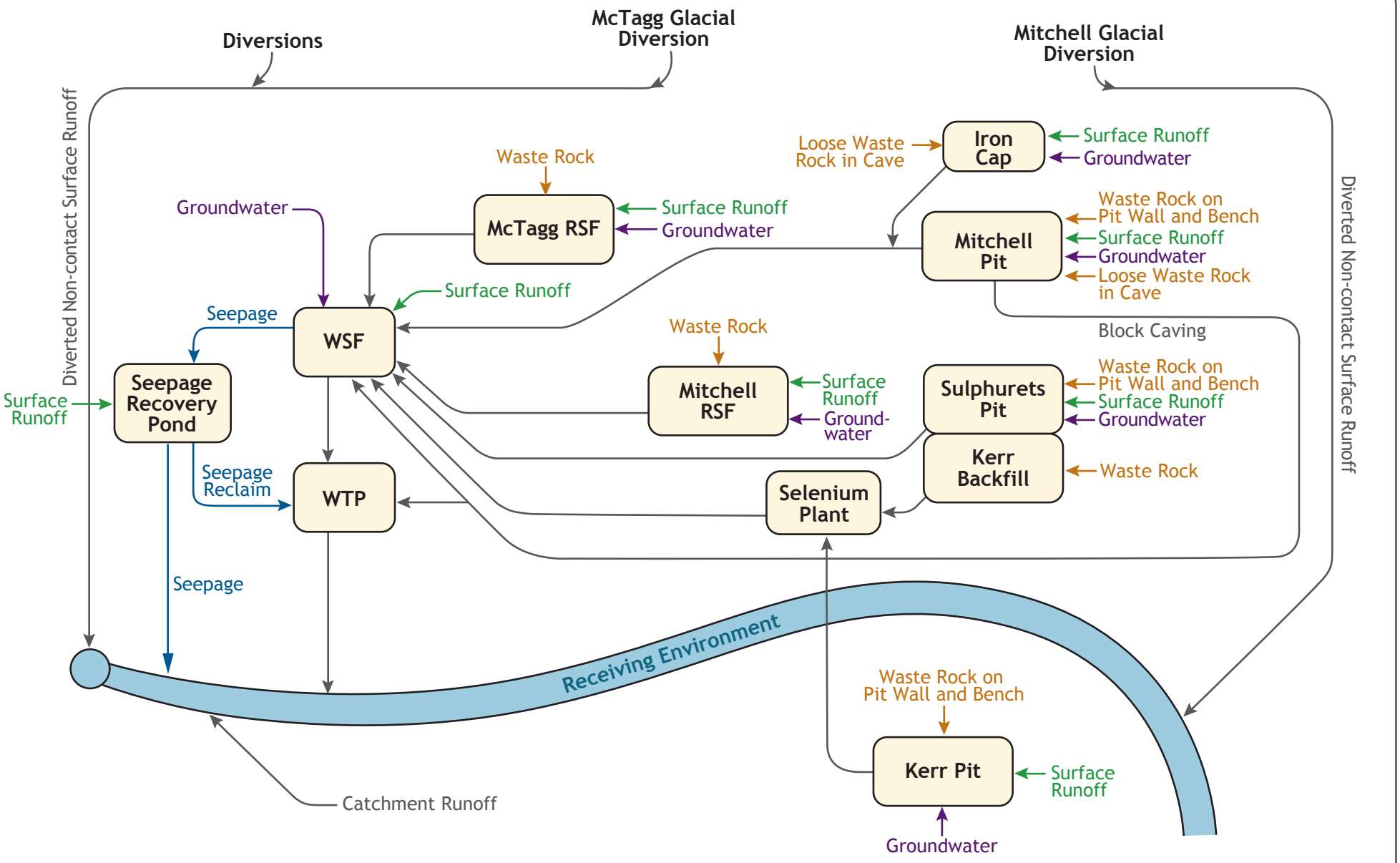

Figure 3-1

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Mine Site Water Quantity and Water Quality Model Schematic

Figure 3-1

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and

$$\sum (Mass\ Loading\ In)_i - \sum (Mass\ Loading\ out)_i = \Delta C_i \times V$$

where:
ΔC_i is the change in concentration of chemical species *i* in a body of water;
V is the volume of the body of water; and
$\sum$(Mass Loading In)$_i$ and $\sum$(Mass Loading out)$_i$ are the sum of masses of chemical species *i* added to, and removed from, the body of water, respectively.

3.2 Key Model Inputs

Model inputs, where possible, are based on data collected from extensive baseline studies, field measurements, laboratory geochemical tests, water treatment pilot tests, pre-feasibility mining and ore processing plans, engineering designs, and professional knowledge and experience. Where uncertainty exists, a conservative assessment or approach is applied. A summary of the key model input parameters is provided in Table 3.2-1 and the mine schedule is presented in Table 3.2-2. Further details are provided in Appendix XI of Appendix 4-J of the Application/EIS and in the following Sections 4 and 6.

Table 3.2-1. Key Model Inputs

Component	Model Input
Water Balance	
Watersheds	Based on Figures 4.1-1 to 4.1-6
Precipitation	1650 mm (base case annual precipitation); adjusted for elevation (Section 4.2.1)
Evaporation	400 mm/yr (Section 4.2.2)
Runoff Distribution	See Section 4.2.3
Diversion Efficiency	See Section 4.2.4
Runoff Coefficient	0.8 (0.9 for Catchments 1 and 2); 0.07 and 0.25 for RSFs during operation and closure, respectively.
Mine Layout and Production	
Mine Life	51.5 years; See Table 3.2-2
Waste Rock Production	Provided by Moose Mountain Technical Services (2013); See Chapter 10
Selenium Treatment Plant	See Appendix 4-V. Maximum Treatment Capacity: 60 L/s
Water Treatment Plant	See Appendix 4-S. Maximum Treatment Capacity: 7.5 m^3/s. Discharge schedule in Appendix 14-I.
Chemistry	
Surface Water	2007 to 2012 baseline data (Appendix 14-A)
Groundwater	2008 to 2012 baseline data (Chapters 11 and 12)
Waste Rock	2008 to 2012 baseline data (Chapter 10)
Seepage beyond WSD	1 L/s with a concentration 5% of the WSF

Table 3.2-2. Mine Schedule

Deposit	Year	Mining Method
Mitchell	-2 to 23	open pit
Sulphurets	-2 to 6	open pit
Sulphurets	23 to 27	open pit
Kerr	27 to 50	open pit
Mitchell	26 to 51.5	block cave
Iron Cap	32 to 51	block cave

4 Water Quantity Modelling

This section presents the water balance component of the Water Quality model for the Mine Site. The water balance component is based upon the water balance model for the Mine Site developed by Seabridge's design engineer (refer to Appendix XI in Appendix 4-J). For the development of the Mine Site water balance model, conservative assumptions were made regarding precipitation inputs, and consequently flows, to the Mine Site as this is critical to the engineering design of water management structures. The water balance for the Water Quality Model was calibrated to streamflows at the downstream assessment points. Sensitivity analysis was conducted on diversion efficiencies and precipitation inputs to examine the effects of variability in these parameters on streamflows at the downstream assessment points. Key elements of the Mine Site water balance model were the operation of the Water Storage Facility (WSF) and the Water Treatment Plant (WTP). The main inflows into the WSF/WTP for the water balance model include:

- precipitation on open water in the WSF and the Water Storage Facility Seepage Recovery Dam SRD impoundments;
- overland runoff in the WSF and SRD catchments;
- runoff and infiltration from Mitchell, McTagg Rock Storage Facilities (RSFs) and Sulphurets Ridge Laydown Area;
- runoff and groundwater seepage from Mitchell, Kerr and Sulphurets Pit catchments;
- runoff from Mitchell Glacier North and South Valley slopes where natural waters are in;
- contact with mineralization upstream of the Mitchell deposit;
- infiltration from surface and groundwater into Mitchell and Iron Cap underground block;
- caving operations (note that these waters are planned to be pumped directly to the WTP, however the WSF has been sized to manage these waters, if required);
- leakage from McTagg Glacier and Mitchell Glacier inlets, as well as the diversion channels;
- seepage from the Mitchell-Treaty Twinned Tunnel (MTT); and
- dewatering of the open pits.

Outflows or losses from the WSF / WTP include:

- evaporation from open water in the impoundments;
- groundwater seepage to Mitchell Creek; and
- water treatment.

Organization of the water quantity modelling sections is as follows:

- Sections 4.1 to 4.3 – GoldSim Input Parameters – These include the production plan, climate and hydrology data, mine water management plan, and infrastructure properties;

- Section 5.1 – Base Case Calibration and Results – In the base case, static inflows (i.e., annual precipitation inputs were held constant for the modelling time frame) and base diversion efficiencies were assumed; and
- Section 5.2 – Sensitivity Analyses and Dynamic Simulation – Variation of diversion efficiencies were considered in the sensitivity analysis; and climate models were used to produce variable inflows.

4.1 Mine Site Water Management Plan

The Mine Site staging plan is divided into four stages, two for operation, one for initial closure and one for final closure. The stages presented here do not necessarily line up with the operational stages in the Processing and Tailing Management Area (PTMA). The stages presented here are based on the routing of water in the Mine Site, thus stages here represent periods where the assessment points have the same catchment and contributing areas reporting to them. The McTagg and Mitchell diversion tunnels will route a majority of the non-contact runoff and glacial meltwater around the mine area and RSF. Secondary surface diversion channels will route runoff from local catchments. General arrangements for these stages, displaying catchment boundaries, are shown on Figure 4.1-1 to Figure 4.1-6. The water management plan is separated into these four stages:

- **Stage 1 (Year 0 to Year 30):** During the first 30 years of operation while the Mitchell deposit is being mined by open pit mining, the Mitchell Diversion Tunnels (MDTs) are provided to divert Mitchell Glacier meltwater to Sulphurets Creek. This stage is further subdivided to a start-up phase in the first 10 years of operation when the Mitchell RSF is in operation; a period between 10 to 25 years of operation when the McTagg RSF is constructed; and a transition period between 26 to 30 years of operation.
- **Stage 2 (Year 30 to Year 51.5):** two additional Mitchell Glacier diversion tunnels will be constructed and enter service in year 30. Closure and post-closure stages are similar to those of the PTMA.
- **Stage 3 (Year 51.5 to Year 56):** This is an assumed period for initial closure during which reclamation activities are ongoing. The actual time period depends on operational facility closures and closure facility construction. Water management is the same as during operations; the pits and waste rock facilities no longer expand. RSF areas are reclaimed and runoff is to be sent to the WSF. Additional non-contact water diversions are commissioned around the RSFs to divert non-contact water to the environment. The Mitchell diversion tunnel continues to operate and a controlled release of a portion of water from the Mitchell glacier catchment flows into the Mitchell pit to fill the pit for closure. The Mitchell closure dam is built. The Mitchell pit water spills to the WSF catchment through a 1.0 m diameter pipe spillway at El. 810 m into the Mitchell RSF Basal Drain at a maximum discharge of 2.25 m^3/s. Storm floods of up to volume of 20 Mm^3 are attenuated by storage provided in the pit lake between El. 810 m and El. 820 m. Water stored after a flood is gradually released to the WSF by the spill pipe around the dam, with invert elevation of 810 m. Higher flow events overtop the spillway invert of El. 820 m and report to the closure channel which routes extreme floods around the WSF to the environment.

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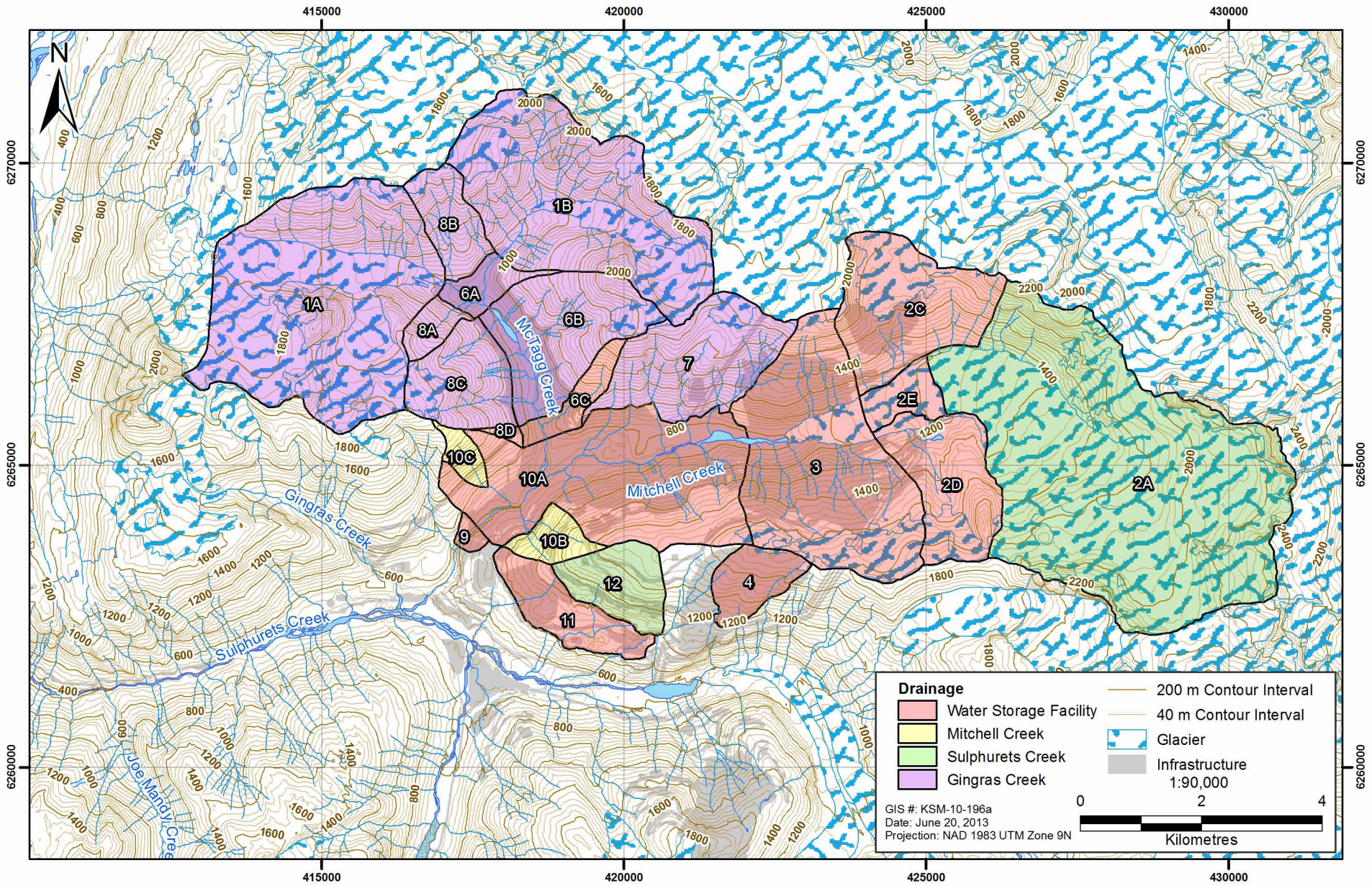

Figure 4.1-1

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Subcatchments of Mine Site Area during Years 0 to 10 of Operation

Figure 4.1-1

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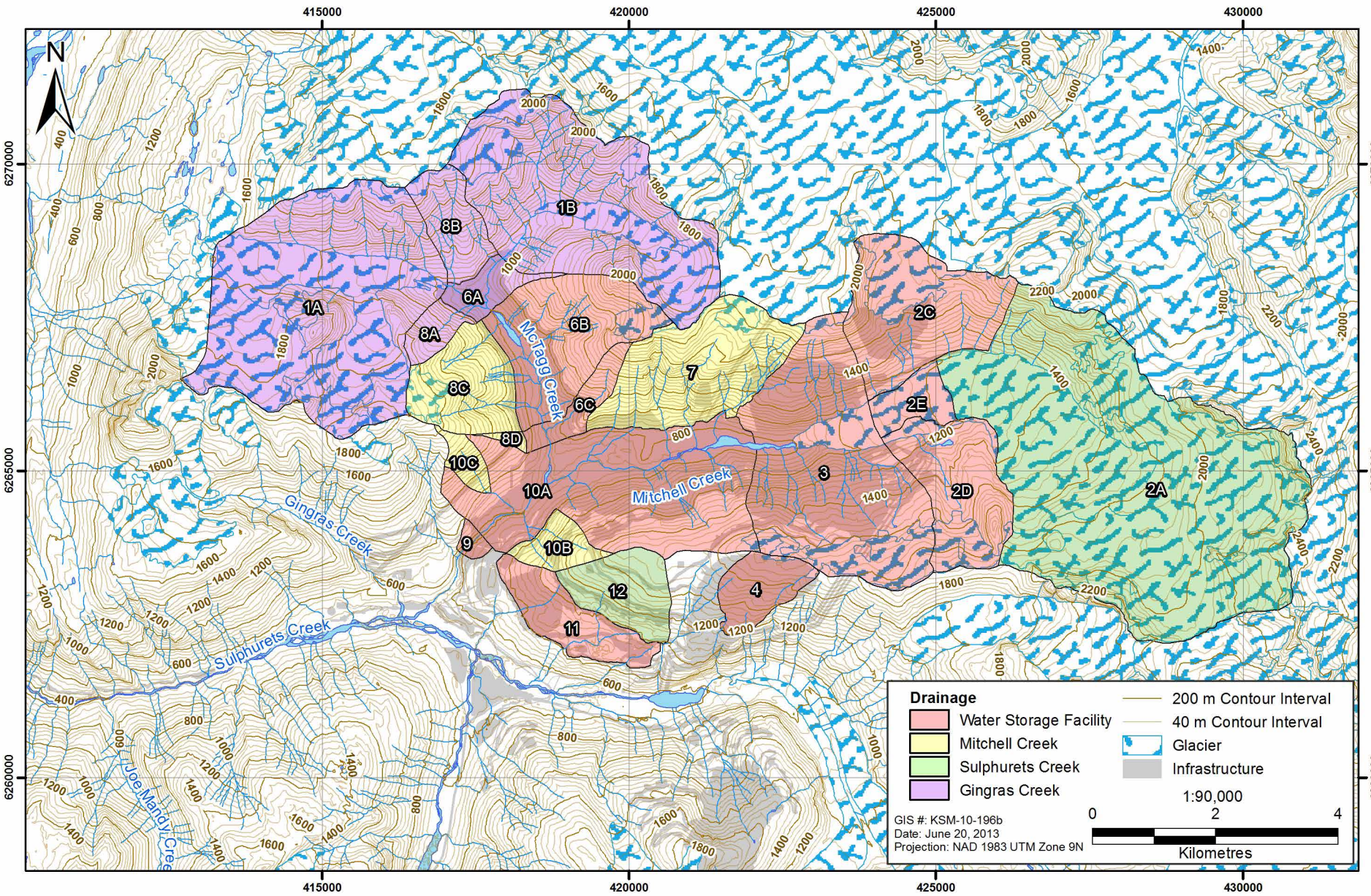

Figure 4.1-2

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Subcatchments of Mine Site Area during Years 10 to 25 of Operation

Figure 4.1-2

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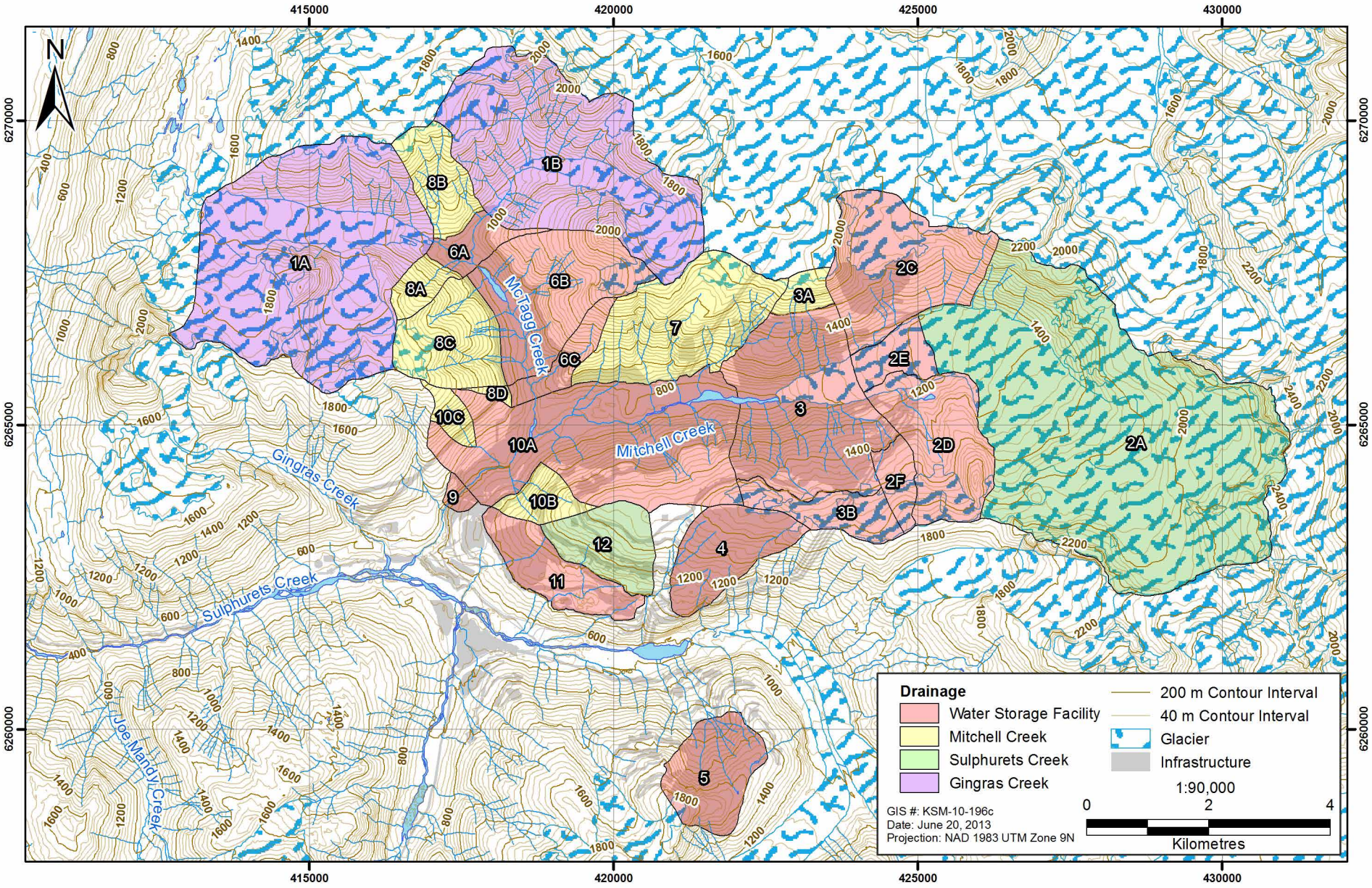

Figure 4.1-3

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Subcatchments of Mine Site Area during Years 26 to 30 of Operation

Figure 4.1-3

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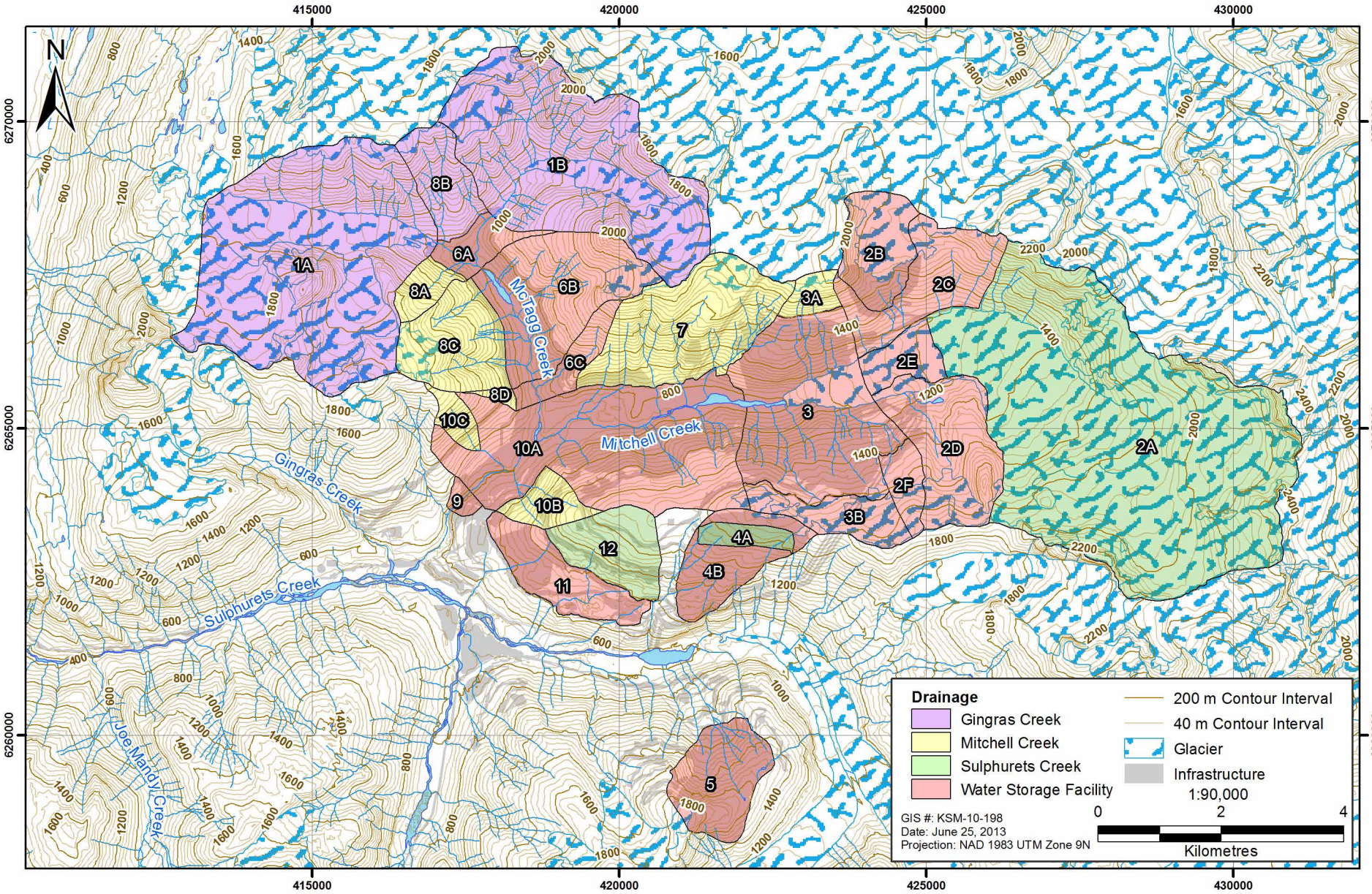

Figure 4.1-4

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Subcatchments of Mine Site Area during Years 30 to 51.5 of Operation

Figure 4.1-4

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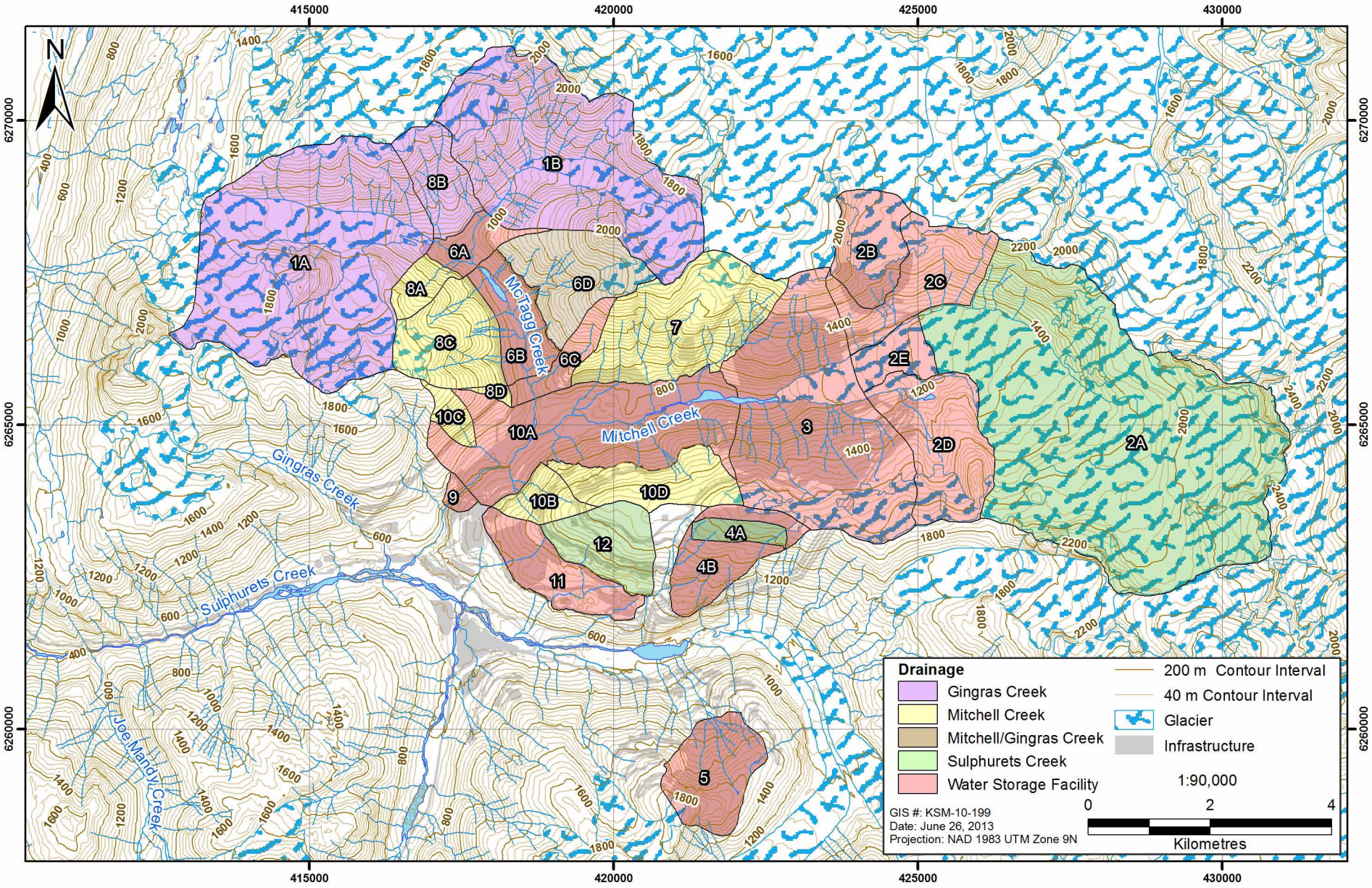

Figure 4.1-5

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Subcatchments of Mine Site Area during Years 51.5 to 56 of Operation

Figure 4.1-5

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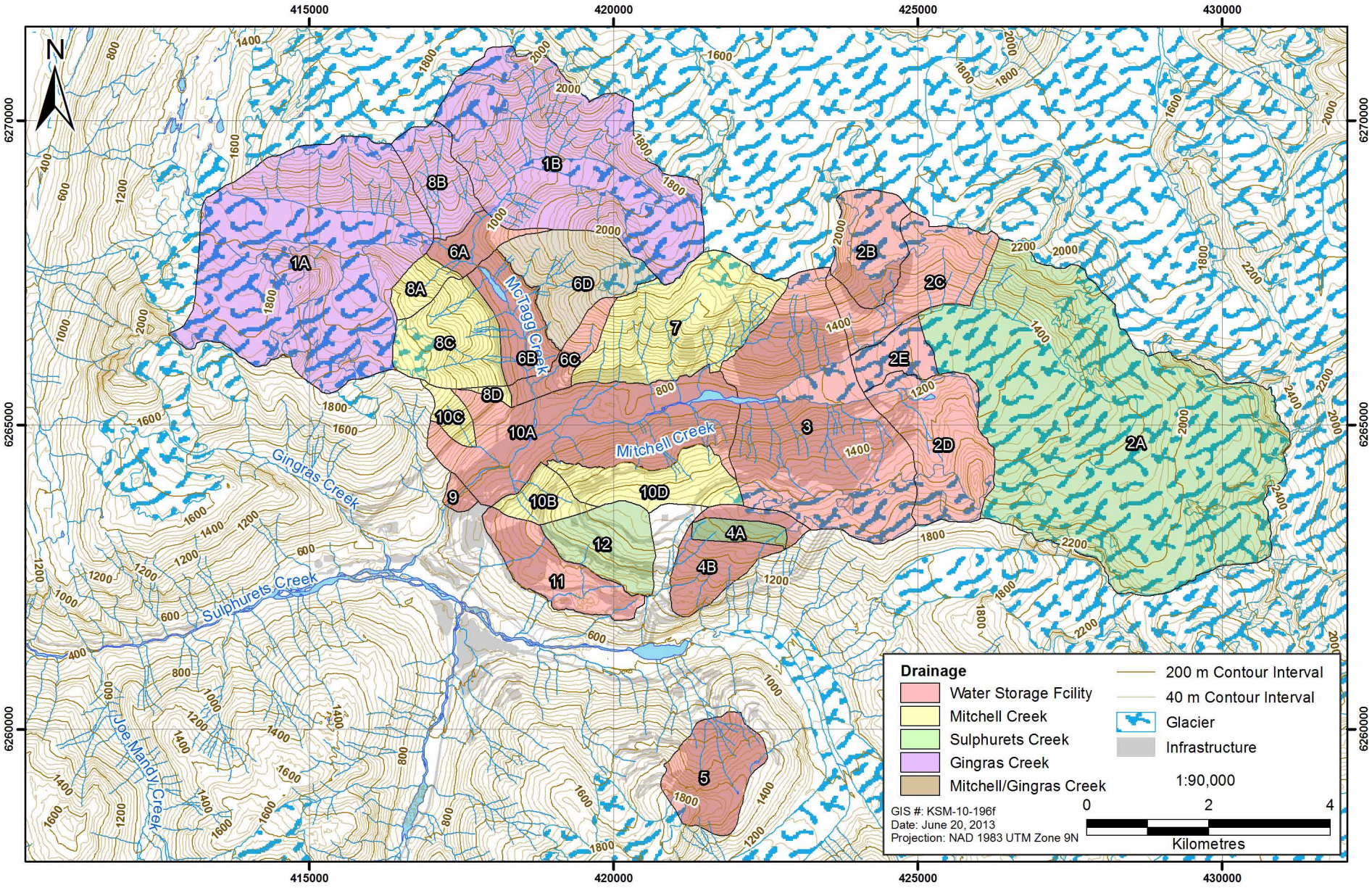

Figure 4.1-6

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Subcatchments of Mine Site Area after 57 Years of Operation

Figure 4.1-6

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Stage 4 (Year 57+): RSF areas are reclaimed and runoff continues to be sent to the WSF. The McTagg Glacier tunnel continues to operate to generate power at closure and a permanent McTagg closure channel and spillway is built to divert non-contact water to the environment and to handle flows in the event of a failure of the McTagg diversion tunnels. A closure pipeline needs to be maintained from Kerr Pit to the Se plant. The WSF and WTP continue to operate as in previous stages.

A general schematic of the water balance during operations is shown on Figure 4.1-7.

4.2 Climate and Hydrology

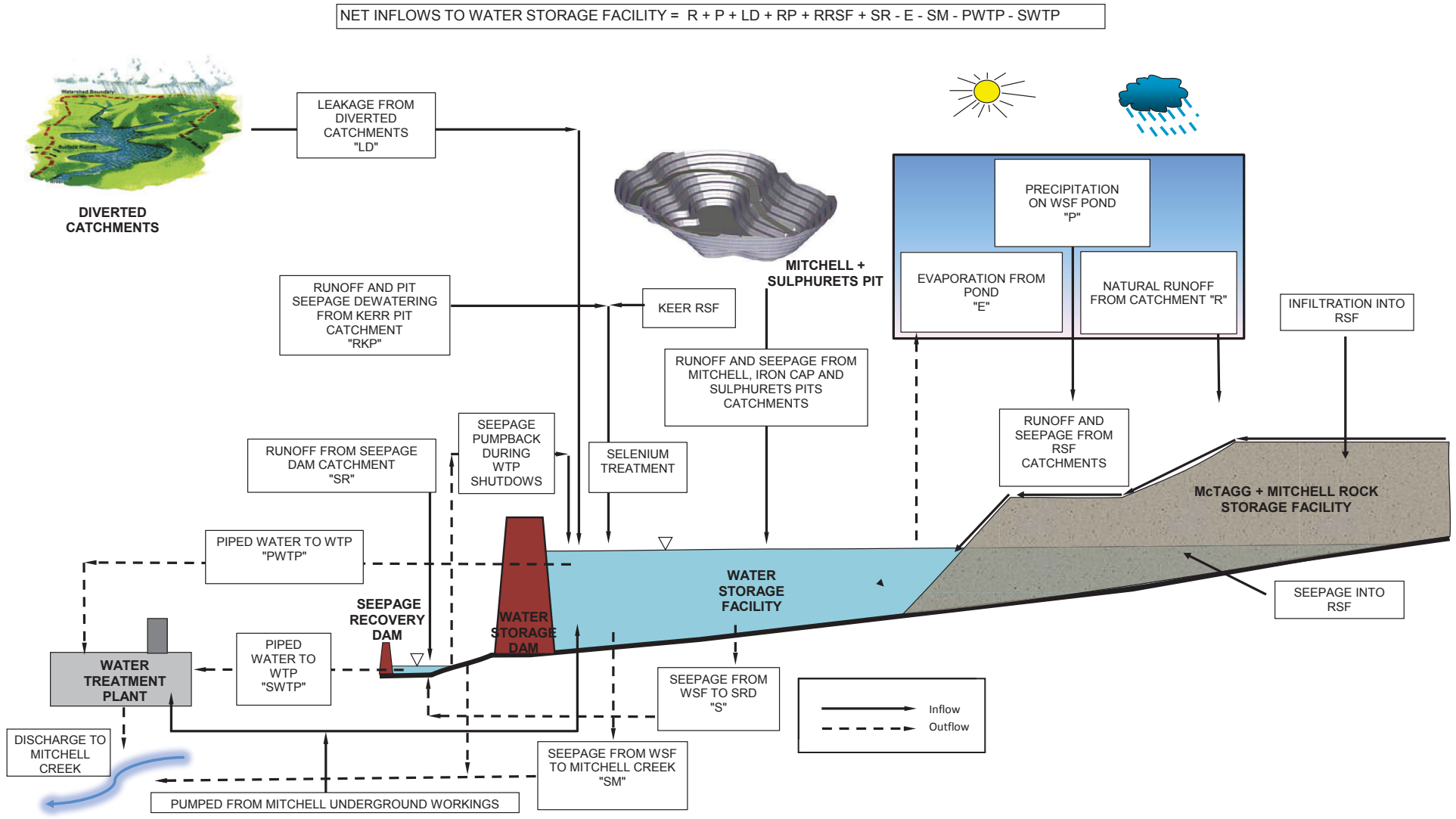
Climate parameters for the water balance model were derived from site data collected in 2008, 2009, 2010 and 2011 as well as long term data from several adjacent climate stations (including Eskay, Bob Quinn, and Stewart). Monthly climate data used in the GoldSim model are shown in Figure 4.2-1 is based on the Hydrology Memorandum in Appendix I of Appendix 4-J.

4.2.1 Precipitation

Estimates for annual average precipitation were adjusted through a calibration process (see Section 5.1). The adjusted values of annual precipitations for each catchment within the Mine Site are also provided in Table 4.2-1.

Table 4.2-1. Estimates for Annual Average Precipitations

Catchment Description	Catchment ID	Initial Average Annual Precipitation (mm)	Adjusted Average Annual Precipitation Based on Calibration Process (mm)
Base Case Annual Precipitation in Mine Site			1650
McTagg West Glacier Diversion	1A	2310	2528
McTagg East Glacier Diversion	1B	2310	2528
Mitchell Glacier Diversion	2A	2502	2508
Iron Cap	2B	2502	2508
North Mitchell Diversion	2C	2502	2508
Mitchell Glacier South Slope Diversion	2D	2502	2508
Mitchell Glacier Toe	2E	2502	2508
Mitchell Glacier South Diversion	2F	2502	2508
Mitchell Pit	3	2128	2128
Mitchell Pit North Diversion	3A	2128	2128
Mitchell Pit South Diversion	3B	2128	2128
Sulphurets Pit	4	2344	2344
Kerr Pit	5	2127	2127
McTagg RSF and Uphill Catchment	6	1749	1749
Mitchell North Diversion	7	2344	2344
McTagg West Diversion 1	8A	2127	2127
McTagg West Diversion 2	8B	2127	2127
McTagg Southwest Diversion	8C	2127	2127
Seepage Collection Dam	9	1749	1749
Mitchell RSF and Uphill Catchment	10A	1749	1749
Mitchell RSF South Diversion	10B &10C	1749	1749
Sulphurets RSF	11	1749	1749
Sulphurets RSF Uphill Catchment	12	1749	1749



Source: Klohn Crippen Berger.

Figure 4.1-7

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Conceptual Water Balance Model for the Mine Site (from Appendix XI in Appendix 4-J)

Figure 4.1-7

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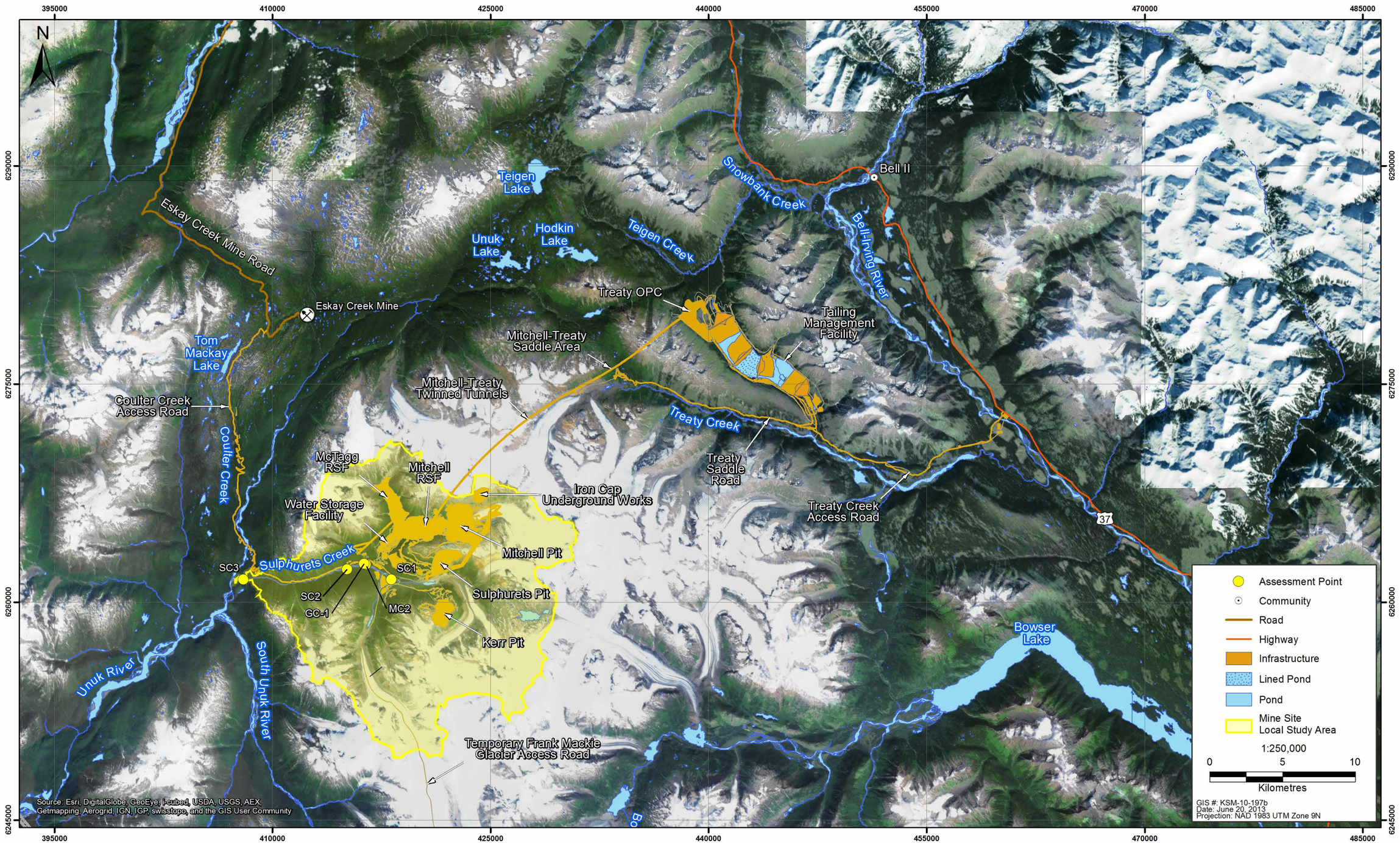

Figure 4.2-1

Surface Water Assessment Points within the Mine Site Local Study Area

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In order to account for uncertainty in precipitation and runoff assumptions, global climate models (GCMs) were used to generate a data set containing 14 scenarios of an annually varying precipitation timeseries each of 150 years in length. The methods and data used to generate these scenarios are discussed in Werner (2011). In short, the prediction of future global climatic conditions requires the use of numerical models, referred to as GCMs. These numerical simulations require projections of future scenarios of greenhouse gases and sulfate aerosols (over 40 different emission scenarios were produced under the International Panel on Climate Change (IPCC; Nakicenovic et al. 2000). These scenarios are essentially a best guess of future emissions. Three of the six classes of scenarios are commonly chosen for GCMs by the various climate institutes around the world; these scenarios are referred to as B1, A1B, and A2. A2 produces the highest climate forcing by the end of the century, however, before mid-century, none of the three scenarios is consistently the highest. B1 is a low emissions scenario, and thus produces the most conservative climate change prediction. Five of the eight climate models used in the Werner (2011) study were randomly selected here. The GCMs selected were:

- CGCM3.1(T47) – Canadian Centre for Climate Modelling and Analysis (Canada);
- CSIRO-Mk3.0 – CSIRO Atmospheric Research (Australia);
- CCSM3 – National Center for Atmospheric Research (USA);
- ECHAM/MPI-OM – Max Plank Institute for Meteorology (Germany); and
- UKMO-HadGEM1 – Hadley Centre for Climatic Prediction and Research Met Office (UK).

All of the centres modelled the three emission scenarios, except for UKMO-HadGEM1 which did not include the low emission scenario (B1). Each scenario includes 150 years of synthetically generated daily precipitation and temperature data from 1950 to 2100. Results of these scenarios for average annual precipitation at Unuk Eskay station are provided in Table 4.2-2. It is seen that if these generated timeseries are adjusted by 11.6%, their average annual precipitation during 2008 to 2011 will match the observed data in the Mine Site (1,650 mm). Therefore, an adjusting factor of -11.6% was applied to the synthetic timeseries for annual precipitation that are used in variable scenarios of water balance modelling (see Section 5.2).

4.2.2 Evaporation

The estimated annual average evaporation of 400 mm/yr used in the water balance is based on lake evaporation at the Topley Landing weather station, corrected for elevation (for further details refer to Appendix I of Appendix 4-J). The monthly distribution of evaporation is given in Table 4.2-3.

4.2.3 Runoff

The addition of the downstream assessment points to the water balance model was done to include data from the surface water quality sampling program in creeks downstream of the Mine Site. This information, however, was always spatially associated with locations that were not necessarily similar to the stations associated with the hydrology baseline program. For instances where the two locations were not the same the water quality sampling location was selected for modelling purposes. The rationale for this was that the flow data could be easily transferred to a

different location within the same stream using a drainage area ratio. The local study area (LSA) assessment points were named using the nomenclature of the surface water quality report (Chapter 14). The locations of these stations are presented in Figure 4.2-1.

Table 4.2-2. Adjusting Synthetic Annual Precipitation Timeseries to Match 2008-2011 Observed Data

Climate Model/Scenario	Annual Precipitation at Unuk Eskay based on Climate Model Predictions (mm)	
	Average of 1950-2099	Average of 2008-2011
ccsm3A1B	1542	1460
ccsm3A2	1531	1569
ccsm3B1	1516	1432
cgcm3A1B	1583	1471
cgcm3A2	1593	1542
cgcm3B1	1572	1465
csiro3A2	1506	1440
csiro3B1	1506	1497
csiroA1B	1530	1556
echam5A1B	1592	1390
echam5A2	1620	1675
echam5B1	1572	1465
hadgemA1B	1507	1281
hadgemA2	1532	1450
Average of climate models predictions	**1550**	**1478**
Average of Observed 2008-2011 data		**1650**
Correction to climate model predictions		**11.6%**

Table 4.2-3. Monthly Distribution of Open Water Evaporation

Month	Percent of Yearly Evaporation
January	0%
February	0%
March	0%
April	0%
May	21.5%
June	23.1%
July	24.7%
August	19.9%
September	10.8%
October	0%
November	0%
December	0%
Total	**100%**

The calibration process, which included the downstream assessment points, resulted in a runoff coefficient of 0.9. The hydrology assessment in Appendix 13-A shows that runoff is highest around late spring and early summer during freshet. Table 4.2-4 presents the monthly distribution of runoff in the Mine Site (Appendix 13-A).Estimated monthly streamflows at these assessment points based on the 2008 to 2011 observations at the hydrometric stations (Appendix 13-A) are summarized in Table 4.2-5.

Table 4.2-4. Monthly Distribution of Annual Runoff

Percentage of Annual Runoff Occurring in Each Month (%)												
Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1.5	1.2	1.2	1.5	7.2	15.2	22.4	22.9	16.9	6.4	2.3	1.3	**100**

Table 4.2-5. Baseline Monthly Average Streamflows during 2008 to 2011

Assessment Point	Baseline Monthly Streamflows (m^3/s)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Mean**
MC2	0.98	0.85	0.76	1.04	4.76	10.32	14.68	15.07	11.45	4.22	1.54	0.87	**5.54**
GC1	0.10	0.09	0.08	0.11	0.49	1.05	1.50	1.54	1.17	0.43	0.16	0.09	**0.57**
SC1	1.13	0.98	0.87	1.20	5.51	11.93	16.99	17.43	13.25	4.88	1.78	1.01	**6.42**
SC2	3.46	3.00	2.67	3.67	16.80	36.41	51.83	53.19	40.43	14.90	5.44	3.07	**19.57**
SC3	3.95	3.42	3.05	4.19	19.18	41.58	59.20	60.74	46.18	17.01	6.21	3.51	**22.35**

4.3 Infrastructure Properties

4.3.1 Site Plan

Drainage catchment areas during the aforementioned stages are summarized in Table 4.3-1. The table also includes to which creek the catchment area reports to. Outflows from the Mine Site can either report to Mitchell Creek directly (MC), Mitchell Creek through the WSF (WSF), Gingras Creek (GC), or Sulphurets Creek (SC).

Diversion ditch efficiencies for average hydrologic conditions are shown in Table 4.3-2. RSF footprint areas are available in Table 4.3-3, which indicates increasing areas over time. Sensitivity analyses were performed and are described in Section 5.2.

4.3.2 Open Pit Properties

Pit contact waters (including groundwater seepage, direct precipitation and catchment runoff) are directed to the WSF, directly to the WTP or first to the Se Plant. Table 4.3-4 gives operating criteria for the open pits.

4.3.3 Water Storage Dam (WSD) Main Impoundment

The Elevation-Storage Area curve for the WSF is shown in Figure 4.3-1.The minimum operating pond volume is 1.0 Mm^3 to provide time and space for settling of suspended sediments.

Table 4.3-1. Area (km^2) and Flow Pathway of Mine Site Subcatchments during Different Phases of the Project

Subcatchment	Code	Years 0-10		Years 10-25		Years 26-30		Years 0-51.5		Years 51.5-56		Years 57+	
McTagg West Glacier Diversion	1A	12.1	GC	12.1	GC	12.1	GC	12.1	GC	12.1	GC	12.1	GC
McTagg East Glacier Diversion	1B	9.3	GC	9.3	GC	9.3	GC	9.3	GC	9.3	GC	9.3	GC
Mitchell Glacier Diversion	2A	20.2	SC	20.2	SC	20.2	SC	20.2	SC	20.2	SC	20.2	SC
Iron Cap	2B	-		-		-		1.9	WSF	1.9	WSF	1.9	WSF
North Mitchell Diversion	2C	4.6	WSF	4.6	WSF	4.6	WSF	2.7	WSF	2.7	WSF	2.7	WSF
Mitchell Glacier South Slope Diversion	2D	3.4	WSF	3.4	WSF	3.4	WSF	3.4	WSF	3.4	WSF	3.4	WSF
Mitchell Glacier Toe	2E	1.0	WSF	1.0	WSF	1.0	WSF	1.0	WSF	1.0	WSF	1.0	WSF
Mitchell Glacier South Diversion	2F	-		-		0.7	WSF	0.7	WSF	-		-	
Mitchell Pit	3	8.8	WSF	8.8	WSF	6.2	WSF	6.2	WSF	8.8	WSF	8.8	WSF
Mitchell Pit North Diversion	3A	-		-		0.5	MC	0.5	MC	-		-	
Mitchell Pit South Diversion	3B	-		-		1.4	WSF	1.4	WSF	-		-	
Sulphurets Pit	4	1.3	WSF	1.3	WSF	2.3	WSF	-		-		-	
	4A	-		-		-		0.5	SC	0.5	SC	0.5	SC
	4B	-		-		-		1.8	WSF	1.8	WSF	1.8	WSF
Kerr Pit	5	-		-		2.3	WSF	2.3	WSF	2.3	WSF	2.3	WSF
McTagg RSF and Uphill Catchment	6	-		-		-		-		-		-	
	6A	0.8	GC	0.8	GC	0.8	WSF	0.8	WSF	0.8	WSF	0.8	WSF
	6B	4.2	GC	4.2	WSF	4.2	WSF	4.2	WSF	1.6	WSF	1.6	WSF
	6C	0.9	WSF	0.9	WSF	0.9	WSF	0.9	WSF	0.9	WSF	0.9	WSF
	6D	-		-		-		-		2.6	MCGC	2.6	MCGC
Mitchell North Diversion	7	4.2	GC	4.2	MC	4.2	MC	4.2	MC	4.2	MC	4.2	MC
McTagg West Diversion 1	8A	0.6	GC	0.6	GC	0.6	MC	0.6	MC	0.6	MC	0.6	MC
McTagg West Diversion 2	8B	1.6	GC	1.6	GC	1.6	MC	1.6	GC	1.6	GC	1.6	GC
McTagg Southwest Diversion	8C	2.5	GC	2.5	MC	2.5	MC	2.5	MC	2.5	MC	2.5	MC
McTagg Southwest Diversion	8D	0.1	WSF	0.1	MC	0.1	MC	0.1	MC	0.1	MC	0.1	MC
Seepage Collection Dam	9	0.2	WSF	0.2	WSF	0.2	WSF	0.2	WSF	0.2	WSF	0.2	WSF
Mitchell RSF and Uphill Catchment	10A	8.7	WSF	8.7	WSF	8.7	WSF	8.7	WSF	6.7	WSF	6.7	WSF
Mitchell RSF South Diversion	10B	0.8	MC	0.8	MC	0.8	MC	0.8	MC	0.8	MC	0.8	MC
Mitchell RSF South Diversion	10C	0.5	MC	0.5	MC	0.5	MC	0.5	MC	0.5	MC	0.5	MC
Mitchell RSF South Diversion	10D	-		-		-		-		2.0	MC	2.0	MC
Sulphurets RSF	11	2.0	WSF	2.0	WSF	2.0	WSF	2.0	WSF	2.0	WSF	2.0	WSF
Sulphurets RSF Uphill Catchment	12	1.9	SC	1.9	SC	1.9	SC	1.9	SC	1.9	SC	1.9	SC

(continued)

Table 4.3-1. Area (km^2) and Flow Pathway of Mine Site Subcatchments during Different Phases of the Project (completed)

Subcatchment	Code	Years 0-10	Years 10-25	Years 26-30	Years 30-51.5	Years 51.5-56	Years 57+
Drainage area contributing to MC2		32.3	43.2	49.5	47.4	46.1	46.1
Drainage area contributing to GC1		35.3	24.4	21.4	23.0	24.3	24.3
Drainage area contributing to SC1		22.1	22.1	22.1	22.6	22.6	22.6
Total		**89.7**	**89.7**	**93.0**	**93.0**	**93.0**	**93.0**

MC: Drains to Mitchell Creek (MC2)
GC: Drains to Gingras Creek (GC1)
SC: Drains to Sulphurets Creek (SC1)
WSF: Drains to Water Storage Facility and then to Mitchell Creek (MC2)
MCGC: Splits between Mitchell and Gingras Creeks (50% each)

Table 4.3-2. Base Case Monthly Diversion Efficiencies (%) and Inlet Losses (L/s)

Subcatchment	Code	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
McTagg West Glacier Diversion	1A						30 L/s						
McTagg East Glacier Diversion	1B						30 L/s						
Mitchell Glacier Diversion	2A						50 L/s						
Iron Cap	2B	-	-	-	-	-	-	-	-	-	-	-	-
North Mitchell Diversion	2C	52	52	52	52	40	40	52	52	52	52	52	52
Mitchell Glacier South Slope Diversion	2D	72	72	72	72	60	60	72	72	72	72	72	72
Mitchell Glacier Toe	2E	90	90	90	90	90	90	90	90	90	90	90	90
Mitchell Glacier South Diversion	2F	65	65	65	65	50	50	65	65	65	65	65	65
Mitchell Pit	3	-	-	-	-	-	-	-	-	-	-	-	-
Mitchell Pit North Diversion	3A	65	65	65	65	65	50	50	65	65	65	65	65
Mitchell Pit South Diversion	3B	65	65	65	65	65	50	50	65	65	65	65	65
Sulphurets Pit	4	-	-	-	-	-	-	-	-	-	-	-	-
Kerr Pit	5	-	-	-	-	-	-	-	-	-	-	-	-
McTagg RSF North	6A	72	72	72	72	72	60	60	72	72	72	72	72
McTagg RSF Central	6B	72	72	72	72	72	60	60	72	72	72	72	72
McTagg RSF South	6C	72	72	72	72	72	60	60	72	72	72	72	72
McTagg RSF Northeast Closure Channel	6D	72	72	72	72	72	60	60	72	72	72	72	72
Mitchell North Diversion	7	72	72	72	72	72	60	60	72	72	72	72	72
McTagg West Diversion 1	8A	72	72	72	72	72	60	60	72	72	72	72	72

(continued)

Table 4.3-2. Base Case Monthly Diversion Efficiencies (%) and Inlet Losses (L/s; completed)

Subcatchment	Code	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
McTagg West Diversion 2	8B	72	72	72	72	72	60	60	72	72	72	72	72
McTagg Southwest Diversion	8C	72	72	72	72	72	60	60	72	72	72	72	72
McTagg Southwest Diversion	8D												
Seepage Collection Dam	9	-	-	-	-	-	-	-	-	-	-	-	-
Mitchell RSF and Uphill Catchment	10A	72	72	72	72	72	60	60	72	72	72	72	72
Mitchell RSF South Diversion	10B	72	72	72	72	72	60	60	72	72	72	72	72
Mitchell RSF South Diversion	10C	-	-	-	-	-	-	-	-	-	-	-	-
Mitchell RSF South Diversion	10D												
Sulphurets RSF	11	72	72	72	72	72	60	60	72	72	72	72	72
Sulphurets RSF Uphill Catchment	12	72	72	72	72	72	60	60	72	72	72	72	72

Table 4.3-3. Rock Storage Facility Footprint Areas (km^2)[1]

	Year											
RSF	**1**	**2**	**3**	**4**	**5**	**10**	**15**	**20**	**30**	**40**	**50**	**51.5**
McTagg North	-	-	-	-	-	-	0.57	0.57	0.57	0.57	0.57	0.57
McTagg Central	-	-	-	-	-	0.23	1.72	1.72	1.72	1.72	1.72	1.72
McTagg South	-	-	-	-	0.06	0.15	0.39	0.39	0.39	0.39	0.39	0.39
Mitchell	1.60	2.02	2.40	2.99	3.64	4.23	4.23	4.23	4.23	4.23	4.23	4.23

[1] RSF areas in the water balance model are to increase linearly between two stated time steps.

