

WATER QUALITY MODELLING

APPENDIX 2.7.2.4B-F

Prepared for:

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- This report is based on facts and opinions contained within the referenced documents and facts. We have attempted to identify and consider relevant facts and documents pertaining to the scope of work, as of the time period during which we conducted this analysis. However, our opinions may change if new information is available or if information we have relied on is altered.
- We applied accepted professional practices and standards in developing and interpreting data obtained by our field measurement, sampling and observation. While we used accepted professional practices in interpreting data provided by Client or third party sources we did not verify the accuracy of data provided by Client or third party sources.
- This report should be considered as a whole and selecting only portions of the report for reliance may create a misleading view of our opinions.

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1.0 Summary and Interpretation of Water Quality Predictions

Water quality modelling was undertaken for drainages within the proposed mine site, for surrounding drainages that would ultimately receive seepage associated with the TSF, and/or for sites that would receive discharge from the Pit Lake system once full (the mixing points). A summary of the water bodies considered in the modelling exercises is provided in Table 1.

Table 1. Water bodies in the Project area for which water quality predictions were made

<i>Location</i>	<i>Water Body</i>
Mine site	Fish Lake
	Upper Fish Creek
	Tributary 1
	Pit Lake (post operations)
Mixing points - downstream of the mine site	Lower Fish Creek roughly 2.5 km d/s of Pit Lake (FC1)
	Lower Fish Creek u/s of the confluence with the Taseko River (FC2)
	Taseko River d/s of the confluence with lower Fish Creek (T3)
	Taseko River u/s of the confluence with the Big Onion Lake outlet (T2)
	Taseko River u/s of the confluence with Beece Creek (T1)
Mixing points - southwest of the TSF	Beece Creek u/s of the confluence with the Taseko (B1)
	Big Onion Lake
	Little Onion Lake
Mixing point - south of the TSF	Wasp Lake

A stochastic model (combining surficial [total] and dissolved [seepage] concentrations) was used to predict water quality at the mine site for Fish Lake, Upper Fish Creek, Tributary 1, and the Pit Lake. Predictions for the Fish Lake system are presented for 5 different periods: Years 1 to 16, Years 17 to 20, Years 21 to 30, Years 31 to 47, and Years 47 to 100. Predictions for the Pit Lake are provided for the post-closure operating period of Year 48+ when the lake is expected to be full (Table 2).

Table 2. Mining phases and dates of interest

<i>Operating phase</i>	<i>Timeframe</i>
Operational	1 – 16
Milling	17-20
Closure 1	21 – 30
Closure 2	31-47
Pit Full	48+

The stochastic model generated daily predictions on the basis of 100 daily iterations and provided predicted values for the following:

- Minimum, mean, median, and maximum concentrations
- 5th percentile, 25th percentile, 75th percentile, 95th percentile values

The minimum, average, and maximum predicted values were compiled and used to evaluate potential effects on water quality for each phase through Year 100. *The maximum values are the model outcomes arising from low probability, short duration events (unlikely to occur overall). The average model values are most reflective of typical conditions expected in the mine site water bodies. The emphasis on the analysis and discussion of maximum values in the following sections represents a conservative approach to characterizing potential effects on water quality.* The mixing point water quality data were modelled using predicted monthly discharge values, along with baseline total metals and predicted water quality values. This model generated 5th and 95th percentiles along with minimum, average, and maximum values. These values were generated by operating and closure periods. Similar to the Pit Lake, only the 48+ predictions for Lower Fish Creek stations are presented here, as the bulk of the flows to Lower Fish Creek will not be restored until the Pit Lake is full.

2.0 Data Interpretation

As a starting point for evaluating potential effects the predicted values were compared with federal and provincial water quality guidelines and published toxicity reference values (TRV)/ecological screening values (ESV) for freshwater aquatic life. Information sources included:

- BC Approved Water Quality Guidelines (updated 2011)
 - Applied the maximum and 30-day average guideline value
- Compendium of Working Water Quality Guidelines (updated 2006)
- Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines (updated 2011)
- TRV/ESV from multiple sources including but not limited to US EPA National Ambient Water Quality Criteria; Suter and Tsao (1996)

An emphasis was placed on evaluating maximums first to characterize potential worst case scenarios. Thereafter, averages became the focus of the analysis, as they were considered to be reflective of more typical conditions. Minimums were considered where potential guideline exceedances were identified.

It is important to note the predicted water quality data were evaluated without consideration for the mitigating effects of water treatment, strategic diversions (depending on water quality), and other mitigation measures that will be implemented during operations and closure as needed. Once again, this reflects a conservative approach to characterizing potential effects associated with changes in water quality.

Provincial and/or federal guideline values for fluoride, cadmium, copper, lead, manganese, nickel, silver, and zinc are calculated on the basis of hardness. Nitrite is calculated using chloride, ammonia using pH and temperature, and aluminum using pH. A summary of the equations used to calculate guideline values is provided in Table 3.

Table 3. Equations used to calculate guideline values

Parameter	Equations and ranges for calculating provincial and federal guidelines for the protection of aquatic life
Dissolved Al @ pH <6.5	5 ug/L if pH < 6.5 (BC and CCME)
	100 ug/L if pH ≥ 6.5 (BC and CCME)
Total cadmium	10 (0.86*log hardness-3.2) (BC and CCME)
Total copper	(0.094(hardness)+2) (BC)
	0.04 (mean hardness) (BC 30 d avg)
	$e^{0.8545 [\ln(\text{hardness})] - 1.465} * 0.2 \mu\text{g/L}$ (CCME)
Total lead	$e^{(1.273 \ln(\text{hardness}) - 1.460)}$ (BC max)
	3.31 + $e^{(1.273 \ln(\text{mean hardness}) - 4.704)}$ (BC 30 d avg)
	$e^{1.273[\ln(\text{hardness})] - 4.705}$ (CCME)
Total manganese	0.01102 hardness + 0.54 (BC max)
	0.0044(hardness)+0.605 (BC 30 d avg)
Total nickel	0.025 mg/L @ hardness <60 mg/L 0.065 mg/L @ hardness >60 <120 mg/L 0.110 mg/L @ hardness >120 <160 mg/L
	$e^{0.76[\ln(\text{hardness})] + 1.06}$ (CCME)
Total silver	0.0001 mg/L maximum @ hardness <100 mg/L 0.003 mg/L maximum @ hardness >100 mg/L 0.00005 mg/L @ hardness <100 mg/L (30 d avg) 0.0015 mg/L @ hardness >100 mg/L (30 d avg)
Total zinc	33 + 0.75 x (hardness-90) (BC max)
	7.5 + 0.75 x (hardness-90) (BC 30 d avg)
Nitrite (mg/L)	0.06 mg/L maximum when chloride is <2 mg/L (BC)
Fluoride (mg/L)	-51.73 + 92.57 log ₁₀ (hardness) and multiply by 0.01 (BC)
Ammonia (mg/L)	Determined with <i>in situ</i> temperature and pH (BC)

3.0 Application of Federal and Provincial Guideline Values

Water quality guidelines are developed using chronic and/or acute toxicity data, with an emphasis on values such as Lowest Observed Effects Levels (LOEL). Where chronic data are not available the lowest available LC₅₀ concentrations are used. The guidelines typically include a safety factor applied to the original toxicity data. For example, the Province has applied a safety factor of 5 to the LOEL of 0.01 mg/L selenium to establish the guideline value of 0.002 mg/L. Toxicity data are expressed in a variety of ways and it is important to understand the terminology as it may relate to the nature of the tests being undertaken for which toxicity data is reported. Examples of terms and data reported in the text are shown and defined below:

- LC₅₀ – the test concentration that results in the death of 50% of the test organisms. The time period for the tests can be from hours to days depending on the design of the test. These types of tests are referred to as bioassays.
- EC₅₀ – the concentration eliciting a response in 50% of the organisms being tested. The response, timeframes, and organisms used can be variable and the main purpose is to determine the levels of a substance eliciting adverse responses.
- NOEL – no observed effects concentration, or, the lowest concentration of a test substance that does not elicit a response¹.
- NAOEL – no adverse observed effects level or the lowest concentration of a substance that does not elicit an adverse response.

Bioassays may also be “acute” where mortality is the measure, or “chronic” where longer-term exposures are used to evaluate the adverse effects of substances. As discussed above, the aggregate toxicity data for a particular substance are considered in establishing a guideline level. Normally, the lowest observed effect level of the most sensitive organism is used and an application or uncertainty factor applied to provide the “guideline” level. Consequently, it is important to note that an exceedance of a guideline value does not always indicate an “effect” and it is important to consider the magnitude and duration of the exceedance before concluding it will elicit an adverse effect. Applying the guideline levels are an important first step in identifying the potential for an effect. There are cases where the natural levels of a given parameter may be higher than guidelines and where fish and other aquatic organisms function without adverse effects. In these cases, guideline levels may default to the higher natural background concentrations, and a procedure for establishing site-specific water quality objectives may be considered. Establishing site-specific water quality or sediment quality objectives will provide a more accurate and defensible basis for comparing and determining the potential for adverse effects in exposed organisms.

¹Note also NOEC – no observed effects concentration, highest concentration at which no adverse effects are observed on test organisms at a specific time of observation.

4.0 Comparison of Predictions with Guidelines and Standards

4.1 Upper Fish Creek, Tributary 1, Fish Lake, and the Pit Lake

The model results indicate potential exceedances of guidelines for the following parameters in the Fish Lake system (Fish Lake, Upper Fish Creek and Tributary 1):

- aluminum²
- boron
- cadmium
- copper
- fluoride
- iron
- lithium
- selenium
- silver
- sulphate
- thallium

Exceedances of these parameters were noted in the Pit Lake dataset, which also included antimony, arsenic, cobalt, mercury, and zinc. An overview of the predicted exceedances is provided in Table 4, with a more detailed summary by Project phase shown in Table 5. Note for those parameters affected by hardness (copper, cadmium, zinc), the baseline hardness values for Fish Lake and the tributaries of 82 mg/L to 138.95 mg/L respectively were used to calculate guidelines. The predicted average hardness in the Pit Lake once full (518.47 mg/L) was used to calculate the appropriate guideline values for that water body.

Table 4. Overview of predicted guideline exceedances for water bodies at the mine site – using baseline hardness values

Parameter (mg/L)	Fish Lake	Tributary 1	Upper Fish Creek	Pit Lake	BC WQG	CCME WQG
Aluminum	0.048 to 0.140	0.022 to 0.188	0.022 to 0.186	0.450 to 0.727	0.05 to 0.1 (dissolved)	
Antimony	0.0001 to 0.00027	0.0001 to 0.0025	0.0001 to 0.0025	0.02 to 0.029	0.02	-
Arsenic	0.0001 to 0.0016	3.1E-0.8 to 0.0023	1.297E-0.5 to 0.0023	0.008 to 0.012	0.005	
Boron	0.073 to 1.593	0.029 to 3.6	0.029 to 3.6	0.514 to 0.684	1.2	1.2 (chronic) 29 (acute)
Cadmium	0.0000699 to 0.000135	0.000067 to 0.000136	0.000067 to 0.000136	0.00056 to 0.000831	0.000028 / 0.000044 (Fish Lake and tribs)	
					0.00014 (Pit Lake)	
Cobalt	0.0003 to 0.0007	0.0003 to 0.001	0.0003 to 0.0001	0.0045 to 0.0066	0.004 (30 d avg) 0.11 (max)	-

² Note: Stochastic modelled values reflect a combination of total and dissolved aluminum, whereas provincial and federal guidelines developed on the basis of dissolved concentrations.

Parameter (mg/L)	Fish Lake	Tributary 1	Upper Fish Creek	Pit Lake	BC WQG	CCME WQG
Copper	0.0008 to 0.0052	0.0003 to 0.0082	0.0003 to 0.0083	0.018 to 0.0272	0.0097 (Fish Lake) 0.01506 (Tribs) (max)	0.002 (Fish Lake)
					0.00328 (Fish Lake) / 0.0056 (Tribs) (30 d avg)	0.00313 (Tribs)
					0.056 (Pit Lake)	0.00965 Pit Lake
Fluoride	0.052 to 0.124	0.05 to 0.124	0.05 to 0.124	0.314 to 0.431	>1.25 @ hardness 82	0.120
Iron	0.36 to 1.15	0.30 to 1.83	0.30 to 1.96	2.198 to 3.754	1 (total) 0.35 (diss)	0.3
Lithium	0.002 to 0.039	0.001 to 0.084	0.001 to 0.084	0.013 to 0.017	0.014 (secondary chronic) 0.096 final chronic value	-
Mercury	4.24E-08 to 0.000016	1.19 E-10 to 0.000014	1.26 E-10 to 0.000014	0.0000997 to 0.000145	0.00002@ 0.5% MeHg	0.000026 (inorganic Hg)
					0.00000125@ 8% MeHg	0.000004 (organic Hg)
Selenium	0.00028 to 0.005	0.0003 to 0.0086	0.0003 to 0.0087	0.008 to 0.011	0.002	0.001
Silver	0.000044 to 0.000195	0.00003 to 0.00039	0.00003 to 0.00039	0.00014 to 0.00017	0.0001 (max) and 0.00005 (30 d avg) @ hardness <100	0.0001
					0.003 (max) and 0.0015 (30 d avg) @ hardness >100	
Sulphate	2.78 to 173.07	1 to 301.31	1.0 to 307.32	326.294 to 520.509	50 (alert level)	-
					100 (max)	
Thallium	0.00013 to 0.00223	0.00005 to 0.008	0.00005 to 0.008	0.0007 to 0.009	0.0008	
Vanadium	0.007 to 0.011	0.007 to 0.015	0.0067 to 0.015	0.02 to 0.027	0.006 - Ontario water quality objective adopted as BC working guideline 0.02 (secondary chronic value)	-
Zinc	0.002 to 0.007	0.002 to 0.009	0.002 to 0.009	0.035 to 0.052	0.033 to 0.0697 (0.354 Pit Lake)	0.03

Table 5. Potential water quality exceedances in Fish Lake, Tributary 1, Upper Fish Creek, and Pit Lake Values (mg/L)

