

DATE March 24, 2016**REFERENCE No.** 1114220046-549-TM-Rev1-4600**TO** Derek Holmes
BURNCO Rock Products Ltd.**FROM** Paul Beddoes,
Kristin Salzsauler**EMAIL** pbeddoes@golder.com;
ksalzsauler@golder.com**GEOCHEMICAL EVALUATION OF GROUNDWATER SAMPLES COLLECTED FROM THE BURNCO AGGREGATE PROJECT, BURNCO ROCK PRODUCTS LTD.****1.0 INTRODUCTION**

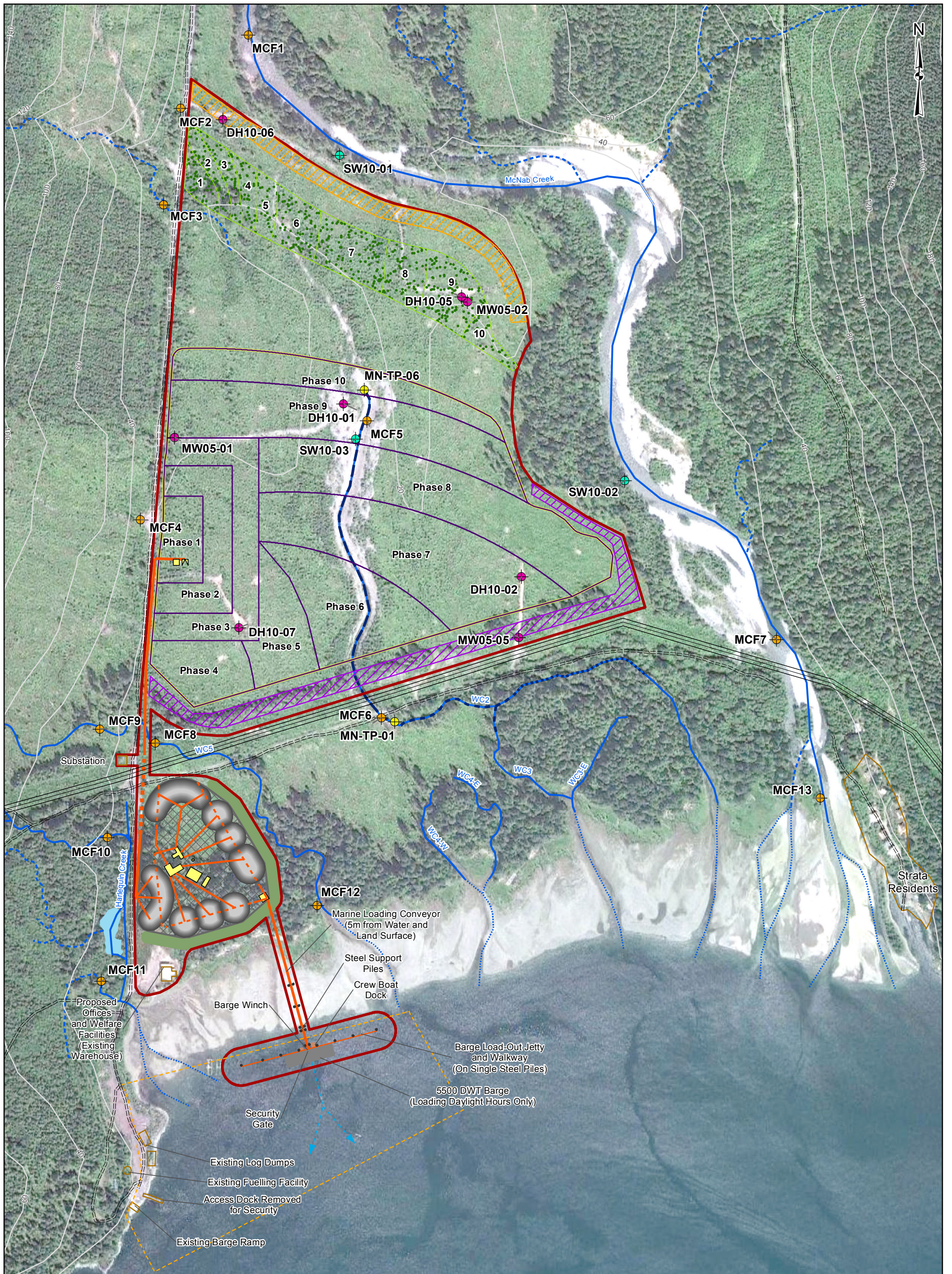
BURNCO Rock Products Ltd. (BURNCO) and 0819042 BC Ltd. are proposing to construct and operate the BURNCO Aggregate Project (Project) in the McNab Valley, British Columbia. The Project is located on the northern shore of Thornbrough Channel, immediately north of Gambier Island and northeast of the Town of Gibsons. The proposed Project is positioned within gently sloping valley floor terrain, and will be bound to the west by a north-south aligned forest service road, to the south by a BC Hydro transmission corridor and to the east and north by McNab Creek. Terrain immediately west of the forest service road is comprised of steep, east-facing slopes (Golder 2013).

Groundwater samples were collected from the Project in 2010, 2012, and 2014. This technical memorandum summarizes the results of analysis of groundwater samples collected from the Project.

2.0 SAMPLE COLLECTION

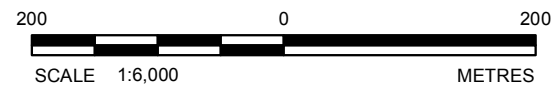
A total of 41 groundwater samples were collected from the Project site by Golder in 2010, 2012, and 2014. Samples were collected from 8 groundwater monitoring wells installed at various locations across the site including MW05-1, MW05-2, MW05-5, DH10-01, DH10-02, DH10-05, DH10-06 and DH10-07 (Figure 1-1). Two, nested 32-millimeter diameter PVC standpipe piezometers were installed in wells DH10-01, DH10-02, DH10-05, DH10-06 and DH10-07. Samples collected from these wells are labelled DH10-#S or DH10-#D to identify shallow and deep standpipes, respectively. These sample locations are discussed in greater detail in Golder (2013).





LEGEND	
	Test Pit Location (Golder 2013)
	Freshwater Quality Sampling Location (Golder 2012)
	Monitoring Well (Golder 2012)
	Surface Water Monitoring Station (Golder 2010)
	Project Area
	Proposed Aggregate Pit Phase
	Final Pit Lake Outline
	Product Stockpile
	Fines Storage Area
	Processing Area
	Existing Feature
	Existing Log Tenure Area
	Possible Processing Plant Configuration
	McNab Creek Flood Protection Dyke
	Pit Lake Containment Berm
	Processing Area Berm
	Elevated Conveyor
	Underground Conveyor
	Barge Load-out
	Transmission Line
	Road (Existing)
	Contour (20m)
	Permanent / Perennial Watercourse
	Intermittent Watercourse
	Intertidal Watercourse
	Constructed Watercourse
	Phase 1 (1985)
	Phase 2 (1998)
	Phase 3 (2001 - 2003)
	Barge Route
	Pile

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



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



FIGURE 1-1

3.0 SAMPLE ANALYSIS AND DATA EVALUATION

All samples were submitted to ALS Environmental in Vancouver, British Columbia for the following analyses:

- physical parameters, including pH, hardness, alkalinity, acidity, total suspended solids, total dissolved solids and turbidity;
- anions, including chloride, bromide, fluoride, sulphate, nitrate, nitrite and ammonia; and
- total and dissolved metals (Al, Sb, As, Ba, Be, Bi, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Hg, Mo, Ni, P, K, Se, Si, Ag, Na, Sr, Tl, Sn, Ti, U, V and Zn).

Attachment 1 presents the results of analysis.

A Piper trilinear diagram (“Piper diagram”) was used to characterize the major ion composition of the groundwater samples. Piper diagrams are a common method for interpreting trends in water chemistry, and are used to visually interpret chemical composition trends for major ions. The results of water quality analysis are plotted on two trilinear diagrams: one diagram assesses the relative ratio of the major cations (calcium [Ca], magnesium [Mg] and sodium + potassium [Na+K] in a sample) and the second diagram assesses the relative ratio of the major anions (chloride [Cl], sulphate [SO₄] and carbonate [CO₃+HCO₃]). The relative cation and anion composition of the sample is then projected onto the rhombohedral portion of the diagram, which is used to further identify trends in major ion composition that may not otherwise be evident.