Table 4.3-4. Open Pit Operating Criteria

	Mitchell Pit	Kerr Pit	Sulphurets Pit	Iron Cap
Groundwater Inflows[1]	Average 10,303 m^3/day	Up to 3,435 m^3/day	Up to 4,320 m^3/day	Average 2,249 m^3/day
Conveyance	Pumped to pit rim, Gravity flow to WSF	Gravity flow through a low level outlet to a pressure pipeline that feeds the Se water treatment plant (possibility of bypass of Se plant during floods) that discharges to WSF	Gravity flow through pipe and ditch section to WSF	Gravity flow via raise bore into North Pit Wall adit tunnel
Maximum Discharge Rate	4.3 m^3/s	2.25 m^3/s Attenuation of 1:200 year flow in Pit	Flows in ditch up to 1:200 year storm event	Flows to 1:200 year storm event
Operating Years	Year 1 to 23	Year 27 to 50	Year -2 to 6 and Year 23 to 27	Year 32 to 51

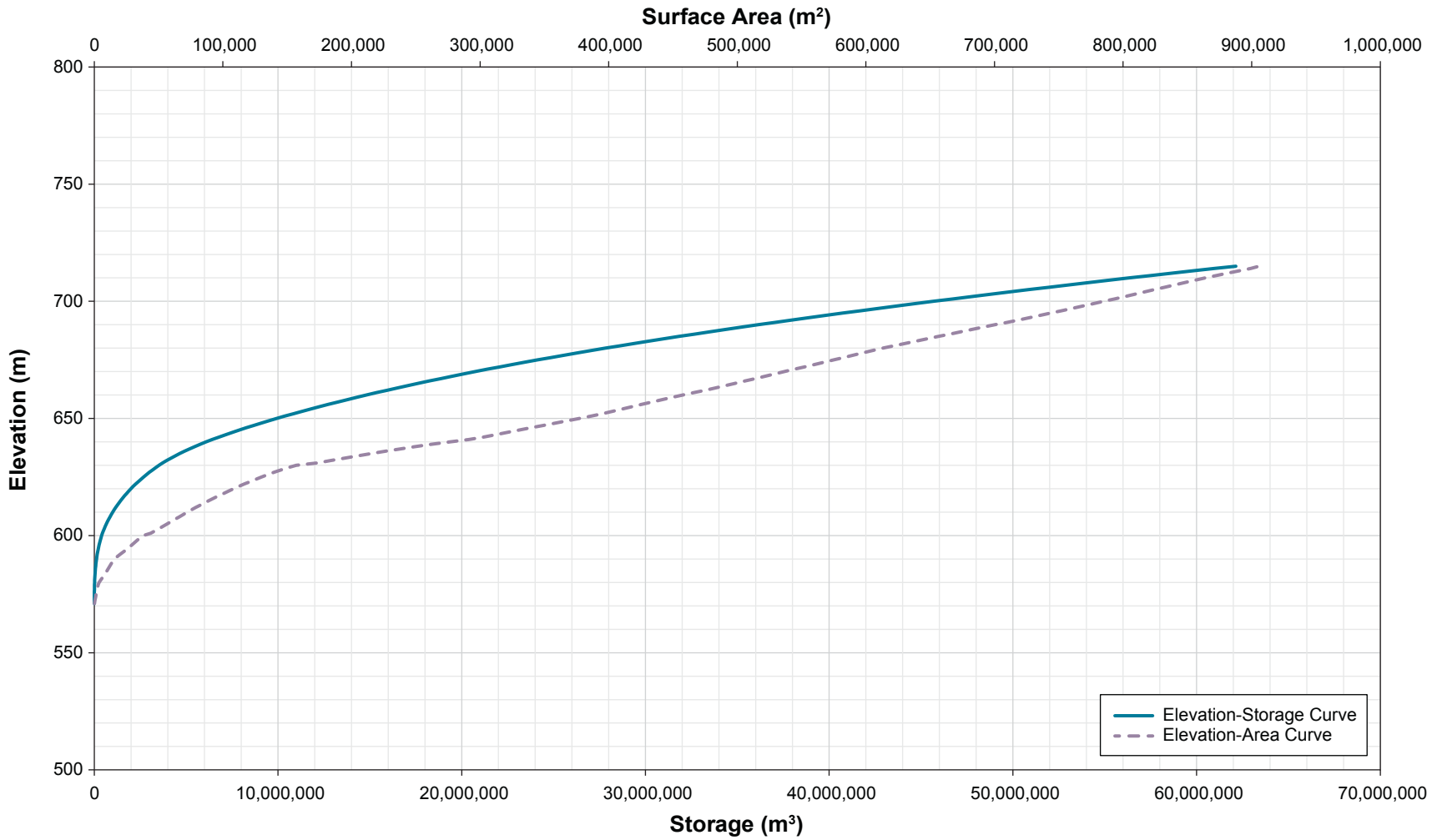

Figure 4.3-1

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Elevation-Storage Area Curves for the Water Storage Facility

Figure 4.3-1

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A constant seepage rate of 20 L/s from the impoundment to the Seepage Collection Pond is included in the water balance. This flow reports directly to the WTP.

To determine the minimum required height of the WSF Dam, 65 runs of the water balance model were completed, and the peak flow of a 1:200 wet year was inserted at every year of the 51.5 year mine life and 13.5 year closure period. The maximum water elevation at each year over the 65 trial runs was taken as the minimum required spillway elevation for the WSF Dam for that.

Excess water above the minimum operating pond volume is sent to the WTP. The WSF Seepage Collection Pond maintains priority throughout the mine life; instead of being pumped to the WSF these drain directly by gravity to the WTP. As a result, the flow rate directed to the WTP from the WSF element in the model is limited by the maximum capacity of the WTP, as well as by the preferential flows from the Seepage Collection Pond and Mitchell Pit /Underground during block caving.

Contact water obtained from Kerr Pit and Kerr RSF is sent to the Se Plant with a possibility of bypass during floods; the bypass discharges to the WSF. The treatment capacity is at 60 L/s. Treated water released from the Se Plant is directed to the WSF.

4.3.4 WSD Seepage Collection Pond

The Elevation-Storage Area curve for the WSD Seepage Collection Pond is shown in Figure 4.3-2.

In the water balance, the Seepage Collection Pond is treated as a separate storage element from the WSF. The following are the parameters used in the model:

- Flow from the Seepage Collection Pond is sent directly to the WTP; and
- The flow rate to the WTP from the Seepage Collection Pond is instantaneous, with a maximum flow rate of 200 L/s corresponding to the pipeline design capacity (coinciding with inflows from the 1:200 year wet event).

4.3.5 Mine Area Water Treatment Plant

Water treatment rates in the model are regulated based on the WSF pond elevation to limit pond fluctuation and maintain sufficient seasonal freeboard as required. During operations, rates are adjusted depending on precipitation and snow accumulation to maintain a yearly treatment rate.

In the model the available maximum treatment capacity of the WTP is 6.0 m^3/s until Year 26 and is 7.5 m^3/s from Year 26 until closure accounting for higher potential peak flow rates during the period that the underground workings are in operation. The monthly treatment rates were adjusted to match the flow patterns in the receiving environment; this was done to minimize any downstream environmental effects.

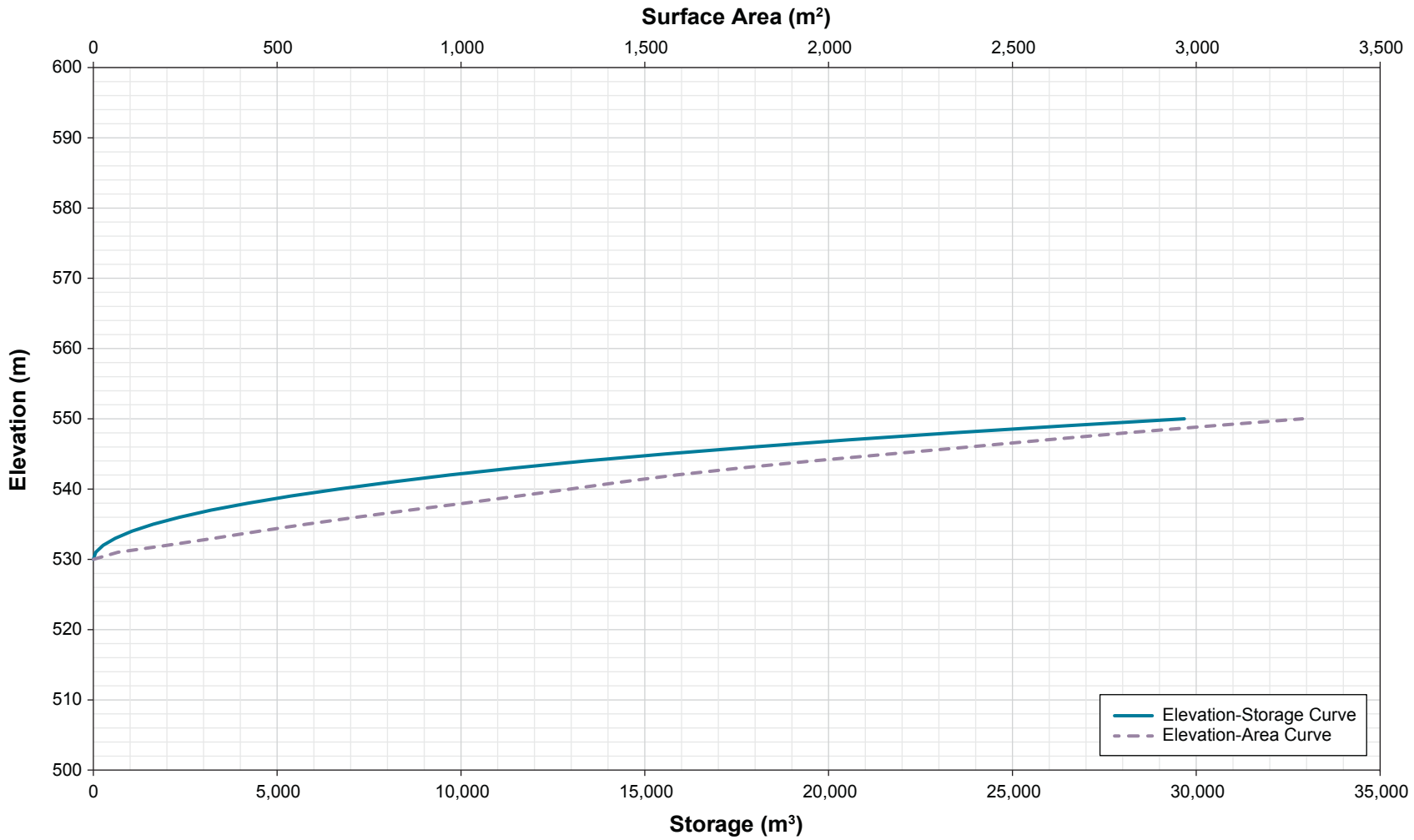

Figure 4.3-2

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Elevation-Storage Area Curves for the Water Storage Facility Seepage Control Pond

Figure 4.3-2

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During the construction period sludge from the WTP is dewatered in filter presses and stored near the plant in an engineered cell landfill. During operations, sludge from the WTP is conveyed along with the ore and ultimately be stored in the Tailing Management Facility (TMF) with the tailing. After closure, sludge is stored in cells constructed on the McTagg RSF. The operations period PTMA water balance and Mine Site water balance have been linked to reflect this connection. During operations, all sludge produced from the WTP is sent to the TMF with the following properties:

- Lime demand per litre of treated water — 0.34 g/L lime added at the WTP
- Hydrated Lime Density — 0.481 t/m^3
- Lime Specific Gravity — 2.691
- Lime % Solids to the PTMA — 50% or less

The total volume of sludge water produced by the treatment plants and contained in the sludge filter case is nominally 2.8 Mm^3 over 60 years, and is a minor component (~0.05%) of the total Mine Site and PTMA water balance.

4.3.6 Rock Storage Facility Characteristics

The RSF operating and closure period evaporation and percolation properties are shown in Table 4.3-5. The associated footprints were previously shown in Table 4.3-3.

Table 4.3-5. Rock Storage Facility Properties

Timeline	Evapotranspiration Coefficient	Runoff Coefficient	Infiltration Coefficient	Infiltration Lagtime (days)
Operations	0.30	0.07	0.63	0
Closure	0.20	0.25	0.55	0

During operations and closure, both the RSF runoff and infiltration report to the WSF. At closure, there is a soil cover placed on all RSF benches for reclamation purposes. The closure infiltration coefficient of 0.55 is an average infiltration rate over all the RSFs.

5 Results: Water Quantity Predictions

Streamflow results from the GoldSim water balance model, based on average monthly precipitation and base case diversion efficiencies, are shown in Section 5.1; sensitivity analysis of diversion efficiencies and variable precipitation data (i.e., dynamic simulation) are discussed in Section 5.2.

5.1 Base Case Results

5.1.1 Calibration for Baseline Conditions

Using the initial estimates for annual precipitation (Table 4.2-1), baseline flows at Mitchell Creek (MC2) were simulated and compared to baseline flows (Figure 5.1-1). Simulated flows at MC2 did not match the historical observed data; the coefficient of variation of the root-mean-square error, i.e., CV(RMSE), for estimated flows was 13.2%.

$$CV(RMSE) = \frac{\sqrt{\frac{\sum_{i=1}^{12}\left(Q_{m,i} - Q_{o,i}\right)^2}{12}}}{Q_{o,ave}}$$

Where
$Q_{m,I}$ = modelled (simulated) flow in the ith month
$Q_{o,I}$ = observed flow in the ith month
$Q_{o,ave}$ = average annual observed flow

The estimates of annual precipitation for catchment areas (Table 4.2-1), and changed the runoff coefficients of catchments 1 and 2 from 0.8 to 0.9, to minimize the difference between simulated and observed data. Figure 5.1-1 shows a visual match between simulated and observed baseline flows. The CV(RMSE) for MC2 flows was improved to 0.8%.

5.1.2 Base Case Streamflow Results (Base Case Diversion Efficiencies, under Average Hydrologic Conditions)

The water balance model was used to simulate streamflows within the Mine Site LSA during all stages of the Project. Simulated base case streamflows at assessment points are summarized in Figure 5.1-2 and Table 5.1-1, along with the annual flow volumes at the baseline condition.

Table 5.1-1. Simulated Annual Flow Volumes within the Mine Site for Baseline Condition and during Different Phases of the Project

		Baseline	Years 0-10	Years 10-25	Years 26-30	Years 30-51.5	Years 51.5-56	Years 57+
MC2	Contributing Drainage (km^2)	84.4	32.3	43.2	49.5	47.4	46.1	46.1
	Annual Flow (m^3/s)	5.54	2.13	2.59	2.77	2.66	2.13	2.55

(continued)

Table 5.1-1. Simulated Annual Flow Volumes within the Mine Site for Baseline Condition and during Different Phases of the Project (completed)

		Baseline	Years 0-10	Years 10-25	Years 26-30	Years 30-51.5	Years 51.5-56	Years 57+
	Change from Baseline (%)	n/a	-61.6%	-53.2%	-50.0%	-52.1%	-61.7%	-54.1%
	Contributing Drainage (km^2)	9.8	45.1	34.2	31.2	32.8	34.1	34.1
GC1	Annual Flow (m^3/s)	0.57	2.63	2.05	2.05	2.11	2.13	2.13
	Change from Baseline (%)	n/a	364.2%	261.4%	262.2%	272.4%	275.6%	275.7%
	Contributing Drainage (km^2)	84.2	97.8	97.8	97.8	98.3	98.3	98.3
SC1	Annual Flow (m^3/s)	6.42	7.87	7.86	7.65	7.58	6.52	7.75
	Change from Baseline (%)	n/a	22.7%	22.6%	19.2%	18.2%	1.7%	20.8%
	Contributing Drainage (km^2)	261.4	258.2	258.2	261.5	261.5	261.5	261.5
SC2	Annual Flow (m^3/s)	19.57	19.68	19.55	19.52	19.40	17.82	19.47
	Change from Baseline (%)	n/a	0.5%	-0.1%	-0.3%	-0.9%	-9.0%	-0.5%
	Contributing Drainage (km^2)	298.4	295.2	295.2	298.5	298.5	298.5	298.5
SC3	Annual Flow (m^3/s)	22.35	22.46	22.33	22.30	22.18	20.60	22.25
	Change from Baseline (%)	n/a	0.5%	-0.1%	-0.2%	-0.8%	-7.8%	-0.5%

5.2 Sensitivity Analysis and Dynamic Simulation

5.2.1 Sensitivity Analysis for Diversion Efficiencies

A sensitivity analysis was conducted to determine the effects of diversion efficiency variations on streamflows at Mitchell Creek (MC2), Gingras Creek (GC1), and Sulphurets Creek (SC1). Base case diversion efficiencies (Table 4.3-2) were increased (decreased) by 10% to represent the upper (lower) diversion efficiency scenarios. Diversion efficiencies of subcatchments 1A, 1B, and 2A were unchanged in this analysis because these catchments report to inlet tunnels, which have much higher efficiencies. Effects of these scenarios on streamflows at MC2, GC1, and SC1 are shown in Figures 5.2-1 to 5.2-3, and Tables 5.2-1 to 5.2-3.

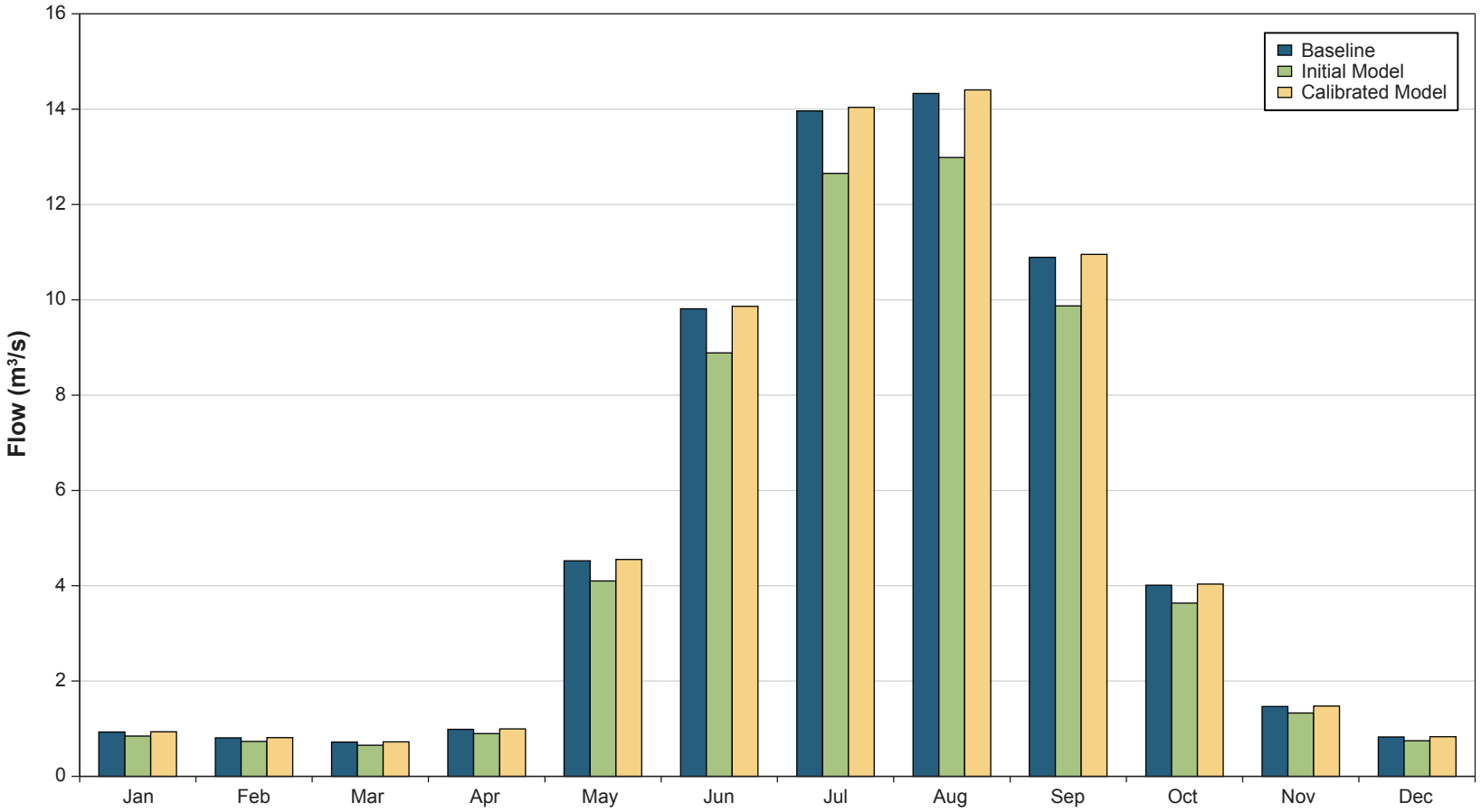

Figure 5.1-1

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Monthly Distribution of Annual Flows at MC2

Figure 5.1-1

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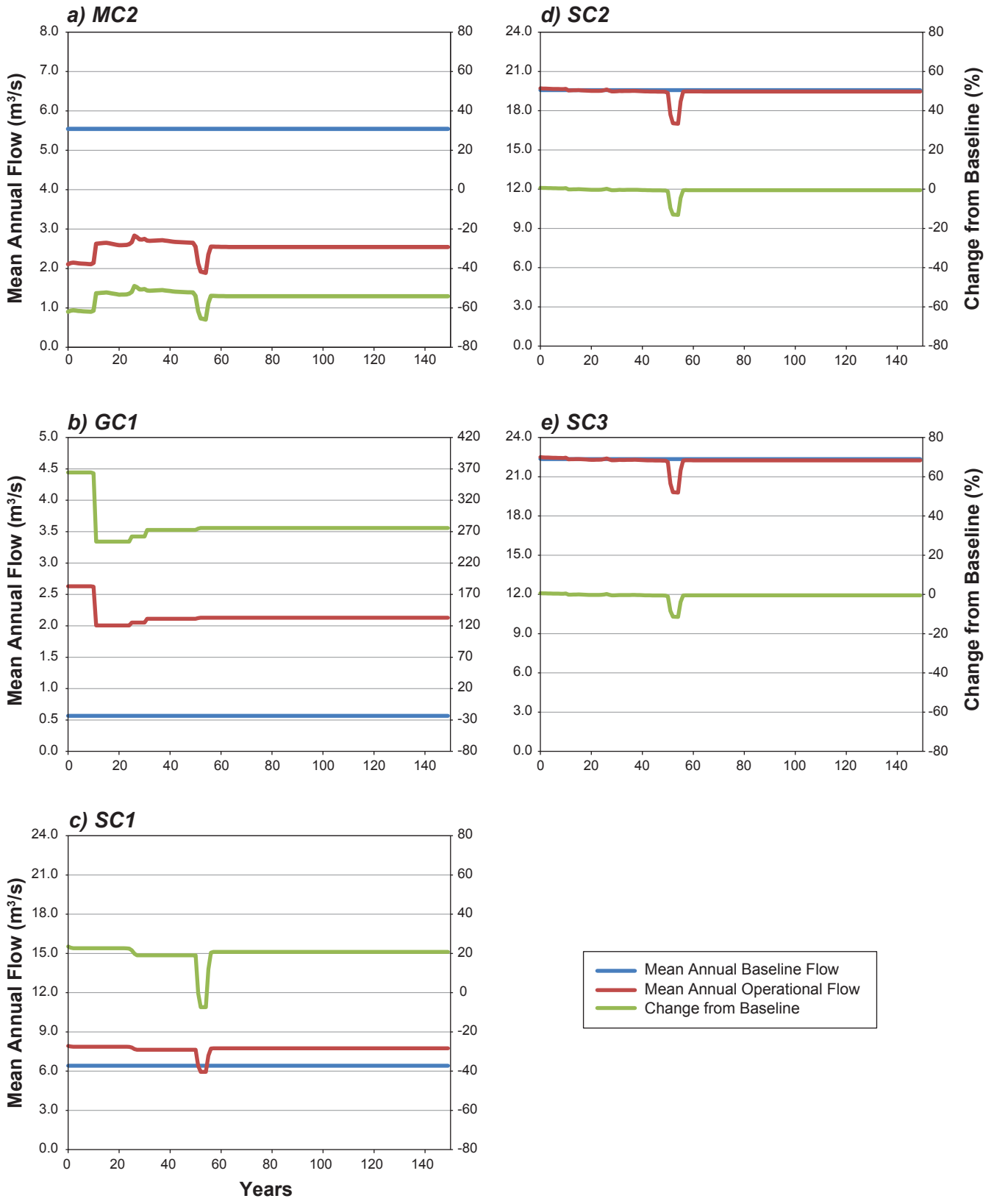

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Annual Flow Volumes in Mine Site Watersheds for the Baseline Condition and during Different Phases of the Project

Figure 5.1-2

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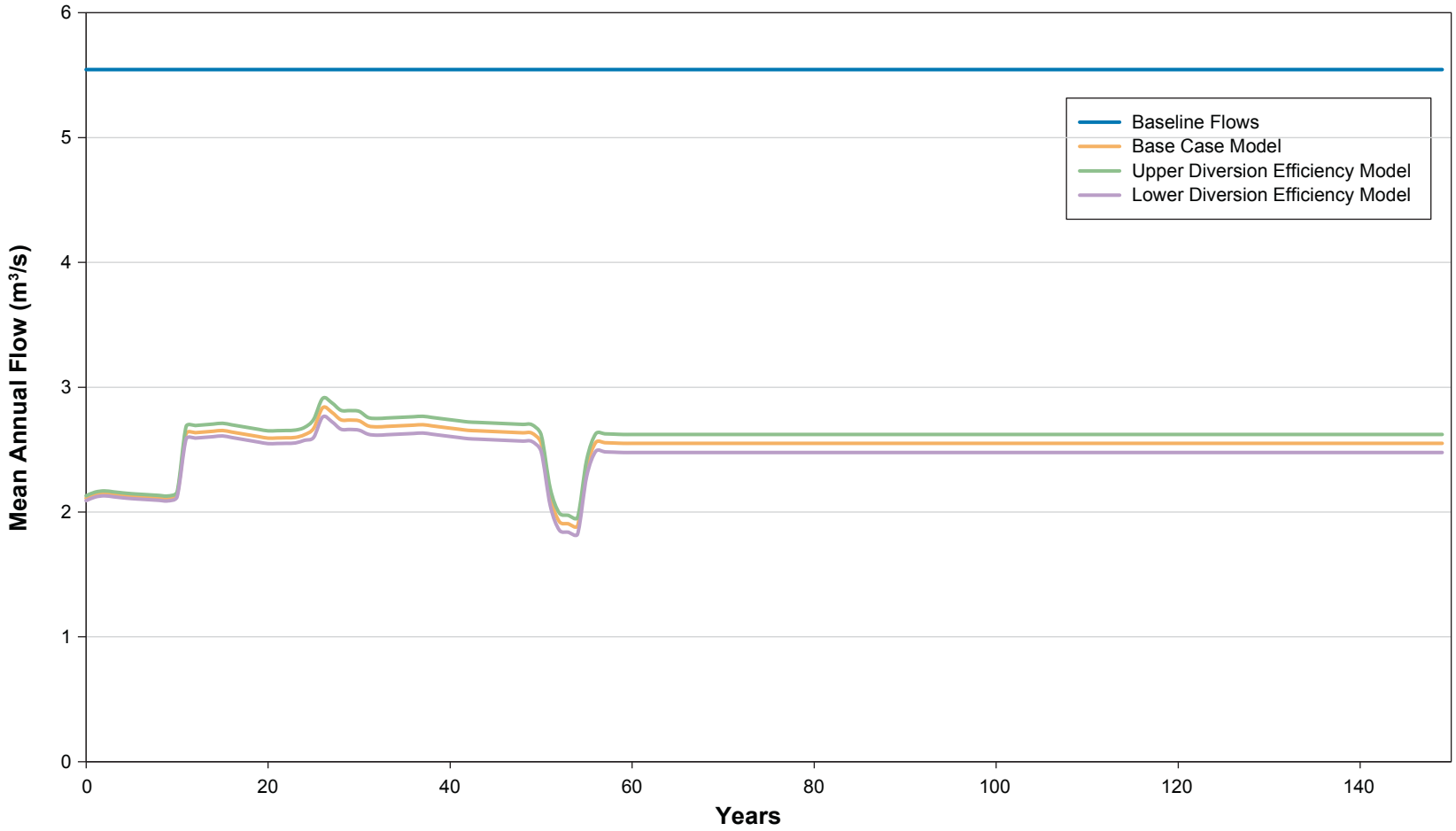

Figure 5.2-1

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Sensitivity of Operational Flows at MC2 to Changes in Diversion Efficiencies

Figure 5.2-1

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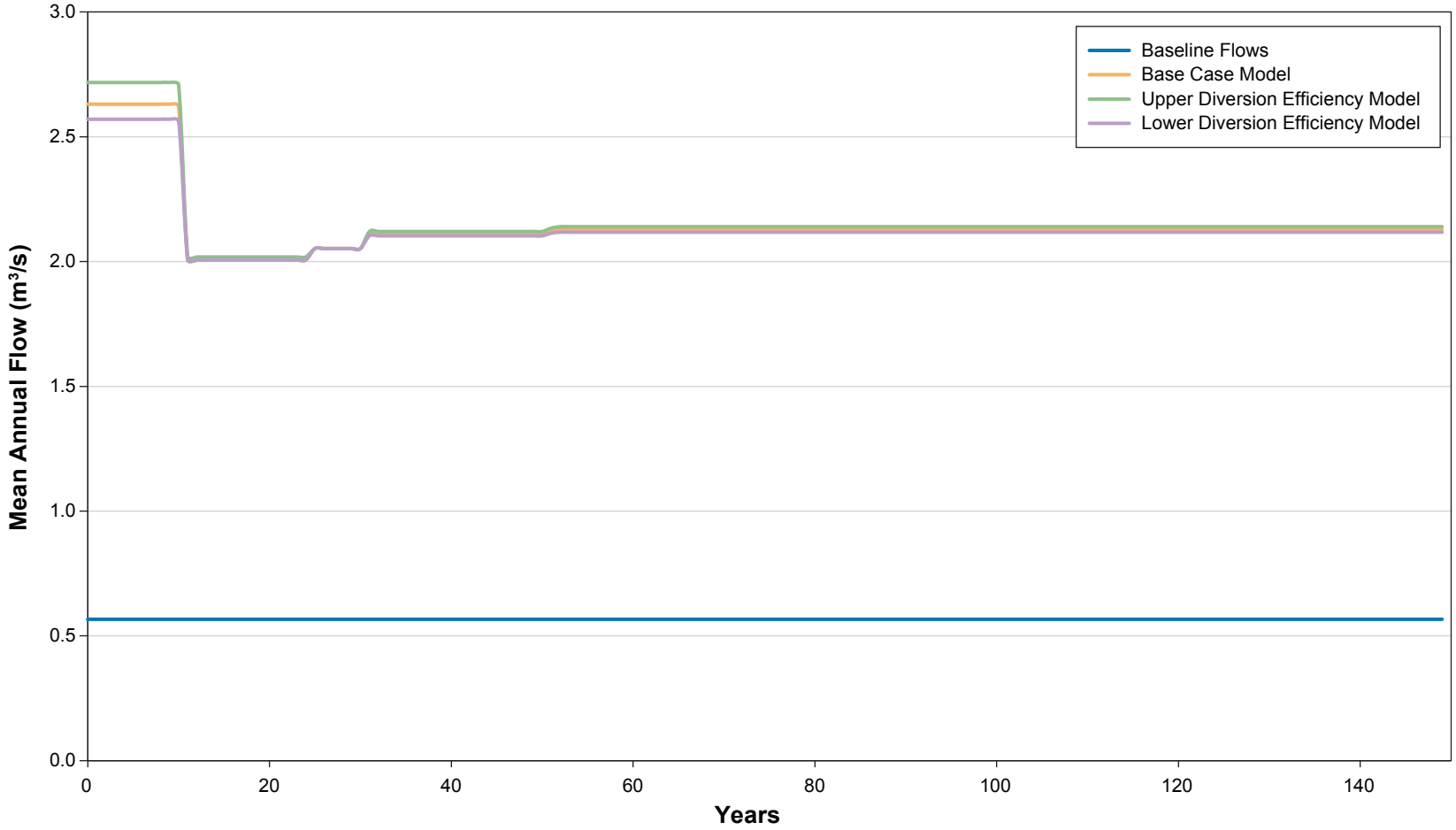

Figure 5.2-2

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Sensitivity of Operational Flows at GC1 to Changes in Diversion Efficiencies

Figure 5.2-2

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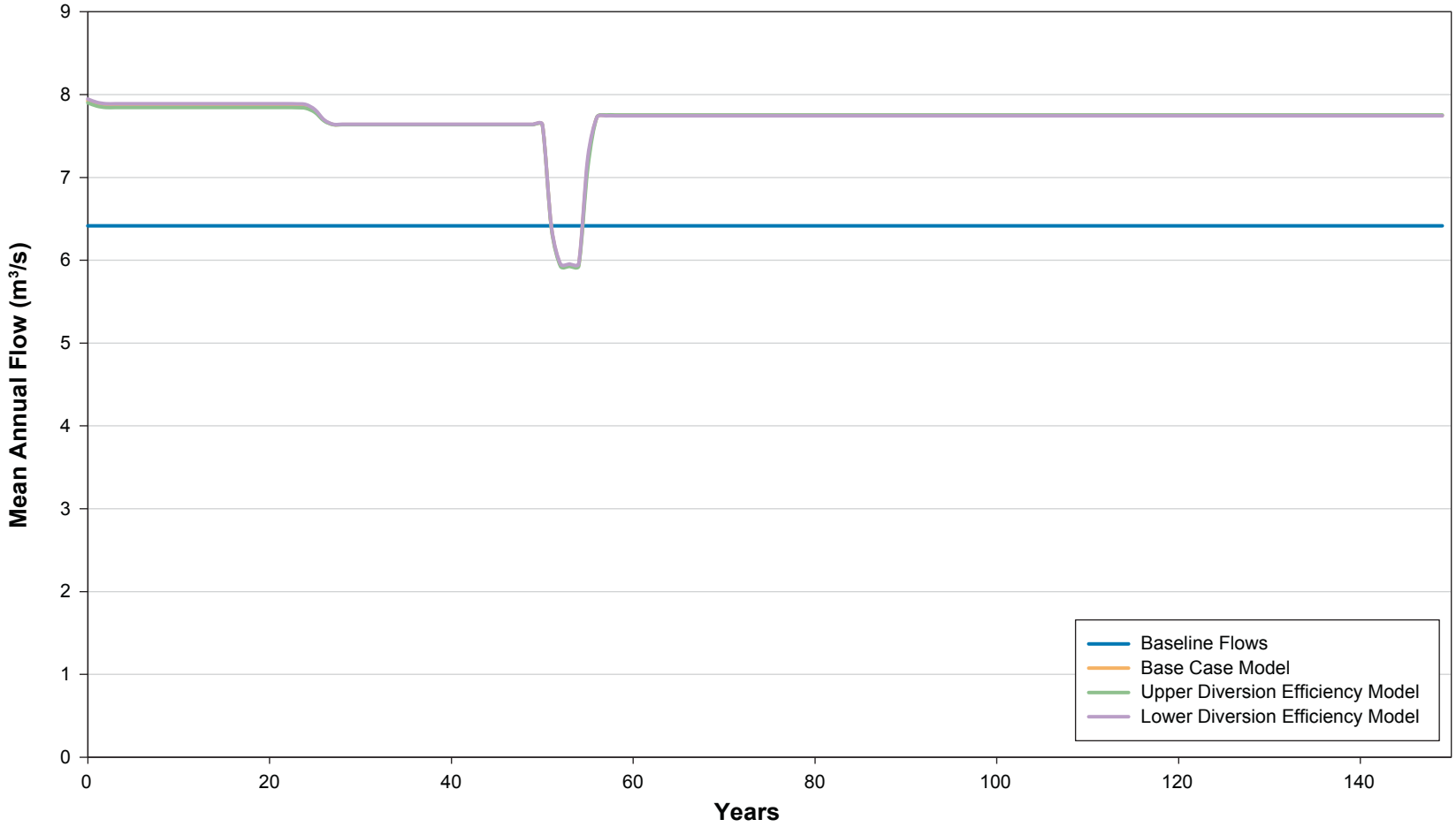

Figure 5.2-3

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Sensitivity of Operational Flows at SC1 to Changes in Diversion Efficiencies

Figure 5.2-3

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Table 5.2-1. Sensitivity of Operational Flows at MC2 to Changes in Diversion Efficiencies

	Years 0-10	Years 10-25	Years 26-30	Years 30-51.5	Years 51.5-56	Years 57+
Upper Diversion Efficiency (Base efficiency + 10%)	0.9%	2.2%	2.7%	2.5%	3.5%	2.8%
Lower Diversion Efficiency (Base efficiency - 10%)	-0.9%	-1.7%	-2.7%	-2.5%	-3.5%	-2.9%

Table 5.2-2. Sensitivity of Operational Flows at GC1 to Changes in Diversion Efficiencies

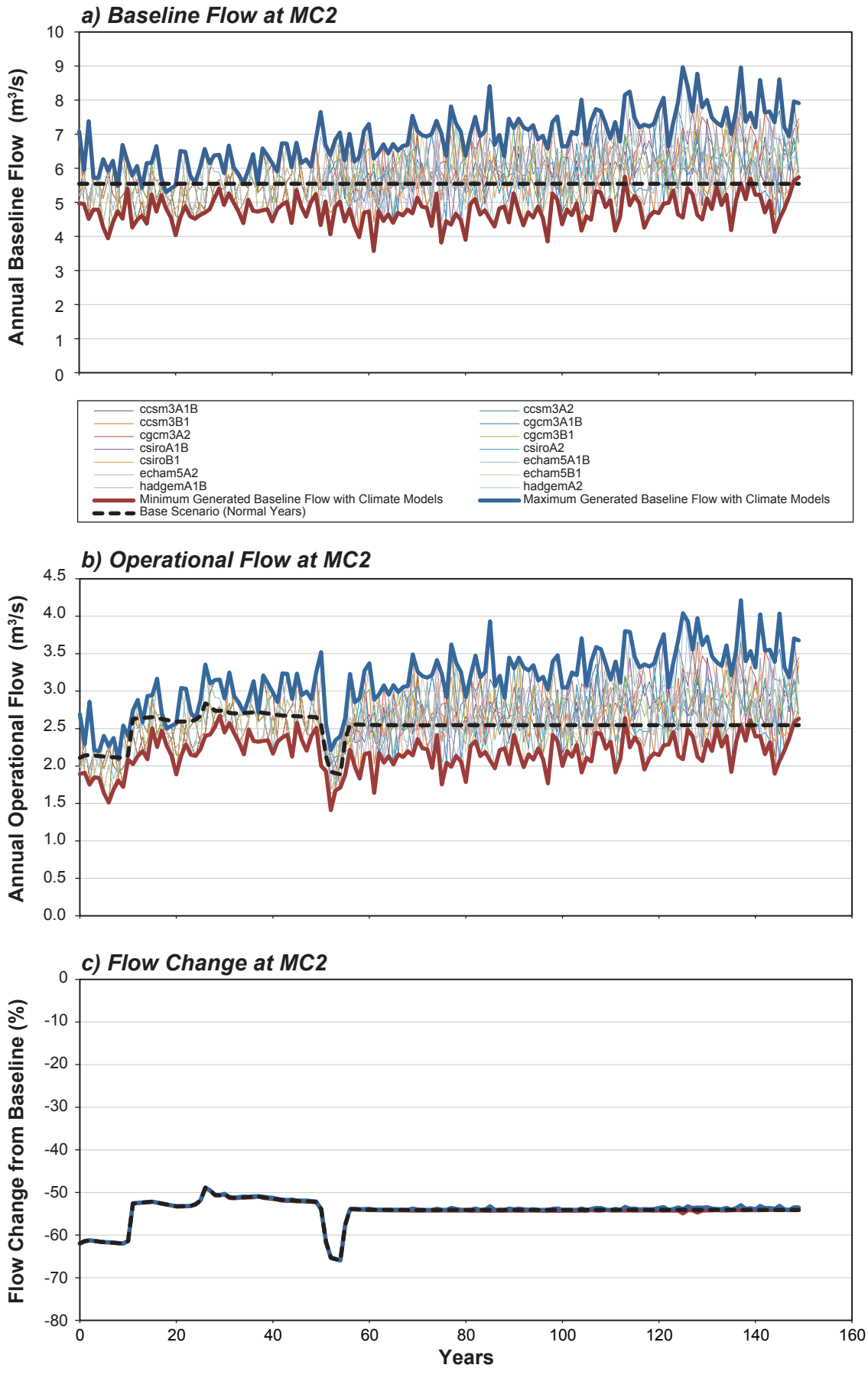
	Years 0-10	Years 10-25	Years 26-30	Years 30-51.5	Years 51.5-56	Years 57+
Upper Diversion Efficiency (Base efficiency + 10%)	3.3%	0.6%	0.0%	0.4%	0.5%	0.5%
Lower Diversion Efficiency (Base efficiency - 10%)	-2.3%	0.0%	0.0%	-0.4%	-0.5%	-0.5%

Table 5.2-3. Sensitivity of Operstional Flows at SC1 to Changes in Diversion Efficiencies

	Years 0-10	Years 10-25	Years 26-30	Years 30-51.5	Years 51.5-56	Years 57+
Upper Diversion Efficiency (Base efficiency + 10%)	-0.3%	-0.3%	0.0%	0.0%	-0.2%	0.1%
Lower Diversion Efficiency (Base efficiency - 10%)	0.3%	0.3%	0.0%	0.0%	0.2%	-0.1%

5.2.2 Dynamic Simulation

To verify the reliability of static simulation results, 14 different scenarios of 150-year projected precipitation data based on the global climate model and emission scenarios in Table 4.2-2 were used as input precipitation data to the GoldSim model. As previously mentioned, results of these scenarios were calibrated so that the average simulated precipitation at Mine Site between 2008 and 2011 matched with observed data during this period (1650 mm). The range of generated baseline flows with these scenarios at MC2, GC1, and SC1 are shown in Figures 5.2-4 to 5.2-6. Annual baseline flows in these scenarios vary from the 100-year dry to 200-year wet values (See Appendix 13-A). These figures also show operational flow volumes and percentage of change from baseline conditions at these locations. The range of effects of these climate scenarios on baseline flows, operational flows, and changes between operational and baseline flows at MC2, GC1, and SC1 are provided in Tables 5.2-4 to 5.2-6. These tables indicate that even though the baseline and operational flows may vary by up to 26.6% from the base case (i.e., static hydrologic parameters), the percentage of annual flow change does not deviate more than 2.3% from the base case or static scenario. That is, the base case scenario simulations reliably represent the effects of the Project on annual flow volumes.



Range of Annual Flow Volumes at MC2 for the Baseline Condition and during Different Phases of the Project

Figure 5.2-4

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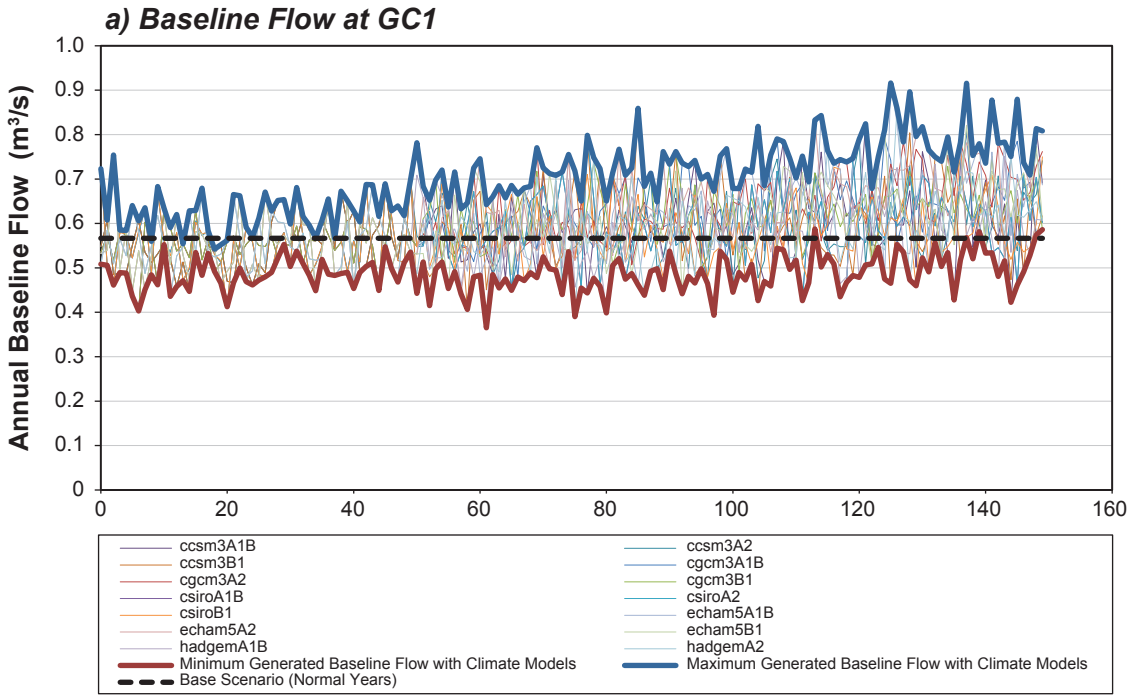

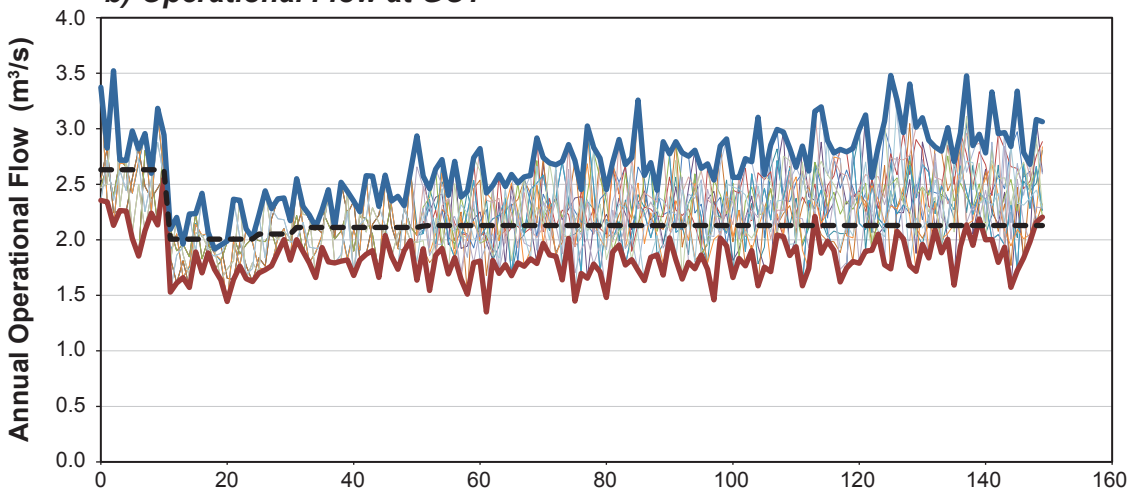

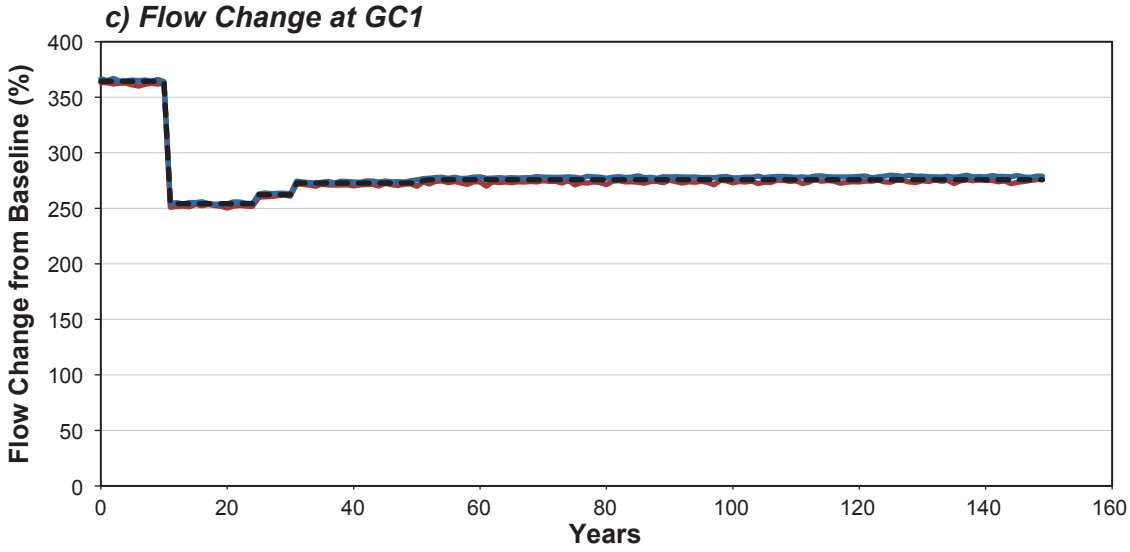

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Range of Annual Flow Volumes at GC1 for the Baseline Condition and during Different Phases of the Project

Figure 5.2-5

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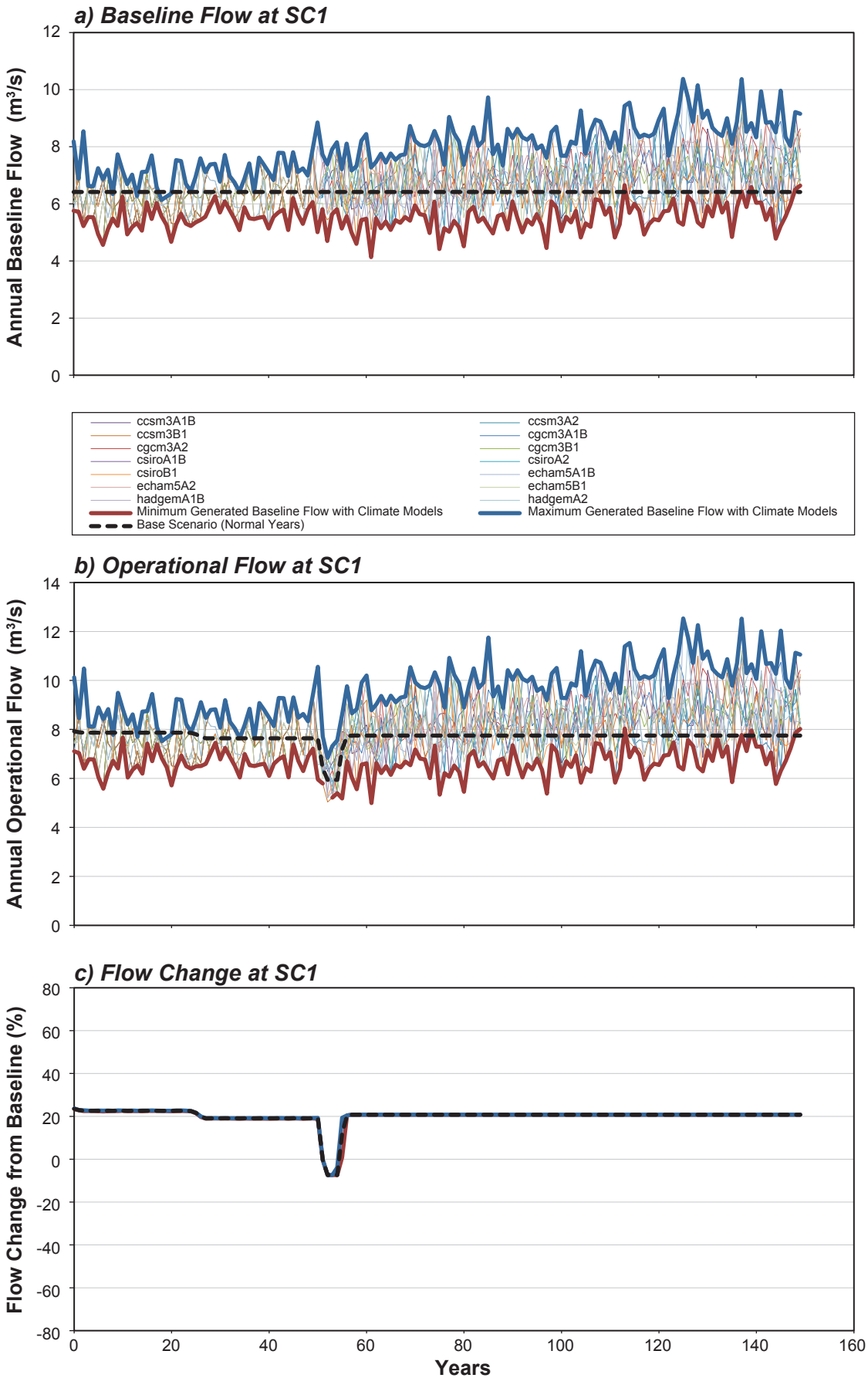

Range of Annual Flow Volumes at SC1 for the Baseline Condition and during Different Phases of the Project

Figure 5.2-6

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Table 5.2-4. Effects of Considering Climate Models on Streamflows at MC2 (Percentage Change from Base Case Scenario)

		Years 0-10	Years 10-25	Years 26-30	Years 30-51.5	Years 51.5-56	Years 57+
Baseline Flow	Difference between Maximum Generated Flow Scenario and Base Case Scenario	12.5%	6.7%	13.1%	14.1%	20.8%	25.9%
	Difference between Minimum Generated Flow Scenario and Base Case Scenario	-15.9%	-15.6%	-10.1%	-12.8%	-15.1%	-17.0%
Operational Flow	Difference between Maximum Generated Flow Scenario and Base Case Scenario	12.5%	6.7%	13.0%	13.4%	20.7%	26.2%
	Difference between Minimum Generated Flow Scenario and Base Case Scenario	-15.8%	-15.6%	-10.0%	-12.6%	-15.1%	-17.0%
Difference between Operational and Baseline Flows	Difference between Maximum Generated Flow Scenario and Base Case Scenario	0.0%	0.0%	0.0%	0.1%	0.0%	0.1%
	Difference between Minimum Generated Flow Scenario and Base Case Scenario	0.0%	0.0%	0.0%	-0.1%	0.0%	-0.1%

Table 5.2-5. Effects of Considering Climate Models on Streamflows at GC1 (Percentage Change from Base Case Scenario)

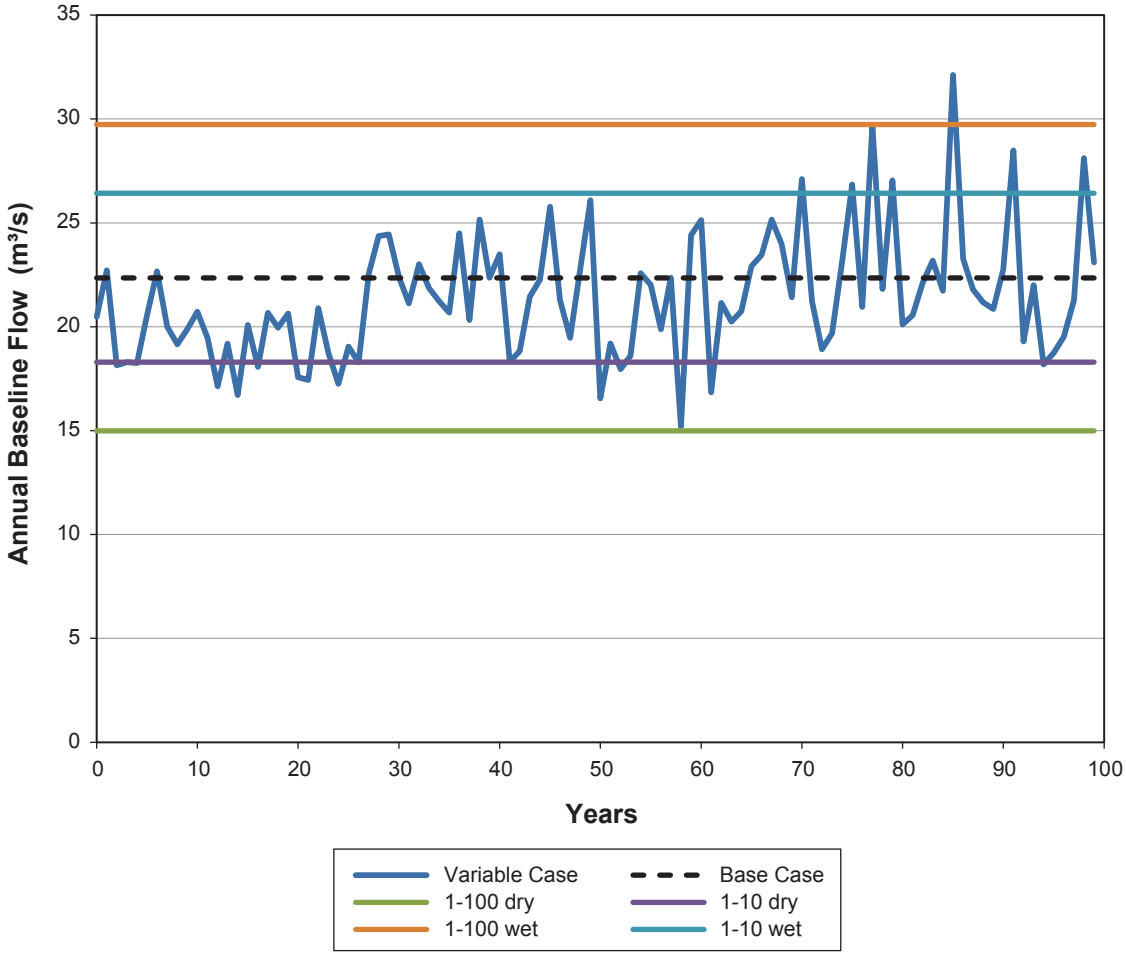
		Years 0-10	Years 10-25	Years 26-30	Years 30-51.5	Years 51.5-56	Years 57+
Baseline Flow	Difference between Maximum Generated Flow Scenario and Base Case Scenario	12.5%	6.7%	13.1%	14.1%	20.8%	25.9%
	Difference between Minimum Generated Flow Scenario and Base Case Scenario	-15.9%	-15.6%	-10.1%	-12.8%	-15.1%	-17.0%
Operational Flow	Difference between Maximum Generated Flow Scenario and Base Case Scenario	12.8%	7.0%	13.5%	14.1%	21.4%	26.6%
	Difference between Minimum Generated Flow Scenario and Base Case Scenario	-16.3%	-15.8%	-10.4%	-13.1%	-15.6%	-17.4%
Difference between Operational and Baseline Flows	Difference between Maximum Generated Flow Scenario and Base Case Scenario	1.1%	0.6%	1.2%	1.2%	1.8%	2.1%
	Difference between Minimum Generated Flow Scenario and Base Case Scenario	-2.1%	-2.0%	-1.2%	-1.6%	-2.0%	-2.3%

Table 5.2-6. Effects of Considering Climate Models on Streamflows at SC1 (Percentage Change from Base Case Scenario)

		Years 0-10	Years 10-25	Years 26-30	Years 30-51.5	Years 51.5-56	Years 57+
Baseline Flow	Difference between Maximum Generated Flow Scenario and Base Case Scenario	12.5%	6.7%	13.1%	14.1%	20.8%	25.9%
	Difference between Minimum Generated Flow Scenario and Base Case Scenario	-15.9%	-15.6%	-10.1%	-12.8%	-15.1%	-17.0%
Operational Flow	Difference between Maximum Generated Flow Scenario and Base Case Scenario	12.6%	6.8%	13.2%	13.7%	22.2%	25.9%
	Difference between Minimum Generated Flow Scenario and Base Case Scenario	-16.0%	-15.7%	-10.1%	-12.9%	-16.6%	-17.0%
Difference between Operational and Baseline Flows	Difference between Maximum Generated Flow Scenario and Base Case Scenario	0.1%	0.0%	0.1%	0.1%	1.8%	0.0%
	Difference between Minimum Generated Flow Scenario and Base Case Scenario	-0.2%	-0.1%	-0.1%	-0.1%	-1.9%	0.0%

5.3 Variable Case for Mine Site Water Quality Model

For the water quality model, a variable case was selected from the 14 different climate scenarios presented in Section 5.2.2. The CCSM3 model under the B1 emission scenario was selected and calibrated to the 2008 – 2011 average precipitation for that period (1650 mm). This calibration process resulted in an adjustment factor of 5.2 %. Please note that this adjustment factor differs from the factor used during the dynamic modelling case (11.6%), where the entire suite of models were calibrated to the estimated precipitation. For comparison purposes, modelled streamflows using both the base case and variable case for Sulphurets Creek (SC3) are provided in Figure 5.3-1.



