Appendix C. Site C PAG Contact RSEM Surface Water Quality Monitoring Time Series Plots – RSEM R6 Monthly and 5 in 30-day Data.

Figure 91. 2018 Peace River (*in-situ*) and RSEM R6 pond (lab) specific conductivity.

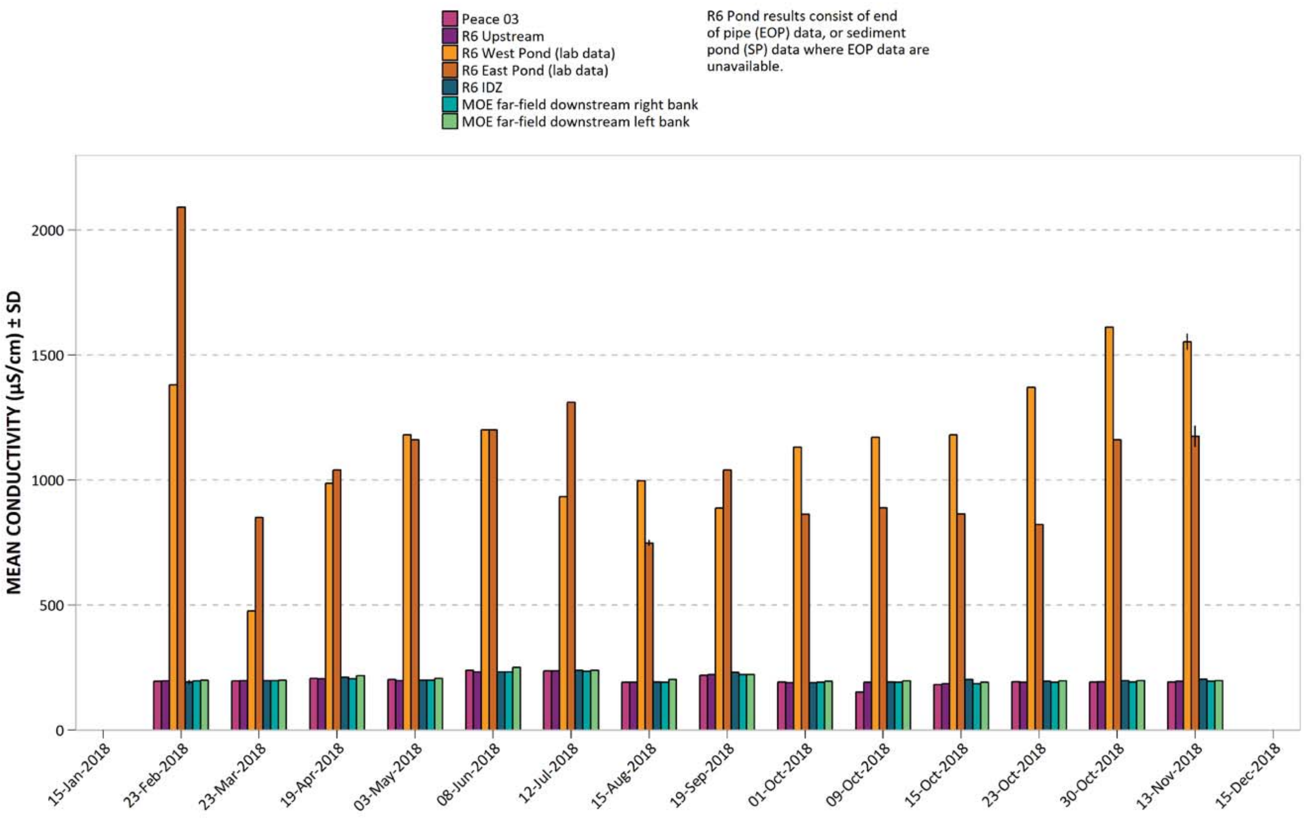


Figure 92. 2018 Peace River and RSEM R6 pond lab specific conductivity.

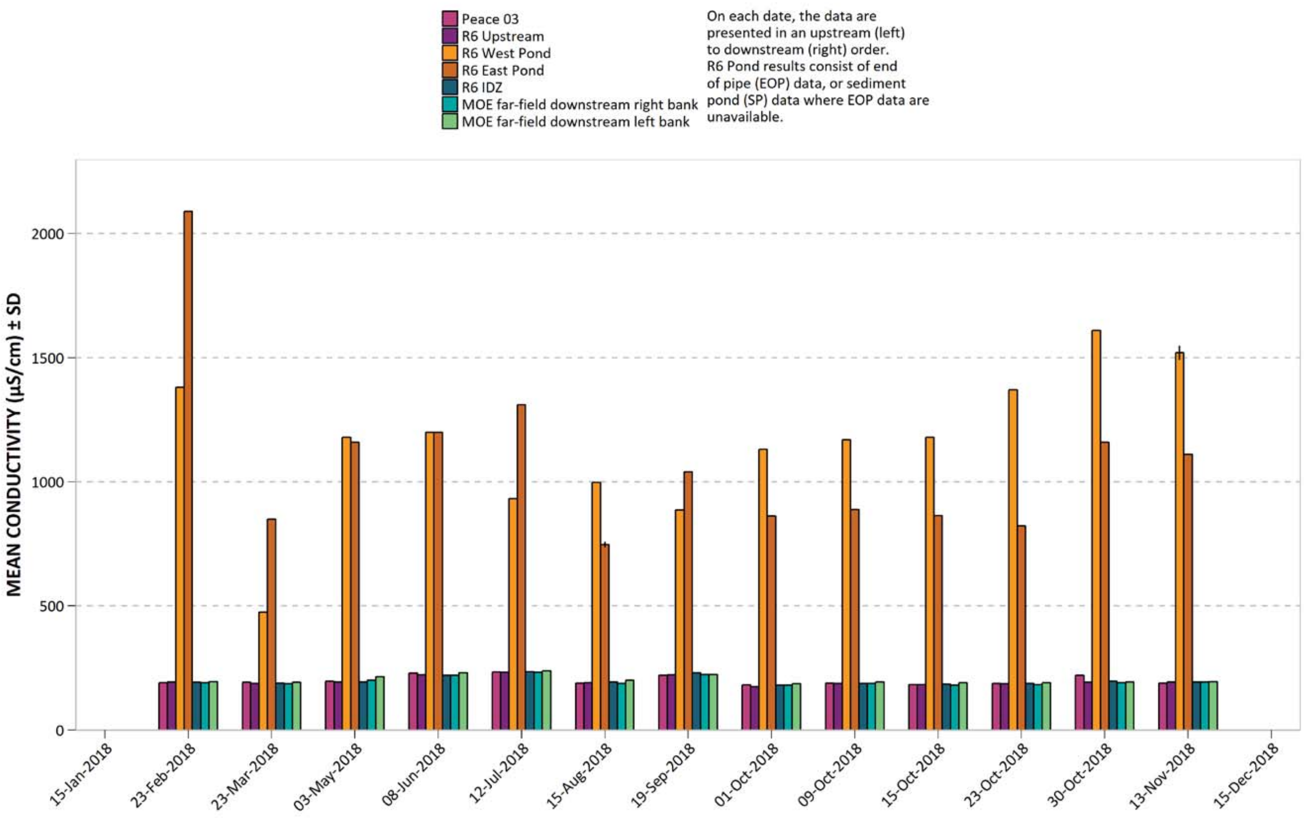


Figure 93. 2018 Peace River and RSEM R6 pond hardness (as $CaCO_3$).

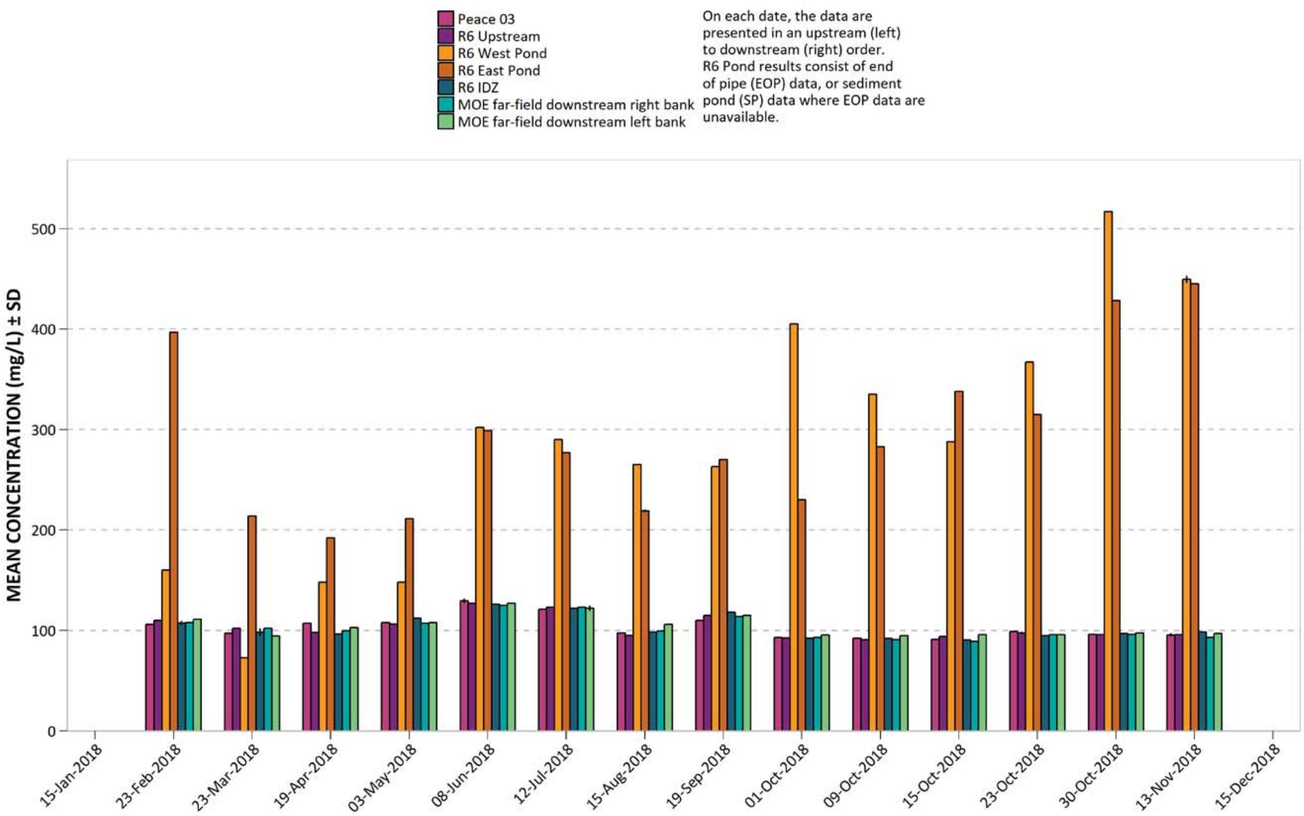


Figure 94. 2018 Peace River and RSEM R6 pond total dissolved solids (TDS).

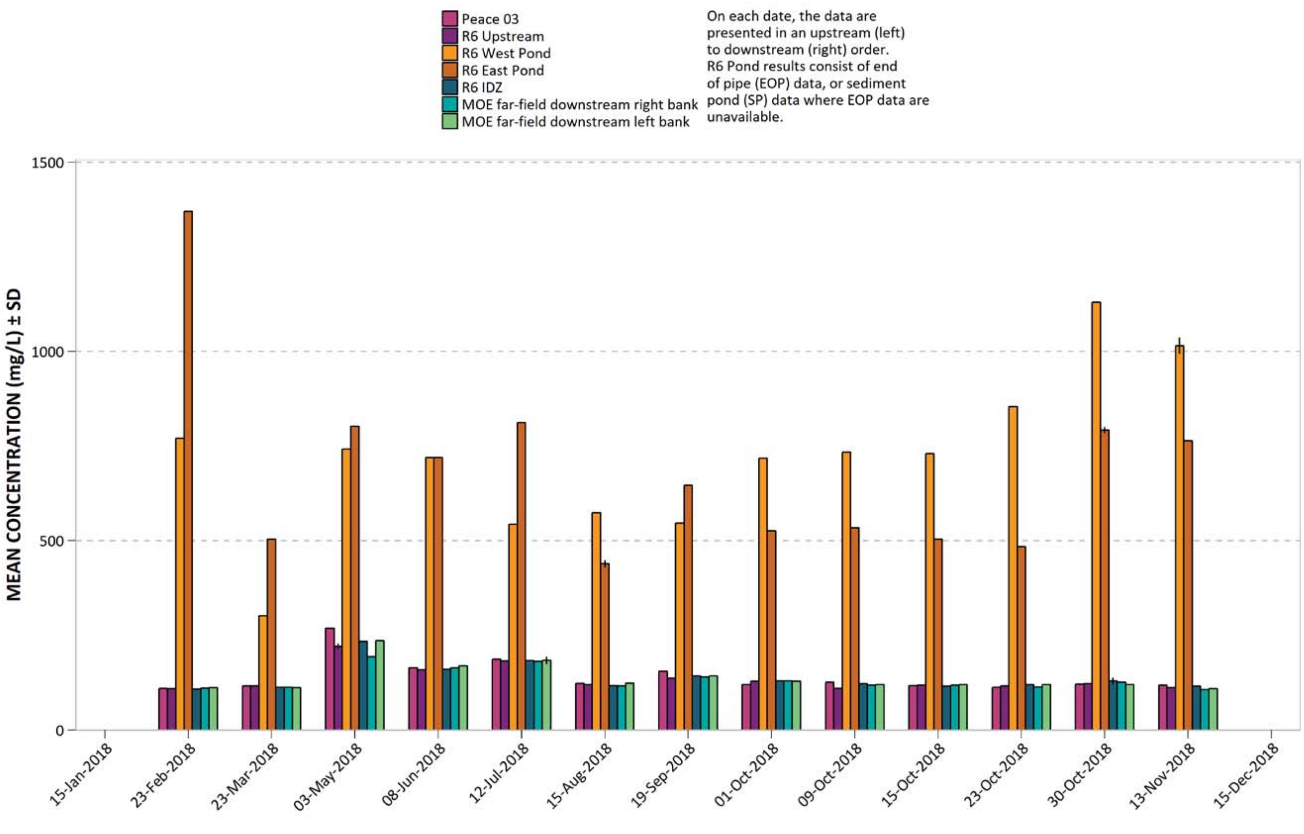
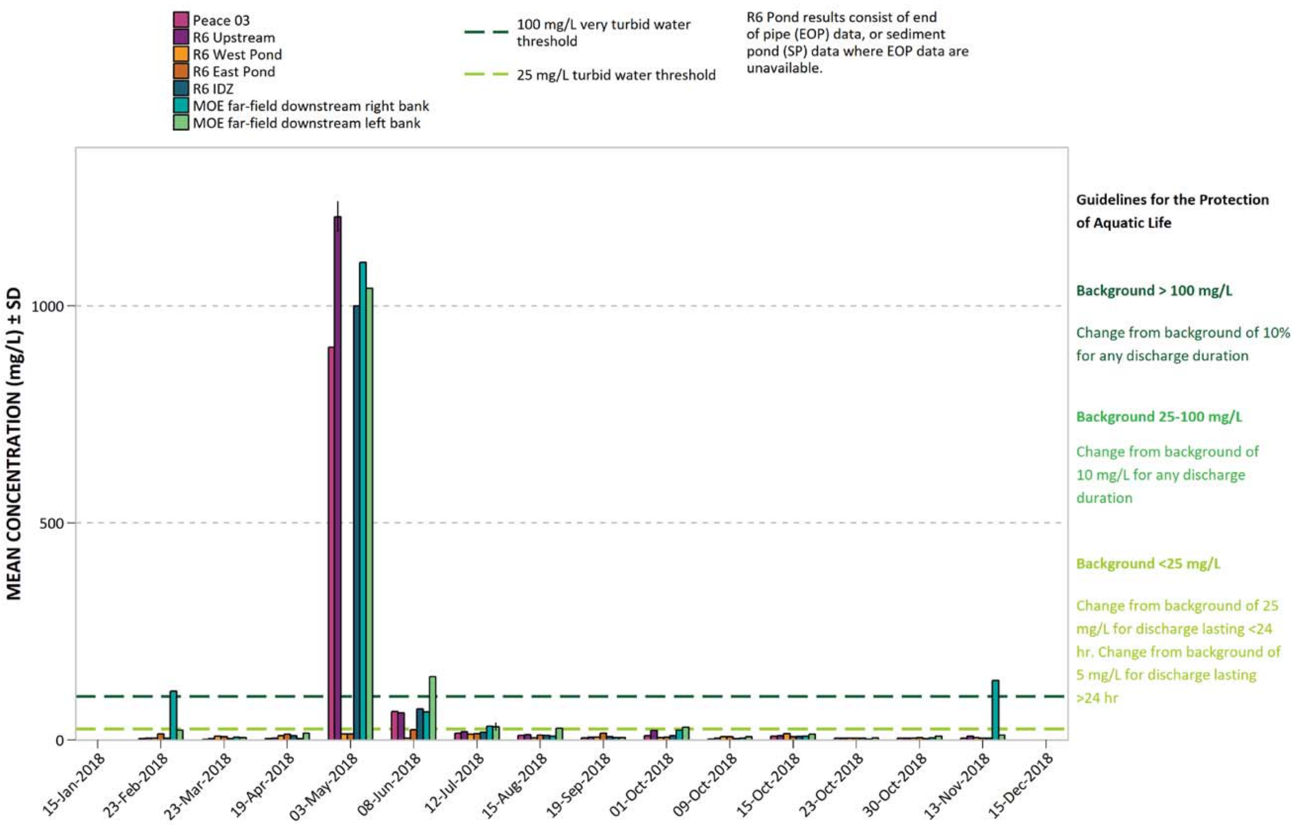


Figure 95. 2018 Peace River and RSEM R6 pond total suspended solids (TSS).



At the Peace River sampling locations, the concentration of total suspended solids (TSS) is obtained preferentially from laboratory data, however if laboratory data are unavailable, TSS is calculated from *in-situ t*urbidity data using site specific TSS:Turbidity relationships.

Figure 96. 2018 Peace River (*in-situ*) and RSEM R6 pond (lab) turbidity.

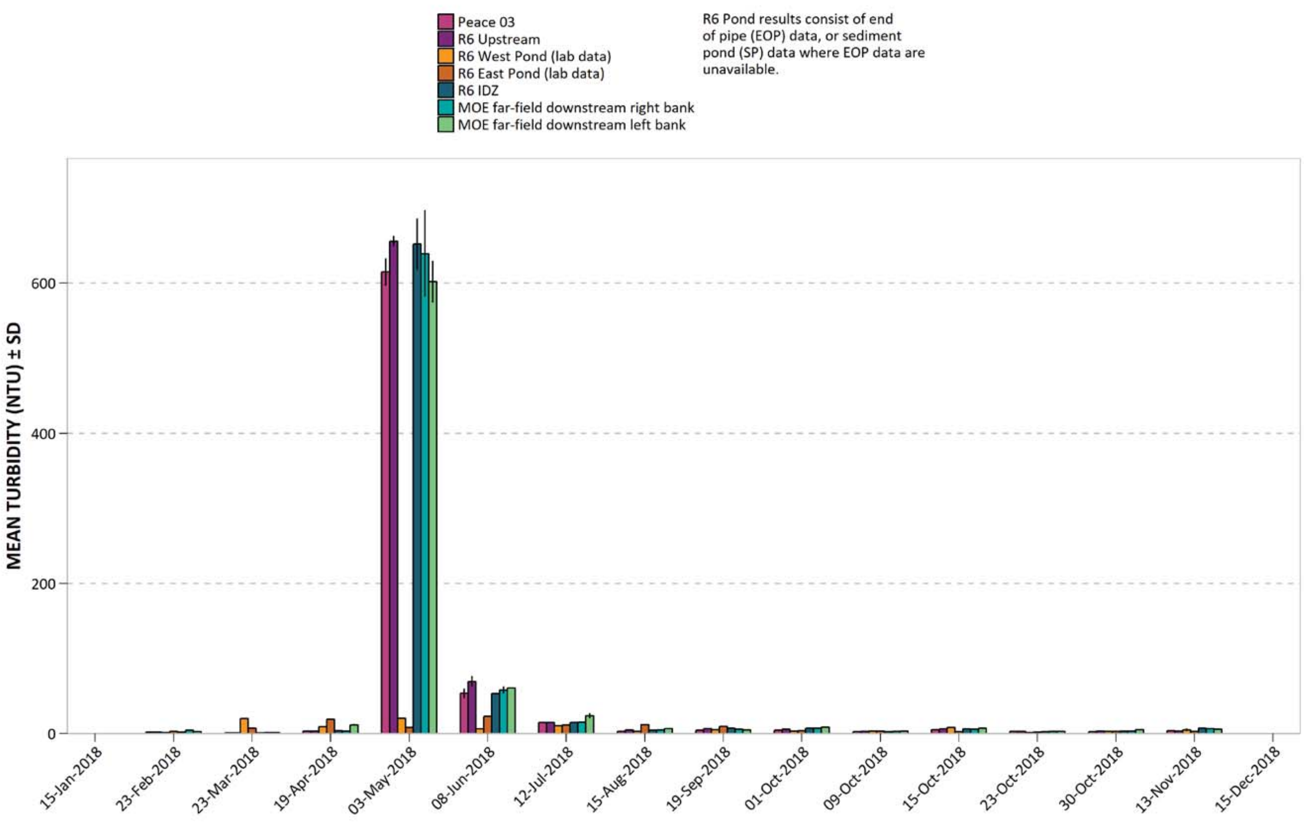


Figure 97. 2018 Peace River (*in-situ*) and RSEM R6 pond (lab) pH.

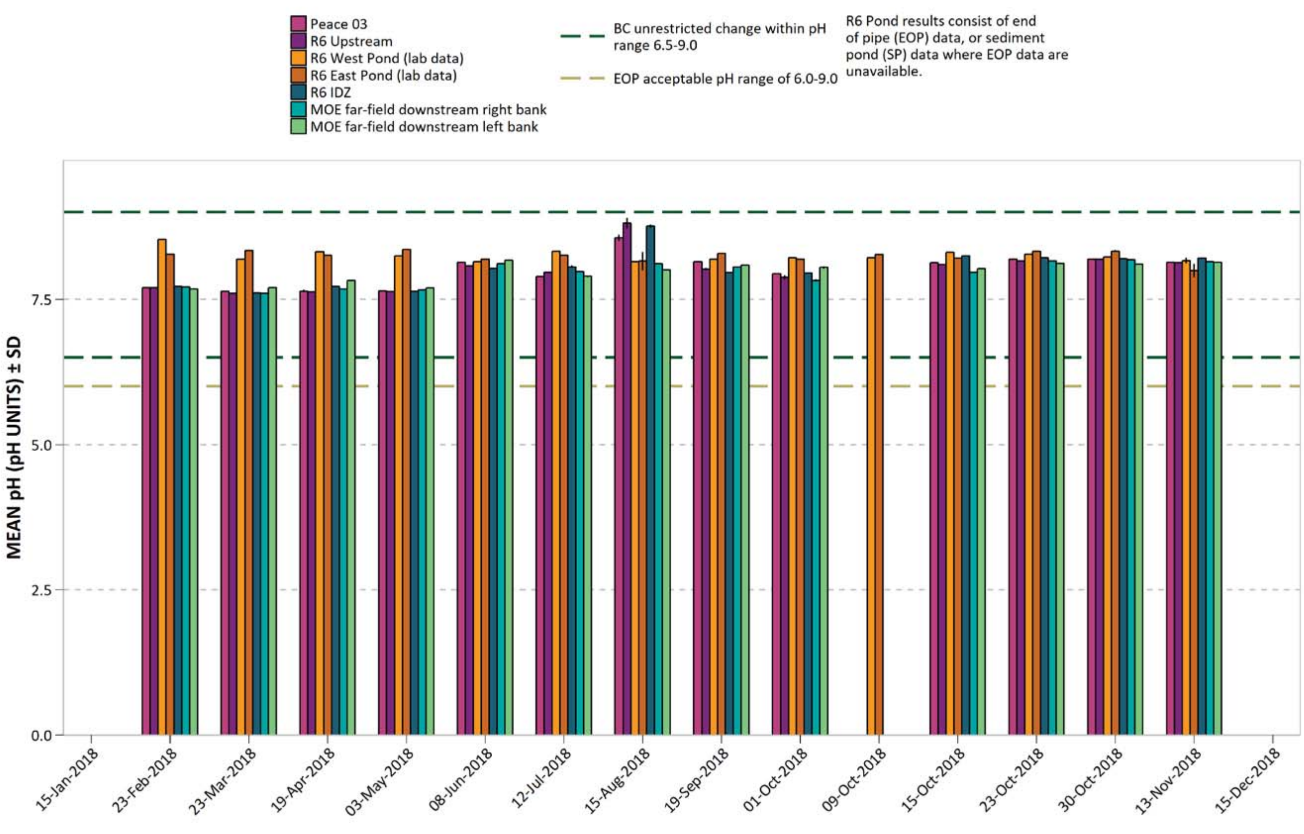


Figure 98. 2018 Peace River and RSEM R6 pond lab pH.

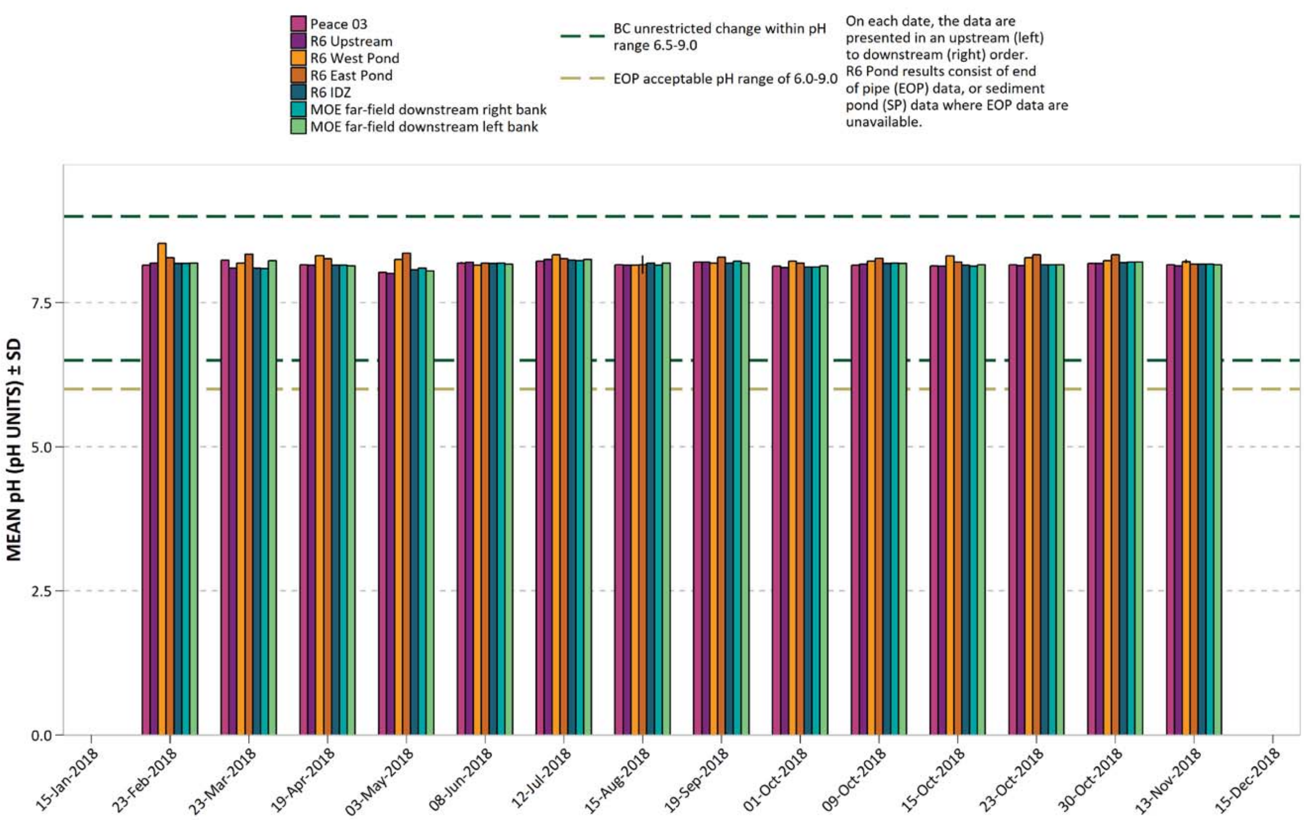


Figure 99. 2018 Peace River and RSEM R6 pond total alkalinity (as $CaCO_3$).

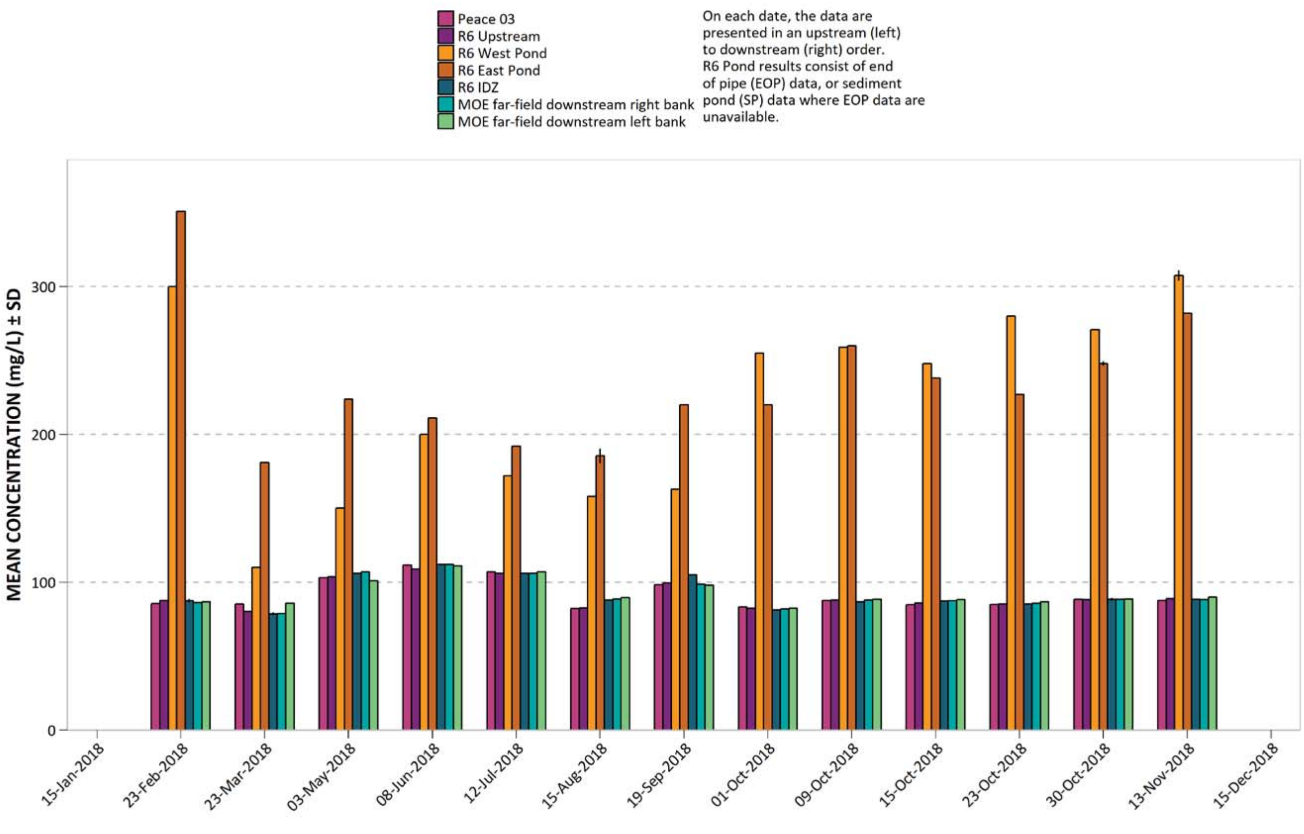


Figure 100. 2018 Peace River and RSEM R6 pond total ammonia (as N).

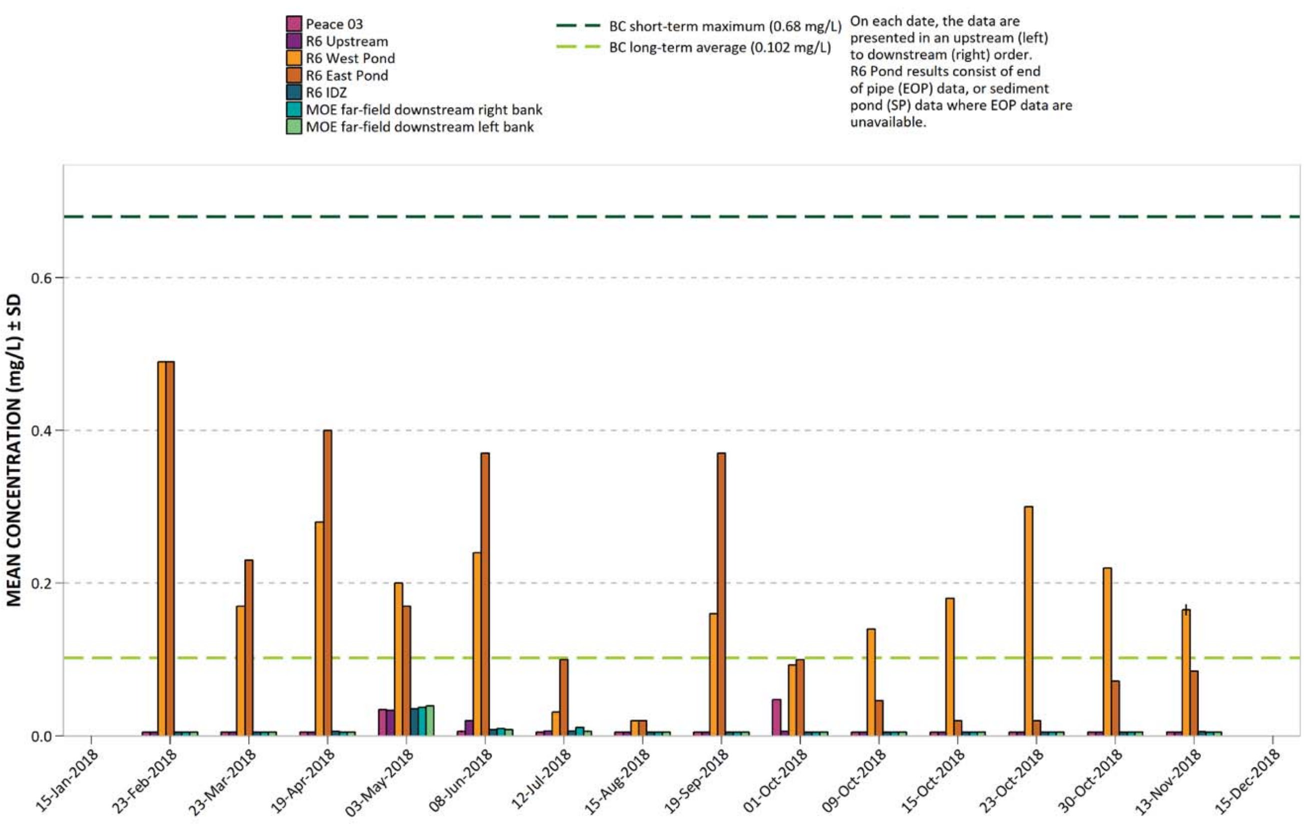
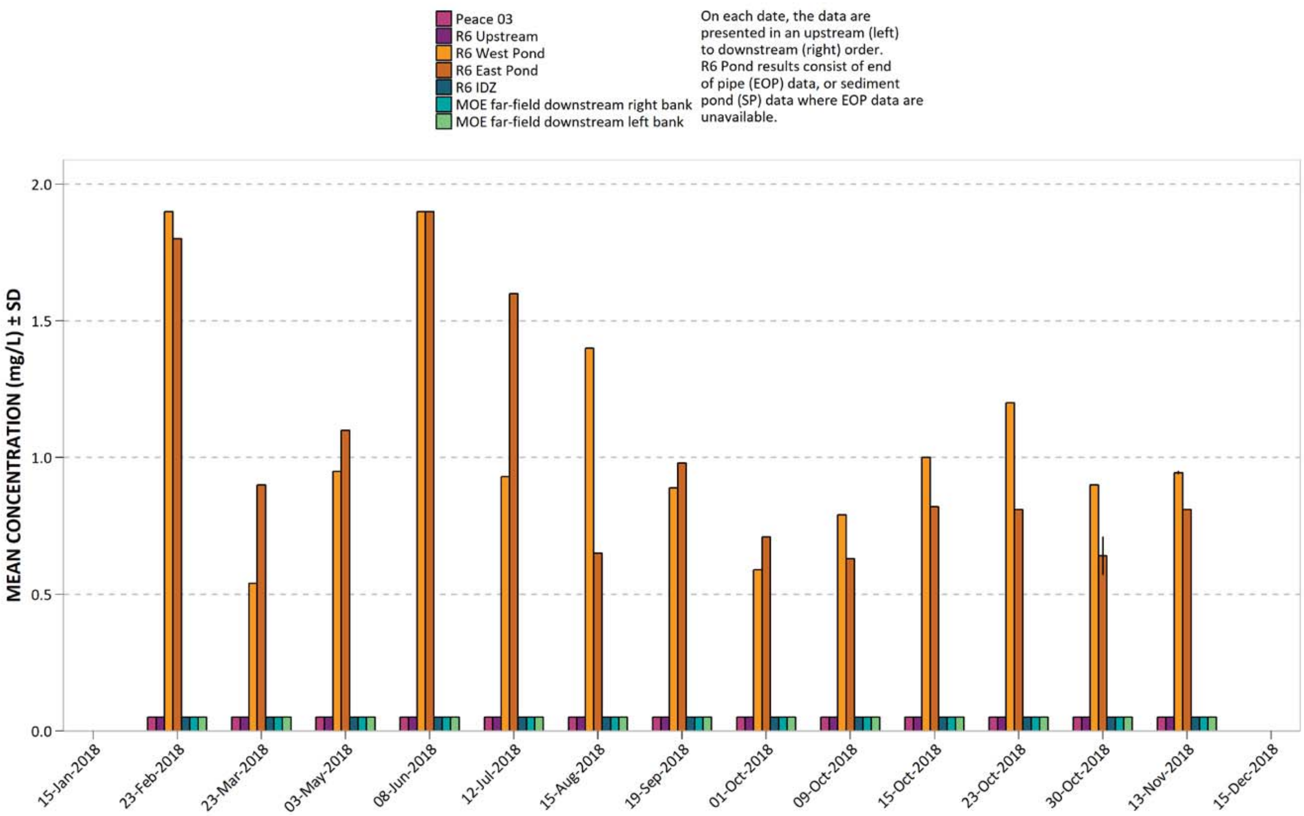
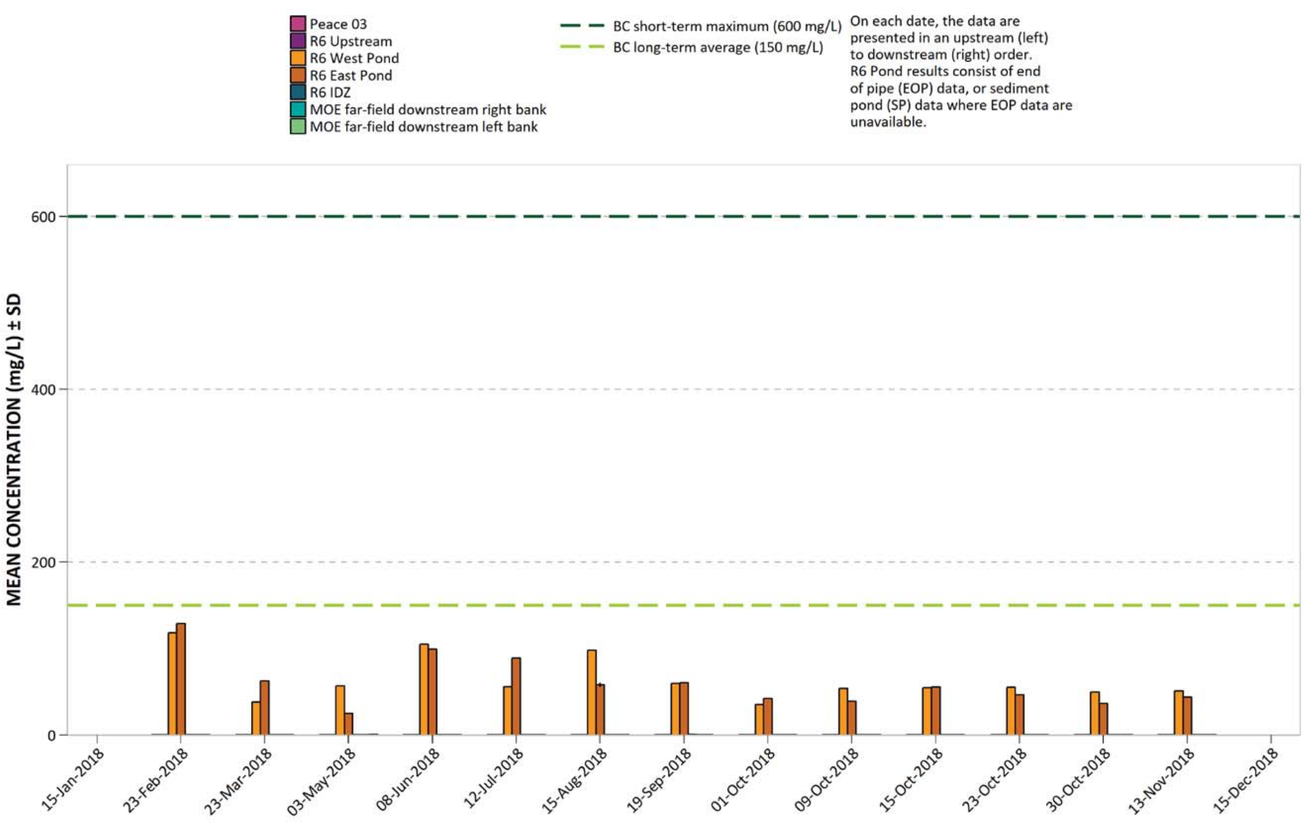


Figure 101. 2018 Peace River and RSEM R6 pond bromide (Br).