	Fish Lake					Upper Fish Creek					Trib 1					Pit Lake 48+	BC Water Quality Guidelines (Working and Approved)		CCME Water quality guidelines
	Years (1 - 16)	Years (17 - 20)	Years (21 - 30)	Years (31 - 47)	Years (48 - 100)	Years (1 - 16)	Years (17 - 20)	Years (21 - 30)	Years (31 - 47)	Years (48 - 100)	Years (1 - 16)	Years (17 - 20)	Years (21 - 30)	Years (31 - 47)	Years (48 - 100)				
Aluminum																			
Min	0.057	0.048	0.051	0.056	0.058	0.0220	0.0232	0.0236	0.0258	0.0285	0.0220	0.0229	0.0231	0.0235	0.0238	0.450	0.05	0.1	0.1
Average	0.098	0.089	0.083	0.087	0.088	0.0855	0.0843	0.0848	0.0904	0.0911	0.08602	0.08511	0.08541	0.08949	0.09050	0.602			
Max	0.140	0.127	0.110	0.116	0.116	0.1838	0.1845	0.1857	0.1725	0.1752	0.184197	0.185125	0.187015	0.187867	0.188052	0.727			
Antimony																			
Min	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.020	0.02	-	
Average	0.0008	0.0004	0.0003	0.0005	0.0009	0.0006	0.0004	0.0003	0.0005	0.0010	0.0006	0.0004	0.0003	0.0005	0.0009	0.025			
Max	0.0027	0.0015	0.0006	0.0014	0.0013	0.0025	0.0014	0.0007	0.0025	0.0021	0.0025	0.0015	0.0008	0.0024	0.0021	0.029			
Arsenic																			
Min	0.0001	0.0001	0.0001	0.0002	0.0002	3.2452E-08	1.2973E-05	1.9753E-05	3.3704E-05	3.1438E-05	3.08472E-08	0.00001	0.00001	0.00001	0.00001	0.008	0.005		
Average	0.0006	0.0006	0.0005	0.0008	0.0010	0.0005	0.0005	0.0006	0.0009	0.0011	0.00052	0.00058	0.00060	0.00082	0.00105	0.010			
Max	0.0014	0.0011	0.0012	0.0016	0.0016	0.0014	0.0012	0.0013	0.0023	0.0021	0.00141	0.00121	0.00140	0.00228	0.00208	0.012			
Boron																			
Min	0.073	0.098	0.075	0.094	0.133	0.029	0.029	0.030	0.031	0.033	0.029	0.029	0.029	0.030	0.030	0.514	1.2	1.2 short term	
Average	0.644	0.629	0.630	0.554	0.561	0.762	0.746	0.733	0.581	0.589	0.708	0.691	0.696	0.640	0.658	0.602		29 long term	
Max	1.593	1.510	1.529	1.478	1.199	3.601	3.590	3.589	3.180	3.252	3.601	3.594	3.593	3.588	3.588	0.684			
Cadmium																			
Min	0.0000716	0.0000704	0.0000705	0.0000699	0.0000724	0.000067	0.000068	0.000068	0.000073	0.000073	0.000067	0.000067	0.000068	0.000069	0.000069	0.000562	0.000028 (Fish Lake @ 82 hardness) 0.000044 (Upper Fish Creek and Trib 1 @ 138.95 hardness)		
Average	0.0000978	0.0000935	0.0000850	0.0000895	0.0000929	0.000092	0.000091	0.000087	0.000092	0.000096	0.000093	0.000092	0.000088	0.000092	0.000095	0.000708			
Max	0.0001353	0.0001256	0.0001018	0.0001097	0.0001145	0.000136	0.000127	0.000113	0.000127	0.000128	0.000136	0.000128	0.000114	0.000124	0.000124	0.000831			
Cobalt																			
Min	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0004	0.0003	0.0003	0.0003	0.0003	0.0004	0.0003	0.0003	0.0003	0.0045	0.004 (30 d avg) 0.110 (max)	-	
Average	0.0004	0.0004	0.0004	0.0003	0.0005	0.0004	0.0004	0.0004	0.0004	0.0005	0.0004	0.0004	0.0004	0.0004	0.0006	0.0054			
Max	0.0005	0.0005	0.0005	0.0007	0.0007	0.0010	0.0011	0.0009	0.0009	0.0009	0.0008	0.0009	0.0008	0.0009	0.0010	0.0066			

Values (mg/L)	Fish Lake					Upper Fish Creek					Trib 1					Pit Lake 48+	BC Water Quality Guidelines (Working and Approved)	CCME Water quality guidelines
	Years (1 - 16)	Years (17 - 20)	Years (21 - 30)	Years (31 - 47)	Years (48 - 100)	Years (1 - 16)	Years (17 - 20)	Years (21 - 30)	Years (31 - 47)	Years (48 - 100)	Years (1 - 16)	Years (17 - 20)	Years (21 - 30)	Years (31 - 47)	Years (48 - 100)			
Copper																		
Min	0.0008	0.0009	0.0009	0.0010	0.0011	0.0003	0.0010	0.0010	0.0011	0.0011	0.0003	0.0009	0.0010	0.0010	0.0010	0.0180	0.0091 (Fish Lake) to 0.015 (Upper Fish Creek and Trib 1)	0.002 (Fish Lake) 0.00313 (Upper Fish Creek and Trib 1)
Average	0.0025	0.0019	0.0012	0.0015	0.0028	0.0018	0.0017	0.0016	0.0019	0.0032	0.0018	0.0018	0.0017	0.0020	0.0031	0.0218		
Max	0.0052	0.0037	0.0016	0.0048	0.0045	0.0043	0.0034	0.0024	0.0083	0.0076	0.0044	0.0034	0.0026	0.0082	0.0074	0.0272		
Fluoride																		
Min	0.05263	0.05161	0.05135	0.05074	0.05391	0.050	0.050	0.050	0.051	0.050	0.050	0.050	0.050	0.050	0.050	0.314	>1.25 @ hardness 82	0.12
Average	0.08401	0.07876	0.07462	0.07804	0.08029	0.081	0.079	0.076	0.079	0.082	0.081	0.079	0.076	0.079	0.082	0.376		
Max	0.12444	0.10543	0.09675	0.09961	0.10451	0.124	0.106	0.102	0.101	0.106	0.124	0.107	0.102	0.102	0.107	0.431		
Lithium																		
Min	0.002	0.002	0.002	0.003	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.013	0.014 secondary chronic value	-
Average	0.014	0.013	0.013	0.012	0.013	0.016	0.015	0.015	0.013	0.014	0.015	0.014	0.014	0.013	0.014	0.015	0.096 Final chronic value	
Max	0.039	0.038	0.038	0.033	0.030	0.084	0.084	0.084	0.075	0.076	0.084	0.084	0.084	0.084	0.084	0.017	0.870 max value	
Iron																		
Min	0.360	0.379	0.353	0.371	0.422	0.302	0.309	0.313	0.321	0.320	0.302	0.306	0.309	0.310	0.309	2.198	1 (ttl) 0.35 (diss)	0.3
Average	0.572	0.610	0.625	0.732	0.803	0.604	0.662	0.697	0.792	0.870	0.596	0.668	0.711	0.809	0.884	3.158		
Max	0.979	0.998	1.035	1.148	1.174	1.820	1.964	1.557	1.551	1.535	1.535	1.621	1.665	1.696	1.829	3.754		
Mercury																		
Min	0.0000006	0.0000001	4.2438206E-08	0.0000002	0.0000003	1.2567917E-10	0.00000007	0.00000011	0.00000018	0.00000017	1.1946485E-10	4.1083144E-08	6.6729455E-08	7.2305835E-08	6.8025120E-08	0.000997	0.00002 @ 0.5% MeHg 0.00000125 @ 8% MeHg	0.000026 (Hg)
Average	0.0000054	0.0000027	0.0000003	0.0000008	0.0000035	0.00000309	0.00000190	0.00000079	0.00000141	0.00000404	0.000003	0.000002	0.000001	0.000001	0.000004	0.000124		0.000004 (MeHg)
Max	0.0000158	0.0000095	0.0000010	0.0000067	0.0000061	0.00001404	0.00000870	0.00000165	0.00001283	0.00001098	0.000014	0.000009	0.000002	0.000013	0.000011	0.000145		
Selenium																		
Min	0.00028	0.00039	0.00041	0.00046	0.00055	0.0003	0.0004	0.0004	0.0004	0.0004	0.0003	0.0004	0.0004	0.0004	0.0004	0.008	0.002	0.001
Average	0.00058	0.00070	0.00074	0.00112	0.00313	0.0005	0.0007	0.0008	0.0013	0.0033	0.0006	0.0008	0.0009	0.0012	0.0030	0.010		
Max	0.00116	0.00118	0.00144	0.00500	0.00466	0.0012	0.0013	0.0017	0.0087	0.0079	0.0013	0.0014	0.0018	0.0086	0.0078	0.011		

Values (mg/L)	Fish Lake					Upper Fish Creek					Trib 1					Pit Lake 48+	BC Water Quality Guidelines (Working and Approved)	CCME Water quality guidelines			
	Years (1 - 16)	Years (17 - 20)	Years (21 - 30)	Years (31 - 47)	Years (48 - 100)	Years (1 - 16)	Years (17 - 20)	Years (21 - 30)	Years (31 - 47)	Years (48 - 100)	Years (1 - 16)	Years (17 - 20)	Years (21 - 30)	Years (31 - 47)	Years (48 - 100)						
Silver																					
Min	0.000044	0.000050	0.000041	0.000047	0.000058	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003	0.00014	0.0001 (max) / 0.00005 (30 d avg) @ hardness <100	0.0001			
Average	0.000110	0.000109	0.000107	0.000101	0.000100	0.00012	0.00012	0.00012	0.00010	0.00010	0.00012	0.00011	0.00011	0.00011	0.00011	0.00016					
Max	0.000195	0.000187	0.000188	0.000184	0.000158	0.00039	0.00039	0.00039	0.00035	0.00036	0.00039	0.00039	0.00039	0.00039	0.00039	0.00017			0.003 (max) / 0.0015 (30 d avg) @ hardness >100		
Sulphate																					
Min	2.777	5.599	6.028	9.893	14.939	1.000	3.238	3.811	5.448	5.203	1.0005	2.6957	3.1308	3.3291	3.2437	326.294	50 (alert)	-			
Average	25.035	30.096	24.414	44.832	106.546	18.539	27.289	28.720	53.596	116.466	20.6903	31.6103	32.1585	49.2888	104.6652	402.234	100 (max)				
Max	64.301	70.950	61.948	173.068	158.305	67.150	78.132	74.025	307.315	272.427	68.7134	80.5531	77.4378	301.3093	267.6812	520.509	-				
Thallium																					
Min	0.000128	0.000153	0.000147	0.000154	0.000280	0.00005	0.0001	0.0001	0.0001	0.0001	0.00005	0.0001	0.0001	0.0001	0.0001	0.0001	0.0007	0.0008			
Average	0.000873	0.000864	0.000852	0.000779	0.000793	0.0011	0.0011	0.0010	0.0008	0.0008	0.0010	0.0010	0.0010	0.0009	0.0010	0.0010	0.0008				
Max	0.002231	0.002004	0.002143	0.001836	0.001860	0.0080	0.0080	0.0080	0.0041	0.0040	0.0080	0.0079	0.0080	0.0079	0.0079	0.0009					
Vanadium																					
Min	0.008	0.008	0.008	0.007	0.007	0.0072	0.0076	0.0073	0.0067	0.0072	0.008	0.008	0.008	0.007	0.007	0.020	0.006 - Ontario water quality objective adopted as BC working guideline	0.02 (secondary chronic value)	-		
Average	0.010	0.010	0.009	0.009	0.009	0.010	0.010	0.010	0.009	0.009	0.010	0.010	0.010	0.009	0.009	0.024					
Max	0.011	0.011	0.011	0.010	0.010	0.015	0.015	0.015	0.011	0.012	0.015	0.015	0.015	0.015	0.015	0.027					
Zinc																					
Min	0.002	0.002	0.003	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.035	0.033 @ hardness ≤90 (0.354 Pit Lake)	0.03			
Average	0.004	0.004	0.004	0.003	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.043					
Max	0.006	0.006	0.005	0.007	0.007	0.007	0.007	0.007	0.009	0.008	0.007	0.007	0.007	0.009	0.007	0.052					

4.2 Comparison of Predicted Exceedances with Published Toxicity Data

As the guidelines reflect a factor of safety and are not always developed in the context of potential mitigating factors outside of hardness (e.g., dissolved organic carbon, sulphide, sulphate) the predicted exceedances were compared with toxicity data used and/or considered in developing the federal and/or provincial guideline values (Table 6). A variety of aquatic TRV/ESV, which are used to evaluate ecological risk, were also used for comparison purposes where toxicity data were not specifically identified (in provincial and federal documentation) for use in developing guidelines. Overall, a limited number of the predicted exceedances in mine site water bodies were greater than the toxicity data used to establish guideline values.

Pit Lake

- Aluminum (0.450 mg/L to 0.727 mg/L) exceeds the US EPA (1998) TRV of 0.087 mg/L, with average and maximum values also exceeding the 0.460 mg/L lowest chronic value (Suter and Tsao, 1996).
- Cadmium (0.00056 mg/L to 0.00083 mg/L) exceeds the 0.00017 mg/L for *Daphnia magna* derived by Biesinger and Christensen (1972). A safety factor of 0.1 was applied to this value to derive the original CCME (1999) guideline of 0.000017 mg/L. Minimum and average values also exceeded the 0.00017 mg/L for *Daphnia magna* (Biesinger and Christensen, 1972).
- Maximum iron in the Pit Lake (3.754 mg/L) slightly exceeds the 3.5 mg/L LC₅₀ for *Hyalloella* in soft water reported by BC MOE (2008). A safety factor of 0.1 was applied to this value to derive the dissolved iron guideline value of 0.35 mg/L³.
- Average and maximum lithium (0.015 mg/L and 0.017 mg/L) exceeds the 0.014 secondary chronic value (Suter and Tsao, 1996).
- Maximum selenium (0.011 mg/L) slightly exceeds the 0.01 LOEL used by MWLAP (2001) to establish the guideline value. A safety factor of 5 was applied to this LOEL to derive the 0.002 mg/L guideline. Average values were 0.01 mg/L.
- Silver (0.00014 mg/L to 0.00017 mg/L) exceeds the (Suter and Tsao, 1996) lowest chronic value of 0.00012 mg/L for Daphnids, but is below the 0.0029 mg/L concentration (@ hardness > 100 mg/L) used as part of the provincial guideline development, and the NOEC of 0.004 mg/L and 0.005 mg/L for Ceriodaphnia derived by Weber et al. (1989).
- Sulphate (326.29 mg/L to 520.51 mg/L) exceeds the 100 mg/L derived by Frahm (1975), but not the reported 96-h LC₅₀ concentrations for *Hyalloella* in medium and hard water of 3,711 mg/L and 6,787 mg/L sulphate, respectively.

³ Note the predicted hardness in the Pit Lake (>500 mg/L) would be reflective of hard water conditions

4.2.1 Fish Lake, Upper Fish Creek and Tributary 1

4.2.1.1 Aluminum

Some average and maximum aluminum concentrations in the Fish Lake system were above the 0.075 mg/L NOEC derived by Neville (1985) for Rainbow Trout and the US EPA TRV of 0.087 mg/L. However, these values were below the lowest chronic effects concentration identified by Suter and Tsao (1996) of 0.460 mg/L for aquatic plants and 1.9 mg/L for Daphnids. Average levels in all years were <0.1 mg/L (maximum guideline) and below the 0.075 mg/L NOEC derived by Neville (1985) for Rainbow Trout. It is important to note the guideline values are for dissolved aluminum concentrations, whereas the stochastic model predictions reflect combined total metals from surface contributions and dissolved metals from seepage water.

4.2.1.2 Lithium

Maximum and some average lithium predictions (≤ 0.16 mg/L in Upper Fish Creek and Tributary 1) exceed the secondary chronic value of 0.014 mg/L (Suter and Tsao, 1996) but are well below the 0.970 mg/L final chronic value and the 0.260 mg/L secondary acute value (Suter and Tsao, 1996). Minimum values are ≤ 0.003 mg/L.

4.2.1.3 Selenium and Silver

Maximum selenium in Upper Fish Creek and Tributary 1 exceed the US EPA (1999) TRV of 0.005 mg/L, but are below the LOEL of 0.01 mg/L used to establish the provincial guideline value. Average predicted values are ≤ 0.0033 mg/L and below the US EPA (1999) TRV of 0.005 mg/L. Maximum silver values in all water bodies exceed the 0.00012 mg/L TRV concentration derived by Suter and Tsao (1996). However, only maximum silver exceeds the 0.0001 mg/L concentration for chronic effects @ hardness <100 mg/L derived by Davies & Goettl (1978). Given the potential for exceedances of the Davies & Goettl (1978) LC₅₀ value, the predicted silver concentrations were further evaluated using the Biotic Ligand Model (BLM) which is discussed in more detail in Appendix 2.7.2.4B-E. Cadmium, copper, and silver concentrations were modelled using the BLM, and predicted concentrations were below the parameter-specific LC₅₀ values generated by the model.