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Example of Base Case and Variable Case Baseline Flows within Mine Site (SC3)

Figure 5.3-1

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6 Water Quality Modelling

6.1 Model Approach and Assumptions

Project-related effects on water quality in the receiving environment were evaluated through comparison of the baseline case and the mine case. The baseline case represents both historical activities and the natural geochemical loadings observed in the baseline study area. The baseline case considers water quality data and hydrological data collected at the Project site from 2008 to 2012. The baseline case is calculated as the sum of all mass loadings carried by all the flows from the Mine Site to the surrounding receiving environment as follows:

$$Baseline\ Case = \sum(C_{Base} \times Q_{Base})$$

Project activities may affect water quantity and water quality beyond the boundaries of the Mine Site. These downstream areas are defined as the receiving environment. In the model, water entered the receiving environment through three pathways: diverted non-contact water through various diversion structures, discharge from the water treatment plant, and estimated seepage through the main water storage facility dam not collected by seepage recovery mitigation measures.

The mine case estimates chemical mass loadings from the Project components, including surface disturbance, open pits, underground block cave mines, rock storage facilities (RSFs), surface water management, and water treatment. The effects of the Project activities on the mass loadings to the receiving environment are calculated from the difference between the baseline case and the mine case:

$$\Delta(Mass\ Loading) = \sum(C_{Mine} \times Q_{Mine}) - \sum(C_{Baseline} \times Q_{Baseline})$$

Applying the conservative assumption that natural attenuation does not occur on the difference in mass loadings (Δ), the concentrations downstream of the receiving environment are calculated as:

$$Concentration_{ENV} = (Baseline\ Case + \Delta(Mass\ Loading))/Q_{Mine}$$

6.1.1 General Model Assumptions

General model assumptions used to simplify the Project and environmental complexities include:

1. physical and chemical mixing of two or more bodies of water is instantaneous, complete, and results in no stratification;
2. dissolved chemical species remain in solution unless removed by mineral precipitation and/or water treatments;
3. concentration equals half the detection limit if a chemical species is below the detection limit of the applied analytical method;
4. project operational and engineering components turn on and off instantaneously;

5. precipitation and evaporation are assumed to be neutral inputs and outputs with no associated chemical loads;
6. monthly chemical loadings are calculated from annual chemical loadings and the monthly precipitation distributions; and
7. chemical loadings from walls of water management structures (e.g., diversion tunnels or ditches) are considered negligible.

Model assumptions specific to various components or activities of the Project are presented in the following sections.

6.1.2 Sensitivity Analysis

The Mine Site water quality model results were dependent on a large number of input parameters, including operational schedules, mine development, hydrology, climate, hydrogeology, and geochemistry.

Two key parameters were varied in model sensitivity analyses: the climatic/hydrologic conditions (Section 5.3) and the geochemical loadings from the Project components. Water balances were developed for the base case or average year and a variable case based on observed climate conditions from the last 50 years. The variable case water balance includes extreme events including up to a 1:100 year dry event and a 1:200 year wet event (see Section 5.3). Two geochemical loading scenarios were considered: the "expected case," which was represented by the statistical mean of the particular geochemical source term (i.e., concentration or leaching rate), and the "upper case," which was represented by the statistical 95th percentile of the particular geochemical source term. When insufficient data were available to conduct a statistical analysis of the input parameter, a constant input was applied. A summary of the four model scenarios is presented in Table 6.1-1.

Table 6.1-1. Water Quality Model Scenarios

Scenario	Water Balance	Geochemical Source Term
Scenario 1	Base case	Expected Case
Scenario 2	Base case	Upper Case
Scenario 3	Variable case	Expected Case
Scenario 4	Variable case	Upper Case

6.1.3 Model Parameters

The water quality model included 40 chemical species or parameters (Table 6.1-2). Total and WAD cyanide were modelled; however, the only sources of cyanide at the Mine Site are naturally occurring.

6.2 Geochemical Source Terms

An overview of the geochemical site conditions for the KSM Project, including characterization data is provided in the following sections. Additional details regarding the development of source terms (e.g., estimates of chemical loadings) for waste rock is provided in Chapter 10 of the Application/EIS.

Table 6.1-2. Modelled Chemical Parameters

Nutrients		Trace Elements			
Ammonia	NH_4	Silver	Ag	Magnesium	Mg
Nitrite	NO_2	Aluminum	Al	Manganese	Mn
Nitrate	NO_3	Arsenic	As	Molybdenum	Mo
Phosphorus	P	Boron	B	Sodium	Na
Anions		Barium	Ba	Nickel	Ni
Bromide	Br	Beryllium	Be	Lead	Pb
Fluoride	F	Calcium	Ca	Antimony	Sb
Sulphate	SO_4	Cadmium	Cd	Selenium	Se
Chloride	Cl	Cobalt	Co	Silicon	Si
Cyanides		Chromium	Cr	Tin	Sn
Total cyanide	CN	Copper	Cu	Strontium	Sr
WAD cyanide	CN WAD	Iron	Fe	Thallium	Tl
		Mercury	Hg	Uranium	U
		Potassium	K	Vanadium	V
		Lithium	Li	Zinc	Zn

6.2.1 Source Term Chemistry

Source term chemistry for the Project components were developed from ML/ARD characterization and predictions (Chapter 10), background groundwater quality (Chapter 12), and background surface water quality (Chapter 14). Model inputs are summarized in Table 6.2-1 and detail is provided in the following sections.

Table 6.2-1. Source Term Chemistry for the Mine Site Area Water Quality Model

Project Component	Data Source	
	Expected Case	**Upper Case**
Mitchell and McTagg RSFs	Operation: 1) waste rock: scaled humidity cell leach rates (mean values) for model codes identified in the waste rock schedule 2) background groundwater quality 3) undiverted natural catchment (background surface water quality)	Operation: 1) waste rock: scaled humidity cell leach rates (95th percentile values) for model codes identified in the waste rock schedule 2) background groundwater quality 3) undiverted natural catchment
	Closure/Post-closure: 1) waste rock: scaled humidity cell leach rates (mean of steady state rates) for model codes identified in the waste rock schedule 2) background groundwater quality 3) undiverted natural catchment (background surface water quality)	Closure/Post-closure: 1) waste rock: scaled humidity cell leach rates (95th percentile of steady state rates) for model codes identified in the waste rock schedule 2) background groundwater quality 3) undiverted natural catchment (background surface water quality)

(continued)

Table 6.2-1. Source Term Chemistry for the Mine Site Area Water Quality Model (continued)

Project Component	Data Source	
	Expected Case	**Upper Case**
Ore Stockpile	Operation: 1) ore: scaled ore humidity cell leach rates (mean values) for model codes identified in the ore schedule	Operation: 1) ore: scaled ore humidity cell leach rates (95th percentile values) for model codes identified in the ore schedule
Kerr Pit	Operation and Closure/Post-closure: 1) pit walls: scaled humidity cell leach rates (mean values) for model codes identified in the waste rock schedule with associated pit wall areas 2) background groundwater quality 3) undiverted natural catchment (background surface water quality)	Operation and Closure/Post-closure: 1) pit walls: scaled humidity cell leach rates (95th percentile values) for model codes identified in the waste rock schedule with associated pit wall areas 2) background groundwater quality 3) undiverted natural catchment (background surface water quality)
Sulphurets Pit	Operation and Closure/Post-closure: 1) pit walls: scaled humidity cell leach rates (mean values) for model codes identified in the waste rock schedule with associated pit wall areas 2) backfill: scaled humidity cell leach rates (mean values) for Kerr waste rock model codes in the waste rock schedule. Chemical loadings from the Sulphurets backfill is calculated for 2 water streams: a) water that infiltrates the cover or exposed waste rock and is collected in the basal drain; and b) water that runs off the cover or exposed waste rock 3) background groundwater quality 4) undiverted natural catchment (background surface water quality)	Operation and Closure/Post-closure: 1) pit walls: scaled humidity cell leach rates (95th percentile values) for model codes identified in the waste rock schedule with associated pit wall areas 2) backfill: scaled humidity cell leach rates (95th percentile) values) for Kerr waste rock model codes in the waste rock schedule. Chemical loadings from the Sulphurets backfill is calculated for 2 water streams: a) water that infiltrates the cover or exposed waste rock and is collected in the basal drain; and b) water that runs off the cover or exposed waste rock 3) background groundwater quality 4) undiverted natural catchment (background surface water quality)
Mitchell Operating Camp	Operation: 1) sewage discharge from the Mitchell operating camp to Sulphurets Creek	Operation: 1) sewage discharge from the Mitchell operating camp to Sulphurets Creek
Mitchell Pit	Operation: 1) pit walls: scaled humidity cell leach rates (mean values) for model codes identified in the waste rock schedule 2) background groundwater quality 3) undiverted natural catchment (background surface water quality)	Operation: 1) pit walls: scaled humidity cell leach rates (95th percentile values) for model codes identified in the waste rock schedule 2) background groundwater quality 3) undiverted natural catchment (background surface water quality)
Mitchell Block Cave Mine	Operation and Closure/Post-closure: 1) pit walls + disturbed materials: scaled humidity cell leach rates (mean values) for Mitchell ore codes 2) background groundwater quality	Operation and Closure/Post-closure: 1) pit walls + disturbed materials: scaled humidity cell leach rates (95th percentile values) for Mitchell ore codes 2) background groundwater quality

(continued)

Table 6.2-1. Source Term Chemistry for the Mine Site Area Water Quality Model (completed)

Project Component	Data Source	
	Expected Case	**Upper Case**
Iron Cap Block Cave Mine	Operation and Closure/Post-closure: 1) disturbed materials: scaled humidity cell leach rates (mean values) for Iron Cap ore 2) background groundwater quality	Operation and Closure/Post-closure: 1) disturbed materials: scaled humidity cell leach rates (95th percentile values) for Iron Cap ore 2) background groundwater quality
Mitchell Pit Lake	Closure/Post-closure: 1) pit walls: scaled humidity cell leach rates (mean values) for model codes identified in the waste rock schedule with associated pit wall areas 2) background groundwater quality 3) undiverted natural catchment (background surface water quality)	Closure/Post-closure: 1) pit walls: scaled humidity cell leach rates (95th percentile values) for model codes identified in the waste rock schedule with associated pit wall areas 2) background groundwater quality 3) undiverted natural catchment (background surface water quality)

Source terms were developed using expected characteristics of each Project component including rock type, grain size distribution, predicted release rates, mine plan, and Project schedule.

The prediction and assessment of the potential for metal leaching and acid rock drainage (ML/ARD) was based on the geochemistry of geological materials that will be disturbed by the proposed Project. Loadings from waste rock, pit walls, and block cave mines will be produced by sub-aerial leaching and release of water quality parameters. Water quality estimates were based on laboratory humidity cell tests of drill core samples from the Project site (Tables 6.2-2 to 6.2-5), and an acid-base accounting (ABA) block model (Table 6.2-6), waste rock production schedule (see Section 6.8), and proposed pit shells provided by MMTS (see Section 6.5). Block cave mine plans were provided by Golder Associates. The mine plan and schedule (Table 3.2-2) were obtained from the Preliminary Feasibility Study (TetraTech-Wardrop 2012).

Table 6.2-2. Waste Rock Humidity Cells Representing Mine Site Waste Rock in the Water Quality Model

Water Quality Model Code		Method
KN	Kerr neutral	All weeks HC 20 Cycle 1-28 HC 22
KA	Kerr acidic	All weeks HC 21 All weeks after cycle 28 HC 22 All weeks HC 23
SON	S Overburden neutral	Proxy: S Undefined neutral
SOA	S Overburden acidic	All weeks HC S-06-05
SAUN	S Au, leach, Raewn neutral	Proxy: S Lower Au neutral
SAUA	S Au, leach, Raewn acidic	Proxy: S Overburden acidic
SLAN	S Lower Au neutral	All weeks HC 24 All weeks HC 25
SLAA	S Lower Au acidic	Proxy: S Overburden acidic

(continued)

Table 6.2-2. Waste Rock Humidity Cells Representing Mine Site Waste Rock in the Water Quality Model (completed)

Water Quality Model Code		Method
SLPN	S LP Hazelton neutral	Proxy: S Undefined neutral
SLPA	S LP Hazelton acidic	Proxy: S Overburden acidic
SUPN	S UP Hazelton neutral	All weeks HC S-06-04 All weeks HC 17
SUPA	S UP Hazelton acidic	Proxy: S Overburden acidic
SMON	S Monzonite neutral	Proxy: HC S-06-04
SMOA	S Monzonite acidic	Proxy: S Overburden acidic
SUNN	S Undefined neutral	All weeks HC 18 All weeks HC 19
SUNA	S Undefined acidic	Proxy: S Overburden acidic
MUPN	M UP Hazelton neutral	All weeks HC M-07-33 All weeks HC M-07-44 All weeks HC 3 All weeks HC 10 All weeks HC 13 All weeks HC 14
MUPA	M UP Hazelton acidic	All weeks HC 2
MLPN	M LP Hazelton neutral	All weeks HC 5 All weeks HC 6 All weeks HC 7 All weeks HC 8 All weeks HC 9 All weeks HC 11 All weeks HC 12 All weeks HC 16 All weeks HC 26
MLPA	M LP Hazelton acidic	All weeks HC M-06-14 All weeks HC M-07-43 All weeks HC 1
MMON	M Monzonite neutral	All weeks HC M-07-30 All weeks HC NM-05-03
MMOA	M Monzonite acidic	Proxy: M UP Hazelton acidic
MBBN	M Leach breccia/bornite breccia neutral	No material of this type in waste rock schedule
MBBA	M Leach breccia/bornite breccia acidic	All weeks HC 15
MUNN	M Undefined neutral	No material of this type in waste rock schedule
MUNA	M Undefined acidic	No material of this type in waste rock schedule
ICN	Iron Cap neutral	All weeks HC IC1 All weeks HC IC2 Cycles 0-9 HC IC4 All weeks HC IC5 Cycles 0-6 HC IC6
ICA	Iron Cap acidic	All weeks HC IC3 All weeks after cycle 9 HC IC4 All weeks after cycle 6 HC IC6

Table 6.2-3. pH and Leaching Rates (mg/kg/week) from Kerr and Iron Cap Humidity Cells

ABA Block Model Codes	KN Kerr Neutral		KA Kerr Acidic		ICN Iron Cap Neutral		ICA Iron Cap Acidic	
List of Parameters	**Mean**	**p95**	**Mean**	**p95**	**Mean**	**p95**	**Mean**	**p95**
pH	6.91	6.36	4.37	3.32	7.18	6.81	3.72	2.81
Ag	0.00001	0.00003	0.00015	0.00022	0.00001	0.00002	0.00030	0.00081
Al	0.02	0.10	4.68	18.77	0.17	0.37	11.09	22.07
As	0.00058	0.00142	0.02223	0.08622	0.00367	0.00817	0.02312	0.07934
B	0.0103	0.0147	0.0118	0.0188	0.0695	0.0794	0.0659	0.0806
Ba	0.0288	0.0524	0.0540	0.1515	0.1150	0.1383	0.0884	0.2005
Be	0.00002	0.00002	0.00290	0.00297	0.00018	0.00014	0.00742	0.01882
Ca	37.8	51.3	43.3	28.6	48.6	72.3	37.1	74.4
Cd	0.00021	0.00031	0.00207	0.00660	0.00121	0.00095	0.03337	0.13624
Cl	0.45	0.43	0.62	0.65	3.13	10.68	0.97	1.99
Co	0.0017	0.0039	0.0378	0.0560	0.0070	0.0045	0.1133	0.2511
Cr	0.0008	0.0018	0.0029	0.0039	0.0002	0.0003	0.0067	0.0231
Cu	0.1269	0.3509	28.6522	49.7143	0.0168	0.0351	11.5893	26.7299
F	0.11	0.27	0.33	0.81	1.29	2.12	13.79	40.74
Fe	0.046	0.052	36.958	60.681	0.016	0.072	47.509	135.622
Hg	0.0000057	0.0000421	0.0000222	0.0000440	0.0000049	0.0000063	0.0000109	0.0000304
K	2.96	8.72	2.95	3.73	15.27	34.39	6.30	15.42
Li	0.0022	0.0060	0.0031	0.0012	0.0052	0.0146	0.0029	0.0059
Mg	5.38	10.74	5.09	12.96	3.66	7.55	1.42	5.82
Mn	1.061	2.114	0.925	2.391	1.093	0.623	1.199	4.231
Mo	0.0122	0.0431	0.0009	0.0031	0.0090	0.0246	0.0008	0.0028
Na	0.69	1.18	2.32	0.33	5.25	8.85	1.71	3.06
Ni	0.0006	0.0012	0.0149	0.0173	0.0013	0.0013	0.0151	0.0363
Pb	0.0007	0.0019	0.0065	0.0138	0.0034	0.0035	0.2670	1.2950
Sb	0.0012	0.0032	0.0052	0.0186	0.0227	0.0238	0.0127	0.0440
Se	0.0081	0.0111	0.0267	0.0539	0.0166	0.0275	0.0182	0.0606
Si	1.05	2.17	3.93	8.04	4.33	5.85	13.74	21.37

(continued)

Table 6.2-3. pH and Leaching Rates (mg/kg/week) from Kerr and Iron Cap Humidity Cells (completed)

ABA Block Model Codes	KN Kerr Neutral		KA Kerr Acidic		ICN Iron Cap Neutral		ICA Iron Cap Acidic	
List of Parameters	**Mean**	**p95**	**Mean**	**p95**	**Mean**	**p95**	**Mean**	**p95**
Sn	0.00037	0.00093	0.00055	0.00146	0.00057	0.00135	0.00116	0.00313
SO_4	102	129	330	326	128	239	314	571
Sr	0.301	0.428	0.586	0.968	0.873	1.306	0.407	1.341
Tl	0.00003	0.00002	0.00007	0.00002	0.00018	0.00026	0.00051	0.00130
U	0.00003	0.00009	0.00174	0.00331	0.00418	0.01505	0.09472	0.29961
V	0.00016	0.00062	0.00054	0.00140	0.00103	0.00355	0.00148	0.00315
Zn	0.006	0.012	0.395	1.466	0.038	0.051	3.143	12.246
Acidity	9.63	13.49	192.91	325.96	3.87	9.26	288.35	684.45
Alkalinity as HCO_3	18.1	36.4	0.0	6.2	28.6	75.0	0.0	0.8

Chloride set to the detection limit when not analyzed
Values of pH and alkalinity are set to the 5th percentiles of data in the cases where the 95th percentile (p95) is used as the conservative case
K = Kerr deposit
S = Sulphurets deposit

Table 6.2-4. pH and Leaching Rates (mg/kg/week) from Sulphurets Humidity Cells

ABA Block Model Codes	SOA S Overburden Acidic		SLAN S lower Au Neutral		SUPN S UP Hazelton Neutral		SUNN S Undefined Neutral	
List of Parameters	**Mean**	**p95**	**Mean**	**p95**	**Mean**	**p95**	**Mean**	**p95**
pH	2.98	2.57	7.28	6.87	7.85	7.52	7.39	7.59
Ag	0.00002	0.00006	0.00002	0.00004	0.00001	0.00002	0.00002	0.00007
Al	6.02	10.61	0.10	0.17	0.27	0.46	0.10	0.18
As	0.13471	0.40880	0.00098	0.00272	0.00132	0.00206	0.00093	0.00231
B	0.0111	0.0115	0.0136	0.0393	0.0075	0.0114	0.0046	0.0095
Ba	0.0029	0.0152	0.0226	0.0294	0.2668	0.4327	0.0500	0.0914
Be	0.00209	0.01571	0.00003	0.00002	0.00028	0.00056	0.00002	0.00002
Ca	23.5	67.9	22.9	33.5	21.9	27.6	33.0	42.7
Cd	0.01641	0.03077	0.00013	0.00030	0.00011	0.00052	0.00409	0.01642

(continued)

Table 6.2-4. pH and Leaching Rates (mg/kg/week) from Sulphurets Humidity Cells (completed)

ABA Block Model Codes	SOA S Overburden Acidic		SLAN S Lower Au Neutral		SUPN S UP Hazelton Neutral		SUNN S Undefined Neutral	
List of Parameters	**Mean**	**p95**	**Mean**	**p95**	**Mean**	**p95**	**Mean**	**p95**
Cl	9.36	21.94	0.42	0.75	0.28	0.40	0.26	0.22
Co	0.1582	0.2773	0.0002	0.0004	0.0001	0.0002	0.0006	0.0014
Cr	0.0046	0.0083	0.0008	0.0017	0.0006	0.0015	0.0008	0.0016
Cu	7.8732	10.1324	0.0072	0.0155	0.0048	0.0104	0.0018	0.0038
F	0.57	1.29	0.78	1.50	0.10	0.43	0.08	0.22
Fe	132.168	288.423	0.079	0.116	0.023	0.116	0.013	0.042
Hg	0.00000001	0.00000002	0.0000103	0.0000410	0.0000031	0.0000211	0.0000055	0.0000210
K	1.08	3.50	3.91	9.90	1.22	3.52	1.39	4.31
Li	0.0006	0.0008	0.0065	0.0145	0.0036	0.0058	0.0030	0.0095
Mg	0.38	0.76	2.82	6.41	0.69	2.38	1.79	5.07
Mn	0.737	2.716	0.126	0.159	0.035	0.066	0.178	0.765
Mo	0.0021	0.0055	0.0304	0.0414	0.2787	0.9369	0.0093	0.0187
Na	0.41	0.56	1.73	5.05	0.86	1.69	0.42	0.87
Ni	0.0825	0.1428	0.0006	0.0014	0.0005	0.0008	0.0006	0.0014
Pb	0.0007	0.0023	0.0006	0.0026	0.0002	0.0008	0.0315	0.0982
Sb	0.0179	0.0326	0.0081	0.0194	0.0036	0.0118	0.0035	0.0150
Se	0.0099	0.0126	0.0028	0.0063	0.0053	0.0114	0.0050	0.0156
Si	8.48	12.37	1.36	2.32	2.00	3.18	1.30	2.17
Sn	0.00011	0.00011	0.00074	0.00182	0.00035	0.00115	0.00043	0.00107
SO_4	587	1125	41	79	14	34	56	87
Sr	0.138	0.443	0.689	1.596	0.568	2.406	0.719	2.156
Tl	0.00073	0.00111	0.00001	0.00002	0.00006	0.00011	0.00002	0.00002
U	0.01407	0.07097	0.00147	0.00462	0.00137	0.00601	0.00120	0.00308
V	0.00224	0.00713	0.00104	0.00252	0.00489	0.01124	0.00359	0.00832
Zn	5.916	11.535	0.005	0.011	0.004	0.010	0.101	0.405
Acidity	552.88	1094.27	9.33	13.81	7.19	12.51	7.94	13.29
Alkalinity as HCO_3	0.0	2.3	39.2	55.6	52.2	61.2	43.1	54.3

Chloride set to the detection limit when not analyzed
Values of pH and alkalinity are set to the 5th percentiles of data in the cases where the 95th percentile (p95) is used as the conservative case
S = Sulphurets deposit

Table 6.2-5. pH and Leaching Rates (mg/kg/week) from Mitchell Humidity Cells

ABA Block Model Codes	MUPN M UP Hazelton Neutral		MUPA M UP Hazelton Acidic		MLPN M LP Hazelton Neutral		MLPA M LP Hazelton Neutral		MMON M Monzonite Neutral		MBBA M Leach breccia/bornite breccia Acidic	
List of Parameters	**Mean**	**p95**	**Mean**	**p95**	**Mean**	**p95**	**Mean**	**p95**	**Mean**	**p95**	**Mean**	**p95**
pH	7.54	7.21	4.93	4.41	7.32	6.95	3.35	2.84	7.90	7.75	2.58	2.19
Ag	0.00003	0.00011	0.00006	0.00015	0.00003	0.00009	0.00011	0.00027	0.00001	0.00001	0.00137	0.00253
Al	0.13	0.33	1.18	3.14	0.08	0.30	9.63	20.95	0.35	0.54	17.01	26.93
As	0.00300	0.01574	0.00102	0.00275	0.00176	0.00592	0.00317	0.00489	0.00099	0.00118	0.20297	0.37197
B	0.0067	0.0119	0.0100	0.0559	0.0056	0.0114	0.0104	0.0122	0.0107	0.0116	0.0060	0.0094
Ba	0.0704	0.1547	0.0332	0.0574	0.0618	0.1500	0.0376	0.0746	0.3430	0.8220	0.0155	0.0310
Be	0.00011	0.00053	0.00078	0.00163	0.00002	0.00053	0.00498	0.02031	0.00053	0.00058	0.00197	0.00854
Ca	27.8	73.0	6.1	16.6	61.3	376.2	12.1	31.3	19.9	27.3	93.3	211.8
Cd	0.00087	0.00430	0.00200	0.00328	0.00010	0.00053	0.01614	0.04267	0.00075	0.00529	0.00101	0.00142
Cl	0.34	0.60	0.28	0.65	0.34	0.81	0.00	2.10	0.00	0.00	7.55	21.00
Co	0.0023	0.0020	0.1430	0.2324	0.0003	0.0019	0.0427	0.0759	0.0001	0.0001	0.2170	0.3875
Cr	0.0008	0.0017	0.0010	0.0020	0.0008	0.0016	0.0043	0.0111	0.0006	0.0006	0.0346	0.1563
Cu	0.0105	0.0236	18.6699	26.1798	0.0050	0.0149	8.0555	17.3443	0.0041	0.0092	1.1004	3.2172
F	0.48	1.68	0.93	1.17	0.31	1.71	1.09	2.96	0.24	1.32	1.63	3.32
Fe	0.020	0.047	0.077	0.314	0.116	0.066	72.403	234.409	0.077	0.212	1055.252	1859.399
Hg	0.0000160	0.0000426	0.0000185	0.0000425	0.0000229	0.0000421	0.0000053	0.0000111	0.00000003	0.00000001	0.0000314	0.0001343
K	1.85	5.02	2.37	6.09	2.01	7.03	2.45	9.38	1.60	3.31	1.96	5.51
Li	0.0028	0.0057	0.0049	0.0076	0.0019	0.0056	0.0196	0.0547	0.0053	0.0058	0.0278	0.0534
Mg	1.22	5.01	0.70	1.98	1.94	5.17	9.28	17.67	0.52	1.15	12.28	21.99
Mn	0.227	0.856	10.895	19.214	0.232	0.502	4.024	17.239	0.046	0.114	2.052	3.628
Mo	0.0202	0.0940	0.0029	0.0111	0.0277	0.0918	0.0008	0.0012	0.0101	0.0441	0.0116	0.0276
Na	0.49	0.91	0.78	1.44	0.74	1.16	4.10	2.15	0.34	0.59	6.72	8.31
Ni	0.0006	0.0013	0.0294	0.0411	0.0008	0.0029	0.0100	0.0212	0.0005	0.0006	0.0266	0.0439
Pb	0.0016	0.0086	0.0061	0.0220	0.0005	0.0018	0.3157	1.4539	0.0001	0.0001	0.0355	0.0726
Sb	0.0569	0.4429	0.0011	0.0054	0.0070	0.0246	0.0005	0.0011	0.0009	0.0012	0.0011	0.0022
Se	0.0081	0.0270	0.0101	0.0138	0.0066	0.0206	0.0154	0.0480	0.0043	0.0112	0.2604	0.4925

(continued)

Table 6.2-5. pH and Leaching Rates (mg/kg/week) from Mitchell Humidity Cells (completed)

ABA Block Model Codes	MUPN M UP Hazelton Neutral		MUPA M UP Hazelton Acidic		MLPN M LP Hazelton Neutral		MLPA M LP Hazelton Neutral		MMON M Monzonite Neutral		MBBA M Leach breccia/bornite breccia Acidic	
List of Parameters	**Mean**	**p95**	**Mean**	**p95**	**Mean**	**p95**	**Mean**	**p95**	**Mean**	**p95**	**Mean**	**p95**
Si	1.58	2.66	3.65	5.00	1.08	2.38	9.96	18.04	2.43	3.37	40.11	78.10
Sn	0.00051	0.00113	0.00107	0.00247	0.00058	0.00151	0.00049	0.00112	0.00012	0.00012	0.00097	0.00219
SO_4	37	129	77	100	137	884	376	823	4	9	3,539	6479
Sr	0.190	0.485	0.063	0.163	0.588	3.608	0.433	2.225	0.111	0.320	0.170	0.304
Tl	0.00003	0.00011	0.00010	0.00055	0.00002	0.00011	0.00016	0.00012	0.00011	0.00012	0.00028	0.00083
U	0.00694	0.02566	0.00358	0.00946	0.00613	0.02181	0.01389	0.04628	0.00153	0.00492	0.01787	0.04390
V	0.00574	0.01763	0.00023	0.00076	0.00060	0.00148	0.00842	0.03778	0.00503	0.01118	0.01832	0.02885
Zn	0.010	0.037	0.086	0.185	0.005	0.012	1.395	3.624	0.001	0.001	0.202	0.372
Acidity	8.14	14.09	49.76	77.28	9.20	14.06	323.04	790.94	5.92	10.48	3,345.11	5,555.56
Alkalinity as HCO_3	42.5	58.3	1.1	3.8	32.7	48.9	0.0	2.3	50.3	64.2	0.2	0.2

Chloride set to detection limit when not analyzed
Values of pH and alkalinity are set to the 5th percentiles of data in the cases where the 95th percentile is used as the conservative case
M = Mitchell deposit
IC = Iron Cap deposit

Table 6.2-6. Acid Base Accounting Block Model Codes and Associated Descriptions

Block Model Codes	Description
Kerr	
KERR	All of the Kerr deposit
Sulphurets	
Overburden	> 50% soil or glaciofluvial material
UP Hazelton	Default for Sulphurets material above STF
Monzonite	Monzonite intrusion
LP Hazelton	Default for Sulphurets below STF
Lower Au zone	Sulphurets low grade ore zone
Au, leach, Raewyn zones	Default for Sulphurets ore zones
Undefined	Default for edge effects or minor units
Mitchell	
Overburden	> 50% soil or glaciofluvial material
Monzonite	Monzonite intrusion
UP Hazelton	Default material above MTF on north or south side of Mitchell Creek
Leach breccia/bornite breccia	Mitchell ore zone
LP Hazelton	Default material below MTF on north or south side of Mitchell Creek
Undefined	Default for edge effects or minor units
Iron Cap	
IRON CAP	All of the Iron Cap deposit

LP = lower panel
UP = upper panel
MTF – Mitchell Thrust Fault
STF = Sulphurets Thrust Fault

To calculate the load or mass flux moving from the solid material into the aqueous phase the rate of release was scaled and multiplied by the mass of solid material available for reaction as follows:

$$L = R \times M$$

where:
L = Load or mass flux (mg/week)
R = Rate of release (mg/[kg × week])
M = Mass of material (kg)

6.2.2 Scaling Factors

Weathering and metal leaching rates of waste rocks and ore materials were measured in standard laboratory scale kinetic tests (e.g., humidity cell tests). Weathering and metal leaching rates of waste rock and pit walls exposed at the Mine Site were calculated from the appropriate laboratory test results after applying scaling factor adjustments for differences in temperature, grain size (surface area), and water contact fraction between the laboratory tests and operating mine conditions. Scaling factors applied to the KSM Project were similar to other projects in the environmental assessment process in BC.

The scaling factor was calculated as follows:

$$SF = K_t \times K_f \times Kc$$

where:
SF = scaling factor;
K_t = adjustment factor for correcting for cooler ambient Project temperatures (unitless);
K_f = adjustment factor for correcting for the larger grain size of run of mine rock (unitless); and
K_c = adjustment factor for correcting for reduced solid/water contact area (unitless).

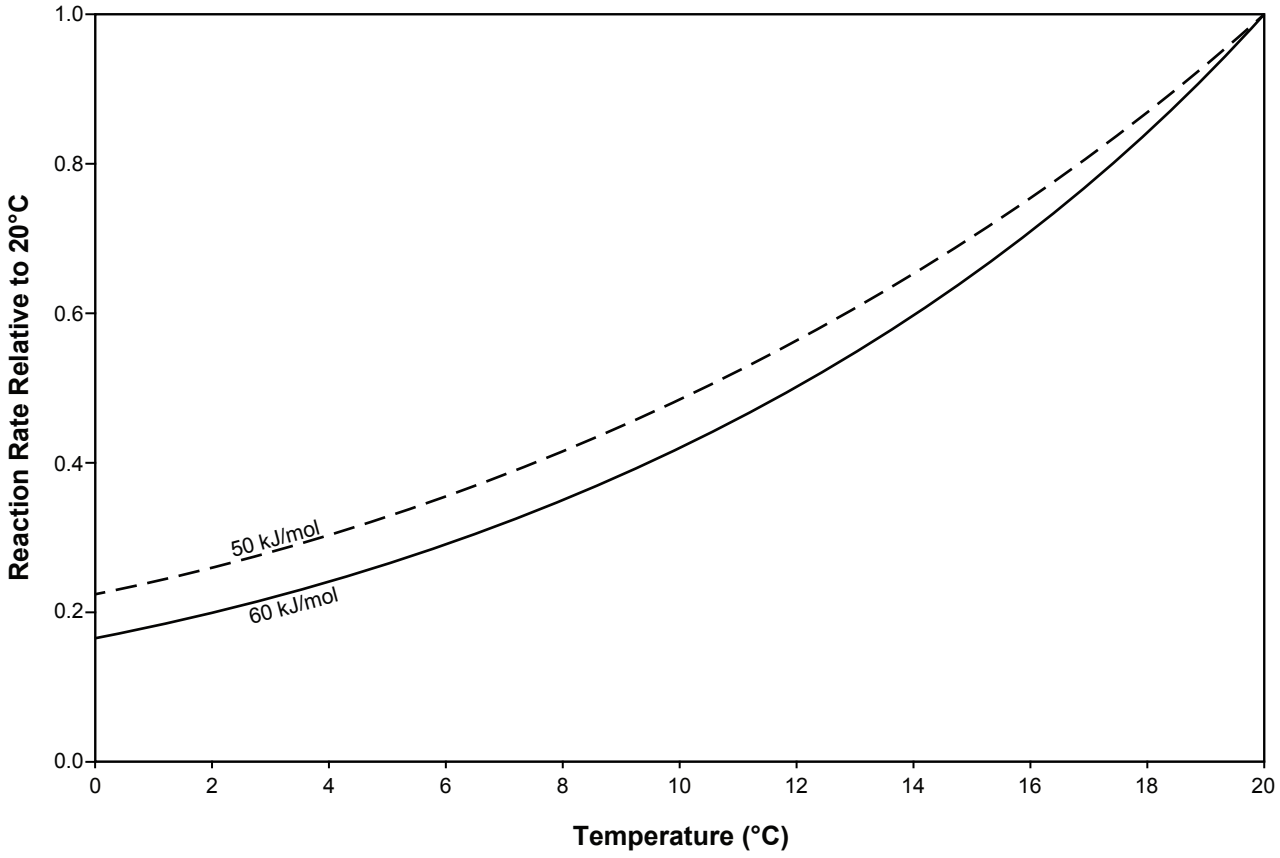
The scaling factor for the temperature effect is estimated based on the Arrhenius equation for pyrite activation energies of 50 and 60 kJ/mol, as described in MEND (2006); Figure 6.2-1). An ambient laboratory and RSF temperatures of 20˚C and 15˚C, respectively, were applied to determine the temperature effect. The K_t was determined to be 0.5 and was applied to the release rates of metals and other parameters. No temperature correction was applied to the Sulphurets Pit Backfill due to the higher sulphide content of Kerr waste rock.

The grain size fraction effect was determined based on the proportion of the reactive fraction present in the Mine Site component. The reactive fraction was represented by the percent of material less than 6 mm (the size fraction of a standard humidity cell). SABREX modelling of blast tests estimated that 10% (K_f = 0.1) of the mass of blasted waste rock will be less than 6 mm. Conservative professional judgement was used to estimate that 20% of the mass of crushed waste rock (e.g., from Kerr Pit) will be less than 6 mm (further details are included in Chapter 10). Estimates for the block cave mines concluded that 1% of the disturbed material will be less than 6 mm. Metal leaching occurs only when liquid water is in direct contact with or flows over the surface of the weathered rocks or ore materials. The scaling factor for the solid/water contact area effect or the degree of flushing was estimated based on the portion of solid surface in contact with water at any given time. In a standard humidity cell test, 100% of the surface area of the solids was assumed to be in contact with water during weekly flushing. Literature values (Elboushi 1975) were used to estimate the portion of material in contact with water. In RSFs and block cave mines, a water contact fraction of 20% was estimated. Pit walls and benches were assumed to be in 100% contact with any precipitation. Preferential flow in the block cave mine subsidence zone and water contact is discussed further in Section 6.3.

Observed water quality in field leach barrels were used to validate scaling factors.

6.2.3 Solubility Considerations

The water quality model assumed that dissolved chemical species remained in solution unless removed by mineral precipitation and/or water treatment. For the four model scenarios, solubility limits are applied in the water quality model based on site-specific maximums observed in groundwater seeps in deposit areas from 2008 to 2012 (Table 6.2-7).



Source: MEND (2006).

SEABRIDGE GOLD
KSM PROJECT

Decrease in Oxidation Rate Predicted by the Arrhenius Equation for Activation Energies of 50 and 60 kJ/mol

Figure 6.2-1

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Table 6.2-7. Solubility Limits

Parameter	Concentration (mg/L)	Parameter	Concentration (mg/L)
Aluminum	202	Manganese	33.5
Arsenic	1.30	Molybdenum	1.14
Cadmium	0.245	Nickel	0.129
Cobalt	0.580	Selenium	0.259
Copper	79.2	Zinc	15.9
Iron	2610	Sulphate	7,380
Lead	0.610		

6.3 Background Water Chemistry

Background surface water and groundwater quality source terms were developed from the five-year baseline database (Sections 12.1 and 14.1; Appendices 11-A, 11-B, 11-C, and 14-A of the Application/EIS). The baseline locations used for background water quality are shown on Figure 6.3-1. Mean values of water quality data were applied to the model for each month (Table 6.3-1). If baseline data were not collected for a particular month, then data were estimated by interpolation. If baseline data sets were limited, then a constant input of the mean of available data was applied. When baseline water quality data were below the detection limits, concentrations equal to half the detection limit were applied in the model.

The water quality of diverted surface runoff water for catchment areas was estimated to be equivalent to relevant background surface water quality. Table 6.3-2 identifies the water quality monitoring site data applied to surface runoff. Water quality modelling indicated the critical importance of diverting good quality non-contact water in the Mitchell Diversion Tunnels (MDT). Natural chemical attenuation processes in the Mitchell Valley will be circumvented by the MDT; therefore, a design criterion was established to locate the sub-glacial inlet outside the mineralized zone delineated by the Mitchell Thrust Fault (MTF). A groundwater seep (stream site IC1) in the north wall of the Mitchell Valley in an unmineralized zone flows under the Mitchell Glacier and was monitored monthly as part of the surface water quality baseline program from July 2011. Glacial melt in an unmineralized area was measured in the McTagg Valley (site MCT) from 2008. For the water quality model, the sub-ice water quality was conservatively estimated to be 50% site IC1 and 50% site MCT.

6.4 Nitrogen Loading from Explosives Residuals

Nitrogen loading from leaching of blasting residues on the surface of waste rock was estimated based on the quantity of explosives used during blasting. These explosive residuals will be transported with waste rock to the RSFs and are sources of nitrogen loadings to the WSF.

Explosives usage was based on an overall 50/50 emulsion/ammonium nitrate-fuel oil (ANFO) mix (Section 4.7.5 of the Application/EIS) and a powder factor of 0.35. Leaching of nitrogen-containing blasting residues was calculated using standard methods for mining operations (Ferguson and Leask 1988). For explosives consisting of more than 20% slurry (considered analogous to emulsion), total nitrogen was calculated as follows:

Explosive loss as N (kg) = 0.0094 × (projected ANFO use as N, in kg) + 0.051 × (projected emulsion use as N, in kg)

Nitrogen species were calculated using the Ferguson and Leask (1988) distribution of 87% nitrate, 11% ammonia, and 2% nitrite. The loadings of ammonia, nitrite, and nitrate to the drainages of the RSFs were calculated as the products of the rates of waste rock production and the contents of ammonia, nitrite, and nitrate in the waste rock materials. Fifty percent of the nitrogen from blasting residues was assumed to be lost during waste rock transport (e.g., prior to storage in the RSFs) due to the high solubility of nitrogen compounds.

6.5 Open Pits

There will be three open pits at the Mine Site: the Sulphurets, Mitchell, and Kerr pits.

Sources of chemical loadings to the drainage at the bottom of the pits are summarized in Table 6.2-1.

The mass of exposed and reactive pit walls was calculated based on the exposed surface area (Tables 6.5-1 to 6.5-3), an estimated reactive depth of 0.5 m for inter-bench areas, and a reactive depth of 1 m for benches.The three dimensional surface areas of the pit walls and benches were estimated from the proposed pit shells. The average bulk density was estimated to be 2.212 t/m^3.

The scaling factor for metal leaching rates is presented in Table 6.5-4. The grain size and temperature effects for the pit walls were assumed to be the same as the RSFs, with the reactive fraction of the total mass estimated to be 10% (K_r = 0.1) and the temperature effect (K_t) estimated to be 0.5. The pit wall surfaces will be exposed to precipitation and 100% of the pit walls will be in contact with runoff mobilizing sulphide mineral oxidation products; therefore, no water contact adjustment was applied. The bulk scaling factor for the pit wall was determined to be 0.05.

The concentrations of chemical species in the drainage accumulated at the bottoms of the open pits was calculated as a function of the sum of chemical loadings divided by the volume of the drainages.

6.6 Block Cave Mines

There will be two underground block caving operations: Mitchell and Iron Cap block cave mines. The Mitchell deposit will bemined through open pit operation first and then followed by block caving. The Iron Cap deposit is mined through block caving methods only (Table 3.2-2).

Sources of chemical loadings to drainage accumulated at the bottom of the block caves mines are presented in Table 6.2-1.