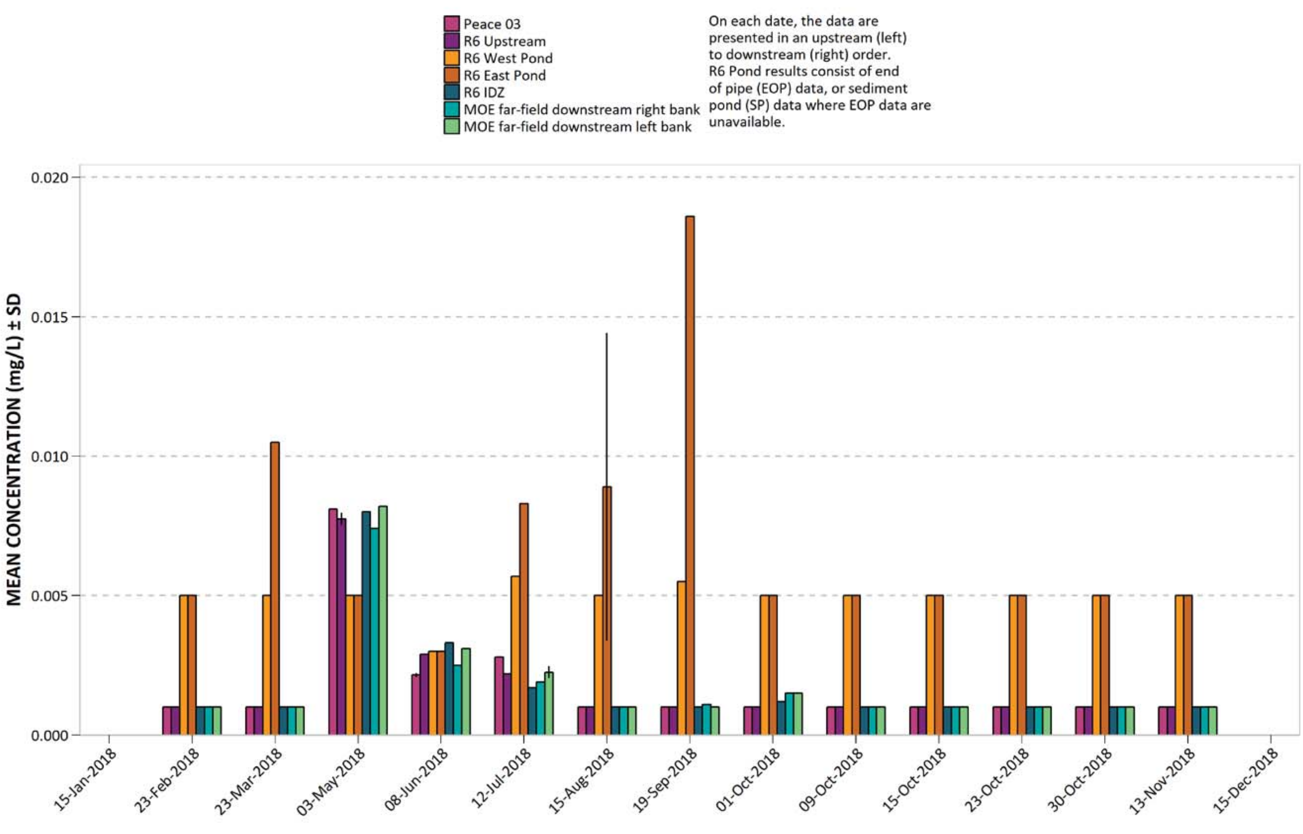
All Peace River results were less than the MDL and thus were assigned the MDL value of 0.05 mg/L.

Figure 102. 2018 Peace River and RSEM R6 pond chloride (Cl).



All Peace River results were less than the MDL and thus were assigned the MDL value of 0.5 mg/L.

Figure 103. 2018 Peace River and RSEM R6 pond dissolved orthophosphate.



Results less than the MDL were assigned the MDL value of 0.005 mg/L (R5b pond) or 0.001 mg/L (Peace River).

Figure 104. 2018 Peace River and RSEM R6 pond fluoride (F).

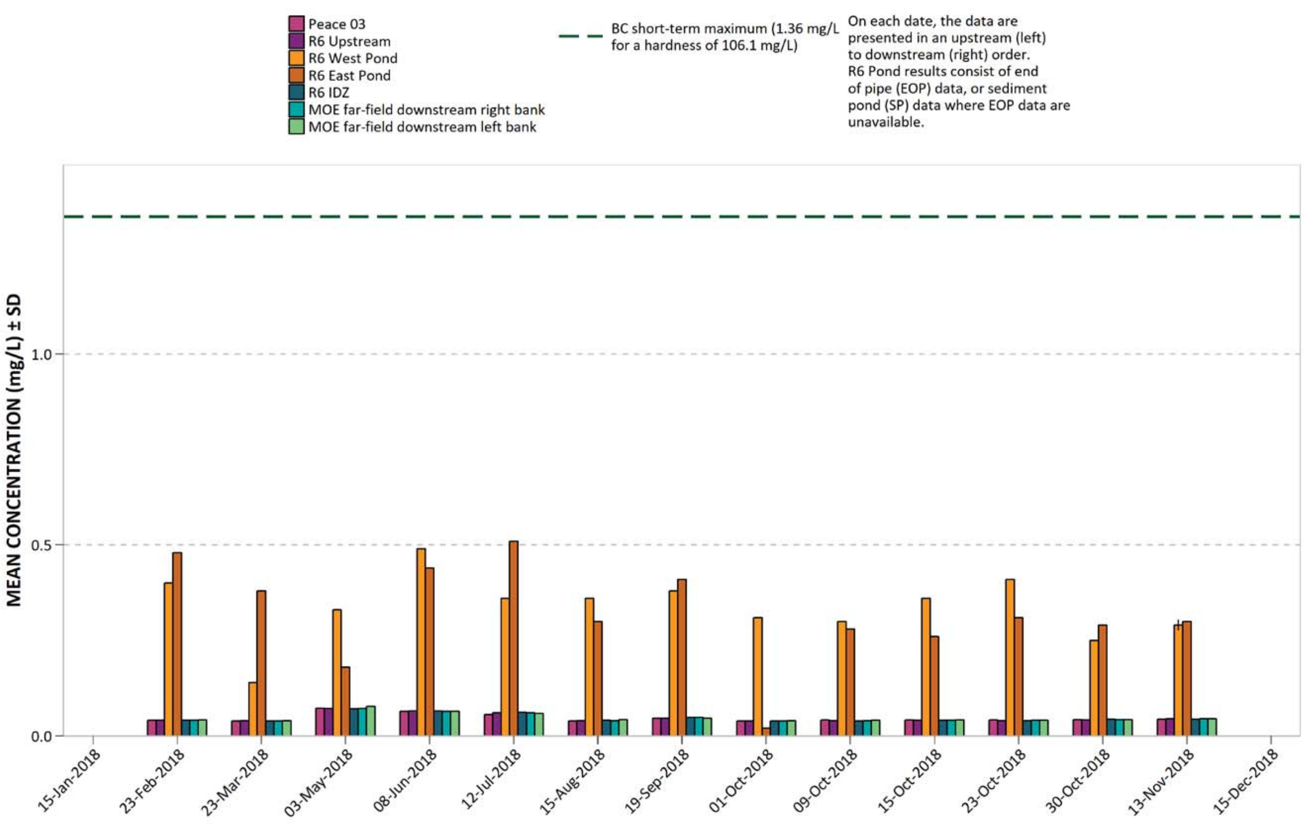


Figure 105. 2018 Peace River and RSEM R6 pond nitrate (as N).

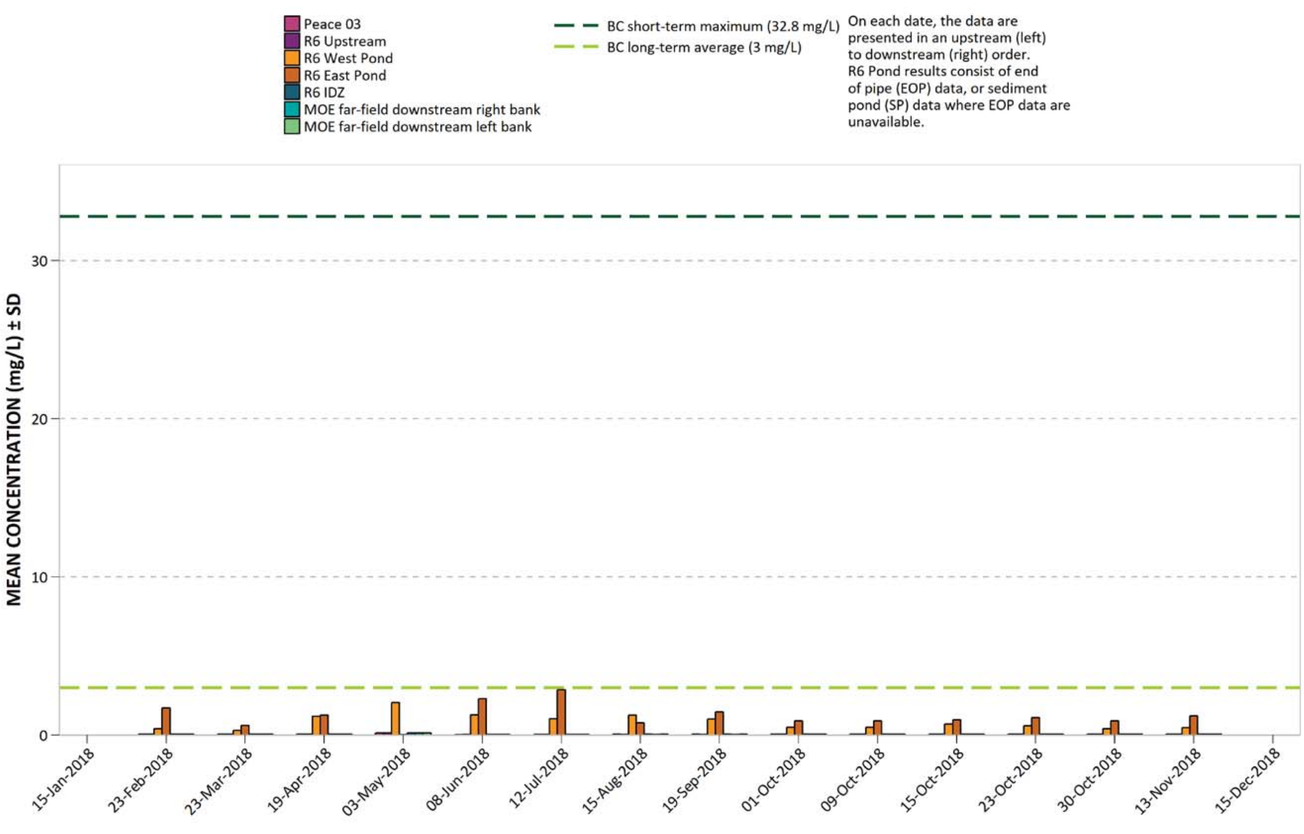
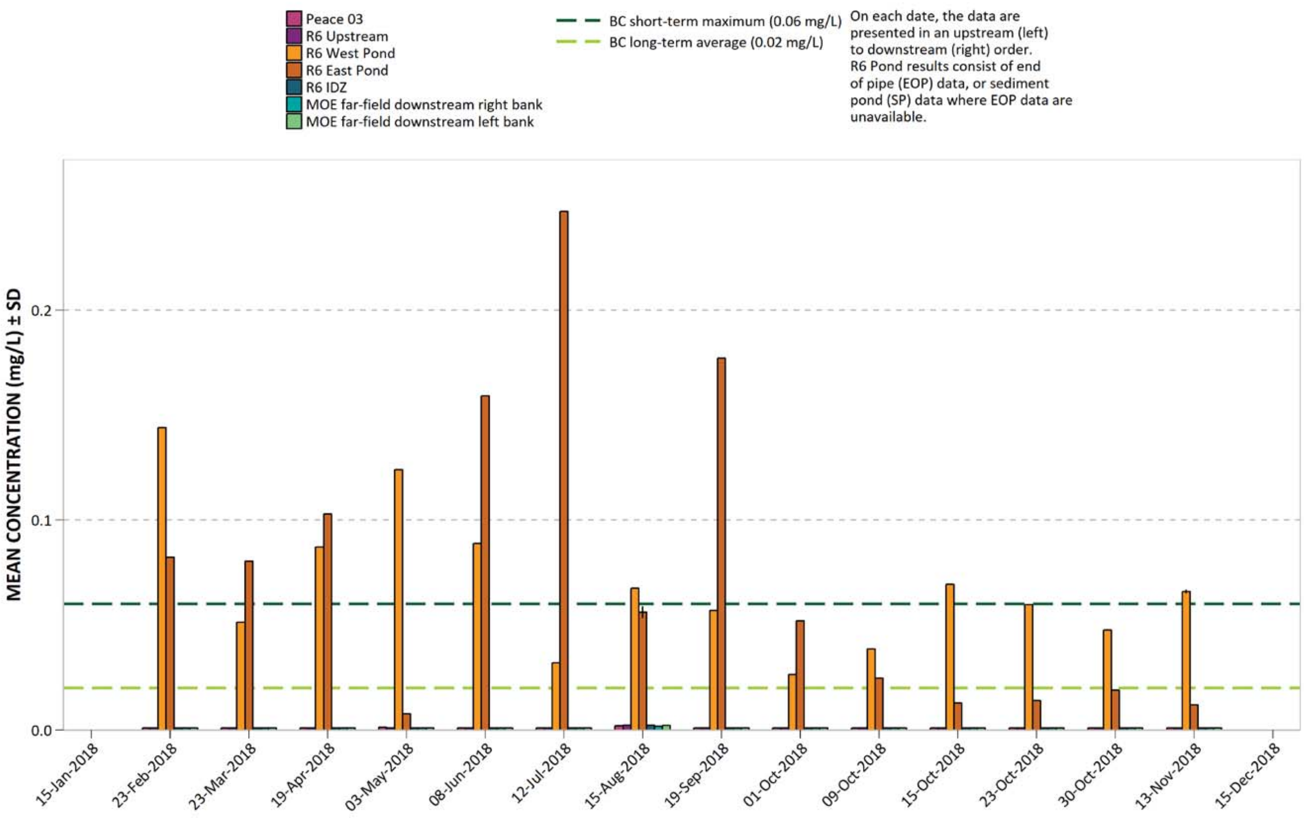


Figure 106. 2018 Peace River and RSEM R6 pond nitrite (as N).



Note: BC WQG for nitrite are chloride dependent, and therefore guidelines depicted in the plot are applicable for Peace River sites only. Based on the range of chloride values observed in the R6 pond, the applicable BC Maximum and 30-day guidelines are 0.6 mg/L and 0.2 mg/L, respectively.

Figure 107. 2018 Peace River and RSEM R6 pond sulfate (SO_4).

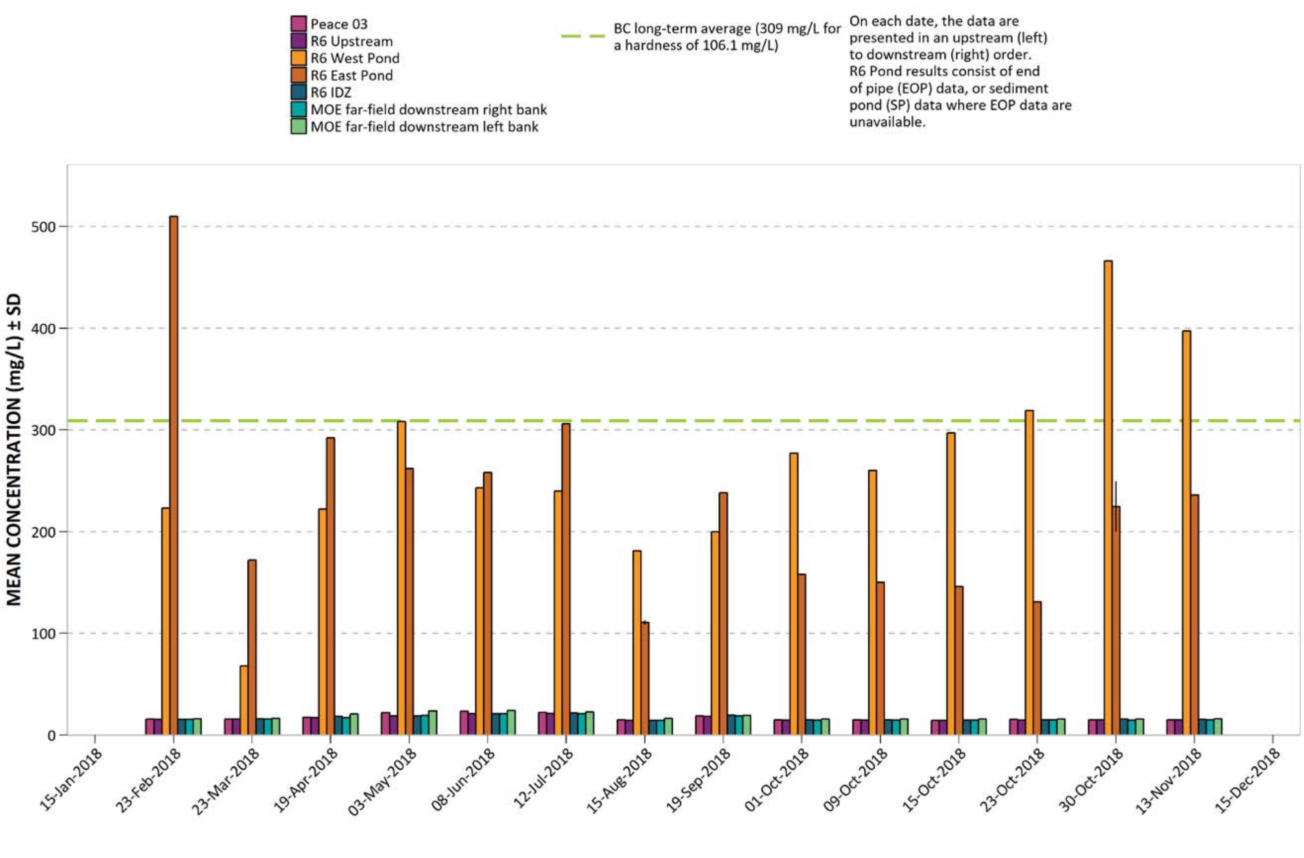


Figure 108. 2018 Peace River and RSEM R6 pond dissolved organic carbon (DOC).

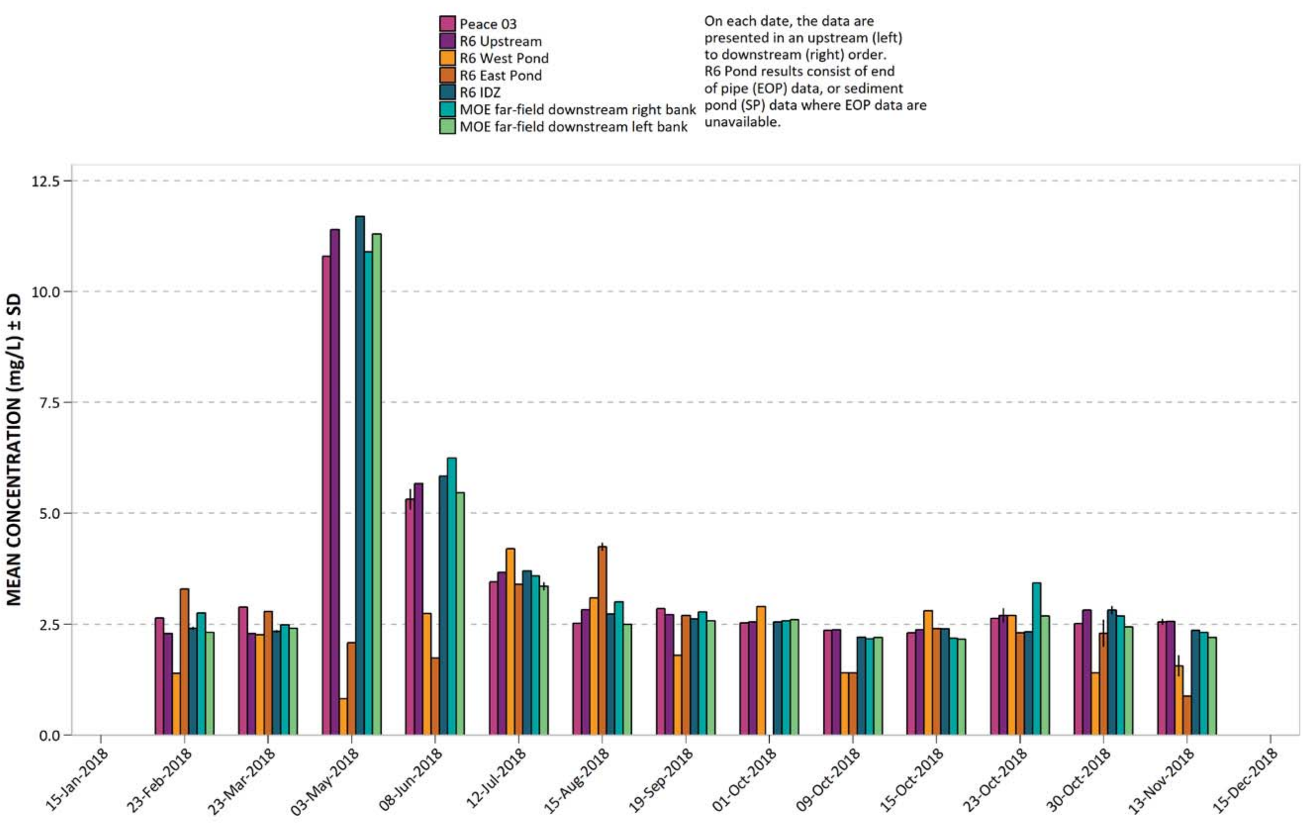


Figure 109. 2018 Peace River and RSEM R6 pond total organic carbon (TOC).

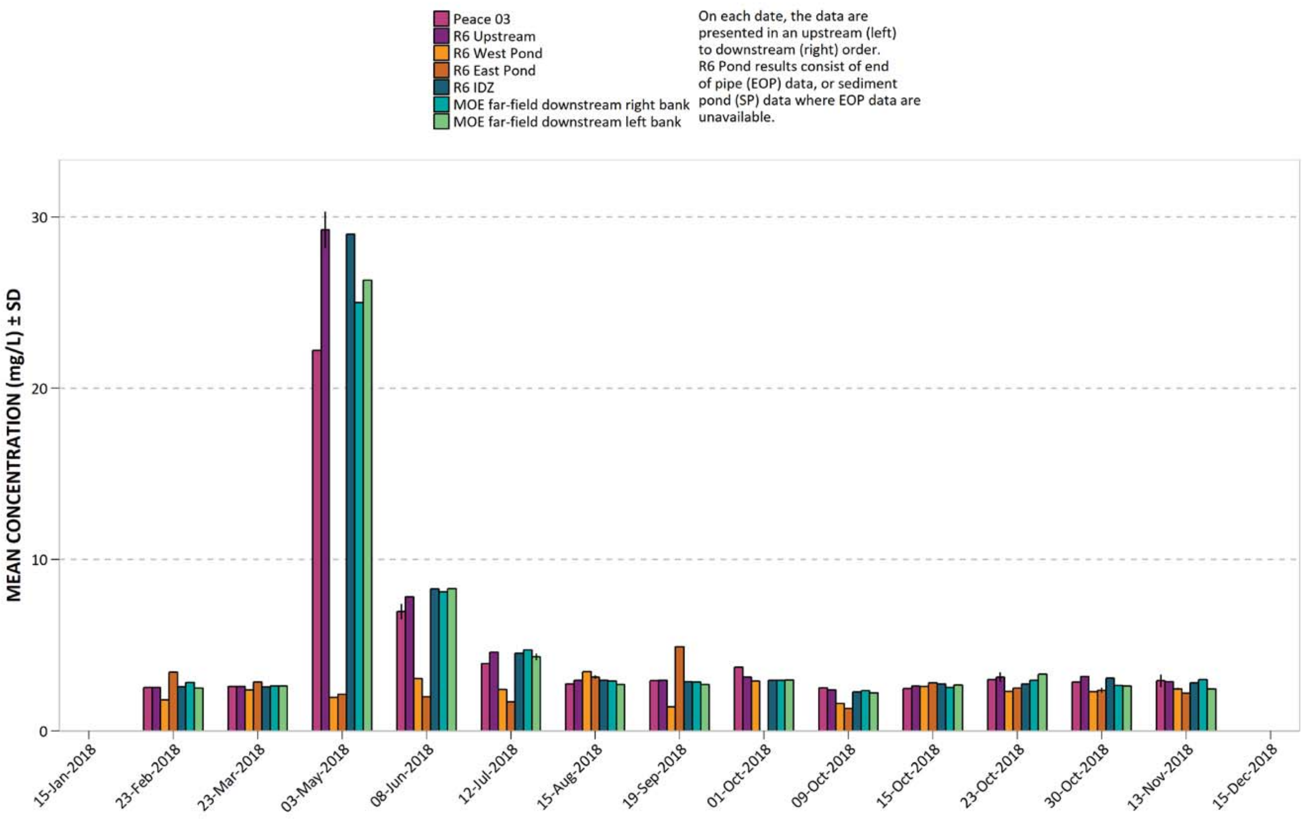


Figure 110. 2018 Peace River and RSEM R6 pond total aluminum (Al).

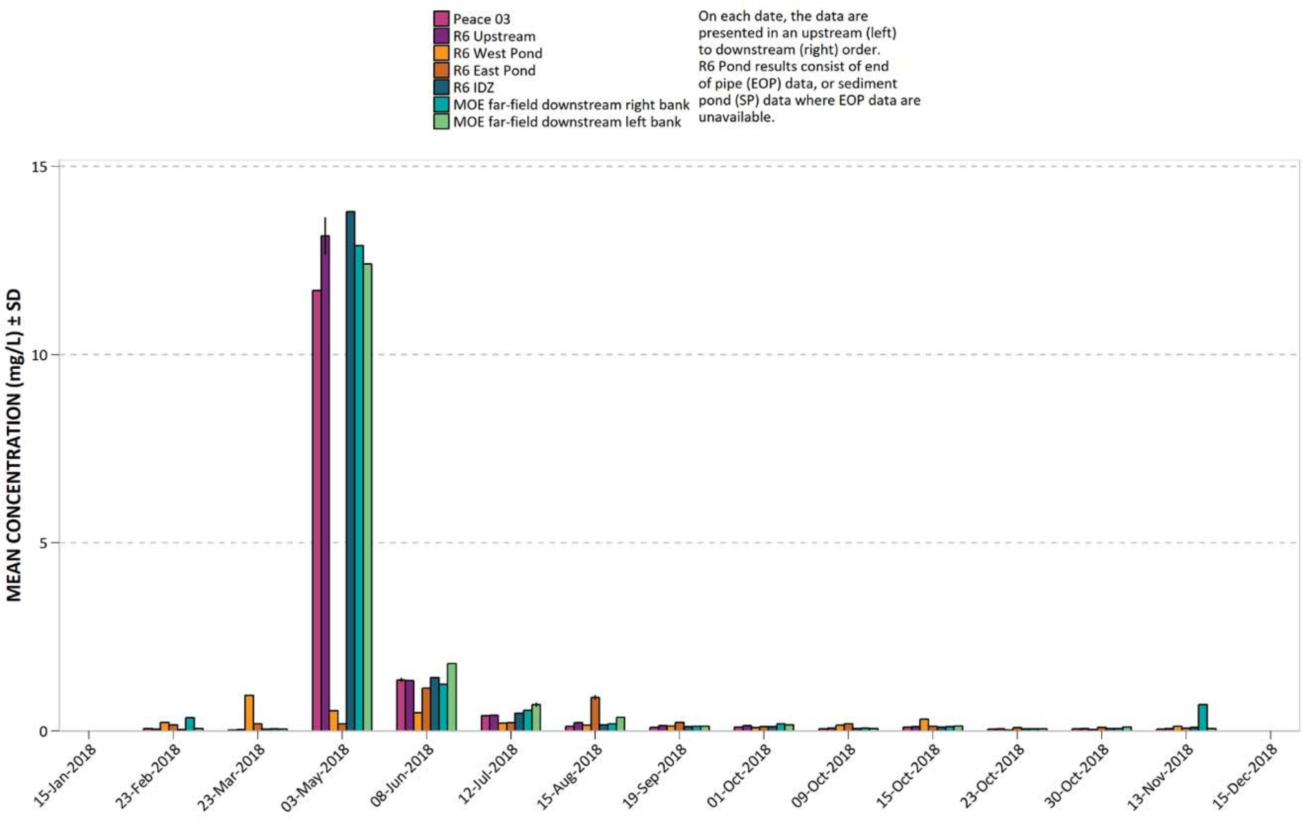
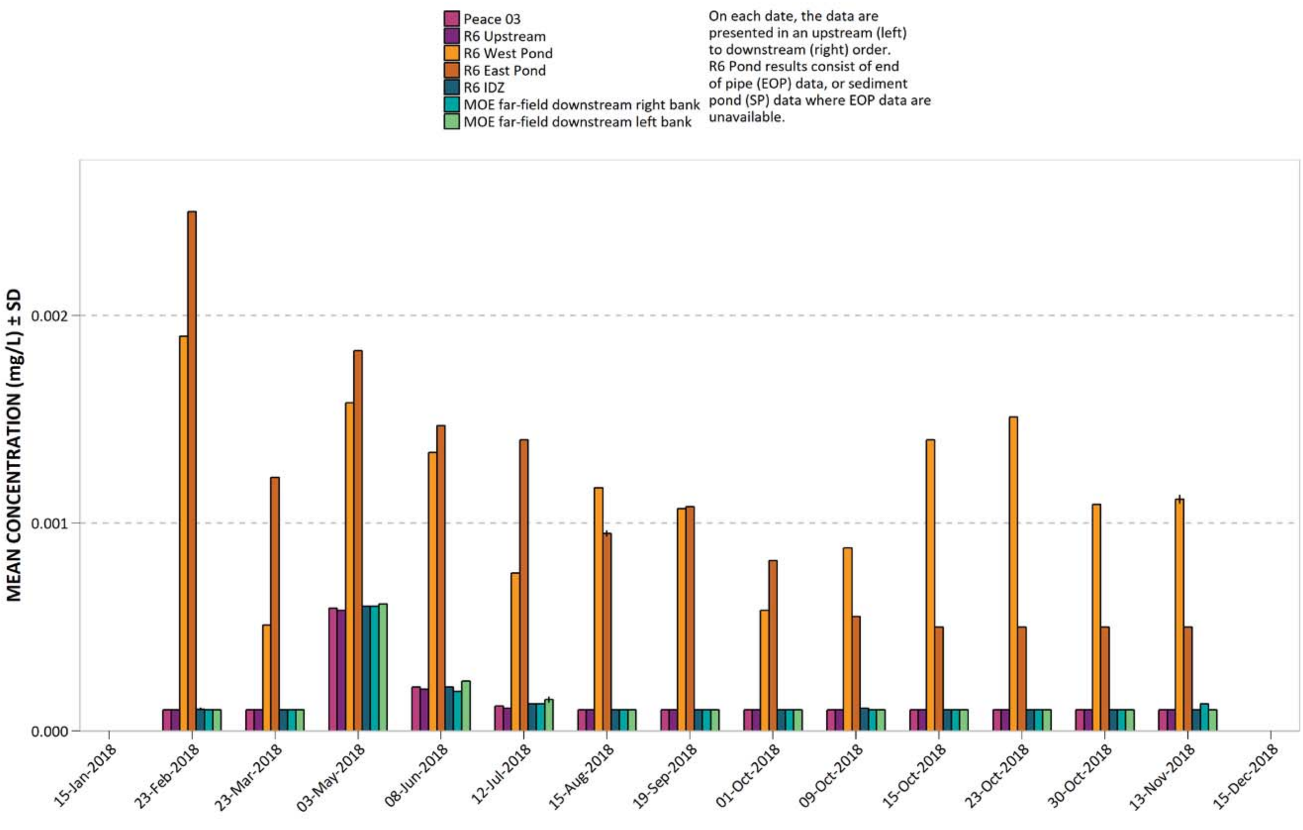


Figure 111. 2018 Peace River and RSEM R6 pond total antimony (Sb).



Results less than the MDL were assigned the MDL value of 0.0005 mg/L (R5b pond) or 0.0001 mg/L (Peace River).

Figure 112. 2018 Peace River and RSEM R6 pond total arsenic (As).