In addition, parameter values were compared to the Environmental Protection Division of British Columbia Water Quality (BCWQ) Guidelines for the protection of aquatic life (30-day average) (BC MoE 2015a, BC MoE 2015b) and Canadian Council of Ministers of the Environment (CCME 1999) in order to identify any parameters of concern in groundwater samples collected at the Project.

4.0 RESULTS

The following sections discuss the general chemical characteristics of groundwater samples collected from the Project. Attachment 1 presents the results of the groundwater laboratory analyses.

4.1 Groundwater Composition

Table 4-1 summarizes the depth and lithological characteristics of the units from which groundwater samples were collected. Major ion characteristics are presented for each sample.

Table 4-1: Summary of Groundwater Quality Samples by Sample Depth, Stratigraphic Horizon and Water Type

Location	Year	Sample ID	Sample Depth	Stratigraphy	Water Type
DH10-06S	2014	23584-01	5.15	Sand, some gravel and cobbles	Ca-HCO ₃
DH10-06S	2012	23582-06	5.15	Sand, some gravel and cobbles	Ca-HCO ₃
DH10-06S	2010	2377-05	5.15	Sand, some gravel and cobbles	Ca-HCO ₃
DH10-06D	2014	23584-02	13.2	Clayey silt, some sand and gravel	Ca-SO ₄
DH10-06D	2012	23582-07	13.2	Clayey silt, some sand and gravel	Ca-SO ₄
DH10-06D	2010	2377-06	13.2	Clayey silt, some sand and gravel	Ca-SO ₄
MW05-1	2014	23585-03	-	-	Ca-SO ₄
MW05-1	2012	23582-11	-	-	Ca-SO ₄
DH10-07S	2014	23586-01	9.9	Sand, with gravel and cobbles	Ca-SO ₄
DH10-07S	2012	23582-01	9.9	Sand, with gravel and cobbles	Ca-SO ₄
DH10-07S	2010	2380-01	9.9	Sand, with gravel and cobbles	Ca-SO ₄
DH10-07D	2014	23586-02	29.4	Gravelly sand	Ca-SO ₄
DH10-07D	2014	23586-03	29.4	Gravelly sand	Ca-SO ₄
DH10-07D	2012	23582-02	29.4	Gravelly sand	Ca-SO ₄
DH10-07D	2010	2380-02	29.4	Gravelly sand	Ca-SO ₄
DH10-05S	2014	23584-03	7.1	Gravel, some sand	Na-HCO ₃
DH10-05S	2012	23582-03	7.1	Gravel, some sand	Na-HCO ₃
DH10-05S	2010	2377-01	7.1	Gravel, some sand	Na-HCO ₃
DH10-05D	2014	23584-04	31.4	Sand, some gravel	Ca-HCO ₃
DH10-05D	2012	23582-04	31.4	Sand, some gravel	Ca-HCO ₃
DH10-05D	2010	2377-02	31.4	Sand, some gravel	Ca-HCO ₃
MW05-2	2014	23584-05	-	-	Ca-HCO ₃
MW05-2	2012	23582-05	-	-	Ca-HCO ₃
MW05-2	2010	2377-03	-	-	Ca-HCO ₃
DH10-01S	2014	23585-01	15.6	Sand, some gravel	Ca-HCO ₃
DH10-01S	2012	23582-08	15.6	Sand, some gravel	Na-HCO ₃
DH10-01S	2010	2379-03	15.6	Sand, some gravel	Ca-HCO ₃
DH10-01D	2014	23585-02	40.3	Gravelly sand	Ca-SO ₄

Location	Year	Sample ID	Sample Depth	Stratigraphy	Water Type
DH10-01D	2012	23582-09	40.3	Gravelly sand	Ca-SO ₄
DH10-01D	2012	23582-10	40.3	Gravelly sand	Ca-SO ₄
DH10-01D	2010	2379-01	40.3	Gravelly sand	Ca-HCO ₃
DH10-01D	2010	2379-02	40.3	Gravelly sand	Ca-SO ₄
DH10-02S	2014	23586-05	10.1	Gravel	Na-HCO ₃
DH10-02S	2012	23583-01	10.1	Gravel	Na-HCO ₃
DH10-02S	2010	2378-01	10.1	Gravel	Na-HCO ₃
DH10-02D	2014	23586-06	37.5	Sand, some gravel	Ca-HCO ₃
DH10-02D	2012	23583-02	37.5	Sand, some gravel	Ca-HCO ₃
DH10-02D	2010	2378-02	37.5	Sand, some gravel	Ca-HCO ₃
MW05-5	2014	23586-04	-	-	Na-HCO ₃
MW05-5	2012	23582-12	-	-	Na-HCO ₃
MW05-5	2010	2378-03	-	-	Na-HCO ₃

Groundwater composition varied by location and the stratigraphic layer from which groundwater samples were collected:

- Most samples collected from MW05-01, DH10-06 and DH10-07 (located downgradient of the steep, east facing slopes on the western boundary of the Project) had a calcium-sulphate (Ca-SO₄) type composition. Shallow groundwater samples collected from DH10-06 had a calcium-bicarbonate (Ca-HCO₃) type composition. These wells were completed in shallow sand to deeper clayey silt.
- Deep groundwater collected from DH10-01 also had a Ca-SO₄ type composition. This well was completed in gravelly sand.
- Samples collected from DH10-05, MW05-02, MW05-05, DH10-02, and shallow water collected from DH10-01 had a sodium bicarbonate (Na-HCO₃) to Ca-HCO₃ type composition. These wells were completed in gravelly sand in the valley floor.

Figure 4-1 presents groundwater composition according to location within the project boundary. Groundwater samples collected from wells MW05-01, DH10-06, DH10-07 at the western edge of the Project were sulphate dominant. In general, most samples collected from monitoring wells completed in gravelly sand in the valley floor on the east edge of the Project had a bicarbonate dominant composition.

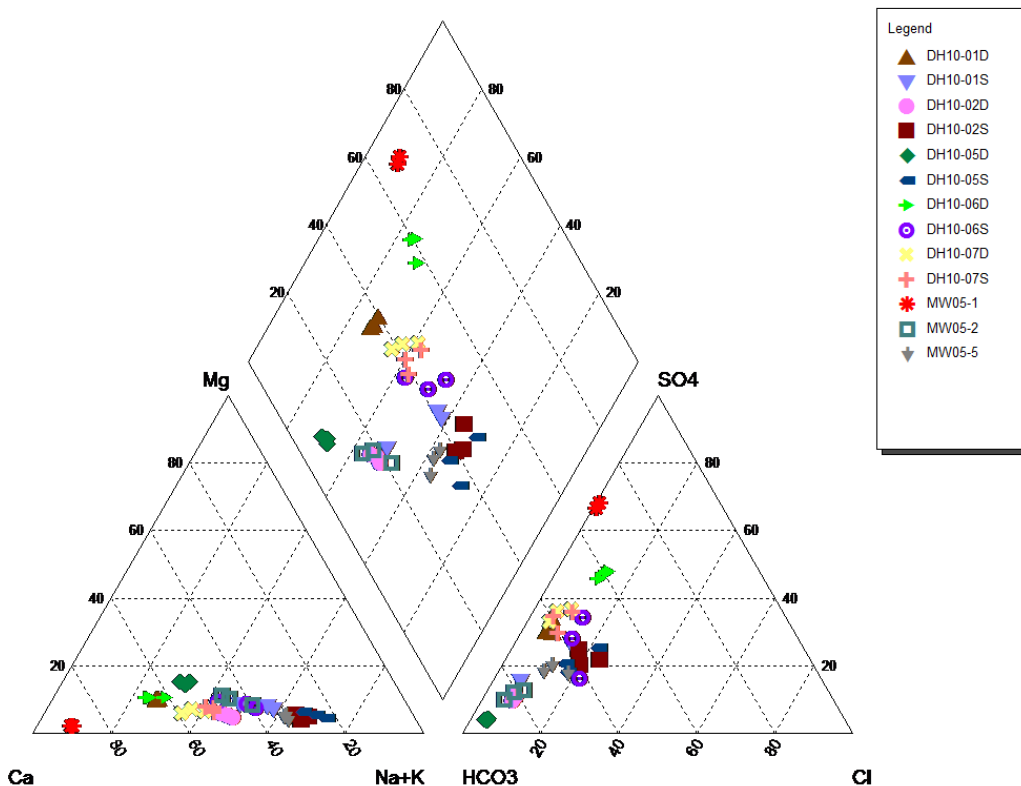


Figure 4-1: Major Ion Composition of Groundwater by Sampling Location

4.2 Groundwater Quality Analysis

Summary statistics of groundwater quality analysis are presented in Table 4-2. Water quality trends of select parameters in groundwater collected from the Project site included:

- **pH:** lab pH ranged from 5.8 to 8.8. Field pH values were outside the range of CCME guidelines (6.5 to 9.0) in seven samples collected from DH10-05S (2 samples), MW05-02 (1 sample), DH10-06S (1 sample), DH10-01S (1 sample), MW05-05 (1 sample), and DH10-02S (1 sample).
- **Ammonia (as N):** Ammonia concentrations ranged from less than the detection limit (<0.005) to 0.043 mg/L.
- **Chloride:** Chloride concentrations ranged from less than the detection limit (<0.50) to 8.0 mg/L.
- **Fluoride:** Fluoride concentrations ranged from less than the detection limit (<0.02) to 0.23 mg/L, exceeding the CCME guideline of 0.12 mg/L in five samples collected from DH10-06D (3 samples) and MW05-01 (2 samples).
- **Nitrate (as N):** Nitrate concentrations ranged from less than the detection limit (<0.005) to 0.49 mg/L.
- **Nitrite (as N):** Nitrite concentrations ranged from less than the detection limit (<0.001) to 0.0026 mg/L.
- **Sulphate:** Sulphate concentrations ranged from less than the detection limit (<0.50) to 120 mg/L.
- **Aluminum:**
 - Concentrations of dissolved aluminum ranged from less than the detection limit (<0.005) to 0.069 mg/L. Aluminum concentrations exceeded the hardness dependent BCWQ guideline in 14 samples collected from DH10-07S, DH10-07D, DH10-02S, DH10-05S, DH10-06S and DH10-06D. The CCME guideline was exceeded in 21 samples from DH10-07S, DH10-07D, DH10-02S, DH10-05S, MW05-02, DH10-06S, DH10-06D and DH10-01D.
 - Concentrations of total aluminum ranged from less than the detection limit (<0.005) to 124 mg/L and exceeded the BCWQ guideline of 0.011 mg/L in 30 samples, collected from all wells at the Project except MW05-05. Total aluminum concentrations exceeded the CCME guideline of 0.005 mg/L in 36 samples collected from all wells.
- **Arsenic:** Concentrations of dissolved arsenic ranged from less than the detection limit (<0.0005) to 0.0058 mg/L, exceeding both the CCME and BCWQ guidelines of 0.005 mg/L in 1 sample collected from DH10-06D. Concentrations of total arsenic ranged from less than the detection limit (<0.0005) to 0.045 mg/L, exceeding both the CCME and BCWQ guidelines in five samples collected from DH10-06S (1 sample), DH10-06D (3 samples) and DH10-01S (1 sample).
- **Beryllium:** Dissolved and total beryllium concentrations were all below detection limit. The detection limits used (<0.001 to <0.01 mg/L) exceeded the BCWQ guidelines of 0.00013 mg/L.
- **Cadmium:** Concentrations of dissolved cadmium ranged from less than the detection limit (<0.00001) to 0.000085 mg/L. Total cadmium ranged from less than the detection limit (<0.00001) to 0.00055 mg/L, exceeding the CCME and/or BCWQ guidelines in five samples collected from DH10-06S (1 sample), DH10-06D (2 samples), and DH10-01S (2 samples).
- **Chromium:** Dissolved chromium concentrations were less than the detection limit (<0.001 mg/L). Total chromium ranged from less than the detection limit (<0.001) to 0.097 mg/L and exceeded the hardness dependent CCME and BCWQ guidelines in five samples collected from DH10-06S (1 sample), DH10-06D (3 samples), and DH10-01S (1 sample).

- **Cobalt:** Dissolved cobalt concentrations were less than the detection limit (<0.0003 to <0.003 mg/L). Total cobalt concentrations ranged from less than the detection limit (<0.0003 mg/L) to 0.033 mg/L, exceeding the BCWQ guideline of 0.004 mg/L in four samples collected from DH10-06S (1 sample), DH10-06D (3 samples), and DH10-01S (1 sample).
- **Copper:** Dissolved copper concentrations were less than the detection limit (<0.001 to <0.01 mg/L). Total copper concentrations ranged from less than the detection limit (<0.001) to 0.16 mg/L and exceeded the hardness dependent BCWQ and CCME guidelines in seven samples collected from DH10-06S (2 samples), DH10-06D (2 samples), DH10-01S (1 sample), and DH10-01D (1 sample).
- **Iron:** Dissolved iron concentrations ranged from less than the detection limit (<0.03) to 0.14 mg/L. Total iron concentrations ranged from less than the detection limit (<0.03) to 75 mg/L and exceeded the CCME guideline of 0.3 mg/L in seven samples collected from MW05-02 (2 samples), DH10-06S (1 sample), DH10-06D (3 samples), and DH10-01S (1 sample).
- **Lead:** Dissolved lead concentrations were less than the detection limit (<0.0005 mg/L to <0.001). Total lead concentrations ranged from less than the detection limit (<0.0005) to 0.018 mg/L and exceeded the hardness dependent BCWQ and CCME guidelines in three samples collected from DH10-06S (1 sample), DH10-06D (2 samples), and the hardness dependent CCME guideline in 1 sample (DH10-01S).
- **Manganese:** Dissolved manganese concentrations ranged from less than the detection limit (<0.0003) to 0.20 mg/L. Total manganese concentrations ranged from less than the detection limit (<0.0003) to 1.2 mg/L, exceeding the hardness dependent BCWQ guideline in one sample collected from DH10-06D.
- **Mercury:** Dissolved mercury concentrations were less than the detection limit (<0.00001 to <0.0002 mg/L). Total mercury concentrations ranged were all less than the detection limit (<0.00001 to <0.0002 mg/L).
- **Nickel:** Dissolved nickel concentrations range from less than the detection limit (<0.001 to <0.01 mg/L) to 0.0012 mg/L. Total nickel concentrations ranged from less than the detection limit (<0.001) to 0.070 mg/L, exceeding the hardness dependent CCME guideline in one sample from DH10-06S.
- **Silver:** Dissolved silver concentrations were less than the detection limit (<0.00002 to <0.0002 mg/L). Total silver concentrations ranged from less than the detection limit (<0.00002) to 0.00035 mg/L, exceeding the hardness dependent BCWQ guideline and CCME guideline of 0.0001 mg/L in four samples collected from DH10-06S (1 sample), DH10-06D (2 samples), and DH10-01S (1 sample).
- **Titanium:** Dissolved titanium concentrations were less than the detection limit (<0.01 mg/L). Total titanium concentrations ranged from less than the detection limit (<0.01) to 5.0 mg/L.
- **Uranium:** Dissolved uranium concentrations were all below detection limit (<0.0002 to 0.002 mg/L). Total uranium concentrations ranged from below detection limit (<0.0002) to 0.014 mg/L, exceeding the BCWQ guideline of 0.0085 mg/L in one sample from DH10-06D.
- **Zinc:** Dissolved zinc concentrations were less than the detection limit (<0.005 mg/L). Total zinc concentrations ranged from less than the detection limit (<0.005) to 0.18 mg/L and exceeded the hardness dependent BCWQ guideline in eight samples collected from DH10-07S (1 sample), DH10-02D (1 sample), DH10-06S (1 sample), DH10-06D (3 samples), DH10-01S (1 sample), and DH10-02D (1 sample), and exceeded the CCME guideline of 0.03 mg/L in three samples collected from DH10-06S (1 sample), DH10-06D (2 samples).