Table 6.3-1. Water Quality of Streams and Rivers of the Mine Site, KSM Project, 2007 to 2012

	Guidelines for the Protection of Freshwater Aquatic Life		Project Area	Mine Site Area																	
			Watershed	Bowser (n = 1 site)				Mitchell (n = 7 sites)				McTagg (n = 4 sites)				Sulphurets (n = 4 sites)				Unuk (n = 9 sites)			
				Nov to Apr (n = 3 samples)		May to Oct (n = 3 samples)		Nov to Apr (n = 33 samples)		May to Oct (n = 91 samples)		Nov to Apr (n = 17 samples)		May to Oct (n = 42 samples)		Nov to Apr (n = 54 samples)		May to Oct (n = 103 samples)		Nov to Apr (n = 42 samples)		May to Oct (n = 105 samples)	
Parameter	BC Chronic (30-day mean)	BC Acute (Maximum)	Units	Mean	Max[1]	Mean	Max[1]	Mean	95th P	Mean	95th P	Mean	95th P	Mean	95th P	Mean	95th P	Mean	95th P	Mean	95th P	Mean	95th P
Physical Parameters																							
Colour, True	background-dependent	-	colour unit	2.5	2.5	2.5	2.5	3.8	12.3	13.9	95.8	2.5	2.5	9.7	92.5	2.5	2.5	7.5	64.3	2.7	2.5	5.7	6.6
Conductivity	-	-	uS/cm	218	258	89	118	518	982	381	1005	396	451	166	256	400	473	185	360	229	330	123	215
Hardness (as $CaCO_3$)	-	-	mg/L	104	122	42.0	54.7	203	314	130	261	199	233	92.3	195	188	223	93.7	210	108	154	59.2	106
pH	-	6.5 to 9.0	pH unit	8.09	8.10	7.85	8.01	6.62	8.21	**5.59**	8.18	8.18	8.29	7.92	8.15	8.04	8.18	7.80	8.14	8.01	8.16	7.79	8.14
Total Suspended Solids	background-dependent	-	mg/L	1.5	1.5	61.0	143	36.5	107	202	602	7.1	23.8	81.5	228	10.2	29.1	153	545	3.2	8.0	68.2	299
Total Dissolved Solids	-	-	mg/L	127	151	66	72	348	677	258	691	253	296	114	163	263	322	125	245	139	203	83	131
Turbidity	background-dependent	-	NTU	1.8	2.3	69.2	122	67.2	170	170	363	3.1	11.8	60.9	160	13.6	32.4	118	371	3.4	10.9	50.5	172
Anions and Nutrients																							
Acidity (as $CaCO_3$)	-	-	mg/L	1.3	1.9	2.0	2.8	38.2	188.0	63.3	288.1	1.8	6.0	2.5	4.2	2.9	5.9	3.2	6.0	2.7	5.2	3.0	5.3
Alkalinity, Total (as $CaCO_3$)	descriptive ranges	-	mg/L	77.3	94.8	33.2	39.9	53.6	94.6	16.9	77.1	111.8	132.2	55.5	82.9	82.1	104.8	35.5	68.2	70.5	90.9	39.4	67.7
Ammonia (as N)	temperature- and pH-dependent	temperature- and pH-dependent	mg/L	0.0039	0.0067	0.0025	0.0025	0.0039	0.0100	0.0045	0.0140	0.0025	0.0025	0.0029	0.0051	0.0026	0.0025	0.0036	0.0102	0.0033	0.0051	0.0033	0.0069
Bromide	-	-	mg/L	0.025	0.025	0.025	0.025	0.128	0.621	0.074	0.250	0.054	0.264	0.025	0.025	0.048	0.303	0.025	0.025	0.025	0.025	0.027	0.025
Chloride	150	-	mg/L	0.25	0.25	0.25	0.25	0.66	2.50	0.73	2.50	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.27	0.25	0.25	0.25
Fluoride	-	hardness-dependent	mg/L	0.0333	0.0420	0.0100	0.0100	0.5152	**1.6780**	0.4687	**1.5055**	0.0475	0.0588	0.0228	0.0369	0.1117	0.1884	0.0766	0.1688	0.0533	0.0949	0.0350	0.0671
Nitrate (as N)	3	32.8	mg/L	0.0291	0.0364	0.0124	0.0217	0.0944	0.182	0.0616	0.285	0.102	0.371	0.0436	0.127	0.0860	0.176	0.0561	0.214	0.0909	0.146	0.0499	0.175
Nitrite (as N)	chloride-dependent	-	mg/L	0.0005	0.0005	0.0005	0.0005	0.0013	0.0050	0.0019	0.0080	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0024	0.0005
Ortho-Phosphate (as P)	-	-	mg/L	0.0005	0.0005	0.0008	0.0013	0.0088	0.0517	0.1018	0.6912	0.0015	0.0021	0.0020	0.0033	0.0008	0.0012	0.0012	0.0030	0.0006	0.0014	0.0093	0.0029
Total Phosphate (as P)	-	-	mg/L	0.0016	0.0029	0.0704	0.151	0.435	1.75	1.41	6.96	0.0148	0.0505	0.121	0.314	0.0390	0.0992	0.286	1.01	0.0100	0.0316	0.315	0.493
Sulphate	hardness-dependent	-	mg/L	36.9	45.8	11.1	16.5	199.4	483.4	156.2	464.0	96.2	115.8	35.3	62.5	122.3	146.7	57.4	114.8	46.6	79.7	22.8	47.4
Cyanides																							
Cyanide, Weak Acid Dissociable	0.005	0.01	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyanide, Total	-	-	mg/L	0.0005	0.0005	0.0005	0.0005	0.0006	0.0008	0.0006	0.0012	0.0005	0.0005	0.0005	0.0005	0.0006	0.0012	0.0006	0.0012	0.0009	0.0019	0.0008	0.0020
Thiocyanate	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carbon																							
Total Organic Carbon	background-dependent	-	mg/L	0.25	0.25	0.25	0.25	0.33	0.70	0.45	0.92	0.38	0.78	0.43	0.93	0.41	0.74	0.53	1.39	0.76	1.43	1.00	2.40
Total Metals																							
Aluminum (Al)	-	-	mg/L	*0.147*	*0.345*	*2.84*	*4.76*	*2.72*	*9.65*	*5.94*	*16.6*	*0.148*	*0.476*	*2.66*	*6.31*	*0.450*	*1.05*	*4.01*	*10.5*	*0.164*	*0.503*	*2.13*	*8.12*
Antimony (Sb)	-	0.02	mg/L	0.000353	0.000360	0.000493	0.000660	0.000787	0.00173	0.00119	0.00301	0.000504	0.000688	0.000640	0.000967	0.000790	0.00140	0.00120	0.00202	0.00186	0.00332	0.00117	0.00232
Arsenic (As)	-	0.005	mg/L	0.00112	0.00148	0.00248	0.00434	**0.0229**	**0.0795**	**0.0690**	**0.425**	0.00053	0.00121	0.00255	0.00475	0.00211	**0.00574**	**0.0110**	**0.0493**	0.00081	0.00203	**0.00653**	**0.0151**
Barium (Ba)	-	-	mg/L	0.0631	0.0724	0.0828	0.119	0.0309	0.0513	0.156	0.427	0.0255	0.0305	0.0497	0.0990	0.0439	0.0558	0.110	0.283	0.0359	0.0443	0.0568	0.144
Beryllium (Be)	0.0053	-	mg/L	0.00025	0.00025	0.00025	0.00025	0.00096	0.00361	0.00099	0.00442	0.00020	0.00025	0.00024	0.00025	0.00021	0.00025	0.00027	0.00053	0.00020	0.00025	0.00022	0.00025
Bismuth (Bi)	-	-	mg/L	0.00025	0.00025	0.00025	0.00025	0.00027	0.00035	0.00032	0.00054	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00026	0.00025	0.00025	0.00025	0.00035	0.00025
Boron (B)	-	1.2	mg/L	0.005	0.005	0.005	0.005	0.009	0.019	0.006	0.010	0.005	0.005	0.005	0.005	0.006	0.013	0.005	0.005	0.005	0.010	0.005	0.005
Cadmium (Cd)	-	hardness-dependent	mg/L	0.000026	**0.000038**	**0.000089**	**0.000176**	**0.0102**	**0.0406**	**0.00952**	**0.0381**	**0.000138**	**0.000286**	**0.000185**	**0.000475**	**0.00110**	**0.00247**	**0.00132**	**0.00377**	**0.000292**	**0.000873**	**0.325**	**0.000891**
Calcium (Ca)	-	-	mg/L	37.9	43.6	17.8	21.0	72.8	114	41.2	80.6	69.4	85.5	33.2	50.3	67.7	80.8	33.4	65.7	36.4	52.8	19.2	31.4
Chromium (Cr)	-	0.001	mg/L	0.00025	0.00025	**0.00274**	**0.00455**	0.00036	**0.00102**	**0.00142**	**0.00311**	0.00033	0.00070	**0.00283**	**0.00736**	0.00035	0.00084	**0.00371**	**0.00940**	0.00030	0.00078	**0.00348**	**0.0146**
Cobalt (Co)	0.004	0.11	mg/L	0.00017	0.00041	0.00157	0.00297	0.0106	0.0360	0.0140	0.0452	0.00024	0.00074	0.00224	0.00492	0.00143	0.00292	0.00383	0.00937	0.00034	0.00102	0.00244	0.00573
Copper (Cu)	hardness-dependent	hardness-dependent	mg/L	0.00100	0.00205	**0.00802**	**0.0151**	**0.629**	**2.06**	**0.892**	**2.74**	0.00147	0.00477	**0.0113**	**0.0256**	**0.0718**	**0.198**	**0.124**	**0.362**	**0.0185**	**0.0708**	**0.327**	**0.0962**
Iron (Fe)	-	1	mg/L	0.279	0.675	**3.07**	**5.85**	**17.0**	**70.7**	**28.5**	**117**	0.348	**1.16**	**4.43**	**9.63**	**1.75**	**4.39**	**7.86**	**19.8**	0.552	**1.74**	**3.28**	**10.5**
Lead (Pb)	hardness-dependent	hardness-dependent	mg/L	0.000348	0.000863	0.00212	0.00439	0.00734	0.0215	0.0175	0.0564	0.000130	0.000452	0.00145	0.00332	0.000966	0.00256	0.00490	0.0127	0.000366	0.00121	0.00209	0.00732
Lithium (Li)	0.014	0.87	mg/L	0.0025	0.0025	0.0025	0.0025	0.0043	0.0102	0.0052	0.0134	0.0021	0.0025	0.0026	0.0030	0.0023	0.0025	0.0029	0.0071	0.0021	0.0025	0.117	0.0061
Magnesium (Mg)	-	-	mg/L	3.06	3.41	2.32	2.64	6.35	10.7	4.25	9.12	7.64	9.09	4.17	5.74	5.63	6.91	4.11	6.92	4.78	6.18	4.14	7.75
Manganese (Mn)	hardness-dependent	hardness-dependent	mg/L	0.0287	0.0472	0.117	0.216	1.15	**3.63**	0.954	**2.99**	0.0116	0.0340	0.118	0.332	0.181	0.346	0.260	0.570	0.0439	0.108	0.0954	0.289
Mercury (Hg)	0.00002	-	mg/L	0.000005	0.000005	0.000007	0.000010	0.000005	0.000005	0.000019	0.000076	0.000006	0.000007	0.000010	0.000022	0.000005	0.000005	0.000011	0.000030	0.000007	0.000005	0.000036	0.000039
Molybdenum (Mo)	1	2	mg/L	0.00180	0.00198	0.00113	0.00141	0.00386	0.00857	0.00602	0.0234	0.00360	0.00560	0.00235	0.00393	0.00243	0.00332	0.00219	0.00452	0.00149	0.00269	0.00119	0.00184
Nickel (Ni)	-	hardness-dependent	mg/L	0.000377	0.000630	0.00213	0.00383	0.00398	0.00918	0.00472	0.0119	0.00347	0.00785	0.00479	0.00949	0.00188	0.00338	0.00407	0.00953	0.000768	0.00160	0.0132	0.0116
Phosphorus (P)	-	-	mg/L	0.15	0.15	0.23	0.38	0.46	1.48	1.46	6.52	0.15	0.15	0.26	0.58	0.15	0.15	0.34	1.00	0.15	0.15	0.24	0.50
Potassium (K)	-	-	mg/L	0.553	0.583	1.01	1.47	0.933	1.21	1.17	2.40	1.06	1.50	1.23	2.03	1.78	4.52	1.93	4.11	0.820	1.39	0.944	2.16
Selenium (Se)	-	0.002	mg/L	0.00111	0.00127	0.00047	0.00071	**0.00302**	**0.00482**	**0.00392**	**0.0178**	**0.00511**	**0.00722**	**0.00277**	**0.00490**	0.00170	**0.00259**	0.00130	**0.00339**	0.00089	0.00141	**0.321**	0.00118
Silicon (Si)	-	-	mg/L	1.83	2.10	5.44	8.88	3.95	6.42	7.38	16.7	2.49	3.21	6.29	13.5	2.71	3.57	8.02	19.0	2.31	2.78	5.33	15.2
Silver (Ag)	hardness-dependent	hardness-dependent	mg/L	0.000005	0.000005	0.000034	0.000061	0.000016	0.000055	0.000250	0.000570	0.000009	0.000019	0.000063	0.000135	0.000007	0.000016	0.000096	0.000280	0.000007	0.000012	**0.022446**	0.000185

(continued)

Table 6.3-1. Water Quality of Streams and Rivers of the Mine Site Area, KSM Project, 2007-2012 (completed)

	Guidelines for the Protection of Freshwater Aquatic Life		Project Area Watershed	Mine Site Area															
				Bowser (n = 1 site)				Mitchell (n = 7 sites)				McTagg (n = 4 sites)				Sulphurets (n = 4 sites)				Unuk (n = 9 sites)			
				Nov to Apr (n = 3 samples)		May to Oct (n = 3 samples)		Nov to Apr (n = 33 samples)		May to Oct (n = 91 samples)		Nov to Apr (n = 17 samples)		May to Oct (n = 42 samples)		Nov to Apr (n = 54 samples)		May to Oct (n = 103 samples)		Nov to Apr (n = 42 samples)		May to Oct (n = 105 samples)	
Parameter	**BC Chronic (30-day mean)**	**BC Acute (Maximum)**	**Units**	**Mean**	**Max[1]**	**Mean**	**Max[1]**	**Mean**	**95th P**	**Mean**	**95th P**	**Mean**	**95th P**	**Mean**	**95th P**	**Mean**	**95th P**	**Mean**	**95th P**	**Mean**	**95th P**	**Mean**	**95th P**
Sodium (Na)	-	-	mg/L	1.0	1.0	1.0	1.0	3.5	5.2	1.4	3.0	1.0	1.0	1.0	1.0	2.2	3.7	1.1	2.2	2.3	3.1	1.1	2.1
Strontium (Sr)	-	-	mg/L	0.183	0.203	0.102	0.124	0.458	0.809	0.263	0.540	0.292	0.340	0.154	0.209	0.375	0.450	0.180	0.349	0.261	0.342	0.156	0.252
Thallium (Tl)	-	0.0003	mg/L	0.00005	0.00005	0.00005	0.00005	0.00005	0.00010	0.00008	0.00022	0.00004	0.00005	0.00005	0.00005	0.00004	0.00005	0.00006	0.00018	0.00004	0.00005	0.00005	0.00010
Tin (Sn)	-	-	mg/L	0.00005	0.00005	0.00007	0.00010	0.00006	0.00010	0.00086	0.00037	0.00005	0.00005	0.00006	0.00012	0.00005	0.00005	0.00008	0.00019	0.00005	0.00005	0.00991	0.00016
Titanium (Ti)	2	-	mg/L	0.013	0.028	0.101	0.197	0.011	0.032	0.146	0.521	0.012	0.032	0.161	0.356	0.016	0.044	0.213	0.642	0.008	0.021	0.110	0.398
Uranium (U)	-	0.3	mg/L	0.000269	0.000329	0.000135	0.000175	0.000845	0.00199	0.00108	0.00320	0.000749	0.000966	0.000316	0.000506	0.000413	0.000717	0.000375	0.000788	0.000147	0.000327	0.000936	0.000342
Vanadium (V)	0.006	-	mg/L	0.0008	0.0013	0.0092	0.0158	0.0034	0.0128	0.0125	0.0321	0.0012	0.0028	0.0139	0.0290	0.0011	0.0030	0.0140	0.0404	0.0007	0.0019	0.0095	0.0378
Zinc (Zn)	hardness-dependent	hardness-dependent	mg/L	0.0017	0.0042	0.0116	0.0208	**0.6672**	**2.7080**	**0.6555**	**2.7400**	0.0091	0.0224	0.0171	**0.0375**	0.0757	**0.1740**	**0.0991**	**0.2843**	0.0208	**0.0644**	0.0260	**0.0775**
Dissolved Metals																							
Aluminum (Al)	pH-dependent	pH-dependent	mg/L	0.0034	0.0040	0.0666	0.127	1.97	9.69	2.74	10.0	0.0039	0.0086	0.0322	0.0789	0.0346	0.0796	0.0502	0.109	0.0243	0.0689	0.0570	0.130
Antimony (Sb)	-	-	mg/L	0.000330	0.000360	0.000233	0.000270	0.000249	0.000529	0.000192	0.000554	0.000471	0.000602	0.000344	0.000430	0.000715	0.00132	0.000592	0.00112	0.00183	0.00341	0.000768	0.00192
Arsenic (As)	-	-	mg/L	0.00076	0.00080	0.00045	0.00059	0.00070	0.00164	0.00556	0.0346	0.00027	0.00035	0.00034	0.00045	0.00020	0.00041	0.00026	0.00072	0.00022	0.00030	0.00060	0.00071
Barium (Ba)	-	-	mg/L	0.0585	0.0636	0.0274	0.036	0.0250	0.0410	0.0406	0.0813	0.0238	0.0269	0.0120	0.0169	0.0394	0.0473	0.0314	0.0420	0.0337	0.0427	0.0226	0.0325
Beryllium (Be)	-	-	mg/L	0.00025	0.00025	0.00025	0.00025	0.00084	0.00374	0.00088	0.00411	0.00021	0.00025	0.00022	0.00025	0.00020	0.00025	0.00021	0.00025	0.00020	0.00025	0.00021	0.00025
Bismuth (Bi)	-	-	mg/L	0.00025	0.00025	0.00025	0.00025	0.00027	0.00036	0.00027	0.00050	0.00026	0.00030	0.00025	0.00025	0.00025	0.00025	0.00026	0.00025	0.00025	0.00025	0.00030	0.00025
Boron (B)	-	-	mg/L	0.005	0.005	0.005	0.005	0.008	0.017	0.005	0.010	0.005	0.006	0.005	0.005	0.006	0.012	0.005	0.005	0.005	0.010	0.005	0.005
Cadmium (Cd)	-	-	mg/L	0.000014	0.000018	0.000009	0.000013	0.00927	0.0422	0.00929	0.0376	0.000107	0.000194	0.000037	0.000091	0.000560	0.00136	0.00065	0.00250	0.000185	0.000450	0.191	0.000463
Calcium (Ca)	-	descriptive ranges	mg/L	36.7	43.2	15.0	19.7	69.8	111	39.4	76.8	67.5	79.4	29.2	43.7	66.2	79.5	31.0	63.2	35.6	52.9	17.8	28.7
Chromium (Cr)	-	-	mg/L	0.00025	0.00025	0.00025	0.00025	0.00020	0.00057	0.00026	0.00087	0.00017	0.00025	0.00021	0.00025	0.00014	0.00025	0.00017	0.00025	0.00015	0.00025	0.00021	0.0003
Cobalt (Co)	-	-	mg/L	0.00005	0.00005	0.00005	0.00005	0.0102	0.0371	0.0125	0.0429	0.00005	0.00006	0.00005	0.00005	0.00105	0.00229	0.00135	0.00451	0.00024	0.00069	0.00023	0.00085
Copper (Cu)	-	-	mg/L	0.00022	0.00029	0.00019	0.00030	0.514	2.12	0.794	2.79	0.00031	0.00059	0.00033	0.00049	0.00462	0.0101	0.00754	0.0107	0.00195	0.00501	0.00264	0.00449
Iron (Fe)	-	0.35	mg/L	0.015	0.015	0.030	0.061	**4.23**	**28.0**	**10.5**	**60.7**	0.015	0.015	0.023	0.064	0.022	0.029	0.064	0.121	0.018	0.041	0.091	0.105
Lead (Pb)	-	-	mg/L	0.000025	0.000025	0.000025	0.000025	0.00409	0.0193	0.00699	0.0350	0.000026	0.000030	0.000028	0.000025	0.000026	0.000025	0.000037	0.000098	0.000031	0.000038	0.000073	0.000200
Lithium (Li)	-	-	mg/L	0.0025	0.0025	0.0025	0.0025	0.0041	0.0101	0.0034	0.0087	0.0021	0.0025	0.0022	0.0025	0.0023	0.0025	0.0022	0.0025	0.0021	0.0025	0.021	0.0025
Magnesium (Mg)	-	-	mg/L	2.91	3.38	1.12	1.42	6.13	10.6	3.37	8.56	7.40	8.90	2.65	4.77	5.41	6.74	2.42	5.10	4.63	6.23	3.09	7.05
Manganese (Mn)	-	-	mg/L	0.0164	0.0182	0.0059	0.0097	1.09	3.56	0.848	2.80	0.0017	0.0040	0.0013	0.0039	0.154	0.319	0.116	0.278	0.0364	0.095	0.0211	0.0782
Mercury (Hg)	-	-	mg/L	0.000007	0.000011	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.000007	0.000005	0.000005	0.000005	0.000005	0.000015	0.000005
Molybdenum (Mo)	-	-	mg/L	0.00183	0.00200	0.00093	0.00109	0.00149	0.00315	0.00086	0.00261	0.00351	0.00525	0.00198	0.00294	0.00225	0.00328	0.00138	0.00245	0.00143	0.00249	0.00078	0.00162
Nickel (Ni)	-	-	mg/L	0.000250	0.000250	0.000250	0.000250	0.00372	0.00967	0.00381	0.0103	0.00296	0.00718	0.000885	0.00188	0.00156	0.00308	0.00103	0.00252	0.000562	0.00116	0.00195	0.00133
Phosphorus (P)	-	-	mg/L	0.15	0.15	0.15	0.15	0.15	0.15	0.22	0.79	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.16	0.15
Potassium (K)	-	-	mg/L	0.510	0.568	0.221	0.241	0.892	1.09	0.523	0.901	1.02	1.38	0.639	1.00	1.69	4.42	0.906	1.94	0.788	1.41	0.448	0.865
Selenium (Se)	-	-	mg/L	0.00102	0.00118	0.00038	0.00049	0.00229	0.00333	0.00154	0.00425	0.00509	0.00687	0.00259	0.00458	0.00159	0.00227	0.00094	0.00212	0.00088	0.00140	0.0125	0.00102
Silicon (Si)	-	-	mg/L	1.58	1.74	0.75	0.86	3.42	6.22	2.41	4.96	2.23	2.51	1.15	1.79	2.20	2.54	1.21	2.14	2.10	2.56	1.40	2.16
Silver (Ag)	-	-	mg/L	0.000005	0.000005	0.000005	0.000005	0.000009	0.000028	0.000021	0.000091	0.000005	0.000006	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.00962	0.000005
Sodium (Na)	-	-	mg/L	1.0	1.0	1.0	1.0	3.4	5.2	1.3	2.8	1.0	1.0	1.0	1.0	2.1	3.6	1.1	1.0	2.1	3.1	1.0	1.0
Strontium (Sr)	-	-	mg/L	0.177	0.193	0.083	0.102	0.440	0.793	0.249	0.530	0.284	0.323	0.133	0.179	0.367	0.449	0.164	0.334	0.255	0.339	0.144	0.249
Thallium (Tl)	-	-	mg/L	0.00005	0.00005	0.00005	0.00005	0.00005	0.00009	0.00004	0.00010	0.00004	0.00005	0.00004	0.00005	0.00004	0.00005	0.00004	0.00005	0.00004	0.00005	0.00004	0.00005
Tin (Sn)	-	-	mg/L	0.00005	0.00005	0.00005	0.00005	0.00005	0.00007	0.00005	0.00010	0.00005	0.00006	0.00005	0.00005	0.00005	0.00005	0.00006	0.00005	0.00005	0.00005	0.00010	0.00005
Titanium (Ti)	-	-	mg/L	0.005	0.005	0.005	0.005	0.005	0.007	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.006	0.005
Uranium (U)	-	-	mg/L	0.000264	0.000329	0.000069	0.000093	0.000633	0.00194	0.00080	0.00307	0.000730	0.000919	0.000211	0.000438	0.000332	0.000678	0.000089	0.000311	0.000129	0.000315	0.000057	0.000161
Vanadium (V)	-	-	mg/L	0.0005	0.0005	0.0005	0.0005	0.0006	0.0010	0.0007	0.0010	0.0005	0.0006	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Zinc (Zn)	-	-	mg/L	0.0005	0.0005	0.0005	0.0005	0.598	2.87	0.634	2.82	0.0060	0.0149	0.0013	0.0029	0.0218	0.0528	0.0301	0.125	0.0084	0.0204	0.0049	0.0191

Notes:

If values were less than the analytical detection limit, half the detection limit was used for calculations.

- indicates no guideline or parameter was not analyzed

[1] the maximum value was calculated instead of the 95th percentile when n < 6

Grey highlighted values exceed BC chronic water quality guidelines; bold values exceed BC acute water quality guidelines.

For total aluminum, italic values exceed CCME pH-dependent water quality guidelines.

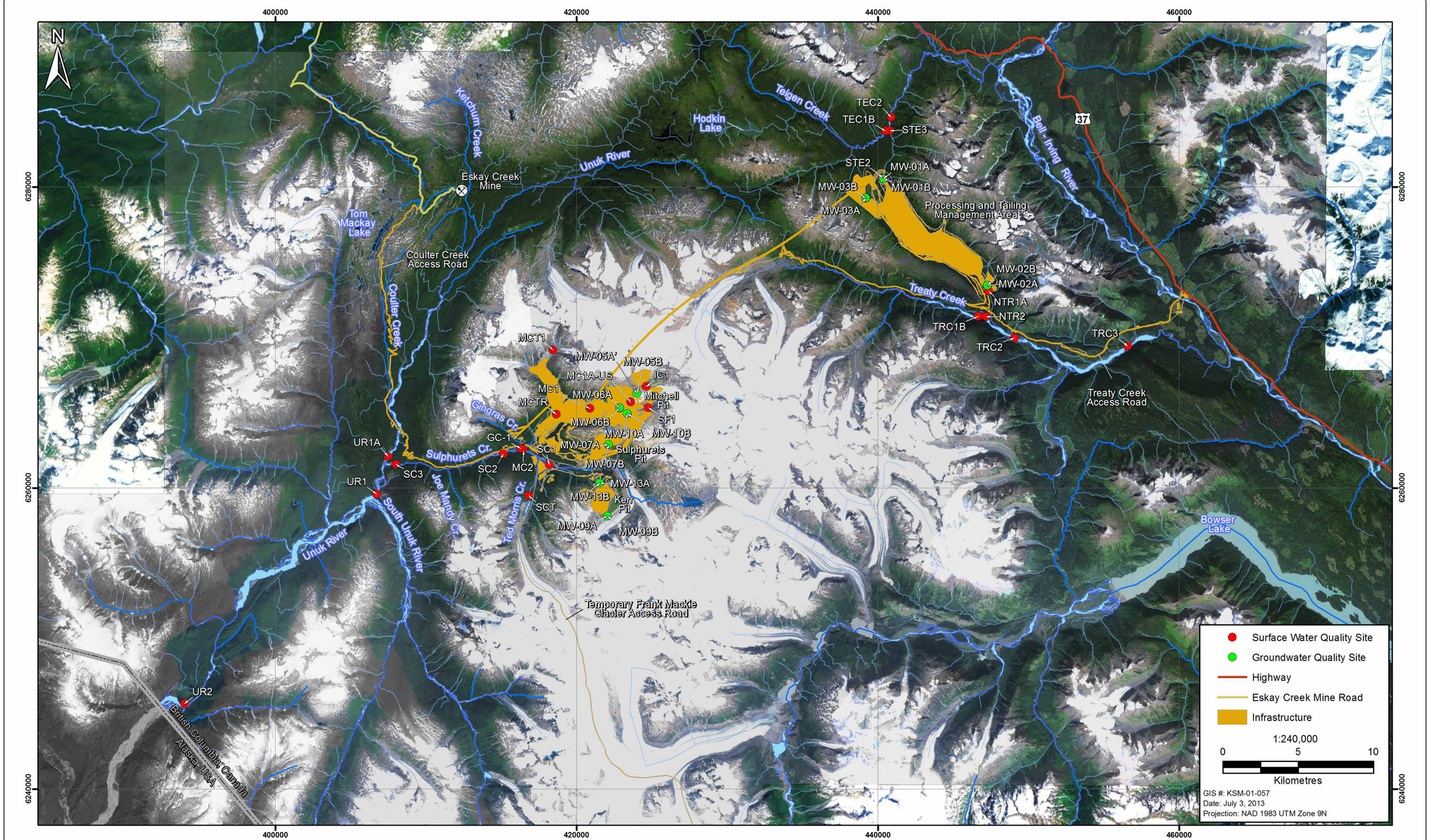

Figure 6.3-1

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Surface Water and Groundwater Quality Baseline Locations Used for Surface Water Quality Modelling

Table 6.3-2. Catchment Water Quality Estimates

Area	Water Quality Source Term
Surface runoff to Sulphurets and Kerr pits	SC1
Mitchell glacier non-contact runoff and surface runoffs to Mitchell Pit and Mitchell RSF	MC1
Mitchell glacier contact runoff	MC1A-US
Surface runoff from McTagg catchment to McTagg RSF	MCTR
Surface runoff to WSF	MC2
Surface runoff to Iron Cap Block Cave Mine	IC1
Diverted water to lower Mitchell Creek	MCTR
McTagg Twinned Diversion Tunnels	MCT1
Mitchell Diversion Tunnels	Estimated water quality under Mitchell Glacier outside the mineralized zone

Table 6.5-1. Area of Exposed Pit Wall in Sulphurets Pit by Model Code

Year	SAUA	SLAA	SLPA	SUPA	SMOA	SUNA	SON	SAUN	SLAN	SLPN	SUPN	SMON	SUNN	Total Area
-2	18.078	0	22.095	68.294	9.039	6.026	15.065	0	0	0.000	130.562	194.839	42.182	506.179
-1	51.092	1.004	40.874	114.447	20.437	60.289	16.350	0	0	15.328	164.517	259.548	220.718	964.603
1	106.683	19.415	46.296	134.863	20.129	57.367	17.110	0	0	8.052	167.070	247.585	342.191	1,166.761
2	195.740	38.245	71.904	119.841	19.973	46.938	17.976	0.999	0	12.983	197.737	225.700	304.595	1,252.630
3	310.263	73.902	64.680	116.222	20.213	83.882	20.213	0	0	13.138	164.732	226.380	281.965	1,375.589
4	348.693	127.339	67.455	119.344	20.756	58.115	18.680	5.189	0	11.416	167.082	232.462	306.144	1,482.675
5	339.860	208.593	65.278	119.158	20.723	55.953	22.796	2.072	4.145	12.434	166.822	232.100	283.908	1,533.841
10	327.551	313.956	69.016	125.981	21.910	59.156	23.005	2.191	7.668	13.146	176.374	245.390	301.260	1,686.604
20	337.136	379.039	71.035	129.668	22.551	60.888	23.678	2.255	7.893	13.531	181.535	252.570	310.075	1,791.855
30	343.321	390.131	159.841	59.659	36.021	87.800	24.764	1.126	22.513	0	260.023	490.780	1,384.540	3,260.520
40	340.402	1,303.494	158.482	59.152	35.714	87.054	24.554	1.116	22.321	0	257.813	486.608	1,372.769	4,149.479
50	344.675	1,292.412	160.472	59.894	36.163	88.147	24.862	1.130	22.602	0	261.049	492.716	1,390.003	4,174.125
51.5	344.675	1,308.637	160.472	59.894	36.163	88.147	24.862	1.130	22.602	0	261.049	492.716	1,390.003	4,190.350

Table 6.5-2. Area of Exposed Pit Wall in Mitchell Pit by Model Code

Year	MOA	MUPA	MLPA	MMOA	MBBA	MON	MGN	MUPN	MLPN	MMON	Total Area
-2	26.112	220.951	0	0	0	0	0	0	0	0	247.064
-1	37.808	440.415	7.153	27.590	0	0	0	57.223	7.153	75.616	652.958
1	58.374	1,433.176	410.629	12.077	0	0	0	22.142	46.296	67.432	2,050.126
2	36.951	2,067.252	631.161	2.996	0	0	0	21.971	57.923	106.858	2,925.111
3	29.308	2,386.091	863.076	2.021	0	0	0	23.244	61.648	119.254	3,484.642
4	15.567	2,336.035	1,383.356	30.096	0	0	0	16.604	132.835	152.553	4,067.046
5	12.434	2,811.101	1,551.131	40.410	0	0	0	16.579	131.592	170.966	4,734.213
10	25.196	3,030.123	2,777.065	87.639	61.347	1.095	4.382	41.629	272.777	710.973	7,012.227
20	16.913	3,407.445	3,593.490	36.081	99.224	0	3.383	28.189	392.386	826.491	8,403.603
30	16.885	3,401.692	3,588.549	36.021	97.931	0	3.377	28.141	391.724	825.096	8,389.415
40	16.741	3,372.771	3,558.039	35.714	97.098	0	3.348	27.902	388.393	818.081	8,318.088
50	16.951	3,415.112	3,602.706	36.163	98.317	0	3.390	28.252	393.269	828.351	8,422.513
51.5	16.951	3,415.112	3,602.706	36.163	98.317	0	3.390	28.252	393.269	828.351	8,422.513

Table 6.5-3. Area of Exposed Pit Wall in Kerr Pit by Model Code

Year	KA	KN	Sum
-2	0	0	0
-1	0	0	0
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
10	0	0	0
20	0	0	0
30	945.540	0	945.540
40	2,658.484	1.116	2,659.601
50	3,633.219	42.943	3,676.162
51.5	3,633.219	42.943	3,676.162

Table 6.5-4. Summary of Scaling Factors Used for the Pit Walls

Scaling Factor	Selected Scaling Factor
Grain Size Effect (K_r)	0.1
Temperature (K_t)	0.5
Water contact (K_c)	1
Bulk scaling factor	0.05

The surface area of disturbed material in the block cave mines is identified in Table 6.6-1. Block caving will generate a volume of disturbed material that subsides into the block cave as ore material is extracted from the cave underground (Table 6.6-2). This area is called the "subsidence zone" and is expressed at the surface as a crater. In order to predict the quality of the water in the underground workings, the flow path of water through the block cave subsidence zone was defined. Precipitation that will fall within the Mitchell and Iron Cap crater areas will flow directly down through the disturbed material. Precipitation that will fall on the Mitchell Pit walls and runoff that will bypass surface diversions flows along the exposed rock of the pit walls, represented by line D1 in Figure 10.2-2. Runoff will preferentially flow through a very narrow zone of disturbed material within the subsidence zone and fractured rock at the outer edge of the subsidence zone, represented by line D2 in Figure 6.6-1.

Table 6.6-1. 2D Areas Associated with Block Caving of the Mitchell and Iron Cap Deposit

	Mitchell		Iron Cap	
Year	Footprint Surface Disturbance (m^2)	Undisturbed Surface Area (m^2)	Footprint Surface Disturbance (m^2)	Undisturbed Surface Area (m^2)
26	31,515	5,766,115	--	--
27	68,595	5,729,035	--	--
28	221,135	5,576,495	--	--
29	420,738	5,376,892	--	--
30	706,427	5,091,203	--	--
31	706,427	5,091,203	--	--
32	972,927	4,824,703	44,868	1,860,216
33	972,927	4,824,703	100,019	1,805,065
34	1,104,626	4,693,004	184,564	1,720,520
35	1,192,964	4,604,666	221,135	1,683,949
36	1,258,444	4,539,186	331,624	1,573,460
37	1,322,205	4,475,425	463,424	1,441,660
38	1,396,935	4,400,695	520,666	1,384,418
39	1,431,955	4,365,675	569,752	1,335,332
40	--	--	599,491	1,305,593

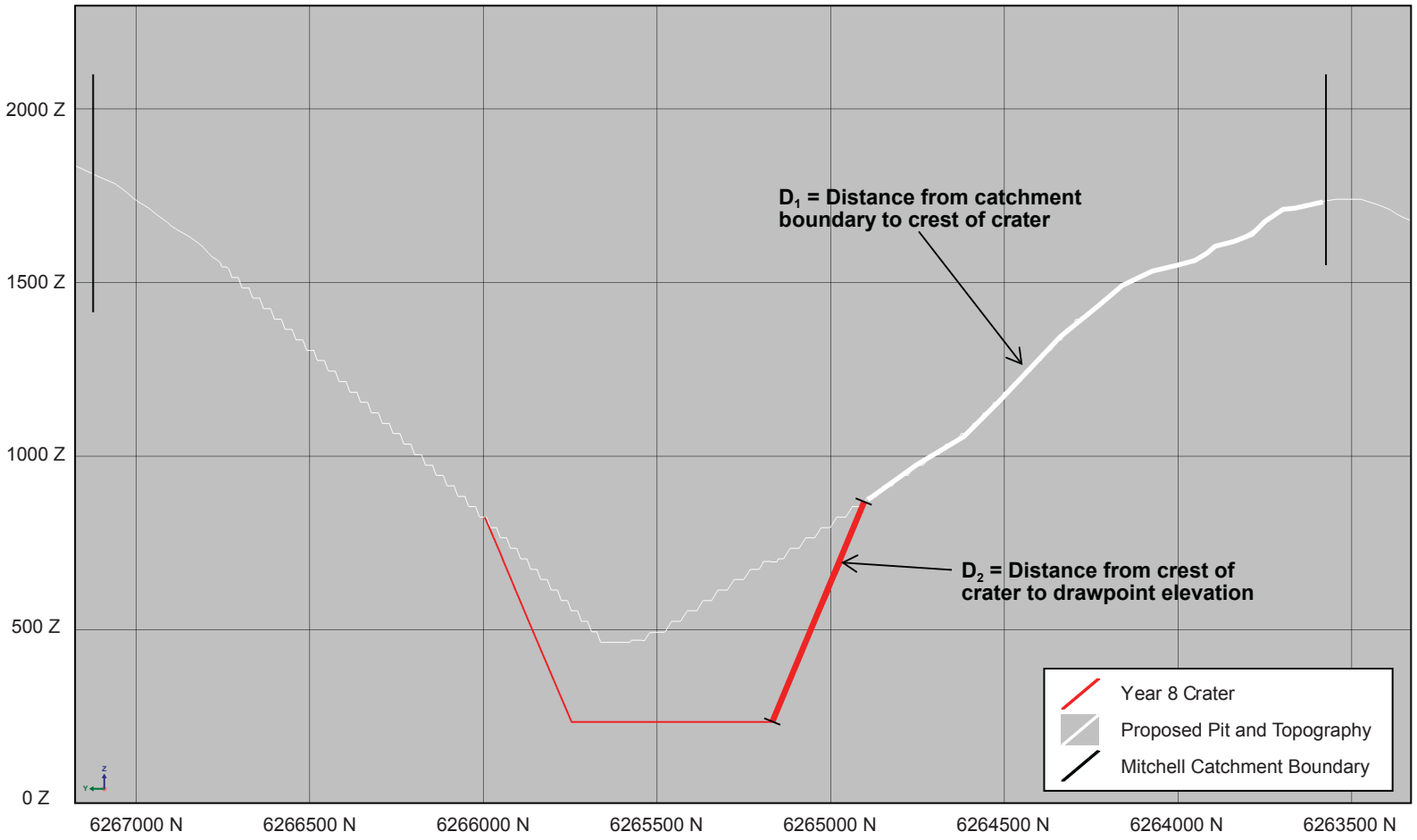

Figure 6.6-1

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Cross Section of Pit and Block Cave Indicating the Surface Areas for Model Inputs

Figure 6.6-1

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Table 6.6-2. Volumes of Disturbed Material within the Mitchell and Iron Cap Subsidence Zones

Year	Mitchell	Iron Cap	Mitchell	Iron Cap
	Mass In-situ Material (Mt)		Mass of Material in Contact (Mt)	
26	16	--	18	--
27	37	--	18	--
28	120	--	18	--
29	231	--	17	--
30	373	--	16	--
31	355	--	16	--
32	477	30.40	15	4.86
33	457	64.85	15	4.72
34	535	108.73	15	4.50
35	590	127.77	14	4.40
36	607	174.41	14	4.10
37	634	235.75	14	3.75
38	667	262.28	13	3.58
39	670	284.27	13	3.44
40	649	291.06	13	3.36
41	627	276.34	13	3.36
42	606	261.61	13	3.36
43	584	246.88	13	3.36
44	562	232.15	13	3.36
45	541	219.43	13	3.36
46	519	209.50	13	3.36
47	497	202.66	13	3.36
48	476	198.22	13	3.36
49	465	196.02	13	3.36
50	459	195.14	13	3.36
51	458	195.01	13	3.36

The scaling factor for metal leaching rates is presented in Table 6.6-3. The scaling factor for the subsidence zone was determined using a K_t of 0.5 and a K_c of 0.2 derived from literature values(Elboushi 1975). The proportion of material less than 6 mm was estimated to be 1%. Therefore, a bulk scaling factor of 0.001 was used for the subsidence zone.

Table 6.6-3. Summary of Scaling Factors Used for the Block Cave Mines

Scaling Factor	Selected Scaling Factor
Grain Size Effect (K_r)	0.01
Temperature (K_t)	0.5
Water contact (K_c)	0.2
Bulk scaling factor	0.001

The concentrations of chemical species in the drainages accumulated at the bottoms of the block cave mines was calculated as a function of the sum of chemical loadings divided by the volume of the drainages.

6.7 Pit Lake

Mitchell Pit will be flooded at the end of mining operations with surface runoff, precipitation, and water redirected from the MDT (Table 6.2-1).

Physical and chemical mixing of the different bodies of water in the pit lake was assumed to be instantaneous and complete. Water stratification in the pit lake was not considered. Chemical loading from the pit walls was assumed to be negligible. The concentrations of chemical species in water in the pit lake were calculated as a function of the sum of chemical loadings divided by the volume of water in the pit lake.

6.8 Rock Storage Facilities

There are two waste rock storage facilities (RSFs) at the Mine Site: Mitchell RSF and McTagg RSF.

Sources of chemical loadings to the drainage at the bottom of the RSFs are summarized in Table 6.2-1. The mass of waste rock is estimated from mine operation waste rock production schedules prepared by Moose Mountain Technical Services (Tables 6.8-1 to 6.8-2). The scaling factor for metal leaching rates is presented in Table 6.8-3. SABREX modelling of blast tests estimated that 10% ($K_f = 0.1$) of the mass of blasted waste rock will be less than 6 mm. An ambient laboratory and RSF temperatures of 20˚C and 15˚C, respectively, were applied to determine the temperature effect. The K_t was determined to be 0.5 and was applied to the release rates of metals and other parameters. Literature values (Elboushi 1975) were used to estimate the portion of material in contact with water. In the RSFs, a water contact fraction of 20% was estimated.

Chemical loadings of ammonia, nitrite, and nitrate from explosive residues on the waste rock in the RSFs was calculated according to the method described in Section 6.4.

The concentrations of chemical species in drainages accumulated at the toes of RSFs was calculated as a function of the sum of chemical loadings divided by the volume of the drainages.

6.9 Sulphurets Pit Backfill

Sulphurets Pit will be backfilled with waste rock from Kerr Pit after year 27 (Table 3.2-2).

Sources of chemical loadings to drainage from Sulphurets Pit Backfill are summarized in Table 6.2-1. The mass of Kerr waste rock was estimated from Kerr waste rock disposal schedules, prepared by Moose Mountain Technical Services (Table 6.9-1). Kerr waste rock will be placed in the pit in 50 m lifts. The outer edge of each bench will be lined with a synthetic liner for a width of 100 m such that about 80 m of the liner will be covered by each subsequent lift. This approach will provide an internal barrier to downward movement of water within the backfill (waste rock) and Kerr waste rock under the synthetic liner will not be subjected to metal leaching. At closure, greater than 95% of the surface will be covered with a liner. In the model, the proportion of the mass of the backfilled Kerr waste rocks under the synthetic liner was assumed to increase progressively from 0% at year 27 to 95% at year 50 and beyond.

Table 6.8-1. Waste Schedule by Model Code to Mitchell Rock Storage Facility (in kt)

Year	Sulphurets - Overburden	Sulphurets - Au, Leach & Raewyn Zones	Sulphurets - Lower Au Zone	Sulphurets - Lower Plate Hazelton	Sulphurets - Upper Plate Hazelton	Sulphurets - Monzonite	Sulphurets - Undefined	Sulphurets - Overburden	Sulphurets - Au, Leach & Raewyn Zones	Sulphurets - Lower Au Zone	Sulphurets - Lower Plate Hazelton	Sulphurets - Upper Plate Hazelton	Sulphurets - Monzonite	Sulphurets - Undefined
	SNPRA<2							SNPRA≥2						
Year -3	5.7	0	0	39.3	852.6	0	54.6	700	0	0	0	1,886	0	873
Year -2	19	0	0	131	2,842	0	182	1,675	0	0	0	4,402	0	2,039
Year -1	302	70	423	1,515	5,562	1,970	2,520	1,318	0	0	1,267	8,660	8,460.2	8,287
Year 1	138	328	401	1,070	3,381	3	2,803	769	0	0	281	5,635	8,410	14,556
Year 2	0	1,440	219	1,099	1,570	0	2,321	755	49	0	170	3,780	2,606	7,690
Year 3	122	2,314	1,456	838	114	0	4,214	894	0	0	183	4,119	471	5,921
Year 4	137	2,175	952	12	0	0	1,905	575	0	0	40	11	0	4,027
Year 5	0	2,663	2,730	1	0	0	50	397	6	105	0	0	0	2,180
Year 6 to 10	0	1,505	1,072	1	0	0	0	74	0	90	0	0	0	65
Year 11 to 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 21 to 30	0.00	18,985.20	48,460.10	25,996.75	21,554.65	6,897.80	27,768.65	6,880.25	631.80	73.45	670.15	59,874.75	74,310.60	151,840.65
Year 31 to 40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 41 to 50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total by model code	718.00	29,480.20	55,713.10	30,663.75	35,023.65	8,870.80	41,763.65	13,337.25	686.80	268.45	2,611.15	86,481.75	94,257.80	196,605.65

Year	Mitchell - Overburden	Mitchell - Glacial Ice	Mitchell - Upper Plate Hazelton	Mitchell - Lower Plate Hazelton	Mitchell - Monzonite	Mitchell - Bornite/Leach Breccia	Mitchell - Overburden	Mitchell - Glacial Ice	Mitchell - Upper Plate Hazelton	Mitchell - Lower Plate Hazelton	Mitchell - Monzonite	Mitchell - Bornite/Leach Breccia	IC	
	SNPRA<2						SNPRA≥2						SNPRA<2	SNPRA≥2
Year -3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year -2	2,270	0	9,855	0	0	0	0	0	0	0	0	0	0	0
Year -1	4,557	0	23,513	27	1,262	0	0	0	3,467	63	6,627	0	0	0
Year 1	6,207	0	74,000	699	1,920	0	0	0	2,188	240	2,913	0	0	0
Year 2	2,724	0	109,481	851	2,255	0	0	0	0	5	3,080	0	0	0
Year 3	1,689	0	113,333	521	0	0	0	0	327	0	1,375	0	0	0
Year 4	1,129	0	74,597	20,027	495	0	0	0	2,136	2,168	3,840	0	177	0
Year 5	543	0	39,241	1,684	6,603	0	0	0	0	72	1,982	0	891	0
Year 6 to 10	2,442	0	228,394	83,392	13,431	2,054	566	452	7,262	2,231	111,461	0	0	0
Year 11 to 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 21 to 30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 31 to 40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 41 to 50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total by model code	21,561	0	672,414	107,201	25,966	2,054	566	452	15,380	4,779	131,278	0	1,068*	0

*** During Iron Cap development some waste rock will be placed in the Mitchell RSF**

Table 6.8-2. Waste Schedule by Model Code to McTagg Rock Storage Facility (in kt)

Year	Sulphurets - Overburden	Sulphurets - Au, Leach & Raewyn Zones	Sulphurets - Lower Au Zone	Sulphurets - Lower Plate Hazelton	Sulphurets - Upper Plate Hazelton	Sulphurets - Monzonite	Sulphurets - Undefined	Sulphurets - Overburden	Sulphurets - Au, Leach & Raewyn Zones	Sulphurets - Lower Au Zone	Sulphurets - Lower Plate Hazelton	Sulphurets - Upper Plate Hazelton	Sulphurets - Monzonite	Sulphurets - Undefined
	SNPRA<2							SNPRA≥2						
Year -2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year -1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 6 to 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 11 to 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 21 to 30	0	10,222.80	26,093.90	13,998.25	11,606.35	3,714.20	14,952.35	3,704.75	340.20	39.55	360.85	32,240.25	40,013.40	81,760.35
Year 31 to 40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 41 to 50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total by model code	0	10,222.80	26,093.90	13,998.25	11,606.35	3,714.20	14,952.35	3,704.75	340.20	39.55	360.85	32,240.25	40,013.40	81,760.35

Year	Mitchell - Overburden	Mitchell - Glacial Ice	Mitchell - Upper Plate Hazelton	Mitchell - Lower Plate Hazelton	Mitchell - Monzonite	Mitchell - Bornite/Leach Breccia	Mitchell - Overburden	Mitchell - Glacial Ice	Mitchell - Upper Plate Hazelton	Mitchell - Lower Plate Hazelton	Mitchell - Monzonite	Mitchell - Bornite/Leach Breccia	IC	
	SNPRA<2						SNPRA≥2						SNPRA<2	2<=SNPRA
Year -2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year -1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 6 to 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 11 to 20	1,206	0	202,860	127,307	9,623	3,771	25	2,467	2,448	1,790	152,792	0	15,724	0
Year 21 to 30	0	0	0	593	0	33	0	0	0	0	0	0	0	0
Year 31 to 40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 41 to 50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total by model code	1,206	0	202,860	127,900	9,623	3,804	25	2,467	2,448	1,790	152,792	0	15,724	0

Table 6.8-3. Summary of Scaling Factors Used for the Rock Storage Facilities

Scaling Factor	Selected Scaling Factor
Grain Size Effect (K_r)	0.1
Temperature (K_t)	0.5
Water contact (K_c)	0.2
Bulk scaling factor	0.01

Table 6.9-1. Waste Schedule by Model Code for Sulphurets Pit Backfill (in kt)

	Kerr	
Year	**SNPRA<2**	**SNPRA≥2**
Year -2	0	0
Year -1	0	0
Year 1	0	0
Year 2	0	0
Year 3	0	0
Year 4	0	0
Year 5	0	0
Year 6 to 10	0	0
Year 11 to 20	0	0
Year 21 to 30	103,715	1,677
Year 31 to 40	358,984	1
Year 41 to 50	196,795	3,821
Total by model code	659,494	5,499

The scaling factor for metal leaching rates is presented in Table 6.9-1. The scaling factor for Sulphurets Pit is summarized in Table 6.9-2. Kerr waste rock will have a higher percentage of fines than Mitchell and Sulphurets waste rock because it will be crushed for transport on a conveyor; therefore, the reactive fraction of Kerr waste rock was estimated to be 20% (K_r = 0.2) of the total mass. The oxidation of sulphide minerals is an exothermic reaction that is anticipated to elevate the internal temperatures of backfilled waste rock above ambient temperatures. Therefore, no temperature adjustment was applied. Literature values (Elboushi 1975) were used to estimate the portion of material in contact with water. In the Sulphurets Pit Backfill, a water contact fraction of 20% was estimated.

Diversion ditches and the synthetic liner will reduce both the volume of water infiltrating through Kerr waste rock and the quantity of Kerr waste rock exposed to water flushing and metal leaching. The concentrations of chemical species in the drainage of infiltrated water and diverted water were calculated separately. The concentrations of chemical species in the drainage were calculated as a function of the sum of chemical loadings divided by the water volume.

Table 6.9-2. Summary of Scaling Factors Used for the Sulphurets Pit Backfill

Scaling Factor	Selected Scaling Factor
Grain Size Effect (K_r)	0.2
Temperature (K_t)	--
Water contact (K_c)	0.2
Bulk scaling factor	0.04

6.10 Selenium Treatment Plant

Drainage from the Kerr Pit and infiltration through Kerr waste rock in the Sulphurets Pit Backfill will be pumped to the selenium treatment plant. A detailed description of the proposed treatment can be found in Appendix 4-V. Effluent from the Selenium Treatment Plant will report to the WSF. Laboratory investigations concluded that iron, selenium, and nitrate concentrations in Kerr waste rock leachate will be reduced (Table 6.10-1). The plant will have a maximum treatment capacity of 60 L/s. Drainage volumes that exceed the treatment capacity are will be routed directly to the WSF without selenium treatment.

Table 6.10-1. Parameters with Reduced Concentrations from the Selenium Treatment Plant

Parameter	Units	Concentration in Feed Water	Concentration in Effluent
Selenium	µg/L	100	< 1
Iron	mg/L	174	17
Nitrate	mg/L	0.23	< 0.05

6.11 Water Storage Facility

Contact water will be routed either to the WSF for temporary storage or directly to the WTP for treatment and discharge.

The sources of chemical loadings to the WSF include:

- undiverted surface runoffs;
- pit water;
- dewatering of block cave mines;
- drainage from RSFs;
- drainage from Sulphurets Pit Backfill;
- effluent from the selenium treatment plant;
- Mitchell Glacier contact water; and
- undiverted McTagg Glacier water.

Physical and chemical mixing of the different drainages and bodies of water in the WSF was assumed to be instantaneous and complete. Water stratification in the WSF was not considered. The concentrations of chemical species in the WSF were calculated as a function of the sum of chemical loadings accumulated in the WSF divided by the volume of water in the WSF. The mass balance approach used for water quality modelling does not predict pH and acidity/alkalinity. Estimates of water quality of the WSF using Phreeqc for engineering design purposes indicated that the pH will range from 3.5 to 5.5 depending on the time of year, freshet, and rainfall events.

Selenite (Se (IV)) is removed during HDS lime water treatment due to sorption to iron oxyhydroxides and co-precipitation with gypsum (Appendix 4-S; (Elrashidi et al. 1987); therefore, an appropriate estimation of the distribution of selenium species in the WSF was a key factor in predicting selenium concentrations in the receiving environment. The estimated distribution of selenium species in the WSF was based on the selenium speciation data collected from groundwater seeps and in Mitchell Creek at the toe of the Mitchell Glacier (see Chapter 14 of the Application/EIS). Reduced selenium species (Se (IV) and organic selenium) ranged from 56% to 89% of the total dissolved selenium at the toe of Mitchell Glacier during two sampling events in October and December 2012. Both selenate (Se (VI)) and selenite (Se (IV)) are stable under moderately oxidizing and acidic conditions (Elrashidi et al. 1987), such as would be expected in drainage from acidic waste rock.

The presence of Se (IV), Se(VI), and organic selenium in groundwater seeps and at the toe of the Mitchell Glacier indicate that microbiological communities involved in the reduction and redox cycling of selenium are endemic to the Mitchell Valley and will influence the selenium chemistry of the proposed RSFs. For the purposes of water quality modelling, a conservative estimate of 25% Se (IV) and 75% Se (VI) was selected as the selenium species distribution in the WSF during construction, operation, closure, and post-closure Project phases.

6.12 Seepage Collection Dam

There will be one seepage collection dam downstream of the WSF. Drainage collected in the seepage collection pond will be pumped directly to the WTP.

Hydrogeological modelling predicted a solute plume that daylights beyond the seepage collection dam. Preliminary modelling that indicated a constant flow rate of 1 L/s and average concentrations of chemical species in the plume of 5% of the WSF concentrations were used in the development of the surface water quality model (see detail in Chapters 11 and 12 of the Application/EIS). No other contaminated groundwater sources to surface water of the receiving environments are identified in the hydrogeological baseline studies and modelling.

7 Results: Water Quality Predictions

7.1 Predictions for the Water Storage Facility

The WSF is designed to store the Mine Site contact water prior to treatment at the WTP and discharge to the receiving environment in lower Mitchell Creek. The WSF will provide a reservoir for the collection and storage of contact water from the Mitchell and McTagg RSFs, water pumped from the open pits and block cave mines, Mitchell Glacier water below the infiltration gallery, and surface runoff. The WSF effectively represents the cumulative geochemical load from the Mine Site prior to water treatment. The WSF was designed to store the probable maximum flood (PMF; see Chapter 4 of the Application/EIS) and water from the WSF will not be discharged without water treatment.

This section presents the water quality predictions for the WSF for the four model scenarios or sensitivity analyses. A detailed summary of the expected case (scenario 1) water quality predictions for drainage from Mine Site components, including the open pits, block cave mines, and RSFs, are included in Appendix 14-H.

Tables 7.1-1 to 7.1-4 present statistical summaries of water quality in the WSF for the four model scenarios for the construction, operation, closure, and post-closure phases. Total metals are presented to enable comparison to water quality guidelines. Figures 7.1-1 to 7.1-4 illustrate the source loadings of 24 parameters in the water storage facility and Mine Site seepage recovery dam during the operation phase for the expected and upper case chemistry. The figures indicate the dominant source loading for each model parameter.

During the construction (pre-production) and operation phases, increasing concentrations of many water quality parameters over time in the WSF are a reflection of increased accumulation of waste rock in the RSFs (Tables 6.8-1 to 6.8-2), and therefore an increased chemical loading to the WSF (see Tables 6.2-3 to 6.2-5 for waste rock release rates). The construction phase water quality predictions (Table 7.1-1) indicated that concentrations of most parameters in the WSF were in the range of an order of magnitude less in Year -1 compared to Year 5. No effect on water quality in the construction phase downstream of the Mine Site was predicted. In the expected case during the operation phase, the predicted mean concentrations of sulphate and copper in the WSF are 994 mg/L and 13.8 mg/L, respectively (Table 7.1-2).

During the closure phase, mean sulphate concentrations are predicted to increase to 1,656 mg/L and mean copper concentrations are predicted to increase to 24.3 mg/L. These increases in concentration represent the larger relative chemical load from the RSFs to the WSF as water of lower concentration is redirected to the Mitchell Pit Lake (Table 7.1-3). The mean post-closure predictions of sulphate and copper in the WSF are 1,027 mg/L and 15.1 mg/L, respectively.

In the WSF in the operation phase, the maximum predicted concentrations in the upper case for most trace elements, including selenium, were 10 to 20% higher than in the expected case (e.g., mean selenium concentrations increased from 0.033 to 0.039 mg/L; Table 7.1-2).

Predicted mean variable case water balance simulation concentrations were between 4% and 20% higher than the base case water balance simulations (Tables 7.1-1 to 7.1-4).

7.2 Predictions for the End-of-Pipe

Water collected at the WSF will be pumped to the crest of the WSF and gravity-fed to the Mine Site WTP located downstream. The Mine Site WTP will use a conventional high-density sludge (HDS) lime water treatment process with a maximum treatment rate of 7.5 m^3/s to allow staging of discharge to the natural hydrograph (Appendix 14-I).

Water quality predictions for effluent from the WTP were based on a pilot-scale testing program of the HDS process completed by SGS Canada Inc. (Appendix 4-S). Feed water for the pilot plant was generated using 10,000 L of water collected from Mitchell Creek at the toe of the Mitchell Glacier and concentrations of dissolved parameters were increased to approximate preliminary estimates of water quality in the WSF.

The feed water quality, estimated effluent quality post-pH adjustment, and removal efficiencies are presented in Table 7.2-1. The measured effluent quality post-pH adjustment was used to model the effluent quality entering the receiving environment. For parameters where no reduction in concentration was observed as a result of water treatment, no reduction in concentration was applied in the model (e.g., nitrate concentrations in WTP effluent were modelled as equivalent to nitrate concentrations in the WSF).

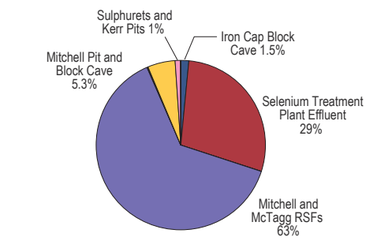
For most COPC, concentrations in the pilot plant effluent were greater than 90% lower than in the feed water and effluent concentrations were frequently lower than baseline concentrations in Mitchell Creek (Table 7.2-1). Effluent concentrations were below Metal Mining Effluent Regulations (SOR/2002-22) maximum authorized monthly mean concentrations and below the lower limit of BC Pollution Control Objectives (BC MOE 1979), with the exception of selenium.

Selenium concentrations were below the upper limit of BC Pollution Control Objectives (range 0.05 to 0.5 mg/L; (BC MOE 1979). Selenium (IV) and organic selenium were effectively removed (> 85%) by the HDS process, while the concentration of selenium (VI) was unaffected by lime treatment. These results reflect that Se(IV) more readily sorbs to the iron oxyhydroxides produced during the HDS process and is therefore less mobile than Se(VI) ((Elrashidi et al. 1987; Martin et al. 2011).

7.3 Predictions for the Receiving Environment

Predicted water quality in the receiving environment downstream of the Mine Site was assessed for Sulphurets Creek and the Unuk River in the construction, operation, closure, and post-closure phases. Water quality predictions were compared to both BC water quality guidelines for the protection of freshwater aquatic life and observed background conditions (95^{th} percentile of baseline data for a given month; Table 6.3-1).