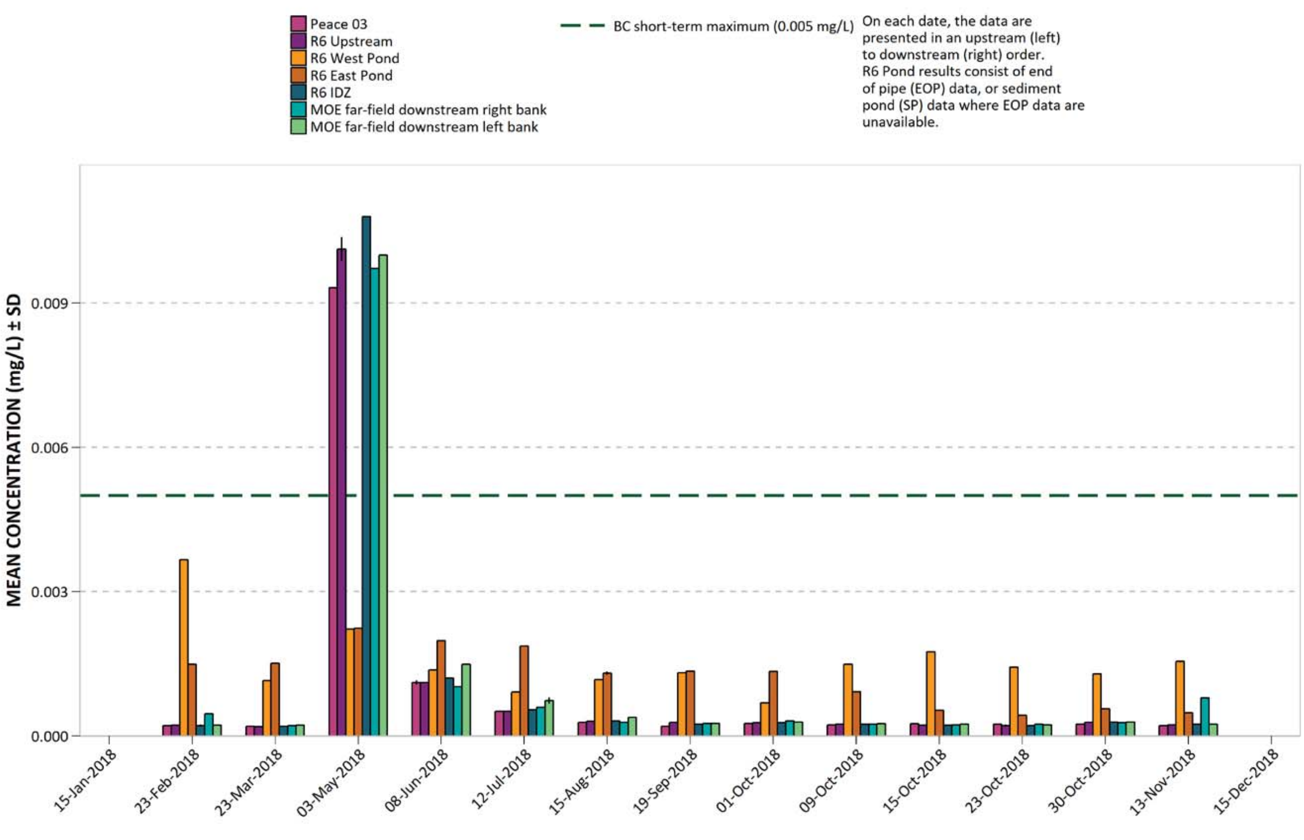


Figure 113. 2018 Peace River and RSEM R6 pond total barium (Ba).

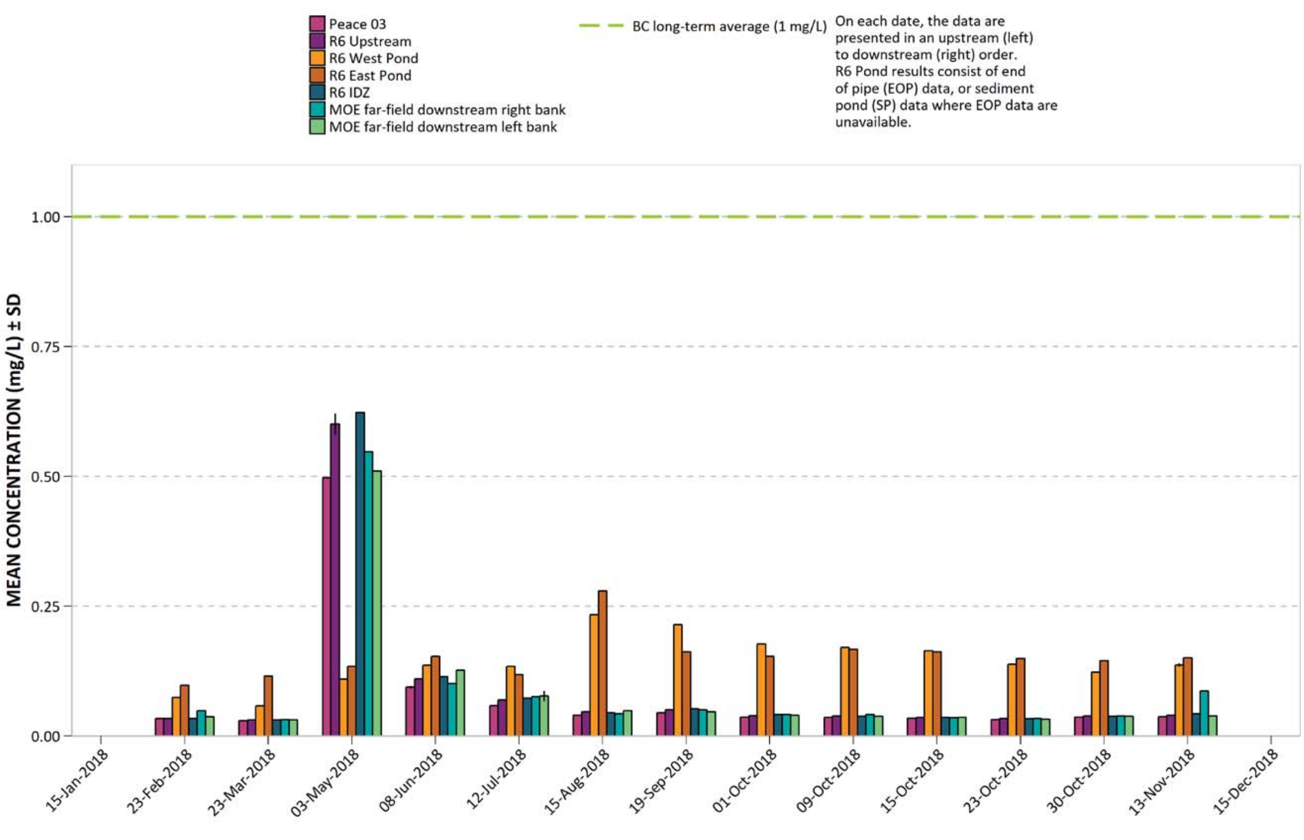
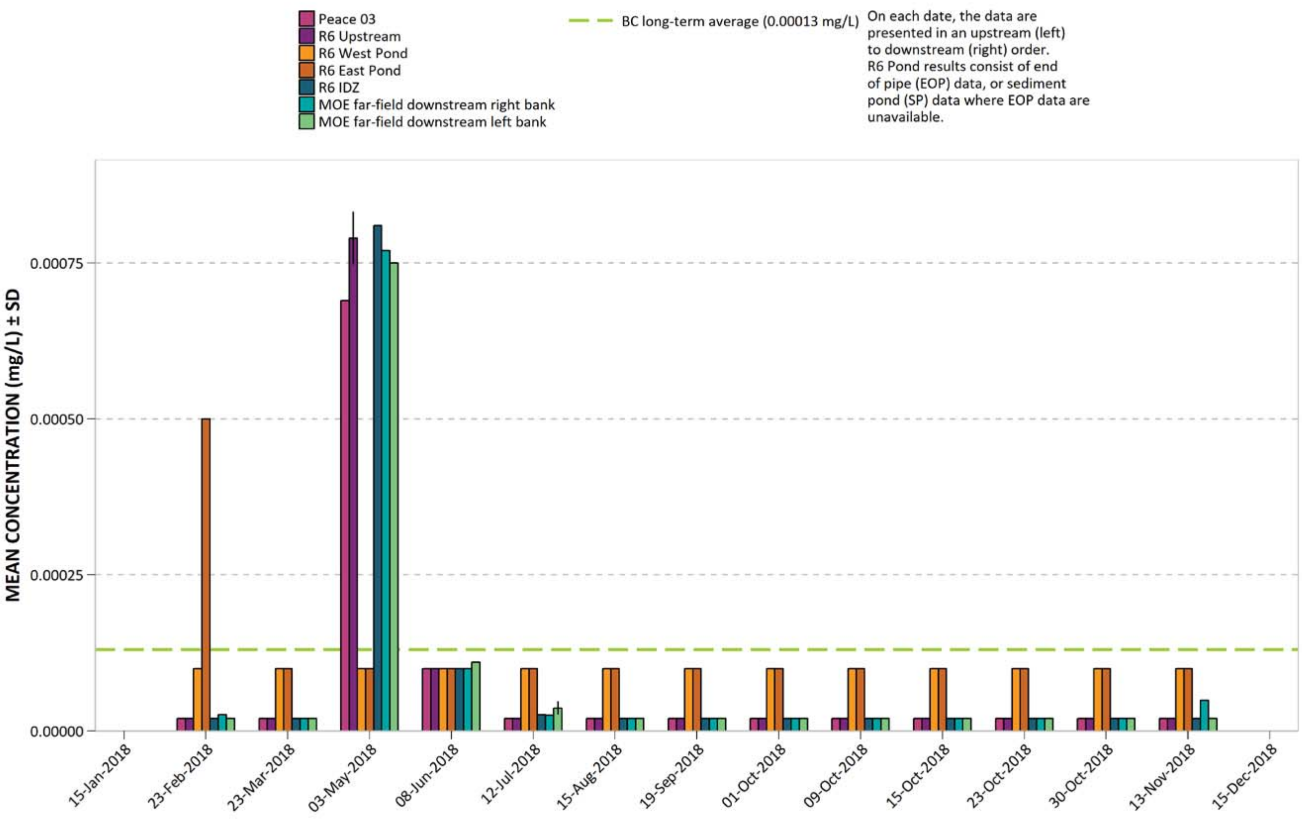
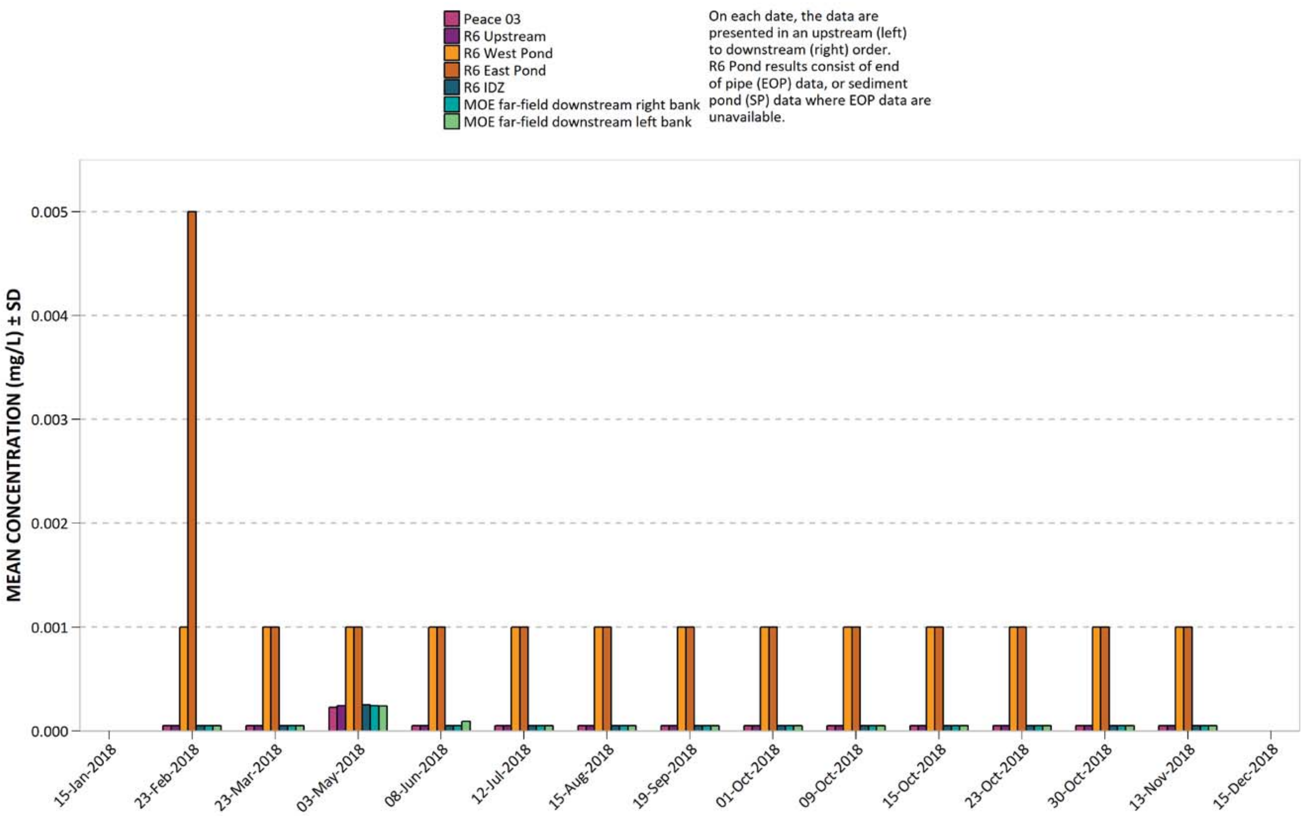


Figure 114. 2018 Peace River and RSEM R6 pond total beryllium (Be).



Results less than the MDL were assigned the MDL value of 0.0001 mg/L (R5b pond, Peace River on June 8) or 0.00002 mg/L (Peace River on remaining dates).

Figure 115. 2018 Peace River and RSEM R6 pond total bismuth (Bi).



Results less than the MDL were assigned the MDL value of 0.001 mg/L (R5b pond) or 0.0001 mg/L (Peace River).

Figure 116. 2018 Peace River and RSEM R6 pond total boron (B).

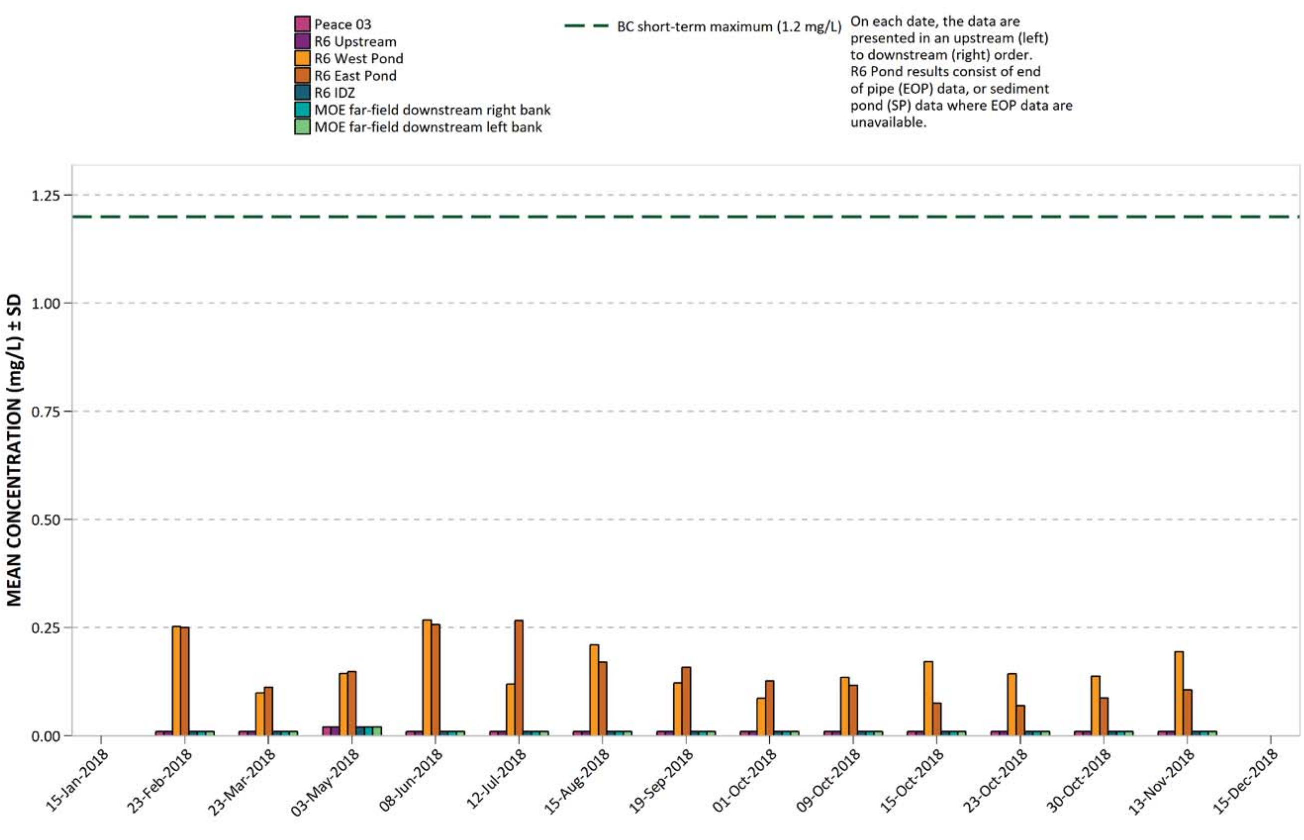


Figure 117. 2018 Peace River and RSEM R6 pond total cadmium (Cd).

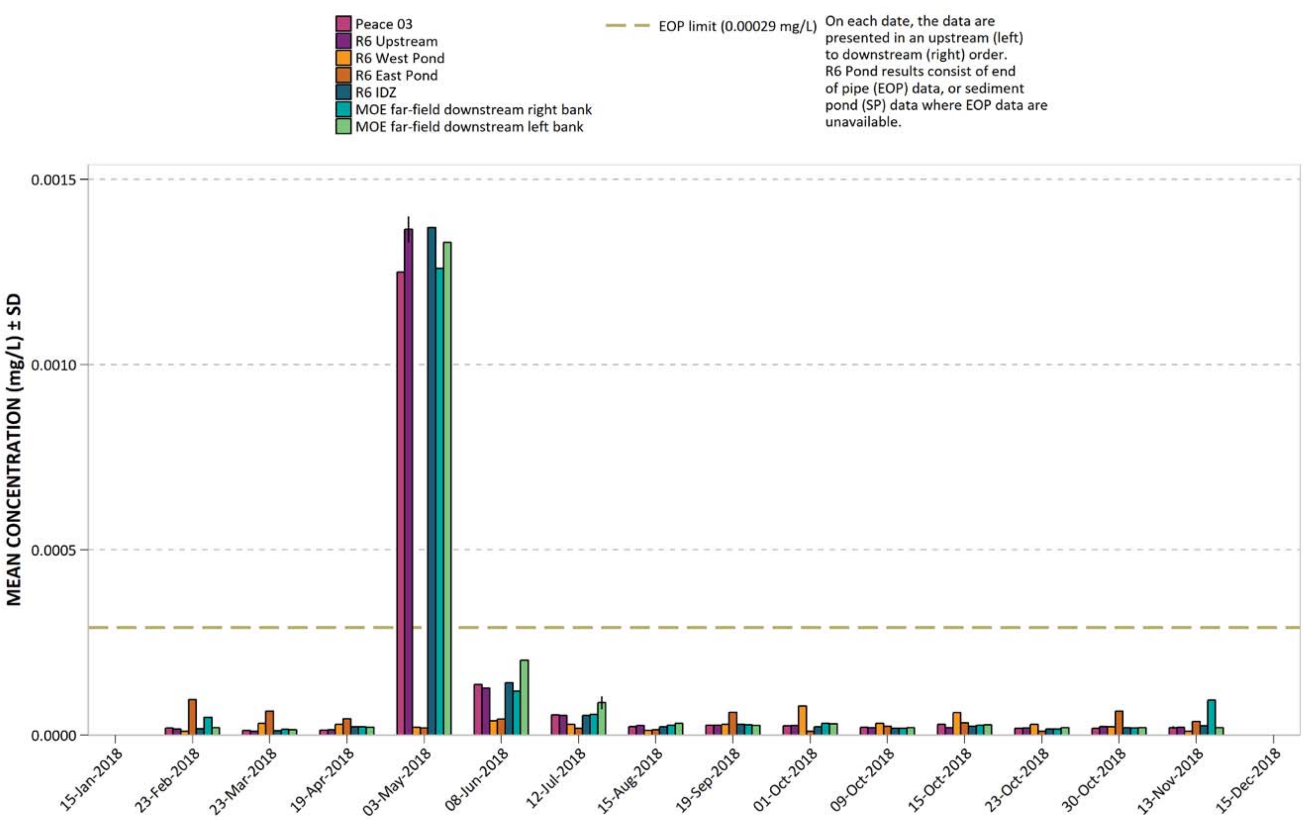


Figure 118. 2018 Peace River and RSEM R6 pond total calcium (Ca).

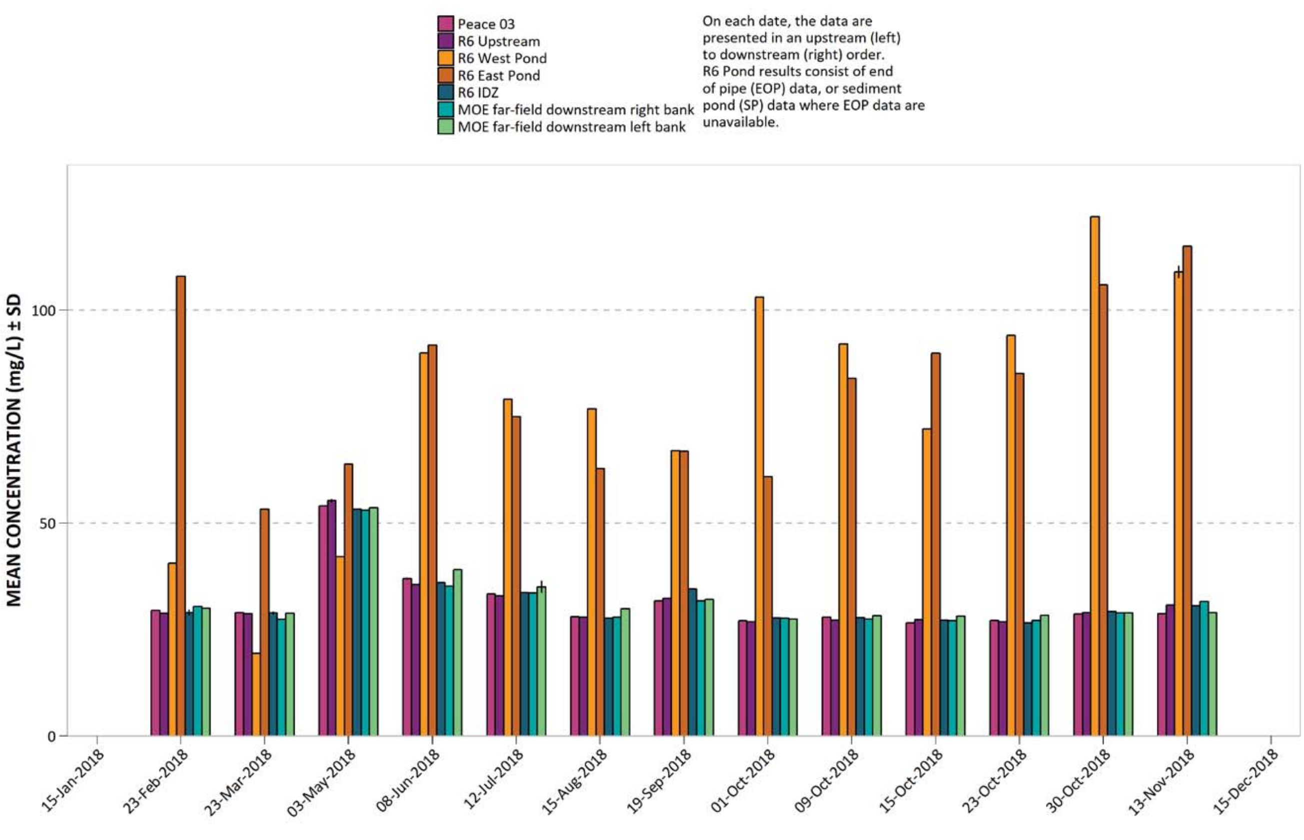


Figure 119. 2018 Peace River and RSEM R6 pond total chromium (Cr).

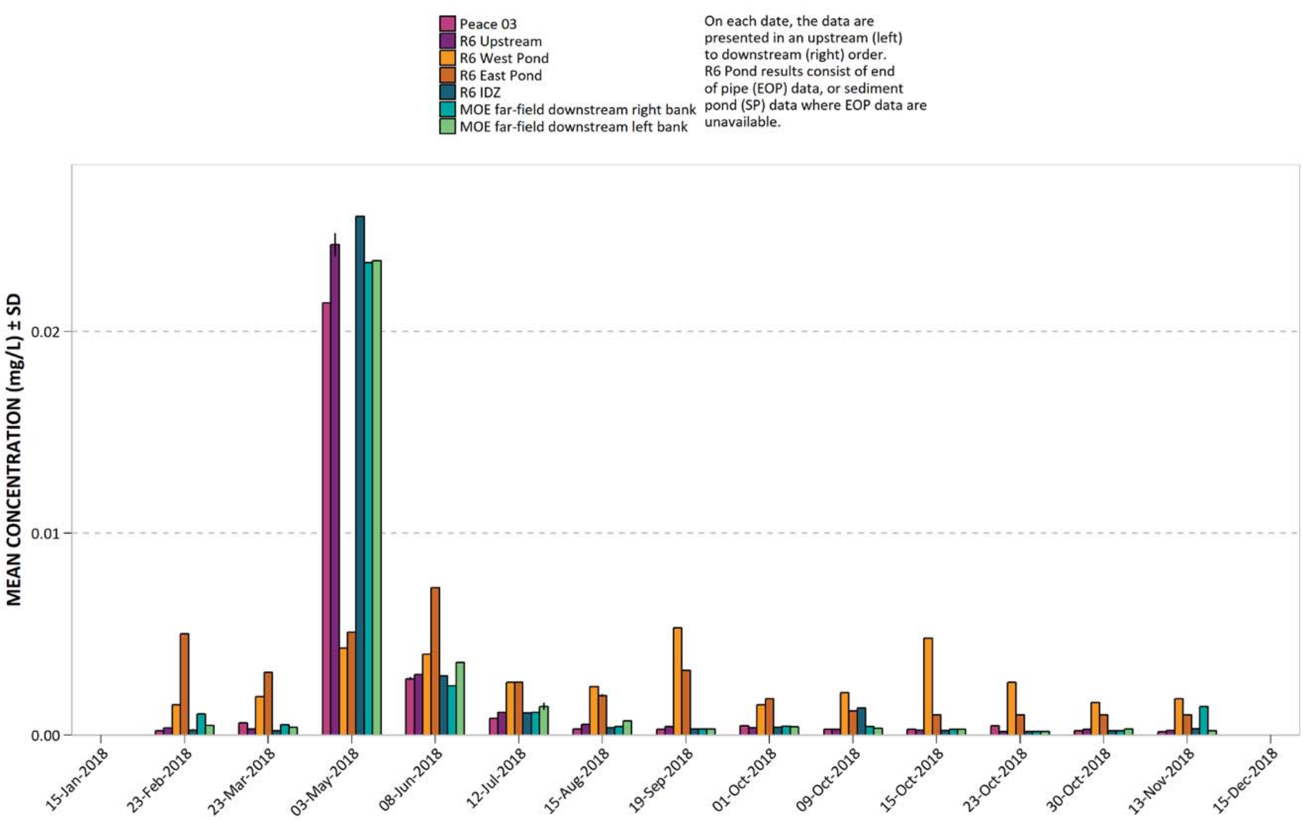


Figure 120. 2018 Peace River and RSEM R6 pond total cobalt (Co).

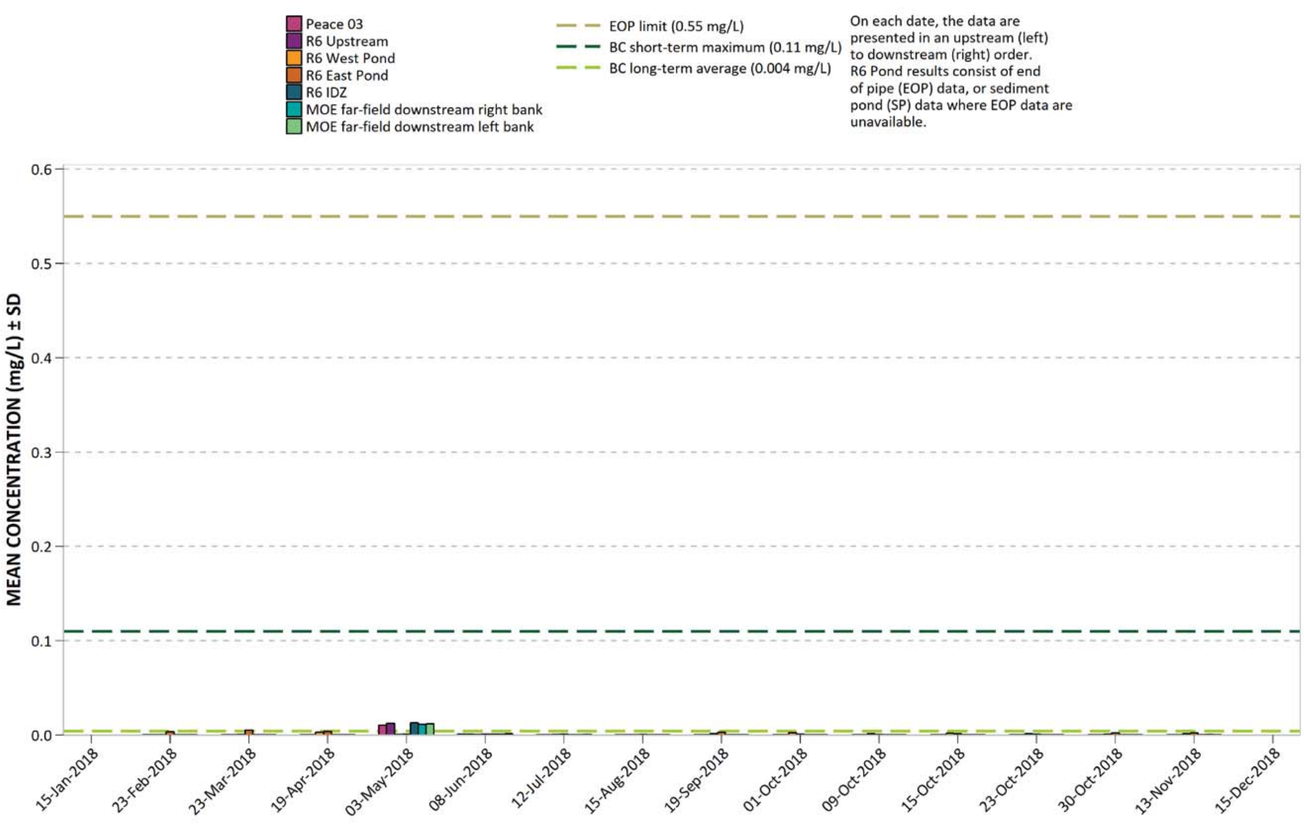


Figure 121. 2018 Peace River and RSEM R6 pond total copper (Cu).

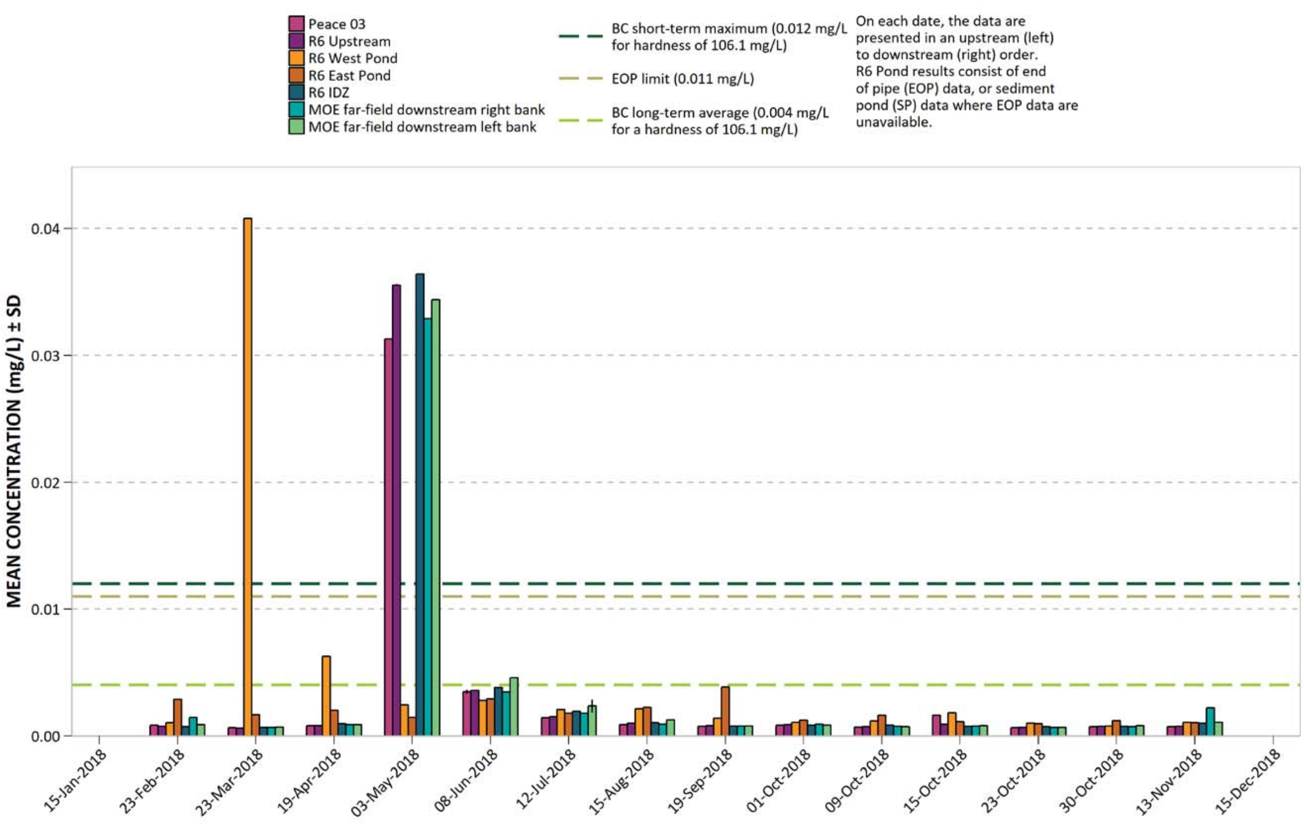


Figure 122. 2018 Peace River and RSEM R6 pond total iron (Fe).

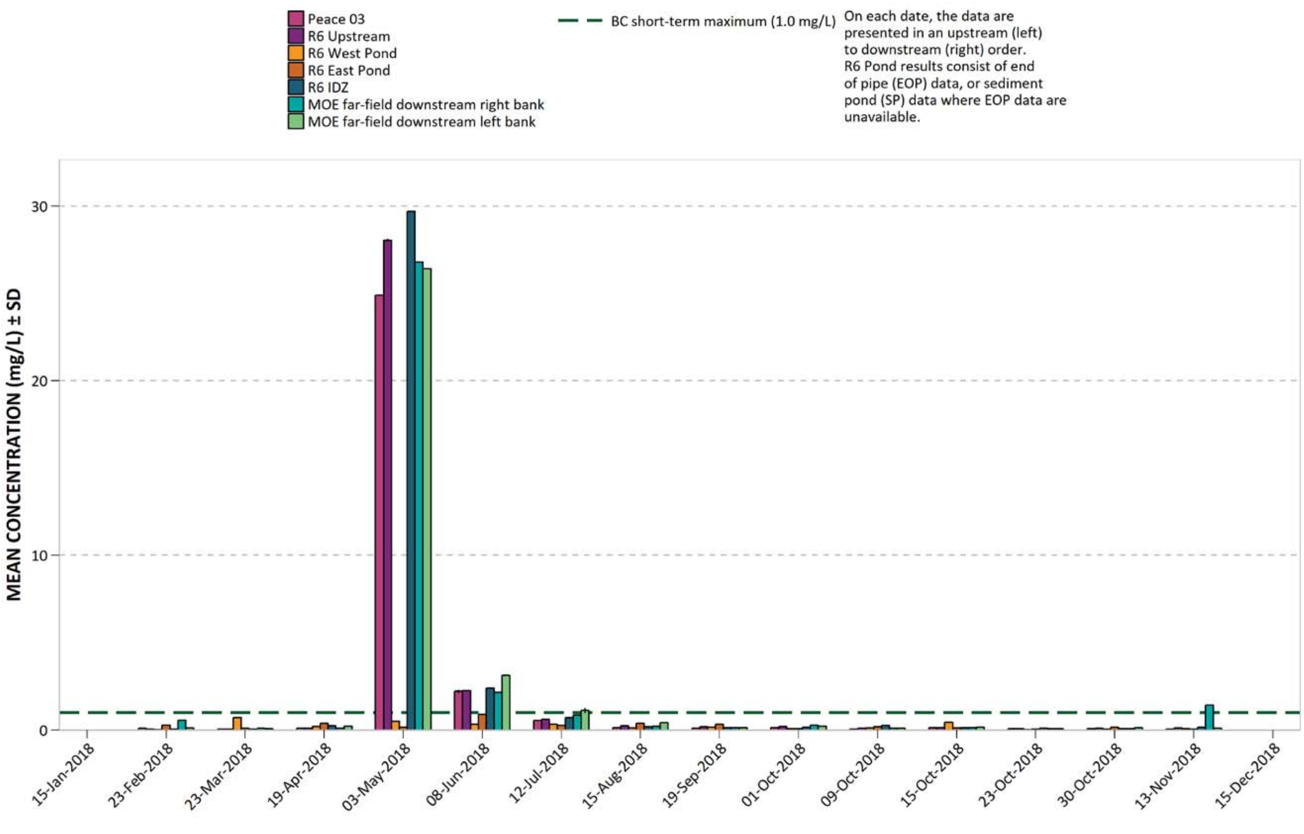


Figure 123. 2018 Peace River and RSEM R6 pond total lead (Pb).