Table 4-2: Summary of Groundwater Quality Data.

Parameter	Units	CCME Guidelines ^a	BC Water Quality Guidelines for the protection of Freshwater Aquatic Life ^b	Summary Statistics			
				30-Day Average	Minimum	Median	95th Percentile
Conventional							
pH (lab)	-	6.5 - 9.0	-	5.8	7.6	8.2	8.8
Total Dissolved Solids ^c	mg/L	-	-	< 10	21	157	248
Alkalinity ^d	mg/L	-	-	2.0	7.6	39	61
Hardness ^e	mg/L	-	-	2.2	9.2	68	177
Major Ions							
Calcium	mg/L	-	-	0.87	3.2	24	70
Chloride	mg/L	120	150	< 0.5	0.7	7.9	8.0
Fluoride	mg/L	0.12	-	< 0.02	< 0.02	0.18	0.23
Magnesium	mg/L	-	-	0.05	0.28	2.3	2.3
Potassium	mg/L	-	-	< 2	< 2	2.7	3.3
Sodium	mg/L	-	-	< 2	< 2	8.1	9.9
Sulphate	mg/L	-	128-429 ^f	0.25	1.4	41	120
Nutrients							
Ammonia	mg/L (as N)	0.41 ^g	1.44 ^g	< 0.005	< 0.005	0.036	0.043
Nitrate	mg/L (as N)	13	3	< 0.005	0.112	0.42	0.49
Nitrite	mg/L (as N)	0.06	0.02-0.04 ^h	< 0.001	< 0.001	< 0.001	0.0026
Total Kjeldhal Nitrogen	mg/L (as N)	-	-	< 0.05	< 0.05	0.18	0.48
Total Phosphorus	mg/L	-	-	< 0.002	0.0022	0.69	1.4
Dissolved Metals							
Aluminum	mg/L	0.005 ⁱ	0.011 ⁱ	< 0.005	0.0054	0.049	0.069
Antimony	mg/L	-	0.009	< 0.0005	< 0.0005	< 0.001	< 0.005
Arsenic	mg/L	0.005	0.005	< 0.0005	< 0.0005	< 0.005	0.0058
Barium	mg/L	-	1	< 0.02	< 0.02	< 0.02	0.021
Beryllium	mg/L	-	0.00013	< 0.001	< 0.001	< 0.002	< 0.01
Boron	mg/L	1.5	1.2	< 0.1	< 0.1	< 0.1	< 0.1
Cadmium	mg/L	0.00004 ^j	0.000013-0.00032 ^j	< 0.00001	0.0000085	0.000023	0.000085
Chromium	mg/L	0.001 ^k	0.001 ^k	< 0.001	< 0.001	< 0.002	< 0.01
Cobalt	mg/L	-	0.004	< 0.0003	< 0.0003	< 0.0006	< 0.003
Copper	mg/L	0.002 ^l	0.002 ^l	< 0.001	< 0.001	< 0.002	< 0.01
Iron	mg/L	0.3	-	< 0.03	< 0.03	0.067	0.141
Lead	mg/L	0.001 ^m	0.0034-0.022 ^m	< 0.0005	< 0.0005	< 0.001	< 0.005
Lithium	mg/L	-	-	< 0.005	< 0.005	< 0.01	< 0.05
Manganese	mg/L	-	0.6-1.9 ⁿ	< 0.0003	0.00133	0.0533	0.2
Mercury	mg/L	0.000026	0.00001 ^o	< 0.00001	< 0.00001	< 0.0002	< 0.0002
Molybdenum	mg/L	0.073	1	< 0.001	< 0.001	0.0022	0.005
Nickel	mg/L	0.025 ^p	0.025-0.11 ^p	< 0.001	< 0.001	0.0012	< 0.01
Selenium	mg/L	0.001	0.002	< 0.0001	< 0.001	< 0.002	< 0.01
Silicon	mg/L	-	-	1.4	3.9	8.9	10
Silver	mg/L	0.0001	0.00005-0.0015 ^q	< 0.00002	< 0.00002	< 0.00004	< 0.0002
Thallium	mg/L	0.0008	0.0008	< 0.0002	< 0.0002	< 0.0004	< 0.002
Tin	mg/L	-	-	< 0.0005	< 0.0005	< 0.001	< 0.005
Titanium	mg/L	-	-	< 0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.015	0.0085	< 0.0002	< 0.0002	< 0.002	< 0.002
Vanadium	mg/L	-	-	< 0.001	< 0.001	< 0.0022	< 0.01
Zinc	mg/L	0.03	0.0075-0.24 ^r	< 0.005	< 0.005	< 0.005	< 0.005
Total Metals							
Aluminum	mg/L	0.005 ⁱ	0.011 ⁱ	0.0025	0.031	36	124
Antimony	mg/L	-	0.009	< 0.0005	< 0.0005	< 0.0025	< 0.005
Arsenic	mg/L	0.005	0.005	< 0.0005	< 0.0005	0.022	0.045
Barium	mg/L	-	1	< 0.02	< 0.02	0.21	0.66
Beryllium	mg/L	-	0.00013	< 0.001	< 0.001	< 0.005	< 0.01
Boron	mg/L	1.5	1.2	< 0.1	< 0.1	< 0.1	< 0.1
Cadmium	mg/L	0.00004 ^j	0.000013-0.00032 ^j	< 0.00001	0.0000085	0.00014	0.00055
Chromium	mg/L	0.001 ^k	0.001 ^k	< 0.001	< 0.001	0.036	0.097
Cobalt	mg/L	-	0.004	< 0.0003	< 0.0003	0.013	0.033
Copper	mg/L	0.002 ^l	0.002 ^l	< 0.001	< 0.001	0.057	0.16
Iron	mg/L	0.3	-	< 0.03	< 0.03	30	75
Lead	mg/L	0.001 ^m	0.0034-0.022 ^m	< 0.0005	< 0.0005	0.0066	0.018
Lithium	mg/L	-	-	< 0.005	< 0.005	0.026	0.074
Manganese	mg/L	-	0.6-1.9 ⁿ	< 0.0003	0.0019	0.48	1.2
Mercury	mg/L	0.000026	0.00001 ^o	< 0.00001	< 0.00001	0.0001	0.0001
Molybdenum	mg/L	0.073	1	< 0.001	< 0.001	0.0025	0.005
Nickel	mg/L	0.025 ^p	-	< 0.001	< 0.001	0.026	0.07
Selenium	mg/L	0.001	0.002	< 0.0001	< 0.001	< 0.005	< 0.01
Silicon	mg/L	-	-	1.3	4.1	44	101
Silver	mg/L	0.0001	0.00005-0.0015 ^q	< 0.00002	< 0.00002	0.00019	0.00035
Thallium	mg/L	0.0008	0.0008	< 0.0002	< 0.0002	< 0.001	< 0.002
Tin	mg/L	-	-	< 0.0005	< 0.0005	< 0.0025	< 0.005
Titanium	mg/L	-	-	< 0.01	< 0.01	1.3	5.0
Uranium	mg/L	0.015	0.0085	< 0.0002	< 0.0002	0.0067	0.014
Vanadium	mg/L	-	-	< 0.001	< 0.001	0.068	0.21
Zinc	mg/L	0.03	0.0075-0.24 ^r	< 0.005	< 0.005	0.06	0.18

Notes:

- a) Canadian Council of Ministers of the Environment (CCME) Guidelines for the protection of Freshwater Aquatic Life
- b) BC Water Quality (BCWQ) Guidelines for the protection of Freshwater Aquatic Life (working guidelines marked in italics)
- c) calculated value: calculated TDS based on standard methods (APHA, 2005)
- d) assumed alkalinity based on mean of SFE test, used for calculation of TDS
- e) calculated hardness based on concentrations of calcium and magnesium
- f) hardness dependent guideline: 128 mg/L for hardness <30 mg/L, 218 mg/L for hardness 31 - 75 mg/L
- g) pH and temperature dependent guideline: based on maximum temperature of 18°C, pH 7.7
- h) chloride dependent guideline: 0.02 mg/L for Cl <2 mg/L, 0.04 mg/L for Cl 2-4 mg/L
- i) pH dependent guideline: CCME 0.005 mg/L if pH<6.5; BC WQG = 0.011 mg/L (based on minimum observed surface water pH = 5.57)
- j) hardness dependent dissolved Cd guideline BC WQG Long-term average (µg/L) = 2.718[0.736*ln(hardness)-4.943]. For the purpose of guideline comparison, the dissolved Cd guideline was used for total Cd.
- k) guideline is for Cr(VI)
- l) hardness dependent guideline: CCME (mg/L) = 0.2*EXP(0.8545(ln(hardness))-1.465)/1000; BC WQG (mg/L) if hardness <= 50 mg/L = 0.002 mg/L, if hardness < 50 mg/L, 0.04*hardness/1000
- m) hardness dependent guideline: CCME (mg/L) = EXP(1.273(ln(hardness))-4.705)/1000; BC WQG (mg/L) = 3.31+EXP(1.273(ln(hardness))-4.704)/1000
- n) hardness dependent guideline: BC WQG (mg/L) = 0.0044*hardness+0.605
- o) assumes 1% MeHg
- p) hardness dependent guideline: CCME (mg/L) = EXP(0.76*(ln(hardness))+1.06)/1000; BC Max WQG = 0.025 at hardness
- q) hardness dependent guideline: BC WQG (mg/L) = if hardness <= 100 mg/L = 0.00005 mg/L, else 0.0015 mg/L
- r) hardness dependent guideline: BC WQG (mg/L) = (7.5+0.75(hardness-90))/1000

123

Indicates concentration exceeding the CCME Guideline
Indicates concentration exceeding the BCWQ Guideline

Most samples with elevated metal concentrations were collected from wells downgradient of the steep east facing slopes on the western boundary of the Project (i.e., DH10-07, DH10-06, DH10-01S and MW05-01). At least one groundwater quality sample from these wells had elevated concentrations of fluoride, aluminum, arsenic, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, silver, uranium, and zinc relative to the BCWQ and/or CCME criteria.

Samples collected from monitoring wells completed in the valley floor (i.e., DH10-05, MW05-02, MW05-05, and DH10-02) had fewer samples with elevated metal concentrations.

5.0 SUMMARY

The results of the evaluation of the groundwater samples indicate that the local groundwater chemistry is influenced by the geographic location and depth from which the water originates, and by the lithology at each well location. Groundwater collected from the western slope bordering the Project site has a Ca-SO₄ signature whereas groundwater collected from the site basin has a bicarbonate signature. Groundwater collected from wells completed in gravelly material is Na-HCO₃ dominant relative to groundwater collected from wells completed in sandy material that is Ca-HCO₃ rich.

Groundwater samples collected at the Project site by pH values that ranged from 5.8 to 8.8. Aluminum, chromium, cobalt, copper, lead, manganese, silver, vanadium and zinc concentrations exceed the BCWQ guidelines in one or more samples collected in 2010, 2012, and 2014. Fluoride, aluminum, arsenic, cadmium, copper, iron, lead, nickel, silver, and zinc concentrations exceeded the CCME guidelines in one or more of the samples collected in 2010, 2012, and 2014. Groundwater quality samples collected from monitoring wells in the east facing slopes on the western project boundary (DH10-07, DH10-06, DH10-01S and MW05-01) generally had higher metal concentrations than groundwater quality samples collected from wells in the valley floor.

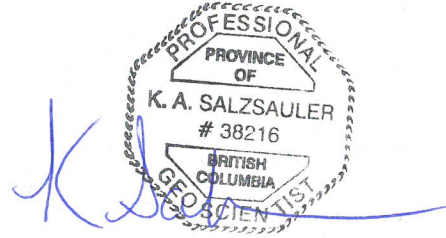
6.0 CLOSURE

We trust that the discussion in this technical memorandum meets your current requirements. Please contact the undersigned with questions or comments.

GOLDER ASSOCIATES LTD.



Paul Beddoes, M.Sc., R.P.Bio., GIT
Environmental Scientist



Kristin Salzsauler, M.Sc., P.Geo. (BC, NT)
Senior Geochemist

PAB/KAS/asd

Attachment 1: Results of Groundwater Analysis

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7.0 REFERENCES

BC MoE 2015a. British Columbia Approved Water Quality Guidelines. [online]:

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BC MoE 2015b. British Columbia Working Water Quality Guidelines. [online]:

<http://www2.gov.bc.ca/gov/topic.page?id=044DD64C7E24415D83D07430964113C9>.

CCME (Canadian Council of Ministers of Environment). 1999. Canadian Water Quality Guidelines for the Protection of Aquatic Life with updates to 2015. Canadian Council of Ministers of the Environment, Winnipeg, Manitoba.

Golder (Golder Associates Ltd.), 2013. Hydrogeological Characterization McNab Valley Aggregate Project. Technical Memorandum. Submitted to BURNCO Rock Projects Ltd.

Parameter	Units	CCME Guidelines ^a	BC Water Quality Guidelines for the protection of Freshwater Aquatic Life 30-Day Average	DH10-07S			DH10-07D				MW05-05			DH10-02S			DH10-02D		
				23-Jul-10	29-Nov-12	19-Feb-14	23-Jul-10	29-Nov-12	19-Feb-14	19-Feb-14	21-Jul-10	30-Nov-12	19-Feb-14	21-Jul-10	30-Nov-12	19-Feb-14	21-Jul-10	30-Nov-12	19-Feb-14
Total Metals																			
Aluminum	mg/L	0.005 ^l	0.011 ^l	0.029	0.022	0.058	0.15	0.031	0.01	0.0088	<0.01	<0.0050	0.0068	0.016	0.022	0.018	0.052	0.0058	0.0057
Antimony	mg/L	-	0.009	<0.0005	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050
Arsenic	mg/L	0.005	0.005	<0.0005	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050
Barium	mg/L	-	1	<0.02	<0.020	<0.020	<0.02	<0.020	<0.020	<0.020	<0.02	<0.020	<0.020	<0.02	<0.020	<0.020	<0.02	<0.020	<0.020
Beryllium	mg/L	-	0.00013	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010
Boron	mg/L	1.5	1.2	<0.1	<0.10	<0.10	<0.1	<0.10	<0.10	<0.10	<0.1	<0.10	<0.10	<0.1	<0.10	<0.10	<0.1	<0.10	<0.10
Cadmium	mg/L	0.00004 ^l	0.000013-0.00032 ^l	<0.000017	0.000021	0.00002	0.000024	<0.000017	0.000012	0.000013	<0.000017	<0.000017	<0.000010	<0.000017	<0.000017	<0.000010	<0.000017	<0.000017	<0.000010
Chromium	mg/L	0.001 ^k	0.001	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010
Cobalt	mg/L	-	0.004	<0.0003	<0.00030	<0.00030	<0.0003	<0.00030	<0.00030	<0.00030	<0.0003	<0.00030	<0.00030	<0.0003	<0.00030	<0.00030	<0.0003	<0.00030	<0.00030
Copper	mg/L	0.002 ^l	0.002 ^l	<0.001	<0.0010	<0.0010	0.0011	<0.0010	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.001	0.0013	<0.0010	<0.001	<0.0010	<0.0010
Iron	mg/L	0.3	-	<0.03	<0.030	<0.030	0.059	<0.030	<0.030	<0.030	<0.03	<0.030	<0.030	<0.03	<0.030	<0.030	0.033	<0.030	<0.030
Lead	mg/L	0.001 ^m	0.0034-0.022 ^m	<0.0005	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050
Lithium	mg/L	-	-	<0.005	<0.0050	<0.0050	<0.005	<0.0050	<0.0050	<0.0050	<0.005	<0.0050	<0.0050	<0.005	<0.0050	<0.0050	<0.005	<0.0050	<0.0050
Manganese	mg/L	-	0.6-1.9 ⁿ	0.010	0.0017	0.0017	0.012	0.00094	0.00058	0.00047	0.00043	0.00046	0.00031	0.0018	0.0013	0.0012	0.0019	0.00051	0.0005
Mercury	mg/L	0.000026	0.00001 ^o	<0.00001	<0.000010	<0.000020	<0.00001	<0.000010	<0.000020	<0.000020	<0.00001	<0.000010	<0.000020	<0.00001	<0.000010	<0.000020	<0.00001	<0.000010	<0.000020
Molybdenum	mg/L	0.073	1	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010
Nickel	mg/L	0.025 ^p	-	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010
Selenium	mg/L	0.001	0.002	<0.001	<0.0010	<0.00010	<0.001	<0.0010	<0.00010	<0.00010	<0.001	<0.0010	<0.00010	<0.001	<0.0010	<0.00010	<0.001	<0.0010	<0.00010
Silicon	mg/L	-	-	3.3	3.2	2.9	4.0	3.6	4.5	4.2	2.4	2.7	2.5	1.8	2.2	2.0	4.1	4.2	4.0
Silver	mg/L	0.0001	0.00005-0.0015 ^q	<0.00002	<0.000020	<0.000020	<0.00002	<0.000020	0.000026	<0.000020	<0.00002	<0.000020	<0.000020	<0.00002	<0.000020	<0.000020	<0.00002	<0.000020	<0.000020
Thallium	mg/L	0.0008	0.0008	<0.0002	<0.00020	<0.00020	<0.0002	<0.00020	<0.00020	<0.00020	<0.0002	<0.00020	<0.00020	<0.0002	<0.00020	<0.00020	<0.0002	<0.00020	<0.00020
Tin	mg/L	-	-	<0.0005	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050
Titanium	mg/L	-	-	<0.01	<0.010	<0.010	<0.01	<0.010	<0.010	<0.010	<0.01	<0.010	<0.010	<0.01	<0.010	<0.010	<0.01	<0.010	<0.010
Uranium	mg/L	0.015	0.0085	<0.0002	<0.00020	<0.00020	<0.0002	<0.00020	<0.00020	<0.00020	<0.0002	<0.00020	<0.00020	<0.0002	<0.00020	<0.00020	<0.0002	<0.00020	<0.00020
Vanadium	mg/L	-	-	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010
Zinc	mg/L	0.03	0.0075-0.24 ^r	<0.005	<0.0050	<0.0050	0.0079	<0.0050	<0.0050	<0.0050	<0.005	<0.0050	<0.0050	<0.005	<0.0050	<0.0050	<0.005	<0.0050	0.019