Silver



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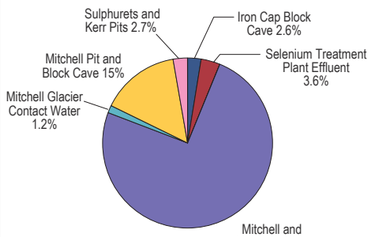

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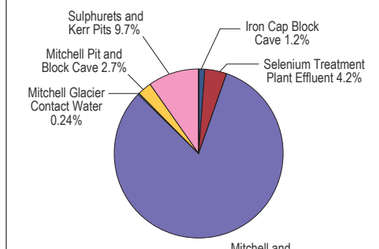

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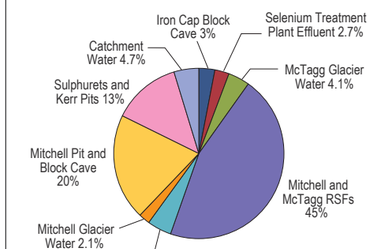

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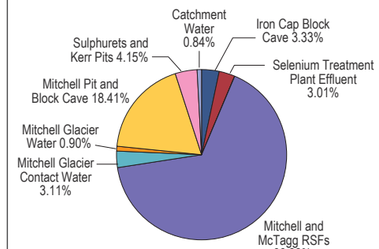

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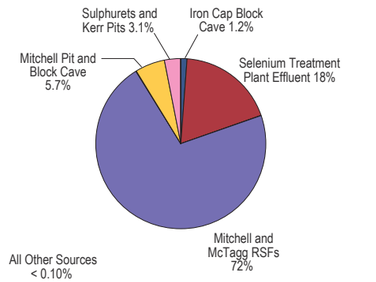

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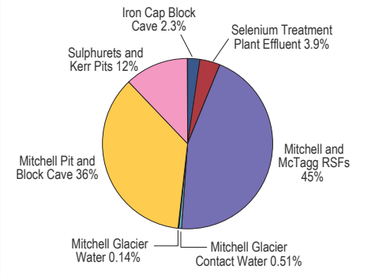
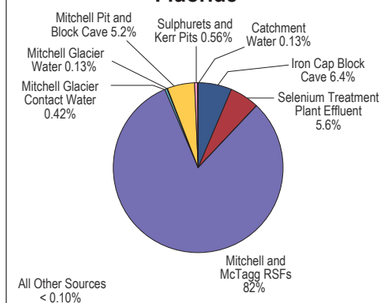
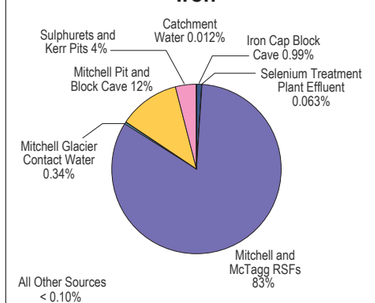


Fluoride



Iron



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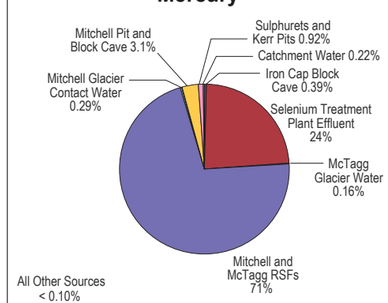

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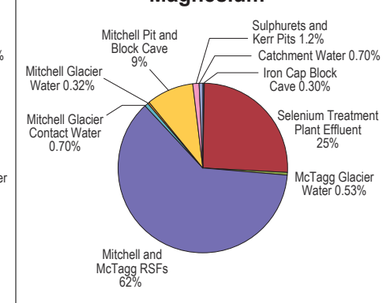

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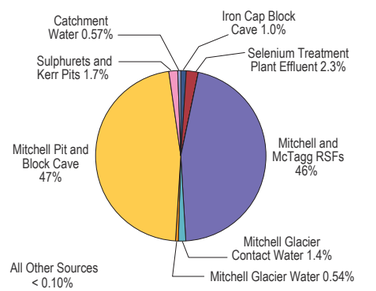
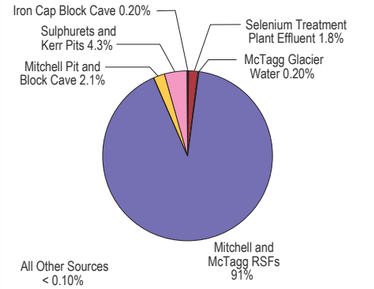
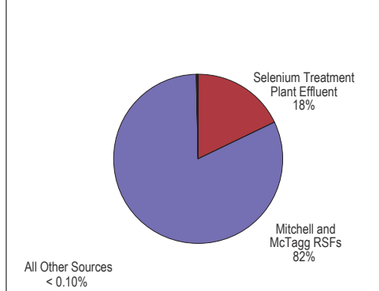


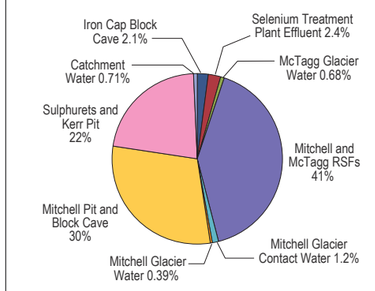
Molybdenum



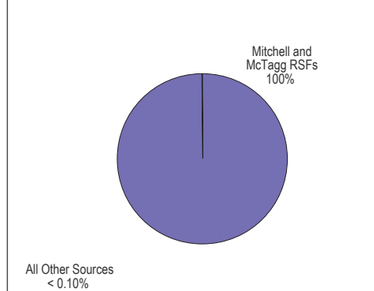
Ammonia



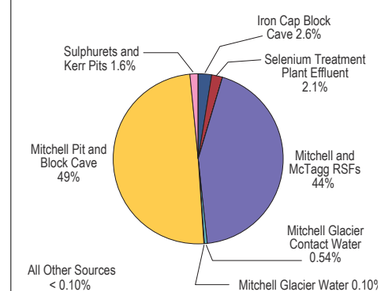
Nickel



Nitrate



Lead



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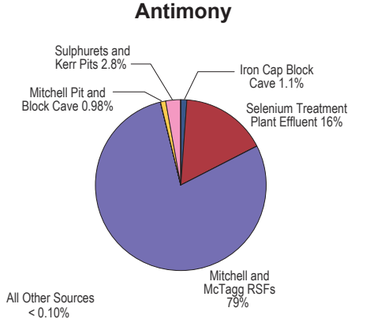

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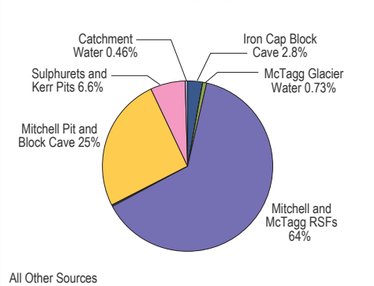
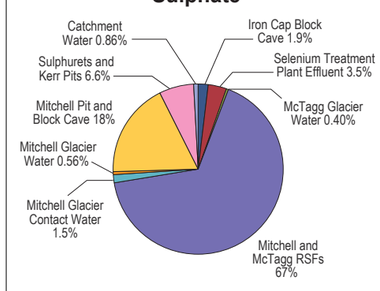
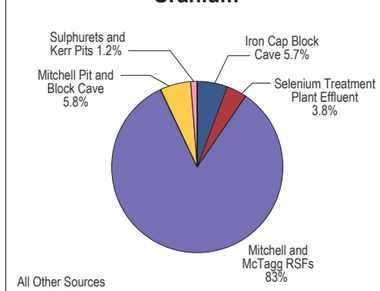


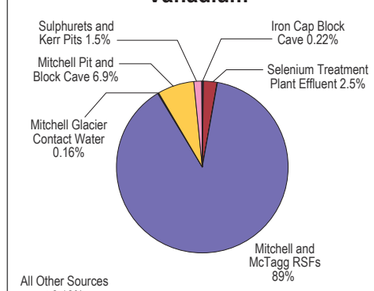
Sulphate



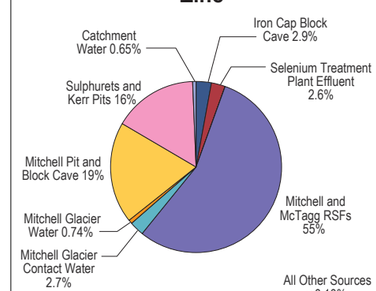
Uranium



Vanadium



Zinc



Iron Cap Block Cave | Selenium Treatment Plant Effluent | McTagg Glacier Water | Mitchell and McTagg RSFs | Mitchell Glacier Contact Water | Mitchell Glacier Water | Mitchell Pit and Block Cave | Sulphurets and Kerr Pits | Catchment Water

Figure 7.1-1

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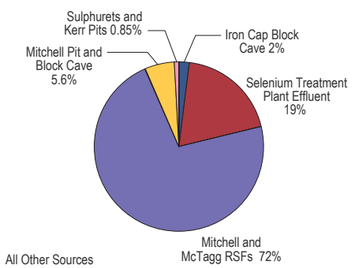
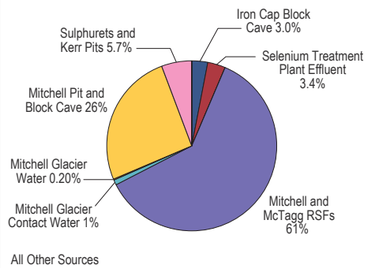
Sources of Loadings to Storage Facility for Each Modelled Parameter; Expected Case

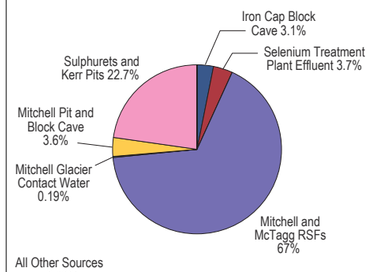
Silver



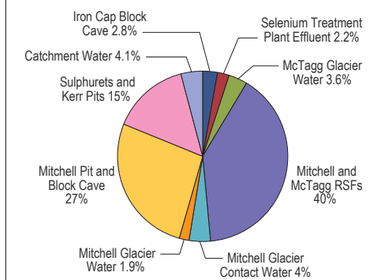
Aluminum



Arsenic



Calcium



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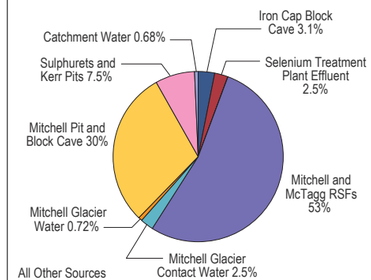

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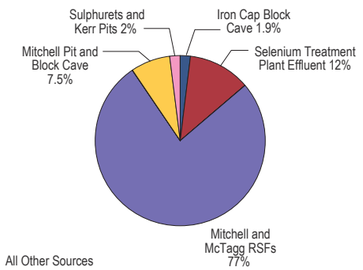
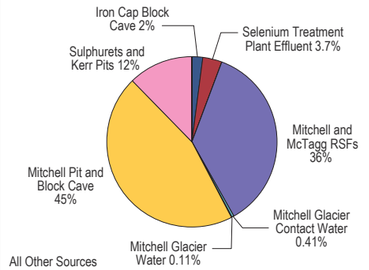


Copper



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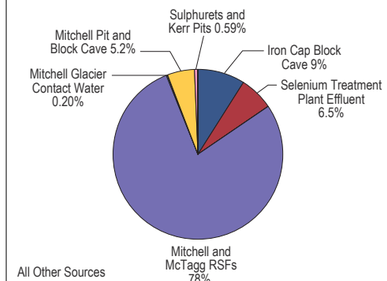

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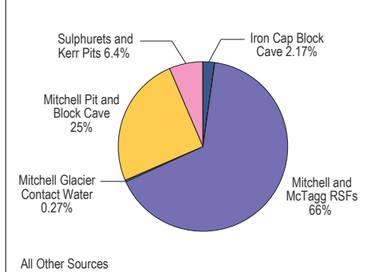
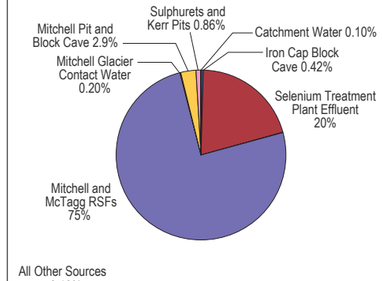
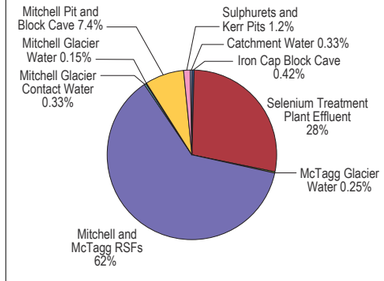


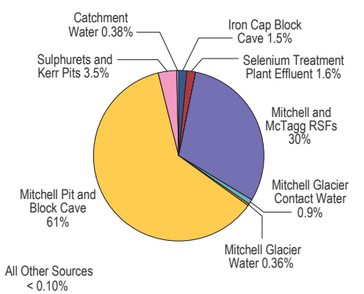
Mercury



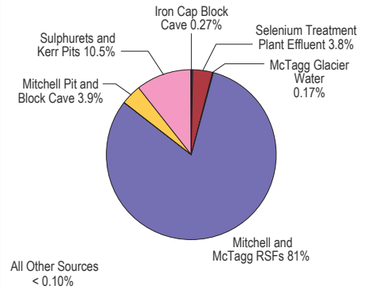
Magnesium



Manganese



Molybdenum



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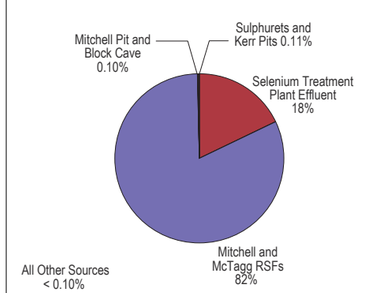

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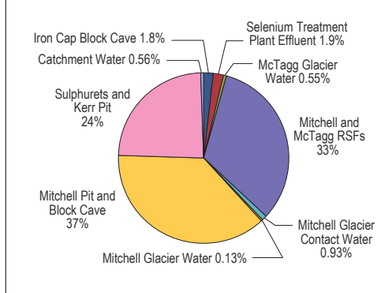

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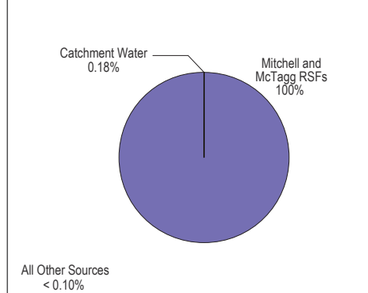

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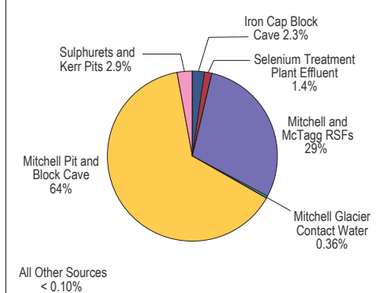

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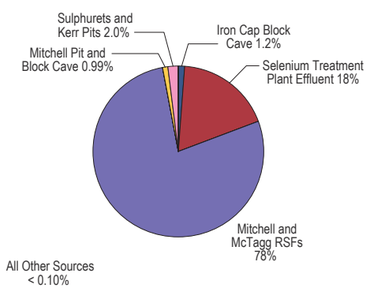

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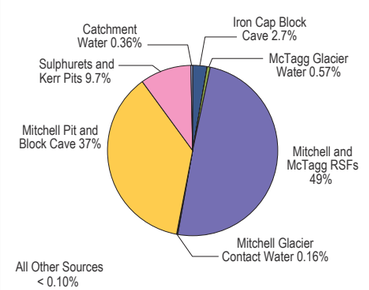

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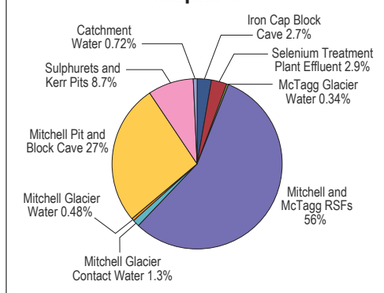

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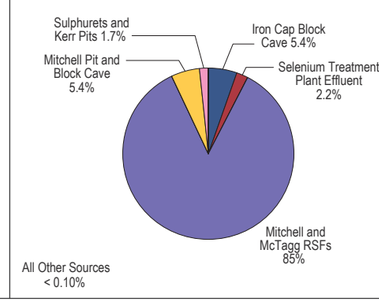

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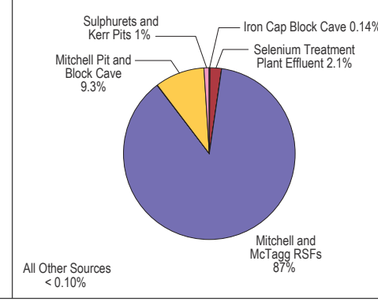

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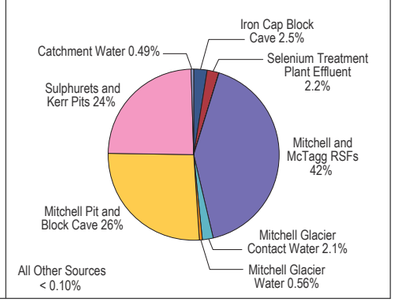

Iron Cap Block Cave | Selenium Treatment Plant Effluent | McTagg Glacier Water | Mitchell and McTagg RSFs | Mitchell Glacier Contact Water | Mitchell Glacier Water | Mitchell Pit and Block Cave | Sulphurets and Kerr Pits | Catchment Water

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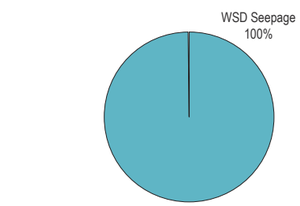
Figure 7.1-2

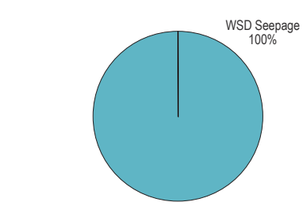
Rescan Engineers & Scientists

Sources of Loadings to Water Storage Facility for Each Modelled Parameter; Upper Case

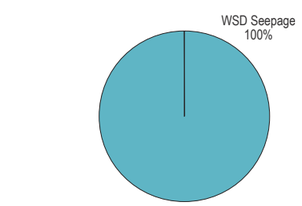
Silver



Aluminum



Arsenic



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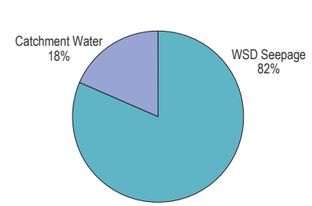

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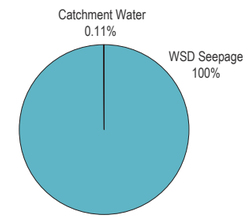
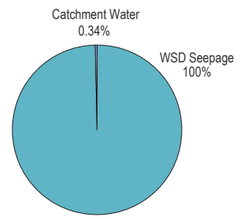


Chromium



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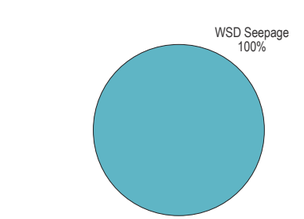

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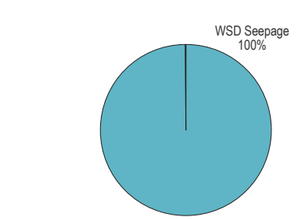

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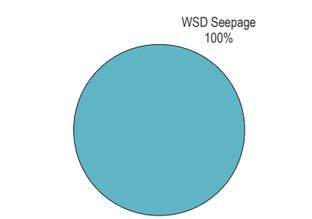
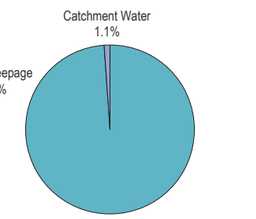


Mercury



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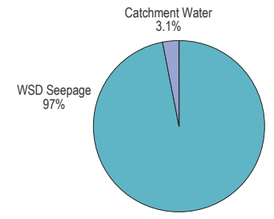

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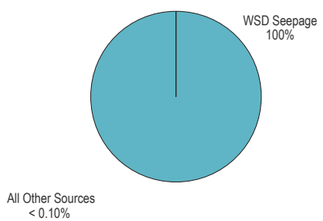
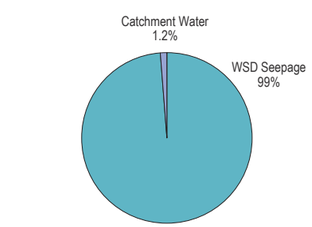


Molybdenum



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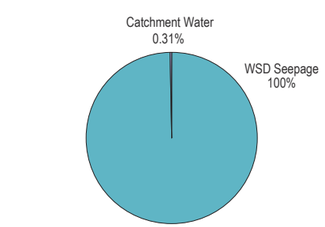
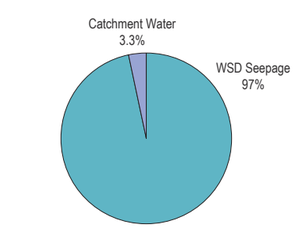


Nickel



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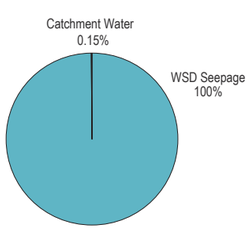
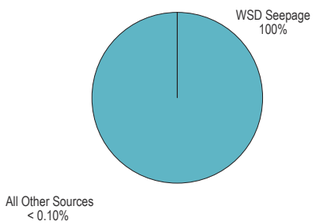


Lead



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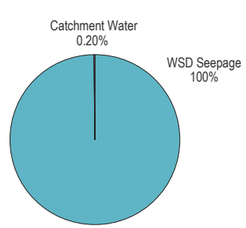
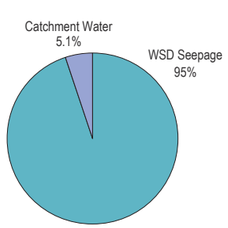
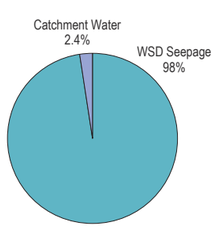


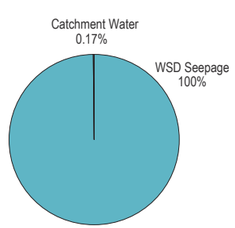
Selenium



Sulphate



Uranium



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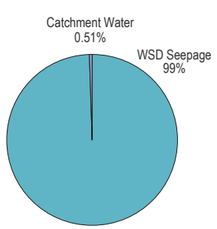

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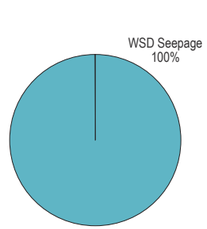

WSD Seepage Catchment Water

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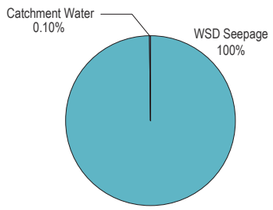
Figure 7.1-3

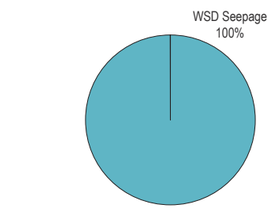
Rescan Engineers & Scientists

Sources of Loadings to Mine Site Seepage Recovery Dam for Each Modelled Parameter; Expected Case

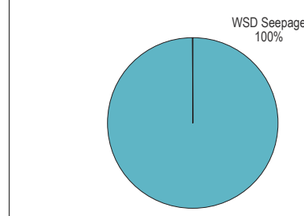
Silver



Aluminum



Arsenic



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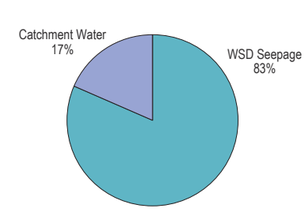
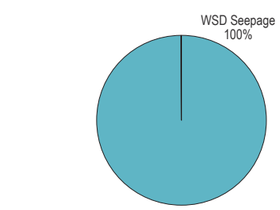
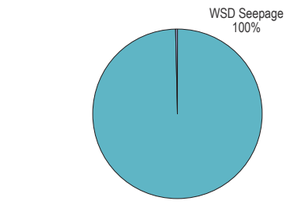


Cadmium



Chromium



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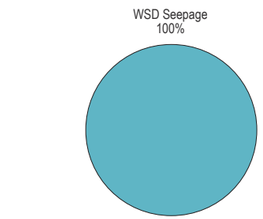

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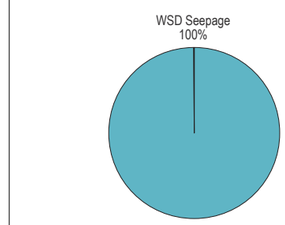

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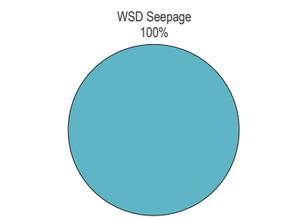
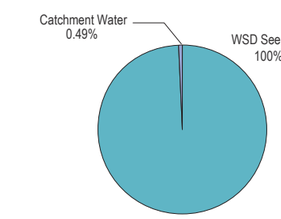
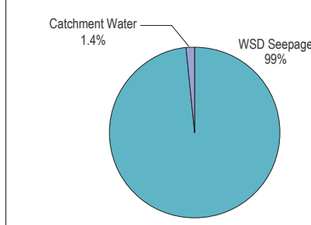


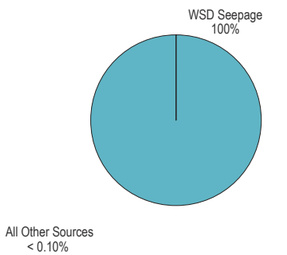
Mercury



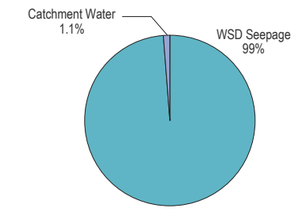
Magnesium



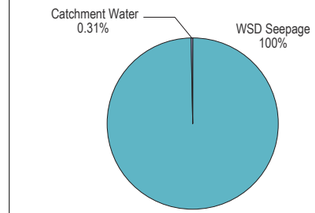
Manganese



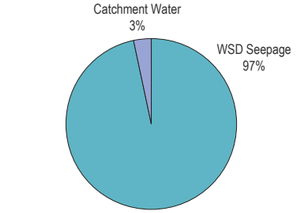
Molybdenum



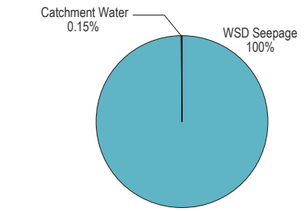
Ammonia



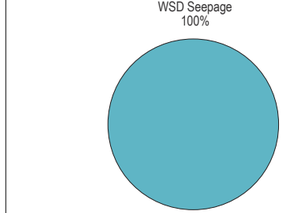
Nickel



Nitrate



Lead



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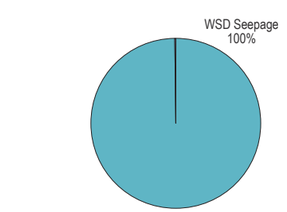
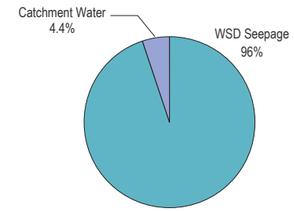


Selenium



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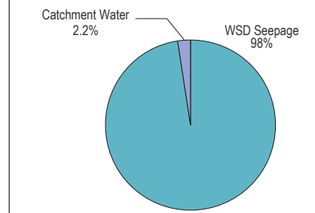
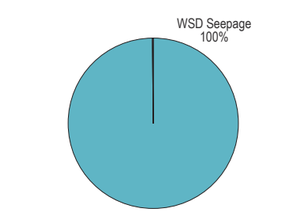
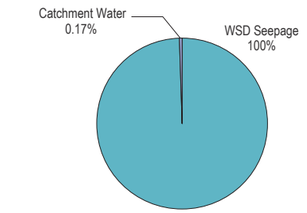


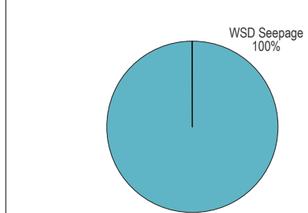
Uranium



Vanadium



Zinc



WSD Seepage Catchment Water

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Figure 7.1-4

Rescan Engineers & Scientists

Sources of Loadings to Mine Site Seepage Recovery Dam for Each Modelled Parameter; Upper Case

Table 7.1-1. Summary Statistics of Water Quality Predictions for the Water Storage Facility (Construction Phase)

Scenario 1: Expected Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.24	0.97	0.88	2.62	2.58	0.68	0.69
Chloride (Cl)	3.43	5.47	5.53	9.49	9.19	1.52	0.28
Fluoride (F)	1.51	**2.45**	**2.70**	**4.51**	**4.39**	0.84	0.34
Nitrate (as N)	6.77	11.80	12.48	22.81	22.08	4.31	0.36
Nitrite (as N)	0.0005	0.0015	0.0018	0.0021	0.0021	0.0006	0.41
Total Phosphate (as P)	0.29	0.54	0.45	1.32	1.31	0.29	0.54
Sulphate (SO_4)	**301**	**339**	**338**	**378**	**372**	26	0.08
Total Metals							
Aluminum (Al)	*4.96*	*7.00*	*7.60*	*9.53*	*9.21*	1.47	0.21
Antimony (Sb)	0.0113	0.0199	**0.0212**	**0.0386**	**0.0374**	0.0074	0.37
Arsenic (As)	**0.0220**	**0.0327**	**0.0366**	**0.0424**	**0.0417**	0.0080	0.24
Barium (Ba)	0.167	0.285	0.306	0.534	0.519	0.101	0.36
Beryllium (Be)	0.0019	0.0031	0.0033	0.0056	0.0055	0.0010	0.33
Boron (B)	0.020	0.036	0.039	0.067	0.065	0.014	0.38
Cadmium (Cd)	**0.011**	**0.013**	**0.012**	**0.016**	**0.016**	0.001	0.11
Calcium (Ca)	32.57	52.94	52.87	74.37	73.06	13.99	0.26
Chromium (Cr)	**0.0039**	**0.0056**	**0.0058**	**0.0099**	**0.0096**	0.0016	0.28
Cobalt (Co)	0.022	0.033	0.036	0.047	0.046	0.008	0.25
Copper (Cu)	**2.30**	**3.71**	**4.31**	**5.42**	**5.29**	1.09	0.29
Iron (Fe)	**47.22**	**73.72**	**82.90**	**94.79**	**94.04**	19.52	0.26
Lead (Pb)	0.015	0.023	0.027	0.031	0.031	0.006	0.27
Lithium (Li)	0.012	0.018	0.019	0.032	0.031	0.006	0.31
Magnesium (Mg)	5.84	7.20	6.94	9.82	9.60	0.89	0.12
Manganese (Mn)	1.68	2.14	2.21	**2.75**	**2.68**	0.35	0.17
Mercury (Hg)	0.000021	0.000043	0.000050	0.000087	0.000084	0.000019	0.44
Molybdenum (Mo)	0.023	0.034	0.038	0.044	0.043	0.008	0.24
Nickel (Ni)	0.008	0.009	0.010	0.013	0.012	0.002	0.17
Potassium (K)	4.38	7.44	8.17	14.24	13.79	2.77	0.37
Selenium (Se)	**0.0077**	**0.0097**	**0.0106**	**0.0117**	**0.0115**	0.0015	0.16
Silicon (Si)	9.54	14.68	15.74	26.67	25.88	4.74	0.32
Silver (Ag)	0.000069	0.000150	0.000172	0.000307	0.000299	0.000069	0.46
Sodium (Na)	4.85	8.12	7.77	12.36	12.04	2.46	0.30
Strontium (Sr)	1.08	1.47	1.48	2.48	2.40	0.36	0.24
Thallium (Tl)	**0.00034**	**0.00058**	**0.00064**	**0.00111**	**0.00108**	0.00021	0.37
Tin (Sn)	0.00113	0.00248	0.00287	0.00517	0.00501	0.00117	0.47
Uranium (U)	0.0085	0.0156	0.0174	0.0308	0.0299	0.0063	0.40
Vanadium (V)	0.0055	0.0093	0.0100	0.0176	0.0170	0.0033	0.36
Zinc (Zn)	0.80	0.93	0.91	1.13	1.11	0.11	0.12

(continued)

Table 7.1-1. Summary Statistics of Water Quality Predictions for the Water Storage Facility (Construction Phase) (continued)

Scenario 2							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.24	0.97	0.88	2.62	2.58	0.68	0.69
Chloride (Cl)	7.01	11.50	12.09	21.24	20.55	3.78	0.33
Fluoride (F)	**2.14**	**3.65**	**4.02**	**6.92**	**6.72**	1.35	0.37
Nitrate (as N)	6.77	11.80	12.48	22.81	22.08	4.31	0.36
Nitrite (as N)	0.0005	0.0015	0.0018	0.0021	0.0021	0.0006	0.41
Total Phosphate (as P)	0.29	0.54	0.45	1.32	1.31	0.29	0.54
Sulphate (SO_4)	**309**	**354**	**354**	**400**	**397**	33	0.09
Total Metals							
Aluminum (Al)	*5.04*	*7.27*	*7.98*	*9.82*	*9.48*	1.62	0.22
Antimony (Sb)	**0.0426**	**0.0773**	**0.0836**	**0.1530**	**0.1481**	0.0304	0.39
Arsenic (As)	**0.0242**	**0.0376**	**0.0423**	**0.0523**	**0.0511**	0.0100	0.27
Barium (Ba)	0.281	0.493	0.532	0.944	0.915	0.182	0.37
Beryllium (Be)	0.0060	0.0107	0.0117	0.0206	0.0200	0.0040	0.38
Boron (B)	0.051	0.116	0.134	0.241	0.233	0.056	0.48
Cadmium (Cd)	**0.012**	**0.014**	**0.013**	**0.017**	**0.017**	0.002	0.12
Calcium (Ca)	34.71	54.67	55.16	75.08	73.81	13.24	0.24
Chromium (Cr)	**0.0061**	**0.0098**	**0.0107**	**0.0185**	**0.0179**	0.0034	0.35
Cobalt (Co)	0.024	0.040	0.045	0.061	0.059	0.012	0.31
Copper (Cu)	**2.43**	**4.21**	**4.99**	**6.49**	**6.28**	1.40	0.33
Iron (Fe)	**48.57**	**77.71**	**88.62**	**102.98**	**101.63**	21.60	0.28
Lead (Pb)	0.016	0.034	0.041	0.053	0.051	0.014	0.42
Lithium (Li)	0.015	0.027	0.030	0.051	0.049	0.010	0.37
Magnesium (Mg)	9.08	12.07	12.20	19.96	19.40	2.90	0.24
Manganese (Mn)	1.83	**2.71**	**2.90**	**3.97**	**3.81**	0.71	0.26
Mercury (Hg)	0.000045	0.000099	0.000114	0.000204	0.000198	0.000046	0.47
Molybdenum (Mo)	0.027	0.041	0.045	0.057	0.056	0.010	0.26
Nickel (Ni)	0.008	0.011	0.012	0.016	0.016	0.002	0.22
Potassium (K)	8.88	17.37	19.68	35.12	33.97	7.52	0.43
Selenium (Se)	**0.0079**	**0.0105**	**0.0116**	**0.0134**	**0.0131**	0.0020	0.19
Silicon (Si)	12.00	19.74	21.42	37.06	35.91	6.99	0.35
Silver (Ag)	0.000151	0.000344	0.000401	0.000719	0.000697	0.000166	0.48
Sodium (Na)	6.86	9.81	10.30	13.18	12.84	1.93	0.20
Strontium (Sr)	2.02	3.12	3.30	5.77	5.58	1.02	0.33
Thallium (Tl)	**0.00074**	**0.00151**	**0.00171**	**0.00308**	**0.00298**	0.00067	0.45
Tin (Sn)	0.00236	0.00542	0.00629	0.01144	0.01107	0.00265	0.49
Uranium (U)	0.0293	0.0546	0.0601	0.1086	0.1050	0.0221	0.40
Vanadium (V)	0.0108	0.0191	0.0207	0.0372	0.0359	0.0073	0.38
Zinc (Zn)	0.85	1.06	1.04	1.35	1.33	0.16	0.15

(continued)

Table 7.1-1. Summary Statistics of Water Quality Predictions for the Water Storage Facility (Construction Phase) (continued)

Scenario 3							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.24	0.95	0.84	2.53	2.50	0.65	0.68
Chloride (Cl)	1.80	5.03	5.43	9.26	8.89	1.84	0.37
Fluoride (F)	0.99	**2.34**	**2.66**	**4.41**	**4.26**	0.90	0.38
Nitrate (as N)	3.85	10.68	12.25	22.25	21.36	5.11	0.48
Nitrite (as N)	0.0004	0.0014	0.0017	0.0021	0.0021	0.0006	0.45
Total Phosphate (as P)	0.22	0.50	0.45	1.32	1.30	0.30	0.59
Sulphate (SO_4)	**206**	**335**	**335**	**378**	**372**	38	0.11
Total Metals							
Aluminum (Al)	*4.10*	*6.80*	*7.63*	*9.53*	*9.14*	1.69	0.25
Antimony (Sb)	0.0066	0.0181	**0.0209**	**0.0377**	**0.0361**	0.0087	0.48
Arsenic (As)	**0.0191**	**0.0318**	**0.0369**	**0.0423**	**0.0415**	0.0089	0.28
Barium (Ba)	0.103	0.262	0.304	0.522	0.503	0.119	0.45
Beryllium (Be)	0.0014	0.0029	0.0033	0.0055	0.0053	0.0011	0.39
Boron (B)	0.013	0.033	0.039	0.066	0.063	0.015	0.45
Cadmium (Cd)	**0.009**	**0.013**	**0.012**	**0.016**	**0.016**	0.002	0.12
Calcium (Ca)	32.34	53.79	45.88	82.80	81.57	18.33	0.34
Chromium (Cr)	**0.0020**	**0.0053**	**0.0057**	**0.0096**	**0.0093**	0.0018	0.33
Cobalt (Co)	0.018	0.032	0.036	0.046	0.045	0.009	0.29
Copper (Cu)	**1.84**	**3.59**	**4.30**	**5.36**	**5.22**	1.19	0.33
Iron (Fe)	**43.01**	**71.64**	**84.01**	**94.77**	**94.03**	21.89	0.31
Lead (Pb)	0.013	0.023	0.026	0.031	0.031	0.007	0.30
Lithium (Li)	0.007	0.017	0.019	0.031	0.030	0.006	0.36
Magnesium (Mg)	3.36	7.00	7.07	9.63	9.37	1.22	0.17
Manganese (Mn)	1.10	2.10	2.19	**2.72**	**2.65**	0.40	0.19
Mercury (Hg)	0.000016	0.000041	0.000049	0.000085	0.000082	0.000020	0.50
Molybdenum (Mo)	0.019	0.033	0.038	0.044	0.043	0.009	0.27
Nickel (Ni)	0.005	0.009	0.009	0.013	0.012	0.002	0.20
Potassium (K)	2.74	7.03	8.07	13.90	13.35	3.00	0.43
Selenium (Se)	**0.0055**	**0.0095**	**0.0106**	**0.0117**	**0.0115**	0.0017	0.18
Silicon (Si)	5.57	13.84	15.57	26.06	25.09	5.26	0.38
Silver (Ag)	0.000051	0.000141	0.000170	0.000300	0.000290	0.000074	0.53
Sodium (Na)	3.52	8.37	6.79	14.02	13.94	3.55	0.42
Strontium (Sr)	0.57	1.38	1.46	2.42	2.33	0.42	0.30
Thallium (Tl)	0.00021	**0.00054**	**0.00062**	**0.00109**	**0.00104**	0.00025	0.46
Tin (Sn)	0.00083	0.00234	0.00283	0.00505	0.00484	0.00126	0.54
Uranium (U)	0.0055	0.0145	0.0171	0.0301	0.0289	0.0070	0.49
Vanadium (V)	0.0032	0.0085	0.0099	0.0172	0.0165	0.0038	0.45
Zinc (Zn)	0.64	0.91	0.86	1.13	1.10	0.12	0.13

(continued)

Table 7.1-1. Summary Statistics of Water Quality Predictions for the Water Storage Facility (Construction Phase) (completed)

Scenario 4: Upper Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.24	0.95	0.84	2.53	2.50	0.65	0.68
Chloride (Cl)	3.76	10.50	11.92	20.73	19.88	4.49	0.43
Fluoride (F)	1.40	**3.44**	**3.96**	**6.76**	**6.51**	1.47	0.43
Nitrate (as N)	3.85	10.68	12.25	22.25	21.36	5.11	0.48
Nitrite (as N)	0.0004	0.0014	0.0017	0.0021	0.0021	0.0006	0.45
Total Phosphate (as P)	0.22	0.50	0.45	1.32	1.30	0.30	0.59
Sulphate (SO_4)	**210**	**349**	**350**	**398**	**396**	43	0.12
Total Metals							
Aluminum (Al)	*4.18*	*7.06*	*8.01*	*9.81*	*9.40*	1.84	0.26
Antimony (Sb)	**0.0258**	**0.0707**	**0.0820**	**0.1492**	**0.1432**	0.0350	0.50
Arsenic (As)	**0.0207**	**0.0363**	**0.0423**	**0.0520**	**0.0506**	0.0113	0.31
Barium (Ba)	0.171	0.451	0.523	0.921	0.886	0.212	0.47
Beryllium (Be)	0.0039	0.0099	0.0116	0.0201	0.0194	0.0046	0.47
Boron (B)	0.038	0.109	0.132	0.235	0.226	0.059	0.54
Cadmium (Cd)	**0.009**	**0.014**	**0.013**	**0.017**	**0.016**	0.002	0.13
Calcium (Ca)	32.89	55.42	48.18	83.46	82.14	17.64	0.32
Chromium (Cr)	**0.0035**	**0.0092**	**0.0105**	**0.0180**	**0.0173**	0.0038	0.42
Cobalt (Co)	0.020	0.038	0.045	0.060	0.058	0.013	0.34
Copper (Cu)	**1.99**	**4.07**	**4.97**	**6.41**	**6.19**	1.51	0.37
Iron (Fe)	**44.17**	**75.41**	**89.64**	**102.75**	**101.35**	24.11	0.32
Lead (Pb)	0.015	0.033	0.041	0.053	0.050	0.015	0.44
Lithium (Li)	0.010	0.025	0.030	0.049	0.048	0.011	0.43
Magnesium (Mg)	5.05	11.54	12.00	19.52	18.85	3.25	0.28
Manganese (Mn)	1.26	**2.65**	**2.89**	**3.91**	**3.74**	0.75	0.28
Mercury (Hg)	0.000033	0.000093	0.000112	0.000199	0.000191	0.000050	0.53
Molybdenum (Mo)	0.021	0.039	0.045	0.057	0.055	0.012	0.30
Nickel (Ni)	0.005	0.011	0.012	0.016	0.016	0.003	0.25
Potassium (K)	6.23	16.32	19.42	34.27	32.87	8.13	0.50
Selenium (Se)	**0.0058**	**0.0103**	**0.0116**	**0.0133**	**0.0130**	0.0022	0.21
Silicon (Si)	7.30	18.53	21.30	36.19	34.80	7.74	0.42
Silver (Ag)	0.000107	0.000323	0.000397	0.000702	0.000675	0.000178	0.55
Sodium (Na)	4.12	9.94	9.60	14.77	14.61	3.05	0.31
Strontium (Sr)	1.12	2.90	3.26	5.63	5.40	1.17	0.40
Thallium (Tl)	**0.00052**	**0.00141**	**0.00168**	**0.00300**	**0.00288**	0.00073	0.52
Tin (Sn)	0.00168	0.00510	0.00621	0.01116	0.01070	0.00283	0.55
Uranium (U)	0.0185	0.0502	0.0591	0.1059	0.1016	0.0251	0.50
Vanadium (V)	0.0064	0.0175	0.0205	0.0363	0.0348	0.0084	0.48
Zinc (Zn)	0.68	1.03	1.02	1.34	1.32	0.18	0.17

Notes:

All measured values are in units of mg/L.

Grey highlighted values exceed BC chronic water quality guidelines; bold values exceed BC acute water quality guidelines.

For pH-dependent guidelines, pH was assumed to be > 6.5.

For total aluminum, italic values exceed CCME pH-dependent water quality guidelines.

Table 7.1-2. Summary Statistics of Water Quality Predictions for the Water Storage Facility (Operation Phase)

Scenario 1: Expected Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.00	0.37	0.23	3.04	1.32	0.45	1.20
Chloride (Cl)	0.28	18.94	19.39	59.92	40.32	13.06	0.69
Fluoride (F)	0.22	**12.75**	**12.61**	**36.67**	**23.89**	6.17	0.48
Nitrate (as N)	0.01	4.16	1.36	26.32	13.46	5.04	1.21
Nitrite (as N)	0.0003	0.0015	0.0016	0.0025	0.0022	0.0006	0.38
Total Phosphate (as P)	0.04	0.39	0.36	1.45	0.60	0.14	0.36
Sulphate (SO_4)	51	**994**	**978**	**1,694**	**1,525**	344	0.35
Total Metals							
Aluminum (Al)	*0.47*	*24.10*	*24.04*	*41.66*	*38.31*	9.11	0.38
Antimony (Sb)	0.0003	**0.0703**	**0.0623**	**0.2366**	**0.1543**	0.0467	0.66
Arsenic (As)	0.0008	**0.1239**	**0.1162**	**0.2351**	**0.2110**	0.0549	0.44
Barium (Ba)	0.008	1.345	1.339	3.845	2.557	0.717	0.53
Beryllium (Be)	0.0003	0.0261	0.0215	0.0905	0.0576	0.0166	0.64
Boron (B)	0.002	0.176	0.161	0.547	0.356	0.098	0.56
Cadmium (Cd)	**0.002**	**0.034**	**0.033**	**0.055**	**0.051**	0.011	0.33
Calcium (Ca)	17.51	78.29	71.92	112.26	110.51	20.34	0.26
Chromium (Cr)	0.0004	**0.0334**	**0.0287**	**0.1095**	**0.0716**	0.0207	0.62
Cobalt (Co)	0.003	0.099	0.105	**0.159**	**0.141**	0.027	0.27
Copper (Cu)	**0.21**	**13.83**	**14.11**	**23.78**	**21.68**	4.80	0.35
Iron (Fe)	**1.31**	**271.27**	**294.30**	**477.92**	**430.66**	109.43	0.40
Lead (Pb)	0.001	0.098	0.102	0.153	0.136	0.028	0.29
Lithium (Li)	0.002	0.097	0.099	0.249	0.167	0.043	0.44
Magnesium (Mg)	1.43	42.43	34.38	141.98	92.30	25.86	0.61
Manganese (Mn)	0.29	**5.49**	**5.68**	**7.80**	**6.99**	1.17	0.21
Mercury (Hg)	0.000002	0.000205	0.000171	0.000671	0.000434	0.000117	0.57
Molybdenum (Mo)	0.001	0.116	0.116	0.203	0.186	0.046	0.40
Nickel (Ni)	0.001	0.028	0.028	0.045	0.043	0.009	0.33
Potassium (K)	0.42	37.09	33.18	115.23	75.25	20.47	0.55
Selenium (Se)	0.0009	**0.0330**	**0.0346**	**0.0589**	**0.0504**	0.0110	0.33
Silicon (Si)	1.15	75.76	71.95	222.06	146.37	39.88	0.53
Silver (Ag)	0.000004	0.001137	0.000887	**0.004117**	0.002626	0.000760	0.67
Sodium (Na)	2.60	27.80	22.87	74.42	52.91	14.16	0.51
Strontium (Sr)	0.14	5.62	4.68	19.68	12.86	3.93	0.70
Thallium (Tl)	0.00002	**0.00255**	**0.00251**	**0.00752**	**0.00500**	0.00146	0.57
Tin (Sn)	0.00005	0.01095	0.01055	0.03083	0.02028	0.00523	0.48
Uranium (U)	0.0005	0.0959	0.0947	0.2828	0.1854	0.0509	0.53
Vanadium (V)	0.0003	0.0448	0.0458	0.1235	0.0817	0.0236	0.53
Zinc (Zn)	0.14	2.59	2.49	4.56	4.07	0.89	0.34

(continued)

Table 7.1-2. Summary Statistics of Water Quality Predictions for the Water Storage Facility (Operation Phase) (continued)

Scenario 2							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.00	0.37	0.23	3.04	1.32	0.45	1.20
Chloride (Cl)	0.34	44.06	46.86	134.04	89.66	28.66	0.65
Fluoride (F)	0.24	**26.51**	**25.88**	**82.65**	**53.05**	14.43	0.54
Nitrate (as N)	0.01	4.16	1.36	26.32	13.46	5.04	1.21
Nitrite (as N)	0.0003	0.0015	0.0016	0.0025	0.0022	0.0006	0.38
Total Phosphate (as P)	0.04	0.39	0.36	1.45	0.60	0.14	0.36
Sulphate (SO_4)	51	**1,098**	**1,122**	**1,821**	**1,656**	362	0.33
Total Metals							
Aluminum (Al)	*0.47*	*26.98*	*27.27*	*47.46*	*42.94*	10.07	0.37
Antimony (Sb)	0.0007	**0.2259**	**0.1934**	**0.7568**	**0.4917**	0.1439	0.64
Arsenic (As)	0.0008	**0.1550**	**0.1373**	**0.3210**	**0.2773**	0.0717	0.46
Barium (Ba)	0.011	2.864	2.819	8.480	5.595	1.580	0.55
Beryllium (Be)	0.0004	0.0801	0.0790	0.2308	0.1515	0.0421	0.53
Boron (B)	0.003	0.502	0.495	**1.352**	0.893	0.225	0.45
Cadmium (Cd)	**0.002**	**0.039**	**0.040**	**0.061**	**0.056**	0.012	0.30
Calcium (Ca)	17.53	83.93	78.65	115.10	113.85	19.26	0.23
Chromium (Cr)	0.0005	**0.0686**	**0.0649**	**0.2093**	**0.1368**	0.0385	0.56
Cobalt (Co)	0.003	**0.123**	**0.126**	**0.182**	**0.165**	0.031	0.25
Copper (Cu)	**0.21**	**16.45**	**17.31**	**24.94**	**23.10**	4.94	0.30
Iron (Fe)	**1.35**	**311.24**	**333.02**	**543.62**	**478.82**	108.59	0.35
Lead (Pb)	0.001	0.148	0.147	0.226	0.216	0.047	0.32
Lithium (Li)	0.002	0.185	0.186	0.439	0.291	0.075	0.41
Magnesium (Mg)	1.53	92.90	72.34	287.25	211.05	59.46	0.64
Manganese (Mn)	0.29	**7.93**	**7.36**	**12.55**	**11.91**	2.39	0.30
Mercury (Hg)	0.000003	0.000470	0.000406	0.001481	0.000962	0.000256	0.55
Molybdenum (Mo)	0.001	0.133	0.134	0.230	0.212	0.051	0.38
Nickel (Ni)	0.001	0.034	0.035	0.046	0.044	0.008	0.24
Potassium (K)	0.56	89.54	87.97	248.44	163.90	42.80	0.48
Selenium (Se)	0.0009	**0.0391**	**0.0412**	**0.0691**	**0.0568**	0.0122	0.31
Silicon (Si)	1.26	121.75	112.80	366.96	239.86	65.11	0.53
Silver (Ag)	0.000007	0.002397	0.002115	**0.007768**	**0.005003**	0.001372	0.57
Sodium (Na)	2.62	26.39	25.71	53.68	41.78	9.82	0.37
Strontium (Sr)	0.15	14.28	13.27	46.01	30.24	9.04	0.63
Thallium (Tl)	0.00003	**0.00597**	**0.00594**	**0.01556**	**0.01052**	0.00279	0.47
Tin (Sn)	0.00009	0.02508	0.02375	0.07225	0.04735	0.01224	0.49
Uranium (U)	0.0009	**0.3210**	**0.3231**	**0.9524**	**0.6272**	0.1789	0.56
Vanadium (V)	0.0005	0.1327	0.1352	0.3425	0.2259	0.0618	0.47
Zinc (Zn)	0.14	3.47	3.34	5.50	5.37	1.27	0.37

(continued)

Table 7.1-2. Summary Statistics of Water Quality Predictions for the Water Storage Facility (Operation Phase) (continued)

Scenario 3							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.00	0.32	0.16	3.04	1.27	0.43	1.34
Chloride (Cl)	0.26	22.12	22.11	51.48	43.16	14.71	0.66
Fluoride (F)	0.20	**15.04**	**14.21**	**31.05**	**25.64**	6.87	0.46
Nitrate (as N)	0.01	4.89	1.74	27.17	15.24	5.70	1.17
Nitrite (as N)	0.0003	0.0013	0.0013	0.0026	0.0020	0.0004	0.28
Total Phosphate (as P)	0.04	0.38	0.36	1.41	0.55	0.10	0.26
Sulphate (SO_4)	46	**1,054**	**994**	**1,635**	**1,575**	387	0.37
Total Metals							
Aluminum (Al)	*0.42*	*25.80*	*24.24*	*41.17*	*39.59*	10.38	0.40
Antimony (Sb)	0.0003	**0.0834**	**0.0702**	**0.1993**	**0.1647**	0.0528	0.63
Arsenic (As)	0.0007	**0.1342**	**0.1190**	**0.2273**	**0.2193**	0.0625	0.47
Barium (Ba)	0.008	1.593	1.539	3.276	2.738	0.797	0.50
Beryllium (Be)	0.0002	0.0310	0.0241	0.0749	0.0619	0.0189	0.61
Boron (B)	0.002	0.209	0.181	0.460	0.380	0.110	0.53
Cadmium (Cd)	**0.002**	**0.036**	**0.033**	**0.053**	**0.052**	0.012	0.35
Calcium (Ca)	15.91	77.15	70.60	106.67	102.09	17.35	0.22
Chromium (Cr)	0.0004	**0.0394**	**0.0323**	**0.0920**	**0.0762**	0.0233	0.59
Cobalt (Co)	0.002	0.109	**0.113**	**0.153**	**0.147**	0.030	0.27
Copper (Cu)	**0.19**	**15.15**	**14.91**	**23.15**	**22.64**	5.30	0.35
Iron (Fe)	**1.18**	**295.38**	**297.60**	**468.33**	**454.02**	122.18	0.41
Lead (Pb)	0.001	0.108	0.115	0.160	0.143	0.029	0.27
Lithium (Li)	0.001	0.114	0.115	0.213	0.179	0.047	0.41
Magnesium (Mg)	1.30	49.66	38.35	117.37	98.89	29.24	0.59
Manganese (Mn)	0.26	**5.93**	**6.22**	**8.08**	**7.33**	1.19	0.20
Mercury (Hg)	0.000002	0.000244	0.000195	0.000556	0.000466	0.000132	0.54
Molybdenum (Mo)	0.001	0.125	0.119	0.198	0.195	0.053	0.42
Nickel (Ni)	0.001	0.030	0.029	0.043	0.042	0.009	0.30
Potassium (K)	0.39	43.88	37.52	96.74	80.31	22.91	0.52
Selenium (Se)	0.0009	**0.0361**	**0.0365**	**0.0566**	**0.0544**	0.0129	0.36
Silicon (Si)	1.05	89.39	81.89	188.18	155.56	44.38	0.50
Silver (Ag)	0.000004	0.001356	0.000983	**0.003384**	0.002817	0.000865	0.64
Sodium (Na)	2.42	30.27	25.02	63.16	55.29	14.60	0.48
Strontium (Sr)	0.13	6.60	5.26	16.46	13.78	4.47	0.68
Thallium (Tl)	0.00002	**0.00302**	**0.00289**	**0.00644**	**0.00538**	0.00163	0.54
Tin (Sn)	0.00005	0.01300	0.01209	0.02610	0.02162	0.00575	0.44
Uranium (U)	0.0004	0.1137	0.1080	0.2402	0.1995	0.0569	0.50
Vanadium (V)	0.0002	0.0530	0.0547	0.1044	0.0894	0.0261	0.49
Zinc (Zn)	0.13	2.77	2.56	4.40	4.21	1.01	0.36

(continued)

Table 7.1-2. Summary Statistics of Water Quality Predictions for the Water Storage Facility (Operation Phase) (completed)

Scenario 4: Upper Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.00	0.32	0.16	3.04	1.27	0.43	1.34
Chloride (Cl)	0.31	51.83	53.71	114.77	98.11	32.15	0.62
Fluoride (F)	0.22	**31.43**	**28.94**	**69.52**	**57.12**	16.28	0.52
Nitrate (as N)	0.01	4.89	1.74	27.17	15.24	5.70	1.17
Nitrite (as N)	0.0003	0.0013	0.0013	0.0026	0.0020	0.0004	0.28
Total Phosphate (as P)	0.04	0.38	0.36	1.41	0.55	0.10	0.26
Sulphate (SO_4)	46	**1,174**	**1,162**	**1,763**	**1,714**	404	0.34
Total Metals							
Aluminum (Al)	*0.42*	*29.13*	*27.92*	*45.87*	*44.78*	11.44	0.39
Antimony (Sb)	0.0007	**0.2686**	**0.2183**	**0.6346**	**0.5253**	0.1627	0.61
Arsenic (As)	0.0008	**0.1709**	**0.1442**	**0.3106**	**0.2939**	0.0825	0.48
Barium (Ba)	0.010	3.400	3.207	7.184	5.966	1.765	0.52
Beryllium (Be)	0.0003	0.0950	0.0909	0.1963	0.1630	0.0468	0.49
Boron (B)	0.003	0.596	0.578	1.150	0.958	0.246	0.41
Cadmium (Cd)	**0.002**	**0.041**	**0.042**	**0.059**	**0.057**	0.013	0.31
Calcium (Ca)	15.93	83.77	80.19	110.58	107.13	16.22	0.19
Chromium (Cr)	0.0005	**0.0812**	**0.0738**	**0.1769**	**0.1455**	0.0431	0.53
Cobalt (Co)	0.002	**0.137**	**0.145**	**0.185**	**0.174**	0.033	0.24
Copper (Cu)	**0.19**	**18.01**	**19.21**	**24.17**	**23.61**	5.14	0.29
Iron (Fe)	**1.21**	**339.88**	**352.98**	**528.34**	**508.06**	124.43	0.37
Lead (Pb)	0.001	0.156	0.159	0.222	0.214	0.042	0.27
Lithium (Li)	0.002	0.218	0.238	0.374	0.321	0.081	0.37
Magnesium (Mg)	1.39	108.43	80.94	254.00	218.13	66.09	0.61
Manganese (Mn)	0.26	**8.53**	**7.75**	**12.41**	**11.89**	2.27	0.27
Mercury (Hg)	0.000002	0.000559	0.000465	0.001234	0.001032	0.000287	0.51
Molybdenum (Mo)	0.001	0.144	0.135	0.224	0.217	0.058	0.40
Nickel (Ni)	0.001	0.035	0.037	0.046	0.043	0.007	0.21
Potassium (K)	0.52	106.08	101.33	211.05	175.00	47.08	0.44
Selenium (Se)	0.0009	**0.0437**	**0.0463**	**0.0662**	**0.0623**	0.0141	0.32
Silicon (Si)	1.16	144.15	128.30	309.07	255.68	72.60	0.50
Silver (Ag)	0.000006	0.002855	0.002394	**0.006473**	**0.005334**	0.001542	0.54
Sodium (Na)	2.44	28.47	28.77	48.09	42.55	9.52	0.33
Strontium (Sr)	0.14	16.87	15.21	38.87	32.29	10.19	0.60
Thallium (Tl)	0.00003	**0.00706**	**0.00703**	**0.01364**	**0.01158**	0.00305	0.43
Tin (Sn)	0.00009	0.02981	0.02727	0.06095	0.05049	0.01350	0.45
Uranium (U)	0.0008	**0.3805**	**0.3676**	**0.8122**	**0.6840**	0.2002	0.53
Vanadium (V)	0.0004	0.1571	0.1665	0.2890	0.2479	0.0674	0.43
Zinc (Zn)	0.13	3.61	3.55	5.43	5.21	1.20	0.33

Notes:

All measured values are in units of mg/L.