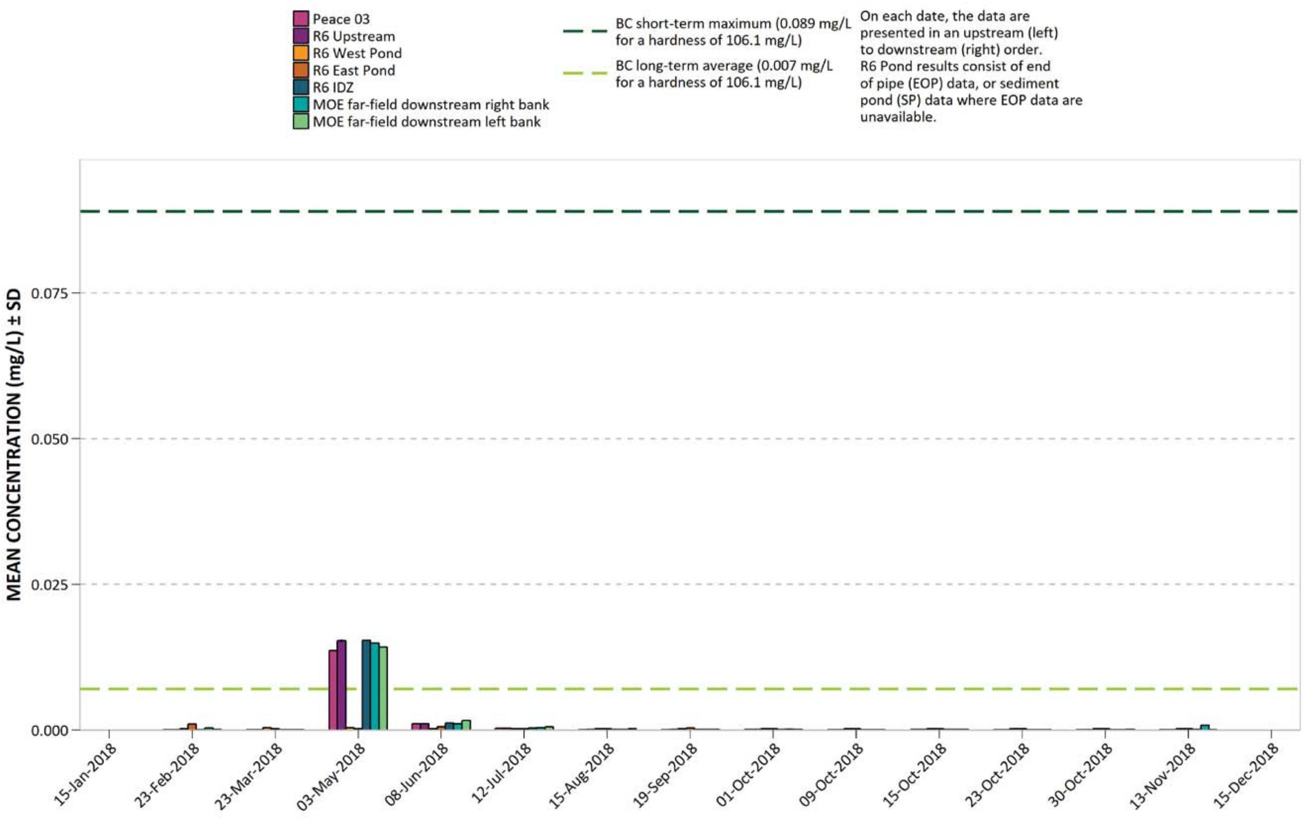


Figure 124. **2018 Peace River and RSEM R6 pond total lithium (Li).**

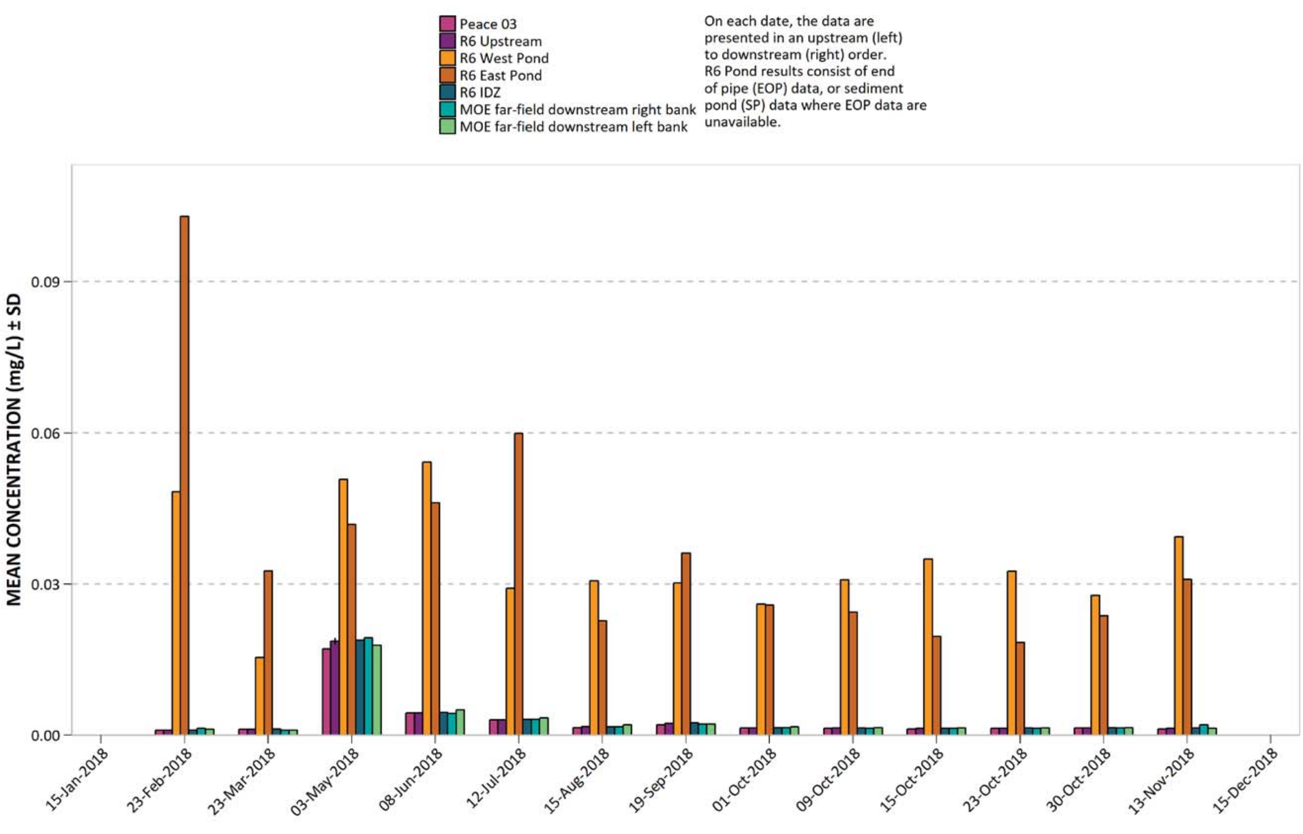


Figure 125. 2018 Peace River and RSEM R6 pond total magnesium (Mg).

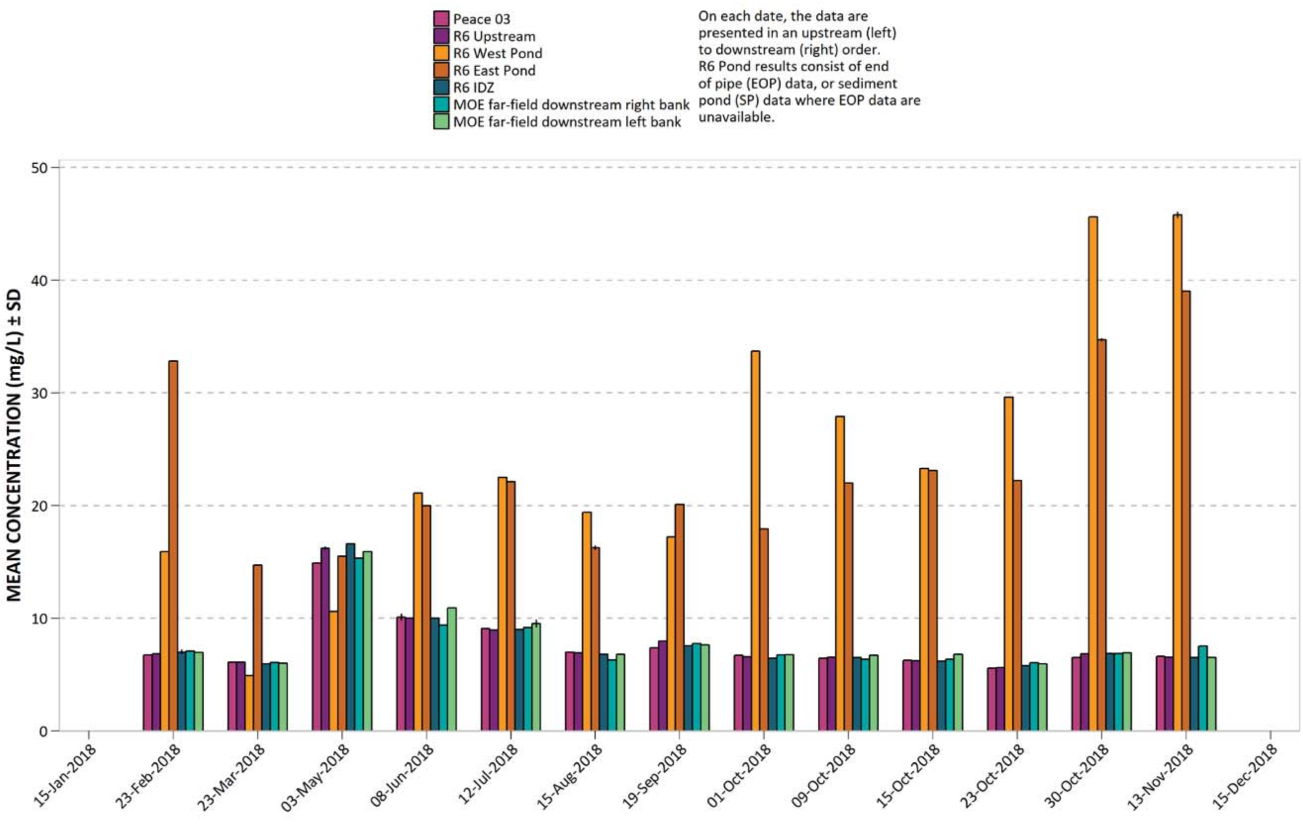


Figure 126. 2018 Peace River and RSEM R6 pond total manganese (Mn).

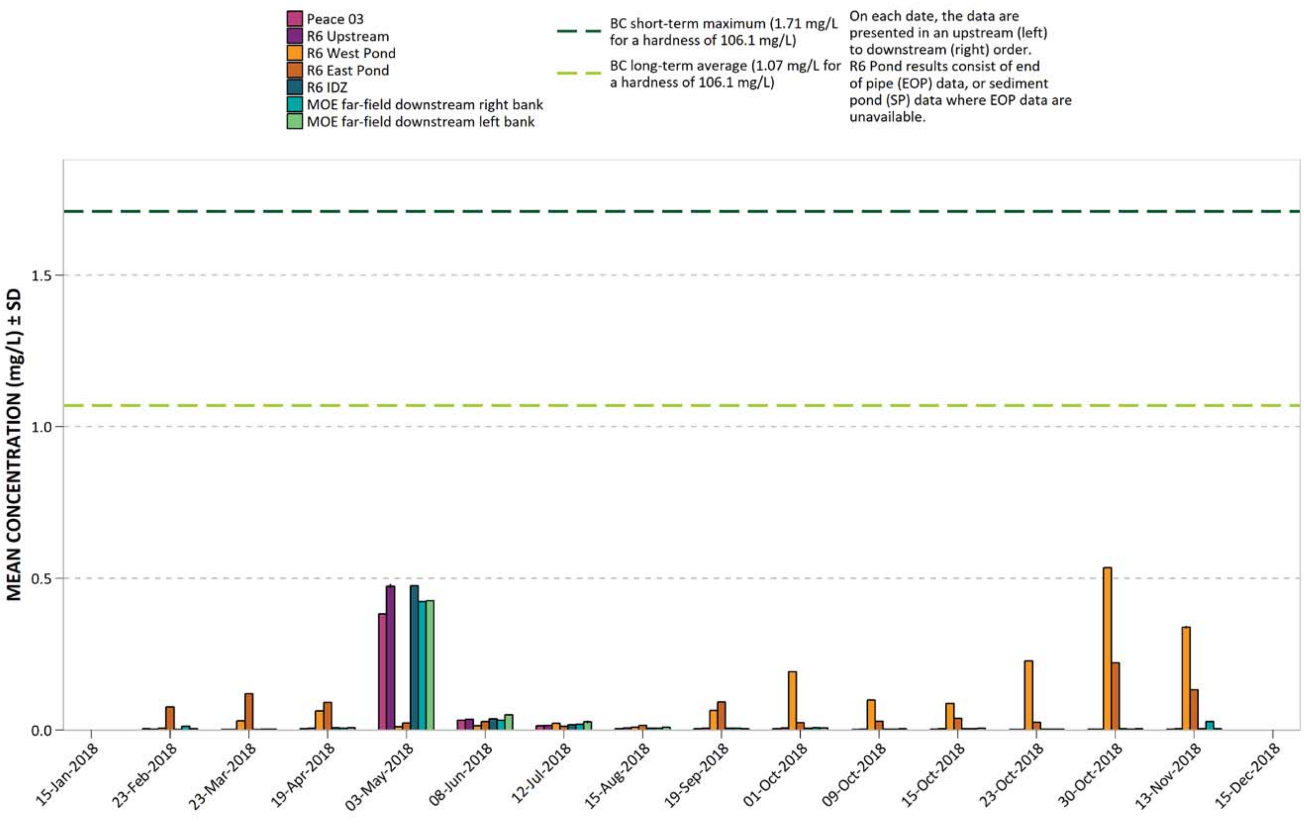
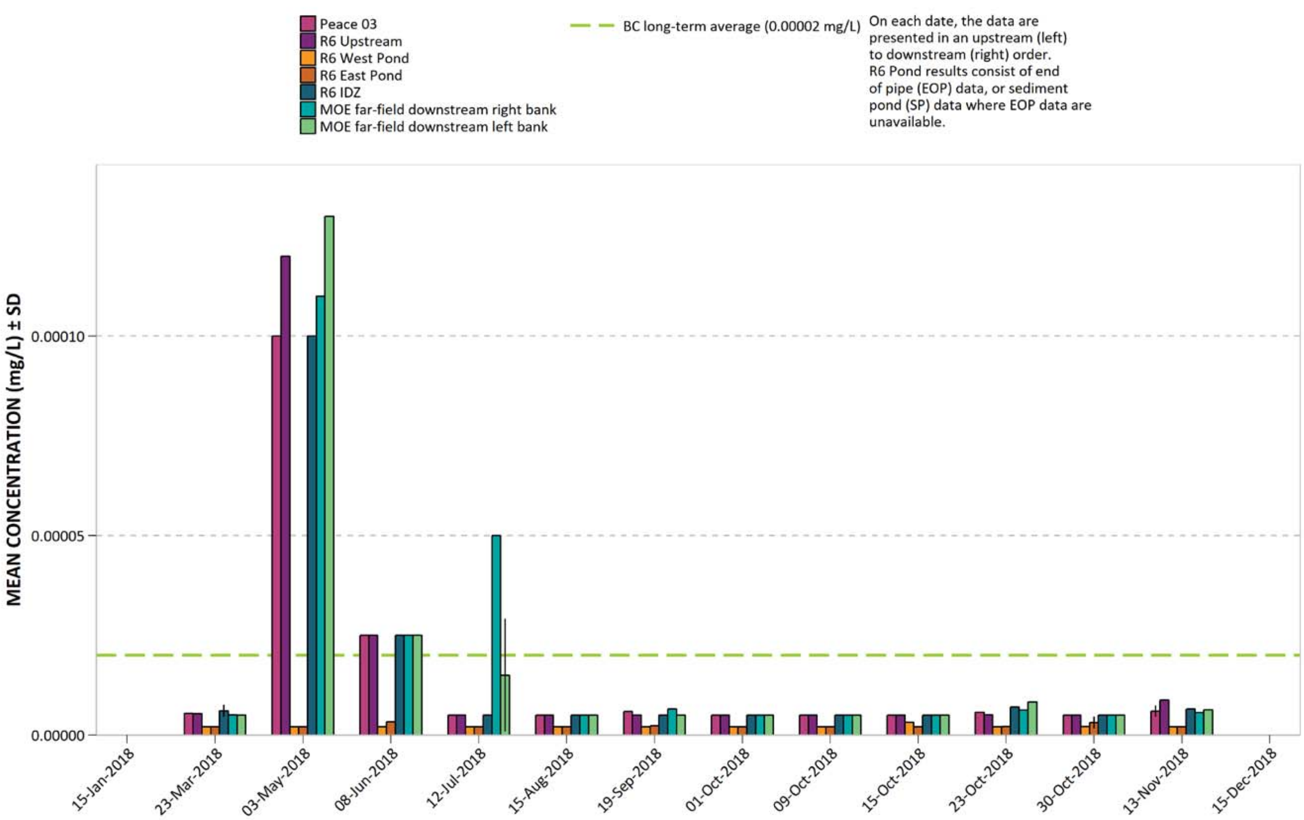


Figure 127. 2018 Peace River and RSEM R6 pond total mercury (Hg).



Results lower than the MDL are assigned the MDL value, which varies for total mercury depending on matrix effects. At various times in 2018 it was 0.000005, 0.000025 or 0.0001 mg/L in the Peace River, while the MDL was 0.000002 mg/L in the R5b pond. Most results in 2018 were assigned the MDL value.

Figure 128. 2018 Peace River and RSEM R6 pond total molybdenum (Mo).

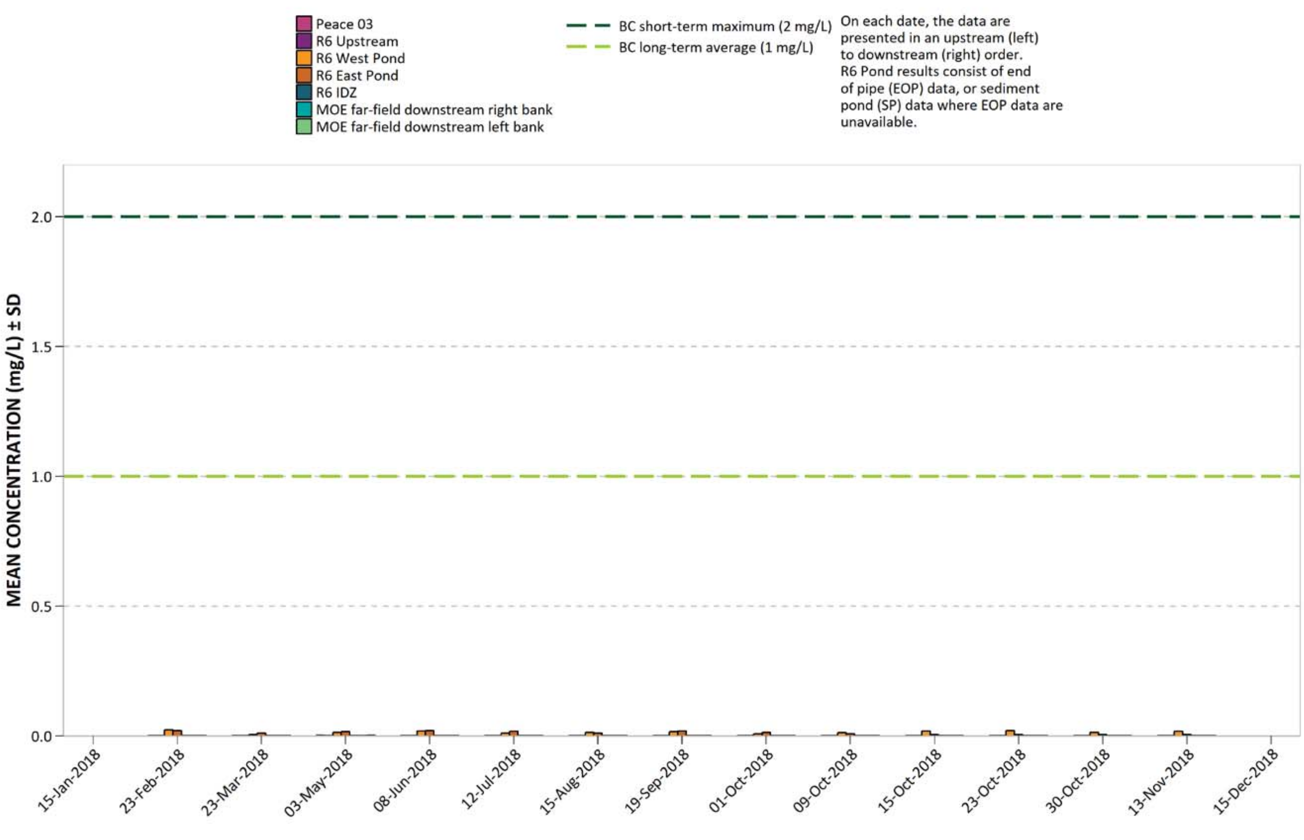


Figure 129. 2018 Peace River and RSEM R6 pond total nickel (Ni).

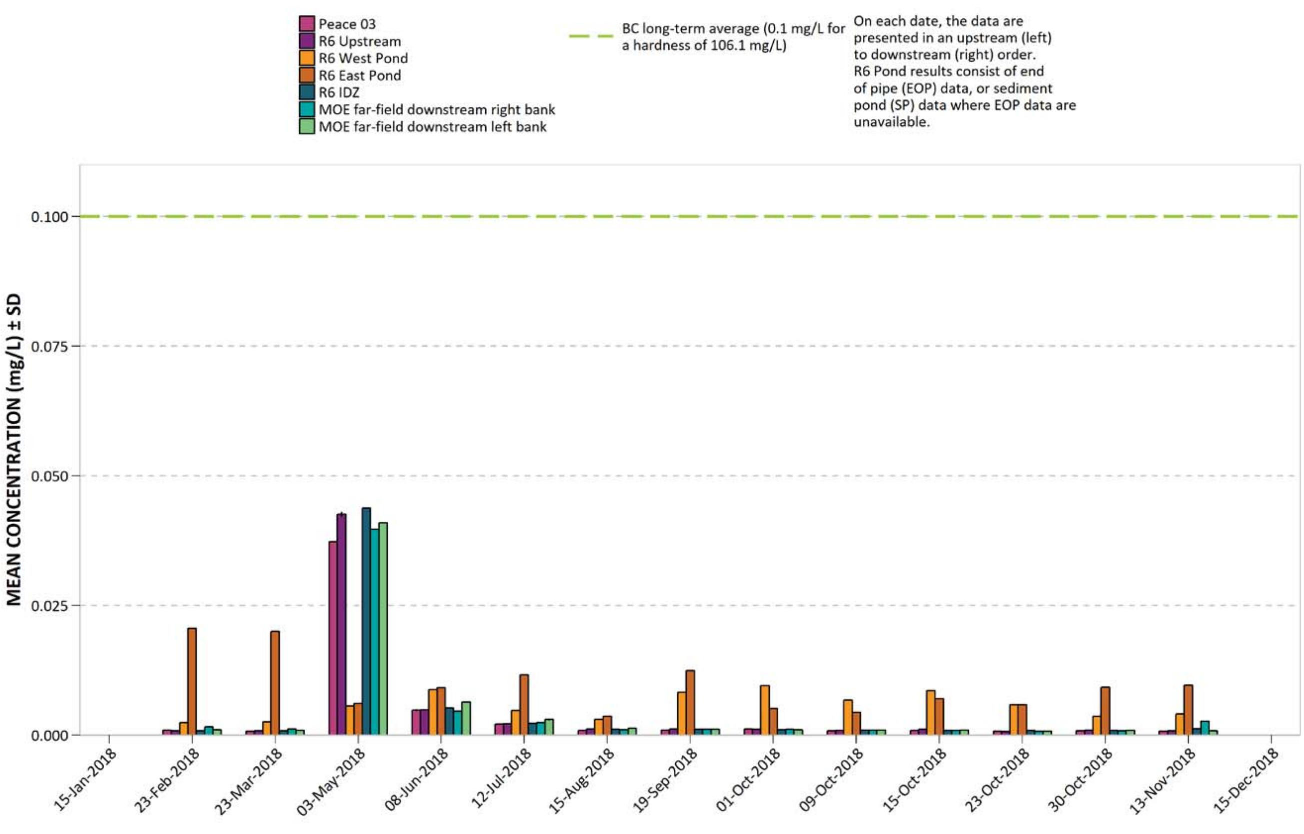


Figure 130. 2018 Peace River and RSEM R6 pond total potassium (K).

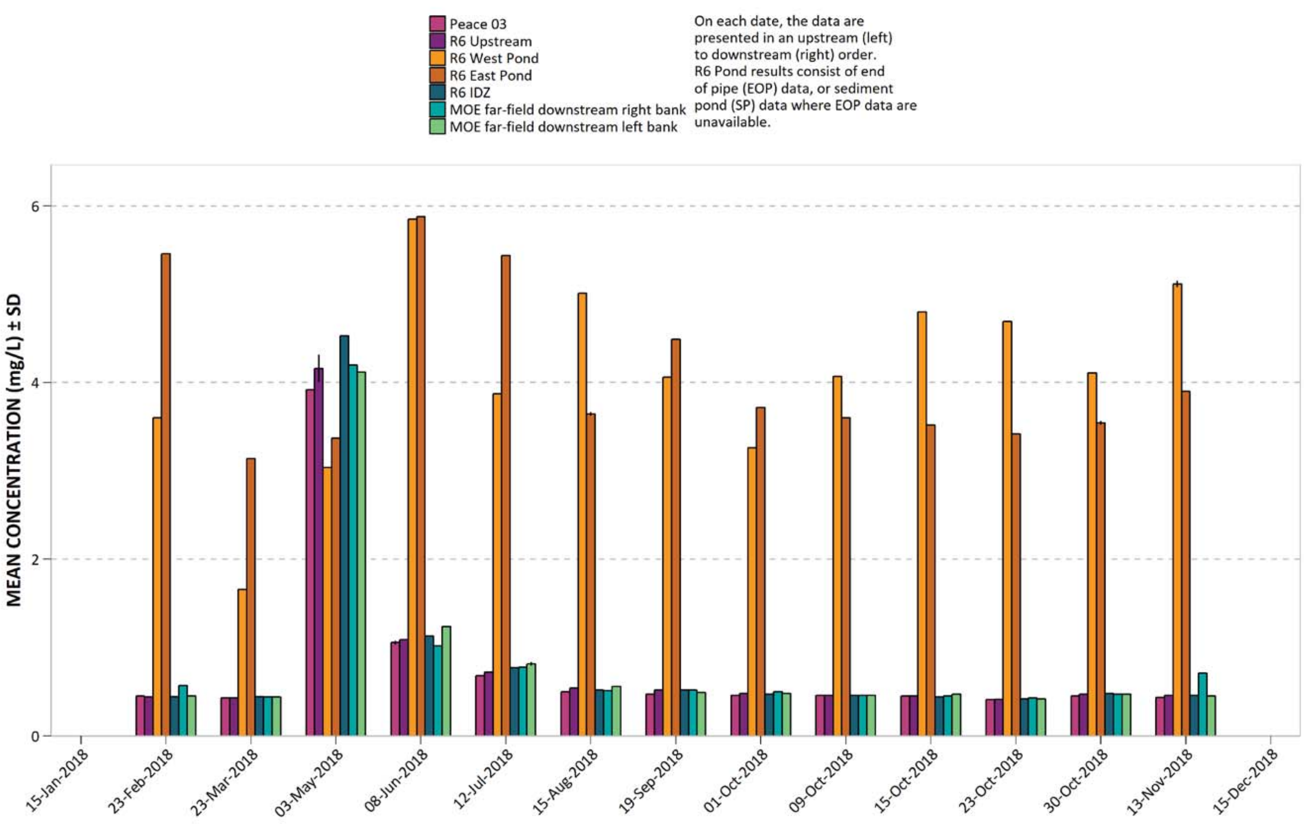


Figure 131. 2018 Peace River and RSEM R6 pond total selenium (Se).

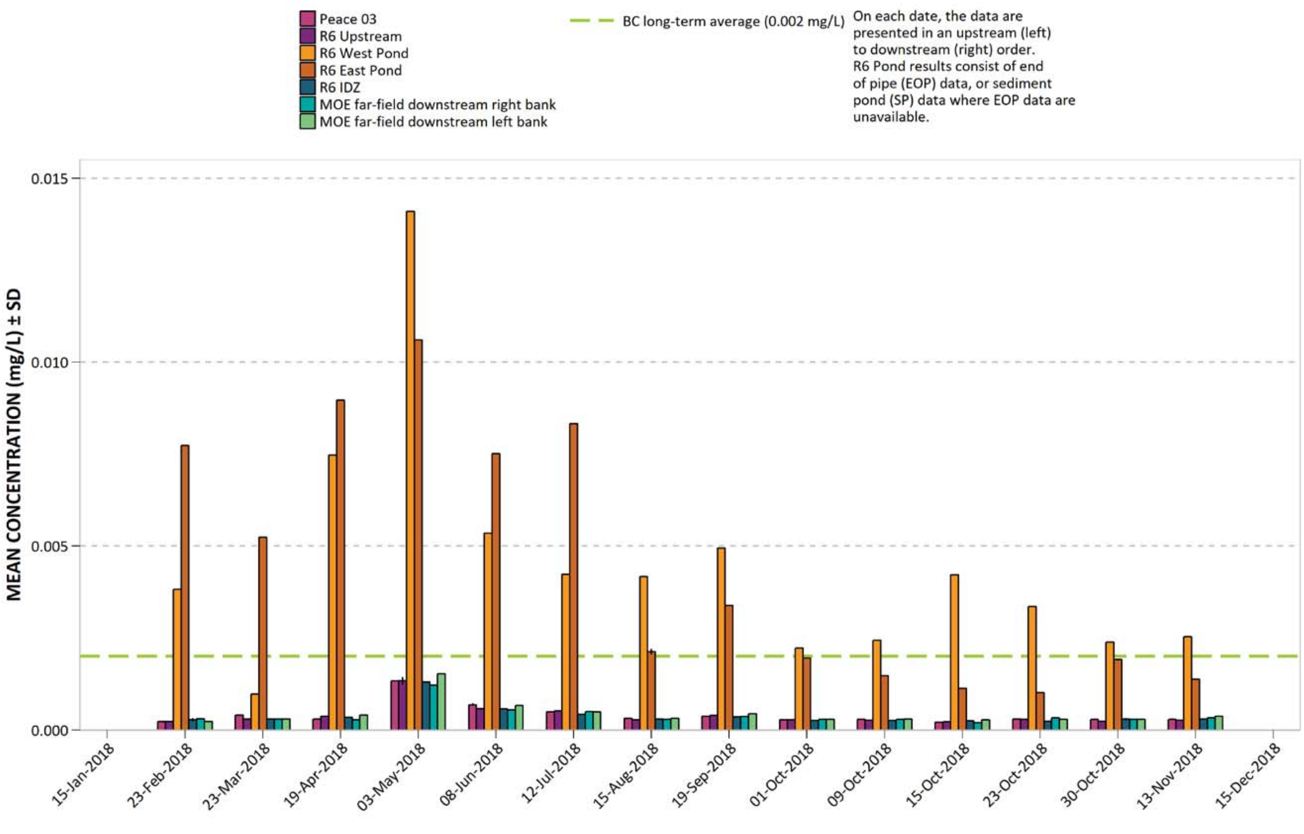


Figure 132. 2018 Peace River and RSEM R6 pond total silicon (Si).

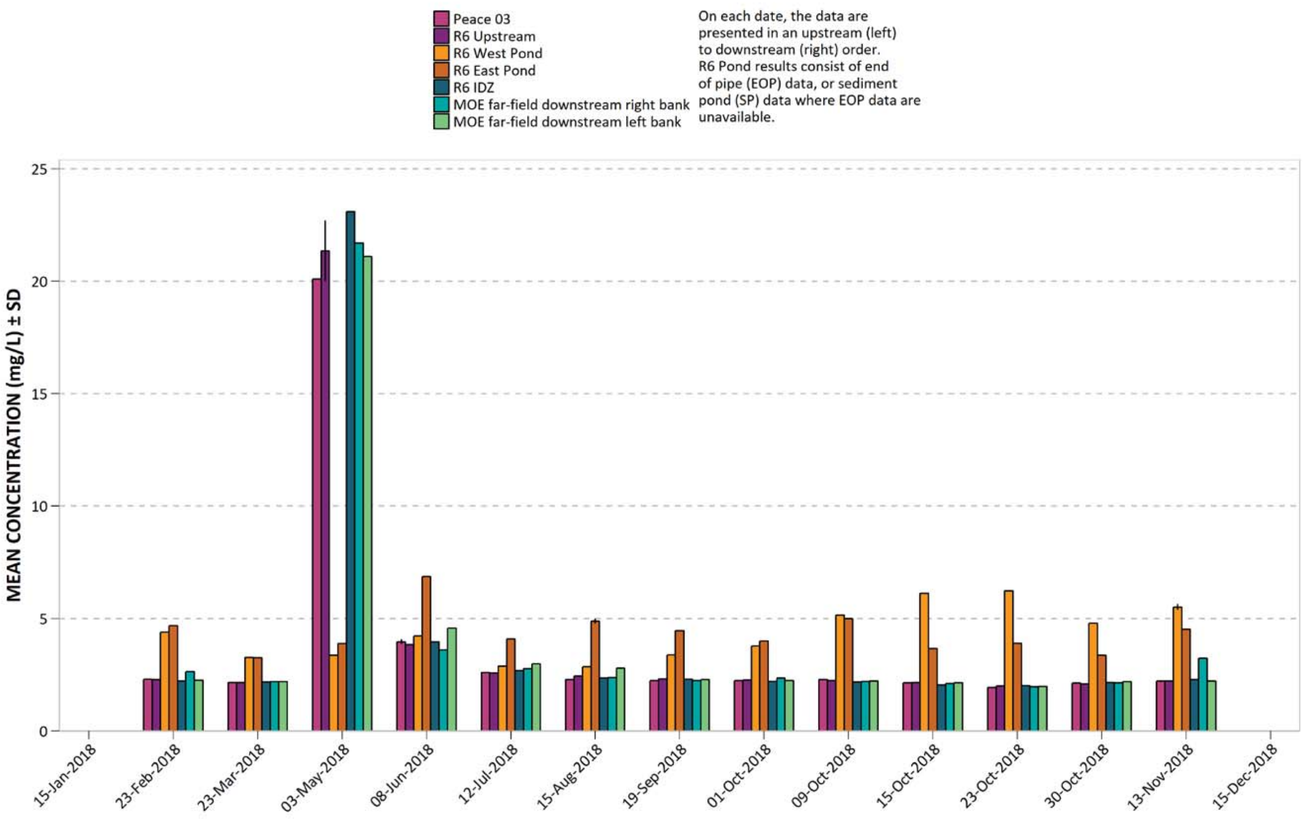


Figure 133. 2018 Peace River and RSEM R6 pond total silver (Ag).

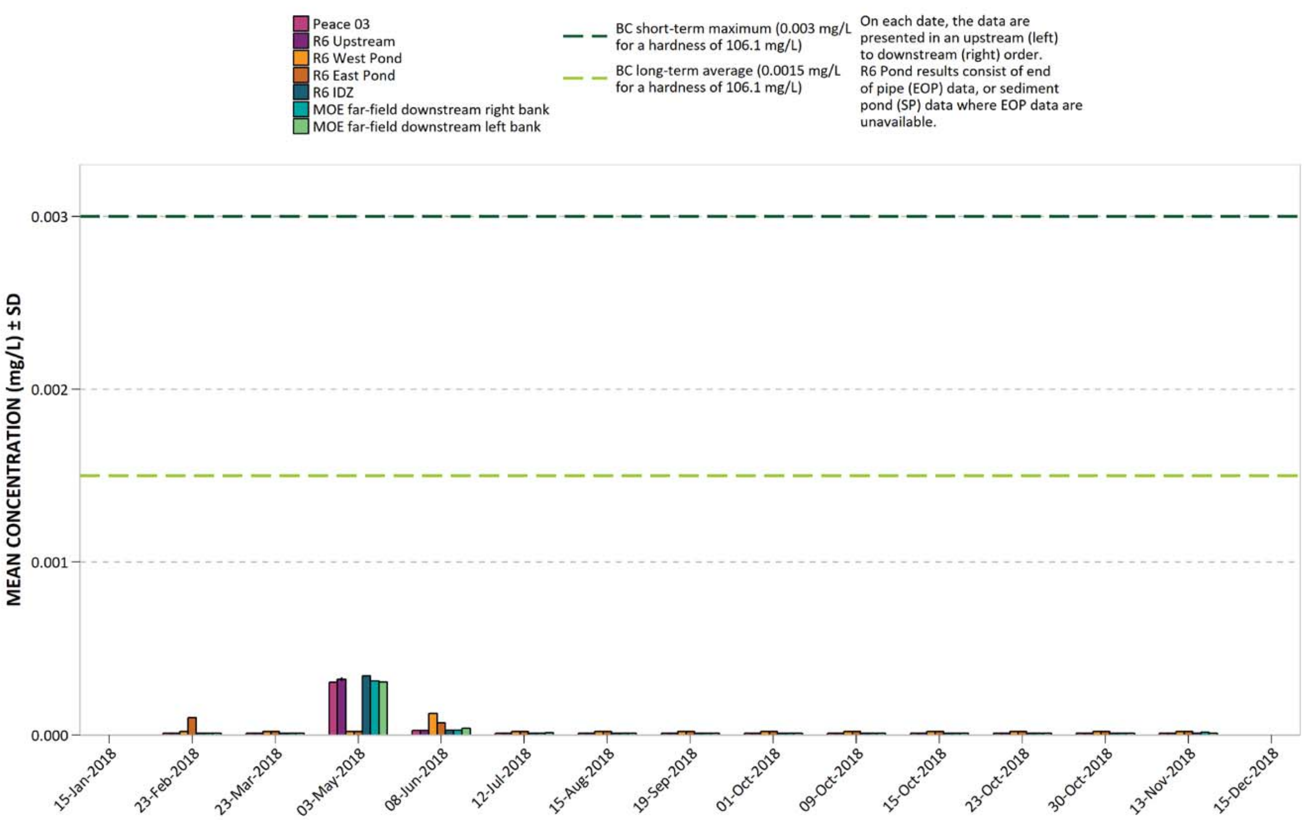


Figure 134. 2018 Peace River and RSEM R6 pond total sodium (Na).