4.2.1.4 Sulphate

Predicted maximum sulphate levels (173.07 mg/L to 307.32) exceed the 100 mg/L derived by Frahm (1975), but not the reported 96-h LC₅₀ concentrations for *Hyalella* in medium and hard water of 3,711 mg/L and 6,787 mg/L sulphate. The highest average predicted sulphate levels are ≤ 116.47 mg/L. The Province released draft sulphate water quality guidelines of 65 mg/L (30-day average) and 250 mg/L (maximum) for discussion in 2011. For the most part (except in Year 48+) the predicted average and maximum levels are below 65 mg/L and 250 mg/L concentrations. Davies (2006) conducted 21-day studies on the toxicity of sulphate (as Na₂SO₄) to *Fontinalis antipyretica* using concentrations of 200 mg/L to 1,500 mg/L in soft water (19 mg/L) and medium hard water (105 mg/L), reporting effects on Chlorophyll *a* and *b* first noted at 400 mg/L. Davies' 2006 study indicated *F. antipyretica* was more tolerant of sulphate than the BC Approved Water Quality guideline suggested, noting the toxicity of 100 mg/L derived in the Frahm (1975) study was more likely due to the potassium (K) than the sulphate. All predicted

maximum sulphate concentrations in the Fish Lake system were ≤ 310 mg/L and below the 400 mg/L level affecting chlorophyll levels reported by Davies (2006).

4.2.1.5 Thallium

Maximum and some average thallium concentrations are at or above the Brown and Rattigan (1979) 14d-EC₅₀ of 0.008 mg/L for *Lemna minor* (duckweed) except in Years 21-30 and 31-47 in Fish Lake where the average concentrations are 0.000779 mg/L and 0.000793 mg/L. However, these values were below the lowest chronic values generated for Daphnids and fish (0.130 mg/L and 0.057 mg/L respectively) generated by Suter and Tsao (1996).

Table 6. Comparison of predicted values with data used to develop provincial and/or federal water quality guideline values and TRV/ESV values

<i>Parameter</i>	<i>Fish Lake range (mg/L)</i>	<i>Upper Fish Cr range (mg/L)</i>	<i>Tributary 1 range (mg/L)</i>	<i>Pit Lake range (mg/L)</i>	<i>Published toxicity data/TRV/ESV (mg/L)</i>
Aluminum	0.048 to 0.140	0.022 to 0.186	0.022 to 0.188	0.450 to 0.727	LOEC <1.5 mg /L @ pH 8 (Freeman and Everheart, 1971)
					Neville (1985) NOEC 0.075 mg/L
					US EPA TRV (1988) 0.087 mg/L
					Suter and Tsao (1996) lowest chronic value 0.460 mg/L (aquatic plants)
					Suter and Tsao (1996) lowest chronic value 1.9 mg/L (Daphnids)
Antimony	0.0001 to 0.00027	0.0001 to 0.0025	0.0001 to 0.0025	0.02 to 0.029	US EPA TRV (1987) 0.03
					Region IV Ambient Water Quality Values (EPA 1995) 0.160 mg/L
					Suter and Tsao (1996) lowest chronic value 0.610 mg/L (aquatic plants)
					Suter and Tsao (1996) lowest chronic value 1.6 mg/L (fish)
					LOEC (7d-LC ₅₀) for <i>Gastrophyne carolinensis</i> of 0.3 mg/L ⁴

⁴ SCIENTIFIC CRITERIA DOCUMENT FOR THE DEVELOPMENT OF AN INTERIM PROVINCIAL WATER QUALITY OBJECTIVE FOR ANTIMONY - JANUARY 1996-Ontario Ministry of Environment and Energy

Parameter	Fish Lake range (mg/L)	Upper Fish Cr range (mg/L)	Tributary 1 range (mg/L)	Pit Lake range (mg/L)	Published toxicity data/TRV/ESV (mg/L)
Arsenic	0.0001 to 0.0016	3.24E-0.8 to 0.0023	3.1E-0.8 to 0.00228	0.008 to 0.012	28-d LOEC 0.01 mg/L
					28-d LC ₅₀ 0.550 mg/L Rainbow Trout (Birge et al., 1979)
					<i>D. magna</i> LOEC 0.02 mg/L (BC guideline document)
					No Observed Effect Concentration 0.01 mg/L
					14-d EC ₅₀ 0.05 mg/L (CCME)
Boron	0.073 to 1.593	0.029 to 3.6	0.029 to 3.6	0.514 to 0.684	48h-LC ₅₀ for <i>D. magna</i> 52.4 mg/L in 100 mg/L hardness MELP (1996)
					(LOEL) of 12.3 mg/L (growth) <i>Selenastrum capricornutum</i>
					(NOEC) 21d chronic <i>Daphnia</i> 13.1 mg/L (in well water) (MELP, 1996)
					(MELP, 1996) NOEC 12.4 mg/L (MELP, 1996)
Cadmium	0.0000699 to 0.000135	0.000067 to 0.000136	0.000067 to 0.000136	0.00056 to 0.000831	Suter and Tsao (1996) lowest chronic value 0.00015 mg/L (Daphnids) and lowest chronic value 0.0017 mg/L (fish)
					48-h LC ₅₀ 0.007 (Baird et al., 1991)
					LOEL of 0.00017 mg/L for <i>Daphnia magna</i> (CCME)
Copper	0.0008 to 0.0052	0.0003 to 0.0083	0.0003 to 0.0082	0.018 to 0.0272	78-d growth EC ₅₀ 0.046 mg/L (Seim et al., 1984)
					30-d 0.032 mg/L (LOEL) (McKim et al., 1978)
					30-d 0.01 mg/L (NOEL) (McKim et al., 1978)
					6-h EC ₅₀ 0.018 mg/L to 0.087 mg/L (Wang et al., 2007)
					24-h EC ₅₀ 0.01 - 0.066 (Wang et al., 2007)
					0.002 mg/L minimum guideline value (Demayo and Taylor 1991- reported in CCME summary table of guidelines ⁵)
Iron ⁶	0.36 to 1.17	0.30 to 1.96	0.30 to 1.83	2.198 to 3.754	96-h LC ₅₀ 3.5 mg/L
					96-h LC ₅₀ 3.6 mg/L (BC)
					EC ₅₀ 7.48 mg/L <i>Daphnia</i> (Billard and Roubaud, 1985)
					NOEC 5.3 mg/L <i>Daphnia</i> (PESC, 1997/98)

⁵ <http://st-ts.ccme.ca/>

⁶ Toxicity data reported in Ministry of Environment Overview Report – Ambient Water Quality Guidelines for Iron

Parameter	Fish Lake range (mg/L)	Upper Fish Cr range (mg/L)	Tributary 1 range (mg/L)	Pit Lake range (mg/L)	Published toxicity data/TRV/ESV (mg/L)
Lithium	0.002 to 0.039	0.001 to 0.084	0.001 to 0.084	0.013 to 0.017	0.014 mg/L secondary chronic value (Suter and Tsao, 1996)
					0.260 secondary acute value (Suter and Tsao, 1996)
Selenium	0.0003 to 0.005	0.0003 to 0.0087	0.0003 to 0.0086	0.008 to 0.011	<i>S. capricornutum</i> 72-h EC ₅₀ 0.075 mg/L (Foe and Knight, Manuscript – reported in MWLAP, 2001)
					EC ₅₀ growth 0.012 mg/L to 5 mg/L (Rainbow Trout)
					US EPA TRV (1999) 0.005
					LOEL of 0.01 (BC) (MWLAP, 2001)
Silver	0.000044 to 0.000195	0.00003 to 0.00039	0.00003 to 0.00039	0.00014 to 0.00017	Hardness <100 mg/L (NOEL) 0.00006 mg/L
					Hardness <100 mg/L (chronic) 0.0001 mg/L
					Hardness <100 mg/L (acute) 0.00039 mg/L
					Hardness >100 mg/L (chronic) 0.0029 mg/L
					Suter and Tsao (1996) lowest chronic value 0.00012 mg/L (Daphnids)
					NOEC (0.004 mg/L / 0.005 mg/L) <i>Ceriodaphnia</i> (Weber et al., 1989)
Sulphate	2.78 to 173.07	1.0 to 307.32	1.0 to 301.31	326.294 to 520.509	7-d LC ₅₀ K ₂ SO ₄ 100 (reported in BC MOE, 2000)
					1, 2, 3, and 4 day LC ₀ (no effect) of 500, 100, 100, and 100 mg/L for <i>Morone saxatilis</i> larvae (reported in BC MOE, 2000)
					1, 2, 3 and 4-d LC ₅₀ of 2,000, 1,000, 500 and 250 mg/L for <i>Morone saxatilis</i> larvae (reported in BC MOE, 2000)
					<i>Fontinalis antipyretica</i> EC ₅₀ (Chlorophyll a and b) 400 mg/L (Davies, 2006)
Thallium	0.00013 to 0.00223	0.00005 to 0.008	0.00005 to 0.008	0.0007 to 0.009	Birge (1978) 28-d LC ₅₀ 0.170 mg/L for Rainbow Trout
					Suter and Tsao (1996) lowest chronic value 0.057 mg/L (fish)
					Suter and Tsao (1996) lowest chronic value 0.130 mg/L (Daphnids)
					10-d EC ₅₀ values of 0.033 mg/L, 0.0418 mg/L and 0.048 mg/L
					LOEL values of 0.0084 mg/L, 0.0146 mg/L and 0.0167 mg/L
					14-d EC ₅₀ 0.008 mg/L (Brown and Rattigan, 1979) (CCME/BC)

Note: Silver values associated with hardness taken from MOELP (MINISTRY OF ENVIRONMENT, LANDS AND PARKS) PROVINCE OF BRITISH COLUMBIA AMBIENT WATER QUALITY CRITERIA FOR SILVER (1996). WARRINGTON, Ph. D, R. P. Bio.

4.3 Assessment of Predicted Water Quality in the Fish Lake System Using the Biotic Ligand Model (BLM)

The Biotic Ligand Model (BLM) was applied to the predicted exceedances of copper, cadmium, and silver for all phases of the Project. The BLM uses published toxicity data for fish and invertebrate species including Rainbow Trout (*Oncorhynchus mykiss*), *Daphnia magna*, *D. pulex*, and *Ceriodaphnia dubia* in combination with ambient water quality data (Table 7) to predict the toxicity of copper, silver, cadmium (and zinc) to aquatic life under a given set of conditions. The BLM generates LC₅₀ values for these metals in the context of the mitigating effects of parameters like dissolved organic matter (DOM), hardness, sodium, sulphide, and others on metal toxicity. A combination of baseline data (e.g., dissolved organic carbon) and predicted concentrations for the BLM input parameters were used to run the model for this assessment. Input data used to run the BLM are provided in Appendix 2.7.2.4B-E. Consideration of background water quality as provided for in the BLM is necessary in order to best understand and predict the potential effects of predicted water quality effects on Rainbow Trout.

Table 7. BLM input parameters and limiting ranges

Parameter	Model Input Range
Temperature °C	10°C to 25°C
pH	4.9 to 9.2
Dissolved organic carbon (DOC)	0.05 mg/L to 29.65 mg/L
Dissolved inorganic carbon (DIC)	0.056 mmol/L to 44.92 mmol/L
Humic Acid Content (%)	10% to 60%
Calcium (Ca)	0.204 mg/L to 120.24 mg/L
Magnesium (Mg)	0.024 mg/L to 51.8 mg/L
Alkalinity	1.99 mg/L to 360 mg/L
Sodium (Na)	0.16 mg/L to 236.9 mg/L
Potassium (K)	0.039 mg/L to 156 mg/L
Sulphate (SO ₄)	0.096 mg/L to 278.4 mg/L
Chloride (Cl ⁻)	0.32 mg/L to 279.72 mg/L
Sulfide (SO ₂)	1E-10 mg/L (default value)

Note: DIC data not available, BLM uses alkalinity and pH to estimate DIC

None of the predicted maximum concentrations of copper, cadmium, and silver exceeded the LC₅₀ values generated with the BLM. A comparison of the lowest LC₅₀ values generated by the model and the maximum predicted concentrations of copper, cadmium, and silver in Fish Lake, Upper Fish Creek, and Tributary 1 is provided in Tables 8 through 10.

Table 8. BLM LC₅₀ values for dissolved copper, cadmium, and silver compared with predicted average and maximum concentrations of copper, cadmium, and silver in Fish Lake

Most sensitive test organism	Dissolved cadmium LC ₅₀ values generated with BLM for Fish Lake					
	Fish Lake		Predicted max concentration	Fish Lake		Predicted concentration (highest average)
	mol/L	mg/L		mol/L	mg/L	
Rainbow Trout	1.892E-07	0.0213	0.000135	1.441E-07	0.0162	0.000098
Most sensitive test organism	Dissolved copper LC ₅₀ values generated with BLM for Fish Lake					
	Fish Lake		Predicted max concentration	Fish Lake		Predicted concentration (highest average)
	mol/L	mg/L		mol/L	mg/L	
<i>Daphnia pulex</i>	3.659E-06	0.233	0.0052	3.507E-06	0.223	0.0028
Most sensitive test organism	Dissolved silver LC ₅₀ values generated with BLM for Fish Lake					
	Fish Lake		Predicted max concentration	Fish Lake)		Predicted concentration (highest average)
	mol/L	mg/L		mol/L	mg/L	
<i>Daphnia magna</i>	1.03E-08	0.00111	0.000195	9.82E-09	0.00106	0.00011

Table 9. BLM LC₅₀ values for dissolved copper, cadmium, and silver compared with predicted average and maximum concentrations of copper, cadmium, and silver in Upper Fish Creek

Most sensitive test organism	Dissolved cadmium LC ₅₀ values generated with BLM for Upper Fish Creek					
	Upper Fish Creek		Predicted max concentration	Upper Fish Creek		Predicted concentration (highest average)
	mol/L	mg/L		mol/L	mg/L	
Rainbow Trout	1.93E-07	0.02168	0.000135	1.48E-07	0.01658	0.000098
Most sensitive test organism	Dissolved copper LC ₅₀ values generated with BLM for upper Fish Creek					
	Upper Fish Creek		Predicted max concentration	Upper Fish Creek		Predicted concentration (highest average)
	mol/L	mg/L		mol/L	mg/L	
<i>Daphnia pulex</i>	3.140E-06	0.200	0.0083	2.899E-06	0.184	0.0032
Most sensitive test organism	Dissolved silver LC ₅₀ values generated with BLM for upper Fish Creek					
	Upper Fish Creek		Predicted max concentration	Upper Fish Creek		Predicted concentration (highest average)
	mol/L	mg/L		mol/L	mg/L	
<i>Daphnia magna</i>	9.895E-09	0.00107	0.00039	9.271E-09	0.001	0.000119

Table 10. Lowest BLM LC₅₀ values for dissolved copper, cadmium, and silver compared with predicted average and maximum concentrations of copper, cadmium, and silver in Tributary 1

Most sensitive test organism	Dissolved cadmium LC ₅₀ values generated with BLM for Trib 1					
	Trib 1		Predicted max concentration	Trib 1		Predicted concentration (highest average)
	mol/L	mg/L		mol/L	mg/L	
Rainbow Trout	1.725E-07	0.01939	0.00014	2.006E-07	0.02255	0.0001
Most sensitive test organism	Dissolved copper LC ₅₀ values generated with BLM for Trib 1					
	Trib 1		Predicted max concentration	Trib 1		Predicted concentration (highest average)
	mol/L	mg/L		mol/L	mg/L	
<i>Daphnia pulex</i>	3.149E-06	0.200	0.008	2.894E-06	0.184	0.003
Most sensitive test organism	Dissolved silver LC ₅₀ values generated with BLM for Trib 1					
	Trib 1		Predicted max concentration	Trib 1		Predicted concentration (highest average)
	mol/L	mg/L		mol/L	mg/L	
<i>Daphnia magna</i>	9.84E-09	0.00106	0.00039	9.257E-09	0.001	0.00012

4.4 **Mixing Points - Beece Creek, Taseko River, Lower Fish Creek, Wasp, Little and Big Onion Lakes**

The predicted mixing point concentrations were evaluated using the same approach applied to the Fish Lake system and Pit Lake. Predicted values were first compared with provincial and federal guidelines (Table 11). Where exceedances were identified, the predicted values were compared with the toxicity data used to develop the guidelines and/or published TRV/ESV. Summaries of the predicted exceedances at the mixing points are provided in Tables 12 to 15. For simplicity, the Beece Creek and Taseko River mixing point summaries are provided separately from the other summaries.