Grey highlighted values exceed BC chronic water quality guidelines; bold values exceed BC acute water quality guidelines.

For pH-dependent guidelines, pH was assumed to be > 6.5.

For total aluminum, italic values exceed CCME pH-dependent water quality guidelines.

Table 7.1-3. Summary Statistics of Water Quality Predictions for the Water Storage Facility (Closure Phase)

Scenario 1: Expected Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0015	0.0020	0.0019	0.0039	0.0033	0.0005	0.27
Chloride (Cl)	22.65	38.57	37.76	67.57	53.73	8.00	0.21
Fluoride (F)	**13.20**	**22.43**	**21.98**	**39.54**	**31.44**	4.72	0.21
Nitrate (as N)	0.01	0.02	0.02	0.04	0.04	0.01	0.33
Nitrite (as N)	0.0003	0.0008	0.0009	0.0015	0.0011	0.0003	0.31
Total Phosphate (as P)	0.11	0.25	0.23	0.68	0.51	0.11	0.43
Sulphate (SO_4)	**1,217**	**1,656**	**1,642**	**2,061**	**1,898**	154	0.09
Total Metals							
Aluminum (Al)	*31.28*	*41.08*	*40.71*	*50.86*	*47.55*	4.03	0.10
Antimony (Sb)	**0.0746**	**0.1261**	**0.1233**	**0.2230**	**0.1768**	0.0268	0.21
Arsenic (As)	**0.1748**	**0.2304**	**0.2279**	**0.2873**	**0.2668**	0.0229	0.10
Barium (Ba)	1.378	2.328	2.278	4.106	3.262	0.492	0.21
Beryllium (Be)	0.0230	0.0392	0.0382	0.0701	0.0560	0.0084	0.21
Boron (B)	0.172	0.290	0.284	0.510	0.406	0.061	0.21
Cadmium (Cd)	**0.041**	**0.055**	**0.054**	**0.066**	**0.062**	0.005	0.09
Calcium (Ca)	69.79	113.26	116.01	129.26	119.82	9.38	0.08
Chromium (Cr)	**0.0321**	**0.0548**	**0.0536**	**0.0957**	**0.0761**	0.0112	0.21
Cobalt (Co)	**0.113**	**0.155**	**0.153**	**0.203**	**0.183**	0.017	0.11
Copper (Cu)	**18.69**	**24.36**	**24.16**	**28.80**	**27.72**	2.07	0.08
Iron (Fe)	**382.32**	**497.81**	**492.68**	**606.40**	**576.90**	48.20	0.10
Lead (Pb)	0.099	0.128	0.127	0.154	0.148	0.012	0.09
Lithium (Li)	0.091	0.155	0.152	0.272	0.216	0.032	0.21
Magnesium (Mg)	34.36	59.25	58.06	102.64	81.90	11.91	0.20
Manganese (Mn)	5.19	**6.92**	**6.86**	**8.37**	**7.87**	0.60	0.09
Mercury (Hg)	0.00017	0.00029	0.00029	0.00052	0.00041	0.00006	0.21
Molybdenum (Mo)	0.164	0.212	0.210	0.250	0.242	0.019	0.09
Nickel (Ni)	0.034	0.047	0.048	0.055	0.052	0.004	0.09
Potassium (K)	34.04	57.96	56.69	101.78	80.88	12.09	0.21
Selenium (Se)	**0.0429**	**0.0580**	**0.0569**	**0.0755**	**0.0702**	0.0067	0.12
Silicon (Si)	74.56	126.71	124.11	223.03	177.26	26.60	0.21
Silver (Ag)	0.00097	0.00163	0.00160	0.00289	0.00229	0.00035	0.21
Sodium (Na)	19.51	36.90	36.87	56.34	46.56	5.49	0.15
Strontium (Sr)	5.43	9.29	9.09	16.19	12.89	1.89	0.20
Thallium (Tl)	**0.00286**	**0.00483**	**0.00473**	**0.00854**	**0.00678**	0.00102	0.21
Tin (Sn)	0.01041	0.01759	0.01721	0.03113	0.02470	0.00374	0.21
Uranium (U)	0.1069	0.1810	0.1771	**0.3204**	0.2543	0.0386	0.21
Vanadium (V)	0.0494	0.0836	0.0819	0.1477	0.1173	0.0177	0.21
Zinc (Zn)	3.17	4.38	4.34	5.76	5.20	0.47	0.11

(continued)

Table 7.1-3. Summary Statistics of Water Quality Predictions for the Water Storage Facility (Closure Phase) (continued)

Scenario 2							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0015	0.0020	0.0019	0.0039	0.0033	0.0005	0.27
Chloride (Cl)	54.03	91.61	89.65	161.54	128.27	19.33	0.21
Fluoride (F)	**28.87**	**48.91**	**47.88**	**86.46**	**68.66**	10.38	0.21
Nitrate (as N)	0.01	0.02	0.02	0.04	0.04	0.01	0.33
Nitrite (as N)	0.0003	0.0008	0.0009	0.0015	0.0011	0.0003	0.31
Total Phosphate (as P)	0.11	0.25	0.23	0.68	0.51	0.11	0.43
Sulphate (SO_4)	**1,347**	**1,825**	**1,809**	**2,270**	**2,089**	170	0.09
Total Metals							
Aluminum (Al)	*35.97*	*47.61*	*47.11*	*59.95*	*55.40*	4.87	0.10
Antimony (Sb)	**0.2278**	**0.3850**	**0.3763**	**0.6817**	**0.5403**	0.0821	0.21
Arsenic (As)	**0.2202**	**0.3062**	**0.3012**	**0.4149**	**0.3695**	0.0375	0.12
Barium (Ba)	2.867	4.844	4.740	8.566	6.798	1.030	0.21
Beryllium (Be)	0.0827	0.1401	0.1369	0.2488	0.1978	0.0300	0.21
Boron (B)	0.482	0.814	0.797	**1.439**	1.142	0.173	0.21
Cadmium (Cd)	**0.044**	**0.060**	**0.059**	**0.075**	**0.070**	0.006	0.10
Calcium (Ca)	72.32	117.54	120.24	136.80	126.24	9.85	0.08
Chromium (Cr)	**0.0689**	**0.1171**	**0.1145**	**0.2061**	**0.1637**	0.0246	0.21
Cobalt (Co)	**0.128**	**0.180**	**0.177**	**0.236**	**0.222**	0.022	0.12
Copper (Cu)	**18.94**	**24.78**	**24.56**	**29.55**	**28.20**	2.15	0.09
Iron (Fe)	**411.42**	**546.98**	**540.46**	**695.80**	**640.86**	58.32	0.11
Lead (Pb)	0.108	0.142	0.140	0.178	0.165	0.014	0.10
Lithium (Li)	0.178	0.303	0.297	0.533	0.424	0.064	0.21
Magnesium (Mg)	75.17	126.48	123.44	212.68	171.94	24.82	0.20
Manganese (Mn)	6.06	8.16	8.08	**10.16**	9.36	0.77	0.09
Mercury (Hg)	0.00041	0.00069	0.00068	0.00122	0.00097	0.00015	0.21
Molybdenum (Mo)	0.176	0.229	0.227	0.280	0.264	0.022	0.09
Nickel (Ni)	0.034	0.051	0.051	0.057	0.054	0.003	0.07
Potassium (K)	86.86	147.22	144.04	259.97	206.38	31.17	0.21
Selenium (Se)	**0.0478**	**0.0661**	**0.0645**	**0.0885**	**0.0829**	0.0086	0.13
Silicon (Si)	115.43	195.75	191.58	345.37	274.19	41.35	0.21
Silver (Ag)	0.00217	**0.00367**	**0.00359**	**0.00650**	**0.00516**	0.00078	0.21
Sodium (Na)	21.18	39.72	39.57	61.35	50.62	6.03	0.15
Strontium (Sr)	14.78	25.09	24.55	44.19	35.09	5.27	0.21
Thallium (Tl)	**0.00652**	**0.01101**	**0.01078**	**0.01949**	**0.01548**	0.00235	0.21
Tin (Sn)	0.02341	0.03957	0.03870	0.07007	0.05556	0.00844	0.21
Uranium (U)	**0.3749**	**0.6337**	**0.6200**	**1.1227**	**0.8908**	0.1354	0.21
Vanadium (V)	0.1374	0.2323	0.2273	0.4111	0.3263	0.0495	0.21
Zinc (Zn)	4.14	6.00	6.08	6.69	6.37	0.38	0.06

(continued)

7.1-3. Summary Statistics of Water Quality Predictions for the Water Storage Facility (Closure Phase) (continued)

Scenario 3							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0007	0.0010	0.0010	0.0017	0.0016	0.0003	0.27
Chloride (Cl)	37.90	48.17	47.96	56.44	53.72	4.00	0.08
Fluoride (F)	**22.04**	**28.07**	**27.96**	**32.94**	**31.34**	2.36	0.08
Nitrate (as N)	0.02	0.02	0.02	0.03	0.03	0.00	0.12
Nitrite (as N)	0.0006	0.0008	0.0008	0.0013	0.0010	0.0001	0.15
Total Phosphate (as P)	0.24	0.31	0.29	0.49	0.42	0.05	0.18
Sulphate (SO_4)	**1,450**	**1,743**	**1,742**	**1,885**	**1,874**	94	0.05
Total Metals							
Aluminum (Al)	*35.47*	*43.00*	*43.03*	*46.86*	*46.54*	2.45	0.06
Antimony (Sb)	**0.1237**	**0.1580**	**0.1575**	**0.1856**	**0.1764**	0.0134	0.08
Arsenic (As)	**0.1979**	**0.2422**	**0.2423**	**0.2643**	**0.2624**	0.0142	0.06
Barium (Ba)	2.285	2.914	2.904	3.419	3.252	0.246	0.08
Beryllium (Be)	0.0389	0.0494	0.0491	0.0583	0.0555	0.0042	0.08
Boron (B)	0.285	0.363	0.362	0.426	0.405	0.030	0.08
Cadmium (Cd)	**0.048**	**0.057**	**0.057**	**0.061**	**0.061**	0.003	0.05
Calcium (Ca)	103.85	117.13	118.99	124.16	121.06	4.12	0.04
Chromium (Cr)	**0.0539**	**0.0684**	**0.0680**	**0.0801**	**0.0763**	0.0056	0.08
Cobalt (Co)	**0.136**	**0.166**	**0.166**	**0.181**	**0.180**	0.010	0.06
Copper (Cu)	**20.75**	**25.05**	**25.06**	**27.15**	**26.98**	1.34	0.05
Iron (Fe)	**421.15**	**515.94**	**516.70**	**564.32**	**559.83**	30.11	0.06
Lead (Pb)	0.109	0.132	0.132	0.144	0.143	0.007	0.06
Lithium (Li)	0.153	0.194	0.193	0.227	0.216	0.016	0.08
Magnesium (Mg)	58.47	73.56	73.13	86.05	81.93	5.91	0.08
Manganese (Mn)	6.03	**7.18**	**7.19**	**7.76**	**7.71**	0.37	0.05
Mercury (Hg)	0.00029	0.00037	0.00037	0.00043	0.00041	0.00003	0.08
Molybdenum (Mo)	0.178	0.217	0.218	0.237	0.235	0.012	0.06
Nickel (Ni)	0.043	0.050	0.051	0.053	0.053	0.002	0.04
Potassium (K)	56.92	72.44	72.14	84.96	80.82	6.04	0.08
Selenium (Se)	**0.0501**	**0.0621**	**0.0621**	**0.0684**	**0.0676**	0.0039	0.06
Silicon (Si)	124.43	158.43	157.82	185.88	176.83	13.28	0.08
Silver (Ag)	0.00161	0.00205	0.00204	0.00241	0.00229	0.00017	0.08
Sodium (Na)	36.35	44.11	44.40	50.20	47.72	2.62	0.06
Strontium (Sr)	9.15	11.58	11.51	13.55	12.90	0.95	0.08
Thallium (Tl)	**0.00474**	**0.00605**	**0.00603**	**0.00711**	**0.00676**	0.00051	0.08
Tin (Sn)	0.01725	0.02205	0.02198	0.02590	0.02463	0.00187	0.08
Uranium (U)	0.1773	0.2268	0.2260	0.2665	0.2534	0.0193	0.09
Vanadium (V)	0.0820	0.1047	0.1043	0.1230	0.1170	0.0089	0.08
Zinc (Zn)	3.95	4.73	4.72	5.16	5.11	0.27	0.06

(continued)

Table 7.1-3. Summary Statistics of Water Quality Predictions for the Water Storage Facility (Closure Phase) (completed)

Scenario 4: Upper Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0007	0.0010	0.0010	0.0017	0.0016	0.0003	0.27
Chloride (Cl)	89.80	114.66	114.23	134.57	128.00	9.68	0.08
Fluoride (F)	**47.98**	**61.27**	**61.05**	**71.95**	**68.44**	5.19	0.08
Nitrate (as N)	0.02	0.02	0.02	0.03	0.03	0.00	0.12
Nitrite (as N)	0.0006	0.0008	0.0008	0.0013	0.0010	0.0001	0.15
Total Phosphate (as P)	0.24	0.31	0.29	0.49	0.42	0.05	0.18
Sulphate (SO_4)	**1,594**	**1,920**	**1,919**	**2,078**	**2,066**	105	0.05
Total Metals							
Aluminum (Al)	*41.22*	*50.21*	*50.24*	*54.76*	*54.39*	2.93	0.06
Antimony (Sb)	**0.3776**	**0.4827**	**0.4812**	**0.5672**	**0.5390**	0.0411	0.09
Arsenic (As)	**0.2734**	**0.3379**	**0.3373**	**0.3704**	**0.3680**	0.0215	0.06
Barium (Ba)	4.752	6.070	6.051	7.128	6.777	0.515	0.08
Beryllium (Be)	0.1376	0.1758	0.1752	0.2069	0.1968	0.0150	0.09
Boron (B)	0.798	1.020	1.017	1.198	1.139	0.087	0.08
Cadmium (Cd)	**0.053**	**0.063**	**0.063**	**0.069**	**0.068**	0.003	0.05
Calcium (Ca)	108.20	122.58	124.53	130.14	127.02	4.44	0.04
Chromium (Cr)	**0.1149**	**0.1465**	**0.1459**	**0.1719**	**0.1635**	0.0123	0.08
Cobalt (Co)	**0.163**	**0.199**	**0.199**	**0.218**	**0.217**	0.012	0.06
Copper (Cu)	**21.16**	**25.58**	**25.59**	**27.74**	**27.56**	1.38	0.05
Iron (Fe)	**469.34**	**578.16**	**578.22**	**633.68**	**628.51**	35.32	0.06
Lead (Pb)	0.122	0.149	0.149	0.163	0.162	0.009	0.06
Lithium (Li)	0.297	0.379	0.377	0.444	0.423	0.032	0.08
Magnesium (Mg)	122.89	154.37	154.00	178.67	170.56	12.20	0.08
Manganese (Mn)	7.15	8.58	8.58	9.29	9.24	0.47	0.05
Mercury (Hg)	0.00068	0.00087	0.00086	0.00102	0.00097	0.00007	0.08
Molybdenum (Mo)	0.195	0.239	0.239	0.260	0.258	0.014	0.06
Nickel (Ni)	0.045	0.052	0.053	0.055	0.054	0.002	0.04
Potassium (K)	144.32	184.36	183.67	216.46	205.87	15.60	0.08
Selenium (Se)	**0.0568**	**0.0715**	**0.0716**	**0.0798**	**0.0788**	0.0049	0.07
Silicon (Si)	191.81	244.26	243.42	286.06	272.22	20.42	0.08
Silver (Ag)	**0.00360**	**0.00460**	**0.00459**	**0.00541**	**0.00514**	0.00039	0.09
Sodium (Na)	39.05	47.63	47.87	54.32	51.66	2.91	0.06
Strontium (Sr)	24.63	31.39	31.27	36.84	35.04	2.64	0.08
Thallium (Tl)	**0.01079**	**0.01380**	**0.01376**	**0.01621**	**0.01542**	0.00117	0.09
Tin (Sn)	0.03879	0.04961	0.04945	0.05828	0.05540	0.00422	0.09
Uranium (U)	**0.6205**	**0.7944**	**0.7918**	**0.9334**	**0.8877**	0.0678	0.09
Vanadium (V)	0.2275	0.2911	0.2901	0.3419	0.3252	0.0248	0.09
Zinc (Zn)	5.33	6.15	6.23	6.45	6.42	0.25	0.04

Notes:

All measured values are in units of mg/L.

Grey highlighted values exceed BC chronic water quality guidelines; bold values exceed BC acute water quality guidelines.

For pH-dependent guidelines, pH was assumed to be > 6.5.

For total aluminum, italic values exceed CCME pH-dependent water quality guidelines.

Table 7.1-4. Summary Statistics of Water Quality Predictions for the Water Storage Facility (Post-closure Phase)

Scenario 1: Expected Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0011	0.0019	0.0019	0.0039	0.0024	0.0003	0.18
Chloride (Cl)	15.60	24.28	23.01	68.89	39.17	7.74	0.32
Fluoride (F)	**8.79**	**14.04**	**13.23**	**40.32**	**22.93**	4.62	0.33
Nitrate (as N)	0.01	0.03	0.03	0.04	0.04	0.01	0.33
Nitrite (as N)	0.0004	0.0011	0.0012	0.0016	0.0015	0.0004	0.35
Total Phosphate (as P)	0.09	0.24	0.22	0.61	0.44	0.08	0.34
Sulphate (SO_4)	**873**	**1,027**	**1,007**	**2,091**	**1,173**	148	0.14
Total Metals							
Aluminum (Al)	*20.50*	*24.63*	*23.97*	*51.60*	*28.70*	3.90	0.16
Antimony (Sb)	**0.0484**	**0.0784**	**0.0736**	**0.2274**	**0.1292**	0.0263	0.34
Arsenic (As)	**0.1141**	**0.1371**	**0.1325**	**0.2916**	**0.1592**	0.0219	0.16
Barium (Ba)	0.901	1.453	1.363	4.187	2.381	0.482	0.33
Beryllium (Be)	0.0154	0.0249	0.0233	0.0715	0.0408	0.0081	0.33
Boron (B)	0.114	0.182	0.172	0.520	0.296	0.059	0.33
Cadmium (Cd)	**0.029**	**0.034**	**0.033**	**0.067**	**0.038**	0.005	0.14
Calcium (Ca)	60.72	86.06	89.90	130.99	96.43	10.80	0.13
Chromium (Cr)	**0.0228**	**0.0347**	**0.0329**	**0.0976**	**0.0554**	0.0107	0.31
Cobalt (Co)	0.076	0.095	0.092	**0.206**	**0.113**	0.016	0.17
Copper (Cu)	**12.70**	**15.07**	**14.69**	**29.19**	**17.47**	2.16	0.14
Iron (Fe)	**244.67**	**293.36**	**286.36**	**615.07**	**343.87**	47.33	0.16
Lead (Pb)	0.067	0.085	0.082	0.156	0.107	0.013	0.15
Lithium (Li)	0.062	0.098	0.092	0.277	0.158	0.031	0.32
Magnesium (Mg)	25.06	38.07	36.19	104.64	59.91	11.49	0.30
Manganese (Mn)	3.62	4.31	4.20	**8.49**	**5.03**	0.61	0.14
Mercury (Hg)	0.00011	0.00018	0.00017	0.00053	0.00030	0.00006	0.33
Molybdenum (Mo)	0.108	0.125	0.121	0.254	0.143	0.019	0.15
Nickel (Ni)	0.025	0.031	0.030	0.056	0.038	0.005	0.16
Potassium (K)	23.23	36.41	34.56	103.78	59.00	11.72	0.32
Selenium (Se)	**0.0276**	**0.0348**	**0.0340**	**0.0766**	**0.0422**	0.0062	0.18
Silicon (Si)	49.91	79.54	74.98	227.41	129.46	25.98	0.33
Silver (Ag)	0.00063	0.00102	0.00096	0.00295	0.00168	0.00034	0.33
Sodium (Na)	16.16	25.79	25.41	57.34	32.39	4.72	0.18
Strontium (Sr)	3.85	5.90	5.61	16.50	9.41	1.83	0.31
Thallium (Tl)	**0.00187**	**0.00302**	**0.00283**	**0.00871**	**0.00495**	0.00100	0.33
Tin (Sn)	0.00676	0.01095	0.01028	0.03174	0.01804	0.00367	0.34
Uranium (U)	0.0695	0.1128	0.1058	**0.3267**	0.1856	0.0378	0.34
Vanadium (V)	0.0325	0.0523	0.0492	0.1506	0.0857	0.0173	0.33
Zinc (Zn)	2.20	2.71	2.62	5.85	3.16	0.45	0.16

(continued)

Table 7.1-4. Summary Statistics of Water Quality Predictions for the Water Storage Facility (Post-closure Phase) (continued)

Scenario 2							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0011	0.0019	0.0019	0.0039	0.0024	0.0003	0.18
Chloride (Cl)	35.86	57.23	53.94	164.72	93.60	18.88	0.33
Fluoride (F)	**18.89**	**30.51**	**28.66**	**88.17**	**50.11**	10.18	0.33
Nitrate (as N)	0.01	0.03	0.03	0.04	0.04	0.01	0.33
Nitrite (as N)	0.0004	0.0011	0.0012	0.0016	0.0015	0.0004	0.35
Total Phosphate (as P)	0.09	0.24	0.22	0.61	0.44	0.08	0.34
Sulphate (SO_4)	**933**	**1,133**	**1,112**	**2,303**	**1,320**	172	0.15
Total Metals							
Aluminum (Al)	*23.84*	*29.16*	*28.38*	*60.84*	*34.29*	4.62	0.16
Antimony (Sb)	**0.1465**	**0.2390**	**0.2240**	**0.6951**	**0.3948**	0.0806	0.34
Arsenic (As)	**0.1436**	**0.1844**	**0.1786**	**0.4217**	**0.2198**	0.0351	0.19
Barium (Ba)	1.857	3.015	2.826	8.734	4.965	1.010	0.34
Beryllium (Be)	0.0539	0.0879	0.0820	0.2537	0.1444	0.0293	0.33
Boron (B)	0.314	0.507	0.476	**1.467**	0.834	0.169	0.33
Cadmium (Cd)	**0.031**	**0.038**	**0.037**	**0.077**	**0.044**	0.006	0.15
Calcium (Ca)	62.89	89.30	92.09	138.68	100.70	10.87	0.12
Chromium (Cr)	**0.0466**	**0.0736**	**0.0696**	**0.2101**	**0.1194**	0.0238	0.32
Cobalt (Co)	0.086	**0.113**	**0.113**	**0.240**	**0.135**	0.020	0.18
Copper (Cu)	**12.91**	**15.61**	**15.24**	**29.95**	**18.39**	2.24	0.14
Iron (Fe)	**262.98**	**327.96**	**319.07**	**706.27**	**391.44**	55.54	0.17
Lead (Pb)	0.132	0.230	0.227	0.284	0.257	0.020	0.09
Lithium (Li)	0.118	0.190	0.178	0.543	0.309	0.062	0.33
Magnesium (Mg)	50.79	79.70	75.40	216.74	123.21	24.62	0.31
Manganese (Mn)	4.42	6.31	6.02	**10.80**	**8.94**	1.30	0.21
Mercury (Hg)	0.00027	0.00043	0.00040	0.00125	0.00071	0.00014	0.33
Molybdenum (Mo)	0.115	0.136	0.133	0.284	0.157	0.021	0.15
Nickel (Ni)	0.027	0.036	0.038	0.057	0.040	0.005	0.13
Potassium (K)	57.27	91.96	86.56	265.09	150.64	30.45	0.33
Selenium (Se)	**0.0302**	**0.0402**	**0.0391**	**0.0897**	**0.0510**	0.0079	0.20
Silicon (Si)	76.26	122.61	115.28	352.16	200.40	40.45	0.33
Silver (Ag)	0.00141	0.00229	0.00215	**0.00663**	**0.00377**	0.00077	0.34
Sodium (Na)	17.53	27.49	26.74	62.45	35.24	5.17	0.19
Strontium (Sr)	9.88	15.74	14.85	45.06	25.64	5.14	0.33
Thallium (Tl)	**0.00421**	**0.00685**	**0.00642**	**0.01988**	**0.01129**	0.00230	0.34
Tin (Sn)	0.01514	0.02460	0.02307	0.07145	0.04059	0.00828	0.34
Uranium (U)	0.2421	**0.3944**	**0.3695**	**1.1449**	**0.6504**	0.1329	0.34
Vanadium (V)	0.0893	0.1453	0.1359	0.4192	0.2384	0.0485	0.33
Zinc (Zn)	3.19	4.24	4.38	6.78	4.67	0.54	0.13

(continued)

Table 7.1-4. Summary Statistics of Water Quality Predictions for the Water Storage Facility (Post-closure Phase) (continued)

Scenario 3							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0004	0.0009	0.0009	0.0026	0.0017	0.0004	0.40
Chloride (Cl)	19.24	29.17	28.67	55.60	39.53	5.41	0.19
Fluoride (F)	**11.18**	**17.01**	**16.72**	**32.48**	**23.07**	3.18	0.19
Nitrate (as N)	0.01	0.02	0.02	0.03	0.03	0.00	0.18
Nitrite (as N)	0.0005	0.0008	0.0008	0.0012	0.0011	0.0002	0.18
Total Phosphate (as P)	0.15	0.27	0.27	0.43	0.35	0.04	0.16
Sulphate (SO_4)	**1,021**	**1,142**	**1,121**	**1,991**	**1,260**	130	0.11
Total Metals							
Aluminum (Al)	*24.71*	*27.83*	*27.38*	*49.57*	*30.20*	3.35	0.12
Antimony (Sb)	**0.0624**	**0.0954**	**0.0937**	**0.1830**	**0.1298**	0.0180	0.19
Arsenic (As)	**0.1358**	**0.1546**	**0.1523**	**0.2792**	**0.1675**	0.0191	0.12
Barium (Ba)	1.160	1.765	1.735	3.372	2.396	0.330	0.19
Beryllium (Be)	0.0200	0.0303	0.0296	0.0577	0.0411	0.0056	0.19
Boron (B)	0.145	0.220	0.217	0.420	0.299	0.041	0.19
Cadmium (Cd)	**0.034**	**0.037**	**0.037**	**0.065**	**0.040**	0.004	0.11
Calcium (Ca)	75.32	84.44	82.94	125.83	94.81	7.04	0.08
Chromium (Cr)	**0.0274**	**0.0415**	**0.0407**	**0.0789**	**0.0563**	0.0077	0.18
Cobalt (Co)	0.094	0.109	0.107	**0.192**	**0.124**	0.013	0.12
Copper (Cu)	**15.31**	**16.91**	**16.61**	**28.86**	**18.16**	1.85	0.11
Iron (Fe)	**295.31**	**332.84**	**326.84**	**600.44**	**356.40**	41.18	0.12
Lead (Pb)	0.083	0.095	0.091	0.154	0.116	0.012	0.12
Lithium (Li)	0.077	0.118	0.116	0.224	0.160	0.022	0.19
Magnesium (Mg)	30.33	45.30	44.46	84.68	60.99	8.10	0.18
Manganese (Mn)	4.37	4.82	4.71	**8.20**	**5.36**	0.54	0.11
Mercury (Hg)	0.00015	0.00022	0.00022	0.00042	0.00030	0.00004	0.19
Molybdenum (Mo)	0.125	0.140	0.137	0.253	0.146	0.017	0.12
Nickel (Ni)	0.027	0.033	0.033	0.054	0.037	0.004	0.11
Potassium (K)	28.88	43.88	43.10	83.70	59.56	8.17	0.19
Selenium (Se)	**0.0349**	**0.0404**	**0.0397**	**0.0725**	**0.0456**	0.0050	0.12
Silicon (Si)	63.30	96.25	94.58	183.26	130.38	17.91	0.19
Silver (Ag)	0.00081	0.00124	0.00122	0.00237	0.00169	0.00023	0.19
Sodium (Na)	18.99	26.83	26.59	48.47	35.06	4.30	0.16
Strontium (Sr)	4.68	7.05	6.93	13.34	9.53	1.29	0.18
Thallium (Tl)	**0.00240**	**0.00366**	**0.00360**	**0.00701**	**0.00498**	0.00069	0.19
Tin (Sn)	0.00872	0.01332	0.01310	0.02554	0.01813	0.00252	0.19
Uranium (U)	0.0897	0.1373	0.1349	0.2629	0.1866	0.0259	0.19
Vanadium (V)	0.0416	0.0635	0.0625	0.1213	0.0863	0.0119	0.19
Zinc (Zn)	2.66	3.08	3.03	5.44	3.48	0.36	0.12

(continued)

Table 7.1-4. Summary Statistics of Water Quality Predictions for the Water Storage Facility (Post-closure Phase) (completed)

Scenario 4: Upper Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0004	0.0009	0.0009	0.0026	0.0017	0.0004	0.40
Chloride (Cl)	45.46	69.33	68.14	132.69	94.18	13.02	0.19
Fluoride (F)	**24.28**	**37.08**	**36.45**	**70.97**	**50.39**	6.98	0.19
Nitrate (as N)	0.01	0.02	0.02	0.03	0.03	0.00	0.18
Nitrite (as N)	0.0005	0.0008	0.0008	0.0012	0.0011	0.0002	0.18
Total Phosphate (as P)	0.15	0.27	0.27	0.43	0.35	0.04	0.16
Sulphate (SO_4)	**1,114**	**1,273**	**1,246**	**2,197**	**1,431**	147	0.12
Total Metals							
Aluminum (Al)	*29.28*	*33.07*	*32.49*	*58.01*	*36.64*	3.86	0.12
Antimony (Sb)	**0.1903**	**0.2911**	**0.2861**	**0.5591**	**0.3965**	0.0552	0.19
Arsenic (As)	**0.1747**	**0.2124**	**0.2092**	**0.3881**	**0.2455**	0.0279	0.13
Barium (Ba)	2.404	3.669	3.607	7.030	4.990	0.691	0.19
Beryllium (Be)	0.0700	0.1070	0.1050	0.2043	0.1451	0.0201	0.19
Boron (B)	0.404	0.617	0.606	1.181	0.839	0.116	0.19
Cadmium (Cd)	**0.038**	**0.042**	**0.042**	**0.073**	**0.047**	0.005	0.11
Calcium (Ca)	78.02	88.34	86.76	131.99	101.29	7.60	0.09
Chromium (Cr)	**0.0583**	**0.0889**	**0.0873**	**0.1694**	**0.1206**	0.0166	0.19
Cobalt (Co)	0.109	**0.130**	**0.128**	**0.228**	**0.154**	0.016	0.12
Copper (Cu)	**15.90**	**17.54**	**17.18**	**29.38**	**19.46**	1.90	0.11
Iron (Fe)	**329.67**	**375.74**	**368.57**	**670.81**	**421.69**	46.12	0.12
Lead (Pb)	0.146	0.247	0.249	0.277	0.263	0.017	0.07
Lithium (Li)	0.151	0.230	0.226	0.438	0.312	0.043	0.19
Magnesium (Mg)	64.31	95.51	94.06	177.52	127.72	16.59	0.17
Manganese (Mn)	5.52	**7.32**	6.81	**11.09**	**10.05**	1.42	0.19
Mercury (Hg)	0.00034	0.00052	0.00052	0.00100	0.00071	0.00010	0.19
Molybdenum (Mo)	0.135	0.153	0.151	0.275	0.163	0.019	0.12
Nickel (Ni)	0.033	0.036	0.035	0.057	0.039	0.003	0.09
Potassium (K)	73.05	111.57	109.66	213.46	151.62	20.97	0.19
Selenium (Se)	**0.0407**	**0.0480**	**0.0468**	**0.0854**	**0.0564**	0.0060	0.12
Silicon (Si)	97.51	148.58	146.05	283.42	201.68	27.65	0.19
Silver (Ag)	0.00182	0.00279	0.00274	**0.00533**	**0.00379**	0.00053	0.19
Sodium (Na)	20.48	28.90	28.63	52.60	37.76	4.68	0.16
Strontium (Sr)	12.50	19.05	18.71	36.31	25.83	3.56	0.19
Thallium (Tl)	**0.00545**	**0.00834**	**0.00819**	**0.01600**	**0.01135**	0.00157	0.19
Tin (Sn)	0.01958	0.02996	0.02945	0.05748	0.04078	0.00567	0.19
Uranium (U)	**0.3136**	**0.4805**	**0.4721**	**0.9210**	**0.6537**	0.0908	0.19
Vanadium (V)	0.1154	0.1768	0.1736	0.3374	0.2398	0.0332	0.19
Zinc (Zn)	3.42	4.21	4.14	6.72	4.53	0.42	0.10

Notes:

All measured values are in units of mg/L.

Grey highlighted values exceed BC chronic water quality guidelines; bold values exceed BC acute water quality guidelines.

For pH-dependent guidelines, pH was assumed to be > 6.5.

For total aluminum, italic values exceed CCME pH-dependent water quality guidelines.

Table 7.2-1. Mine Site Water Treatment Plant Effluent Quality

Parameter	Units	Mitchell Creek Average Water Quality	Feed Water Quality (Dissolved)	Effluent Quality (Dissolved)	Removal Efficiency (Dissolved)	Effluent Quality (Total)
Physical Parameters						
Hardness (as $CaCO_3$)	mg/L	154	426	1,210	n.a.	1,210
pH	pH unit	6.10	2.68	7.31	n.a.	7.31
Total Suspended Solids	mg/L	119	61.6	12.0	n.a.	12.0
Anions and Nutrients						
Ammonia (as N)	mg/L	0.0042	0.0088	0.0546	n.a.	-
Bromide (Br)	mg/L	0.10	0.42	0.50	n.a.	-
Chloride (Cl)	mg/L	0.69	4.2	b.d.	n.a.	-
Fluoride (F)	mg/L	0.492	1.13	0.20	82.3	-
Nitrate (as N)	mg/L	0.078	0.53	0.55	n.a.	-
Nitrite (as N)	mg/L	0.0016	0.015	b.d.	n.a.	-
Total Phosphate (as P)	mg/L	0.92	0.0884	0.0502	n.a.	-
Sulphate (SO_4)	mg/L	178	1217	1,200	n.a.	-
Metals						
Aluminum (Al)	mg/L	2.36	34.2	0.145	99.6	2.31
Antimony (Sb)	mg/L	0.00022	0.00041	0.00025 [2]	38.4	0.00025 [2]
Arsenic (As)	mg/L	0.00313	0.130	0.00025 [2]	99.8	0.00084
Barium (Ba)	mg/L	0.033	0.088	0.020	77.0	0.021
Beryllium (Be)	mg/L	0.00086	0.00859	0.00025 [2]	97.1	0.00025 [2]
Bismuth (Bi)	mg/L	0.00027	0.0013	0.0013 [2]	n.a.	0.0013 [2]
Boron (B)	mg/L	0.007	0.025	0.025 [2]	n.a.	0.025 [2]
Cadmium (Cd)	mg/L	0.00928	0.0431	0.000108	99.8	0.00022
Calcium (Ca)	mg/L	54.6	130	484	n.a.	482
Chromium (Cr)	mg/L	0.00023	0.0236	0.00426	82.0	0.00467
Cobalt (Co)	mg/L	0.0113	0.499	0.00025 [2]	99.9	0.0013
Copper (Cu)	mg/L	0.654	22.6	0.0046	100.0	0.064
Iron (Fe)	mg/L	7.40	236	0.025 [2]	100.0	0.63
Lead (Pb)	mg/L	0.00554	0.0367	0.00067	98.2	0.056
Lithium (Li)	mg/L	0.0038	0.0121	0.0060	50.8	0.0061
Magnesium (Mg)	mg/L	4.75	24.6	0.71	97.1	0.80
Manganese (Mn)	mg/L	0.971	14.8	0.00302	100.0	0.039
Mercury (Hg)	mg/L	0.000005	0.000024	0.000005 [2]	78.9	0.00003
Molybdenum (Mo)	mg/L	0.00118	0.0569	0.0143	75.0	0.0154
Nickel (Ni)	mg/L	0.00376	0.194	0.0013 [2]	99.3	0.0013 [2]
Potassium (K)	mg/L	0.708	1.80	1.93	n.a.	2.01

(continued)

Table 7.2-1. Mine Site Water Treatment Plant Effluent Quality (completed)

Parameter	Units	Mitchell Creek Average Water Quality	Feed Water Quality (Dissolved)	Effluent Quality (Dissolved)	Removal Efficiency (Dissolved)	Effluent Quality (Total)
Selenium (Se (IV))	mg/L	-	0.061	0.0097	84.6	-
Selenium (Se(VI))	mg/L	0.00192 [1]	0.060	0.065	n.a.	0.068 [3]
Selenium (Se(MeSe))	mg/L	-	0.00061	0.00050 [2]	100.0	-
Silicon (Si)	mg/L	2.91	6.536	0.140	97.9	0.184
Silver (Ag)	mg/L	0.000015	0.00411	0.000025 [2]	99.4	0.000025 [2]
Sodium (Na)	mg/L	2.40	5.31	4.05	n.a.	4.23
Strontium (Sr)	mg/L	0.344	0.776	0.820	n.a.	0.859
Thallium (Tl)	mg/L	0.00005	0.000139	0.000025 [2]	82.0	0.000025 [2]
Tin (Sn)	mg/L	0.00005	0.00094	0.00025 [2]	73.4	0.00025 [2]
Titanium (Ti)	mg/L	0.005	0.867	0.05 [2]	94.2	0.05 [2]
Uranium (U)	mg/L	0.00072	0.00200	0.000025 [2]	98.8	0.000025 [2]
Vanadium (V)	mg/L	0.0006	0.0044	0.0025 [2]	42.9	0.0025 [2]
Zinc (Zn)	mg/L	0.616	3.69	0.0025 [2]	99.9	0.024

Notes:
n.a. indicates concentration reduction was not observed.
b.d. indicates below detection and concentration was not used as an upper limit for effluent quality.
Where concentrations were below detection, half the detection limit was used for calculations or removal efficiencies.
[1] Total dissolved selenium concentrations were monitored for baseline studies in Mitchell Creek .
[2] Concentration in effluent was below detection.
[3]Total selenium concentration only was measured.

7.3.1 Sulphurets Creek

Predictions for site SC2 (Sulphurets Creek at the confluence of Mitchell Creek) are included in Appendix 14-H. The following sections focus on water quality predictions in lower Sulphurets Creek below the cascades (site SC3), which is the first point downstream of the Mine Site where fish have been detected in baseline studies (see Chapter 15). Tables 7.3-1 to 7.3-4 present statistical summaries of water quality in Sulphurets Creek (site SC3) for the four model scenarios for the construction, operation, closure, and post-closure phases.

Water treatment at the HDS WTP, including settling for TSS control, is predicted to reduce the total concentrations of various metals below baseline conditions (e.g., cadmium, copper, and zinc). HQ calculations were used to screen for potential residual effects. Sporadic hazard quotients greater than 1.0 were calculated for total chromium and total copper during the operation, closure, and post-closure phases. Further investigation indicated that these predictions were a result of uncertainties in the model due to monthly inputs in flow and concentration values; therefore, no residual effects in Sulphurets Creek are expected related to chromium and copper. HQs greater than 1.0 were calculated for dissolved aluminum and total selenium concentrations in all Project phases.

Table 7.3-1. Summary Statistics of Water Quality Predictions for Sulphurets Creek (site SC3; Construction Phase)

Scenario 1: Expected Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.002	0.099	0.099	0.191	0.175	0.045	0.46
Chloride (Cl)	0.25	0.85	0.82	1.16	1.15	0.20	0.24
Fluoride (F)	0.03	0.08	0.08	0.11	0.11	0.02	0.27
Nitrate (as N)	0.08	1.38	1.25	2.10	2.08	0.42	0.31
Nitrite (as N)	0.0005	0.0007	0.0007	0.0008	0.0008	0.0001	0.18
Total Phosphate (as P)	0.01	0.16	0.11	0.52	0.51	0.15	0.90
Sulphate (SO_4)	39	**105**	**115**	**168**	**167**	37	0.35
Total Metals							
Aluminum (Al)	0.002	*1.69*	*0.36*	*6.95*	*6.95*	2.24	1.33
Antimony (Sb)	0.0004	0.0007	0.0006	0.0012	0.0012	0.0002	0.32
Arsenic (As)	0.0001	0.0024	0.0006	**0.0109**	**0.0109**	0.0031	1.29
Barium (Ba)	0.028	0.062	0.040	0.154	0.154	0.041	0.66
Beryllium (Be)	0.0001	0.0004	0.0002	0.0011	0.0011	0.0004	0.92
Boron (B)	0.005	0.007	0.007	0.008	0.008	0.001	0.10
Cadmium (Cd)	0.000005	**0.00040**	**0.00035**	**0.00123**	**0.00123**	0.00034	0.86
Calcium (Ca)	19.87	48.92	51.66	71.64	71.22	16.09	0.33
Chromium (Cr)	0.0002	**0.0024**	**0.0012**	**0.0084**	**0.0084**	0.0023	0.96
Cobalt (Co)	0.0001	0.001	0.001	0.005	0.005	0.002	1.11
Copper (Cu)	0.0003	**0.03**	0.01	**0.12**	**0.12**	0.04	1.20
Iron (Fe)	0.01	**2.83**	0.72	**11.42**	**11.41**	3.79	1.34
Lead (Pb)	0.000	0.002	0.001	0.006	0.006	0.002	1.23
Lithium (Li)	0.001	0.003	0.003	0.005	0.005	0.001	0.24
Magnesium (Mg)	2.58	4.02	3.97	5.55	5.55	0.73	0.18
Manganese (Mn)	0.00003	0.10	0.06	0.33	0.33	0.10	0.99
Mercury (Hg)	0.000005	0.000007	0.000005	0.000019	0.000019	0.000004	0.63
Molybdenum (Mo)	0.002	0.004	0.004	0.005	0.005	0.001	0.21
Nickel (Ni)	0.001	0.003	0.002	0.008	0.008	0.002	0.61
Potassium (K)	1.15	1.75	1.63	2.90	2.90	0.47	0.27
Selenium (Se)	0.0012	**0.0023**	**0.0022**	**0.0035**	**0.0035**	0.0005	0.24
Silicon (Si)	1.56	4.51	2.36	12.58	12.58	3.49	0.77
Silver (Ag)	0.000005	0.000050	0.000011	0.000197	0.000197	0.000064	1.26
Sodium (Na)	1.17	1.81	1.83	2.81	2.81	0.54	0.30
Strontium (Sr)	0.14	0.32	0.35	0.43	0.43	0.10	0.31
Thallium (Tl)	0.00003	0.00005	0.00004	0.00010	0.00010	0.00002	0.44
Tin (Sn)	0.00005	0.00010	0.00010	0.00013	0.00013	0.00002	0.22
Uranium (U)	0.0002	0.0003	0.0003	0.0004	0.0004	0.0001	0.26
Vanadium (V)	0.0005	0.0068	0.0017	0.0303	0.0303	0.0091	1.35
Zinc (Zn)	0.002	0.033	0.026	0.099	0.099	0.027	0.82

(continued)

Table 7.3-1. Summary Statistics of Water Quality Predictions for Sulphurets Creek (site SC3; Construction Phase) (continued)

Scenario 2							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.002	0.028	0.017	0.199	0.102	0.033	1.15
Chloride (Cl)	0.25	2.98	1.94	12.36	9.34	2.55	0.86
Fluoride (F)	0.03	0.08	0.08	0.12	0.11	0.02	0.27
Nitrate (as N)	0.01	0.37	0.16	2.35	1.25	0.41	1.11
Nitrite (as N)	0.0005	0.0006	0.0006	0.0008	0.0007	0.0001	0.10
Total Phosphate (as P)	0.001	0.13	0.07	0.58	0.52	0.16	1.19
Sulphate (SO_4)	33	**149**	**149**	**237**	**204**	35	0.23
Total Metals							
Aluminum (Al)	0.002	*1.69*	*0.42*	*7.95*	*7.12*	2.24	1.32
Antimony (Sb)	0.0004	0.0007	0.0007	0.0012	0.0011	0.0002	0.29
Arsenic (As)	0.0001	0.0025	0.0007	**0.0109**	**0.0104**	0.0030	1.22
Barium (Ba)	0.025	0.063	0.043	0.173	0.157	0.040	0.64
Beryllium (Be)	0.0001	0.0004	0.0002	0.0019	0.0011	0.0004	0.99
Boron (B)	0.005	0.006	0.006	0.009	0.008	0.001	0.16
Cadmium (Cd)	0.000005	**0.00041**	**0.00037**	**0.00123**	**0.00119**	0.00033	0.80
Calcium (Ca)	19.41	51.40	55.07	74.19	71.11	14.84	0.29
Chromium (Cr)	0.0002	**0.0023**	0.0009	**0.0095**	**0.0086**	0.0025	1.09
Cobalt (Co)	0.0001	0.001	0.001	0.006	0.005	0.002	1.09
Copper (Cu)	0.0003	**0.03**	0.01	**0.12**	**0.12**	0.04	1.14
Iron (Fe)	0.01	**2.86**	0.79	**13.04**	**11.69**	3.78	1.32
Lead (Pb)	0.000	0.002	0.001	0.007	0.006	0.002	1.23
Lithium (Li)	0.001	0.003	0.003	0.005	0.005	0.001	0.27
Magnesium (Mg)	2.47	4.21	4.17	5.99	5.62	0.85	0.20
Manganese (Mn)	0.00003	0.10	0.07	0.37	0.33	0.09	0.96
Mercury (Hg)	0.000005	0.000007	0.000005	0.000019	0.000019	0.000004	0.61
Molybdenum (Mo)	0.002	0.003	0.003	0.005	0.004	0.0005	0.14
Nickel (Ni)	0.001	0.003	0.002	0.008	0.008	0.002	0.62
Potassium (K)	0.80	1.76	1.67	3.22	2.95	0.51	0.29
Selenium (Se)	0.0010	**0.0039**	**0.0037**	**0.0070**	**0.0064**	0.0013	0.33
Silicon (Si)	1.56	4.62	2.60	14.23	12.86	3.39	0.73
Silver (Ag)	0.000005	0.000050	0.000010	0.000224	0.000201	0.000064	1.30
Sodium (Na)	1.00	1.74	1.63	2.82	2.73	0.49	0.28
Strontium (Sr)	0.14	0.30	0.32	0.43	0.39	0.07	0.23
Thallium (Tl)	0.00003	0.00005	0.00005	0.00010	0.00010	0.00002	0.43
Tin (Sn)	0.00005	0.00009	0.00009	0.00014	0.00014	0.00003	0.31
Uranium (U)	0.0002	0.0003	0.0003	0.0005	0.0004	0.0001	0.25
Vanadium (V)	0.0005	0.0068	0.0017	0.0345	0.0310	0.0093	1.38
Zinc (Zn)	0.002	0.034	0.029	0.099	0.095	0.026	0.76

(continued)

Table 7.3-1. Summary Statistics of Water Quality Predictions for Sulphurets Creek (site SC3; Construction Phase) (continued)

Scenario 3							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.002	0.035	0.019	0.232	0.124	0.042	1.21
Chloride (Cl)	0.25	1.37	0.89	6.19	4.22	1.14	0.83
Fluoride (F)	0.03	0.08	0.08	0.12	0.11	0.02	0.28
Nitrate (as N)	0.01	0.35	0.15	2.50	1.25	0.42	1.18
Nitrite (as N)	0.0005	0.0006	0.0006	0.0008	0.0007	0.0001	0.10
Total Phosphate (as P)	0.00	0.13	0.08	0.58	0.52	0.16	1.21
Sulphate (SO_4)	33	**140**	**138**	**240**	**204**	36	0.26
Total Metals							
Aluminum (Al)	0.002	*1.71*	*0.42*	*8.03*	*7.18*	2.27	1.32
Antimony (Sb)	0.0004	0.0007	0.0007	0.0012	0.0011	0.0002	0.30
Arsenic (As)	0.0001	0.0025	0.0007	**0.0113**	**0.0105**	0.0031	1.22
Barium (Ba)	0.025	0.063	0.043	0.175	0.158	0.041	0.64
Beryllium (Be)	0.0001	0.0004	0.0002	0.0021	0.0011	0.0004	0.97
Boron (B)	0.005	0.006	0.006	0.009	0.008	0.001	0.16
Cadmium (Cd)	0.000005	**0.00041**	**0.00037**	**0.00127**	**0.00119**	0.00033	0.81
Calcium (Ca)	19.29	50.50	54.62	73.54	71.01	15.05	0.30
Chromium (Cr)	0.0002	**0.0023**	0.0009	**0.0096**	**0.0086**	0.0025	1.09
Cobalt (Co)	0.0001	0.001	0.001	0.006	0.005	0.002	1.09
Copper (Cu)	0.0003	**0.03**	0.01	**0.13**	**0.12**	0.04	1.14
Iron (Fe)	0.01	**2.89**	0.81	**13.18**	**11.78**	3.82	1.32
Lead (Pb)	0.000	0.002	0.001	0.007	0.006	0.002	1.23
Lithium (Li)	0.001	0.003	0.003	0.005	0.005	0.001	0.27
Magnesium (Mg)	2.44	4.22	4.16	6.01	5.65	0.85	0.20
Manganese (Mn)	0.00003	0.10	0.07	0.38	0.34	0.10	0.96
Mercury (Hg)	0.000005	0.000007	0.000005	0.000020	0.000019	0.000004	0.61
Molybdenum (Mo)	0.002	0.003	0.003	0.005	0.004	0.000	0.14
Nickel (Ni)	0.001	0.003	0.002	0.008	0.008	0.002	0.63
Potassium (K)	0.80	1.77	1.69	3.26	2.97	0.52	0.29
Selenium (Se)	0.0010	**0.0033**	**0.0031**	**0.0057**	**0.0053**	0.0010	0.31
Silicon (Si)	1.55	4.66	2.63	14.36	12.95	3.43	0.74
Silver (Ag)	0.000005	0.000050	0.000010	0.000226	0.000203	0.000065	1.30
Sodium (Na)	1.00	1.75	1.64	2.87	2.74	0.50	0.28
Strontium (Sr)	0.14	0.30	0.32	0.44	0.39	0.07	0.23
Thallium (Tl)	0.00003	0.00005	0.00005	0.00010	0.00010	0.00002	0.44
Tin (Sn)	0.00005	0.00009	0.00009	0.00015	0.00014	0.00003	0.31
Uranium (U)	0.0002	0.0003	0.0003	0.0005	0.0004	0.0001	0.26
Vanadium (V)	0.0005	0.0068	0.0017	0.0348	0.0312	0.0094	1.38
Zinc (Zn)	0.002	0.034	0.030	0.102	0.095	0.026	0.77

(continued)

Table 7.3-1. Summary Statistics of Water Quality Predictions for Sulphurets Creek (site SC3; Construction Phase) (completed)

Scenario 4: Upper Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.002	0.035	0.019	0.232	0.124	0.042	1.21
Chloride (Cl)	0.25	2.94	1.83	13.54	9.46	2.61	0.89
Fluoride (F)	0.03	0.08	0.08	0.12	0.11	0.02	0.28
Nitrate (as N)	0.01	0.35	0.15	2.50	1.25	0.42	1.18
Nitrite (as N)	0.0005	0.0006	0.0006	0.0008	0.0007	0.0001	0.10
Total Phosphate (as P)	0.00	0.13	0.08	0.58	0.52	0.16	1.21
Sulphate (SO_4)	33	**146**	**147**	**240**	**205**	36	0.25
Total Metals							
Aluminum (Al)	0.002	*1.71*	*0.42*	*8.03*	*7.18*	2.27	1.32
Antimony (Sb)	0.0004	0.0007	0.0007	0.0012	0.0011	0.0002	0.30
Arsenic (As)	0.0001	0.0025	0.0007	**0.0113**	**0.0105**	0.0031	1.22
Barium (Ba)	0.025	0.063	0.043	0.175	0.158	0.041	0.64
Beryllium (Be)	0.0001	0.0004	0.0002	0.0021	0.0011	0.0004	0.97
Boron (B)	0.005	0.006	0.006	0.009	0.008	0.001	0.16
Cadmium (Cd)	0.000005	**0.00041**	**0.00037**	**0.00127**	**0.00119**	0.00033	0.81
Calcium (Ca)	19.35	51.46	55.36	74.41	71.60	15.15	0.29
Chromium (Cr)	0.0002	**0.0023**	0.0009	**0.0096**	**0.0086**	0.0025	1.09
Cobalt (Co)	0.0001	0.001	0.001	0.006	0.005	0.002	1.09
Copper (Cu)	0.0003	**0.03**	0.01	**0.13**	**0.12**	0.04	1.14
Iron (Fe)	0.01	**2.89**	0.81	**13.18**	**11.78**	3.82	1.32
Lead (Pb)	0.000	0.002	0.001	0.007	0.006	0.002	1.23
Lithium (Li)	0.001	0.003	0.003	0.005	0.005	0.001	0.27
Magnesium (Mg)	2.44	4.22	4.17	6.01	5.65	0.85	0.20
Manganese (Mn)	0.00003	0.10	0.07	0.38	0.34	0.10	0.96
Mercury (Hg)	0.000005	0.000007	0.000005	0.000020	0.000019	0.000004	0.61
Molybdenum (Mo)	0.002	0.003	0.003	0.005	0.004	0.000	0.14
Nickel (Ni)	0.001	0.003	0.002	0.008	0.008	0.002	0.63
Potassium (K)	0.80	1.77	1.69	3.26	2.97	0.52	0.29
Selenium (Se)	0.0010	**0.0038**	**0.0036**	**0.0070**	**0.0064**	0.0014	0.36
Silicon (Si)	1.55	4.66	2.63	14.36	12.95	3.43	0.74
Silver (Ag)	0.000005	0.000050	0.000010	0.000226	0.000203	0.000065	1.30
Sodium (Na)	1.00	1.75	1.64	2.87	2.74	0.50	0.28
Strontium (Sr)	0.14	0.30	0.32	0.44	0.39	0.07	0.23
Thallium (Tl)	0.00003	0.00005	0.00005	0.00010	0.00010	0.00002	0.43
Tin (Sn)	0.00005	0.00009	0.00009	0.00015	0.00014	0.00003	0.31
Uranium (U)	0.0002	0.0003	0.0003	0.0005	0.0004	0.0001	0.26
Vanadium (V)	0.0005	0.0068	0.0017	0.0348	0.0312	0.0094	1.38
Zinc (Zn)	0.002	0.034	0.030	0.102	0.095	0.026	0.77

Notes:

All measured values are in units of mg/L.

Grey highlighted values exceed BC chronic water quality guidelines; bold values exceed BC acute water quality guidelines.

For pH-dependent guidelines, pH was assumed to be > 6.5.

For total aluminum, italic values exceed CCME pH-dependent water quality guidelines.