Notes:

- a) Canadian Council of Ministers of the Environment (CCME) Guidelines for the protection of Freshwater Aquatic Life
- b) BC Water Quality (BCWQ) Guidelines for the protection of Freshwater Aquatic Life (working guidelines marked in italics)
- c) calculated value: calculated TDS based on standard methods (APHA, 2005)
- d) assumed alkalinity based on mean of SFE test, used for calculation of TDS
- e) calculated hardness based on concentrations of calcium and magnesium
- f) hardness dependent guideline: 128 mg/L for hardness <30 mg/L, 218 mg/L for hardness 31 - 75 mg/L
- g) pH and temperature dependent guideline: based on maximum temperature of 18°C, pH 7.7
- h) chloride dependent guideline: 0.02 mg/L for Cl <2 mg/L, 0.04 mg/L for Cl 2-4 mg/L
- i) pH dependent guideline: CCME 0.005 mg/L if pH<6.5; BC WQG = 0.011 mg/L (based on minimum observed surface water pH = 5.57)
- j) hardness dependent dissolved Cd guideline BC WQG Long-term average (ug/L) = 2.718[0.736*ln(hardness)-4.943]. For the purpose of guideline comparison, the dissolved Cd guideline was used for total Cd.
- k) guideline is for Cr(VI)
- l) hardness dependent guideline: CCME (mg/L) = 0.2*EXP(0.8545(ln(hardness))-1.465)/1000; BC WQG (mg/L) if hardness <= 50 mg/L = 0.002 mg/L, if hardness < 50 mg/L, 0.04*hardness/1000
- m) hardness dependent guideline: CCME (mg/L) = EXP(1.273(ln(hardness))-4.705)/1000; BC WQG (mg/L) = 3.31+EXP(1.273(ln(hardness))-4.704)/1000
- n) hardness dependent guideline: BC WQG (mg/L) = 0.0044*hardness+0.605
- o) assumes 1% MeHg
- p) hardness dependent guideline: CCME (mg/L) = EXP(0.76*(ln(hardness))+1.06)/1000; BC Max WQG = 0.025 at hardness <60 mg/L, at hardness 60-120 mg/L =0.065, at hardness 120-180 mg/L = 0.11, at hardness >180 mg/L = 0.15
- q) hardness dependent guideline: BC WQG (mg/L) = if hardness <= 100 mg/L = 0.00005 mg/L, else 0.0015
- r) hardness dependent guideline: BC WQG (mg/L) = (7.5+0.75(hardness-90))/1000