Table 11. Predicted exceedances by mixing point location

<i>Parameter</i>	<i>Provincial and/Federal Guideline Exceedance (Y/N)</i>					
	<i>Beece</i>	<i>Taseko</i>	<i>Lower Fish Creek</i>	<i>Wasp Lake</i>	<i>Little Onion Lake</i>	<i>Big Onion Lake</i>
Aluminum	y	y	y	y	y	y
Arsenic	-	-	-	y	-	-
Beryllium	-	-	-	y	-	-
Cadmium	y	y	y	y	-	-
Copper	y	y	y	y	-	-
Fluoride	-	-	y	y	-	y
Iron	-	-	y	y	-	y
Selenium	-	-	y	y	-	y
Silver	-	-	y	y	-	-
Sulphate	-	-	y	y	-	y
Vanadium	-	-	y	-	-	-

4.4.1 Beece Creek and the Taseko River

Predicted exceedances of available guidelines at the Beece and Taseko mixing points are as follows:

- All aluminum predictions for the Taseko River exceed the provincial 0.1 mg/L guideline. Predicted maximum aluminum in Beece Creek exceeds the maximum guideline (0.1 mg/L) in all periods, with values up to 0.116 mg/L. The mixing point model uses total metals concentrations whereas the guidelines are for dissolved concentrations.

- All predicted cadmium values exceed the provincial and federal guidelines in Beece Creek and the Taseko River.
- Average and maximum copper in the Taseko River exceed the hardness-based 30-day average and maximum guideline values in all operating periods. Predicted Beece Creek concentrations are below the copper guideline values.
- Iron exceeds the provincial and/or federal guidelines in the Taseko River in all operating periods, whereas Beece Creek concentrations are below the dissolved (0.35 mg/L) and total (1 mg/L) guidelines.
- Average (and maximum) silver exceeds the 30-day average guideline value of 0.00005 mg/L @ hardness <100 mg/L.

Table 12. Overview of predicted guideline exceedances for Beece Creek and the Taseko River

<i>Parameter (mg/L)</i>	<i>Beece Creek</i>	<i>Taseko 1</i>	<i>Taseko 2</i>	<i>Taseko 3</i>	<i>BC WQG</i>	<i>CCME WQG</i>
Aluminum	0.011 to 0.0259	0.606 to 1.664	0.606 to 1.664	0.606 to 1.664	0.05 to 0.1 (dissolved)	
Cadmium	0.000025 to 0.00002507	0.000025 (all)	0.000025 (all)	0.000025 to 0.000028	0.00001 @ hardness 25.1	
					0.000013 @ hardness 33.0	
Copper	0.0004 to 0.00145	0.00159 to 0.00489	0.006 to 0.00489	0.006 to 0.005	0.002 (30 d avg)	0.002
					0.00436 to 0.0051(max)	
Iron	0.03 to 0.208	0.33 to 1.238	0.33 to 1.238	0.33 to 1.239	1 (total)	
					0.35 (dissolved)	
Silver	0.00001 to 0.00004	0.00001 to 0.00009	0.00001 to 0.00009	0.00001 to 0.00009	0.00005 @ hardness <100 (30 d avg)	
					0.0001 @ hardness <100 (max)	

Table 13. Summary of predicted exceedances in mixing point data – Beece Creek and Taseko River

Values (mg/L)	Beece Creek					Taseko 1					Taseko 2					Taseko 3					BCWQG 30d avg	BCWQG Max	CCME WQG	
	Years	Years	Years	Years	Years	Years	Years	Years	Years	Years	Years	Years	Years	Years	Years	Years	Years	Years	Years	Years				
	(1 - 16)	(17 - 20)	(21 - 30)	(31 - 47)	(48 - 100)	(1 - 16)	(17 - 20)	(21 - 30)	(31 - 47)	(48 - 100)	(1 - 16)	(17 - 20)	(21 - 30)	(31 - 47)	(48 - 100)	(1 - 16)	(17 - 20)	(21 - 30)	(31 - 47)	(48 - 100)				
Aluminum																								
Min	0.011	0.013	0.013	0.013	0.013	0.606	0.606	0.606	0.606	0.606	0.606	0.606	0.606	0.606	0.606	0.602	0.602	0.602	0.602	0.602	0.05	0.1	0.1	
Average	0.066	0.068	0.073	0.115	0.116	1.019	1.023	1.019	1.019	1.02	1.019	1.023	1.019	1.019	1.02	1.016	1.021	1.017	1.016	1.018				
Max	0.259	0.259	0.259	0.259	0.259	1.664	1.664	1.664	1.664	1.664	1.664	1.664	1.664	1.664	1.657	1.657	1.657	1.657	1.658					
Cadmium																								
Min	0.000025	0.000025	2.5E-05	2.5E-05	2.5E-05	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	2.498E-05	2.498E-05	2.498E-05	2.498E-05	2.498E-05	0.00001 mg/L @ 25.1 hardness and 0.000013 mg/L @ 33.0 mg/L hardness			
Average	2.5E-05	2.5E-05	2.501E-05	2.501E-05	2.501E-05	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025				2.575E-05
Max	2.501E-05	2.501E-05	2.507E-05	2.506E-05	2.503E-05	0.000025	0.000025	2.5E-05	2.5E-05	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025				2.846E-05
Copper																								
Min	0.0004	0.0004	0.0004	0.0004	0.0004	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.002	0.00436 to 0.0051	0.002	
Average	0.0009	0.0009	0.0009	0.0009	0.0009	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029				
Max	0.0014	0.0014	0.0015	0.0014	0.0014	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049				
Iron																								
Min	0.03	0.03	0.03	0.03	0.03	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	-	1 (ttl) 0.35 (diss)	0.3	
Average	0.078	0.078	0.078	0.079	0.079	0.739	0.746	0.741	0.741	0.81	0.739	0.746	0.741	0.739	0.741	0.738	0.745	0.739	0.738	0.743				
Max	0.207	0.207	0.208	0.208	0.208	1.238	1.238	1.238	1.238	1.238	1.238	1.238	1.238	1.238	1.238	1.233	1.233	1.233	1.233	1.239				
Silver																								
Min	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00005 30 d avg @ hardness <100	0.0001 mg/L @ hardness <100	0.0001	
Average	0.00001	0.00001	0.00001	0.00001	0.00001	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006				
Max	0.00004	0.00004	0.00004	0.00004	0.00004	0.00009	0.00009	0.00009	0.00009	0.00009	0.00009	0.00009	0.00009	0.00009	0.00009	0.00009	0.00009	0.00009	0.00009	0.00009				

4.4.2 Lower Fish Creek

Predicted exceedances of the guidelines at the Lower Fish Creek indicate average and/or maximum predicted values exceeding provincial and/or federal guidelines for the following:

- aluminum
- cadmium
- copper
- fluoride
- iron
- mercury
- selenium
- silver
- sulphate

Average and/or predicted values exceeding the provincial and/or federal guideline at both of the Lower Fish Creek mixing points are shown in Table 14. Predicted minimum concentrations were generally below guideline values.

Table 14. Summary of predicted exceedances in mixing point data - Lower Fish Creek

Values (mg/L)	Fish Creek 1	Fish Creek 2	BCWQG 30d avg	BCWQG Max	CCME WQG
	Years (48 - 100)				
Aluminum					
Min	0.006	0.006	0.05 (dissolved)	0.1 dissolved)	0.1 (dissolved)
Average	0.291	0.291			
Max	0.354	0.354			
Arsenic					
Min	0.0002	0.0002	-	0.005	0.005
Average	0.0047	0.0047			
Max	0.0051	0.0051			
Cadmium					
Min	0.000023	0.000025	0.000057		
Average	0.000334	0.000340			
Max	0.000359	0.000359			
Copper					
Min	0.0007	0.0007	0.0075	0.0196	0.004
Average	0.0104	0.0104			
Max	0.0118	0.0118			

Values (mg/L)	Fish Creek 1	Fish Creek 2	BCWQG 30d avg	BCWQG Max	CCME WQG
	Years (48 - 100)				
Fluoride					
Min	0.052	0.052	>2.62 (calculated LC ₅₀)	-	0.12
Average	0.203	0.203			
Max	0.215	0.215			
Iron					
Min	0.096	0.096	-	1 (ttl) 0.35 (diss)	0.3
Average	1.557	1.557			
Max	1.714	1.713			
Mercury					
Min	0.00001	0.00001	0.00002 @ 0.5% MeHg / 0.00000125 @ 8% MeHg		0.000026 (Hg) / 0.000004 (MeHg)
Average	0.000061	0.000061			
Max	0.000065	0.000065			
Selenium					
Min	0.0005	0.0005	0.002	-	0.001
Average	0.00461	0.00461			
Max	0.00483	0.00483			
Silver					
Min	0.00001	0.00001	0.0015	0.003	0.0001
Average	0.0001	0.0001			
Max	0.00011	0.00011			
Sulphate					
Min	0.832	0.832	50 (alert) / 100 (max)		-
Average	180.205	180.152			
Max	217.358	217.295			
Vanadium					
Min	0.0012	0.0017	0.006 mg/L - Ontario water quality objective adopted as BC working guideline		-
Average	0.012	0.01214			
Max	0.0126	0.0126	0.02 mg/L (secondary chronic value)		

4.4.3 Wasp Lake, Little and Big Onion Lake

Predicted exceedances of the guidelines at the Wasp and Onion lakes mixing points are as follows:

- Maximum aluminum exceeds the provincial 0.1 mg/L maximum guideline in Wasp Lake in Year 21 and onward. The 30-day average guideline of 0.05 mg/L is exceeded in all periods in Little and Big Onion lakes.
- Maximum arsenic exceeds the provincial and federal guideline value of 0.005 mg/L in Wasp Lake in Years 21 through 47.
- Maximum beryllium exceedances occur in Wasp Lake in all years.
- Maximum cadmium exceeds the hardness-based provincial and federal guidelines in Wasp Lake in Years 17 and onward.
- Copper exceeds either the 30-day average or the maximum guideline value in Wasp Lake in Year 21 and onward.
- Maximum and average fluoride exceeds the federal guideline of 0.120 mg/L at Wasp and Big Onion lakes in all years, and reaches the guideline level in Little Onion Lake in Years 1-16.
- Maximum and/or average iron exceeds the provincial and federal guidelines in Wasp Lake and Big Onion Lake (Years 21 and onward).
- Some minimum, average, and maximum mercury concentrations exceed provincial and/or federal guideline values in Wasp Lake in all years. Average and maximum concentrations in Big Onion Lake exceed guideline values in Years 31 through 47.
- Average and maximum silver concentrations exceeded the federal guideline (0.0001 mg/L) in Wasp Lake in all years.
- Some average and maximum sulphate concentrations exceeded the maximum guideline value of 100 mg/L in Wasp Lake (Years 21 and onward). The 50 mg/L alert level was exceeded in Big Onion Lake in Year 21 and onward.

Table 15. Overview of predicted guideline exceedances for Wasp, Little and Big Onion Lakes

Parameter (mg/L)	Wasp	Little Onion	Big Onion	BC 30 d avg and max WQG	CCME WQG
Aluminum	0.011 to 0.237	0.018 to 0.067	0.015 to 0.076	0.05 to 0.1 (dissolved)	
Arsenic	0.0002 to 0.0064	0.0003 to 0.0006	0.0003 to 0.0012	0.005	
Beryllium	0.0033 to 0.0082	0.0018 to 0.0034	0.0025 to 0.0029	0.0053	-
Cadmium	0.000025 to 0.000389	0.000024 to 0.00003	0.000024 to 0.000056	0.000042 @ hardness 132.1 (Big Onion)	
				0.000116 @ hardness 430.3 (Wasp)	
Copper	0.001 to 0.0177	0.0006 to 0.0009	0.0007 to 0.003	0.0006 to 0.01662	0.0035 to 0.004
				0.016 to 0.041	
Fluoride	0.077 to 0.216	0.102 to 0.119	0.116 to 0.127	>2.44 (calc LC ₅₀)	0.12
Iron	0.075 to 3.514	0.033 to 0.088	0.03 to 0.454	1 (total)	0.3
				0.35 (dissolved)	
Mercury	0.0000099 to 0.001326	0.00001 to 0.0000115	0.0000099 to 0.000938	0.00002 @ 0.5% MeHg	0.000026 (Hg) 0.000004 (MeHg)
				0.00000125 @ 8% MeHg	
Selenium	0.0005 to 0.0142	0.0005 to 0.0007	0.0005 to 0.0017	0.002	0.001
Silver	0.0001 to 0.00017	0.00004 to 0.00007	0.00005 to 0.00006	0.0015 (30 d avg)	0.0001
				0.003 (max)	
Sulphate	1.155 to 648.177	5.875 to 8.323	6.653 to 66.205	50 (alert)	-
				100 (max)	

Table 16. Summary of predicted exceedances in mixing point data – Wasp Lake, Little and Big Onion Lake