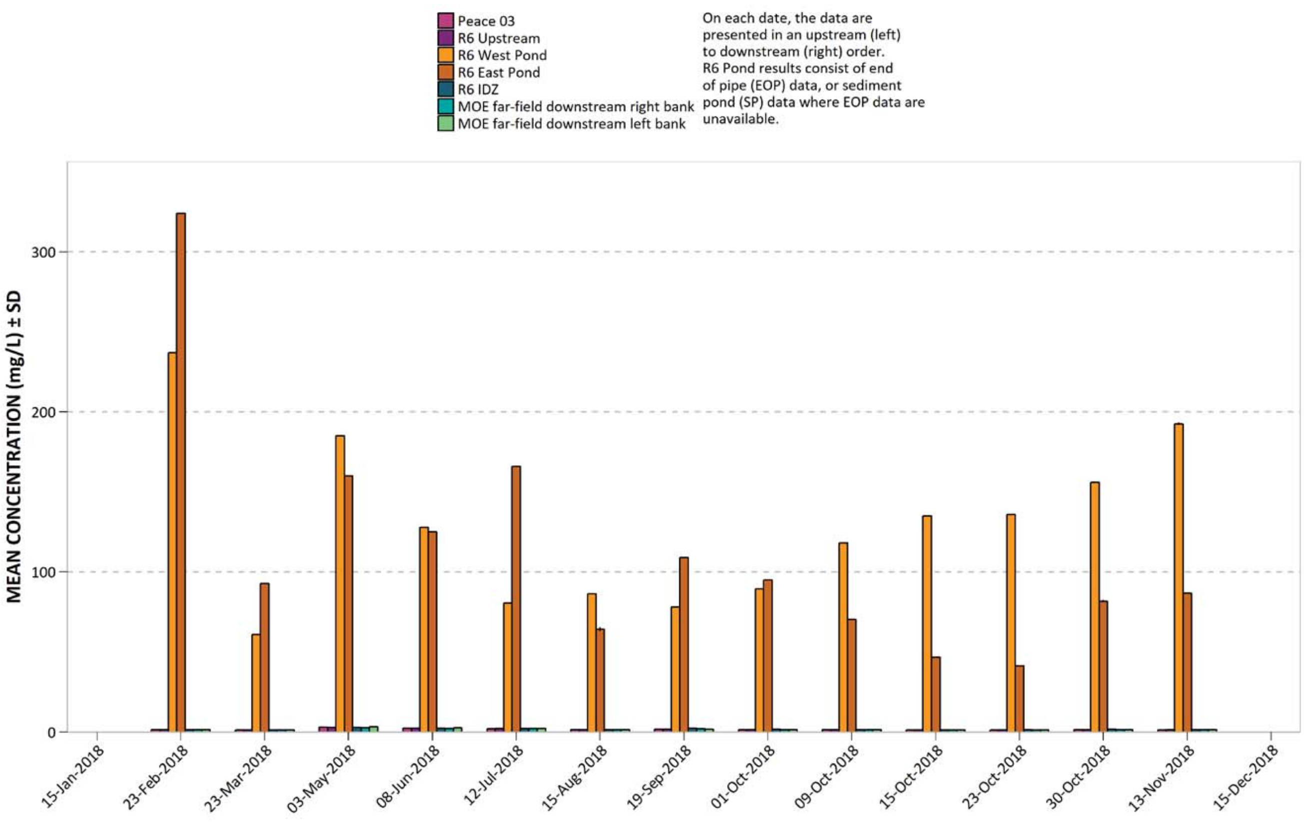


Figure 135. 2018 Peace River and RSEM R6 pond total strontium (Sr).

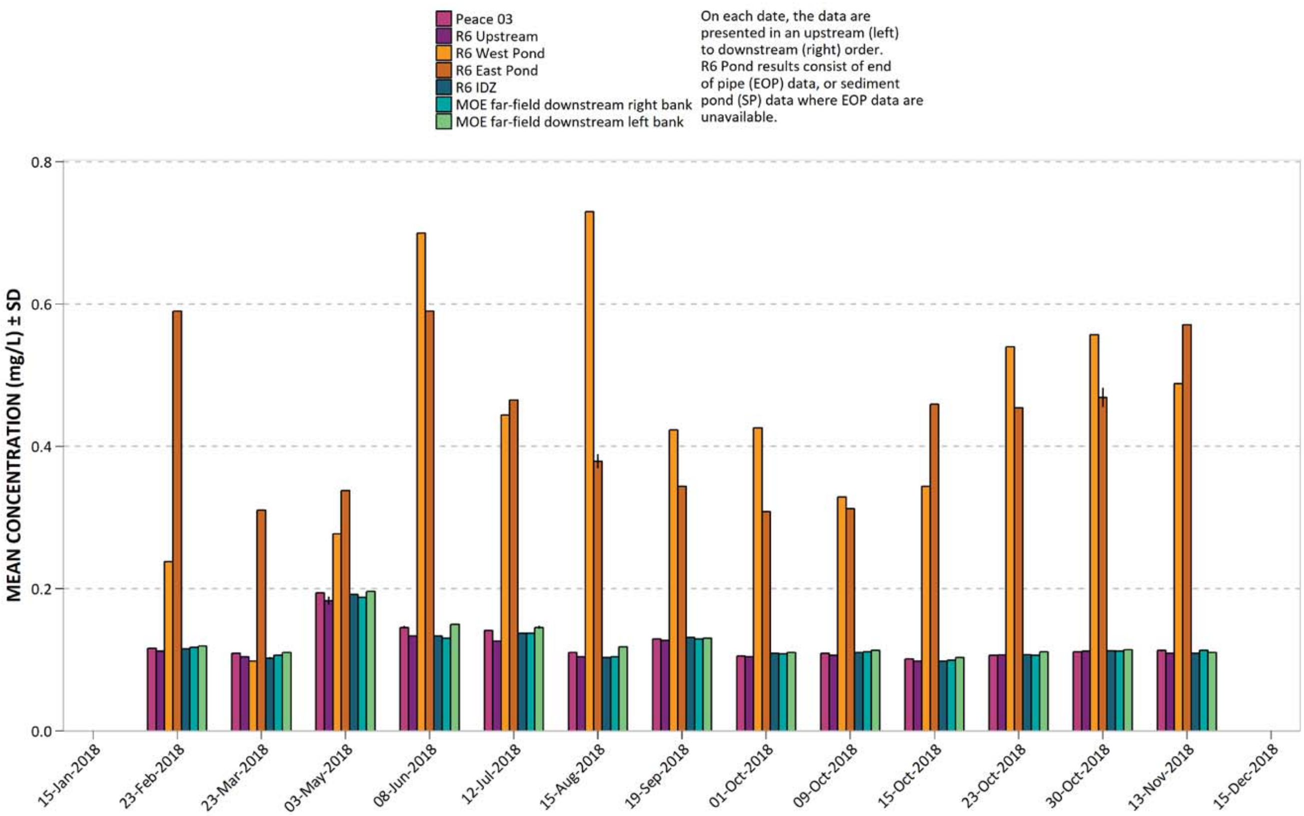


Figure 136. 2018 Peace River and RSEM R6 pond total sulfur (S).

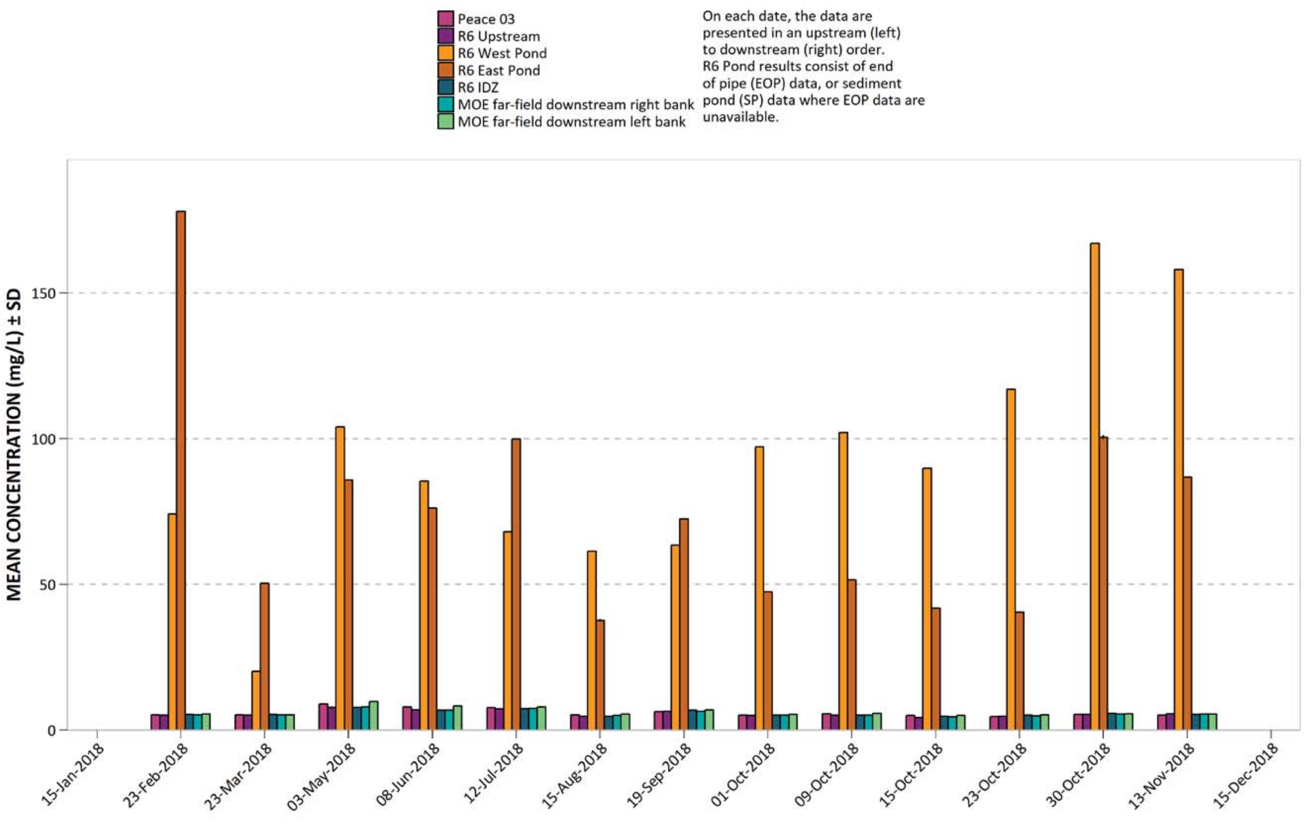
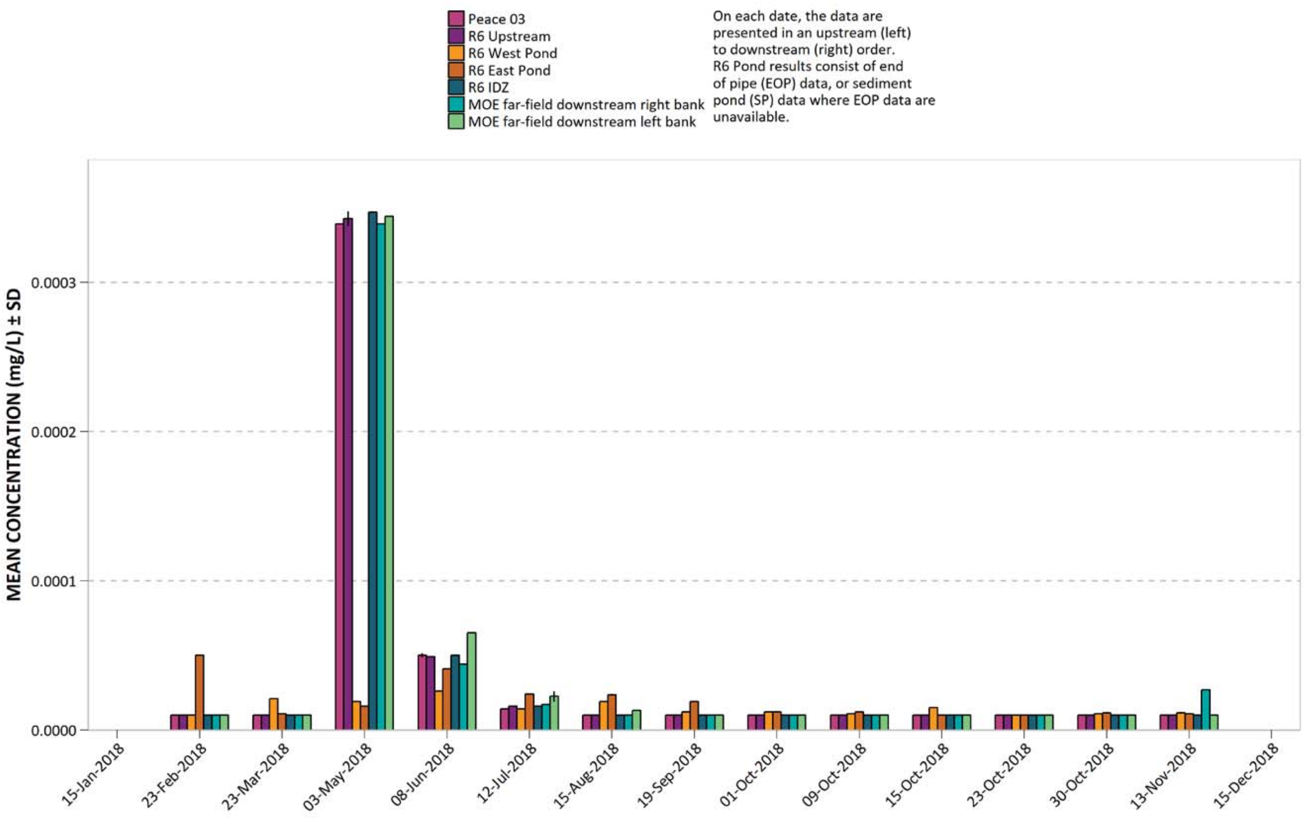
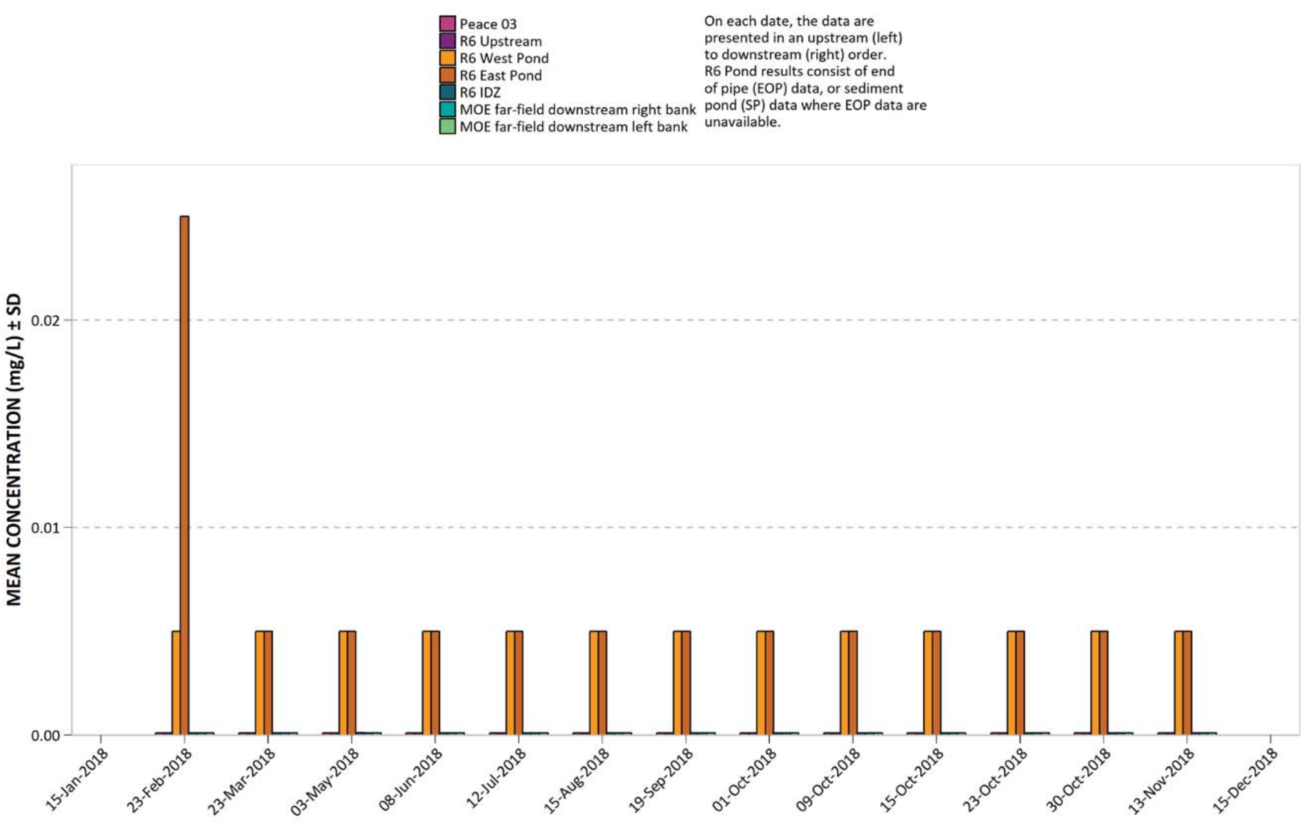


Figure 137. 2018 Peace River and RSEM R6 pond total thallium (Tl).



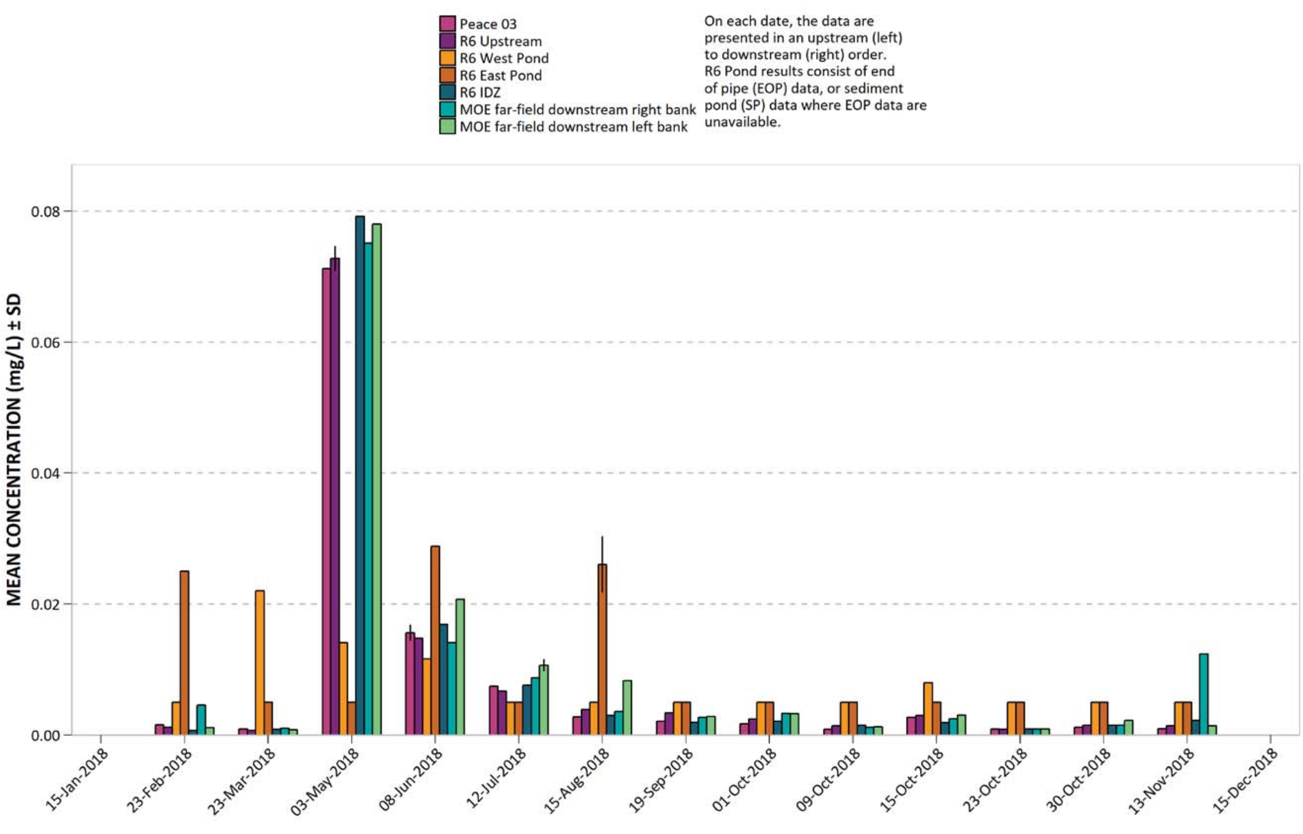
Results less than the MDL were assigned the MDL value of 0.00001 mg/L (R5b pond and Peace River).

Figure 138. 2018 Peace River and RSEM R6 pond total tin (Sn).



Results less than the MDL were assigned the MDL value of 0.005 mg/L (R5b pond) or 0.0001 mg/L (Peace River).

Figure 139. 2018 Peace River and RSEM R6 pond total titanium (Ti).



R5b pond results less than the MDL were assigned the MDL value of 0.005 mg/L.

Figure 140. 2018 Peace River and RSEM R6 pond total uranium (U).

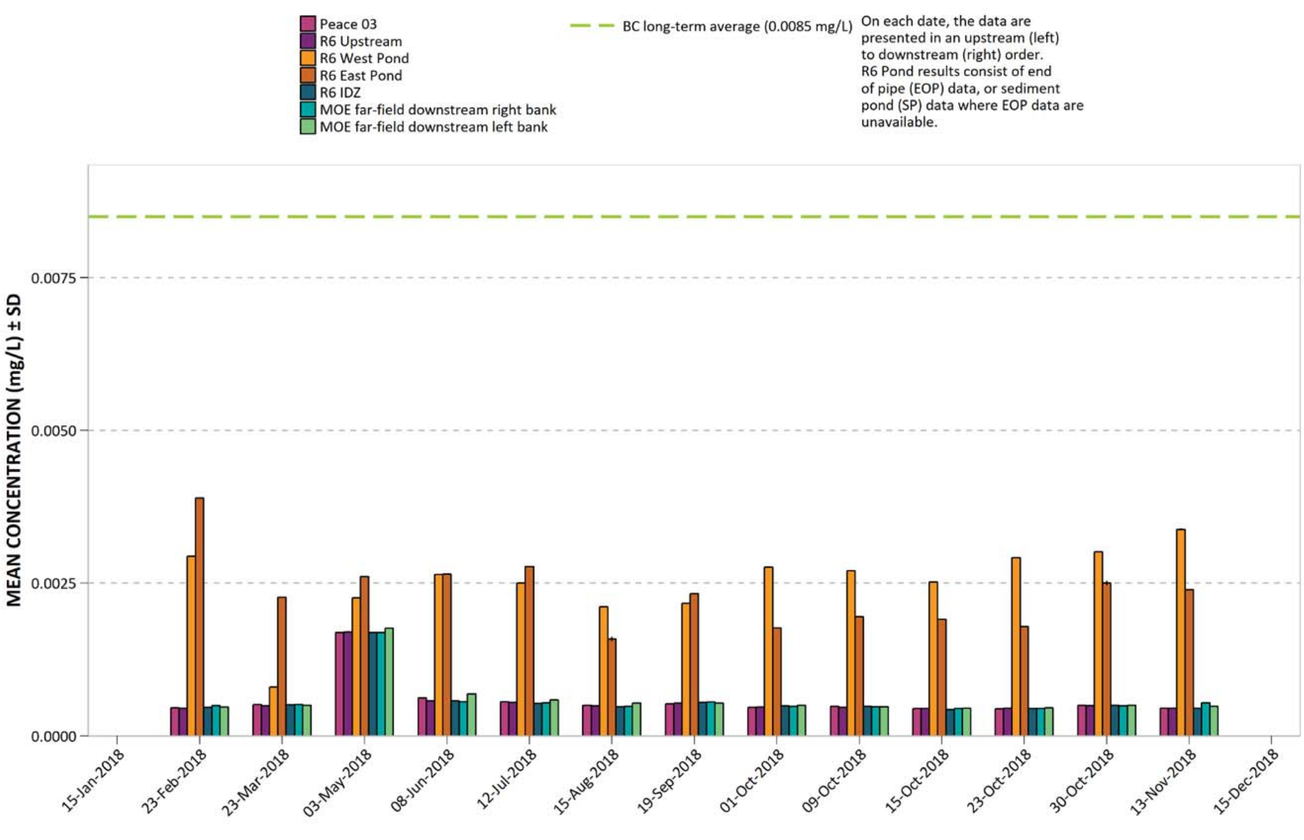
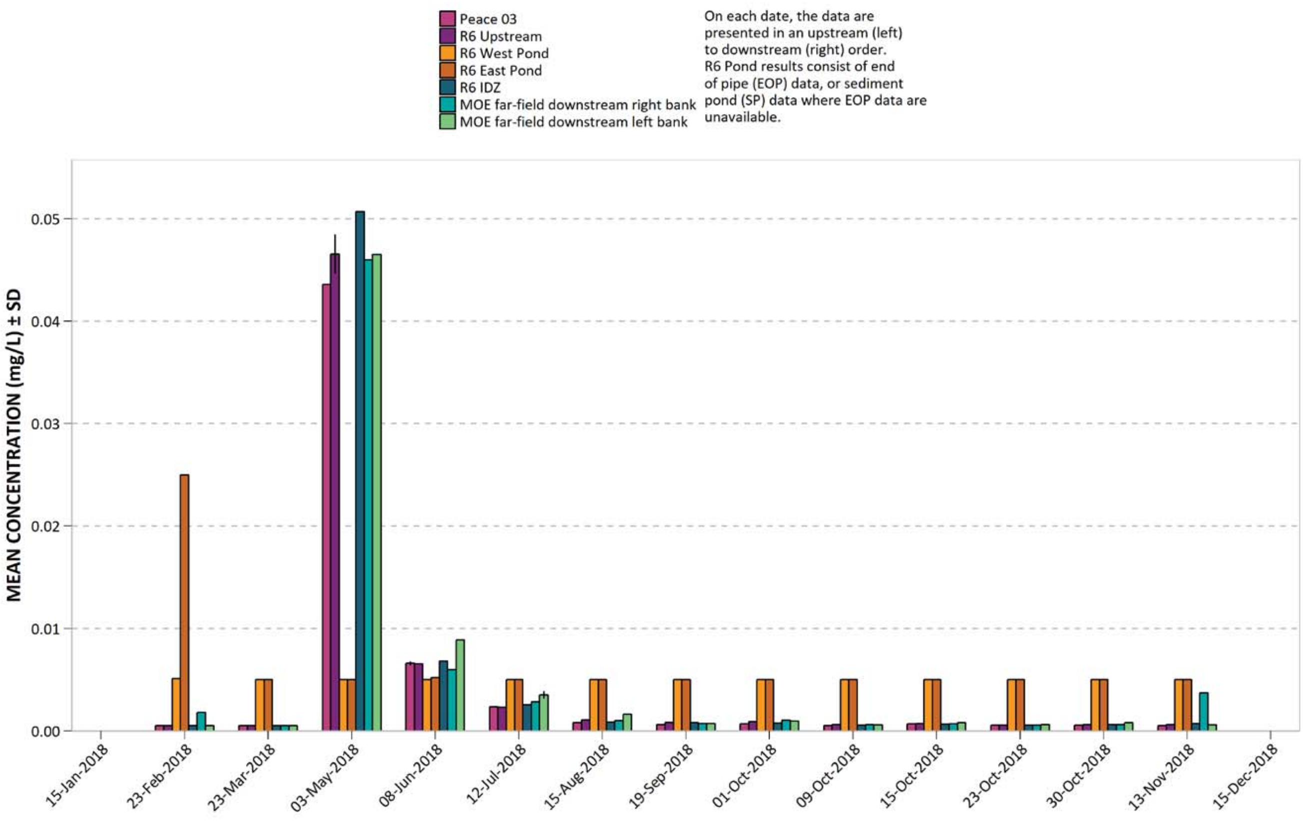
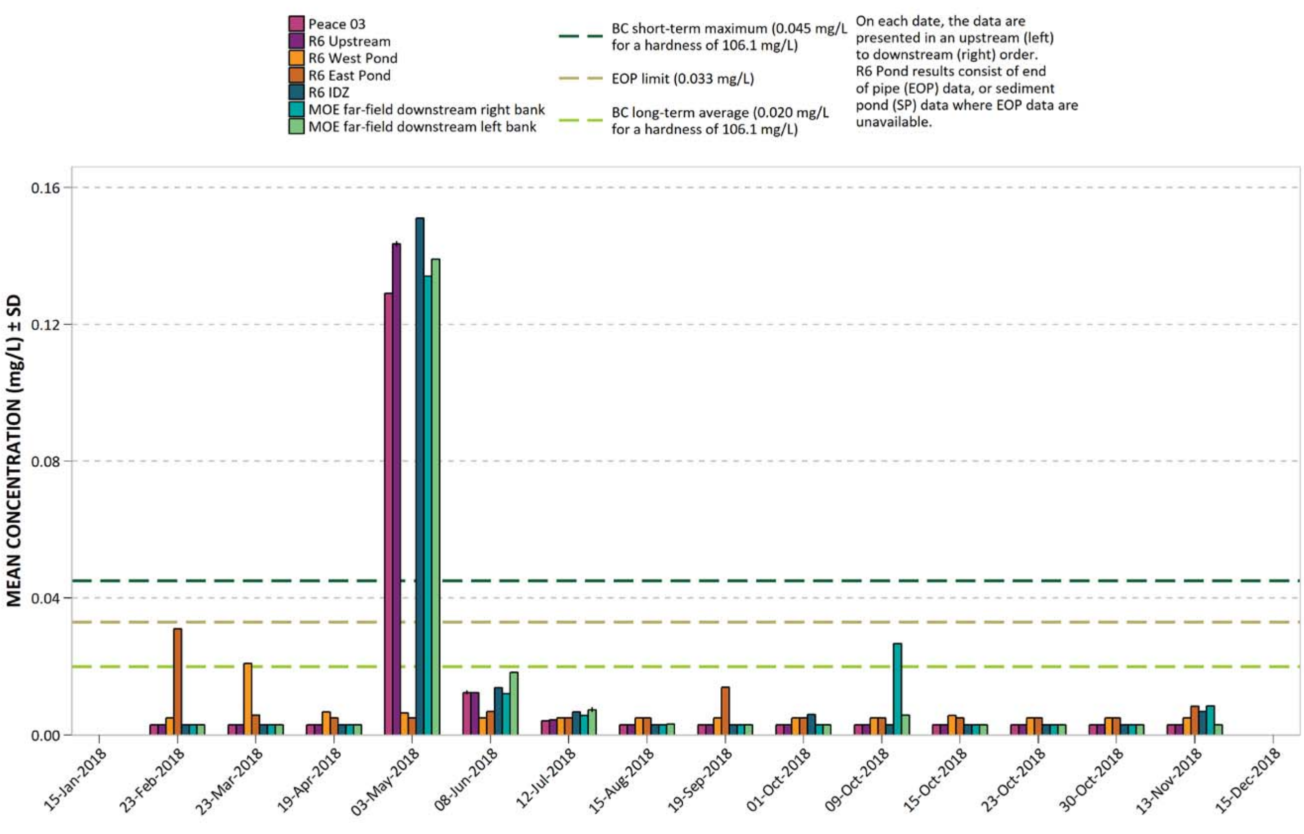


Figure 141. 2018 Peace River and RSEM R6 pond total vanadium (V).



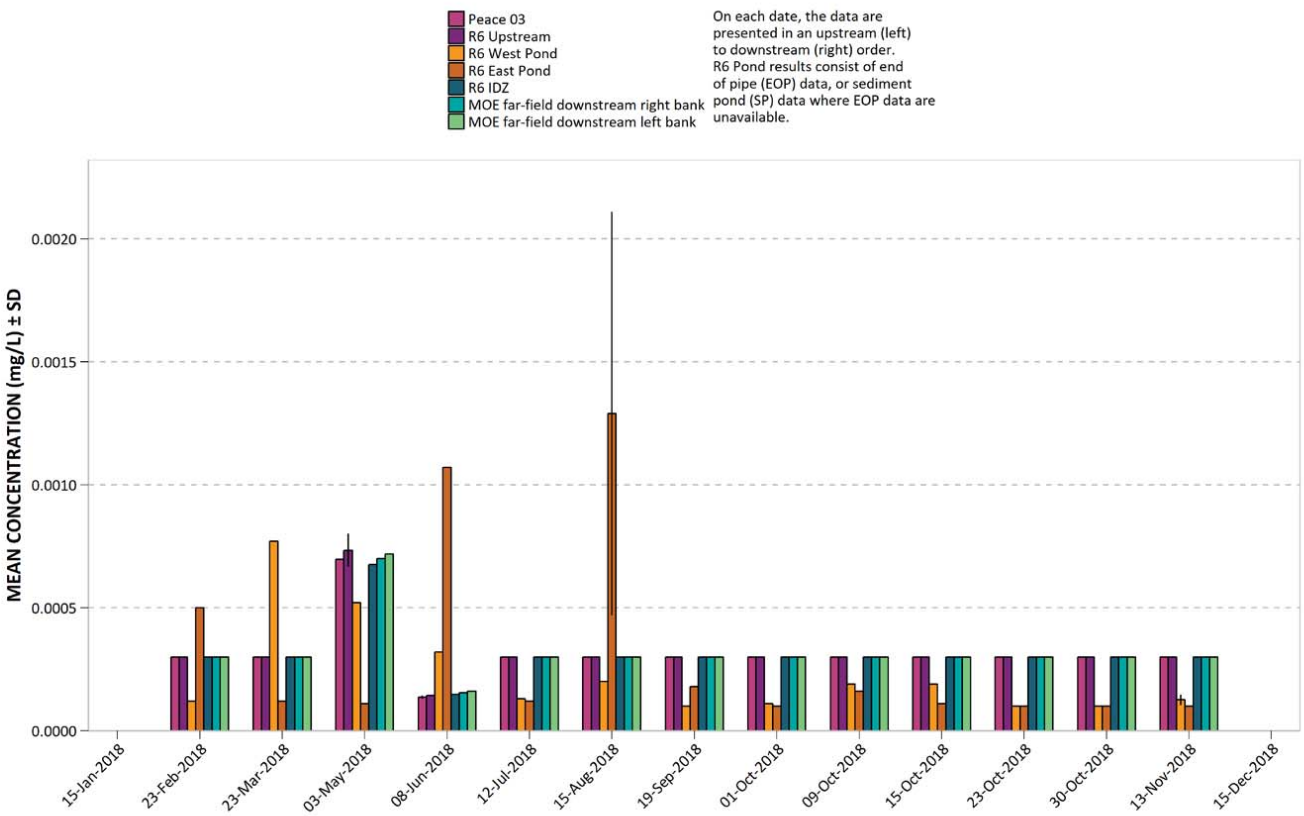
Results less than the MDL were assigned the MDL value of 0.005 mg/L (R5b pond) or 0.0005 mg/L (Peace River).

Figure 142. 2018 Peace River and RSEM R6 pond total zinc (Zn).



Results less than the MDL were assigned the MDL value of 0.005 mg/L (R5b pond) or 0.003 mg/L (Peace River).

Figure 143. 2018 Peace River and RSEM R6 pond total zirconium (Zr).



R5b pond results less than the MDL were assigned the MDL value of 0.0003 mg/L. The MDL in the Peace River varied in 2018 between 0.00006 and 0.0003 mg/L, such that much of the data were assigned the MDL of 0.0003 mg/L while lower values exist on some dates.

Figure 144. 2018 Peace River and RSEM R6 pond dissolved aluminum (Al).