Table 7.3-2. Summary Statistics of Water Quality Predictions for Sulphurets Creek (site SC3; Operation Phase)

Scenario 1: Expected Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0334	0.0185	0.2337	0.1210	0.0401	1.20
Chloride (Cl)	0.3	1.4	0.9	5.9	4.0	1.1	0.83
Fluoride (F)	0.03	0.07	0.08	0.11	0.11	0.02	0.27
Nitrate (as N)	0.01	0.43	0.19	2.39	1.36	0.46	1.09
Nitrite (as N)	0.0005	0.0006	0.0006	0.0008	0.0007	0.00006	0.10
Total Phosphate (as P)	0.001	0.133	0.072	0.522	0.518	0.159	1.20
Sulphate (SO_4)	33	**143**	**144**	**226**	**204**	34	0.23
Total Metals							
Aluminum (Al)	0.002	*1.69*	*0.40*	*7.16*	*7.12*	2.22	1.32
Antimony (Sb)	0.0004	0.0007	0.0007	0.0012	0.0011	0.0002	0.29
Arsenic (As)	0.0001	0.0025	0.0007	**0.0109**	**0.0104**	0.0030	1.22
Barium (Ba)	0.03	0.06	0.04	0.16	0.16	0.04	0.63
Beryllium (Be)	0.0001	0.0004	0.0002	0.0011	0.0011	0.0003	0.92
Boron (B)	0.005	0.006	0.006	0.008	0.008	0.001	0.16
Cadmium (Cd)	0.000005	**0.000410**	**0.000373**	**0.001232**	**0.001187**	0.000330	0.81
Calcium (Ca)	19.7	50.5	54.5	73.4	70.5	14.6	0.29
Chromium (Cr)	0.0003	**0.0022**	0.0010	**0.0086**	**0.0086**	0.0024	1.09
Cobalt (Co)	0.0001	0.0015	0.0006	0.0051	0.0050	0.0016	1.08
Copper (Cu)	0.0003	**0.0315**	0.0096	**0.1224**	**0.1177**	0.0359	1.14
Iron (Fe)	0.015	**2.845**	0.786	**11.755**	**11.687**	3.734	1.31
Lead (Pb)	0.00003	0.00170	0.00054	0.00631	0.00628	0.00208	1.22
Lithium (Li)	0.002	0.003	0.003	0.005	0.005	0.001	0.27
Magnesium (Mg)	2.5	4.2	4.2	5.6	5.6	0.8	0.20
Manganese (Mn)	0.00003	0.09875	0.06782	0.33502	0.33311	0.09360	0.95
Mercury (Hg)	0.000005	0.000007	0.000005	0.000019	0.000019	0.000004	0.61
Molybdenum (Mo)	0.002	0.003	0.003	0.005	0.004	0.0004	0.14
Nickel (Ni)	0.001	0.003	0.002	0.008	0.008	0.002	0.62
Potassium (K)	1.0	1.8	1.7	3.0	2.9	0.5	0.28
Selenium (Se)	0.0012	**0.0040**	**0.0037**	**0.0071**	**0.0065**	0.0012	0.31
Silicon (Si)	1.6	4.6	2.6	12.9	12.9	3.4	0.73
Silver (Ag)	0.000005	0.000049	0.000010	0.000202	0.000201	0.000064	1.29
Sodium (Na)	1.0	1.7	1.6	2.8	2.7	0.5	0.28
Strontium (Sr)	0.14	0.30	0.32	0.43	0.38	0.07	0.23
Thallium (Tl)	0.00003	0.00005	0.00005	0.00010	0.00010	0.00002	0.43
Tin (Sn)	0.00005	0.00009	0.00009	0.00014	0.00014	0.00003	0.31
Uranium (U)	0.0002	0.0003	0.0003	0.0004	0.0004	0.0001	0.26
Vanadium (V)	0.0005	0.0067	0.0017	0.0311	0.0310	0.0092	1.37
Zinc (Zn)	0.0015	0.0336	0.0291	0.0988	0.0948	0.0257	0.76

(continued)

Table 7.3-2. Summary Statistics of Water Quality Predictions for Sulphurets Creek (site SC3; Operation Phase) (continued)

Scenario 2							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0334	0.0185	0.2337	0.1210	0.0401	1.20
Chloride (Cl)	0.3	3.0	1.9	13.0	8.7	2.6	0.86
Fluoride (F)	0.03	0.07	0.08	0.11	0.11	0.02	0.27
Nitrate (as N)	0.01	0.43	0.19	2.39	1.36	0.46	1.09
Nitrite (as N)	0.0005	0.0006	0.0006	0.0008	0.0007	0.00006	0.10
Total Phosphate (as P)	0.001	0.133	0.072	0.522	0.518	0.159	1.20
Sulphate (SO_4)	34	**150**	**153**	**226**	**204**	33	0.22
Total Metals							
Aluminum (Al)	0.002	*1.69*	*0.40*	*7.16*	*7.12*	2.22	1.32
Antimony (Sb)	0.0004	0.0007	0.0007	0.0012	0.0011	0.0002	0.29
Arsenic (As)	0.0001	0.0025	0.0007	**0.0109**	**0.0104**	0.0030	1.22
Barium (Ba)	0.03	0.06	0.04	0.16	0.16	0.04	0.63
Beryllium (Be)	0.0001	0.0004	0.0002	0.0011	0.0011	0.0003	0.91
Boron (B)	0.005	0.006	0.006	0.009	0.008	0.001	0.16
Cadmium (Cd)	0.000005	**0.000410**	**0.000373**	**0.001232**	**0.001187**	0.000330	0.80
Calcium (Ca)	19.8	51.5	54.6	73.5	71.0	14.6	0.28
Chromium (Cr)	0.0003	**0.0022**	0.0010	**0.0086**	**0.0086**	0.0024	1.08
Cobalt (Co)	0.0001	0.0015	0.0006	0.0051	0.0050	0.0016	1.08
Copper (Cu)	0.0003	**0.0315**	0.0096	**0.1224**	**0.1177**	0.0359	1.14
Iron (Fe)	0.015	**2.845**	0.786	**11.755**	**11.687**	3.734	1.31
Lead (Pb)	0.00003	0.00170	0.00054	0.00631	0.00628	0.00208	1.22
Lithium (Li)	0.002	0.003	0.003	0.005	0.005	0.001	0.26
Magnesium (Mg)	2.5	4.2	4.2	5.6	5.6	0.8	0.20
Manganese (Mn)	0.00003	0.09876	0.06783	0.33503	0.33312	0.09360	0.95
Mercury (Hg)	0.000005	0.000007	0.000005	0.000019	0.000019	0.000004	0.61
Molybdenum (Mo)	0.002	0.003	0.003	0.005	0.004	0.0004	0.14
Nickel (Ni)	0.001	0.003	0.002	0.008	0.008	0.002	0.62
Potassium (K)	1.0	1.8	1.7	3.0	2.9	0.5	0.28
Selenium (Se)	0.0012	**0.0048**	**0.0046**	**0.0085**	**0.0080**	0.0017	0.35
Silicon (Si)	1.6	4.6	2.6	12.9	12.9	3.4	0.73
Silver (Ag)	0.000005	0.000049	0.000010	0.000202	0.000201	0.000064	1.29
Sodium (Na)	1.0	1.7	1.6	2.8	2.7	0.5	0.28
Strontium (Sr)	0.14	0.30	0.32	0.43	0.38	0.07	0.23
Thallium (Tl)	0.00003	0.00005	0.00005	0.00010	0.00010	0.00002	0.43
Tin (Sn)	0.00006	0.00009	0.00009	0.00014	0.00014	0.00003	0.31
Uranium (U)	0.0002	0.0003	0.0003	0.0004	0.0004	0.0001	0.26
Vanadium (V)	0.0005	0.0067	0.0017	0.0311	0.0310	0.0092	1.37
Zinc (Zn)	0.0015	0.0336	0.0291	0.0988	0.0948	0.0257	0.76

(continued)

Table 7.3-2. Summary Statistics of Water Quality Predictions for Sulphurets Creek (site SC3; Operation Phase) (continued)

Scenario 3							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0269	0.0121	0.2803	0.1064	0.0375	1.39
Chloride (Cl)	0.3	1.5	0.9	6.0	4.1	1.2	0.86
Fluoride (F)	0.04	0.07	0.08	0.10	0.10	0.02	0.29
Nitrate (as N)	0.02	0.44	0.23	2.50	1.46	0.48	1.10
Nitrite (as N)	0.0005	0.0005	0.0005	0.0007	0.0006	0.00004	0.07
Total Phosphate (as P)	0.001	0.129	0.059	0.524	0.514	0.162	1.25
Sulphate (SO_4)	35	**142**	**136**	**261**	**206**	38	0.27
Total Metals							
Aluminum (Al)	0.002	*1.69*	*0.40*	*7.06*	*7.02*	2.21	1.31
Antimony (Sb)	0.0004	0.0007	0.0007	0.0011	0.0011	0.0002	0.29
Arsenic (As)	0.0001	0.0025	0.0007	**0.0107**	**0.0106**	0.0030	1.23
Barium (Ba)	0.03	0.06	0.04	0.16	0.16	0.04	0.63
Beryllium (Be)	0.0001	0.0004	0.0002	0.0011	0.0011	0.0003	0.91
Boron (B)	0.005	0.006	0.006	0.008	0.008	0.001	0.16
Cadmium (Cd)	0.000005	**0.000411**	**0.000352**	**0.001215**	**0.001202**	0.000332	0.81
Calcium (Ca)	19.7	50.5	55.6	70.9	70.2	14.4	0.29
Chromium (Cr)	0.0002	**0.0022**	0.0008	**0.0085**	**0.0085**	0.0024	1.10
Cobalt (Co)	0.0001	0.0015	0.0006	0.0050	0.0050	0.0016	1.08
Copper (Cu)	0.0003	**0.0315**	0.0098	**0.1207**	**0.1194**	0.0361	1.15
Iron (Fe)	0.015	**2.850**	0.798	**11.605**	**11.532**	3.721	1.31
Lead (Pb)	0.00003	0.00170	0.00054	0.00623	0.00620	0.00207	1.22
Lithium (Li)	0.002	0.003	0.003	0.005	0.005	0.001	0.27
Magnesium (Mg)	2.5	4.2	4.2	5.6	5.6	0.8	0.20
Manganese (Mn)	0.00003	0.09896	0.06753	0.33049	0.32860	0.09303	0.94
Mercury (Hg)	0.000005	0.000007	0.000005	0.000019	0.000019	0.000004	0.61
Molybdenum (Mo)	0.002	0.003	0.003	0.004	0.004	0.0005	0.15
Nickel (Ni)	0.001	0.003	0.002	0.008	0.008	0.002	0.61
Potassium (K)	1.1	1.8	1.7	2.9	2.9	0.5	0.28
Selenium (Se)	0.0012	**0.0040**	**0.0039**	**0.0081**	**0.0064**	0.0014	0.34
Silicon (Si)	1.9	4.6	2.6	12.8	12.7	3.3	0.72
Silver (Ag)	0.000005	0.000050	0.000010	0.000200	0.000199	0.000064	1.28
Sodium (Na)	1.0	1.7	1.6	2.7	2.7	0.5	0.29
Strontium (Sr)	0.14	0.30	0.34	0.39	0.37	0.07	0.23
Thallium (Tl)	0.00003	0.00005	0.00005	0.00010	0.00010	0.00002	0.42
Tin (Sn)	0.00005	0.00009	0.00008	0.00014	0.00014	0.00003	0.31
Uranium (U)	0.0002	0.0003	0.0003	0.0004	0.0004	0.0001	0.26
Vanadium (V)	0.0005	0.0067	0.0016	0.0308	0.0306	0.0091	1.36
Zinc (Zn)	0.0015	0.0338	0.0269	0.0972	0.0962	0.0258	0.76

(continued)

Table 7.3-2. Summary Statistics of Water Quality Predictions for Sulphurets Creek (site SC3; Operation Phase) (completed)

Scenario 4: Upper Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0269	0.0121	0.2803	0.1064	0.0375	1.39
Chloride (Cl)	0.3	3.2	2.0	13.1	9.3	2.8	0.88
Fluoride (F)	0.04	0.07	0.08	0.10	0.10	0.02	0.29
Nitrate (as N)	0.02	0.44	0.23	2.50	1.46	0.48	1.10
Nitrite (as N)	0.0005	0.0005	0.0005	0.0007	0.0006	0.00004	0.07
Total Phosphate (as P)	0.001	0.129	0.059	0.524	0.514	0.162	1.25
Sulphate (SO_4)	36	**149**	**147**	**261**	**221**	38	0.26
Total Metals							
Aluminum (Al)	0.002	*1.69*	*0.40*	*7.06*	*7.02*	2.21	1.31
Antimony (Sb)	0.0005	0.0007	0.0007	0.0011	0.0011	0.0002	0.29
Arsenic (As)	0.0001	0.0025	0.0007	**0.0107**	**0.0106**	0.0030	1.23
Barium (Ba)	0.03	0.06	0.04	0.16	0.16	0.04	0.63
Beryllium (Be)	0.0001	0.0004	0.0002	0.0011	0.0011	0.0003	0.90
Boron (B)	0.005	0.006	0.006	0.008	0.008	0.001	0.16
Cadmium (Cd)	0.000005	**0.000411**	**0.000352**	**0.001215**	**0.001202**	0.000332	0.81
Calcium (Ca)	19.8	51.6	56.3	72.8	70.8	14.5	0.28
Chromium (Cr)	0.0002	**0.0022**	0.0008	**0.0085**	**0.0085**	0.0024	1.10
Cobalt (Co)	0.0001	0.0015	0.0006	0.0050	0.0050	0.0016	1.08
Copper (Cu)	0.0003	**0.0315**	0.0098	**0.1207**	**0.1194**	0.0361	1.15
Iron (Fe)	0.015	**2.850**	0.799	**11.605**	**11.532**	3.721	1.31
Lead (Pb)	0.00003	0.00170	0.00054	0.00623	0.00620	0.00207	1.22
Lithium (Li)	0.002	0.003	0.003	0.005	0.005	0.001	0.27
Magnesium (Mg)	2.5	4.2	4.2	5.6	5.6	0.8	0.20
Manganese (Mn)	0.00003	0.09897	0.06758	0.33049	0.32861	0.09302	0.94
Mercury (Hg)	0.000005	0.000007	0.000005	0.000019	0.000019	0.000004	0.61
Molybdenum (Mo)	0.002	0.003	0.003	0.004	0.004	0.0005	0.15
Nickel (Ni)	0.001	0.003	0.002	0.008	0.008	0.002	0.61
Potassium (K)	1.1	1.8	1.7	2.9	2.9	0.5	0.28
Selenium (Se)	0.0012	**0.0049**	**0.0048**	**0.0095**	**0.0078**	0.0018	0.37
Silicon (Si)	1.9	4.6	2.6	12.8	12.7	3.3	0.72
Silver (Ag)	0.000005	0.000050	0.000010	0.000200	0.000199	0.000064	1.28
Sodium (Na)	1.0	1.7	1.6	2.7	2.7	0.5	0.29
Strontium (Sr)	0.15	0.30	0.34	0.39	0.37	0.07	0.23
Thallium (Tl)	0.00003	0.00005	0.00005	0.00010	0.00010	0.00002	0.42
Tin (Sn)	0.00005	0.00009	0.00008	0.00014	0.00014	0.00003	0.30
Uranium (U)	0.0002	0.0003	0.0003	0.0004	0.0004	0.0001	0.26
Vanadium (V)	0.0005	0.0067	0.0016	0.0308	0.0306	0.0091	1.36
Zinc (Zn)	0.0015	0.0338	0.0269	0.0972	0.0962	0.0258	0.76

Notes:

All measured values are in units of mg/L.

Grey highlighted values exceed BC chronic water quality guidelines; bold values exceed BC acute water quality guidelines.

For pH-dependent guidelines, pH was assumed to be > 6.5.

For total aluminum, italic values exceed CCME pH-dependent water quality guidelines.

Table 7.3-3. Summary Statistics of Water Quality Predictions for Sulphurets Creek (site SC3; Closure Phase)

Scenario 1: Expected Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0035	0.0025	0.0082	0.0082	0.0018	0.53
Chloride (Cl)	0.7	2.3	2.1	5.9	4.5	1.1	0.49
Fluoride (F)	0.04	0.07	0.07	0.10	0.10	0.02	0.30
Nitrate (as N)	0.02	0.07	0.09	0.16	0.15	0.04	0.58
Nitrite (as N)	0.0005	0.0005	0.0005	0.0006	0.0005	0.00002	0.03
Total Phosphate (as P)	0.001	0.128	0.045	0.568	0.567	0.180	1.41
Sulphate (SO_4)	66	**136**	**130**	**193**	**192**	37	0.27
Total Metals							
Aluminum (Al)	0.002	*1.90*	*0.51*	*8.07*	*8.07*	2.51	1.33
Antimony (Sb)	0.0004	0.0007	0.0007	0.0012	0.0012	0.0002	0.34
Arsenic (As)	0.0001	0.0028	0.0011	**0.0118**	**0.0118**	0.0034	1.23
Barium (Ba)	0.03	0.07	0.05	0.17	0.17	0.05	0.67
Beryllium (Be)	0.0001	0.0002	0.0002	0.0011	0.0003	0.0002	0.75
Boron (B)	0.005	0.006	0.006	0.008	0.008	0.001	0.16
Cadmium (Cd)	0.000005	**0.000441**	**0.000379**	**0.001322**	**0.001321**	0.000365	0.83
Calcium (Ca)	23.3	52.4	56.5	74.4	74.3	14.8	0.28
Chromium (Cr)	0.0004	**0.0023**	0.0009	**0.0095**	**0.0095**	0.0027	1.17
Cobalt (Co)	0.0001	0.0016	0.0007	0.0057	0.0057	0.0018	1.12
Copper (Cu)	0.0003	**0.0354**	**0.0179**	**0.1331**	**0.1330**	0.0403	1.14
Iron (Fe)	0.015	**3.225**	0.994	**13.280**	**13.277**	4.238	1.31
Lead (Pb)	0.00003	0.00189	0.00081	0.00708	0.00708	0.00234	1.24
Lithium (Li)	0.002	0.003	0.003	0.005	0.005	0.001	0.31
Magnesium (Mg)	2.6	4.4	4.4	6.2	6.2	0.9	0.20
Manganese (Mn)	0.00003	0.10898	0.07683	0.37738	0.37731	0.10673	0.98
Mercury (Hg)	0.000005	0.000007	0.000005	0.000021	0.000021	0.000005	0.66
Molybdenum (Mo)	0.002	0.003	0.003	0.004	0.004	0.0004	0.13
Nickel (Ni)	0.001	0.003	0.002	0.009	0.009	0.002	0.70
Potassium (K)	1.1	1.9	1.8	3.2	3.2	0.6	0.30
Selenium (Se)	**0.0022**	**0.0041**	**0.0041**	**0.0067**	**0.0062**	0.0012	0.28
Silicon (Si)	1.9	5.0	2.8	14.5	14.5	3.8	0.76
Silver (Ag)	0.000005	0.000054	0.000010	0.000227	0.000227	0.000072	1.32
Sodium (Na)	1.0	1.7	1.5	2.8	2.8	0.5	0.31
Strontium (Sr)	0.15	0.29	0.32	0.38	0.38	0.07	0.25
Thallium (Tl)	0.00003	0.00005	0.00005	0.00011	0.00011	0.00002	0.47
Tin (Sn)	0.00005	0.00009	0.00008	0.00014	0.00014	0.00003	0.35
Uranium (U)	0.0002	0.0003	0.0003	0.0004	0.0004	0.0001	0.27
Vanadium (V)	0.0005	0.0075	0.0020	0.0350	0.0350	0.0104	1.40
Zinc (Zn)	0.0015	0.0368	0.0311	0.1065	0.1064	0.0288	0.78

(continued)

Table 7.3-3. Summary Statistics of Water Quality Predictions for Sulphurets Creek (site SC3; Closure Phase) (continued)

Scenario 2							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0035	0.0025	0.0082	0.0082	0.0018	0.53
Chloride (Cl)	1.3	5.1	4.7	13.7	10.5	2.7	0.53
Fluoride (F)	0.04	0.07	0.07	0.10	0.10	0.02	0.30
Nitrate (as N)	0.02	0.07	0.09	0.16	0.15	0.04	0.58
Nitrite (as N)	0.0005	0.0005	0.0005	0.0006	0.0005	0.00002	0.03
Total Phosphate (as P)	0.001	0.128	0.045	0.568	0.567	0.180	1.41
Sulphate (SO_4)	66	**136**	**130**	**193**	**192**	37	0.27
Total Metals							
Aluminum (Al)	0.002	*1.90*	*0.51*	*8.07*	*8.07*	2.51	1.33
Antimony (Sb)	0.0004	0.0007	0.0007	0.0012	0.0012	0.0002	0.34
Arsenic (As)	0.0001	0.0028	0.0011	**0.0118**	**0.0118**	0.0034	1.23
Barium (Ba)	0.03	0.07	0.05	0.17	0.17	0.05	0.67
Beryllium (Be)	0.0001	0.0002	0.0002	0.0011	0.0003	0.0002	0.75
Boron (B)	0.005	0.006	0.006	0.008	0.008	0.001	0.16
Cadmium (Cd)	0.000005	**0.000441**	**0.000379**	**0.001322**	**0.001321**	0.000365	0.83
Calcium (Ca)	23.5	52.6	56.7	74.7	74.6	14.8	0.28
Chromium (Cr)	0.0004	**0.0023**	0.0009	**0.0095**	**0.0095**	0.0027	1.17
Cobalt (Co)	0.0001	0.0016	0.0007	0.0057	0.0057	0.0018	1.12
Copper (Cu)	0.0003	**0.0354**	**0.0179**	**0.1331**	**0.1330**	0.0403	1.14
Iron (Fe)	0.015	**3.225**	0.995	**13.280**	**13.277**	4.237	1.31
Lead (Pb)	0.00003	0.00189	0.00081	0.00708	0.00708	0.00234	1.24
Lithium (Li)	0.002	0.003	0.003	0.005	0.005	0.001	0.31
Magnesium (Mg)	2.6	4.4	4.4	6.2	6.2	0.9	0.20
Manganese (Mn)	0.00003	0.10899	0.07685	0.37738	0.37731	0.10673	0.98
Mercury (Hg)	0.000005	0.000007	0.000005	0.000021	0.000021	0.000005	0.66
Molybdenum (Mo)	0.002	0.003	0.003	0.004	0.004	0.0004	0.13
Nickel (Ni)	0.001	0.003	0.002	0.009	0.009	0.002	0.70
Potassium (K)	1.1	1.9	1.8	3.2	3.2	0.6	0.30
Selenium (Se)	**0.0023**	**0.0045**	**0.0044**	**0.0075**	**0.0069**	0.0014	0.31
Silicon (Si)	1.9	5.0	2.8	14.5	14.5	3.8	0.76
Silver (Ag)	0.000005	0.000054	0.000010	0.000227	0.000227	0.000072	1.32
Sodium (Na)	1.0	1.7	1.5	2.8	2.8	0.5	0.31
Strontium (Sr)	0.15	0.29	0.32	0.38	0.38	0.07	0.25
Thallium (Tl)	0.00003	0.00005	0.00005	0.00011	0.00011	0.00002	0.47
Tin (Sn)	0.00005	0.00009	0.00008	0.00014	0.00014	0.00003	0.35
Uranium (U)	0.0002	0.0003	0.0003	0.0004	0.0004	0.0001	0.27
Vanadium (V)	0.0005	0.0075	0.0020	0.0350	0.0350	0.0104	1.40
Zinc (Zn)	0.0015	0.0368	0.0312	0.1065	0.1064	0.0288	0.78

(continued)

Table 7.3-3. Summary Statistics of Water Quality Predictions for Sulphurets Creek (site SC3; Closure Phase) (continued)

Scenario 3							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0034	0.0025	0.0078	0.0078	0.0017	0.50
Chloride (Cl)	1.3	2.9	2.9	5.5	5.2	1.2	0.40
Fluoride (F)	0.03	0.07	0.08	0.10	0.10	0.02	0.32
Nitrate (as N)	0.02	0.07	0.09	0.15	0.15	0.04	0.58
Nitrite (as N)	0.0005	0.0005	0.0005	0.0006	0.0005	0.00001	0.02
Total Phosphate (as P)	0.001	0.128	0.047	0.561	0.560	0.179	1.40
Sulphate (SO_4)	83	**136**	**132**	**206**	**205**	30	0.22
Total Metals							
Aluminum (Al)	0.002	*1.89*	*0.50*	*7.84*	*7.83*	2.48	1.31
Antimony (Sb)	0.0004	0.0007	0.0007	0.0012	0.0012	0.0002	0.34
Arsenic (As)	0.0001	0.0027	0.0012	**0.0119**	**0.0119**	0.0034	1.24
Barium (Ba)	0.03	0.07	0.05	0.17	0.17	0.04	0.66
Beryllium (Be)	0.0001	0.0002	0.0002	0.0011	0.0003	0.0002	0.76
Boron (B)	0.005	0.006	0.006	0.008	0.008	0.001	0.15
Cadmium (Cd)	0.000005	**0.000439**	**0.000379**	**0.001335**	**0.001334**	0.000367	0.83
Calcium (Ca)	24.0	52.6	57.3	73.0	72.9	14.5	0.28
Chromium (Cr)	0.0003	**0.0023**	0.0009	**0.0093**	**0.0093**	0.0027	1.16
Cobalt (Co)	0.0001	0.0016	0.0007	0.0055	0.0055	0.0018	1.12
Copper (Cu)	0.0003	**0.0352**	**0.0178**	**0.1345**	**0.1344**	0.0405	1.15
Iron (Fe)	0.015	**3.203**	0.975	**12.884**	**12.876**	4.178	1.30
Lead (Pb)	0.00003	0.00188	0.00081	0.00689	0.00689	0.00232	1.23
Lithium (Li)	0.002	0.003	0.003	0.005	0.005	0.001	0.31
Magnesium (Mg)	2.7	4.4	4.4	6.0	6.0	0.9	0.20
Manganese (Mn)	0.00003	0.10819	0.07587	0.36622	0.36596	0.10470	0.97
Mercury (Hg)	0.000005	0.000007	0.000005	0.000021	0.000021	0.000005	0.67
Molybdenum (Mo)	0.002	0.003	0.003	0.004	0.004	0.0005	0.17
Nickel (Ni)	0.001	0.003	0.002	0.008	0.008	0.002	0.70
Potassium (K)	1.1	1.9	1.8	3.2	3.2	0.6	0.30
Selenium (Se)	**0.0028**	**0.0043**	**0.0041**	**0.0070**	**0.0070**	0.0012	0.28
Silicon (Si)	1.9	5.0	2.7	14.1	14.1	3.8	0.75
Silver (Ag)	0.000005	0.000054	0.000010	0.000221	0.000220	0.000071	1.31
Sodium (Na)	1.0	1.7	1.6	2.8	2.8	0.5	0.32
Strontium (Sr)	0.14	0.29	0.32	0.37	0.37	0.07	0.25
Thallium (Tl)	0.00003	0.00005	0.00005	0.00010	0.00010	0.00002	0.46
Tin (Sn)	0.00005	0.00009	0.00008	0.00014	0.00014	0.00003	0.34
Uranium (U)	0.0002	0.0003	0.0003	0.0004	0.0004	0.0001	0.27
Vanadium (V)	0.0005	0.0074	0.0020	0.0340	0.0340	0.0102	1.38
Zinc (Zn)	0.0015	0.0367	0.0312	0.1076	0.1075	0.0288	0.79

(continued)

Table 7.3-3. Summary Statistics of Water Quality Predictions for Sulphurets Creek (site SC3; Closure Phase) (completed)

Scenario 4: Upper Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0034	0.0025	0.0078	0.0078	0.0017	0.50
Chloride (Cl)	2.8	6.6	6.5	12.7	11.9	2.8	0.42
Fluoride (F)	0.03	0.07	0.08	0.10	0.10	0.02	0.32
Nitrate (as N)	0.02	0.07	0.09	0.15	0.15	0.04	0.58
Nitrite (as N)	0.0005	0.0005	0.0005	0.0006	0.0005	0.00001	0.02
Total Phosphate (as P)	0.001	0.128	0.047	0.561	0.560	0.179	1.40
Sulphate (SO_4)	83	**136**	**132**	**206**	**205**	30	0.22
Total Metals							
Aluminum (Al)	0.002	*1.89*	*0.50*	*7.84*	*7.83*	2.48	1.31
Antimony (Sb)	0.0004	0.0007	0.0007	0.0012	0.0012	0.0002	0.34
Arsenic (As)	0.0001	0.0027	0.0012	**0.0119**	**0.0119**	0.0034	1.24
Barium (Ba)	0.03	0.07	0.05	0.17	0.17	0.04	0.66
Beryllium (Be)	0.0001	0.0002	0.0002	0.0011	0.0003	0.0002	0.76
Boron (B)	0.005	0.006	0.006	0.008	0.008	0.001	0.15
Cadmium (Cd)	0.000005	**0.000439**	**0.000379**	**0.001335**	**0.001334**	0.000367	0.83
Calcium (Ca)	24.3	52.9	57.6	73.2	73.1	14.4	0.27
Chromium (Cr)	0.0003	**0.0023**	0.0009	**0.0093**	**0.0093**	0.0027	1.16
Cobalt (Co)	0.0001	0.0016	0.0007	0.0055	0.0055	0.0018	1.12
Copper (Cu)	0.0003	**0.0352**	**0.0178**	**0.1345**	**0.1344**	0.0405	1.15
Iron (Fe)	0.015	**3.203**	0.976	**12.885**	**12.876**	4.178	1.30
Lead (Pb)	0.00003	0.00188	0.00081	0.00689	0.00689	0.00232	1.23
Lithium (Li)	0.002	0.003	0.003	0.005	0.005	0.001	0.31
Magnesium (Mg)	2.7	4.4	4.4	6.0	6.0	0.9	0.20
Manganese (Mn)	0.00003	0.10820	0.07589	0.36622	0.36597	0.10469	0.97
Mercury (Hg)	0.000005	0.000007	0.000005	0.000021	0.000021	0.000005	0.67
Molybdenum (Mo)	0.002	0.003	0.003	0.004	0.004	0.0005	0.17
Nickel (Ni)	0.001	0.003	0.002	0.008	0.008	0.002	0.70
Potassium (K)	1.1	1.9	1.8	3.2	3.2	0.6	0.30
Selenium (Se)	**0.0030**	**0.0047**	**0.0045**	**0.0078**	**0.0077**	0.0014	0.29
Silicon (Si)	1.9	5.0	2.7	14.1	14.1	3.8	0.75
Silver (Ag)	0.000005	0.000054	0.000010	0.000221	0.000220	0.000071	1.31
Sodium (Na)	1.0	1.7	1.6	2.8	2.8	0.5	0.32
Strontium (Sr)	0.14	0.29	0.33	0.37	0.37	0.07	0.25
Thallium (Tl)	0.00003	0.00005	0.00005	0.00010	0.00010	0.00002	0.46
Tin (Sn)	0.00006	0.00009	0.00008	0.00014	0.00014	0.00003	0.34
Uranium (U)	0.0002	0.0003	0.0003	0.0004	0.0004	0.0001	0.27
Vanadium (V)	0.0005	0.0074	0.0020	0.0340	0.0340	0.0102	1.38
Zinc (Zn)	0.0015	0.0367	0.0312	0.1076	0.1075	0.0288	0.79

Notes:

All measured values are in units of mg/L.

Grey highlighted values exceed BC chronic water quality guidelines; bold values exceed BC acute water quality guidelines.

For pH-dependent guidelines, pH was assumed to be > 6.5.

For total aluminum, italic values exceed CCME pH-dependent water quality guidelines.

Table 7.3-4. Summary Statistics of Water Quality Predictions for Sulphurets Creek (site SC3; Post-closure Phase)

Scenario 1: Expected Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0033	0.0025	0.0082	0.0070	0.0015	0.45
Chloride (Cl)	0.7	2.1	2.2	5.6	4.1	1.0	0.49
Fluoride (F)	0.04	0.07	0.08	0.10	0.10	0.02	0.28
Nitrate (as N)	0.01	0.07	0.08	0.16	0.15	0.04	0.58
Nitrite (as N)	0.0005	0.0005	0.0005	0.0006	0.0006	0.00003	0.06
Total Phosphate (as P)	0.001	0.123	0.055	0.568	0.513	0.159	1.29
Sulphate (SO_4)	66	**145**	**143**	**216**	**195**	26	0.18
Total Metals							
Aluminum (Al)	0.002	*1.71*	*0.55*	*8.07*	*7.06*	2.228	1.30
Antimony (Sb)	0.0004	0.0007	0.0007	0.0012	0.0011	0.0002	0.28
Arsenic (As)	0.0001	0.0025	0.0014	**0.0118**	**0.0105**	0.0030	1.22
Barium (Ba)	0.03	0.06	0.05	0.17	0.16	0.04	0.63
Beryllium (Be)	0.0001	0.0004	0.0002	0.0011	0.0011	0.0003	0.92
Boron (B)	0.005	0.006	0.006	0.008	0.008	0.001	0.16
Cadmium (Cd)	0.000005	**0.000413**	**0.000377**	**0.001324**	**0.001193**	0.000330	0.80
Calcium (Ca)	23.0	51.1	51.7	74.6	71.5	14.8	0.29
Chromium (Cr)	0.0004	**0.0022**	0.0010	**0.0095**	**0.0085**	0.0025	1.10
Cobalt (Co)	0.0001	0.0015	0.0008	0.0057	0.0050	0.0016	1.07
Copper (Cu)	0.0003	**0.0318**	**0.0237**	**0.1333**	**0.1184**	0.0360	1.13
Iron (Fe)	0.015	**2.885**	**1.020**	**13.282**	**11.594**	3.748	1.30
Lead (Pb)	0.00003	0.00172	0.00095	0.00708	0.00622	0.00209	1.22
Lithium (Li)	0.002	0.003	0.003	0.005	0.005	0.001	0.27
Magnesium (Mg)	2.5	4.2	4.2	6.2	5.6	0.8	0.20
Manganese (Mn)	0.00003	0.09993	0.07586	0.37744	0.33031	0.09369	0.94
Mercury (Hg)	0.000005	0.000007	0.000005	0.000021	0.000019	0.000004	0.61
Molybdenum (Mo)	0.002	0.003	0.003	0.004	0.004	0.0004	0.13
Nickel (Ni)	0.001	0.003	0.003	0.009	0.008	0.002	0.61
Potassium (K)	1.1	1.7	1.7	3.2	2.9	0.5	0.29
Selenium (Se)	**0.0022**	**0.0038**	**0.0036**	**0.0080**	**0.0052**	0.0009	0.24
Silicon (Si)	1.9	4.7	2.7	14.5	12.8	3.4	0.72
Silver (Ag)	0.000005	0.000050	0.000010	0.000227	0.000199	0.000064	1.28
Sodium (Na)	1.0	1.7	1.5	2.8	2.7	0.5	0.27
Strontium (Sr)	0.15	0.29	0.31	0.38	0.37	0.06	0.22
Thallium (Tl)	0.00003	0.00005	0.00005	0.00011	0.00010	0.00002	0.43
Tin (Sn)	0.00005	0.00009	0.00009	0.00015	0.00014	0.00003	0.32
Uranium (U)	0.0002	0.0003	0.0003	0.0004	0.0004	0.0001	0.26
Vanadium (V)	0.0005	0.0068	0.0021	0.0350	0.0307	0.0092	1.36
Zinc (Zn)	0.0015	0.0339	0.0312	0.1066	0.0954	0.0257	0.76

(continued)

Table 7.3-4. Summary Statistics of Water Quality Predictions for Sulphurets Creek (site SC3; Post-closure Phase) (continued)

Scenario 2							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0033	0.0025	0.0082	0.0070	0.0015	0.45
Chloride (Cl)	1.3	4.8	4.9	13.0	9.6	2.5	0.53
Fluoride (F)	0.04	0.07	0.08	0.11	0.10	0.02	0.28
Nitrate (as N)	0.01	0.07	0.08	0.16	0.15	0.04	0.58
Nitrite (as N)	0.0005	0.0005	0.0005	0.0006	0.0006	0.00003	0.06
Total Phosphate (as P)	0.001	0.123	0.055	0.568	0.513	0.159	1.29
Sulphate (SO_4)	66	**151**	**151**	**216**	**202**	27	0.18
Total Metals							
Aluminum (Al)	0.002	*1.71*	*0.55*	*8.07*	*7.06*	2.23	1.30
Antimony (Sb)	0.0004	0.0007	0.0007	0.0012	0.0011	0.0002	0.28
Arsenic (As)	0.0001	0.0025	0.0014	**0.0118**	**0.0105**	0.0030	1.22
Barium (Ba)	0.03	0.06	0.05	0.17	0.16	0.04	0.63
Beryllium (Be)	0.0001	0.0004	0.0002	0.0011	0.0011	0.0003	0.92
Boron (B)	0.005	0.006	0.006	0.008	0.008	0.001	0.16
Cadmium (Cd)	0.000005	**0.000413**	**0.000377**	**0.001324**	**0.001193**	0.000330	0.80
Calcium (Ca)	23.2	51.4	52.1	74.8	71.7	14.8	0.29
Chromium (Cr)	0.0004	**0.0022**	0.0010	**0.0095**	**0.0085**	0.0025	1.10
Cobalt (Co)	0.0001	0.0015	0.0008	0.0057	0.0050	0.0016	1.07
Copper (Cu)	0.0003	**0.0318**	**0.0237**	**0.1333**	**0.1184**	0.0360	1.13
Iron (Fe)	0.015	**2.885**	**1.020**	**13.282**	**11.594**	3.748	1.30
Lead (Pb)	0.00003	0.00172	0.00095	0.00708	0.00622	0.00209	1.22
Lithium (Li)	0.002	0.003	0.003	0.005	0.005	0.001	0.27
Magnesium (Mg)	2.5	4.2	4.2	6.2	5.6	0.8	0.20
Manganese (Mn)	0.00003	0.09994	0.07588	0.37745	0.33031	0.09369	0.94
Mercury (Hg)	0.000005	0.000007	0.000005	0.000021	0.000019	0.000004	0.61
Molybdenum (Mo)	0.002	0.003	0.003	0.004	0.004	0.0004	0.13
Nickel (Ni)	0.001	0.003	0.003	0.009	0.008	0.002	0.61
Potassium (K)	1.1	1.7	1.7	3.2	2.9	0.5	0.29
Selenium (Se)	**0.0023**	**0.0041**	**0.0040**	**0.0089**	**0.0059**	0.0011	0.26
Silicon (Si)	1.9	4.7	2.7	14.5	12.8	3.4	0.72
Silver (Ag)	0.000005	0.000050	0.000010	0.000227	0.000199	0.000064	1.28
Sodium (Na)	1.0	1.7	1.5	2.8	2.7	0.5	0.27
Strontium (Sr)	0.15	0.29	0.31	0.38	0.38	0.06	0.22
Thallium (Tl)	0.00003	0.00005	0.00005	0.00011	0.00010	0.00002	0.43
Tin (Sn)	0.00005	0.00009	0.00009	0.00015	0.00014	0.00003	0.32
Uranium (U)	0.0002	0.0003	0.0003	0.0004	0.0004	0.0001	0.26
Vanadium (V)	0.0005	0.0068	0.0021	0.0350	0.0307	0.0092	1.36
Zinc (Zn)	0.0015	0.0339	0.0312	0.1066	0.0954	0.0257	0.76

(continued)

Table 7.3-4. Summary Statistics of Water Quality Predictions for Sulphurets Creek (site SC3; Post-closure Phase) (continued)

Scenario 3							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0033	0.0025	0.0078	0.0071	0.0015	0.46
Chloride (Cl)	0.9	2.3	2.1	6.2	3.9	0.9	0.41
Fluoride (F)	0.03	0.07	0.07	0.10	0.10	0.02	0.29
Nitrate (as N)	0.02	0.07	0.08	0.15	0.14	0.04	0.56
Nitrite (as N)	0.0005	0.0005	0.0005	0.0006	0.0006	0.00002	0.04
Total Phosphate (as P)	0.001	0.123	0.048	0.560	0.510	0.161	1.31
Sulphate (SO_4)	82	**145**	**137**	**242**	**216**	30	0.20
Total Metals							
Aluminum (Al)	0.002	*1.73*	*0.52*	*7.84*	*7.03*	2.24	1.30
Antimony (Sb)	0.0004	0.0007	0.0007	0.0012	0.0011	0.0002	0.29
Arsenic (As)	0.0001	0.0025	0.0015	**0.0119**	**0.0106**	0.0031	1.23
Barium (Ba)	0.03	0.06	0.05	0.17	0.16	0.04	0.63
Beryllium (Be)	0.0001	0.0004	0.0002	0.0011	0.0011	0.0003	0.92
Boron (B)	0.005	0.006	0.006	0.008	0.008	0.001	0.15
Cadmium (Cd)	0.000005	**0.000416**	**0.000381**	**0.001336**	**0.001206**	0.000335	0.80
Calcium (Ca)	22.8	50.9	55.1	73.5	70.9	14.5	0.28
Chromium (Cr)	0.0003	**0.0022**	**0.0012**	**0.0094**	**0.0085**	0.0025	1.11
Cobalt (Co)	0.0001	0.0015	0.0008	0.0055	0.0050	0.0016	1.07
Copper (Cu)	0.0003	**0.0321**	**0.0224**	**0.1346**	**0.1198**	0.0366	1.14
Iron (Fe)	0.015	**2.914**	0.947	**12.890**	**11.543**	3.766	1.29
Lead (Pb)	0.00003	0.00173	0.00095	0.00689	0.00620	0.00210	1.21
Lithium (Li)	0.002	0.003	0.003	0.005	0.005	0.001	0.28
Magnesium (Mg)	2.5	4.3	4.2	6.0	5.6	0.9	0.20
Manganese (Mn)	0.00003	0.10081	0.07681	0.36639	0.32887	0.09397	0.93
Mercury (Hg)	0.000005	0.000007	0.000005	0.000021	0.000019	0.000004	0.62
Molybdenum (Mo)	0.002	0.003	0.003	0.004	0.004	0.0005	0.15
Nickel (Ni)	0.001	0.003	0.003	0.008	0.008	0.002	0.61
Potassium (K)	1.1	1.7	1.7	3.2	2.9	0.5	0.29
Selenium (Se)	**0.0026**	**0.0039**	**0.0036**	**0.0087**	**0.0058**	0.0009	0.24
Silicon (Si)	1.9	4.7	2.7	14.1	12.7	3.4	0.72
Silver (Ag)	0.000005	0.000050	0.000011	0.000221	0.000199	0.000064	1.28
Sodium (Na)	1.0	1.7	1.6	2.8	2.6	0.5	0.29
Strontium (Sr)	0.14	0.29	0.32	0.37	0.37	0.07	0.24
Thallium (Tl)	0.00003	0.00005	0.00005	0.00010	0.00010	0.00002	0.43
Tin (Sn)	0.00006	0.00009	0.00009	0.00014	0.00014	0.00003	0.31
Uranium (U)	0.0002	0.0003	0.0003	0.0004	0.0004	0.0001	0.26
Vanadium (V)	0.0005	0.0068	0.0021	0.0340	0.0306	0.0092	1.35
Zinc (Zn)	0.0015	0.0342	0.0316	0.1077	0.0965	0.0260	0.76

(continued)

Table 7.3-4. Summary Statistics of Water Quality Predictions for Sulphurets Creek (site SC3; Post-closure Phase) (completed)

Scenario 4: Upper Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0033	0.0025	0.0078	0.0071	0.0015	0.46
Chloride (Cl)	1.7	5.1	4.7	14.4	9.0	2.2	0.44
Fluoride (F)	0.03	0.07	0.07	0.10	0.10	0.02	0.29
Nitrate (as N)	0.02	0.07	0.08	0.15	0.14	0.04	0.56
Nitrite (as N)	0.0005	0.0005	0.0005	0.0006	0.0006	0.00002	0.04
Total Phosphate (as P)	0.001	0.123	0.048	0.560	0.510	0.161	1.31
Sulphate (SO_4)	82	**151**	**140**	**242**	**232**	33	0.22
Total Metals							
Aluminum (Al)	0.002	*1.73*	*0.52*	*7.84*	*7.03*	2.24	1.30
Antimony (Sb)	0.0004	0.0007	0.0007	0.0012	0.0011	0.0002	0.28
Arsenic (As)	0.0001	0.0025	0.0015	**0.0119**	**0.0106**	0.0031	1.22
Barium (Ba)	0.03	0.06	0.05	0.17	0.16	0.04	0.63
Beryllium (Be)	0.0001	0.0004	0.0002	0.0011	0.0011	0.0003	0.91
Boron (B)	0.005	0.006	0.006	0.008	0.008	0.001	0.15
Cadmium (Cd)	0.000005	**0.000416**	**0.000381**	**0.001336**	**0.001206**	0.000335	0.80
Calcium (Ca)	23.0	51.2	55.8	73.8	71.1	14.4	0.28
Chromium (Cr)	0.0003	**0.0022**	**0.0012**	**0.0094**	**0.0085**	0.0025	1.11
Cobalt (Co)	0.0001	0.0015	0.0008	0.0055	0.0050	0.0016	1.07
Copper (Cu)	0.0003	**0.0321**	**0.0224**	**0.1346**	**0.1198**	0.0366	1.14
Iron (Fe)	0.015	**2.915**	0.947	**12.890**	**11.543**	3.766	1.29
Lead (Pb)	0.00003	0.00173	0.00095	0.00689	0.00620	0.00210	1.21
Lithium (Li)	0.002	0.003	0.003	0.005	0.005	0.001	0.28
Magnesium (Mg)	2.5	4.3	4.2	6.0	5.6	0.9	0.20
Manganese (Mn)	0.00003	0.10083	0.07682	0.36639	0.32888	0.09396	0.93
Mercury (Hg)	0.000005	0.000007	0.000005	0.000021	0.000019	0.000004	0.62
Molybdenum (Mo)	0.002	0.003	0.003	0.004	0.004	0.0005	0.15
Nickel (Ni)	0.001	0.003	0.003	0.008	0.008	0.002	0.61
Potassium (K)	1.1	1.7	1.7	3.2	2.9	0.5	0.29
Selenium (Se)	**0.0028**	**0.0043**	**0.0040**	**0.0097**	**0.0065**	0.0011	0.26
Silicon (Si)	1.9	4.7	2.7	14.1	12.7	3.4	0.72
Silver (Ag)	0.000005	0.000050	0.000011	0.000221	0.000199	0.000064	1.28
Sodium (Na)	1.0	1.7	1.6	2.8	2.6	0.5	0.29
Strontium (Sr)	0.14	0.29	0.32	0.37	0.37	0.07	0.24
Thallium (Tl)	0.00003	0.00005	0.00005	0.00010	0.00010	0.00002	0.43
Tin (Sn)	0.00006	0.00009	0.00009	0.00014	0.00014	0.00003	0.31
Uranium (U)	0.0002	0.0003	0.0004	0.0004	0.0004	0.0001	0.26
Vanadium (V)	0.0005	0.0068	0.0021	0.0340	0.0306	0.0092	1.35
Zinc (Zn)	0.0015	0.0342	0.0316	0.1077	0.0965	0.0260	0.76

Notes:

All measured values are in units of mg/L.

Grey highlighted values exceed BC chronic water quality guidelines; bold values exceed BC acute water quality guidelines.

For pH-dependent guidelines, pH was assumed to be > 6.5.

For total aluminum, italic values exceed CCME pH-dependent water quality guidelines.

Extensive mitigation for management of selenium is included in the Project design including segregation and covering of Kerr waste rock and an ion-exchange Selenium Treatment Plant. Total selenium concentrations, however, are predicted to be higher than BC water quality guidelines (0.002 mg/L) and baseline concentrations in Sulphurets Creek at site SC3 at times throughout the life of the Project. Total selenium concentrations are predicted to increase throughout the operation phase and range from 0.0016 to 0.0076 mg/L at site SC3.

Concentrations of some major ions, including sulphate and nitrate, are expected to increase in concentration in the receiving environment downstream of the Mine Site. No water quality guideline exceedances are predicted.

In the receiving environment, water quality predictions for the expected and upper case water model scenarios are only distinguishable for modelled parameters that are not effectively treated at the HDS WTP. In Sulphurets Creek (SC3), the maximum predicted selenium concentrations in the upper case model scenarios during the operation phase was 20% higher than in the expected case (0.0071 mg/L (scenario 1) versus 0.0085 mg/L (scenario 2; Table 7.3-2). Predicted mean variable case water balance simulation concentrations were typically less than 1% different from the base case water balance simulations (Tables 7.3-1 to 7.3-4).

7.3.2 Unuk River

This section presents water quality predictions in the Unuk River at site UR1 (downstream of Sulphurets Creek) and site UR2 (near the BC-Alaska border). Tables 7.3-5 to 7.3-8 present statistical summaries of water quality in the Unuk River for the four model scenarios for the construction, operation, closure, and post-closure phases.

Potential residual effects on water quality in the Unuk River were only assessed for selenium, given that no other residual effects are predicted upstream in Sulphurets Creek. Selenium concentrations in the Unuk River are predicted to increase throughout the operation phase and range from 0.001 to 0.003 mg/L at site UR1 and 0.001 to 0.002 mg/L at site UR2. Selenium concentrations at UR1 were predicted to be below water quality guidelines (HQ < 1.0) for the first 15 years of the operation phase; sporadic concentrations above 0.002 mg/L are within the uncertainty of the model. Selenium concentrations at UR2 were predicted to be below water quality guidelines (HQ < 1.0) throughout all Project phases. No residual effects are therefore predicted for water quality in the Unuk River in Alaska.

In the Unuk River, the maximum predicted selenium concentrations in model scenario 2 during the operation phase at site UR1 was 0.0041 mg/L (compared to 0.0034 in the expected case). At site UR2, the maximum predicted selenium concentration in model scenario 2 was 0.0023 mg/L (compared to 0.0017 in the expected case). Predicted mean variable case water balance simulation concentrations were typically within 2% of the base case water balance simulations (Tables 7.3-5 to 7.3-8).

Table 7.3-5. Summary Statistics of Water Quality Predictions for the Unuk River (site UR1; Construction Phase)

Scenario 1: Expected Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0189	0.0443	0.0439	0.0756	0.0730	0.0179	0.40
Chloride (Cl)	0.39	0.50	0.51	0.59	0.58	0.05	0.11
Fluoride (F)	0.03	0.05	0.05	0.06	0.06	0.01	0.25
Nitrate (as N)	0.39	0.63	0.63	0.85	0.85	0.12	0.19
Nitrite (as N)	0.0005	0.0006	0.0006	0.0006	0.0006	0.0000	0.08
Total Phosphate (as P)	0.02	0.09	0.05	0.48	0.47	0.12	1.33
Sulphate (SO_4)	28	56	64	81	81	19	0.35
Total Metals							
Aluminum (Al)	0.02	*1.80*	*0.47*	*11.78*	*11.78*	3.17	1.76
Antimony (Sb)	0.0009	0.0015	0.0014	0.0023	0.0023	0.0003	0.22
Arsenic (As)	0.0001	0.0023	0.0013	**0.0123**	**0.0123**	0.0033	1.42
Barium (Ba)	0.032	0.060	0.039	0.225	0.225	0.052	0.87
Beryllium (Be)	0.0001	0.0003	0.0002	0.0006	0.0006	0.0002	0.58
Boron (B)	0.005	0.006	0.006	0.009	0.009	0.001	0.15
Cadmium (Cd)	0.000005	**0.000231**	**0.000212**	**0.000702**	**0.000702**	0.000202	0.88
Calcium (Ca)	18.82	34.73	36.18	49.14	49.02	10.53	0.30
Chromium (Cr)	0.0004	**0.0030**	**0.0010**	**0.0185**	**0.0185**	0.0049	1.64
Cobalt (Co)	0.0001	0.0013	0.0006	0.0079	0.0079	0.0021	1.60
Copper (Cu)	0.0003	**0.0216**	**0.0143**	**0.0803**	**0.0803**	0.0237	1.10
Iron (Fe)	0.01	**2.97**	**1.41**	**19.25**	**19.25**	5.14	1.73
Lead (Pb)	0.00003	0.00161	0.00095	0.00807	0.00807	0.00216	1.34
Lithium (Li)	0.002	0.003	0.003	0.009	0.009	0.002	0.60
Magnesium (Mg)	2.61	4.25	4.14	8.30	8.30	1.40	0.33
Manganese (Mn)	0.00003	0.08237	0.05037	0.46287	0.46285	0.12156	1.48
Mercury (Hg)	0.000005	0.000010	0.000006	0.000050	0.000050	0.000012	1.17
Molybdenum (Mo)	0.001	0.002	0.002	0.003	0.003	0.000	0.21
Nickel (Ni)	0.001	0.003	0.002	0.017	0.017	0.004	1.35
Potassium (K)	0.86	1.32	1.06	3.62	3.62	0.71	0.54
Selenium (Se)	0.0008	0.0013	0.0014	0.0017	0.0017	0.0003	0.21
Silicon (Si)	2.01	4.98	2.73	22.40	22.40	5.50	1.11
Silver (Ag)	0.000005	0.000043	0.000010	**0.000270**	**0.000270**	0.000072	1.67
Sodium (Na)	1.07	1.75	1.78	2.59	2.59	0.58	0.33
Strontium (Sr)	0.13	0.25	0.26	0.34	0.34	0.07	0.27
Thallium (Tl)	0.00002	0.00005	0.00005	0.00015	0.00015	0.00003	0.62
Tin (Sn)	0.00006	0.00007	0.00006	0.00011	0.00011	0.00001	0.21
Uranium (U)	0.0001	0.0002	0.0002	0.0003	0.0003	0.0001	0.35
Vanadium (V)	0.0005	0.0078	0.0016	0.0531	0.0531	0.0143	1.84
Zinc (Zn)	0.0015	0.0221	0.0153	0.0601	0.0601	0.0191	0.86

(continued)

Table 7.3-5. Summary Statistics of Water Quality Predictions for the Unuk River (site UR1; Construction Phase) (continued)

Scenario 2							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0143	0.0091	0.0789	0.0464	0.0145	1.02
Chloride (Cl)	0.26	1.40	0.92	5.96	4.00	1.14	0.81
Fluoride (F)	0.03	0.05	0.05	0.06	0.06	0.01	0.22
Nitrate (as N)	0.01	0.20	0.12	0.90	0.60	0.17	0.87
Nitrite (as N)	0.0005	0.0005	0.0005	0.0006	0.0006	0.0000	0.04
Total Phosphate (as P)	0.00	0.08	0.04	0.50	0.48	0.13	1.59
Sulphate (SO_4)	24	74	75	100	96	15	0.20
Total Metals							
Aluminum (Al)	0.01	*1.80*	*0.37*	*12.64*	*11.93*	3.20	1.78
Antimony (Sb)	0.0009	0.0015	0.0015	0.0025	0.0023	0.0003	0.22
Arsenic (As)	0.0001	0.0023	0.0009	**0.0131**	**0.0124**	0.0033	1.42
Barium (Ba)	0.032	0.060	0.040	0.241	0.228	0.053	0.87
Beryllium (Be)	0.0001	0.0003	0.0002	0.0009	0.0006	0.0002	0.62
Boron (B)	0.005	0.006	0.006	0.009	0.009	0.001	0.16
Cadmium (Cd)	0.000005	**0.000232**	**0.000220**	**0.000728**	**0.000720**	0.000204	0.88
Calcium (Ca)	18.55	35.37	39.38	50.58	48.83	9.45	0.27
Chromium (Cr)	0.0002	**0.0029**	0.0006	**0.0198**	**0.0188**	0.0050	1.70
Cobalt (Co)	0.0001	0.0013	0.0005	0.0085	0.0080	0.0021	1.61
Copper (Cu)	0.0003	**0.0217**	0.0091	**0.0836**	**0.0828**	0.0239	1.10
Iron (Fe)	0.01	**2.98**	**1.23**	**20.65**	**19.50**	5.19	1.74
Lead (Pb)	0.00003	0.00161	0.00072	0.00866	0.00818	0.00218	1.36
Lithium (Li)	0.001	0.003	0.003	0.009	0.009	0.002	0.63
Magnesium (Mg)	2.55	4.33	4.20	8.72	8.37	1.43	0.33
Manganese (Mn)	0.00003	0.08266	0.04821	0.49659	0.46888	0.12261	1.48
Mercury (Hg)	0.000005	0.000010	0.000005	0.000053	0.000050	0.000012	1.18
Molybdenum (Mo)	0.001	0.002	0.002	0.003	0.003	0.000	0.15
Nickel (Ni)	0.001	0.003	0.002	0.018	0.017	0.004	1.38
Potassium (K)	0.81	1.32	1.07	3.83	3.65	0.73	0.55
Selenium (Se)	0.0007	0.0020	0.0018	**0.0033**	**0.0029**	0.0005	0.27
Silicon (Si)	2.01	5.02	2.54	23.97	22.69	5.54	1.10
Silver (Ag)	0.000005	0.000043	0.000009	**0.000289**	**0.000273**	0.000073	1.69
Sodium (Na)	1.00	1.73	1.73	2.59	2.51	0.54	0.31
Strontium (Sr)	0.13	0.24	0.26	0.34	0.32	0.05	0.22
Thallium (Tl)	0.00002	0.00005	0.00005	0.00015	0.00015	0.00003	0.62
Tin (Sn)	0.00005	0.00007	0.00006	0.00011	0.00011	0.00002	0.26
Uranium (U)	0.0001	0.0002	0.0002	0.0003	0.0003	0.0001	0.36
Vanadium (V)	0.0005	0.0078	0.0011	0.0569	0.0538	0.0144	1.86
Zinc (Zn)	0.0015	0.0223	0.0156	0.0643	0.0608	0.0192	0.86

(continued)

Table 7.3-5. Summary Statistics of Water Quality Predictions for the Unuk River (site UR1; Construction Phase) (continued)

Scenario 3							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0168	0.0103	0.1069	0.0587	0.0183	1.09
Chloride (Cl)	0.25	0.72	0.51	3.05	1.88	0.50	0.70
Fluoride (F)	0.03	0.05	0.05	0.07	0.06	0.01	0.22
Nitrate (as N)	0.01	0.19	0.12	0.95	0.59	0.17	0.91
Nitrite (as N)	0.0005	0.0005	0.0005	0.0006	0.0006	0.0000	0.04
Total Phosphate (as P)	0.00	0.08	0.04	0.51	0.48	0.13	1.61
Sulphate (SO_4)	24	70	71	**100**	93	15	0.22
Total Metals							
Aluminum (Al)	0.01	*1.81*	*0.37*	*12.71*	*11.98*	3.22	1.78
Antimony (Sb)	0.0009	0.0015	0.0015	0.0025	0.0024	0.0003	0.22
Arsenic (As)	0.0001	0.0023	0.0009	**0.0132**	**0.0125**	0.0033	1.42
Barium (Ba)	0.032	0.060	0.040	0.242	0.229	0.053	0.88
Beryllium (Be)	0.0001	0.0003	0.0002	0.0010	0.0006	0.0002	0.61
Boron (B)	0.005	0.006	0.006	0.009	0.009	0.001	0.16
Cadmium (Cd)	0.000005	**0.000232**	**0.000220**	**0.000730**	**0.000721**	0.000	0.88
Calcium (Ca)	18.49	34.92	39.22	51.14	48.19	9.55	0.27
Chromium (Cr)	0.0002	**0.0029**	0.0006	**0.0200**	**0.0189**	0.0050	1.70
Cobalt (Co)	0.0001	0.0013	0.0005	0.0086	0.0081	0.002	1.61
Copper (Cu)	0.0003	**0.0218**	0.0092	**0.0840**	**0.0829**	0.02	1.10
Iron (Fe)	0.01	**2.99**	**1.24**	**20.76**	**19.59**	5.22	1.74
Lead (Pb)	0.00003	0.00162	0.00072	0.00871	0.00821	0.002	1.36
Lithium (Li)	0.001	0.003	0.003	0.009	0.009	0.002	0.63
Magnesium (Mg)	2.54	4.33	4.18	8.75	8.40	1.44	0.33
Manganese (Mn)	0.00003	0.08303	0.04828	0.49921	0.47087	0.12	1.48
Mercury (Hg)	0.000005	0.000011	0.000005	0.000053	0.000051	0.000012	1.18
Molybdenum (Mo)	0.001	0.002	0.002	0.003	0.003	0.000	0.15
Nickel (Ni)	0.001	0.003	0.002	0.018	0.017	0.004	1.38
Potassium (K)	0.81	1.32	1.07	3.86	3.67	0.73	0.55
Selenium (Se)	0.0007	0.0017	0.0016	**0.0029**	**0.0024**	0.0004	0.24
Silicon (Si)	2.01	5.04	2.54	24.09	22.78	5.57	1.11
Silver (Ag)	0.000005	0.000043	0.000009	**0.000290**	**0.000274**	0.000073	1.69
Sodium (Na)	1.00	1.73	1.73	2.61	2.51	0.54	0.31
Strontium (Sr)	0.13	0.24	0.26	0.34	0.32	0.05	0.22
Thallium (Tl)	0.00002	0.00005	0.00005	0.00015	0.00015	0.00003	0.63
Tin (Sn)	0.00005	0.00007	0.00006	0.00011	0.00011	0.00002	0.27
Uranium (U)	0.0001	0.0002	0.0002	0.0003	0.0003	0.0001	0.37
Vanadium (V)	0.0005	0.0078	0.0011	0.0572	0.0540	0.0145	1.86
Zinc (Zn)	0.0015	0.0224	0.0155	0.0646	0.0611	0.0193	0.86

(continued)

Table 7.3-5. Summary Statistics of Water Quality Predictions for the Unuk River (site UR1; Construction Phase) (completed)

Scenario 4: Upper Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0168	0.0103	0.1069	0.0587	0.0183	1.09
Chloride (Cl)	0.26	1.39	0.89	6.52	3.96	1.16	0.84
Fluoride (F)	0.03	0.05	0.05	0.07	0.06	0.01	0.22
Nitrate (as N)	0.01	0.19	0.12	0.95	0.59	0.17	0.91
Nitrite (as N)	0.0005	0.0005	0.0005	0.0006	0.0006	0.0000	0.04
Total Phosphate (as P)	0.00	0.08	0.04	0.51	0.48	0.13	1.61
Sulphate (SO_4)	24	73	73	**103**	95	16	0.21
Total Metals							
Aluminum (Al)	0.01	*1.81*	*0.37*	*12.71*	*11.98*	3.22	1.78
Antimony (Sb)	0.0009	0.0015	0.0015	0.0025	0.0024	0.0003	0.22
Arsenic (As)	0.0001	0.0023	0.0009	**0.0132**	**0.0125**	0.0033	1.42
Barium (Ba)	0.032	0.060	0.040	0.242	0.229	0.053	0.88
Beryllium (Be)	0.0001	0.0003	0.0002	0.0010	0.0006	0.0002	0.61
Boron (B)	0.005	0.006	0.006	0.009	0.009	0.001	0.16
Cadmium (Cd)	0.000	**0.000**	**0.000**	**0.001**	**0.001**	0.000	0.88
Calcium (Ca)	18.52	35.31	39.38	51.19	48.70	9.57	0.27
Chromium (Cr)	0.0002	**0.0029**	0.0006	**0.0200**	**0.0189**	0.0050	1.70
Cobalt (Co)	0.000	0.001	0.001	0.009	0.008	0.002	1.61
Copper (Cu)	0.00	**0.02**	0.01	**0.08**	**0.08**	0.02	1.10
Iron (Fe)	0.01	**2.99**	**1.24**	**20.76**	**19.59**	5.22	1.74
Lead (Pb)	0.00003	0.00162	0.00072	0.00871	0.00821	0.002	1.36
Lithium (Li)	0.001	0.003	0.003	0.009	0.009	0.002	0.63
Magnesium (Mg)	2.54	4.33	4.18	8.75	8.40	1.44	0.33
Manganese (Mn)	0.00	0.08	0.05	0.50	0.47	0.12	1.48
Mercury (Hg)	0.000005	0.000011	0.000005	0.000053	0.000051	0.000012	1.18
Molybdenum (Mo)	0.001	0.002	0.002	0.003	0.003	0.000	0.15
Nickel (Ni)	0.001	0.003	0.002	0.018	0.017	0.004	1.38
Potassium (K)	0.81	1.32	1.07	3.86	3.67	0.73	0.55
Selenium (Se)	0.0007	0.0019	0.0018	**0.0036**	**0.0029**	0.0006	0.30
Silicon (Si)	2.01	5.04	2.54	24.09	22.78	5.57	1.11
Silver (Ag)	0.000005	0.000043	0.000009	**0.000290**	**0.000274**	0.000073	1.69
Sodium (Na)	1.00	1.73	1.73	2.61	2.51	0.54	0.31
Strontium (Sr)	0.13	0.24	0.26	0.34	0.32	0.05	0.22
Thallium (Tl)	0.00002	0.00005	0.00005	0.00015	0.00015	0.00003	0.63
Tin (Sn)	0.00005	0.00007	0.00006	0.00011	0.00011	0.00002	0.27
Uranium (U)	0.0001	0.0002	0.0002	0.0003	0.0003	0.0001	0.37
Vanadium (V)	0.0005	0.0078	0.0011	0.0572	0.0540	0.0145	1.86
Zinc (Zn)	0.00	0.02	0.02	0.06	0.06	0.02	0.86

Notes:

All measured values are in units of mg/L.