Values (mg/L)	Wasp Lake					Little Onion					Big Onion					BCWQG 30d avg	BCWQG Max	CCME WQG	
	Years (1 - 16)	Years (17 - 20)	Years (21 - 30)	Years (31 - 47)	Years (48 - 100)	Years (1 - 16)	Years (17 - 20)	Years (21 - 30)	Years (31 - 47)	Years (48 - 100)	Years (1 - 16)	Years (17 - 20)	Years (21 - 30)	Years (31 - 47)	Years (48 - 100)				
Aluminum																			
Min	0.011	0.018	0.019	0.036	0.036	0.018	0.041	0.041	0.041	0.041	0.015	0.050	0.052	0.063	0.074	0.05	0.1	0.1	
Average	0.016	0.020	0.031	0.114	0.116	0.056	0.057	0.057	0.057	0.057	0.047	0.053	0.064	0.071	0.075				
Max	0.020	0.020	0.191	0.237	0.190	0.067	0.067	0.067	0.067	0.067	0.054	0.055	0.069	0.076	0.076				
Arsenic																			
Min	0.0002	0.0006	0.0006	0.0009	0.0009	0.0003	0.0004	0.0004	0.0004	0.0004	0.0003	0.0006	0.0006	0.0009	0.0011	-	0.005	0.005	
Average	0.0005	0.0007	0.0010	0.0029	0.0030	0.0005	0.0005	0.0005	0.0005	0.0005	0.0006	0.0006	0.0009	0.0010	0.0011				
Max	0.0007	0.0007	0.0052	0.0064	0.0049	0.0006	0.0006	0.0006	0.0006	0.0006	0.0007	0.0007	0.0010	0.0012	0.0012				
Beryllium																			
Min	0.0049	0.0073	0.0053	0.0033	0.0033	0.0018	0.0019	0.0019	0.0019	0.0019	0.0025	0.0025	0.0026	0.0025	0.0027	-	0.0053	-	
Average	0.0069	0.0078	0.0078	0.0042	0.0042	0.0030	0.0030	0.0030	0.0030	0.0030	0.0027	0.0027	0.0028	0.0027	0.0028				
Max	0.0080	0.0081	0.0082	0.0054	0.0045	0.0034	0.0034	0.0034	0.0034	0.0034	0.0028	0.0028	0.0029	0.0029	0.0028				
Cadmium																			
Min	0.000025	0.000046	0.000066	0.000045	0.000044	0.000024	0.000025	0.000025	0.000025	0.000025	0.000025	0.000032	0.000033	0.000041	0.000041	0.000042 @ hardness 132.1 0.000116 @ hardness 430.3			
Average	0.000041	0.000050	0.000293	0.000124	0.000122	0.000028	0.000028	0.000028	0.000028	0.000028	0.000032	0.000034	0.000042	0.000044	0.000048				
Max	0.000050	0.000051	0.000389	0.000388	0.000191	0.000030	0.000030	0.000030	0.000030	0.000030	0.000034	0.000034	0.000046	0.000046	0.000052				
Copper																			
Min	0.0010	0.0016	0.0017	0.0033	0.0033	0.0006	0.0007	0.0007	0.0007	0.0007	0.0007	0.0008	0.0009	0.0020	0.0027	0.00425 to 0.0307	0.0132 to 0.0529	0.00264 to 0.004	
Average	0.0015	0.0018	0.0028	0.0107	0.0108	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0008	0.0008	0.0019	0.0026				0.0028
Max	0.0018	0.0018	0.0180	0.0223	0.0177	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0023	0.0030				0.0030

Values (mg/L)	Wasp Lake					Little Onion					Big Onion					BCWQG 30d avg	BCWQG Max	CCME WQG
	Years (1 - 16)	Years (17 - 20)	Years (21 - 30)	Years (31 - 47)	Years (48 - 100)	Years (1 - 16)	Years (17 - 20)	Years (21 - 30)	Years (31 - 47)	Years (48 - 100)	Years (1 - 16)	Years (17 - 20)	Years (21 - 30)	Years (31 - 47)	Years (48 - 100)			
Fluoride																		
Min	0.092	0.152	0.145	0.077	0.077	0.102	0.102	0.103	0.103	0.103	0.116	0.120	0.119	0.118	0.123	>2.44 (calculated LC ₅₀)	-	0.12
Average	0.140	0.162	0.166	0.129	0.128	0.114	0.114	0.114	0.114	0.114	0.124	0.125	0.123	0.123	0.124			
Max	0.165	0.167	0.194	0.216	0.165	0.120	0.119	0.119	0.119	0.119	0.127	0.127	0.125	0.125	0.124			
Iron																		
Min	0.075	0.169	0.181	0.485	0.483	0.033	0.060	0.060	0.060	0.060	0.030	0.095	0.108	0.276	0.404	-	1 (t/l) 0.35 (diss)	0.3
Average	0.139	0.185	0.353	1.652	1.685	0.076	0.077	0.077	0.077	0.077	0.091	0.102	0.263	0.379	0.429			
Max	0.183	0.196	2.824	3.514	2.796	0.088	0.088	0.087	0.087	0.087	0.105	0.105	0.327	0.454	0.454			
Mercury																		
Min	0.0000099	0.0001549	0.0002203	0.0000254	0.0000299	0.0000098	0.0000100	0.0000100	0.0000100	0.0000100	0.0000099	0.0000114	0.0000115	0.0000126	0.0008300	0.00002 @ 0.5% MeHg / 0.00000125 @ 8% MeHg	0.000026 (Hg) / 0.000004 (MeHg)	
Average	0.0000510	0.0001879	0.0003318	0.0000904	0.0004470	0.0000107	0.0000107	0.0000107	0.0000107	0.0000107	0.0000115	0.0000118	0.0000128	0.0005940	0.0008900			
Max	0.0001692	0.0002356	0.0004279	0.0003596	0.0013255	0.0000111	0.0000112	0.0000112	0.0000112	0.0000112	0.0000120	0.0000120	0.0000134	0.0009380	0.0009380			
Selenium																		
Min	0.0005	0.0008	0.0009	0.0021	0.0020	0.0005	0.0006	0.0006	0.0006	0.0006	0.0005	0.0006	0.0007	0.0014	0.0015	0.002	-	0.001
Average	0.00076	0.00089	0.00150	0.00677	0.00675	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0007	0.0013	0.0015	0.0016			
Max	0.0009	0.0009	0.01138	0.01417	0.01087	0.0007	0.0007	0.0007	0.0007	0.0006	0.0007	0.0007	0.0016	0.0017	0.0017			
Silver																		
Min	0.00010	0.00015	0.00012	0.00007	0.00007	0.00004	0.00004	0.00004	0.00004	0.00004	0.00005	0.00005	0.00005	0.00005	0.00006	0.0015	0.003	0.0001
Average	0.00014	0.00016	0.00016	0.00011	0.00011	0.00006	0.00006	0.00006	0.00006	0.00006	0.00005	0.00005	0.00006	0.00006	0.00006			
Max	0.00016	0.00016	0.00017	0.00016	0.00013	0.00007	0.00007	0.00007	0.00007	0.00007	0.00006	0.00006	0.00006	0.00006	0.00006			
Sulphate																		
Min	1.155	4.240	5.262	81.792	81.171	5.875	6.326	6.332	6.332	6.332	6.653	7.302	9.197	44.292	58.379	50 (alert) / 100 (max)	-	
Average	2.482	4.882	35.334	303.000	304.363	7.721	7.739	7.750	7.750	7.750	7.487	7.595	40.769	56.402	62.214			
Max	4.608	5.651	515.631	648.177	506.625	8.305	8.322	8.323	8.323	8.323	7.735	7.817	52.943	66.205	66.108			

4.5 Comparison of Predicted Exceedances at the Mixing Points with Published Toxicity Data

4.5.1 Lower Fish Creek

A comparison of the Lower Fish Creek water quality predictions and the toxicity data used to establish guideline values or published TRV/ESV values is provided in Table 17. Average and maximum predicted values exceeded the toxicity data and/or TRV/ESV values as follows:

- Aluminum is above the US EPA TRV of (1988) 0.087 mg/L.
- Cadmium is above the 0.00017 mg/L LOEL value used to establish the original CCME water quality guideline.
- Copper is above the 0.002 mg/L minimum guideline (Demayo and Taylor, 1981) used by the CCME.
- Sulphate is above the Frahm (1975) concentration of 100 mg/L for *Fontinalis*.

Table 17. Comparison of toxicity data used to establish guideline values or published TRV/ESV values with predicted Lower Fish Creek exceedances

Values (mg/L)	Fish Creek 1	Fish Creek 2	Toxicity data used to develop guideline	Toxicity reference values/benchmarks
Aluminum	0.291 to 0.354	0.291 to 0.354	US EPA TRV (1988) 0.087 mg/L	
			Suter and Tsao (1996) lowest chronic value 0.460 mg/L (aquatic plants)	
			Suter and Tsao (1996) lowest chronic value 1.9 mg/L (Daphnids)	
Cadmium	0.000334 to 0.000359	0.00034 to 0.000359	LOEL of 0.00017 mg/L for <i>Daphnia magna</i> (CCME)	
			48-h LC ₅₀ 0.007 (Baird et al., 1991)	
			Suter and Tsao (1996) lowest chronic value 0.00015 mg/L (Daphnids)	
			Suter and Tsao (1996) lowest chronic value 0.0017 mg/L (fish)	
Copper	0.0104 to 0.0118	0.0104 to 0.0118	0.002 mg/L minimum guideline (Demayo and Taylor, 1981)	
			6-h EC ₅₀ 0.018 mg/L to 0.087 mg/L (Wang et al., 2007)	
			30-d 0.032 mg/L (LOEL) (McKim et al., 1978)	
Sulphate	180.205 to 217.358	180.152 to 217.295	7-d LC ₅₀ K ₂ SO ₄ 100	
			1, 2, 3, and 4 day LC ₀ (no effect) of 500, 100, 100, and 100 mg/L for <i>Morone saxatilis</i> larvae ; 1, 2, 3 and 4-d LC ₅₀ of 2,000, 1,000, 500 and 250 mg/L for <i>Morone saxatilis</i> larvae	
			<i>Fontinalis antipyretica</i> EC ₅₀ (Chlorophyll a and b) 400 mg/L - (Davies, 2006)	

4.5.2 Beece Creek and Taseko River

A comparison of the Beece and Taseko predicted water quality and the toxicity data used to establish guideline values or published TRV/ESV values is provided in Table 18. Examples of predicted copper values in excess of the 0.002 mg/L minimum guideline (Demayo and Taylor, 1981) used by the CCME were noted for the Taseko River mixing points. Some aluminum concentrations also exceeded published TRV for 0.087 mg/L (US EPA, 1988), although average baseline total aluminum in the Taseko River ranged from 0.652 mg/L to 0.999 mg/L, and maximum values ranged from 1.19 mg/L to 3.98 mg/L. The predicted cadmium concentrations were below the 0.00017 mg/L LOEL for *Daphnia* used to establish the original CCME guideline value.

Table 18. Comparison of toxicity data used to establish guideline values or published TRV/ESV values with predicted water quality exceedances at the Beece and Taseko River mixing points

<i>Parameter</i>	<i>Beece Creek</i>	<i>Taseko River (T1)</i>	<i>Taseko River (T2)</i>	<i>Taseko River (T3)</i>	<i>Published toxicity data/TRV/ESV (mg/L)</i>
Aluminum	0.066 to 0.259	0.606 to 1.664	0.606 to 1.664	0.602 to 1.658	LOEC <1.5 mg /L @ pH 8 (Freeman and Everheart, 1971)
					Neville (1985) NOEC 0.075 mg/L
					US EPA TRV (1988) 0.087 mg/L
					Suter and Tsao (1996) lowest chronic value 0.460 mg/L (aquatic plants)
					Suter and Tsao (1996) lowest chronic value 1.9 mg/L (Daphnids)
Copper	0.0004 to 0.00145	0.00286 to 0.00489	0.00286 to 0.00489	0.00158 to 0.004897	78-d growth EC ₅₀ 0.046 mg/L (Seim et al., 1984)
					30-d 0.032 mg/L (LOEL) (McKim et al., 1978)
					30-d 0.01 mg/L (NOEL) (McKim et al., 1978)
					6-h EC ₅₀ 0.018 mg/L to 0.087 mg/L (Wang et al., 2007)
					24-h EC ₅₀ 0.01 - 0.066 (Wang et al., 2007)
					0.002 mg/L minimum guideline (Demayo and Taylor, 1981)

4.5.3 Wasp Lake, Little, and Big Onion Lakes

A comparison of the Wasp and Onion lakes predicted water quality and the toxicity data used to establish guideline values or published TRV/ESV values is provided in Table 19 and summarized below:

- Aluminum exceeds the Neville (1985) NOEC of 0.075 mg/L and/or the US EPA TRV (1988) 0.087 mg/L in Wasp and Big Onion lakes.
- Beryllium exceeds the Suter and Tsao (1996) lowest chronic value of 0.0053 mg/L for Daphnids at Wasp Lake.
- Cadmium exceeds the 0.00017 mg/L LOEL cadmium value used to establish the CCME guideline in Wasp Lake, but not in the Onion Lakes.
- Copper exceeds the 0.002 mg/L minimum guideline (Demayo and Taylor, 1981) in the Wasp and Big Onion mixing points. Maximum copper in Wasp Lake also exceeded the 30-d 0.01 mg/L (NOEL) determined by McKim et al. (1978).
- Mercury (selected maximums) exceed the inorganic mercury LOAEL of 0.00026 mg/L for juvenile Fathead Minnow (*Pimephales promelas*) in Wasp and Big Onion lakes.
- Selenium exceeds the LOEL of 0.01 (MWLAP, 2001) in Wasp Lake and the US EPA TRV (1999) 0.005 mg/L in Little Onion lake.
- Sulphate exceeds the 7-d LC₅₀ potassium sulphate (K₂SO₄) of 100 mg/ L (Frahm, 1975) in Wasp Lake.

Table 19. Comparison of toxicity data used to establish guideline values or published TRV/ESV values with predicted water quality exceedances at the Wasp and Onion Lake mixing points

Parameter	Wasp Lake	Little Onion Lake	Big Onion Lake	Published toxicity data/TRV/ESV (mg/L)
Aluminum	0.114 to 0.237	0.056 to 0.067	0.053 to 0.076	LOEC <1.5 mg /L @ pH 8 (Freeman and Everheart, 1971)
				Neville (1985) NOEC 0.075 mg/L
				US EPA TRV (1988) 0.087 mg/L
				Suter and Tsao (1996) lowest chronic value 0.460 mg/L (aquatic plants)
				Suter and Tsao (1996) lowest chronic value 1.9 mg/L (Daphnids)
Beryllium	0.0054 to 0.0082	0.0018 to 0.0034	0.0025 to 0.0029	Suter and Tsao (1996) lowest chronic value 0.057 mg/L (fish)
				Suter and Tsao (1996) lowest chronic value 100 mg/L (aquatic plants)
				Suter and Tsao (1996) lowest chronic value 0.0053 mg/L (Daphnids)
Cadmium	0.000191 to 0.000389	0.000024 to 0.00003	0.000025 to 0.000052	Suter and Tsao (1996) lowest chronic value 0.00015 mg/L (Daphnids)
				Suter and Tsao (1996) lowest chronic value 0.0017 mg/L (fish)
				48-h LC ₅₀ 0.007 (Baird et al., 1991)
				LOEL of 0.00017 mg/L for <i>Daphnia magna</i> (CCME)
Copper	0.01069 to 0.0223	0.0006 to 0.000947	0.0007 to 0.003	78-d growth EC ₅₀ 0.046 mg/L (Seim et al., 1984)
				30-d 0.032 mg/L (LOEL) (McKim et al., 1978)
				30-d 0.01 mg/L (NOEL) (McKim et al., 1978)
				6-h EC ₅₀ 0.018 mg/L to 0.087 mg/L (Wang et al., 2007)
				24-h EC ₅₀ 0.01 - 0.066 (Wang et al., 2007)
				0.002 mg/L minimum guideline (Demayo and Taylor, 1981)