123	Indicates concentration exceeding the CCME Guideline
123	Indicates concentration exceeding the BCWQ Guideline

Parameter	Units	CCME Guidelines ^a	BC Water Quality Guidelines for the protection of Freshwater Aquatic Life 30-Day Average	DH10-05S			DH10-05D			MW05-02			DH10-06S			DH10-06D			DH10-01S		
				20-Jul-10	29-Nov-12	17-Feb-14	20-Jul-10	29-Nov-12	17-Feb-14	20-Jul-10	29-Nov-12	17-Feb-14	20-Jul-10	29-Nov-12	17-Feb-14	20-Jul-10	29-Nov-12	17-Feb-14	22-Jul-10	30-Nov-12	18-Feb-14
Total Metals																					
Aluminum	mg/L	0.005 ^l	0.011 ^l	0.054	0.057	0.061	<0.05	<0.0050	<0.0050	0.096	0.8	0.96	36	0.065	0.044	83	124	8.9	30	0.064	0.038
Antimony	mg/L	-	0.009	<0.0005	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050	<0.0025	<0.00050	<0.00050	<0.005	<0.0025	<0.00050	<0.001	<0.00050	<0.00050
Arsenic	mg/L	0.005	0.005	<0.0005	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050	0.013	<0.00050	<0.00050	0.022	0.045	0.0066	0.028	<0.00050	<0.00050
Barium	mg/L	-	1	<0.02	<0.020	<0.020	<0.02	<0.020	<0.020	<0.02	<0.020	<0.020	0.21	<0.020	<0.020	0.46	0.66	0.057	0.097	<0.020	<0.020
Beryllium	mg/L	-	0.00013	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.005	<0.0010	<0.0010	<0.01	<0.0050	<0.0010	<0.002	<0.0010	<0.0010
Boron	mg/L	1.5	1.2	<0.1	<0.10	<0.10	<0.1	<0.10	<0.10	<0.1	<0.10	<0.10	<0.1	<0.10	<0.10	<0.1	<0.10	<0.10	<0.1	<0.10	<0.10
Cadmium	mg/L	0.00004 ^j	0.000013-0.00032 ^j	<0.000017	<0.000017	<0.000010	<0.000017	<0.000017	<0.000010	<0.000017	<0.000017	<0.000010	0.00014	0.000021	0.000016	0.00041	0.00055	0.000037	0.0001	0.000024	0.00002
Chromium	mg/L	0.001 ^k	0.001	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	0.036	<0.0010	<0.0010	0.063	0.097	0.0062	0.018	<0.0010	<0.0010
Cobalt	mg/L	-	0.004	<0.0003	<0.00030	<0.00030	<0.0003	<0.00030	<0.00030	<0.0003	<0.00030	0.00031	0.013	0.00031	<0.00030	0.023	0.033	0.0022	0.0074	<0.00030	<0.00030
Copper	mg/L	0.002 ^l	0.002 ^l	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.001	0.0014	0.0018	0.057	0.0029	<0.0010	0.12	0.16	0.0099	0.044	<0.0010	<0.0010
Iron	mg/L	0.3	-	<0.03	<0.030	<0.030	<0.03	<0.030	<0.030	0.059	0.57	0.8	30	<0.030	<0.030	48	75	5.1	15	<0.030	<0.030
Lead	mg/L	0.001 ^m	0.0034-0.022 ^m	<0.0005	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050	0.0066	<0.00050	<0.00050	0.012	0.018	0.0013	0.0051	<0.00050	<0.00050
Lithium	mg/L	-	-	<0.005	<0.0050	<0.0050	<0.005	<0.0050	<0.0050	<0.005	<0.0050	<0.0050	0.026	<0.0050	<0.0050	0.052	<0.0050	0.0066	0.01	<0.0050	<0.0050
Manganese	mg/L	-	0.6-1.9 ⁿ	0.00079	0.00044	0.00051	<0.0003	<0.00030	<0.00030	0.0017	0.0098	0.013	0.48	0.017	0.0048	0.87	1.2	0.099	0.21	0.0038	0.0029
Mercury	mg/L	0.000026	0.00001 ^o	<0.00001	<0.000010	<0.000020	<0.00001	<0.000010	<0.000020	<0.00001	<0.000010	<0.000020	0.000011	<0.000010	<0.000020	0.000015	<0.000050	<0.000020	0.000035	<0.000010	<0.000020
Molybdenum	mg/L	0.073	1	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.005	<0.0010	<0.0010	<0.01	<0.0050	0.0017	<0.002	<0.0010	<0.0010
Nickel	mg/L	0.025 ^p	-	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	0.026	<0.0010	<0.0010	0.047	0.07	0.0048	0.017	<0.0010	<0.0010
Selenium	mg/L	0.001	0.002	<0.001	<0.0010	<0.00010	<0.001	<0.0010	<0.00010	<0.001	<0.0010	<0.00010	<0.005	<0.0010	<0.00010	<0.01	<0.0050	<0.00010	<0.002	<0.0010	<0.00010
Silicon	mg/L	-	-	1.3	1.9	1.9	9.2	10	8.8	3.1	5.7	5.9	44	2.6	2.3	72	101	16	24	2.6	2.6
Silver	mg/L	0.0001	0.00005-0.0015 ^q	<0.00002	<0.000020	<0.000020	<0.00002	<0.000020	<0.000020	0.000043	0.000035	0.000049	0.00013	<0.000020	<0.000020	0.00023	0.00035	0.000021	0.00019	<0.000020	<0.000020
Thallium	mg/L	0.0008	0.0008	<0.0002	<0.00020	<0.00020	<0.0002	<0.00020	<0.00020	<0.0002	<0.00020	<0.00020	<0.001	<0.00020	<0.00020	<0.002	<0.0010	<0.00020	<0.0004	<0.00020	<0.00020
Tin	mg/L	-	-	<0.0005	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050	<0.0005	<0.00050	<0.00050	<0.0025	<0.00050	<0.00050	<0.005	<0.0025	<0.00050	<0.001	<0.00050	<0.00050
Titanium	mg/L	-	-	<0.01	<0.010	<0.010	<0.01	<0.010	<0.010	<0.01	0.03	0.037	1.3	<0.010	<0.010	3.6	5.0	0.36	0.5	<0.010	<0.010
Uranium	mg/L	0.015	0.0085	<0.0002	<0.00020	<0.00020	<0.0002	<0.00020	<0.00020	<0.0002	<0.00020	<0.00020	0.0031	<0.00020	<0.00020	0.0067	0.014	0.0014	0.0084	<0.00020	<0.00020
Vanadium	mg/L	-	-	<0.001	<0.0010	<0.0010	<0.001	<0.0010	<0.0010	<0.001	0.0014	0.002	0.068	<0.0010	<0.0010	0.14	0.21	0.013	0.03	<0.0010	<0.0010
Zinc	mg/L	0.03	0.0075-0.24 ^r	<0.005	<0.0050	<0.0050	<0.005	<0.0050	<0.0050	<0.005	<0.0050	<0.0050	0.06	<0.0050	<0.0050	0.12	0.18	0.013	0.029	<0.0050	<0.0050

Notes:

- a) Canadian Council of Ministers of the Environment (CCME) Guidelines for the protection of Freshwater Aquatic Life
- b) BC Water Quality (BCWQ) Guidelines for the protection of Freshwater Aquatic Life (working guidelines marked in italics)
- c) calculated value: calculated TDS based on standard methods (APHA, 2005)
- d) assumed alkalinity based on mean of SFE test, used for calculation of TDS
- e) calculated hardness based on concentrations of calcium and magnesium
- f) hardness dependent guideline: 128 mg/L for hardness <30 mg/L, 218 mg/L for hardness 31 - 75 mg/L
- g) pH and temperature dependent guideline: based on maximum temperature of 18°C, pH 7.7
- h) chloride dependent guideline: 0.02 mg/L for Cl <2 mg/L, 0.04 mg/L for Cl 2-4 mg/L
- i) pH dependent guideline: CCME 0.005 mg/L if pH<6.5; BC WQG = 0.011 mg/L (based on minimum observed surface water pH = 5.57)
- j) hardness dependent dissolved Cd guideline BC WQG Long-term average (ug/L) = 2.718[0.736*ln(hardness)-4.943]. For the purpose of guideline comparison, the dissolved Cd guideline was used for total Cd.
- k) guideline is for Cr(VI)
- l) hardness dependent guideline: CCME (mg/L) = 0.2*EXP(0.8545(ln(hardness))-1.465)/1000; BC WQG (mg/L) if hardness <= 50 mg/L = 0.002 mg/L, if hardness < 50 mg/L, 0.04*hardness/1000
- m) hardness dependent guideline: CCME (mg/L) = EXP(1.273(ln(hardness))-4.705)/1000; BC WQG (mg/L) = 3.31+EXP(1.273(ln(hardness))-4.704)/1000
- n) hardness dependent guideline: BC WQG (mg/L) = 0.0044*hardness+0.605
- o) assumes 1% MeHg
- p) hardness dependent guideline: CCME (mg/L) = EXP(0.76*(ln(hardness))+1.06)/1000; BC Max WQG = 0.025 at hardness <60 mg/L, at hardness 60-120 mg/L =0.065, at hardness 120-180 mg/L = 0.11, at hardness >180 mg/L = 0.15
- q) hardness dependent guideline: BC WQG (mg/L) = if hardness <= 100 mg/L = 0.00005 mg/L, else 0.0015
- r) hardness dependent guideline: BC WQG (mg/L) = (7.5+0.75(hardness-90))/1000