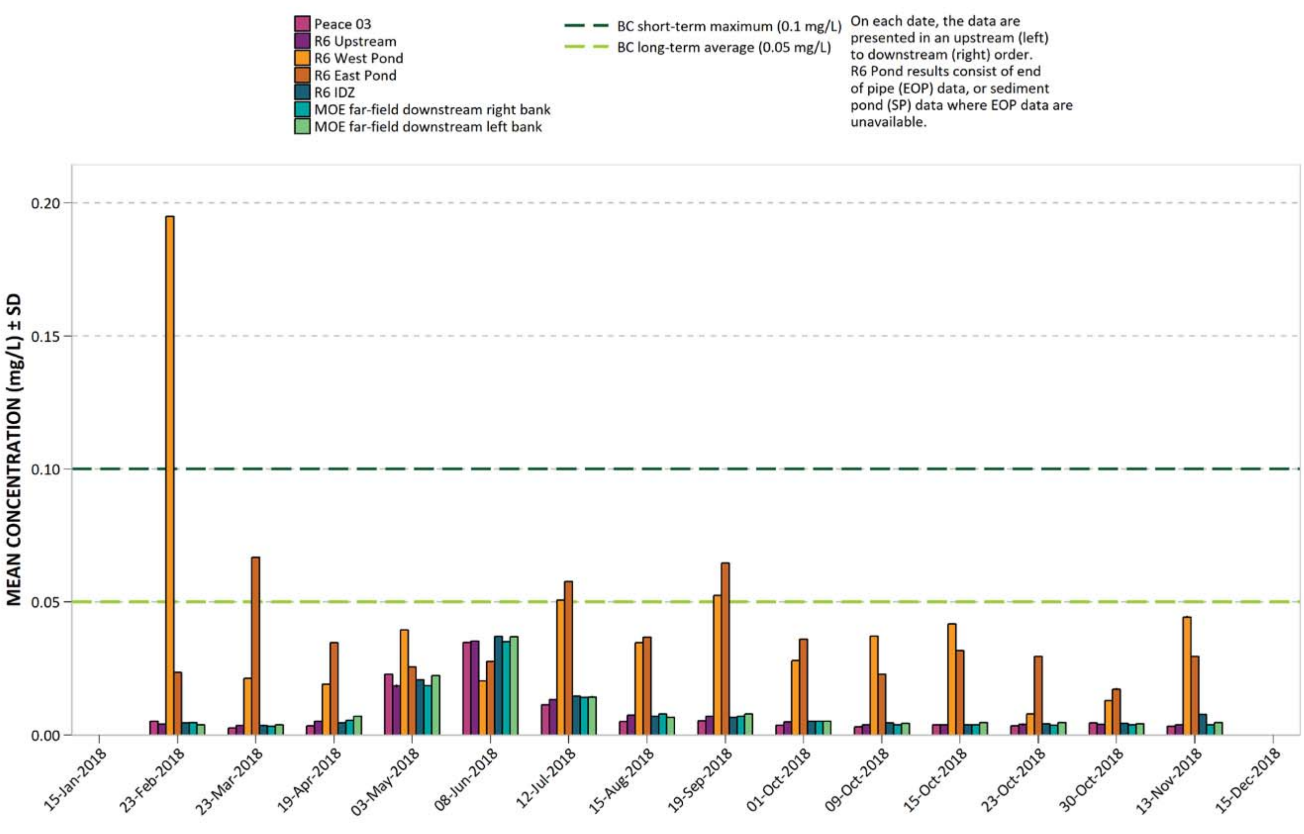
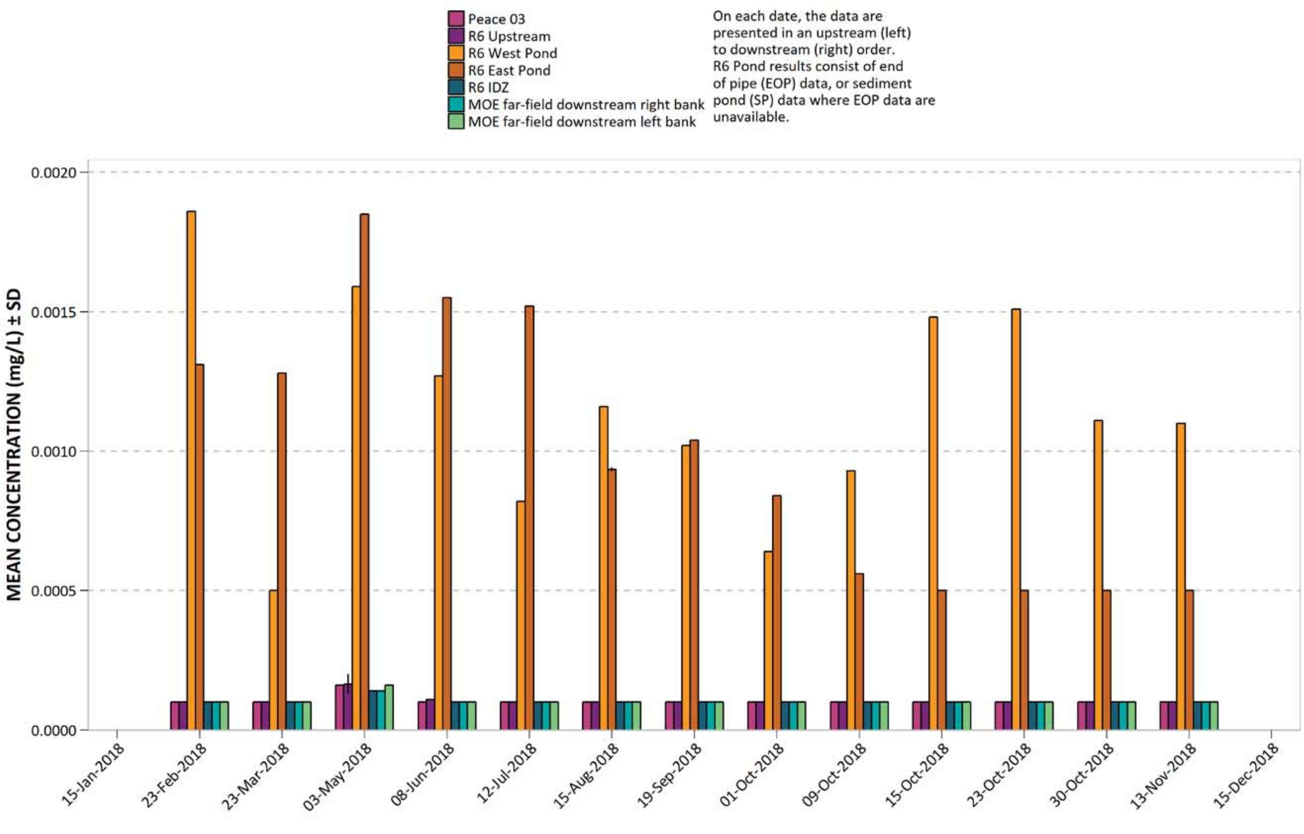


Figure 145. 2018 Peace River and RSEM R6 pond dissolved antimony (Sb).



Results less than the MDL were assigned the MDL value of 0.0005 mg/L (R5b pond) or 0.0001 mg/L (Peace River).

Figure 146. 2018 Peace River and RSEM R6 pond dissolved arsenic (As).

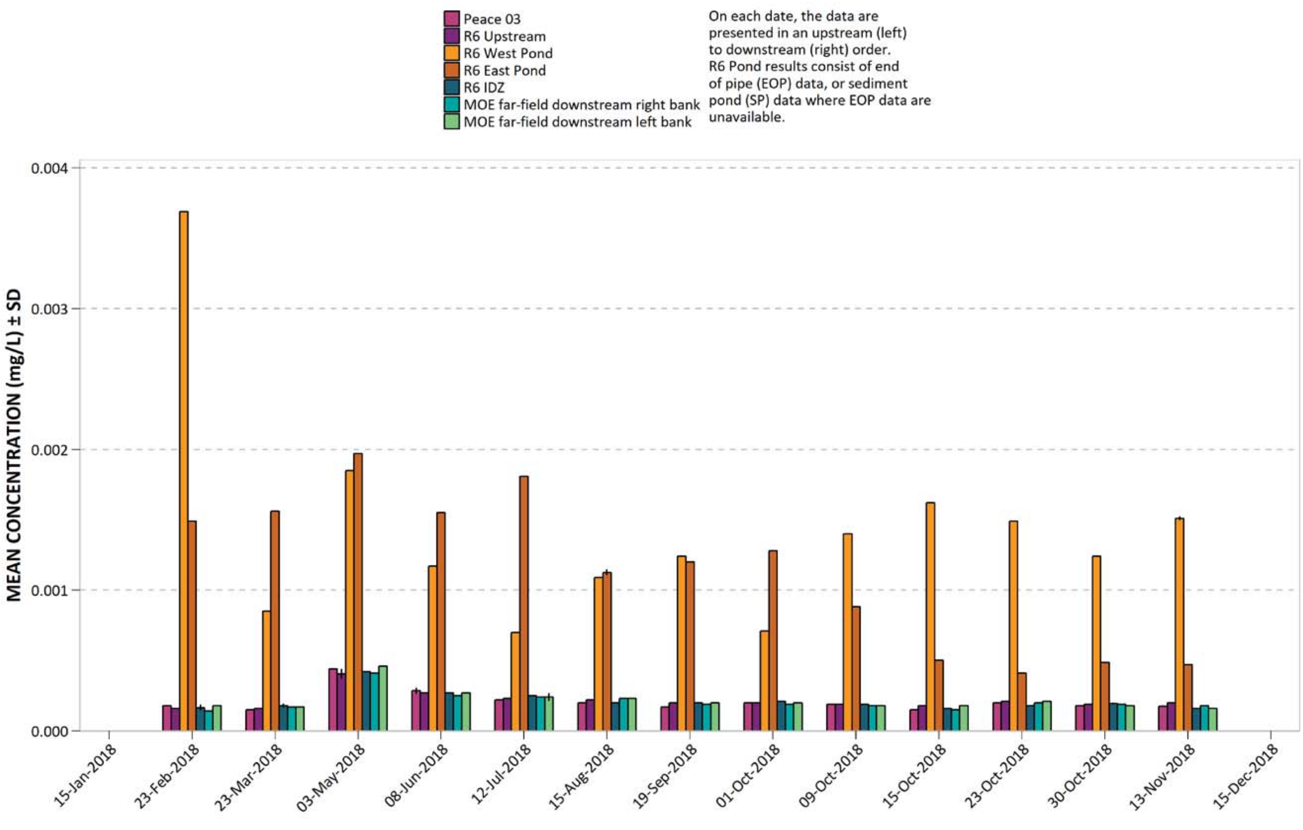


Figure 147. 2018 Peace River and RSEM R6 pond dissolved barium (Ba).

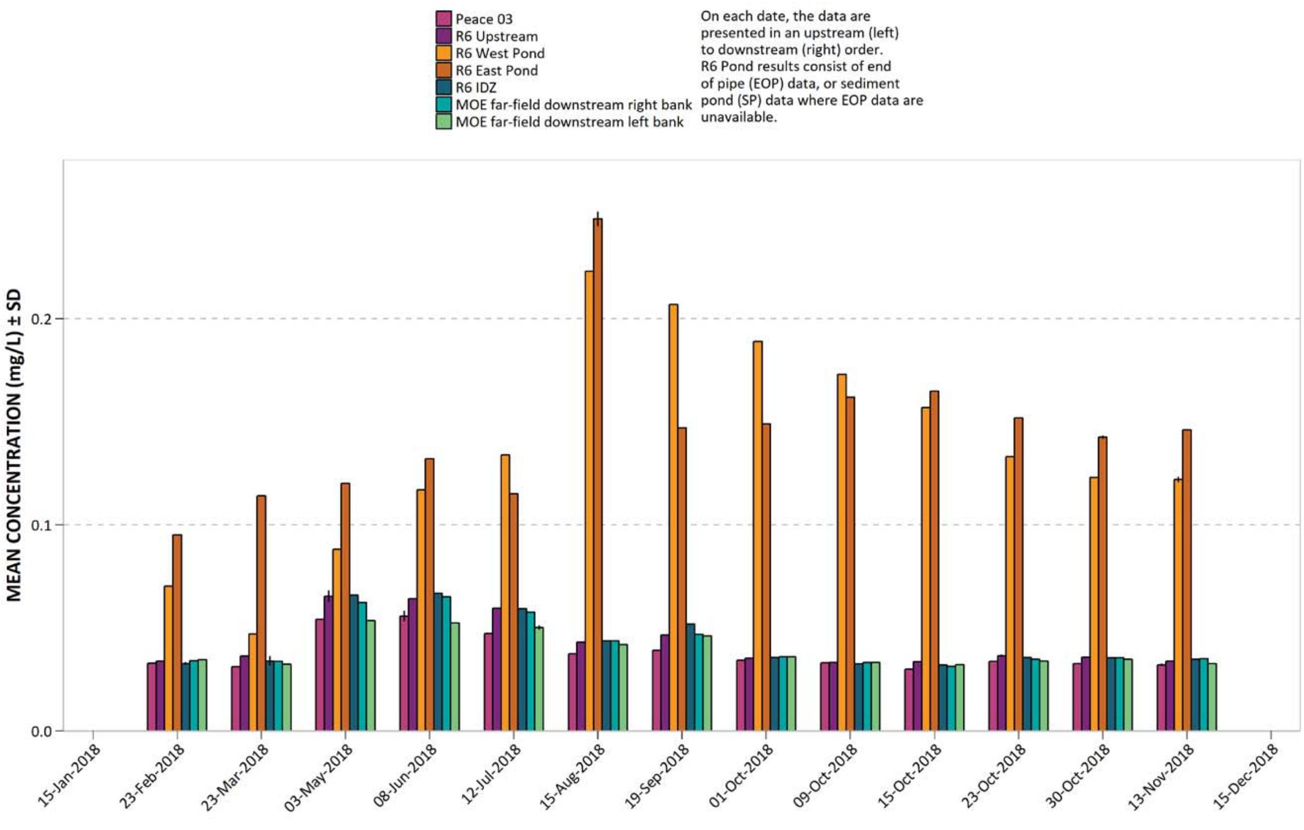
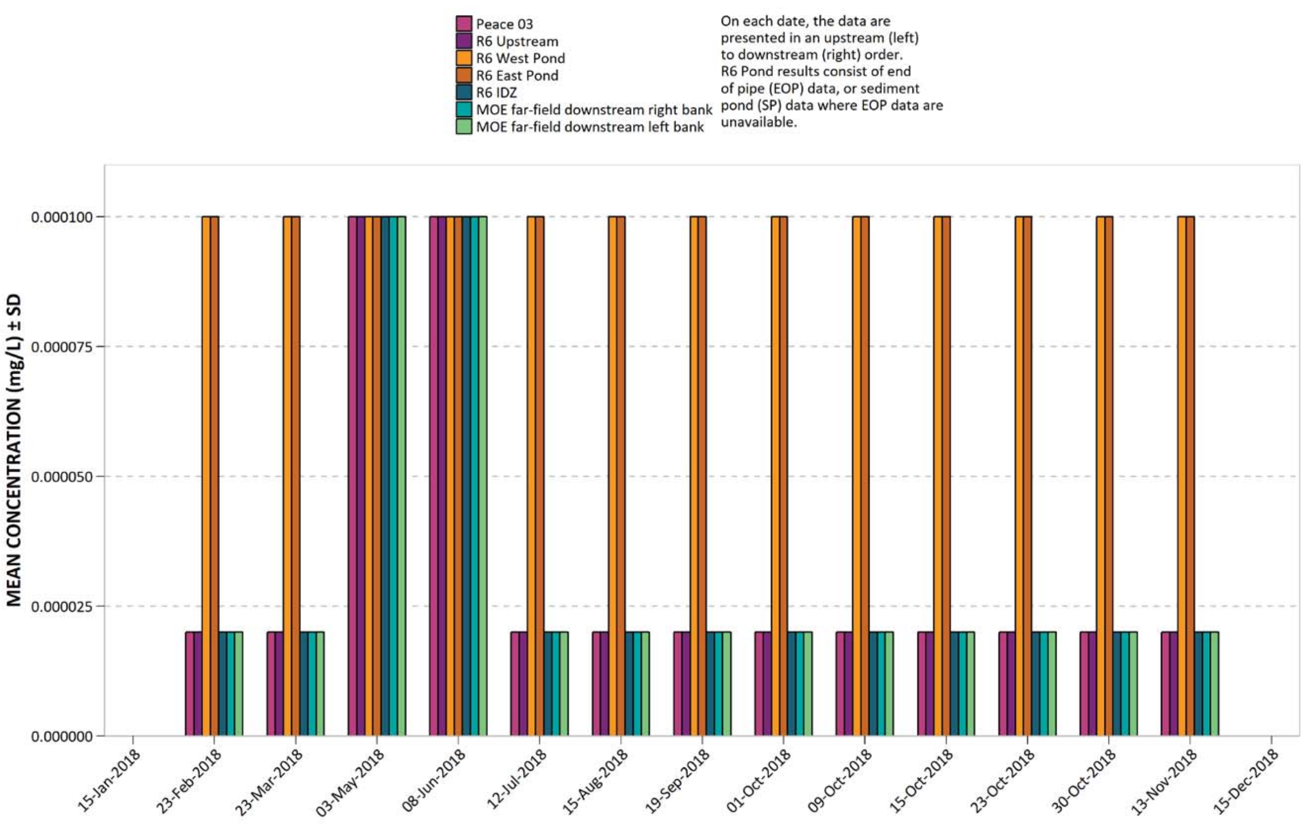
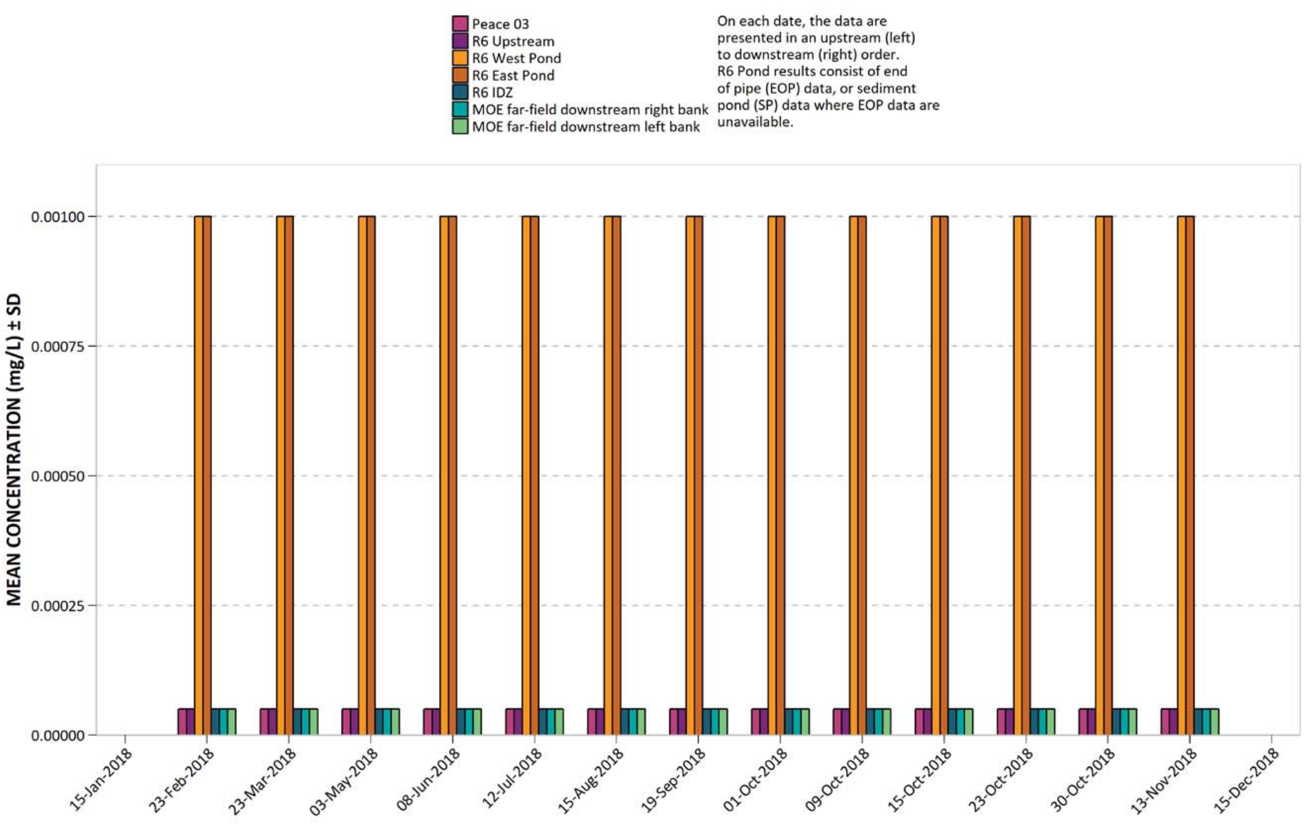


Figure 148. 2018 Peace River and RSEM R6 pond dissolved beryllium (Be).



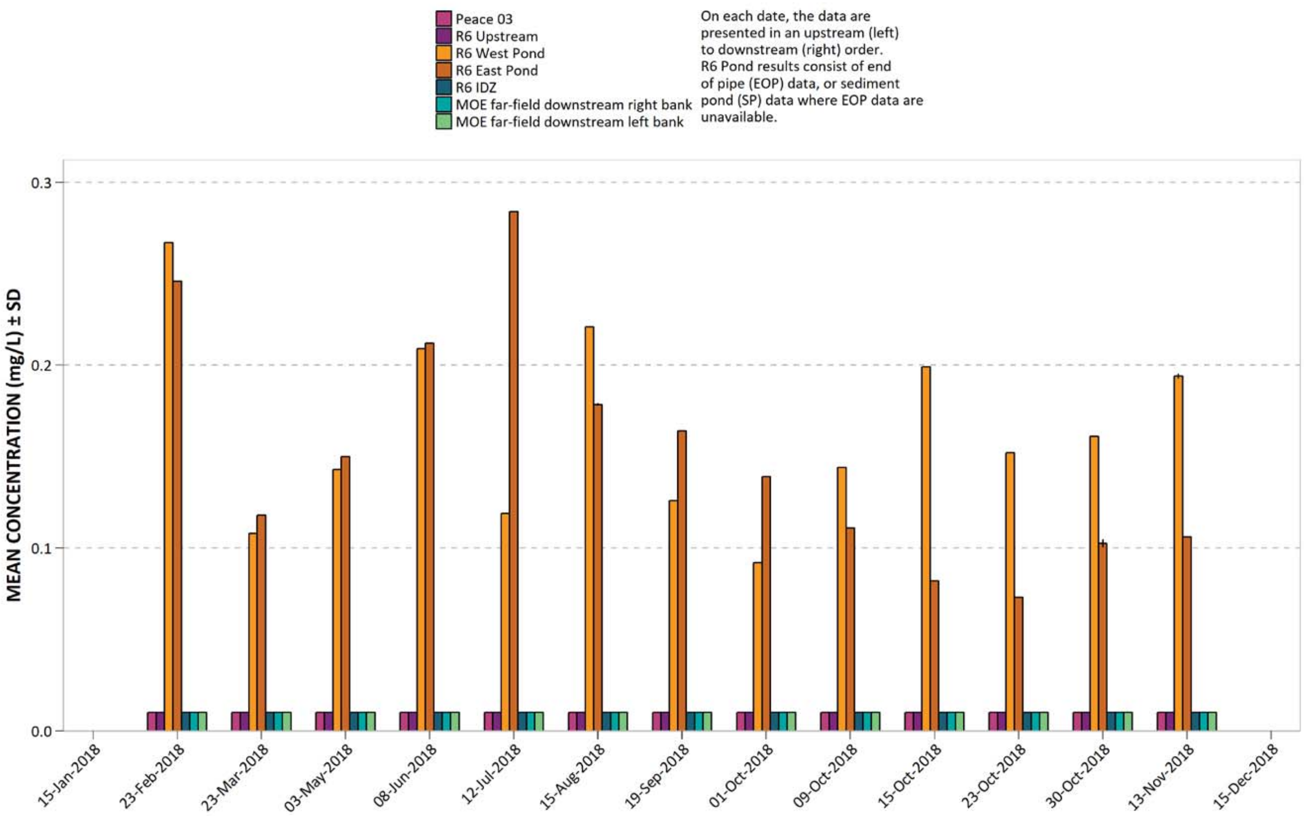
All results were less than the MDL and thus were assigned the MDL value of 0.0001 mg/L (R5b pond, Peace River on May 3 and June 8) or 0.00002 mg/L (Peace River on remaining dates).

Figure 149. 2018 Peace River and RSEM R6 pond dissolved bismuth (Bi).



All results were less than the MDL and thus were assigned the MDL value of 0.001 mg/L (R5b pond) or 0.00005 mg/L (Peace River).

Figure 150. 2018 Peace River and RSEM R6 pond dissolved boron (B).



Peace River results were less than the MDL and thus were assigned the MDL value of 0.01 mg/L.

Figure 151. 2018 Peace River and RSEM R6 pond dissolved cadmium (Cd).

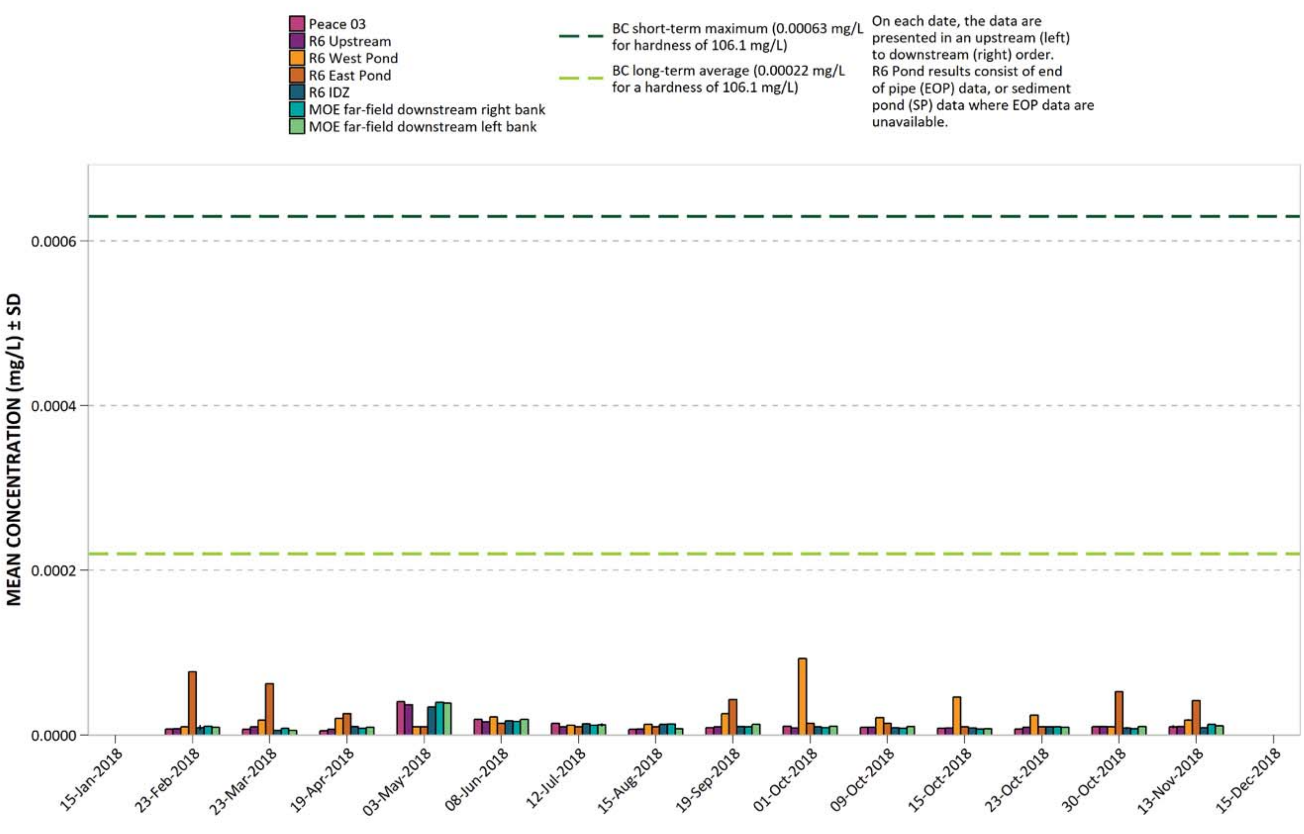


Figure 152. 2018 Peace River and RSEM R6 pond dissolved calcium (Ca).

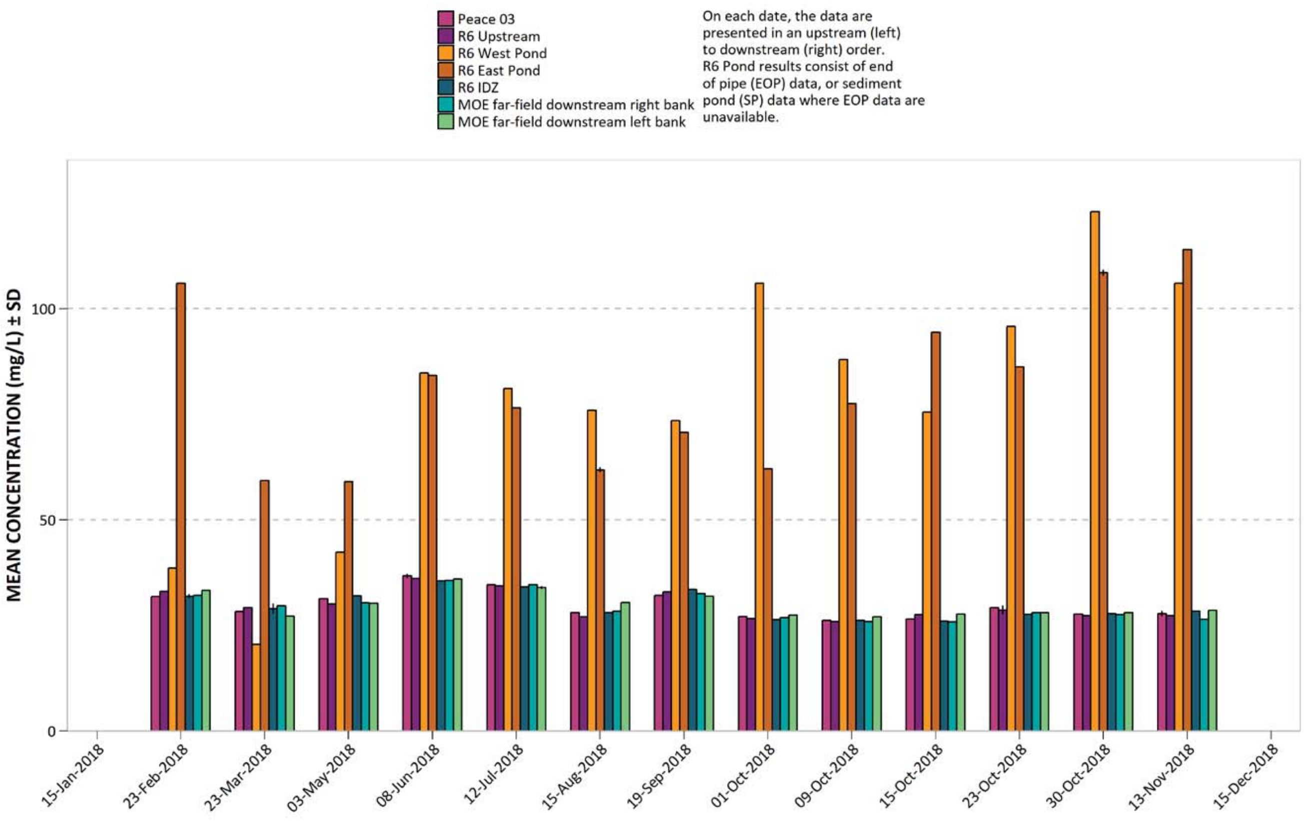
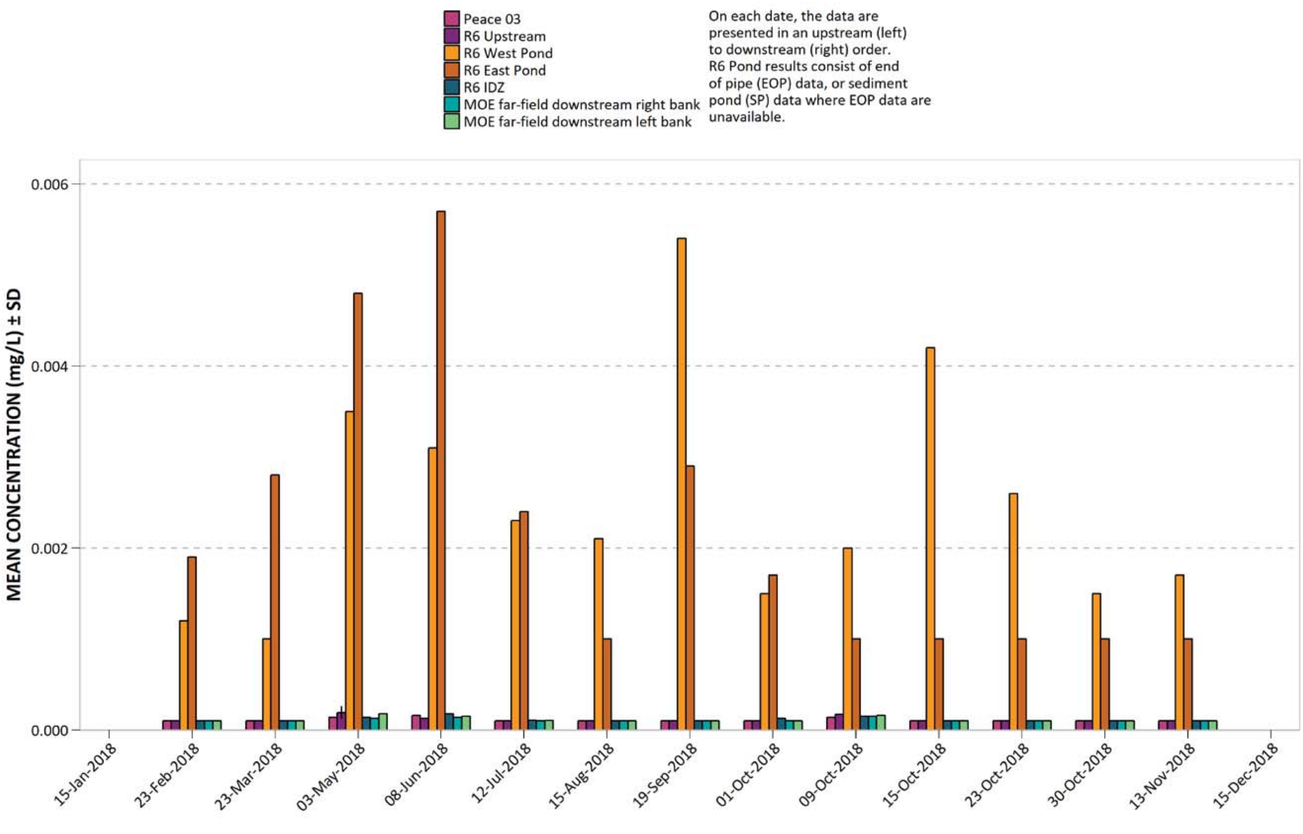
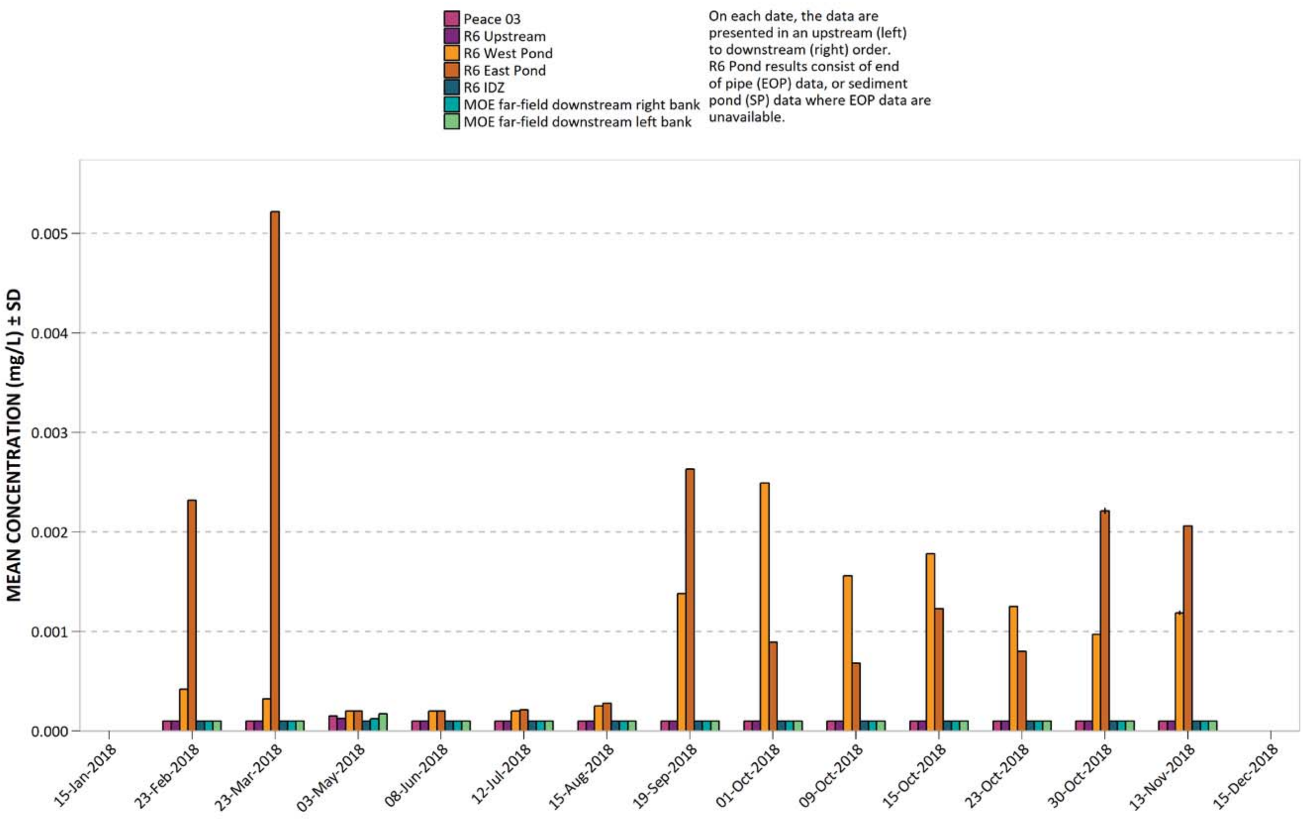


Figure 153. 2018 Peace River and RSEM R6 pond dissolved chromium (Cr).



Results less than the MDL were assigned the MDL value of 0.001 mg/L (R5b pond) or 0.0001 mg/L (Peace River).

Figure 154. 2018 Peace River and RSEM R6 pond dissolved cobalt (Co).



Results less than the MDL were assigned the MDL value of 0.0002 mg/L (R5b pond) or 0.0001 mg/L (Peace River).

Figure 155. 2018 Peace River and RSEM R6 pond dissolved copper (Cu).