Parameter	Wasp Lake	Little Onion Lake	Big Onion Lake	Published toxicity data/TRV/ESV (mg/L)
Mercury	0.000155 to 0.000133	0.0000098 to 0.0000112	0.0000099 to 0.0000938	Suter and Tsao (1996) lowest chronic value <0.00023 mg/L (fish)
				Suter and Tsao (1996) lowest chronic value 0.00096 mg/L (Daphnids)
				Suter and Tsao (1996) lowest chronic value 0.0005 mg/L (aquatic plants)
				Organic Hg LOAEL of 0.00004 mg/L, <i>D. magna</i> , Biesinger et al. (1982)
				Inorganic Hg LOAEL of 0.00026 mg/L, juvenile Fathead Minnow (<i>Pimephales promelas</i>)
Selenium	0.0068 to 0.0142	0.0005 to 0.0006	0.0005 to 0.0017	<i>S. capricornutum</i> 72-h EC ₅₀ 0.075 mg/L (Foe and Knight, Manuscript)
				EC ₅₀ growth 0.012 mg/L to 5 mg/L (Rainbow Trout)
				US EPA TRV (1999) 0.005
				LOEL of 0.01 (BC) (MWLAP, 2001)
Silver	0.00011 to 0.00017	0.000035 to 0.000069	0.00005 to 0.0000605	Hardness <100 mg/L (NOEL) 0.00006 mg/L
				Hardness <100 mg/L (chronic) 0.0001 mg/L
				Hardness <100 mg/L (acute) 0.00039 mg/L
				Hardness >100 mg/L (chronic) 0.0029 mg/L
				Suter and Tsao (1996) lowest chronic value 0.00012 mg/L (Daphnids)
				NOEC (0.004 mg/L /0.005 mg/L) <i>Ceriodaphnia</i> (Weber et al., 1989)
Sulphate	303 to 648.17	5.876 to 8.323	6.653 to 66.205	7-d LC ₅₀ K ₂ SO ₄ 100 (BC)
				1, 2, 3, and 4 day LC ₀ (no effect) of 500, 100, 100, and 100 mg/L for <i>Morone saxatilis</i> larvae (BC)
				1, 2, 3 and 4-d LC ₅₀ of 2,000, 1,000, 500 and 250 mg/L for <i>Morone saxatilis</i> larvae (BC)
				<i>Fontinalis antipyretica</i> EC ₅₀ (Chlorophyll a and b) 400 mg/L - (Davies, 2006)
				205 mg/L at 25 mg/L hardness to 3,711 mg/L at 100 mg/L hardness for Hyallela (MOE, 2000)

4.6 Comparison of Predicted Exceedances with Published Toxicity Data

4.6.1 Lower Fish Creek

Although the predicted average and maximum aluminum values in Lower Fish Creek exceed the TRV of 0.087 mg/L, they are below the Suter and Tsao (1996) lowest chronic value of 0.460 mg/L for aquatic plants and 1.9 mg/L for Daphnids. Average and maximum predicted copper and cadmium exceed the toxicity data and/or guidelines used to develop the CCME guideline values (0.00017 mg Cd/L LOEL for *Daphnia magna* and 0.002 mg Cu/L respectively). Copper concentrations also exceeded the 0.00607 mg/L lowest chronic value for invertebrates (Suter and Tsao, 1996). Cadmium exceeded the 0.00015 mg/L lowest chronic level for Daphnids but was below the secondary chronic value for fish of 0.0017 mg/L, also noted by Suter and Tsao (1996). Sulphate levels exceed the Frahm (1975) level of 100 mg/L but were below the Davies (2006) *Fontinalis antipyretica* EC₅₀ (Chlorophyll a and b) of 400 mg/L.

4.6.2 Beece Creek and Taseko River

Although average and maximum aluminum levels in the Taseko River exceed the Suter and Tsao (1996) lowest chronic value of 0.460 mg/L for aquatic plants, predicted concentrations are below the 1.9 mg/L for Daphnids. Beece Creek levels were below the lowest chronic value of 0.460 mg/L for aquatic plants. Copper levels were above the 0.002 mg/L concentration derived by Demayo and Taylor (1981), but were below the 24-h EC₅₀ 0.01 to 0.066 reported by Wang et al. (2007) and the 30-d 0.01 mg/L (NOEL) reported by McKim et al. (1978).

4.6.3 Wasp, Little and Big Onion Lake

- Predicted aluminum in Wasp and Big Onion lakes are below the Suter and Tsao (1996) lowest chronic value of 0.460 mg/L for aquatic plants and 1.9 mg/L for Daphnids.
- Beryllium at Wasp Lake exceeds the lowest chronic effect level of 0.0053 mg/L, which has been adopted as the provincial working water quality guideline.
- Cadmium exceeds the LOEL of 0.00017 mg/L for *Daphnia magna* (CCME) and the Suter and Tsao (1996) lowest chronic value 0.00015 mg/L (Daphnids), but is below the 0.002 mg/L secondary chronic value for aquatic plants and the 0.0017 mg/L secondary chronic value for fish.
- Copper levels at Wasp Lake exceed the 30-d 0.01 mg/L (NOEL) reported by McKim et al. (1978) but not the 30-d 0.032 mg/L (LOEL) (McKim et al., 1978). Copper levels at Big Onion Lake exceed the 0.002 mg/L concentration derived by Demayo and Taylor (1981).
- Mercury levels in Wasp and Big Onion lakes exceed the mercury used to establish the CCME guideline values (e.g., Inorganic Hg LOAEL of 0.00026 mg/L, juvenile Fathead Minnow). However, they are below the lowest chronic value of 0.00096 mg/L for Daphnids (Suter and Tsao, 1996).
- Selenium levels in Wasp Lake exceed the LOEL of 0.01 mg/L d (MWLAP, 2001) used to establish the provincial guideline, but are below the lowest chronic values for aquatic

plants (0.10 mg/L), fish (0.0883 mg/L), and Daphnids (0.0917 mg/L) (Suter and Tsao, 1996).

- Silver in Wasp Lake exceeds the Suter and Tsao (1996) lowest chronic value of 0.00012 mg/L (Daphnids), but is below the lowest chronic values of 0.0026 mg/L for Daphnids and 0.03 mg/L for aquatic plants⁷.
- Maximum predicted sulphate exceeds the lowest LC₅₀ value of 100 mg/L for *Fontinalis* derived by Frahm (1975) and the no observable effect in chlorophyll levels to *F. noemexicana* at 500 mg/L (hardness of 160 mg/L) reported by Beak International Incorporated and Michigan Technological University (1998).

4.7 Assessment of Predicted Water Quality at the Mixing Points with the BLM

The BLM was applied to maximum predicted cadmium, copper, and silver exceedances at selected mixing points (Beece Creek, Lower Fish Creek, Taseko River, and Wasp Lake – Table 20). As a starting point, the model was run on the highest predicted maximum concentrations at each of the mixing points. Thereafter, predicted averages were evaluated for selected parameters. Using the maximums was considered a conservative approach to evaluating the data. The predicted averages are considered more reflective of the conditions that will occur. Cadmium, copper, or silver guideline exceedances were not noted in the Little and Big Onion datasets, and as a result, those mixing points were not evaluated with the BLM. Similarly, silver exceedances were only predicted at Wasp Lake and Lower Fish Creek. A combination of baseline and predicted water quality data were used to run the BLM on the mixing points. Given the BLM temperature restriction of $\geq 10^{\circ}\text{C}$ ⁸, we used baseline pH and dissolved organic carbon values corresponding with temperatures $\geq 10^{\circ}\text{C}$. In some cases, only total organic carbon (TOC) data were available, and these were used to run the model. Predicted ambient conditions from the period the maximum value occurred were used in the model.

⁷ Silver toxicity values for Daphnids and aquatic plants from Suter and Tsao

⁸ The BLM input temperature range is 10°C to 25°C

Table 20. BLM results for cadmium and silver at mixing points with predicted guideline exceedances

Most sensitive test organism (identified with BLM modelling)	Dissolved cadmium LC ₅₀ values generated with BLM using predicted maximums								
	Beece			Taseko 1			Taseko 3		
Rainbow Trout	mol/L	mg/L	Predicted max (mg/L)	mol/L	mg/L	Predicted max (mg/L)	mol/L	mg/L	Predicted max (mg/L)
	1.76E-08	0.00197	0.000025	1.82E-08	0.00204	0.000025	1.92E-08	0.0022	0.0000285
	Wasp			Fish Creek 1			Fish Creek 2		
	mol/L	mg/L	Predicted max (mg/L)	mol/L	mg/L	Predicted max (mg/L)	mol/L	mg/L	Predicted max (mg/L)
	4.84E-07	0.0544	0.000389	2.57E-07	0.0294	0.00036	2.60E-07	0.0325	0.00036
<i>Daphnia magna</i>	Dissolved silver LC ₅₀ values generated with BLM using predicted maximums								
	Wasp			Fish Creek 1			Fish Creek 2		
	mol/L	mg/L	Predicted max mg/L	mol/L	mg/L	Predicted max mg/L	mol/L	mg/L	Predicted max mg/L
	1.11E-08	0.0012	0.00017	9.42E-09	0.00102	0.00011	9.44E-09	0.00102	0.00011

Maximum predicted copper levels were below the LC₅₀ generated by the BLM for Wasp Lake, Lower Fish Creek, and one of two mixing points in the Taseko River. The maximum predicted copper concentration at Taseko 1 was 0.0049 mg/L, and the corresponding lowest LC₅₀ (for *Daphnia pulex*) was 0.0044 mg/L. The remaining LC₅₀ values generated for *Ceriodaphnia* and *Daphnia magna* were 0 below the BLM generated LC₅₀. Once again, it is important to note the BLM predicts the dissolved concentrations and the mixing point model predicts total concentrations. As a result, the predicted maxima may be considered conservative estimates of potential toxicity relative to the BLM results. However, given the modelled exceedance of the LC₅₀ copper value for *Ceriodaphnia* using maximum predicted concentrations, modelling was also conducted on predicted averages for the mixing points and these results are shown in Table 21^{9,10}. Consistent with the approach of modelling the maximums, the averages were modelled in the context of the concurrent predicted average ambient conditions for the BLM input parameters (Ca, Mg, Na, Cl, SO₄, alkalinity, pH, temperature etc.). Note that average cadmium values were modelled along with average copper values. The analysis of the lowest average cadmium and copper concentrations (generally consistent with lower hardness values) indicated no

⁹ Note: copper and cadmium analyses were run on the water bodies with the lowest hardness values (Beece and Taseko River) as these would be reflective of the most sensitive mixing points. Average Beece Creek copper levels did not exceed guideline values

¹⁰ Both copper and cadmium were modelled for information purposes.

exceedances of the predicted LC₅₀ values for these parameters. Additionally, we reviewed the entire pH baseline dataset from the closest historical Taseko River station and found an average pH of 7.39 (consistent with the mean lab pH of 7.4 reported for all historical Taseko sampling stations between 1992 and 2007)¹¹. Using this pH value, the predicted average and maximum values were below the BLM generated LC₅₀ at Taseko 1 (Table 22).

¹¹ See Taseko Prosperity Gold-Copper Project, VOLUME 5: BIOTIC ENVIRONMENT, SECTION 2: WATER QUALITY AND AQUATIC ECOLOGY, BASELINE REPORT, April 2007. Appendix 5-2-A, Appendix Table B9-2: Summary for Taseko River, All Sites and All Dates, 1992 to 2007

Table 21. BLM results for copper at mixing points with predicted guideline exceedances

Test organism	WASP LC₅₀ - dissolved copper - 10 °C											
	mol/L	mg/L	Pred avg (1)	mol/L	mg/L	Pred avg (2)	mol/L	mg/L	Pred max (1)	mol/L	mg/L	Pred max (2)
Daphnia pulex	4.87E-06	0.3096	0.0015	5.44E-06	0.34544	0.0107	4.96E-06	0.31487	0.0018	6.04E-06	0.38356	0.0223
	LOWER FISH CREEK 1 LC₅₀ -dissolved cadmium - 12.84°C						LOWER FISH CREEK 2 LC₅₀ -dissolved cadmium - 11.52°C					
	mol/L	mg/L	Pred avg (1)	mol/L	mg/L	Pred max (1)	mol/L	mg/L	Pred avg (1)	mol/L	mg/L	Pred max (1)
	3.17E-06	0.2014	0.0104	3.18E-06	0.20208	0.0104	3.01E-06	0.19146	0.01181	3.01E-06	0.19146	0.0118
	LOWER FISH CREEK 1 LC₅₀ -dissolved cadmium - 20.5°C						LOWER FISH CREEK 2 LC₅₀ -dissolved cadmium -20.5°C					
	mol/L	mg/L	Pred avg (1)	mol/L	mg/L	Pred max (1)	mol/L	mg/L	Pred avg (1)	mol/L	mg/L	Pred max (1)
	3.48E-06	0.2212	0.0104	3.49E-06	0.22197	0.0104	3.47E-06	0.2205	0.01181	3.47E-06	0.2205	0.0118
	TASEKO 1 LC₅₀ -dissolved copper - 12.19°C											
	mol/L	mg/L	Pred avg (1)	mol/L	mg/L	Pred avg (2)	mol/L	mg/L	Pred max (1)	mol/L	mg/L	Pred max (2)
	6.88E-08	0.0044	0.0029	6.88E-08	0.0044	0.0029	6.89E-08	0.0044	0.0049	6.89E-08	0.0044	0.0049
	TASEKO 3 LC₅₀ -dissolved copper - 12.18°C											
	mol/L	mg/L	Pred avg (1)	mol/L	mg/L	Pred avg (2)	mol/L	mg/L	Pred max (1)	mol/L	mg/L	Pred max (2)
	1.42E-07	0.009	0.0029	1.42E-07	0.009	0.0029	1.42E-07	0.009	0.0049	1.42E-07	0.009	0.0049

Table 22. BLM results for copper at Taseko River 1 – using baseline pH of 7.39

Test organism	TASEKO 1 LC₅₀ -dissolved copper - 12.19°C - pH of 7.39			
	mol/L	mg/L	Pred avg	Pred max
<i>Daphnia pulex</i>	1.204E-07	0.0077	0.0029	0.0049
	TASEKO 1 LC₅₀ -dissolved copper - 10°C - pH of 7.39			
	mol/L	mg/L	Pred avg	Pred max
	1.198E-07	0.0076	0.0029	0.0049

5.0 Summary Discussion

The modelled water quality data for the mine site and mixing points were evaluated without consideration for mitigation measures such as water treatment and strategic flow diversions (as needed to protect or maintain water quality) – reflecting a conservative approach to identifying potential effects. Water quality guidelines were used as a first step to identify potential effects on water quality, followed by a more in depth review using published toxicity data, ecological risk assessment values (TRV/ESV) and the Biotic Ligand Model (BLM) for cadmium, copper, and silver specifically. The BLM was first used to evaluate maximum predicted concentrations, and was then used to investigate average cadmium and copper concentrations where maximum levels indicated potential exceedances of the BLM LC₅₀ predictions. Water quality guideline exceedances were noted for a variety of predicted average and maximum concentrations. Predicted maximum concentrations in particular exceeded provincial and/or federal guideline values for parameters like aluminum, cadmium, iron, sulphate, selenium, and silver. As indicated at the beginning of this section, (and especially with respect to the stochastic model for the Fish Lake system) the maximum predicted values are not considered typical of the anticipated water quality conditions in the Project area. The predicted averages would be most reflective of anticipated conditions.

The range of modelled averages for parameters showing potential exceedances (either as average or maximum values) for mine site waterbodies is provided in Table 23. With some exceptions by parameter and location (most notably Pit Lake), several predicted average concentrations are below guideline values. Where guideline values are exceeded, the predicted averages are often below the corresponding toxicity data used to establish the guidelines, and/or published TRV/ESV risk assessment values.