123	Indicates concentration exceeding the CCME Guideline
123	Indicates concentration exceeding the BCWQ Guideline

Parameter	Units	CCME Guidelines ^a	BC Water Quality Guidelines for the protection of Freshwater Aquatic Life ^b	DH10-01D					MW05-1	
				30-Day Average	22-Jul-10	22-Jul-10	30-Nov-12	30-Nov-12	18-Feb-14	30-Nov-12
Conventional										
pH	-	6.5 - 9	-	7.4	8.8	7.7	7.7	7.6	8.2	8.1
Total Dissolved Solids ^c	mg/L	-	-	56	55	54	50	68	245	248
Alkalinity ^d	mg/L	-	-	21	21	22	22	26	57	61
Hardness ^e	mg/L	-	-	27	27	28	28	32	175	177
Major Ions										
Calcium	mg/L	-	-	9.5	9.5	9.6	9.6	11	69	70
Chloride	mg/L	120	150	2.0	2.1	1.5	1.5	1.9	0.91	0.91
Fluoride	mg/L	0.12	-	0.027	0.031	0.042	0.042	0.054	0.22	0.23
Magnesium	mg/L	-	-	0.91	0.91	0.91	0.9	1.1	0.93	0.94
Potassium	mg/L	-	-	<2	<2	<2.0	<2.0	<2.0	<2.0	<2.0
Sodium	mg/L	-	-	3.5	3.5	3.5	3.4	4.1	6.1	6.7
Sulphate	mg/L	-	128-429 ^f	9.9	10	12	12	12	120	119
Nutrients										
Ammonia	mg/L (as N)	0.41 ^g	1.44 ^g	0.0098	0.012	<0.0050	<0.0050	<0.0050	0.043	0.043
Nitrate	mg/L (as N)	13	3	0.11	0.12	0.11	0.11	0.08	<0.0050	0.02
Nitrite	mg/L (as N)	0.06	0.02-0.04 ^h	<0.001	<0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Total Kjeldhal Nitrogen	mg/L (as N)	-	-	<0.05	<0.05	<0.050	<0.050	<0.050	0.081	0.088
Total Phosphorus	mg/L	-	-	0.0022	0.0027	0.004	0.0051	0.0038	0.11	0.12
Dissolved Metals										
Aluminum	mg/L	0.005 ⁱ	0.011 ⁱ	<0.005	0.0058	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Antimony	mg/L	-	0.009	<0.0005	<0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Arsenic	mg/L	0.005	0.005	<0.0005	<0.0005	<0.00050	<0.00050	<0.00050	0.0022	0.0022
Barium	mg/L	-	1	<0.02	<0.02	<0.020	<0.020	<0.020	0.021	0.021
Beryllium	mg/L	-	0.00013	<0.001	<0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Boron	mg/L	1.5	1.2	<0.1	<0.1	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium	mg/L	0.00004 ^j	0.000013-0.00032 ^j	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017
Chromium	mg/L	0.001 ^k	0.001 ^k	<0.001	<0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cobalt	mg/L	-	0.004	<0.0003	<0.0003	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
Copper	mg/L	0.002 ^l	0.002 ^l	<0.001	<0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Iron	mg/L	0.3	-	<0.03	<0.03	<0.030	<0.030	<0.030	0.14	0.089
Lead	mg/L	0.001 ^m	0.0034-0.022 ^m	<0.0005	<0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Lithium	mg/L	-	-	<0.005	<0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Manganese	mg/L	-	0.6-1.9 ⁿ	0.0049	0.0051	0.0037	0.0038	0.0021	0.2	0.15
Mercury	mg/L	0.000026	0.00001 ^o	<0.00001	<0.00001	<0.000010	<0.000010	<0.000020	<0.000010	<0.000020
Molybdenum	mg/L	0.073	1	<0.001	<0.001	<0.0010	<0.0010	<0.0010	0.0018	0.0022
Nickel	mg/L	0.025 ^p	0.025-0.11 ^p	<0.001	<0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Selenium	mg/L	0.001	0.002	<0.001	<0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Silicon	mg/L	-	-	7.2	7.1	7.3	7.2	7.6	6.3	6.2
Silver	mg/L	0.0001	0.00005-0.0015 ^q	<0.00002	<0.00002	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Thallium	mg/L	0.0008	0.0008	<0.0002	<0.0002	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Tin	mg/L	-	-	<0.0005	<0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Titanium	mg/L	-	-	<0.01	<0.01	<0.010	<0.010	<0.010	<0.010	<0.010
Uranium	mg/L	0.015	0.0085	<0.0002	<0.0002	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Vanadium	mg/L	-	-	0.001	0.0011	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Zinc	mg/L	0.03	0.0075-0.24 ^r	<0.005	<0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Parameter	Units	CCME Guidelines ^a	BC Water Quality Guidelines for the protection of Freshwater Aquatic Life 30-Day Average	DH10-01D					MW05-1	
				22-Jul-10	22-Jul-10	30-Nov-12	30-Nov-12	18-Feb-14	30-Nov-12	18-Feb-14
Total Metals										
Aluminum	mg/L	0.005 ^l	0.011 ^l	0.011	<0.01	0.013	0.014	0.0091	0.04	0.04
Antimony	mg/L	-	0.009	<0.0005	<0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Arsenic	mg/L	0.005	0.005	<0.0005	<0.0005	<0.00050	<0.00050	<0.00050	0.0024	0.0023
Barium	mg/L	-	1	<0.02	<0.02	<0.020	<0.020	<0.020	0.021	0.021
Beryllium	mg/L	-	0.00013	<0.001	<0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Boron	mg/L	1.5	1.2	<0.1	<0.1	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium	mg/L	0.00004 ^l	0.000013-0.00032 ^l	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017
Chromium	mg/L	0.001 ^k	0.001	<0.001	<0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cobalt	mg/L	-	0.004	<0.0003	<0.0003	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
Copper	mg/L	0.002 ^l	0.002 ^l	<0.001	<0.001	<0.0010	0.0024	<0.0010	<0.0010	<0.0010
Iron	mg/L	0.3	-	<0.03	<0.03	<0.030	<0.030	<0.030	0.2	0.16
Lead	mg/L	0.001 ^m	0.0034-0.022 ^m	<0.0005	<0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Lithium	mg/L	-	-	<0.005	<0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Manganese	mg/L	-	0.6-1.9 ⁿ	0.0056	0.0056	0.0041	0.0041	0.0027	0.2	0.15
Mercury	mg/L	0.000026	0.00001 ^o	<0.00001	<0.00001	<0.000010	<0.000010	<0.000020	<0.000010	<0.000020
Molybdenum	mg/L	0.073	1	<0.001	<0.001	<0.0010	<0.0010	<0.0010	0.0021	0.0024
Nickel	mg/L	0.025 ^p	-	<0.001	<0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Selenium	mg/L	0.001	0.002	<0.001	<0.001	<0.0010	<0.0010	<0.00010	<0.0010	<0.00010
Silicon	mg/L	-	-	7.1	7.1	7.2	7.2	7.7	6.4	6.3
Silver	mg/L	0.0001	0.00005-0.0015 ^q	0.000044	<0.00002	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Thallium	mg/L	0.0008	0.0008	<0.0002	<0.0002	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Tin	mg/L	-	-	<0.0005	<0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Titanium	mg/L	-	-	<0.01	<0.01	<0.010	<0.010	<0.010	<0.010	<0.010
Uranium	mg/L	0.015	0.0085	<0.0002	<0.0002	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Vanadium	mg/L	-	-	0.0012	0.0012	<0.0010	0.001	<0.0010	<0.0010	<0.0010
Zinc	mg/L	0.03	0.0075-0.24 ^r	<0.005	<0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Notes:

- a) Canadian Council of Ministers of the Environment (CCME) Guidelines for the protection of Freshwater Aquatic Life
- b) BC Water Quality (BCWQ) Guidelines for the protection of Freshwater Aquatic Life (working guidelines marked in italics)
- c) calculated value: calculated TDS based on standard methods (APHA, 2005)
- d) assumed alkalinity based on mean of SFE test, used for calculation of TDS
- e) calculated hardness based on concentrations of calcium and magnesium
- f) hardness dependent guideline: 128 mg/L for hardness <30 mg/L, 218 mg/L for hardness 31 - 75 mg/L
- g) pH and temperature dependent guideline: based on maximum temperature of 18°C, pH 7.7
- h) chloride dependent guideline: 0.02 mg/L for Cl <2 mg/L, 0.04 mg/L for Cl 2-4 mg/L
- i) pH dependent guideline: CCME 0.005 mg/L if pH<6.5; BC WQG = 0.011 mg/L (based on minimum observed surface water pH = 5.57)
- j) hardness dependent dissolved Cd guideline BC WQG Long-term average (ug/L) = 2.718[0.736*ln(hardness)-4.943]. For the purpose of guideline comparison, the dissolved Cd guideline was used for total Cd.
- k) guideline is for Cr(VI)
- l) hardness dependent guideline: CCME (mg/L) = 0.2*EXP(0.8545(ln(hardness))-1.465)/1000; BC WQG (mg/L) if hardness <= 50 mg/L = 0.002 mg/L, if hardness < 50 mg/L, 0.04*hardness/1000
- m) hardness dependent guideline: CCME (mg/L) = EXP(1.273(ln(hardness))-4.705)/1000; BC WQG (mg/L) = 3.31+EXP(1.273(ln(hardness))-4.704)/1000
- n) hardness dependent guideline: BC WQG (mg/L) = 0.0044*hardness+0.605
- o) assumes 1% MeHg
- p) hardness dependent guideline: CCME (mg/L) = EXP(0.76*(ln(hardness))+1.06)/1000; BC Max WQG = 0.025 at hardness <60 mg/L, at hardness 60-120 mg/L =0.065, at hardness 120-180 mg/L = 0.11, at hardness >180 mg/L = 0.15
- q) hardness dependent guideline: BC WQG (mg/L) = if hardness <= 100 mg/L = 0.00005 mg/L, else 0.0015
- r) hardness dependent guideline: BC WQG (mg/L) = (7.5+0.75(hardness-90))/1000

123	Indicates concentration exceeding the CCME Guideline
123	Indicates concentration exceeding the BCWQ Guideline