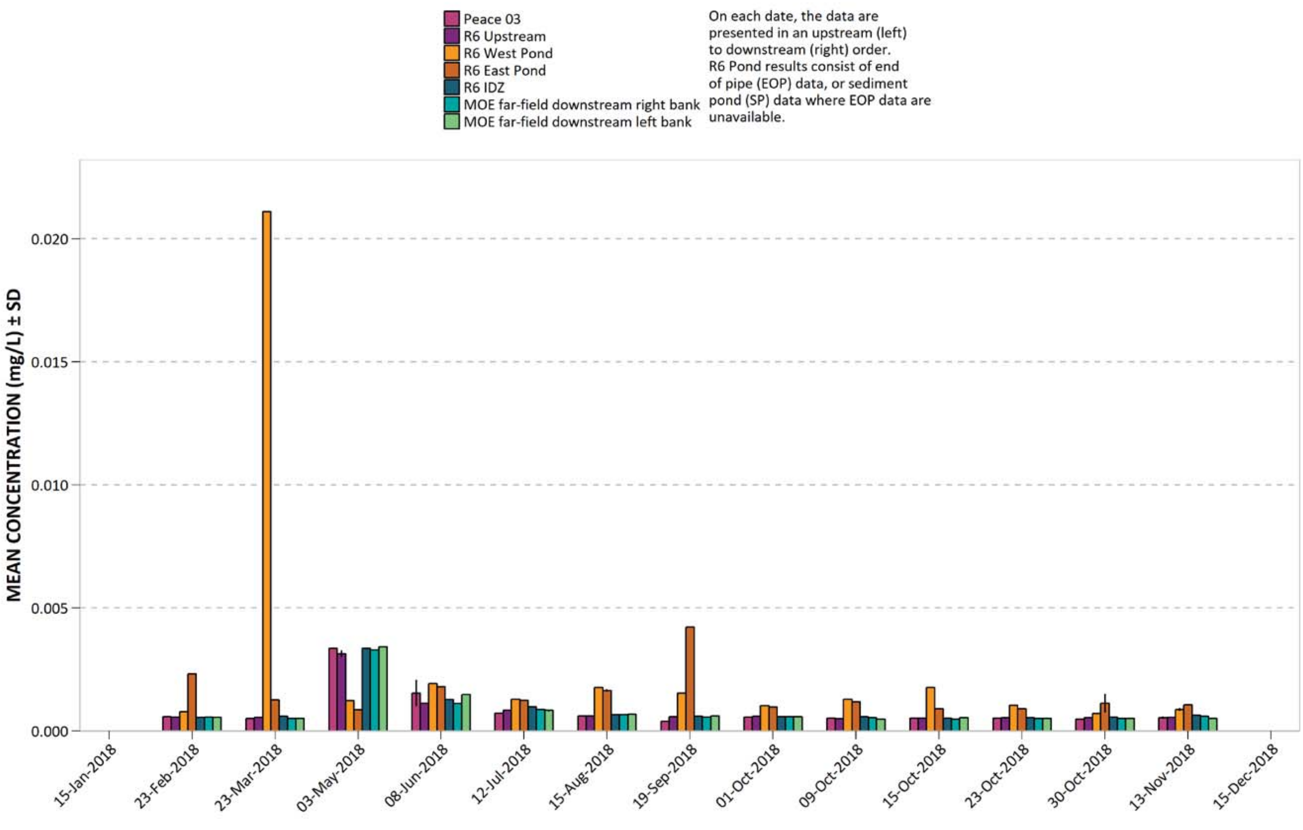
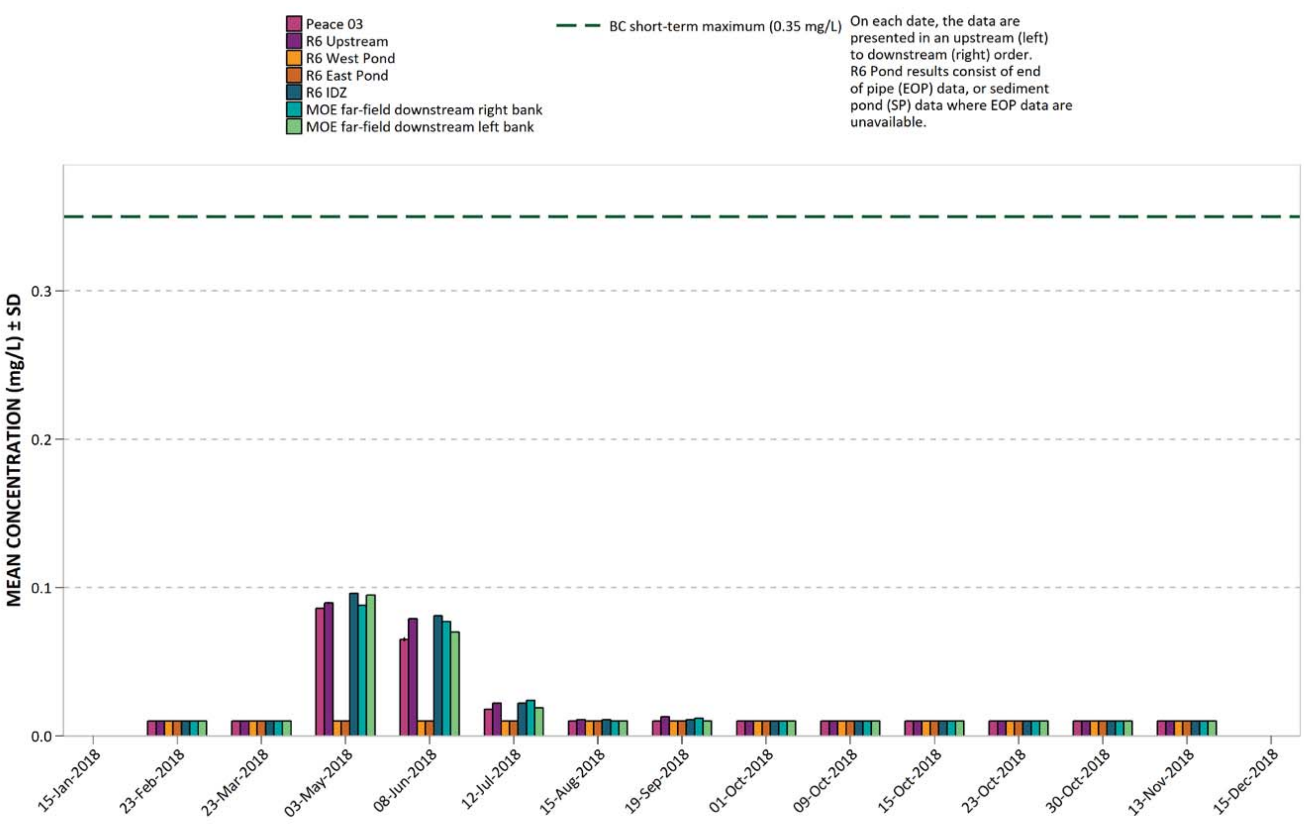
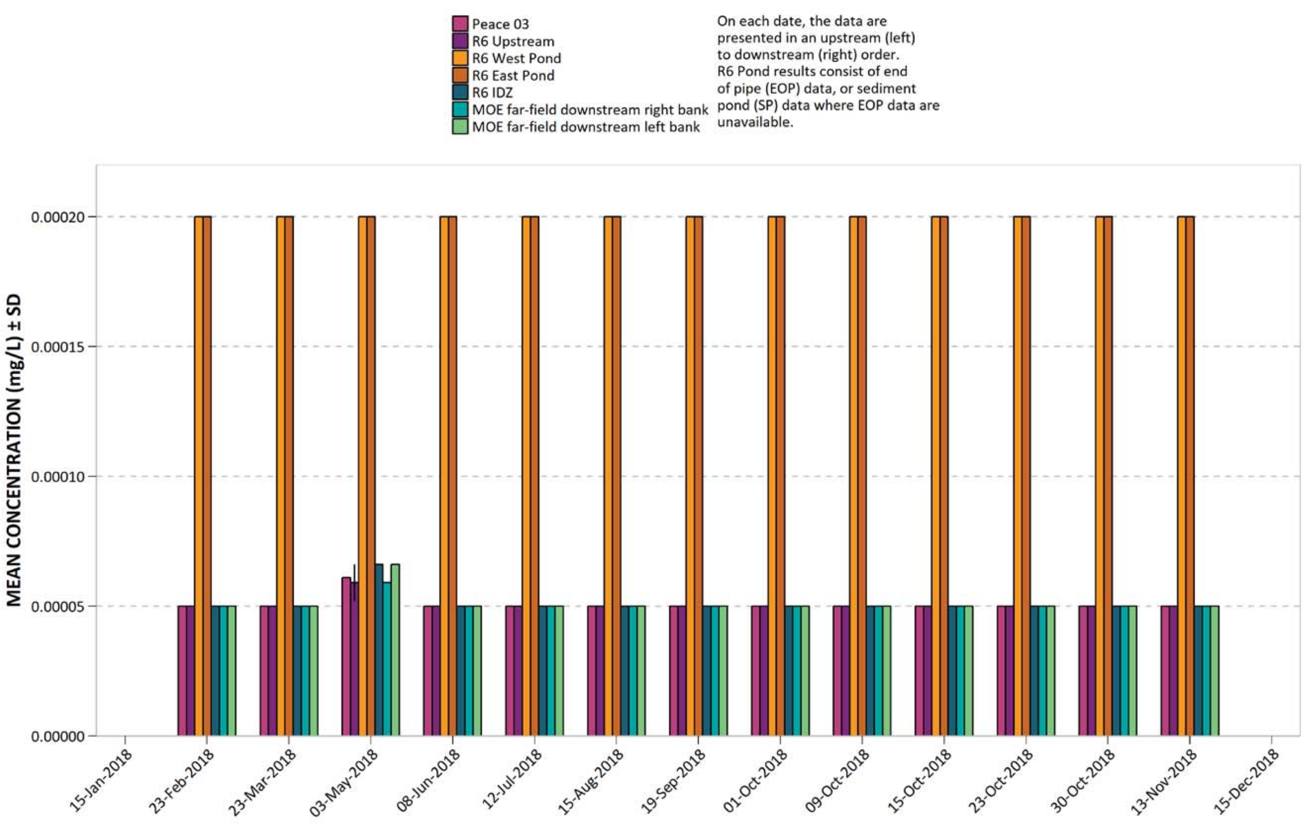


Figure 156. 2018 Peace River and RSEM R6 pond dissolved iron (Fe).



Results less than the MDL were assigned the MDL value of 0.01 mg/L.

Figure 157. 2018 Peace River and RSEM R6 pond dissolved lead (Pb).



Results less than the MDL were assigned the MDL value of 0.0002 mg/L (R5b pond) or 0.00005 mg/L (Peace River).

Figure 158. 2018 Peace River and RSEM R6 pond dissolved lithium (Li).

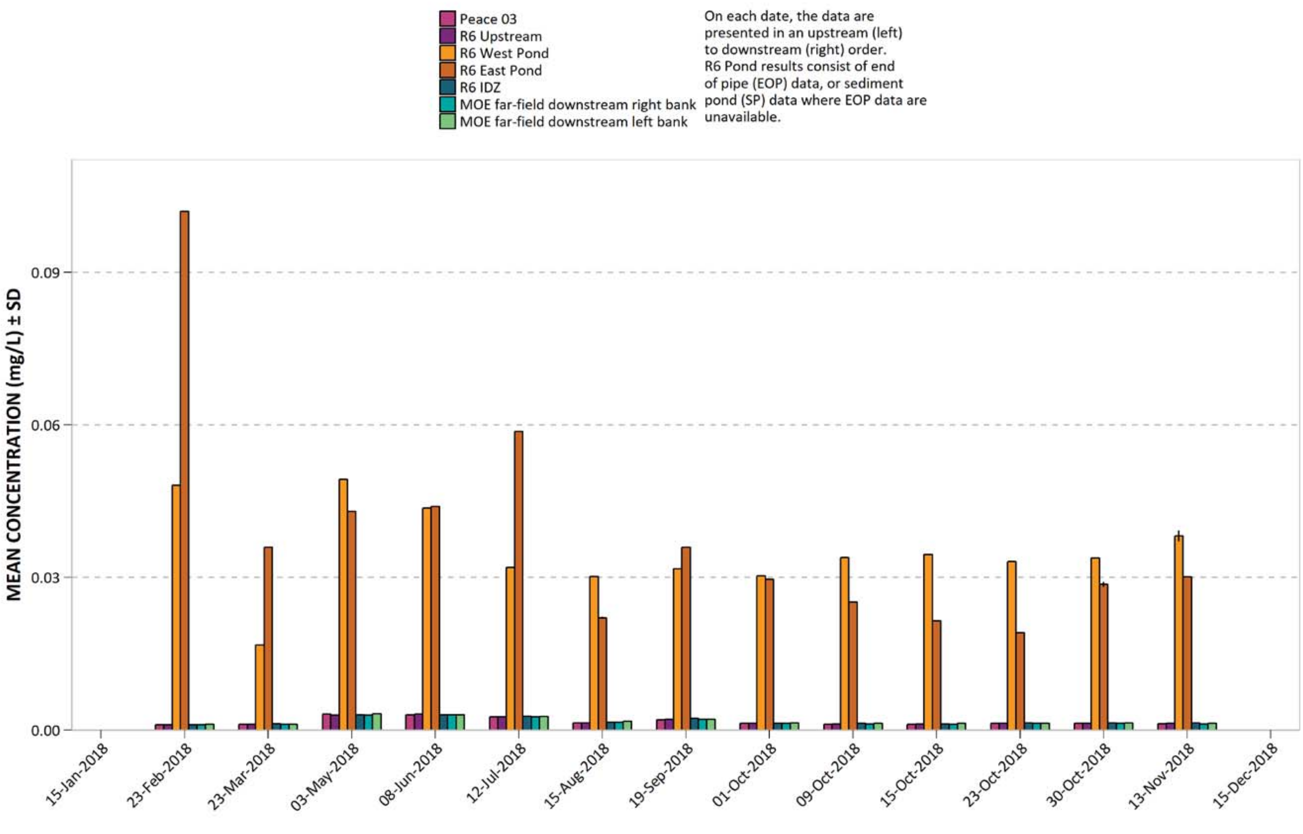


Figure 159. 2018 Peace River and RSEM R6 pond dissolved magnesium (Mg).

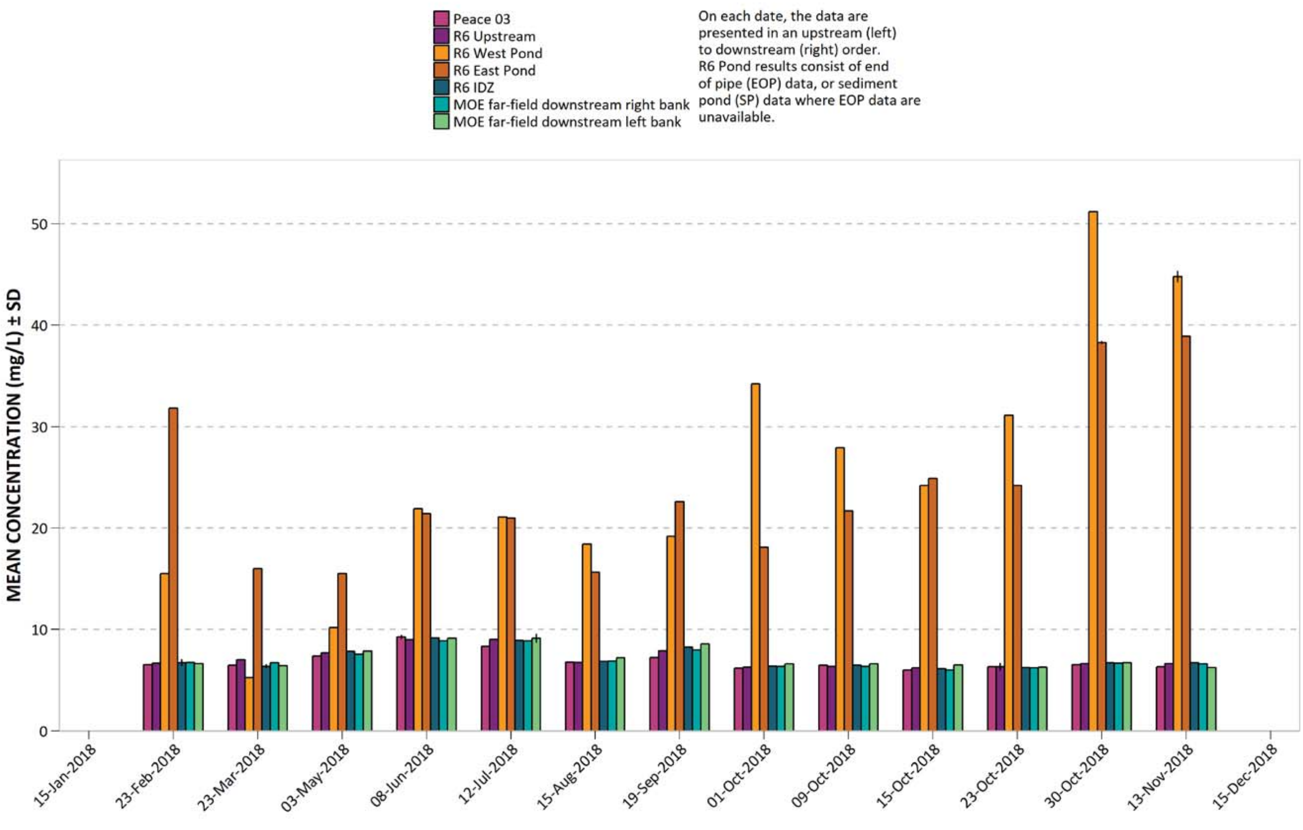


Figure 160. 2018 Peace River and RSEM R6 pond dissolved manganese (Mn).

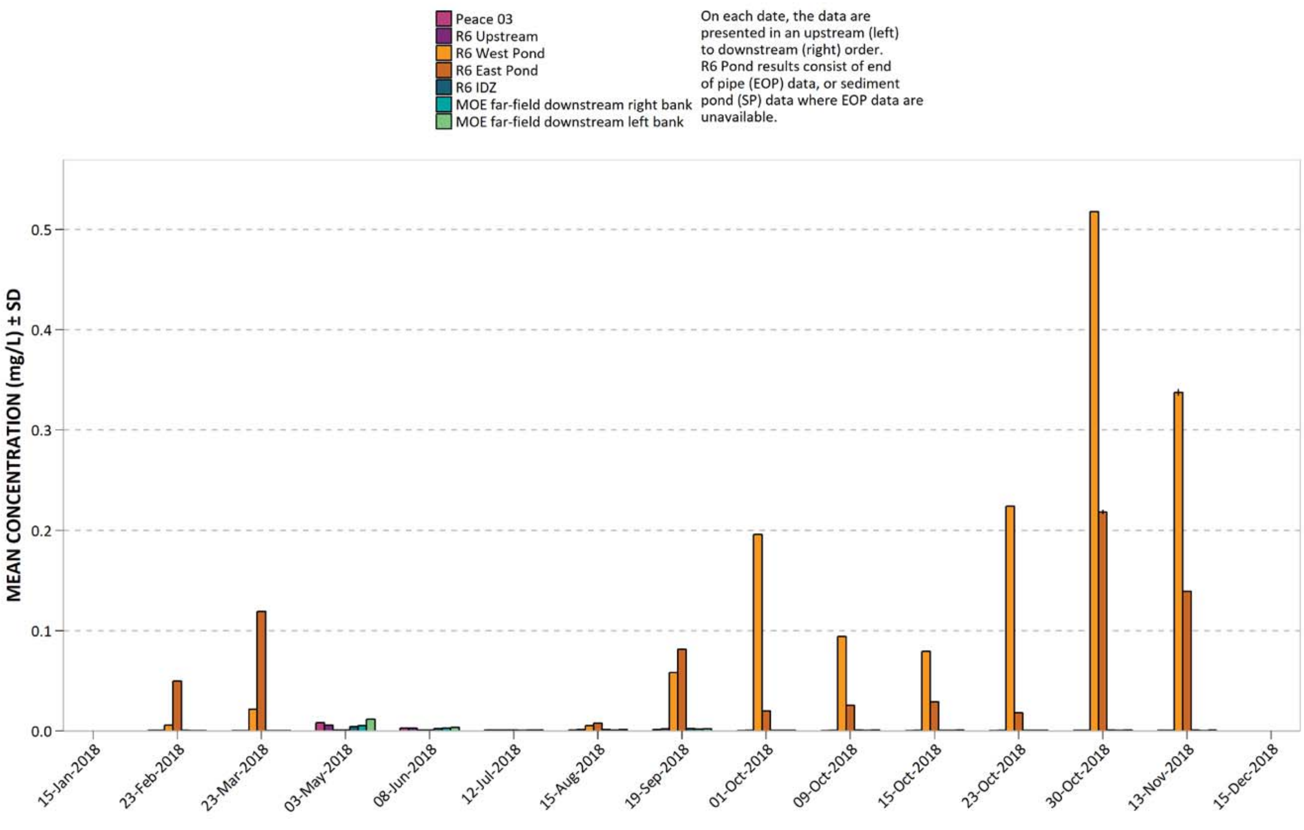
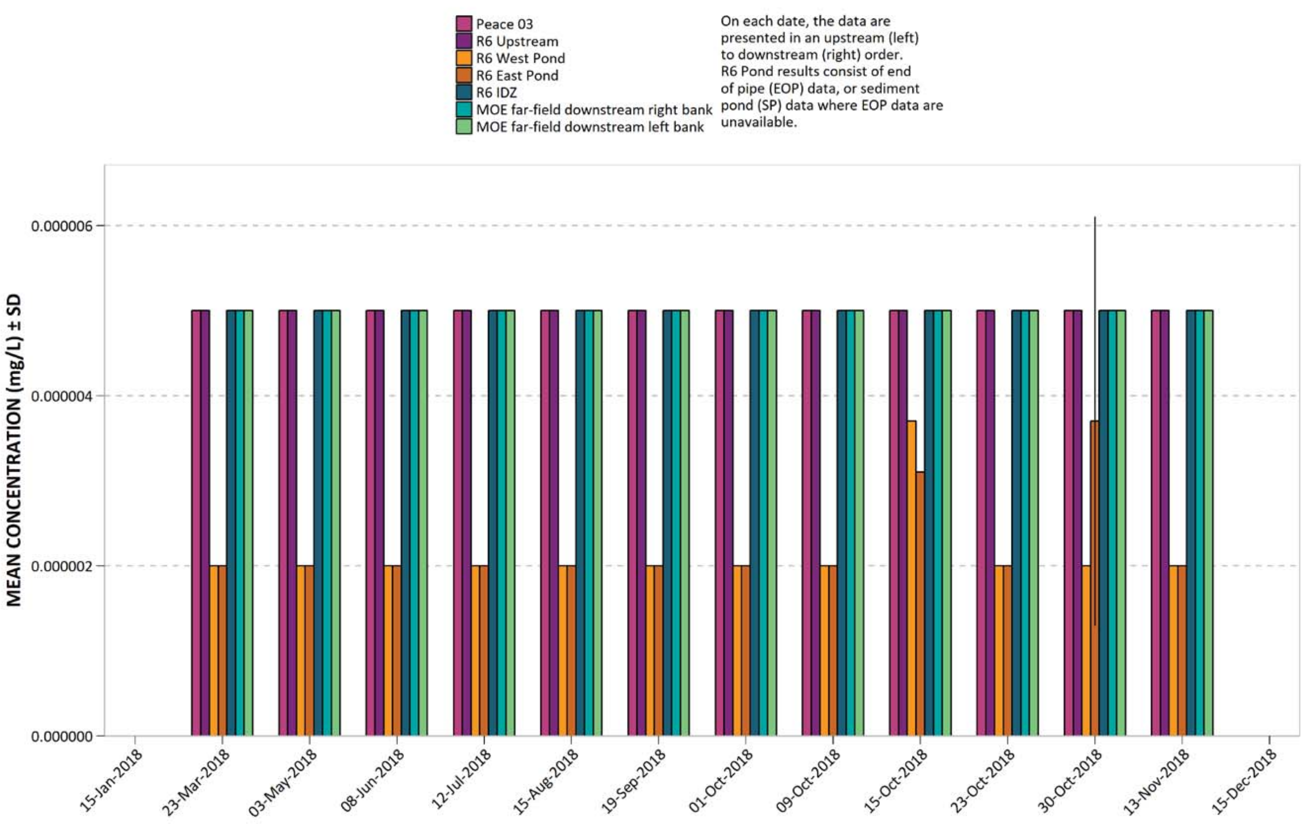


Figure 161. 2018 Peace River and RSEM R6 pond dissolved mercury (Hg).



Results less than the MDL were assigned the MDL value of 0.000005 mg/L (Peace River), 0.000002 mg/L (R5b pond)

Figure 162. 2018 Peace River and RSEM R6 pond dissolved molybdenum (Mo).

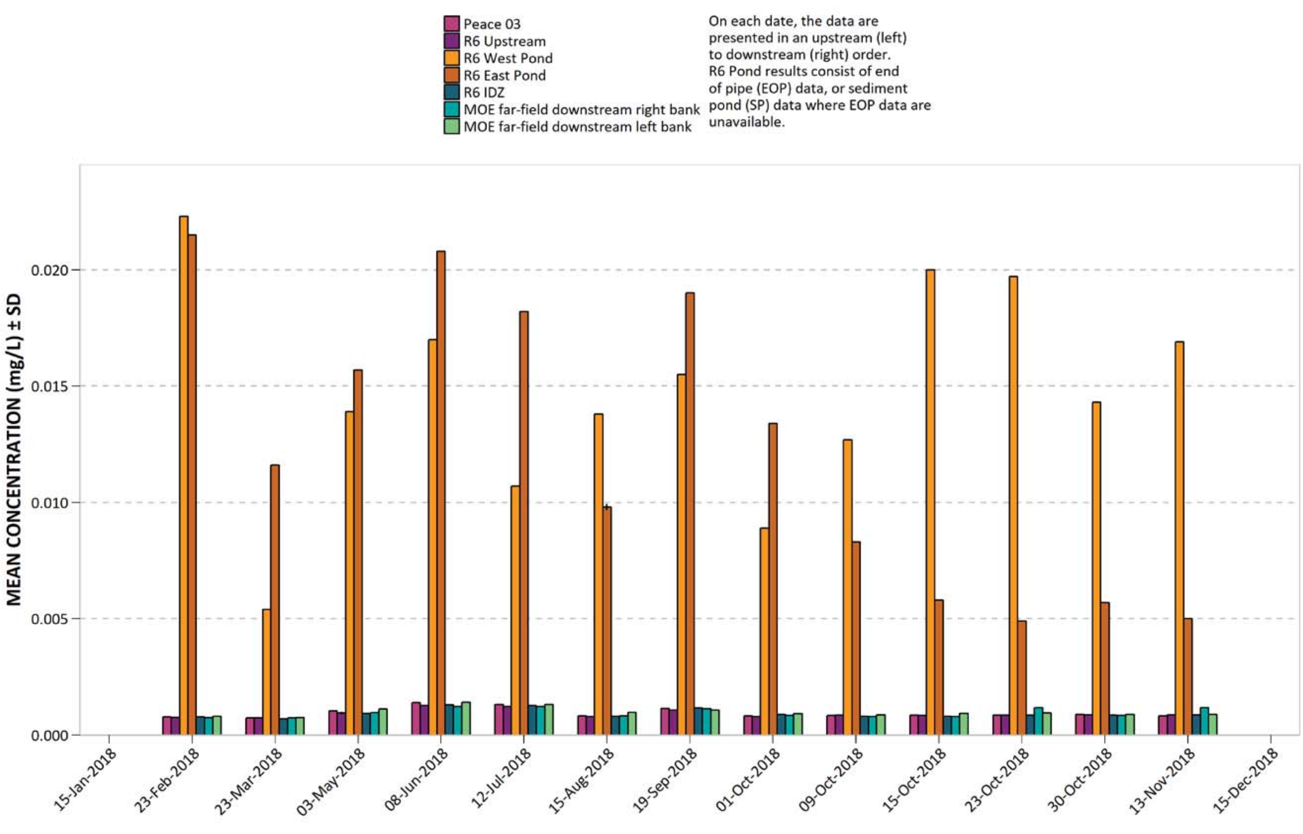


Figure 163. 2018 Peace River and RSEM R6 pond dissolved nickel (Ni).

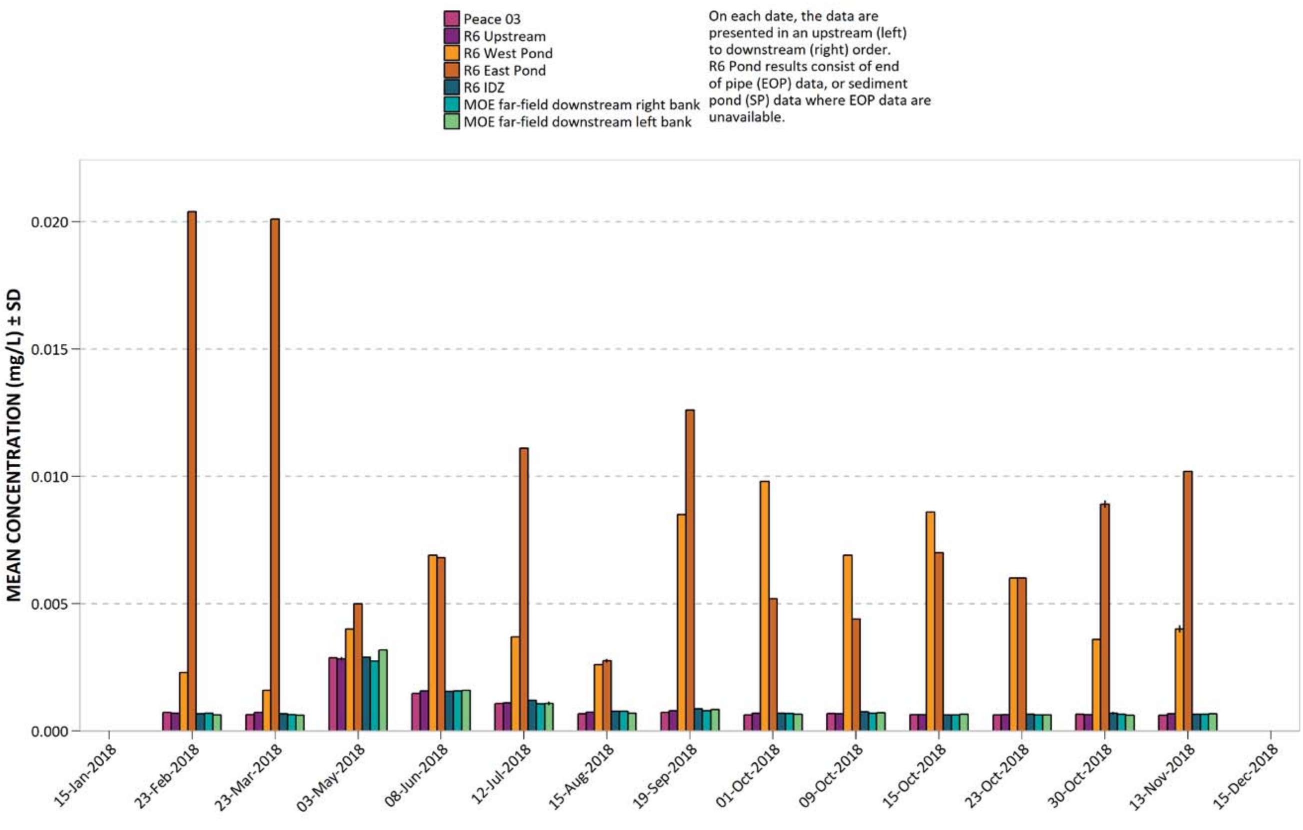


Figure 164. 2018 Peace River and RSEM R6 pond dissolved potassium (K).

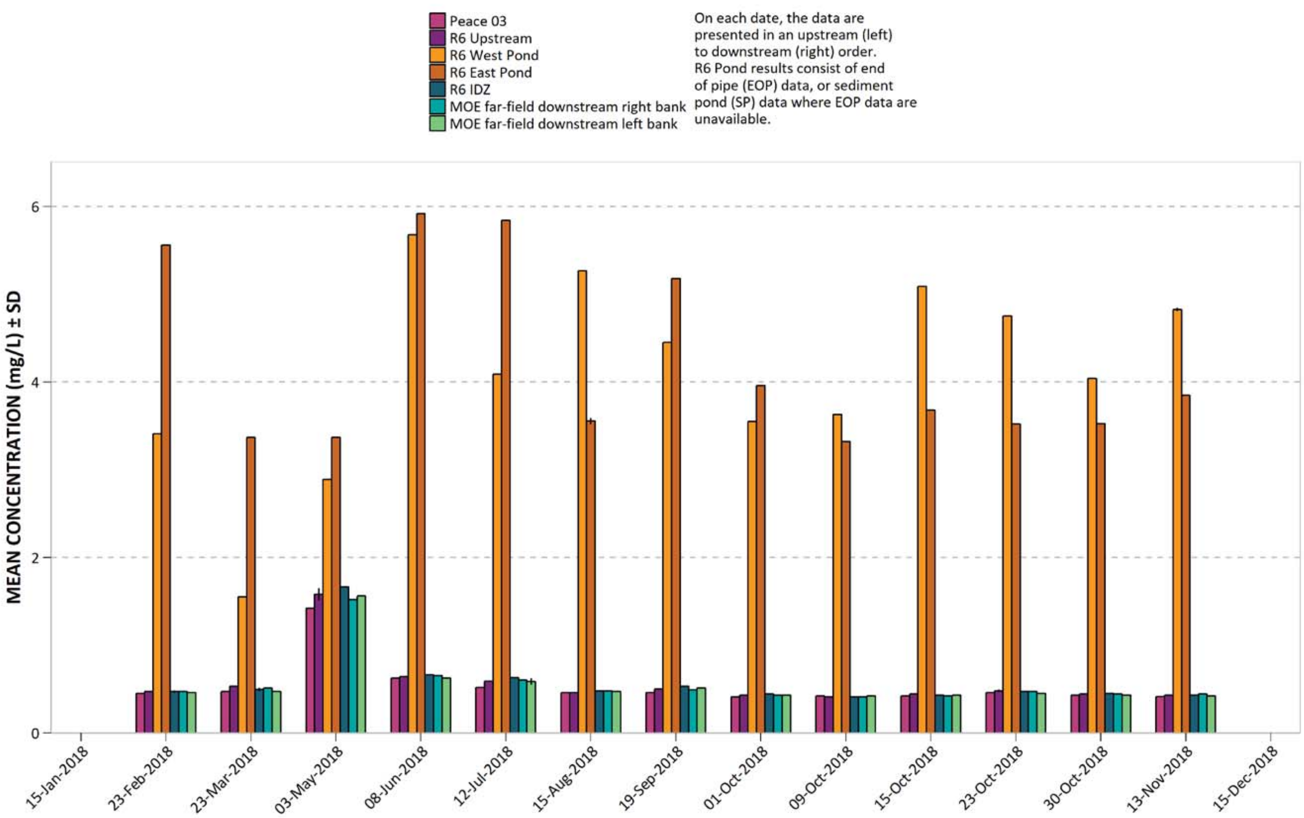


Figure 165. 2018 Peace River and RSEM R6 pond dissolved selenium (Se).

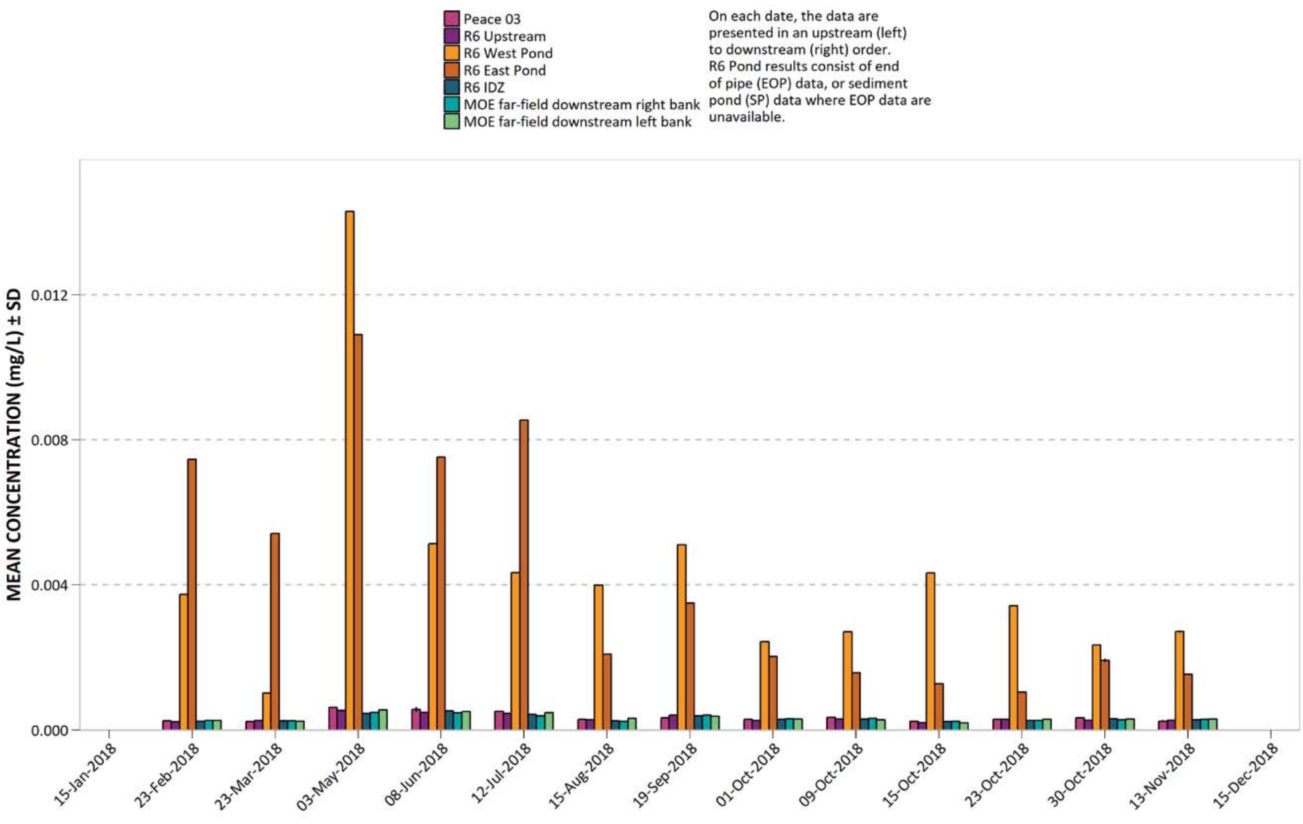


Figure 166. 2018 Peace River and RSEM R6 pond dissolved silicon (Si).