Grey highlighted values exceed BC chronic water quality guidelines; bold values exceed BC acute water quality guidelines.

For pH-dependent guidelines, pH was assumed to be > 6.5.

For total aluminum, italic values exceed CCME pH-dependent water quality guidelines.

Table 7.3-6. Summary Statistics of Water Quality Predictions for the Unuk River (site UR1;Operation Phase)

Scenario 1: Expected Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0165	0.0102	0.1102	0.0588	0.0182	1.10
Chloride (Cl)	0.25	0.73	0.50	2.91	1.78	0.51	0.70
Fluoride (F)	0.03	0.05	0.05	0.06	0.06	0.01	0.22
Nitrate (as N)	0.01	0.22	0.13	0.97	0.64	0.20	0.89
Nitrite (as N)	0.0005	0.0005	0.0005	0.0006	0.0006	0.0000	0.04
Total Phosphate (as P)	0.00	0.08	0.03	0.48	0.47	0.12	1.59
Sulphate (SO_4)	24	71	72	95	92	14	0.20
Total Metals							
Aluminum (Al)	0.01	*1.79*	*0.37*	*11.97*	*11.93*	3.17	1.77
Antimony (Sb)	0.0009	0.0015	0.0015	0.0024	0.0023	0.0003	0.22
Arsenic (As)	0.0001	0.0023	0.0008	**0.0125**	**0.0124**	0.0033	1.42
Barium (Ba)	0.032	0.060	0.039	0.229	0.228	0.052	0.87
Beryllium (Be)	0.0001	0.0003	0.0002	0.0006	0.0006	0.0002	0.58
Boron (B)	0.005	0.006	0.006	0.009	0.009	0.001	0.16
Cadmium (Cd)	0.000005	**0.000231**	**0.000207**	**0.000727**	**0.000719**	0.000204	0.88
Calcium (Ca)	18.71	34.94	39.26	49.54	47.99	9.30	0.27
Chromium (Cr)	0.0002	**0.0029**	0.0006	**0.0188**	**0.0188**	0.0049	1.69
Cobalt (Co)	0.0001	0.0013	0.0005	0.0081	0.0080	0.0021	1.60
Copper (Cu)	0.0003	**0.0217**	0.0091	**0.0835**	**0.0828**	0.0239	1.10
Iron (Fe)	0.01	**2.96**	**1.19**	**19.56**	**19.50**	5.14	1.73
Lead (Pb)	0.00003	0.00160	0.00070	0.00820	0.00817	0.00216	1.35
Lithium (Li)	0.001	0.003	0.003	0.009	0.009	0.002	0.62
Magnesium (Mg)	2.55	4.32	4.20	8.39	8.37	1.42	0.33
Manganese (Mn)	0.00003	0.08234	0.04762	0.47027	0.46881	0.12140	1.47
Mercury (Hg)	0.000005	0.000010	0.000005	0.000051	0.000050	0.000012	1.17
Molybdenum (Mo)	0.001	0.002	0.002	0.003	0.003	0.000	0.15
Nickel (Ni)	0.001	0.003	0.001	0.017	0.017	0.004	1.37
Potassium (K)	0.81	1.31	1.07	3.66	3.65	0.72	0.55
Selenium (Se)	0.0008	**0.0020**	0.0019	**0.0034**	**0.0029**	0.0005	0.25
Silicon (Si)	2.01	5.01	2.54	22.75	22.68	5.48	1.09
Silver (Ag)	0.000005	0.000043	0.000009	**0.000274**	**0.000273**	0.000072	1.68
Sodium (Na)	1.00	1.73	1.73	2.59	2.50	0.54	0.31
Strontium (Sr)	0.13	0.24	0.26	0.34	0.32	0.05	0.22
Thallium (Tl)	0.00002	0.00005	0.00005	0.00015	0.00015	0.00003	0.62
Tin (Sn)	0.00005	0.00007	0.00006	0.00011	0.00011	0.00002	0.26
Uranium (U)	0.0001	0.0002	0.0002	0.0003	0.0003	0.0001	0.36
Vanadium (V)	0.0005	0.0077	0.0011	0.0539	0.0538	0.0143	1.85
Zinc (Zn)	0.0015	0.0223	0.0150	0.0610	0.0608	0.0191	0.86

(continued)

Table 7.3-6. Summary Statistics of Water Quality Predictions for the Unuk River (site UR1; Operation Phase) (continued)

Scenario 2							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0165	0.0102	0.1102	0.0588	0.0182	1.10
Chloride (Cl)	0.25	1.41	0.93	6.24	3.80	1.16	0.82
Fluoride (F)	0.03	0.05	0.05	0.06	0.06	0.01	0.22
Nitrate (as N)	0.01	0.22	0.13	0.97	0.64	0.20	0.89
Nitrite (as N)	0.0005	0.0005	0.0005	0.0006	0.0006	0.0000	0.04
Total Phosphate (as P)	0.00	0.08	0.03	0.48	0.47	0.12	1.59
Sulphate (SO_4)	25	74	76	95	94	14	0.19
Total Metals							
Aluminum (Al)	0.01	*1.79*	*0.37*	*11.97*	*11.93*	3.17	1.77
Antimony (Sb)	0.0009	0.0015	0.0015	0.0024	0.0023	0.0003	0.22
Arsenic (As)	0.0001	0.0023	0.0008	**0.0125**	**0.0124**	0.0033	1.42
Barium (Ba)	0.032	0.060	0.039	0.229	0.228	0.052	0.87
Beryllium (Be)	0.0001	0.0003	0.0002	0.0006	0.0006	0.0002	0.58
Boron (B)	0.005	0.006	0.006	0.009	0.009	0.001	0.16
Cadmium (Cd)	0.000005	**0.000231**	**0.000207**	**0.000727**	**0.000719**	0.000204	0.88
Calcium (Ca)	18.77	35.37	39.45	49.66	48.37	9.30	0.26
Chromium (Cr)	0.0002	**0.0029**	0.0006	**0.0188**	**0.0188**	0.0049	1.69
Cobalt (Co)	0.0001	0.0013	0.0005	0.0081	0.0080	0.0021	1.60
Copper (Cu)	0.0003	**0.0217**	0.0091	**0.0836**	**0.0828**	0.0239	1.10
Iron (Fe)	0.01	**2.96**	**1.19**	**19.56**	**19.50**	5.14	1.73
Lead (Pb)	0.00003	0.00160	0.00070	0.00820	0.00817	0.00216	1.35
Lithium (Li)	0.001	0.003	0.003	0.009	0.009	0.002	0.62
Magnesium (Mg)	2.55	4.32	4.20	8.39	8.37	1.42	0.33
Manganese (Mn)	0.00003	0.08235	0.04763	0.47027	0.46881	0.12140	1.47
Mercury (Hg)	0.000005	0.000010	0.000005	0.000051	0.000050	0.000012	1.17
Molybdenum (Mo)	0.001	0.002	0.002	0.003	0.003	0.000	0.15
Nickel (Ni)	0.001	0.003	0.001	0.017	0.017	0.004	1.37
Potassium (K)	0.81	1.31	1.07	3.66	3.65	0.72	0.55
Selenium (Se)	0.0008	**0.0023**	**0.0022**	**0.0041**	**0.0035**	0.0007	0.30
Silicon (Si)	2.01	5.01	2.54	22.75	22.68	5.48	1.09
Silver (Ag)	0.000005	0.000043	0.000009	**0.000274**	**0.000273**	0.000072	1.68
Sodium (Na)	1.00	1.73	1.73	2.59	2.50	0.54	0.31
Strontium (Sr)	0.13	0.24	0.26	0.34	0.32	0.05	0.22
Thallium (Tl)	0.00002	0.00005	0.00005	0.00015	0.00015	0.00003	0.62
Tin (Sn)	0.00005	0.00007	0.00006	0.00011	0.00011	0.00002	0.26
Uranium (U)	0.0001	0.0002	0.0002	0.0003	0.0003	0.0001	0.36
Vanadium (V)	0.0005	0.0077	0.0011	0.0539	0.0538	0.0143	1.85
Zinc (Zn)	0.0015	0.0223	0.0150	0.0610	0.0608	0.0191	0.86

(continued)

Table 7.3-6. Summary Statistics of Water Quality Predictions for the Unuk River (site UR1; Operation Phase) (continued)

Scenario 3							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0138	0.0071	0.1321	0.0514	0.0175	1.27
Chloride (Cl)	0.25	0.76	0.51	2.33	1.81	0.52	0.69
Fluoride (F)	0.03	0.05	0.05	0.06	0.06	0.01	0.21
Nitrate (as N)	0.01	0.22	0.13	1.19	0.65	0.20	0.90
Nitrite (as N)	0.0005	0.0005	0.0005	0.0006	0.0005	0.0000	0.03
Total Phosphate (as P)	0.00	0.08	0.02	0.48	0.47	0.13	1.62
Sulphate (SO_4)	25	70	70	**101**	89	13	0.18
Total Metals							
Aluminum (Al)	0.01	*1.79*	*0.37*	*11.88*	*11.84*	3.15	1.76
Antimony (Sb)	0.0009	0.0015	0.0015	0.0023	0.0023	0.0003	0.21
Arsenic (As)	0.0001	0.0023	0.0008	**0.0124**	**0.0123**	0.0033	1.41
Barium (Ba)	0.033	0.060	0.039	0.227	0.227	0.052	0.86
Beryllium (Be)	0.0001	0.0003	0.0002	0.0006	0.0006	0.0002	0.58
Boron (B)	0.005	0.006	0.006	0.009	0.009	0.001	0.16
Cadmium (Cd)	0.000005	**0.000231**	**0.000207**	**0.000725**	**0.000722**	0.000205	0.89
Calcium (Ca)	18.73	34.91	39.07	48.38	47.81	9.12	0.26
Chromium (Cr)	0.0002	**0.0029**	0.0004	**0.0187**	**0.0187**	0.0049	1.70
Cobalt (Co)	0.0001	0.0013	0.0005	0.0080	0.0080	0.0021	1.60
Copper (Cu)	0.0003	**0.0217**	0.0090	**0.0836**	**0.0831**	0.0240	1.10
Iron (Fe)	0.01	**2.96**	**1.17**	**19.43**	**19.36**	5.10	1.73
Lead (Pb)	0.00003	0.00160	0.00071	0.00814	0.00812	0.00215	1.34
Lithium (Li)	0.001	0.003	0.003	0.009	0.009	0.002	0.63
Magnesium (Mg)	2.59	4.33	4.30	8.34	8.31	1.41	0.33
Manganese (Mn)	0.00003	0.08222	0.04748	0.46698	0.46540	0.12064	1.47
Mercury (Hg)	0.000005	0.000010	0.000005	0.000050	0.000050	0.000012	1.17
Molybdenum (Mo)	0.001	0.002	0.002	0.003	0.003	0.000	0.15
Nickel (Ni)	0.001	0.003	0.001	0.017	0.017	0.004	1.37
Potassium (K)	0.82	1.31	1.06	3.65	3.64	0.72	0.55
Selenium (Se)	0.0008	**0.0020**	0.0019	**0.0033**	**0.0030**	0.0005	0.26
Silicon (Si)	2.09	5.00	2.53	22.60	22.52	5.44	1.09
Silver (Ag)	0.000005	0.000043	0.000008	0.000272	0.000271	0.000072	1.68
Sodium (Na)	1.00	1.72	1.71	2.51	2.50	0.54	0.31
Strontium (Sr)	0.13	0.24	0.25	0.32	0.31	0.05	0.22
Thallium (Tl)	0.00002	0.00005	0.00005	0.00015	0.00015	0.00003	0.61
Tin (Sn)	0.00005	0.00006	0.00006	0.00011	0.00011	0.00002	0.27
Uranium (U)	0.0001	0.0002	0.0002	0.0003	0.0003	0.0001	0.36
Vanadium (V)	0.0005	0.0077	0.0010	0.0536	0.0534	0.0142	1.84
Zinc (Zn)	0.0015	0.0223	0.0151	0.0606	0.0604	0.0191	0.86

(continued)

Table 7.3-6. Summary Statistics of Water Quality Predictions for the Unuk River (site UR1; Operation Phase) (completed)

Scenario 4: Upper Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0138	0.0071	0.1321	0.0514	0.0175	1.27
Chloride (Cl)	0.25	1.49	0.94	4.93	3.83	1.19	0.80
Fluoride (F)	0.03	0.05	0.05	0.06	0.06	0.01	0.21
Nitrate (as N)	0.01	0.22	0.13	1.19	0.65	0.20	0.90
Nitrite (as N)	0.0005	0.0005	0.0005	0.0006	0.0005	0.0000	0.03
Total Phosphate (as P)	0.00	0.08	0.02	0.48	0.47	0.13	1.62
Sulphate (SO_4)	26	73	74	**101**	95	12	0.17
Total Metals							
Aluminum (Al)	0.01	*1.79*	*0.37*	*11.88*	*11.84*	3.15	1.76
Antimony (Sb)	0.0009	0.0015	0.0015	0.0023	0.0023	0.0003	0.21
Arsenic (As)	0.0001	0.0023	0.0008	**0.0124**	**0.0123**	0.0033	1.41
Barium (Ba)	0.033	0.060	0.039	0.227	0.227	0.052	0.86
Beryllium (Be)	0.0001	0.0003	0.0002	0.0006	0.0006	0.0002	0.57
Boron (B)	0.005	0.006	0.006	0.009	0.009	0.001	0.16
Cadmium (Cd)	0.000005	**0.000231**	**0.000207**	**0.000725**	**0.000722**	0.000205	0.89
Calcium (Ca)	18.80	35.36	39.29	49.57	47.99	9.11	0.26
Chromium (Cr)	0.0002	**0.0029**	0.0004	**0.0187**	**0.0187**	0.0049	1.70
Cobalt (Co)	0.0001	0.0013	0.0005	0.0080	0.0080	0.0021	1.60
Copper (Cu)	0.0003	**0.0217**	0.0090	**0.0836**	**0.0831**	0.0240	1.10
Iron (Fe)	0.01	**2.96**	**1.17**	**19.43**	**19.36**	5.10	1.73
Lead (Pb)	0.00003	0.00160	0.00071	0.00814	0.00812	0.00215	1.34
Lithium (Li)	0.001	0.003	0.003	0.009	0.009	0.002	0.63
Magnesium (Mg)	2.59	4.33	4.30	8.34	8.31	1.41	0.33
Manganese (Mn)	0.00003	0.08223	0.04749	0.46698	0.46540	0.12064	1.47
Mercury (Hg)	0.000005	0.000010	0.000005	0.000050	0.000050	0.000012	1.17
Molybdenum (Mo)	0.001	0.002	0.002	0.003	0.003	0.000	0.15
Nickel (Ni)	0.001	0.003	0.001	0.017	0.017	0.004	1.37
Potassium (K)	0.82	1.31	1.06	3.65	3.64	0.72	0.55
Selenium (Se)	0.0008	**0.0024**	**0.0023**	**0.0040**	**0.0035**	0.0007	0.30
Silicon (Si)	2.09	5.00	2.53	22.60	22.52	5.44	1.09
Silver (Ag)	0.000005	0.000043	0.000008	**0.000272**	**0.000271**	0.000072	1.68
Sodium (Na)	1.00	1.72	1.71	2.51	2.50	0.54	0.31
Strontium (Sr)	0.14	0.24	0.25	0.32	0.31	0.05	0.22
Thallium (Tl)	0.00002	0.00005	0.00005	0.00015	0.00015	0.00003	0.61
Tin (Sn)	0.00005	0.00006	0.00006	0.00011	0.00011	0.00002	0.27
Uranium (U)	0.0001	0.0002	0.0002	0.0003	0.0003	0.0001	0.36
Vanadium (V)	0.0005	0.0077	0.0010	0.0536	0.0534	0.0142	1.84
Zinc (Zn)	0.0015	0.0223	0.0151	0.0606	0.0604	0.0191	0.86

Notes:

All measured values are in units of mg/L.

Grey highlighted values exceed BC chronic water quality guidelines; bold values exceed BC acute water quality guidelines.

For pH-dependent guidelines, pH was assumed to be > 6.5.

For total aluminum, italic values exceed CCME pH-dependent water quality guidelines.

Table 7.3-7. Summary Statistics of Water Quality Predictions for the Unuk River (site UR1; Closure Phase)

Scenario 1: Expected Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0034	0.0025	0.0074	0.0074	0.0017	0.49
Chloride (Cl)	0.40	1.06	0.92	2.74	2.30	0.51	0.48
Fluoride (F)	0.03	0.04	0.05	0.06	0.06	0.01	0.24
Nitrate (as N)	0.01	0.07	0.08	0.12	0.12	0.03	0.46
Nitrite (as N)	0.0005	0.0005	0.0005	0.0005	0.0005	0.0000	0.01
Total Phosphate (as P)	0.00	0.07	0.02	0.50	0.50	0.13	1.78
Sulphate (SO_4)	35	65	64	87	87	14	0.21
Total Metals							
Aluminum (Al)	0.01	*1.91*	*0.49*	*12.76*	*12.75*	3.42	1.79
Antimony (Sb)	0.0009	0.0015	0.0015	0.0025	0.0025	0.0003	0.23
Arsenic (As)	0.0001	0.0024	0.0014	**0.0132**	**0.0132**	0.0035	1.44
Barium (Ba)	0.033	0.062	0.040	0.242	0.242	0.056	0.90
Beryllium (Be)	0.0001	0.0002	0.0002	0.0006	0.0004	0.0001	0.49
Boron (B)	0.005	0.006	0.005	0.008	0.008	0.001	0.16
Cadmium (Cd)	0.000005	**0.000234**	**0.000214**	**0.000738**	**0.000738**	0.000214	0.91
Calcium (Ca)	20.53	34.99	35.64	48.73	48.70	9.10	0.26
Chromium (Cr)	0.0002	**0.0030**	0.0008	**0.0200**	**0.0200**	0.0053	1.74
Cobalt (Co)	0.0001	0.0014	0.0006	0.0086	0.0086	0.0023	1.64
Copper (Cu)	0.0003	**0.0228**	**0.0152**	**0.0861**	**0.0861**	0.0250	1.10
Iron (Fe)	0.01	**3.16**	**1.52**	**20.86**	**20.86**	5.54	1.75
Lead (Pb)	0.00003	0.00169	0.00099	0.00872	0.00872	0.00232	1.37
Lithium (Li)	0.001	0.003	0.003	0.009	0.009	0.002	0.67
Magnesium (Mg)	2.64	4.42	4.28	8.85	8.85	1.52	0.34
Manganese (Mn)	0.00003	0.08674	0.05275	0.50097	0.50092	0.13089	1.51
Mercury (Hg)	0.000005	0.000011	0.000006	0.000054	0.000054	0.000013	1.22
Molybdenum (Mo)	0.001	0.002	0.002	0.002	0.002	0.000	0.13
Nickel (Ni)	0.001	0.003	0.002	0.018	0.018	0.005	1.44
Potassium (K)	0.83	1.34	1.06	3.84	3.84	0.77	0.58
Selenium (Se)	0.0011	0.0020	0.0019	**0.0031**	**0.0028**	0.0005	0.23
Silicon (Si)	2.10	5.24	2.88	24.21	24.21	5.93	1.13
Silver (Ag)	0.000005	0.000045	0.000009	**0.000291**	**0.000291**	0.000078	1.72
Sodium (Na)	1.00	1.72	1.70	2.53	2.53	0.57	0.33
Strontium (Sr)	0.14	0.23	0.23	0.32	0.32	0.05	0.23
Thallium (Tl)	0.00002	0.00005	0.00005	0.00016	0.00016	0.00003	0.65
Tin (Sn)	0.00005	0.00006	0.00005	0.00010	0.00010	0.00002	0.28
Uranium (U)	0.0001	0.0002	0.0002	0.0004	0.0004	0.0001	0.39
Vanadium (V)	0.0005	0.0082	0.0016	0.0575	0.0574	0.0154	1.87
Zinc (Zn)	0.0015	0.0231	0.0160	0.0649	0.0649	0.0204	0.88

(continued)

Table 7.3-7. Summary Statistics of Water Quality Predictions for the Unuk River (site UR1; Closure Phase) (continued)

Scenario 2							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0034	0.0025	0.0074	0.0074	0.0017	0.49
Chloride (Cl)	0.60	2.18	1.85	6.23	5.17	1.22	0.56
Fluoride (F)	0.03	0.04	0.05	0.06	0.06	0.01	0.24
Nitrate (as N)	0.01	0.07	0.08	0.12	0.12	0.03	0.46
Nitrite (as N)	0.0005	0.0005	0.0005	0.0005	0.0005	0.0000	0.01
Total Phosphate (as P)	0.00	0.07	0.02	0.50	0.50	0.13	1.78
Sulphate (SO_4)	35	65	64	87	87	14	0.21
Total Metals							
Aluminum (Al)	0.01	*1.91*	*0.49*	*12.76*	*12.75*	3.42	1.79
Antimony (Sb)	0.0009	0.0015	0.0015	0.0025	0.0025	0.0003	0.23
Arsenic (As)	0.0001	0.0024	0.0014	**0.0132**	**0.0132**	0.0035	1.44
Barium (Ba)	0.033	0.062	0.040	0.242	0.242	0.056	0.90
Beryllium (Be)	0.0001	0.0002	0.0002	0.0006	0.0004	0.0001	0.49
Boron (B)	0.005	0.006	0.005	0.008	0.008	0.001	0.16
Cadmium (Cd)	0.000005	**0.000234**	**0.000214**	**0.000738**	**0.000738**	0.000214	0.91
Calcium (Ca)	20.65	35.08	35.68	48.82	48.79	9.06	0.26
Chromium (Cr)	0.0002	**0.0030**	0.0008	**0.0200**	**0.0200**	0.0053	1.74
Cobalt (Co)	0.0001	0.0014	0.0006	0.0086	0.0086	0.0023	1.64
Copper (Cu)	0.0003	**0.0228**	**0.0152**	**0.0861**	**0.0861**	0.0250	1.10
Iron (Fe)	0.01	**3.16**	**1.52**	**20.86**	**20.86**	5.54	1.75
Lead (Pb)	0.00003	0.00169	0.00099	0.00872	0.00872	0.00232	1.37
Lithium (Li)	0.001	0.003	0.003	0.009	0.009	0.002	0.67
Magnesium (Mg)	2.64	4.42	4.28	8.85	8.85	1.52	0.34
Manganese (Mn)	0.00003	0.08674	0.05276	0.50097	0.50092	0.13089	1.51
Mercury (Hg)	0.000005	0.000011	0.000006	0.000054	0.000054	0.000013	1.22
Molybdenum (Mo)	0.001	0.002	0.002	0.002	0.002	0.000	0.13
Nickel (Ni)	0.001	0.003	0.002	0.018	0.018	0.005	1.44
Potassium (K)	0.83	1.34	1.06	3.84	3.84	0.77	0.58
Selenium (Se)	0.0011	**0.0021**	0.0020	**0.0036**	**0.0032**	0.0006	0.26
Silicon (Si)	2.11	5.24	2.88	24.21	24.21	5.93	1.13
Silver (Ag)	0.000005	0.000045	0.000009	**0.000291**	**0.000291**	0.000078	1.72
Sodium (Na)	1.00	1.72	1.70	2.53	2.53	0.57	0.33
Strontium (Sr)	0.14	0.23	0.23	0.32	0.32	0.05	0.23
Thallium (Tl)	0.00002	0.00005	0.00005	0.00016	0.00016	0.00003	0.65
Tin (Sn)	0.00005	0.00006	0.00005	0.00010	0.00010	0.00002	0.28
Uranium (U)	0.0001	0.0002	0.0002	0.0004	0.0004	0.0001	0.38
Vanadium (V)	0.0005	0.0082	0.0016	0.0575	0.0574	0.0154	1.87
Zinc (Zn)	0.0015	0.0231	0.0160	0.0649	0.0649	0.0204	0.88

(continued)

Table 7.3-7. Summary Statistics of Water Quality Predictions for the Unuk River (site UR1; Closure Phase) (continued)

Scenario 3							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0034	0.0025	0.0073	0.0073	0.0016	0.48
Chloride (Cl)	0.68	1.27	1.26	1.99	1.91	0.47	0.37
Fluoride (F)	0.03	0.04	0.04	0.06	0.06	0.01	0.24
Nitrate (as N)	0.01	0.07	0.08	0.12	0.12	0.03	0.46
Nitrite (as N)	0.0005	0.0005	0.0005	0.0005	0.0005	0.0000	0.01
Total Phosphate (as P)	0.00	0.07	0.02	0.50	0.49	0.13	1.77
Sulphate (SO_4)	49	65	65	75	74	7	0.11
Total Metals							
Aluminum (Al)	0.01	*1.89*	*0.49*	*12.56*	*12.56*	3.36	1.78
Antimony (Sb)	0.0009	0.0015	0.0015	0.0024	0.0024	0.0003	0.22
Arsenic (As)	0.0001	0.0024	0.0014	**0.0130**	**0.0130**	0.0035	1.42
Barium (Ba)	0.033	0.062	0.040	0.239	0.239	0.055	0.89
Beryllium (Be)	0.0001	0.0002	0.0002	0.0006	0.0004	0.0001	0.49
Boron (B)	0.005	0.006	0.005	0.009	0.009	0.001	0.17
Cadmium (Cd)	0.000005	**0.000234**	**0.000214**	**0.000736**	**0.000736**	0.000213	0.91
Calcium (Ca)	20.82	35.06	36.62	47.91	47.83	8.91	0.25
Chromium (Cr)	0.0002	**0.0030**	0.0009	**0.0197**	**0.0197**	0.0052	1.74
Cobalt (Co)	0.0001	0.0014	0.0006	0.0085	0.0085	0.0022	1.63
Copper (Cu)	0.0003	**0.0227**	**0.0150**	**0.0859**	**0.0859**	0.0250	1.10
Iron (Fe)	0.01	**3.14**	**1.50**	**20.54**	**20.53**	5.44	1.74
Lead (Pb)	0.00003	0.00168	0.00099	0.00859	0.00859	0.00229	1.36
Lithium (Li)	0.001	0.003	0.003	0.009	0.009	0.002	0.67
Magnesium (Mg)	2.67	4.42	4.27	8.73	8.72	1.49	0.34
Manganese (Mn)	0.00003	0.08612	0.05249	0.49328	0.49311	0.12869	1.49
Mercury (Hg)	0.000005	0.000011	0.000006	0.000053	0.000053	0.000013	1.21
Molybdenum (Mo)	0.001	0.002	0.002	0.002	0.002	0.000	0.17
Nickel (Ni)	0.001	0.003	0.002	0.018	0.018	0.005	1.43
Potassium (K)	0.83	1.34	1.06	3.81	3.81	0.76	0.57
Selenium (Se)	0.0016	**0.0020**	**0.0021**	**0.0028**	**0.0027**	0.0004	0.18
Silicon (Si)	2.13	5.22	2.84	23.84	23.83	5.82	1.11
Silver (Ag)	0.000005	0.000045	0.000009	0.000287	0.000287	0.000076	1.70
Sodium (Na)	1.00	1.71	1.71	2.52	2.52	0.57	0.33
Strontium (Sr)	0.13	0.23	0.24	0.31	0.31	0.05	0.23
Thallium (Tl)	0.00002	0.00005	0.00005	0.00015	0.00015	0.00003	0.64
Tin (Sn)	0.00005	0.00006	0.00005	0.00011	0.00011	0.00002	0.29
Uranium (U)	0.0001	0.0002	0.0002	0.0004	0.0004	0.0001	0.38
Vanadium (V)	0.0005	0.0082	0.0016	0.0566	0.0566	0.0152	1.86
Zinc (Zn)	0.0015	0.0230	0.0159	0.0639	0.0639	0.0202	0.88

(continued)

Table 7.3-7. Summary Statistics of Water Quality Predictions for the Unuk River (site UR1; Closure Phase) (completed)

Scenario 4: Upper Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0034	0.0025	0.0073	0.0073	0.0016	0.48
Chloride (Cl)	1.27	2.69	2.66	4.40	4.21	1.11	0.41
Fluoride (F)	0.03	0.04	0.04	0.06	0.06	0.01	0.24
Nitrate (as N)	0.01	0.07	0.08	0.12	0.12	0.03	0.46
Nitrite (as N)	0.0005	0.0005	0.0005	0.0005	0.0005	0.0000	0.01
Total Phosphate (as P)	0.00	0.07	0.02	0.50	0.49	0.13	1.77
Sulphate (SO_4)	49	65	65	75	74	7	0.11
Total Metals							
Aluminum (Al)	0.01	*1.89*	*0.49*	*12.56*	*12.56*	3.36	1.78
Antimony (Sb)	0.0009	0.0015	0.0015	0.0024	0.0024	0.0003	0.22
Arsenic (As)	0.0001	0.0024	0.0014	**0.0130**	**0.0130**	0.0035	1.42
Barium (Ba)	0.033	0.062	0.040	0.239	0.239	0.055	0.89
Beryllium (Be)	0.0001	0.0002	0.0002	0.0006	0.0004	0.0001	0.49
Boron (B)	0.005	0.006	0.005	0.009	0.009	0.001	0.17
Cadmium (Cd)	0.000005	**0.000234**	**0.000214**	**0.000736**	**0.000736**	0.000213	0.91
Calcium (Ca)	20.98	35.18	36.74	47.97	47.88	8.85	0.25
Chromium (Cr)	0.0002	**0.0030**	0.0009	**0.0197**	**0.0197**	0.0052	1.74
Cobalt (Co)	0.0001	0.0014	0.0006	0.0085	0.0085	0.0022	1.63
Copper (Cu)	0.0003	**0.0227**	**0.0150**	**0.0859**	**0.0859**	0.0250	1.10
Iron (Fe)	0.01	**3.14**	**1.50**	**20.54**	**20.53**	5.44	1.74
Lead (Pb)	0.00003	0.00168	0.00099	0.00859	0.00859	0.00229	1.36
Lithium (Li)	0.001	0.003	0.003	0.009	0.009	0.002	0.66
Magnesium (Mg)	2.67	4.42	4.27	8.73	8.72	1.49	0.34
Manganese (Mn)	0.00003	0.08613	0.05250	0.49329	0.49311	0.12869	1.49
Mercury (Hg)	0.000005	0.000011	0.000006	0.000053	0.000053	0.000013	1.21
Molybdenum (Mo)	0.001	0.002	0.002	0.002	0.002	0.000	0.17
Nickel (Ni)	0.001	0.003	0.002	0.018	0.018	0.005	1.43
Potassium (K)	0.83	1.34	1.06	3.81	3.81	0.76	0.57
Selenium (Se)	0.0017	**0.0022**	**0.0022**	**0.0031**	**0.0030**	0.0004	0.20
Silicon (Si)	2.13	5.22	2.84	23.84	23.83	5.82	1.11
Silver (Ag)	0.000005	0.000045	0.000009	**0.000287**	**0.000287**	0.000076	1.70
Sodium (Na)	1.00	1.71	1.71	2.52	2.52	0.57	0.33
Strontium (Sr)	0.13	0.23	0.24	0.31	0.31	0.05	0.23
Thallium (Tl)	0.00002	0.00005	0.00005	0.00015	0.00015	0.00003	0.64
Tin (Sn)	0.00005	0.00006	0.00005	0.00011	0.00011	0.00002	0.29
Uranium (U)	0.0001	0.0002	0.0002	0.0004	0.0004	0.0001	0.38
Vanadium (V)	0.0005	0.0082	0.0016	0.0566	0.0566	0.0152	1.86
Zinc (Zn)	0.0015	0.0230	0.0159	0.0639	0.0639	0.0202	0.88

Notes:

All measured values are in units of mg/L.

Grey highlighted values exceed BC chronic water quality guidelines; bold values exceed BC acute water quality guidelines.

For pH-dependent guidelines, pH was assumed to be > 6.5.

For total aluminum, italic values exceed CCME pH-dependent water quality guidelines.

Table 7.3-8. Summary Statistics of Water Quality Predictions for the Unuk River (site UR1) (Post-closure Phase)

Scenario 1: Expected Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0034	0.0025	0.0074	0.0071	0.0016	0.46
Chloride (Cl)	0.40	1.04	0.96	2.58	2.07	0.47	0.45
Fluoride (F)	0.03	0.05	0.05	0.06	0.06	0.01	0.23
Nitrate (as N)	0.01	0.07	0.08	0.12	0.12	0.03	0.46
Nitrite (as N)	0.0005	0.0005	0.0005	0.0005	0.0005	0.0000	0.02
Total Phosphate (as P)	0.00	0.07	0.03	0.50	0.47	0.13	1.68
Sulphate (SO_4)	35	72	72	92	89	10	0.13
Total Metals							
Aluminum (Al)	0.01	*1.82*	*0.57*	*12.76*	*11.88*	3.19	1.76
Antimony (Sb)	0.0009	0.0015	0.0015	0.0025	0.0023	0.0003	0.22
Arsenic (As)	0.0001	0.0023	0.0018	**0.0132**	**0.0124**	0.0033	1.41
Barium (Ba)	0.033	0.060	0.040	0.242	0.227	0.052	0.87
Beryllium (Be)	0.0001	0.0003	0.0002	0.0006	0.0006	0.0002	0.58
Boron (B)	0.005	0.006	0.006	0.009	0.009	0.001	0.16
Cadmium (Cd)	0.000005	**0.000234**	**0.000224**	**0.000738**	**0.000716**	0.000204	0.87
Calcium (Ca)	20.51	35.14	34.36	48.77	48.59	9.39	0.27
Chromium (Cr)	0.0002	**0.0029**	**0.0014**	**0.0200**	**0.0187**	0.0050	1.69
Cobalt (Co)	0.0001	0.0013	0.0006	0.0086	0.0080	0.0021	1.59
Copper (Cu)	0.0003	**0.0219**	**0.0200**	**0.0861**	**0.0821**	0.0239	1.09
Iron (Fe)	0.01	**3.00**	**1.73**	**20.86**	**19.42**	5.16	1.72
Lead (Pb)	0.00003	0.00162	0.00122	0.00872	0.00814	0.00217	1.34
Lithium (Li)	0.001	0.003	0.003	0.009	0.009	0.002	0.63
Magnesium (Mg)	2.57	4.33	4.15	8.85	8.35	1.43	0.33
Manganese (Mn)	0.00003	0.08341	0.05634	0.50101	0.46676	0.12195	1.46
Mercury (Hg)	0.000005	0.000011	0.000007	0.000054	0.000050	0.000012	1.17
Molybdenum (Mo)	0.001	0.002	0.002	0.003	0.003	0.000	0.15
Nickel (Ni)	0.001	0.003	0.002	0.018	0.017	0.004	1.37
Potassium (K)	0.83	1.31	1.08	3.84	3.64	0.72	0.55
Selenium (Se)	0.0011	0.0019	**0.0020**	**0.0032**	**0.0024**	0.0004	0.18
Silicon (Si)	2.10	5.05	3.05	24.22	22.59	5.51	1.09
Silver (Ag)	0.000005	0.000043	0.000011	**0.000291**	**0.000272**	0.000072	1.67
Sodium (Na)	1.00	1.71	1.70	2.53	2.49	0.53	0.31
Strontium (Sr)	0.14	0.23	0.24	0.32	0.31	0.05	0.22
Thallium (Tl)	0.00002	0.00005	0.00005	0.00016	0.00015	0.00003	0.62
Tin (Sn)	0.00005	0.00006	0.00006	0.00011	0.00011	0.00002	0.27
Uranium (U)	0.0001	0.0002	0.0002	0.0004	0.0003	0.0001	0.36
Vanadium (V)	0.0005	0.0078	0.0021	0.0575	0.0536	0.0144	1.83
Zinc (Zn)	0.0015	0.0225	0.0167	0.0649	0.0606	0.0191	0.85

(continued)

Table 7.3-8. Summary Statistics of Water Quality Predictions for the Unuk River (site UR1) (Post-closure Phase) (continued)

Scenario 2							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0034	0.0025	0.0074	0.0071	0.0016	0.46
Chloride (Cl)	0.61	2.13	1.94	5.83	4.63	1.14	0.53
Fluoride (F)	0.03	0.05	0.05	0.06	0.06	0.01	0.23
Nitrate (as N)	0.01	0.07	0.08	0.12	0.12	0.03	0.46
Nitrite (as N)	0.0005	0.0005	0.0005	0.0005	0.0005	0.0000	0.02
Total Phosphate (as P)	0.00	0.07	0.03	0.50	0.47	0.13	1.68
Sulphate (SO_4)	35	75	74	92	92	10	0.13
Total Metals							
Aluminum (Al)	0.01	*1.82*	*0.57*	*12.76*	*11.88*	3.19	1.76
Antimony (Sb)	0.0009	0.0015	0.0015	0.0025	0.0023	0.0003	0.22
Arsenic (As)	0.0001	0.0023	0.0018	**0.0132**	**0.0124**	0.0033	1.41
Barium (Ba)	0.033	0.060	0.040	0.242	0.227	0.052	0.87
Beryllium (Be)	0.0001	0.0003	0.0002	0.0006	0.0006	0.0002	0.57
Boron (B)	0.005	0.006	0.006	0.009	0.009	0.001	0.16
Cadmium (Cd)	0.000005	**0.000234**	**0.000224**	**0.000738**	**0.000716**	0.000204	0.87
Calcium (Ca)	20.62	35.25	34.58	48.86	48.63	9.35	0.27
Chromium (Cr)	0.0002	**0.0029**	**0.0014**	**0.0200**	**0.0187**	0.0050	1.69
Cobalt (Co)	0.0001	0.0013	0.0006	0.0086	0.0080	0.0021	1.59
Copper (Cu)	0.0003	**0.0219**	**0.0200**	**0.0861**	**0.0821**	0.0239	1.09
Iron (Fe)	0.01	**3.00**	**1.73**	**20.86**	**19.42**	5.16	1.72
Lead (Pb)	0.00003	0.00162	0.00122	0.00872	0.00814	0.00217	1.34
Lithium (Li)	0.001	0.003	0.003	0.009	0.009	0.002	0.63
Magnesium (Mg)	2.57	4.33	4.15	8.85	8.35	1.43	0.33
Manganese (Mn)	0.00003	0.08342	0.05635	0.50102	0.46676	0.12195	1.46
Mercury (Hg)	0.000005	0.000011	0.000007	0.000054	0.000050	0.000012	1.17
Molybdenum (Mo)	0.001	0.002	0.002	0.003	0.003	0.000	0.15
Nickel (Ni)	0.001	0.003	0.002	0.018	0.017	0.004	1.37
Potassium (K)	0.83	1.31	1.08	3.84	3.64	0.72	0.55
Selenium (Se)	0.0011	**0.0021**	**0.0021**	**0.0036**	**0.0027**	0.0004	0.21
Silicon (Si)	2.11	5.05	3.05	24.22	22.59	5.51	1.09
Silver (Ag)	0.000005	0.000043	0.000011	**0.000291**	**0.000272**	0.000072	1.67
Sodium (Na)	1.00	1.71	1.70	2.53	2.49	0.53	0.31
Strontium (Sr)	0.14	0.23	0.24	0.32	0.31	0.05	0.22
Thallium (Tl)	0.00002	0.00005	0.00005	0.00016	0.00015	0.00003	0.62
Tin (Sn)	0.00005	0.00006	0.00006	0.00011	0.00011	0.00002	0.27
Uranium (U)	0.0001	0.0002	0.0002	0.0004	0.0003	0.0001	0.36
Vanadium (V)	0.0005	0.0078	0.0021	0.0575	0.0536	0.0144	1.83
Zinc (Zn)	0.0015	0.0225	0.0167	0.0649	0.0606	0.0191	0.85

(continued)

Table 7.3-8. Summary Statistics of Water Quality Predictions for the Unuk River (site UR1) (Post-closure Phase) (continued)

Scenario 3							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0034	0.0025	0.0074	0.0070	0.0016	0.46
Chloride (Cl)	0.52	1.08	1.03	2.46	1.72	0.41	0.38
Fluoride (F)	0.03	0.05	0.05	0.06	0.06	0.01	0.22
Nitrate (as N)	0.01	0.07	0.08	0.12	0.12	0.03	0.45
Nitrite (as N)	0.0005	0.0005	0.0005	0.0005	0.0005	0.0000	0.01
Total Phosphate (as P)	0.00	0.07	0.03	0.49	0.47	0.13	1.69
Sulphate (SO_4)	48	72	71	92	84	7	0.09
Total Metals							
Aluminum (Al)	0.01	*1.82*	*0.58*	*12.56*	*11.85*	3.18	1.75
Antimony (Sb)	0.0009	0.0015	0.0015	0.0024	0.0023	0.0003	0.21
Arsenic (As)	0.0001	0.0023	0.0018	**0.0130**	**0.0123**	0.0033	1.40
Barium (Ba)	0.033	0.060	0.041	0.239	0.227	0.052	0.86
Beryllium (Be)	0.0001	0.0003	0.0002	0.0006	0.0006	0.0002	0.58
Boron (B)	0.005	0.006	0.006	0.009	0.009	0.001	0.16
Cadmium (Cd)	0.000005	**0.000234**	**0.000226**	**0.000736**	**0.000720**	0.000205	0.87
Calcium (Ca)	20.36	35.04	33.87	48.36	48.13	9.18	0.26
Chromium (Cr)	0.0002	**0.0029**	**0.0014**	**0.0197**	**0.0187**	0.0050	1.70
Cobalt (Co)	0.0001	0.0013	0.0006	0.0085	0.0080	0.0021	1.59
Copper (Cu)	0.0003	**0.0220**	**0.0201**	**0.0858**	**0.0826**	0.0240	1.09
Iron (Fe)	0.01	**3.01**	**1.73**	**20.54**	**19.37**	5.15	1.71
Lead (Pb)	0.00003	0.00162	0.00122	0.00860	0.00812	0.00217	1.34
Lithium (Li)	0.001	0.003	0.003	0.009	0.009	0.002	0.63
Magnesium (Mg)	2.60	4.34	4.17	8.73	8.33	1.42	0.33
Manganese (Mn)	0.00003	0.08355	0.05581	0.49340	0.46565	0.12166	1.46
Mercury (Hg)	0.000005	0.000011	0.000007	0.000053	0.000050	0.000012	1.17
Molybdenum (Mo)	0.001	0.002	0.002	0.003	0.003	0.000	0.15
Nickel (Ni)	0.001	0.003	0.002	0.018	0.017	0.004	1.36
Potassium (K)	0.83	1.31	1.07	3.81	3.63	0.72	0.55
Selenium (Se)	0.0016	0.0020	0.0020	**0.0031**	**0.0025**	0.0003	0.15
Silicon (Si)	2.12	5.06	3.08	23.85	22.54	5.49	1.08
Silver (Ag)	0.000005	0.000043	0.000010	0.000287	0.000271	0.000072	1.67
Sodium (Na)	1.00	1.70	1.69	2.52	2.49	0.54	0.32
Strontium (Sr)	0.13	0.23	0.23	0.31	0.31	0.05	0.22
Thallium (Tl)	0.00002	0.00005	0.00005	0.00015	0.00015	0.00003	0.62
Tin (Sn)	0.00005	0.00006	0.00006	0.00011	0.00011	0.00002	0.28
Uranium (U)	0.0001	0.0002	0.0002	0.0004	0.0003	0.0001	0.36
Vanadium (V)	0.0005	0.0078	0.0021	0.0566	0.0534	0.0144	1.83
Zinc (Zn)	0.0015	0.0226	0.0168	0.0640	0.0604	0.0192	0.85

(continued)

Table 7.3-8. Summary Statistics of Water Quality Predictions for the Unuk River (site UR1) (Post-closure Phase) (completed)

Scenario 4: Upper Case							
Parameter	**Minimum**	**Mean**	**Median**	**Maximum**	**95th Percentile**	**Standard Deviation**	**Coefficient of Variation**
Anions and Nutrients							
Ammonia (as N)	0.0025	0.0034	0.0025	0.0074	0.0070	0.0016	0.46
Chloride (Cl)	0.91	2.24	2.13	5.55	3.78	0.97	0.44
Fluoride (F)	0.03	0.05	0.05	0.06	0.06	0.01	0.22
Nitrate (as N)	0.01	0.07	0.08	0.12	0.12	0.03	0.45
Nitrite (as N)	0.0005	0.0005	0.0005	0.0005	0.0005	0.0000	0.01
Total Phosphate (as P)	0.00	0.07	0.03	0.49	0.47	0.13	1.69
Sulphate (SO_4)	48	74	73	92	90	8	0.10
Total Metals							
Aluminum (Al)	0.01	*1.82*	*0.58*	*12.56*	*11.85*	3.18	1.75
Antimony (Sb)	0.0009	0.0015	0.0015	0.0024	0.0023	0.0003	0.21
Arsenic (As)	0.0001	0.0023	0.0018	**0.0130**	**0.0123**	0.0033	1.40
Barium (Ba)	0.033	0.060	0.041	0.239	0.227	0.052	0.86
Beryllium (Be)	0.0001	0.0003	0.0002	0.0006	0.0006	0.0002	0.58
Boron (B)	0.005	0.006	0.006	0.009	0.009	0.001	0.16
Cadmium (Cd)	0.000005	**0.000234**	**0.000226**	**0.000736**	**0.000720**	0.000205	0.87
Calcium (Ca)	20.47	35.15	34.04	48.45	48.19	9.13	0.26
Chromium (Cr)	0.0002	**0.0029**	**0.0014**	**0.0197**	**0.0187**	0.0050	1.70
Cobalt (Co)	0.0001	0.0013	0.0006	0.0085	0.0080	0.0021	1.59
Copper (Cu)	0.0003	**0.0220**	**0.0201**	**0.0858**	**0.0826**	0.0240	1.09
Iron (Fe)	0.01	**3.01**	**1.73**	**20.54**	**19.37**	5.15	1.71
Lead (Pb)	0.00003	0.00162	0.00122	0.00860	0.00812	0.00217	1.33
Lithium (Li)	0.001	0.003	0.003	0.009	0.009	0.002	0.63
Magnesium (Mg)	2.60	4.34	4.17	8.73	8.33	1.42	0.33
Manganese (Mn)	0.00003	0.08356	0.05581	0.49340	0.46565	0.12166	1.46
Mercury (Hg)	0.000005	0.000011	0.000007	0.000053	0.000050	0.000012	1.17
Molybdenum (Mo)	0.001	0.002	0.002	0.003	0.003	0.000	0.15
Nickel (Ni)	0.001	0.003	0.002	0.018	0.017	0.004	1.36
Potassium (K)	0.83	1.31	1.07	3.81	3.63	0.72	0.55
Selenium (Se)	0.0017	**0.0021**	**0.0022**	**0.0035**	**0.0027**	0.0004	0.17
Silicon (Si)	2.12	5.06	3.08	23.85	22.54	5.49	1.08
Silver (Ag)	0.000005	0.000043	0.000010	**0.000287**	**0.000271**	0.000072	1.67
Sodium (Na)	1.00	1.70	1.69	2.52	2.49	0.54	0.32
Strontium (Sr)	0.13	0.23	0.23	0.31	0.31	0.05	0.22
Thallium (Tl)	0.00002	0.00005	0.00005	0.00015	0.00015	0.00003	0.62
Tin (Sn)	0.00005	0.00006	0.00006	0.00011	0.00011	0.00002	0.28
Uranium (U)	0.0001	0.0002	0.0002	0.0004	0.0003	0.0001	0.35
Vanadium (V)	0.0005	0.0078	0.0021	0.0566	0.0534	0.0144	1.83
Zinc (Zn)	0.0015	0.0226	0.0168	0.0640	0.0604	0.0192	0.85

Notes:

All measured values are in units of mg/L.

Grey highlighted values exceed BC chronic water quality guidelines; bold values exceed BC acute water quality guidelines.

For pH-dependent guidelines, pH was assumed to be > 6.5.

For total aluminum, italic values exceed CCME pH-dependent water quality guidelines.

8 Summary and Conclusions

A GoldSim model, an industry standard approach, was developed to predict water quantity and water quality at the Mine Site of the proposed KSM Project, and predict potential effects of Project activities on the water quantity and quality of the receiving environment.

The model is based on a mass balance principle and has taken into consideration key components and activities, including climate, hydrology, hydrogeology, water chemistry, rock and overburden geochemistry, water management structures, mine operations, and water treatment.

Where possible, inputs to the model were based on a large quantity of data collected from extensive baseline studies, field measurements, laboratory and pilot scale tests, mine plans and engineering designs, and extensive and in-depth professional knowledge and experience. Where uncertainty exists, a conservative assessment or approach was applied.

Predictive water quality modelling into the far-future has an inherent level of uncertainty. The uncertainty of model predictions depends largely on uncertainties associated with various model inputs and the necessary simplifications or assumptions applied in the model, such as physical and chemical homogeneity of large water bodies (e.g., water storage facility) and waste rock. To address this uncertainty, different model scenarios considered the range of possible geochemistry (both expected and upper case), the average water balance based on five years of baseline data, and a variable water balance with extreme dry and wet years. Selenium concentrations are predicted to be higher than BC water quality guidelines for the protection of freshwater aquatic life in Sulphurets Creek and 1.5 km downstream in the Unuk River during the operation, closure, and post-closure phases. Water quality is predicted to meet water quality guidelines at a regional scale at the BC-Alaska border, 35 km downstream of the proposed Mine Site.

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