Table 23. Overview of predicted averages relative to provincial and federal guideline values – mine site water bodies

Parameter (mg/L)	Mine site water bodies – 5 phases Years 1-16, 17-20, 21-30, 31-47, 48-100				Provincial and federal guidelines		Number of predicted averages above guideline values over the 5 phases
	Fish Lake	Upper Fish Creek	Trib 1	Pit Lake	BC WQG	CCME WQG	
Aluminum	0.083 to 0.098	0.0843 to 0.0911	0.085 to 0.0905	0.602	0.05 ~ 30 d avg 0.1 max		5 of 5 occurrences of >0.05 mg/L 30 d avg in Fish Lake system; Pit Lake average > maximum 0.1
Antimony	0.0003 to 0.0009	0.0003 to 0.001	0.0003 to 0.001	0.025	0.02	-	0 of 5 occurrences in Fish Lake system; Pit Lake average > 0.02 guideline
Arsenic	0.0005 to 0.001	0.0005 to 0.0011	0.00052 to 0.00105	0.01	0.005		0 of 5 occurrences in Fish Lake system; Pit Lake average > 0.005 guideline

Parameter (mg/L)	Mine site water bodies – 5 phases Years 1-16, 17-20, 21-30, 31-47, 48-100				Provincial and federal guidelines		Number of predicted averages above guideline values over the 5 phases
	Fish Lake	Upper Fish Creek	Trib 1	Pit Lake	BC WQG	CCME WQG	
Cadmium	0.000085 to 0.0000978	0.000087 to 0.000096	0.000088 to 0.000093	0.000708	0.000028 (Fish Lake) / 0.000044 (Trib) / 0.000147 (Pit)		5 of 5 occurrences of >0.05 mg/L 30 d avg in Fish Lake system; Pit Lake average > guideline of 0.000147
Cobalt	0.0003 to 0.0005	0.0004 to 0.0005	0.0004 to 0.0006	0.0054	0.004 30d avg 0.110 (max)	-	0 of 5 occurrences in Fish Lake system; Pit Lake average > 0.004 – 30 d avg
Copper	0.0012 to 0.0028	0.0016 to 0.0032	0.0017 to 0.0031	0.0218	0.0091 (Fish Lake) / 0.015 (trib) / 0.056 (Pit)	0.002 (Fish Lake) / 0.003 (Trib) / 0.0097 (Pit)	5 of 5 occurrences in Fish Lake system (either as federal or provincial guidelines); Pit Lake average > 0.0097 (federal guideline)
Fluoride	0.0746 to 0.084	0.076 to 0.081	0.076 to 0.082	0.376	≥1.25	0.12	0 of 5 occurrences in Fish Lake system; Pit Lake average >0.12 guideline
Iron	0.572 to 0.803	0.604 to 0.870	0.596 to 0.884	3.158	0.35 (diss) 1 mg/L (total)	0.3	0 of 5 occurrences in Fish Lake system (provincial total iron); Pit Lake average >1 mg/L guideline; all values above federal guideline of 0.3
Lithium	0.012 to 0.014	0.013 to 0.016	0.013 to 0.015	0.015	0.014 secondary / 0.096 final	-	5 of 5 occurrences in Fish Lake system above secondary chronic value; Pit Lake average above 0.014 – all values below final chronic value of 0.096
Mercury	0.0000003 to 0.0000054	0.00000079 to 0.00000141	0.000001 to 0.000004	0.000124	0.00002 @ 0.5% MeHg	0.000026 (Hg) / 0.000004 (MeHg)	0 of 5 occurrences in Fish Lake system; Pit Lake average > 0.12 guideline
Selenium	0.00058 to 0.00313	0.0005 to 0.0033	0.0006 to 0.003	0.01	0.002	0.001	2 of 5 occurrences in Fish Lake system provincial or federal guideline values in each Fish Lake system water body; Pit Lake average above provincial and federal guidelines (0.002 / 0.001)

Parameter (mg/L)	Mine site water bodies – 5 phases Years 1-16, 17-20, 21-30, 31-47, 48-100				Provincial and federal guidelines		Number of predicted averages above guideline values over the 5 phases
	Fish Lake	Upper Fish Creek	Trib 1	Pit Lake	BC WQG	CCME WQG	
Silver	0.0001 to 0.00011	0.0001 to 0.00012	0.00011 to 0.00012	0.00016	0.0001 (max) Fish Lake / 0.003 mg/L (max) (Trib and Pit Lake)	0.0001	Minimum of 3 of 5 occurrences in Fish Lake system (up to 5 in Trib 1) of provincial and federal 0.0001 guideline; Pit Lake average > federal but not provincial guideline
Sulphate	24.4 to 106.5	18.5 to 116.5	20.7 to 104.7	402.2	50 (alert) / 100 (max)	-	1 of 5 occurrences above 100 mg/L in each water body of the Fish Lake system; Pit Lake avg > 100 guideline
Thallium	0.00079 to 0.000873	0.0008 to 0.0011	0.0009 to 0.001	0.0008	0.0008		Minimum of 3 of 5 occurrences in Fish Lake system
Vanadium	0.009 to 0.01	0.009 to 0.01	0.009 to 0.01	0.024	0.006 / 0.02	-	5 of 5 occurrences in Fish Lake system above 0.006 / 0 of 5 above 0.02; Pit Lake average above 0.02
Zinc	0.003 to 0.005	0.004 to 0.005	0.004 to 0.005	0.043	0.0075 to 0.240 (30 d avg) 0.033 to 0.265 (max) (0.0328 / 0.354 Pit Lake)	0.03	0 of 5 occurrences in Fish Lake system; Pit Lake average > 0.03 federal guideline but below provincial guideline of 0.265 @ hardness ≥ 400

A summary of the relevant toxicity data and/or TRV/ESV for parameters with average predicted concentrations in excess of provincial or federal guideline values is provided in Table 24. Some exceedances of the supporting toxicity data and/or TRV/ESV were noted for aluminum, cadmium, cobalt, copper, lithium, silver, sulphate, vanadium, and zinc – primarily in Pit Lake, but with some occurrences in the Fish Lake system (e.g., aluminum, lithium, sulphate).

Table 24. Comparison of averages (for parameters with guideline exceedances) with published toxicity data/TRV/ESV – mine site water bodies

Parameter (mg/L)	Mine site water bodies				Toxicity values used to establish guideline values and/or relevant TRV/ ESV
	Fish Lake	Upper Fish Creek	Trib 1	Pit Lake	
Aluminum	0.083 to 0.098	0.0843 to 0.0911	0.085 to 0.0905	0.602	US EPA TRV (1988) 0.087 mg/L
					Suter and Tsao (1996) lowest chronic value 0.460 mg/L (aquatic plants)
					Suter and Tsao (1996) lowest chronic value 1.9 mg/L (Daphnids)
Antimony	0.0003 to 0.0009	0.0003 to 0.001	0.0003 to 0.0009	0.025	US EPA TRV (1987) 0.03(secondary chronic) Region IV Ambient Water Quality Values (EPA 1995) 0.160 mg/L
					LOEC (7d-LC ₅₀) for <i>Gastrophyne carolinensis</i> of 0.3 mg/L
Arsenic	0.0005 to 0.001	0.0005 to 0.0011	0.00052 to 0.00105	0.01	14-d EC ₅₀ , growth inhibition, 0.05 mg/L
					(LOEC) for growth 0.02 mg/L, 21-d flow-through chronic bioassay (US pesticide regulatory tests)
					No Observed Effect Concentration (NOEC) 0.0105 mg/L arsenic (US pesticide regulatory tests)
Cadmium	0.000085 to 0.000098	0.000087 to 0.000096	0.000088 to 0.000095	0.000708	0.00017 mg/L LOEL (Daphnia) (CCME factsheet 1999)
					Suter and Tsao (1996) lowest chronic value 0.00015 mg/L (Daphnids)
					Suter and Tsao (1996) lowest chronic value 0.0017 mg/L (fish)
Cobalt	0.0003 to 0.0005	0.0004 to 0.0005	0.0004 to 0.0006	0.0054	Suter and Tsao (1996) lowest chronic value 0.290 mg/L (fish)
					Suter and Tsao (1996) lowest chronic value 0.0051 mg/L (Daphnids)

Parameter (mg/L)	Mine site water bodies				Toxicity values used to establish guideline values and/or relevant TRV/ ESV
	Fish Lake	Upper Fish Creek	Trib 1	Pit Lake	
Copper	0.0012 to 0.0028	0.0016 to 0.0032	0.0017 to 0.0031	0.0218	78-d growth EC ₅₀ 0.046 mg/L (Seim et al., 1984)
					30-d 0.032 mg/L (LOEL) (McKim et al., 1978)
					30-d 0.01 mg/L (NOEL) (McKim et al., 1978)
					6-h EC ₅₀ 0.018 mg/L to 0.087 mg/L (Wang et al., 2007)
					Suter and Tsao (1996) lowest chronic value 0.0038 mg/L (fish)
Fluoride	0.0746 to 0.084	0.076 to 0.082	0.076 to 0.082	0.376	10 mg/L NOEC - <i>Synechococcus leopoliensis</i> - Hekman et al. (1984) ¹²
					0.9 mg/L – Wright (1977) - no mortality - Brown Trout
					144-h LC ₅₀ value of 11.5 mg /L for the caddisfly <i>Hydropsyche bronta</i> - (Camargo et al. 1992; Camargo 1996).
Iron	0.572 to 0.803	0.604 to 0.870	0.596 to 0.884	3.158	3.5 mg/L LC ₅₀ for <i>Hyallela</i> (reported by BC MOE in guideline document)
Lithium	0.012 to 0.014	0.013 to 0.016	0.013 to 0.015	0.015	0.014, secondary chronic value; 0.096 Final chronic value; 0.870 Aquatic maximum value ¹³

¹² Original data reported in MOE (1990) – Ambient Water Quality Criteria for Fluoride

¹³ From BC Compendium of working water quality guidelines

Parameter (mg/L)	Mine site water bodies				Toxicity values used to establish guideline values and/or relevant TRV/ ESV
	Fish Lake	Upper Fish Creek	Trib 1	Pit Lake	
Mercury ¹⁴	0.0000003 to 0.0000054	0.00000079 to 0.00000141	0.000001 to 0.000004	0.000124	LOAEL for inorganic Hg of 0.00026 mg/L Fathead Minnow, Snarski and Olson (1982).
					LOAEL of 0.00004 mg/L (<i>D. magna</i>) (Biesinger et al. 1982) (MeHg)
					(EC ₅₀ s) (invertebrates) 0.00128 mg/L to 0.012 mg/L inorganic Hg (Biesinger et al. 1982; Spehar and Fiandt 1986).
Selenium	0.00058 to 0.00313	0.0005 to 0.0033	0.0006 to 0.003	0.01	Suter and Tsao (1996) lowest chronic value 0.0917 mg/L (Daphnids)
					Suter and Tsao (1996) lowest chronic value 0.0883 mg/L (fish)
					LOEL of 0.01 (BC) (MWLAP, 2001)
Silver	0.0001 to 0.00011	0.0001 to 0.00012	0.00011 to 0.00012	0.00016	Suter and Tsao (1996) lowest chronic value 0.00012 mg/L (Daphnids)
					NOEC (0.004 mg/L /0.005 mg/L) Ceriodaphnia (Weber et al., 1989)
					Hardness >100 mg/L (chronic) 0.0029 mg/L
Sulphate	24.4 to 106.5	18.5 to 116.5	20.7 to 104.7	402.2	7-d LC ₅₀ K ₂ SO ₄ 100 (BC)
					1, 2, 3, and 4 day LC ₀ (no effect) of 500, 100, 100, and 100 mg/L for <i>Morone saxatilis</i> larvae (BC)
					1, 2, 3 and 4-d LC ₅₀ of 2,000, 1,000, 500 and 250 mg/L for <i>Morone saxatilis</i> larvae (BC)
					<i>Fontinalis antipyretica</i> EC ₅₀ (Chlorophyll a and b) 400 mg/L - (Davies, 2006)

¹⁴ Toxicity values shown as reported in CCME factsheet for mercury

Parameter (mg/L)	Mine site water bodies				Toxicity values used to establish guideline values and/or relevant TRV/ ESV
	Fish Lake	Upper Fish Creek	Trib 1	Pit Lake	
Thallium	0.00077 to 0.000873	0.0008 to 0.0011	0.0009 to 0.001	0.0008	Birge (1978) 28-d LC ₅₀ 0.170 mg/L for Rainbow Trout
					Suter and Tsao (1996) lowest chronic value 0.057 mg/L (fish)
					14-d EC ₅₀ 0.008 mg/L. <i>Lemna minor</i> , (Brown and Rattigan, 1979) (CCME / BC)
					<i>Elodea canadensis</i> , 24-h IC ₅₀ and IC ₉₀ values 1.43 and 2.75 mg/L- respectively (Brown and Rattigan, 1979)
Vanadium	0.009 to 0.01	0.009 to 0.01	0.009 to 0.01	0.024	Suter and Tsao (1996) 0.08 mg/L lowest chronic value (fish)
					Suter and Tsao (1996) 1.9 mg/L lowest chronic value (Daphnids)
					Suter and Tsao (1996) secondary chronic value – 0.02 mg/L
Zinc	0.003 to 0.005	0.004 to 0.005	0.004 to 0.005	0.043	(LOEL), 0.015 mg/L, copepod, reported in BC MOE, overview document for zinc guideline - 1999
					Suter and Tsao (1996) 0.0467 mg/L lowest chronic value (Daphnids)
					Suter and Tsao (1996) 0.0364 mg/L lowest chronic value (fish)

Predicted averages at the Beece, Taseko and Lower Fish Creek mixing points indicated some potential exceedances of federal and/or provincial guidelines for many of the same parameters as the mine site water bodies. The bulk of the potential exceedances appear to occur at Lower Fish Creek. A summary of the stream mixing point averages and associated guideline exceedances is provided in Table 25.

Table 25. Overview of predicted averages relative to provincial and federal guideline values – stream mixing points

Parameter (mg/L)	Stream mixing points – 5 phases Years 1-16, 17-20, 21-30, 31-47, 48-100			Provincial and federal guidelines	
	Beece	Taseko	Lower Fish Creek	BC WQG	CCME WQG
Aluminum	0.066 to 0.116	1.016 to 1.023	0.291	0.05 - 30 d avg 0.1 max @ pH >6.5	
Cadmium	0.000025 to 0.000025014	0.000025 to 0.00002575	0.00034	0.000057 (Lower Fish Creek) / 0.00001 - 0.000013 (Beece and Taseko)	
Copper	0.0009	0.0029	0.0104	0.002 (30 d avg); 0.00436 to 0.0051 (max) (Beece /Taseko) 0.0075 / 0.0196 (Lower Fish Creek)	0.002 (Beece and Taseko) 0.004 (Lower Fish Creek)
Fluoride	0.0633 to 0.0645	0.038 to 0.041	0.203	≥1.81	0.12
Iron	0.078 to 0.079	0.739 to 0.810	1.557	0.35 (diss) / 1 (total)	0.3
Mercury	0.00001	0.00001	0.000061	0.00002 @ MeHg 0.5%	0.000026 (inorganic Hg)
Selenium	0.0005 to 0.00051	0.0005 to 0.00051	0.00461	0.002	0.001
Silver	0.00001	0.00006	0.0001	0.00005 (30 d avg - Beece and Taseko); 0.0001 (max) Beece and Taseko; 0.015 (30 d avg - Lower fish Creek) 0.003 (max - Lower Fish Creek)	0.0001
Sulphate	2.86 to 2.99	6.67 to 6.95	180.205 to 180.152	50 (alert) / 100 (max)	-
Vanadium	0.001	0.00231 to 0.00234	0.012 to 0.01214	0.006 / 0.02	-

A comparison of the stream mixing point predicted averages and relevant toxicity data and/or TRV/ESV for parameters in excess of provincial or federal guideline values is provided in Table 26. The bulk of the toxicity data/TRV/ESV exceedances (where they occurred) were at Lower Fish Creek. None were identified for Beece Creek and only predicted aluminum levels in the Taseko River indicated some potential for toxicity data/TRV/ESV exceedances.

Table 26. Comparison of averages (for parameters with guideline exceedances) with published toxicity data/TRV/ESV – stream mixing points

Parameter (mg/L)	Stream mixing points – 5 phases Years 1-16, 17-20, 21-30, 31-47, 48-100			Toxicity values used to establish guideline values and/or relevant TRV/ESV
	Beece	Taseko	Lower Fish Creek	
Aluminum	0.066 to 0.116	1.016 to 1.023	0.291	US EPA TRV (1988) 0.087 mg/L
				Suter and Tsao (1996) lowest chronic value 0.460 mg/L (aquatic plants)
				Suter and Tsao (1996) lowest chronic value 1.9 mg/L (Daphnids)
Cadmium	0.000025 to 0.000025014	0.000025 to 0.00002575	0.00034	0.00017 mg/L LOEL (Daphnia) (CCME)
				Suter and Tsao (1996) lowest chronic value 0.00015 mg/L (Daphnids)
				Suter and Tsao (1996) lowest chronic value 0.0017 mg/L (fish)
Copper	0.0009	0.0029	0.0104	78-d growth EC ₅₀ 0.046 mg/L (Seim et al., 1984)
				30-d 0.032 mg/L (LOEL) (McKim et al., 1978)
				30-d 0.01 mg/L (NOEL) (McKim et al., 1978)
				6-h EC ₅₀ 0.018 mg/L to 0.087 mg/L (Wang et al., 2007)
				Suter and Tsao (1996) lowest chronic value 0.0038 mg/L (fish)
Fluoride	0.0633 to 0.0645	0.038 to 0.041	0.203	10 mg/L NOEC - <i>Synechococcus leopoliensis</i> - Hekman et al., 1984
				0.9 mg/L – Wright (1977) - no mortality - Brown Trout
				144-h LC ₅₀ value of 11.5 mg /L for the caddisfly <i>Hydropsyche bronta</i> - (Camargo et al., 1992; Camargo, 1996).
Iron	0.078 to 0.079	0.739 to 0.810	1.557	3.5 mg/L LC ₅₀ for <i>Hyallela</i> (reported by BC MOE in guideline document)
Mercury	0.00001	0.00001	0.000061	LOAEL for inorganic Hg of 0.00026 mg/L Fathead Minnow, Snarski and Olson (1982)

Parameter (mg/L)	Stream mixing points – 5 phases Years 1-16, 17-20, 21-30, 31-47, 48-100			Toxicity values used to establish guideline values and/or relevant TRV/ESV
	Beece	Taseko	Lower Fish Creek	
				LOAEL of 0.00004 mg/L (<i>D. magna</i>) (Biesinger et al. 1982) (MeHg)
				(EC ₅₀ s) (invertebrates) 0.00128 mg/L to 0.012 mg/L inorganic Hg (Biesinger et al. 1982; Spehar and Fiandt 1986).
Selenium	0.0005 to 0.00051	0.0005 to 0.00051	0.00461	Suter and Tsao (1996) lowest chronic value 0.0917 mg/L (Daphnids)
				Suter and Tsao (1996) lowest chronic value 0.0883 mg/L (fish)
				LOEL of 0.01 (BC) (MWLAP, 2001)
Silver	0.00001	0.00006	0.0001	Suter and Tsao (1996) lowest chronic value 0.00012 mg/L (Daphnids)
				NOEC (0.004 mg/L /0.005 mg/L) Ceriodaphnia (Weber et al., 1989)
				Hardness >100 mg/L (chronic) 0.0029 mg/L
Sulphate	2.86 to 2.99	6.67 to 6.95	180.205 to 180.152	7-d LC ₅₀ K ₂ SO ₄ 100 (BC)
				1, 2, 3, and 4 day LC ₀ (no effect) of 500, 100, 100, and 100 mg/L for <i>Morone saxatilis</i> larvae (BC)
				1, 2, 3 and 4-d LC ₅₀ of 2,000, 1,000, 500 and 250 mg/L for <i>Morone saxatilis</i> larvae (BC)
				<i>Fontinalis antipyretica</i> EC ₅₀ (Chlorophyll a and b) 400 mg/L - (Davies, 2006)
Vanadium	0.001	0.00231 to 0.00234	0.012 to 0.01214	Suter and Tsao (1996) 0.08 mg/L lowest chronic value (fish)
				Suter and Tsao (1996) 1.9 mg/L lowest chronic value (Daphnids)
				Suter and Tsao (1996) secondary chronic value – 0.02 mg/L

Finally, the predicted averages at the lake mixing points also indicated potential exceedances of guideline values for selected metals; with the widest variety of parameters and the highest overall averages generally occurring in Wasp Lake (with the exception of mercury in Big Onion Lake beginning in Year 31). The fewest exceedances were noted at Little Onion Lake. None of the predicted average aluminum values at the lakes exceeded the 0.1 mg/L maximum guideline. Fluoride, mercury, and selenium were elevated in Wasp and Big Onion lakes. A summary of the lakes' mixing point averages and associated guideline exceedances is provided in Table 27.

Table 27. Overview of predicted averages relative to provincial and federal guideline values – lake mixing points

Parameter (mg/L)	Lake mixing points – 5 phases Years 1-16, 17-20, 21-30, 31-47, 48-100			Provincial and federal guidelines	
	Wasp	Little Onion	Big Onion	BC WQG	CCME WQG
Aluminum	0.016 to 0.116	0.056 to 0.057	0.047 to 0.075	0.05 - 30 d avg	
Beryllium	0.0042 to 0.0078	0.003 (all)	0.0027 to 0.0028	0.0053	-
Cadmium	0.000041 to 0.000124	0.000028 (all)	0.000032 to 0.000048	0.000038 to 0.00057	
Copper	0.0015 to 0.0108	0.0009 (all)	0.0008 to 0.0028	0.0048 to 0.0076 (30 d avg) 0.013 to 0.019 (max)	0.00274 to 0.004
Fluoride	0.128 to 0.166	0.114 (all)	0.123 to 0.125	≥2.44	0.12
Iron	0.139 to 1.685	0.076 to 0.077	0.091 to 0.429	0.35 (diss) 1 mg/L (total)	0.3
Mercury	0.00005 to 0.0004470	0.0000107 (all)	0.0000115 to 0.00089	0.00002 @ 0.5% MeHg	0.000026 (Hg) / 0.000004 (MeHg)
Selenium	0.00076 to 0.0068	0.0006 (all)	0.0006 to 0.0016	0.002	0.001
Silver	0.00011 to 0.00016	0.00006 (all)	0.00005 to 0.00006	0.015 (30 d avg) 0.003 (max)	0.0001
Sulphate	2.482 to 304.363	7.72 to 7.75	7.74 to 66.205	50 (alert) 100 (max)	-

With the exception of mercury at Big Onion Lake, all of the predicted averages exceeding selected toxicity and/or TRV/ESV are limited to Wasp Lake. Only the predicted iron and fluoride at Wasp Lake do not exceed some of the available toxicity data and screening values provided. While aluminum exceedances are relatively minor (up to 0.116 mg/L predicted versus the guideline maximum of 0.1 mg/L) other parameters showed more notable differences. For example, average selenium in Wasp Lake is higher than the 0.01 mg/L LOEL used to establish the provincial guideline value. Similarly, average mercury at Wasp and Big Onion is higher than the LOAEL for inorganic Hg of 0.00026 mg/L for Fathead Minnow which Snarski and Olson (1982) used as the basis for the CCME guideline.

Table 28. Comparison of averages (for parameters with guideline exceedances) with published toxicity data/TRV/ESV – lake mixing points

Parameter	Lake mixing points – 5 phases Years 1-16, 17-20, 21-30, 31-47, 48-100			Toxicity values used to establish guideline values and/or relevant TRV/ESV
	Wasp	Little Onion	Big Onion	
Aluminum	0.016 to 0.116	0.056 to 0.057	0.047 to 0.075	US EPA TRV (1988) 0.087 mg/L
				Suter and Tsao (1996) lowest chronic value 0.460 mg/L (aquatic plants)
				Suter and Tsao (1996) lowest chronic value 1.9 mg/L (Daphnids)
Beryllium	0.0042 to 0.0078	0.003 (all)	0.0027 to 0.0028	Suter and Tsao (1996) lowest chronic value 0.057 mg/L (fish)
				Suter and Tsao (1996) lowest chronic value 0.0053 mg/L (fish)
				Suter and Tsao (1996) lowest chronic value 100 mg/L (aquatic plants)
Cadmium	0.000041 to 0.000124	0.000028 (all)	0.000032 to 0.000048	0.00017 mg/L LOEL (Daphnia) (CCME)
				Suter and Tsao (1996) lowest chronic value 0.00015 mg/L (Daphnids)
				Suter and Tsao (1996) lowest chronic value 0.0017 mg/L (fish)
Copper	0.0015 to 0.0108	0.0009 (all)	0.0008 to 0.0028	78-d growth EC ₅₀ 0.046 mg/L (Seim et al., 1984)
				30-d 0.032 mg/L (LOEL) (McKim et al., 1978)
				30-d 0.01 mg/L (NOEL) (McKim et al., 1978)
				6-h EC ₅₀ 0.018 mg/L to 0.087 mg/L (Wang et al., 2007)
				Suter and Tsao (1996) lowest chronic value 0.0038 mg/L (fish)

Parameter	Lake mixing points – 5 phases Years 1-16, 17-20, 21-30, 31-47, 48-100			Toxicity values used to establish guideline values and/or relevant TRV/ESV
	Wasp	Little Onion	Big Onion	
Fluoride	0.128 to 0.166	0.114	0.123 to 0.125	10 mg/L NOEC - <i>Synechococcus leopoliensis</i> - Hekman et al., 1984
				0.9 mg/L - Wright, 1977 - no mortality - Brown Trout
				144-h LC ₅₀ value of 11.5 mg /L for the caddisfly <i>Hydropsyche bronta</i> - (Camargo et al. 1992; Camargo, 1996).
Iron	0.139 to 1.685	0.076 to 0.077	0.091 to 0.429	3.5 mg/L LC ₅₀ for <i>Hyallolela</i> (reported by MOE in guideline document)
Mercury	0.00005 to 0.000447	0.0000107 (all)	0.0000115 to 0.00089	LOAEL for inorganic Hg of 0.00026 mg/L Fathead Minnow, Snarski and Olson (1982).
				LOAEL of 0.00004 mg/L (<i>D. magna</i>) (Biesinger et al., 1982) (MeHg)
				(EC ₅₀) (invertebrates) 0.00128 mg/L to 0.012 mg/L inorganic Hg (Biesinger et al. 1982; Spehar and Fiandt, 1986).
				Suter and Tsao (1996) lowest chronic value (0.00096 mg/L) (Daphnids)
Selenium	0.00076 to 0.0068	0.0006 (all)	0.0006 to 0.0016	Suter and Tsao (1996) lowest chronic value 0.0917 mg/L (Daphnids)
				Suter and Tsao (1996) lowest chronic value 0.0883 mg/L (fish)
				LOEL of 0.01 (BC) (MWLAP, 2001)
Silver	0.00011 to 0.00016	0.00006 (all)	0.00005 to 0.00006	Suter and Tsao (1996) lowest chronic value 0.00012 mg/L (Daphnids)
				NOEC (0.004 mg/L /0.005 mg/L) Ceriodaphnia (Weber et al., 1989)
				Hardness >100 mg/L (chronic) 0.0029 mg/L
Sulphate	2.482 to 304.363	7.72 to 7.75	7.74 to 66.205	7-d LC ₅₀ K ₂ SO ₄ 100 (BC)
				1, 2, 3, and 4 day LC ₀ (no effect) of 500, 100, 100, and 100 mg/L for <i>Morone saxatilis</i> larvae (BC)
				1, 2, 3 and 4-d LC ₅₀ of 2,000, 1,000, 500 and 250 mg/L for <i>Morone saxatilis</i> larvae (BC)
				<i>Fontinalis antipyretica</i> EC ₅₀ (Chlorophyll a and b) 400 mg/L - (Davies, 2006)

Our comparison of the predicted averages with toxicity data and ecological risk assessment values presented in this document indicates the following:

- Pit and Wasp lakes show the widest range of parameters and predicted exceedances for the modelled water bodies, with the Pit Lake showing the highest average concentrations above selected toxicity values overall.
- Aluminum exceeds the guideline values in almost all of the modelled water bodies (either as a 30-day average or maximum). However, exceedances of selected aluminum toxicity data were noted for the mine site and the Taseko River but not in Beece Creek, Little Onion, or Big Onion lake.
- Although the predicted averages often exceed the cadmium and copper guidelines, exceedances of relevant toxicity data were only noted for the Pit Lake, Lower Fish Creek, and Wasp Lake.
- Mercury exceeded guideline values and selected toxicity data/ecological screening values at Lower Fish Creek, Wasp Lake, and Big Onion Lake.
- Examples of average sulphate concentrations in excess of guidelines and selected toxicity data (specifically the Frahm, 1975 value of 100 mg/L) were noted for all of the mine site water bodies (Fish Lake, Upper Fish Creek, Tributary 1, and the Pit Lake) as well as Lower Fish Creek and Wasp Lake.
- Predicted selenium concentrations are highest for Wasp Lake and Lower Fish Creek and exceed the toxicity data used to develop the provincial guideline.
- Average silver exceeds selected toxicity data and screening values at Wasp Lake.
- Average zinc exceeds selected toxicity data and screening values at Pit Lake.

Although these potential exceedances have been identified, they are generally considered conservative given the nature of the models used and that predictions were made without consideration for treatment and other mitigation efforts. The predicted aluminum for the stochastic model reflects surface (total) and dissolved (from seepage) concentrations, and the mixing point model is based on total concentrations. Guidelines for aluminum are based on dissolved concentrations. The results of the BLM indicate that overall the predicted average and maximum values for copper, cadmium and silver are expected to be less than the modelled LC₅₀ for dissolved concentrations generated by the BLM. In some cases (e.g. cadmium in the Fish Lake system) the predicted concentrations were at least 100 times lower than the LC₅₀ generated with the BLM. Although mercury levels in some waterbodies exceeded the LOAEL of 0.00026 mg/L for fathead minnow used by the CCME to establish the inorganic mercury guideline, the predicted levels were below EC₅₀ values of 0.00128 mg/L to 0.012 mg/L for invertebrates identified by Biesinger et al. (1982) and Spehar and Fiandt (1986). Sulphate levels above the Frahm 1975 100 mg/L limit were identified in most waterbodies, but were below more recently published toxicity values (e.g. Davies, 2006). Although some selenium values were above the LOEL of 0.01 mg/L used by the province to establish the guideline value, predicted values were generally below TRV of 0.0917 mg/L and 0.0883 mg/L identified by Suter and Tsao (1996). Finally, while the predicted zinc levels in the Pit Lake may exceed the federal guideline of 0.03 mg/L and the (LOEL) 0.015 mg/L for copepods, the predicted average and maximum values of

0.043 mg/L and 0.052 mg/L were well below their provincial hardness based guidelines of 0.328 mg/L (30 d avg) and 0.354 mg/L (maximum). They were also below Suter and Tsao's (1996) lowest chronic values of 0.0467 mg/L (Daphnids) and 0.0364 mg/L (fish).

6.0 References and Selected Information Sources

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