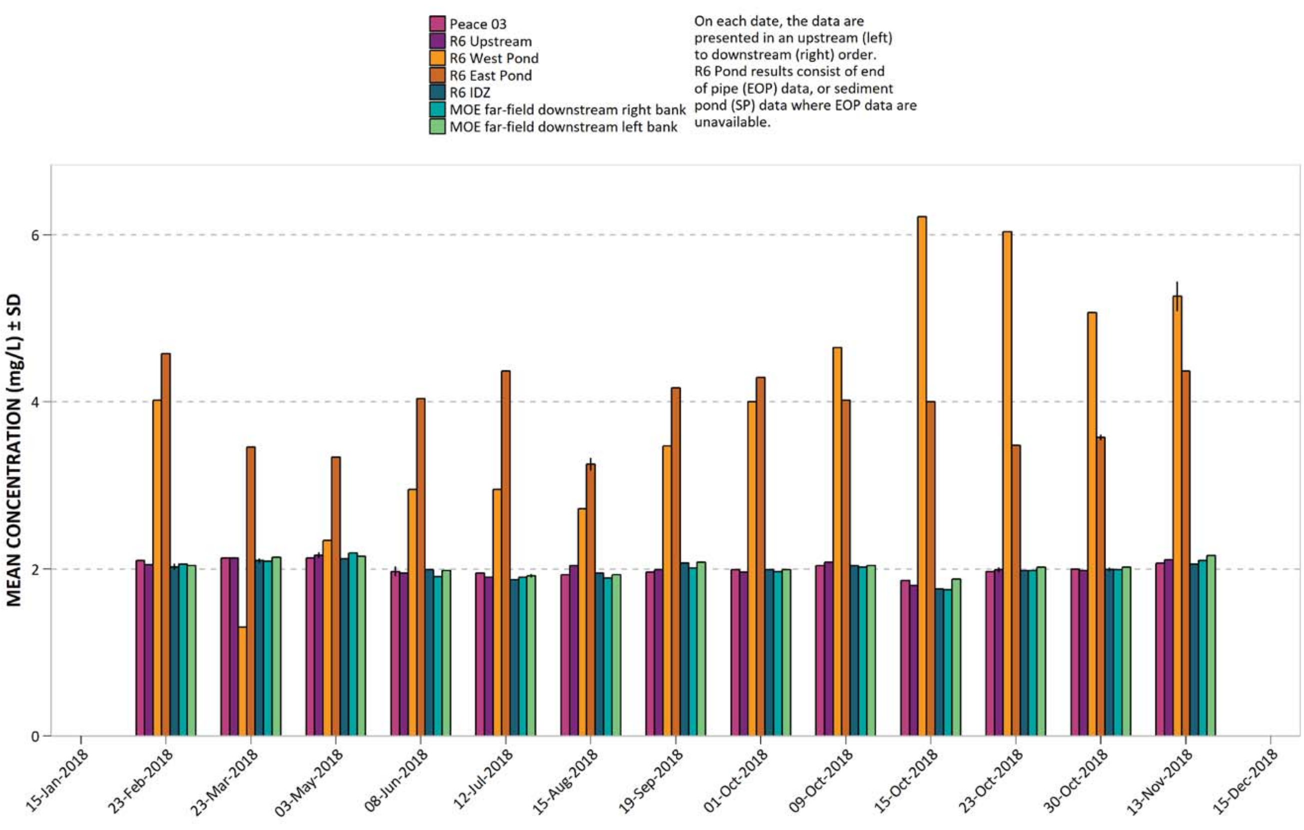
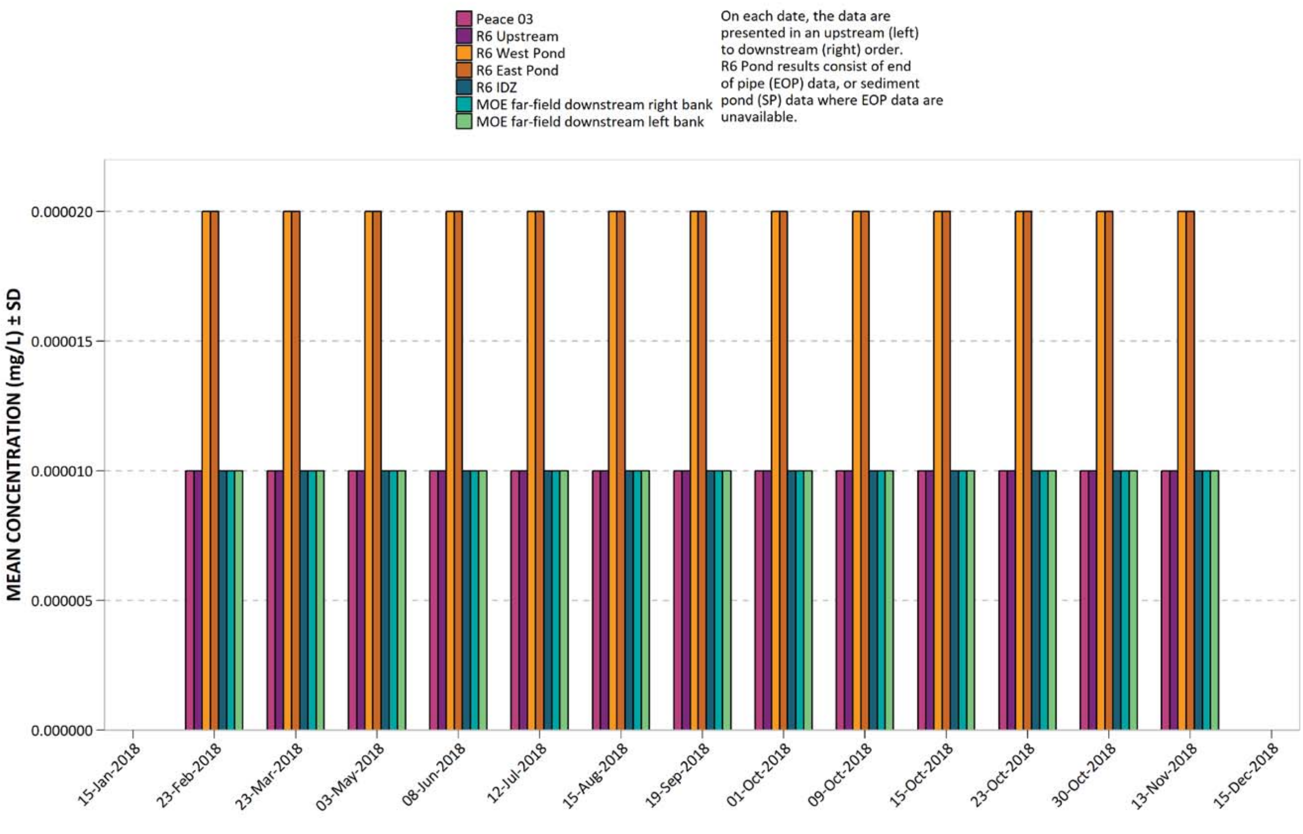


Figure 167. 2018 Peace River and RSEM R6 pond dissolved silver (Ag).



Results less than the MDL were assigned the MDL value of 0.00002 mg/L (R5b pond) or 0.00001 mg/L (Peace River).

Figure 168. 2018 Peace River and RSEM R6 pond dissolved sodium (Na).

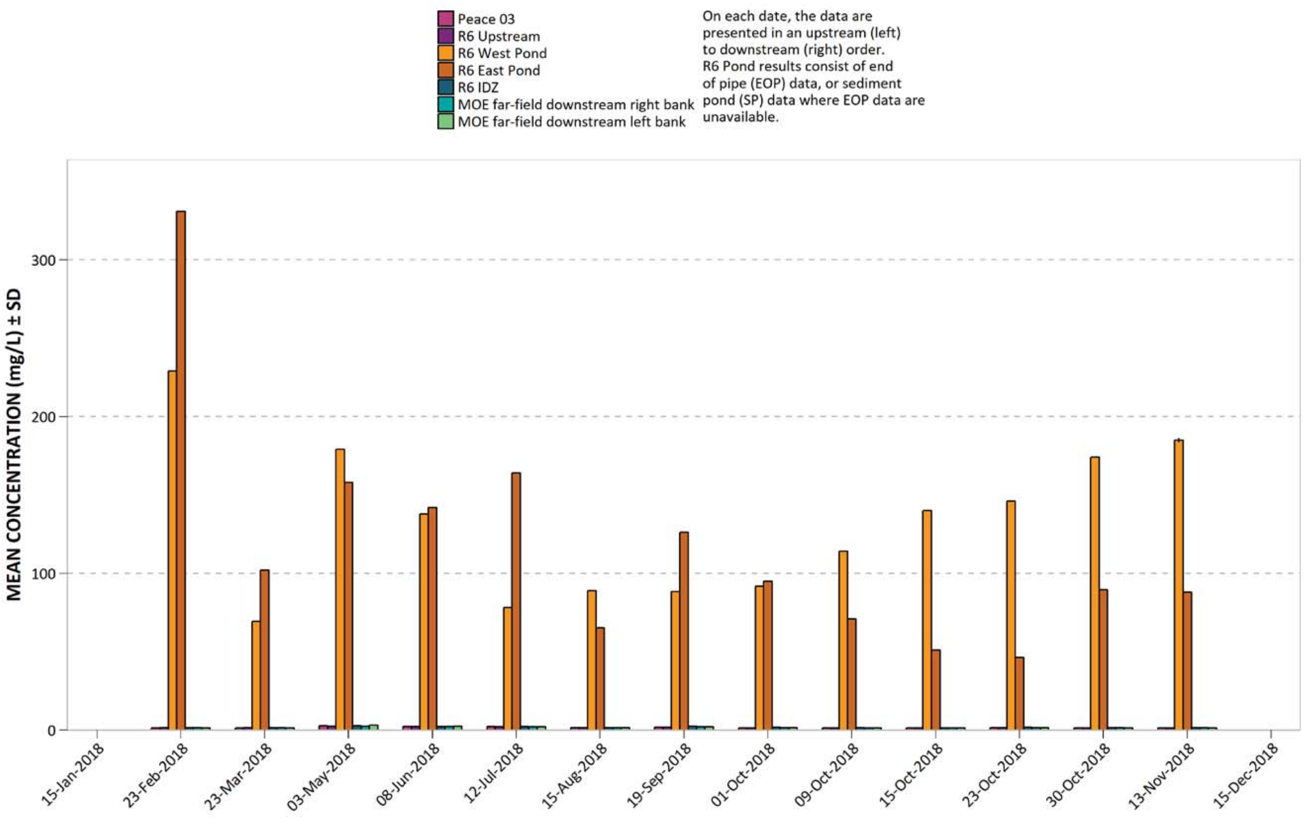


Figure 169. 2018 Peace River and RSEM R6 pond dissolved strontium (Sr).

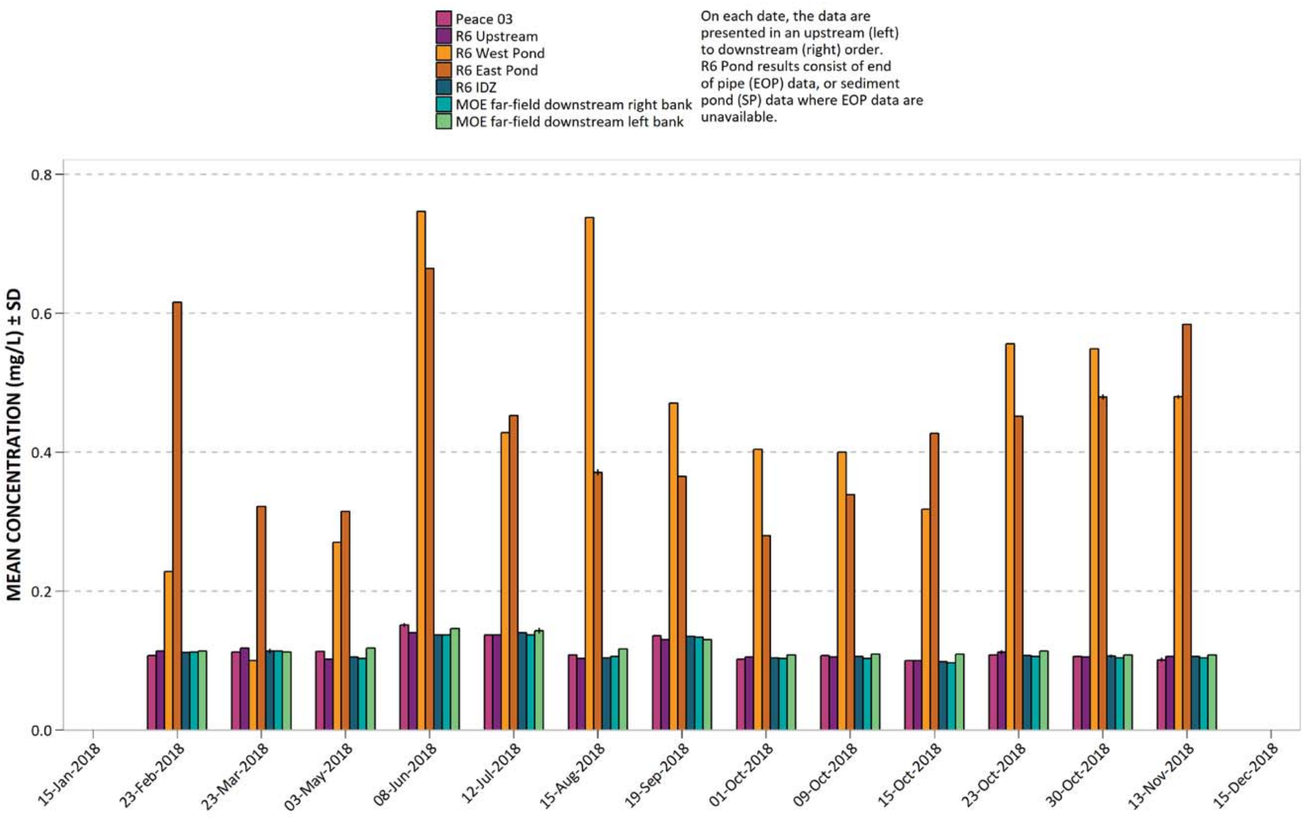


Figure 170. 2018 Peace River and RSEM R6 pond dissolved sulfur (S).

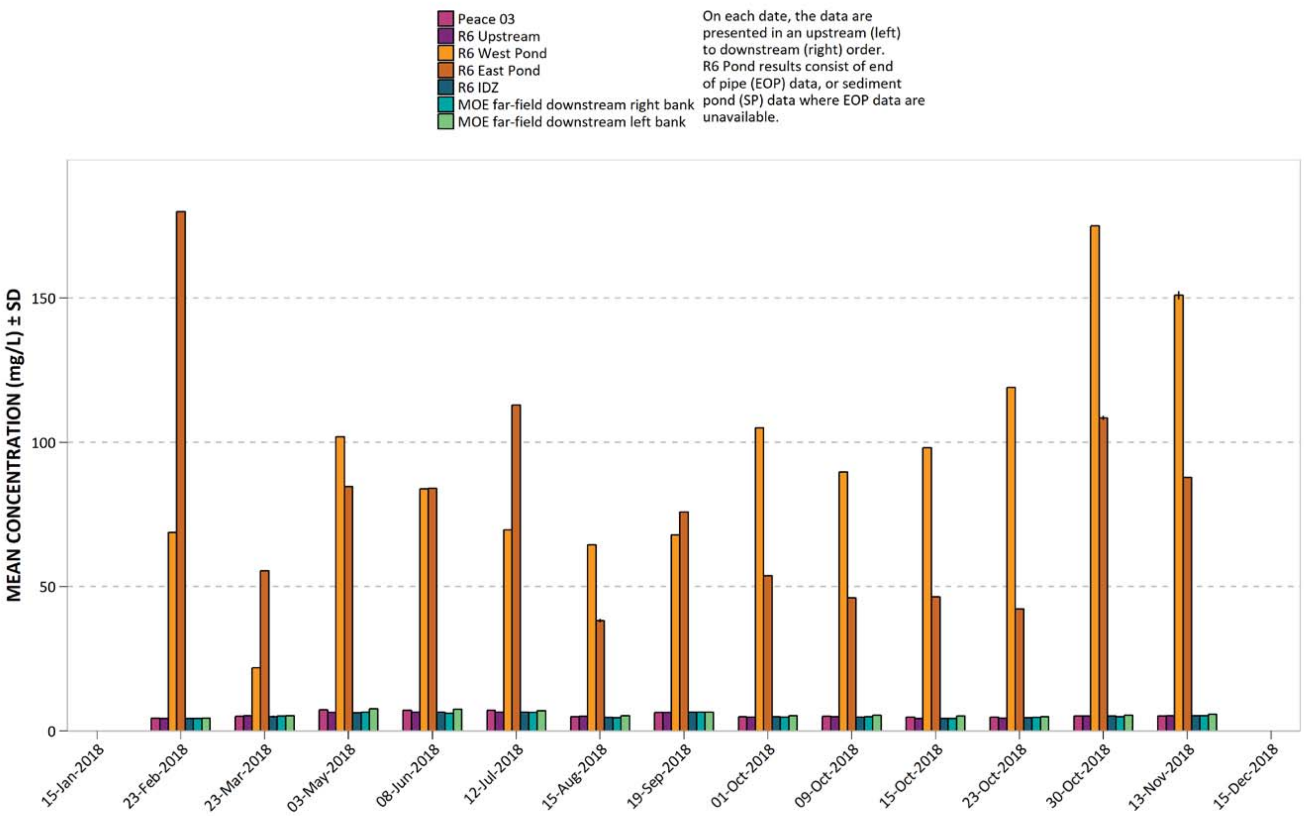
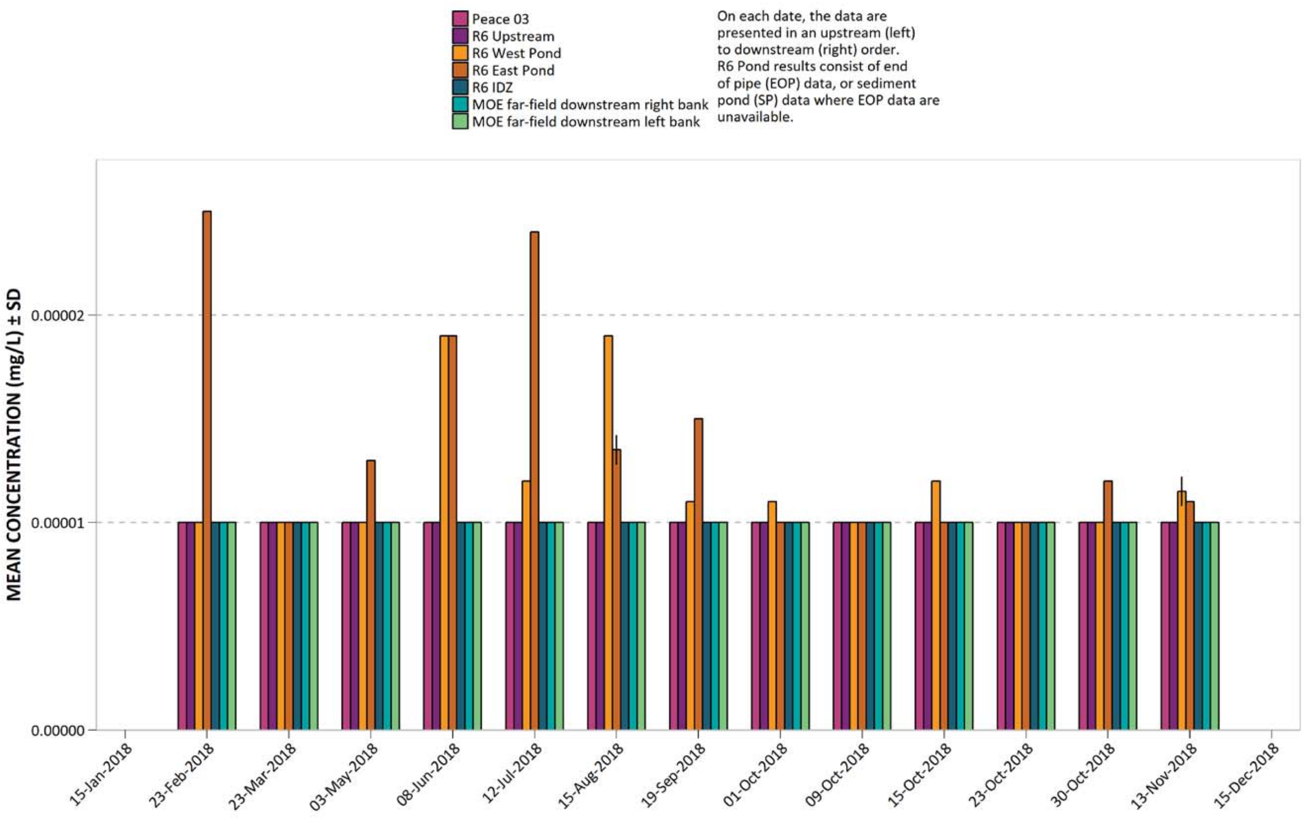
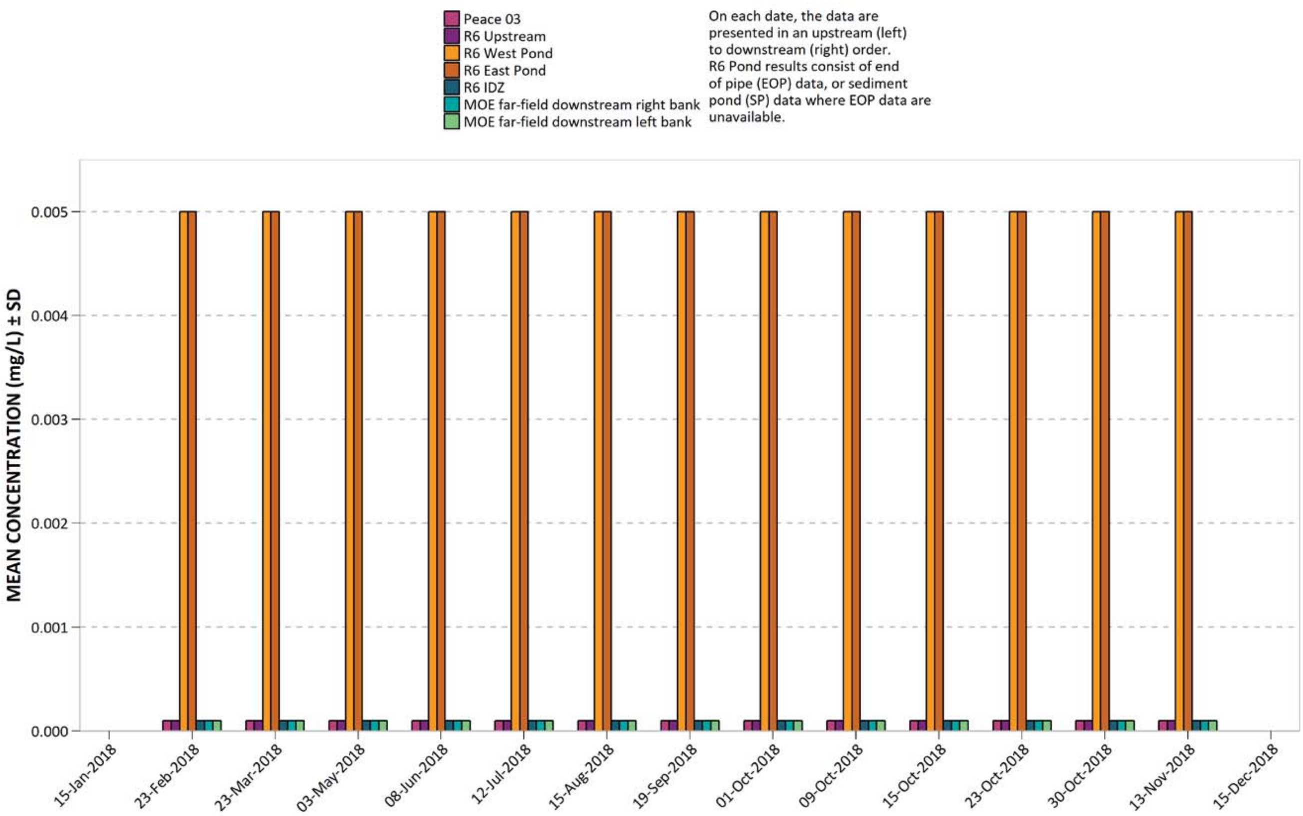


Figure 171. 2018 Peace River and RSEM R6 pond dissolved thallium (Tl).



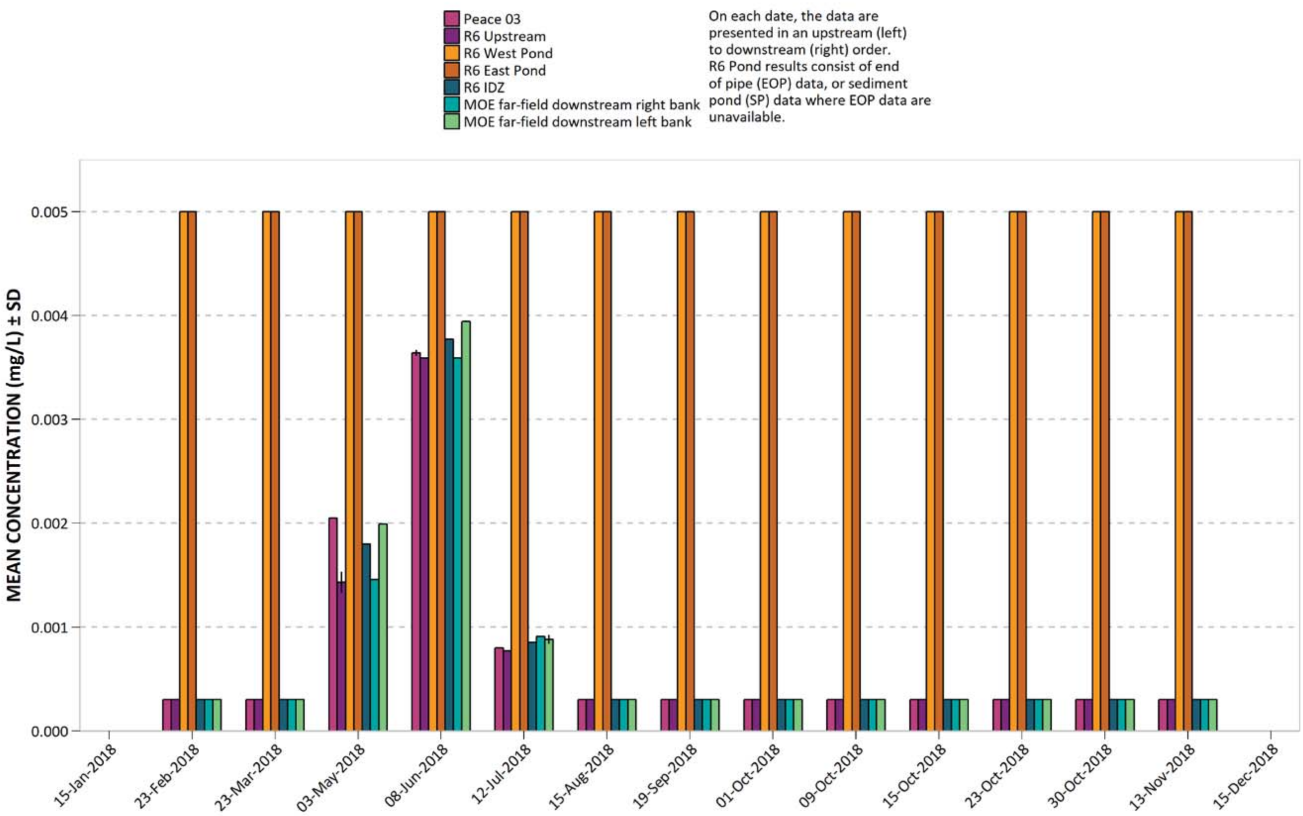
Results less than the MDL were assigned the MDL value of 0.00001 mg/L.

Figure 172. 2018 Peace River and RSEM R6 pond dissolved tin (Sn).



All results were less than the MDL and thus were assigned the MDL value of 0.005 mg/L (R5b pond) or 0.0001 mg/L (Peace River).

Figure 173. 2018 Peace River and RSEM R6 pond dissolved titanium (Ti).



Results less than the MDL were assigned the MDL value of 0.005 mg/L (R5b pond) or 0.0003 mg/L (Peace River).

Figure 174. 2018 Peace River and RSEM R6 pond dissolved uranium (U).

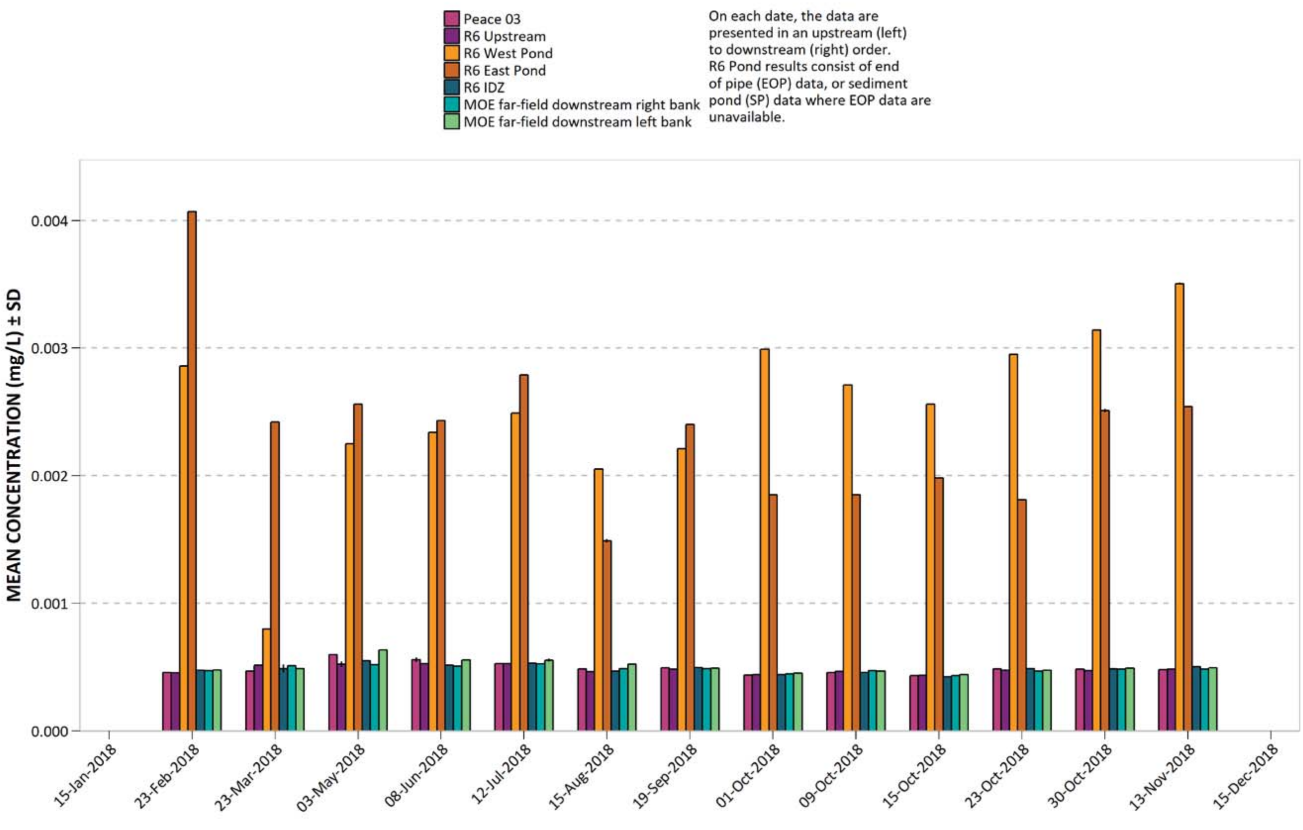
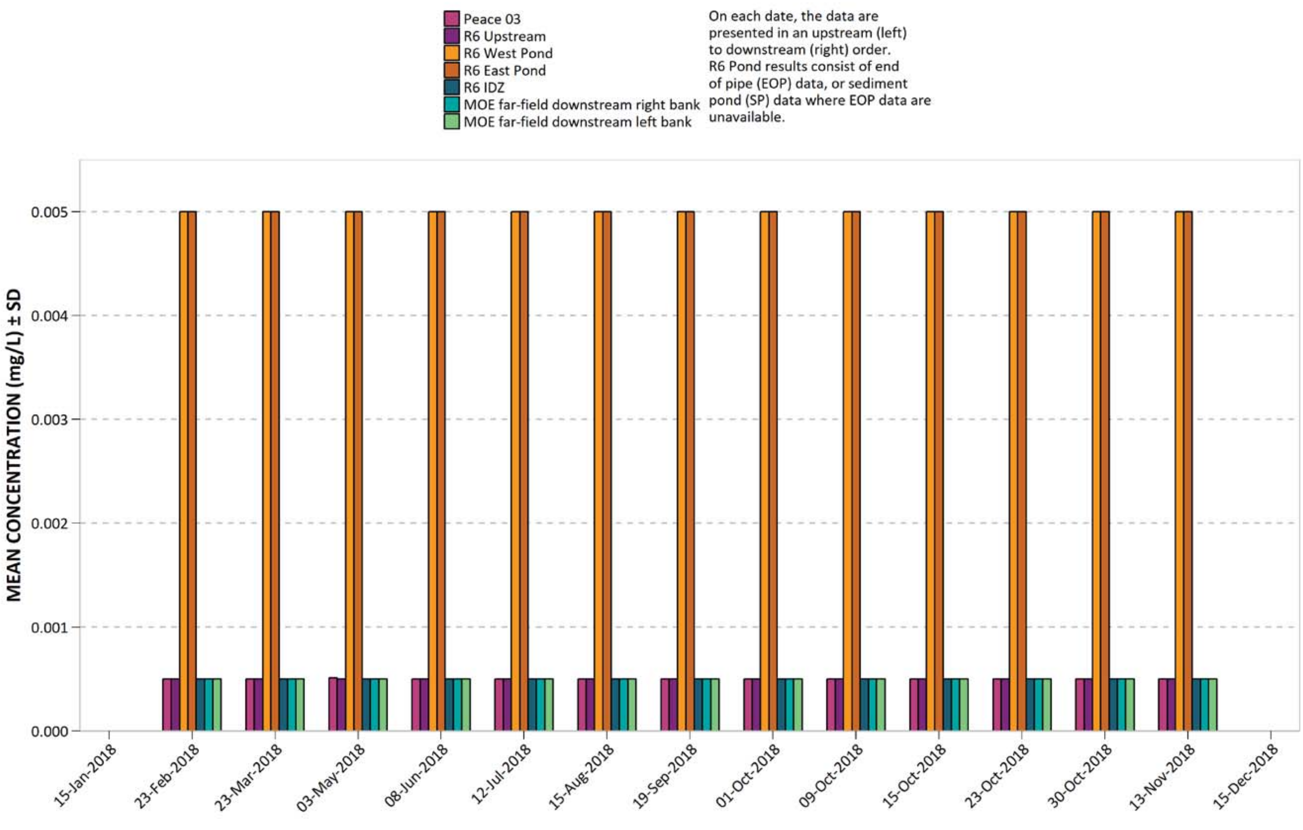
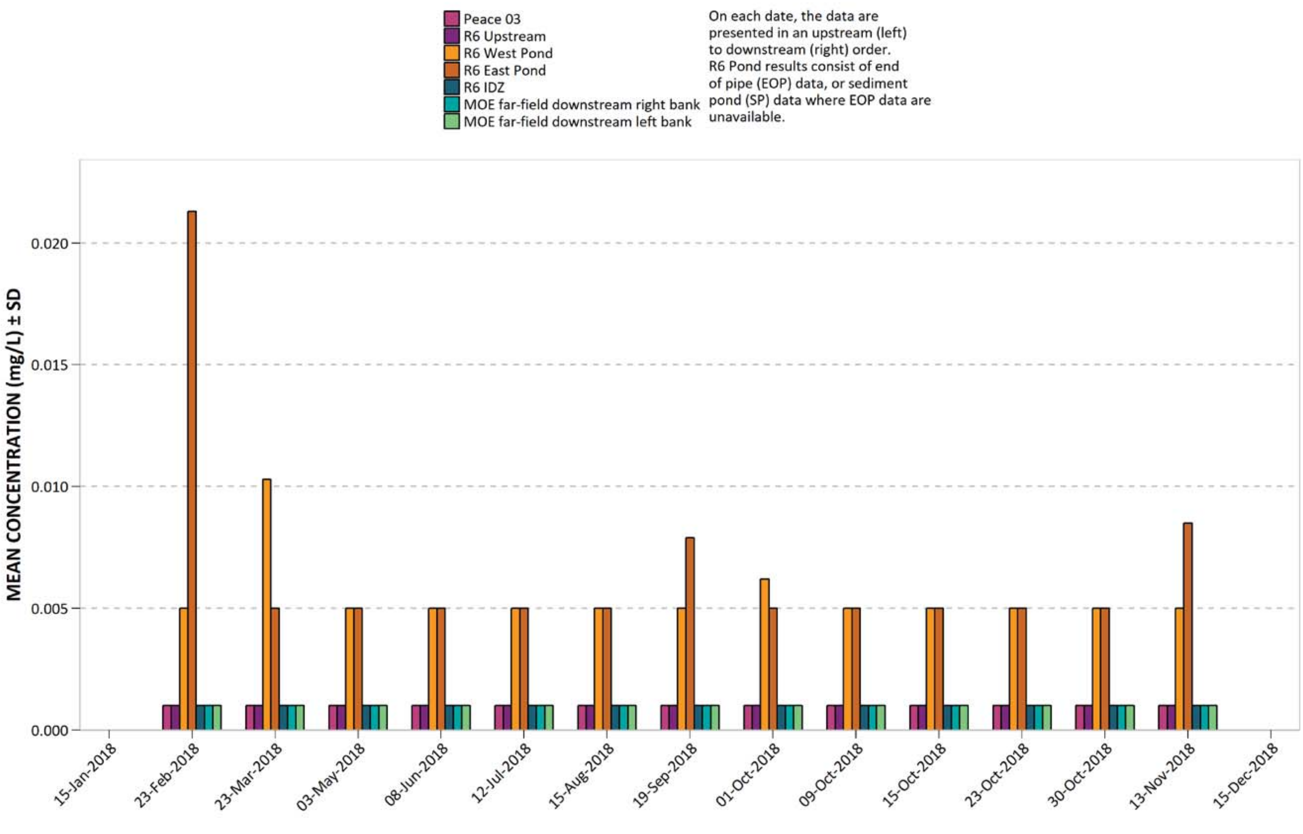


Figure 175. 2018 Peace River and RSEM R6 pond dissolved vanadium (V).



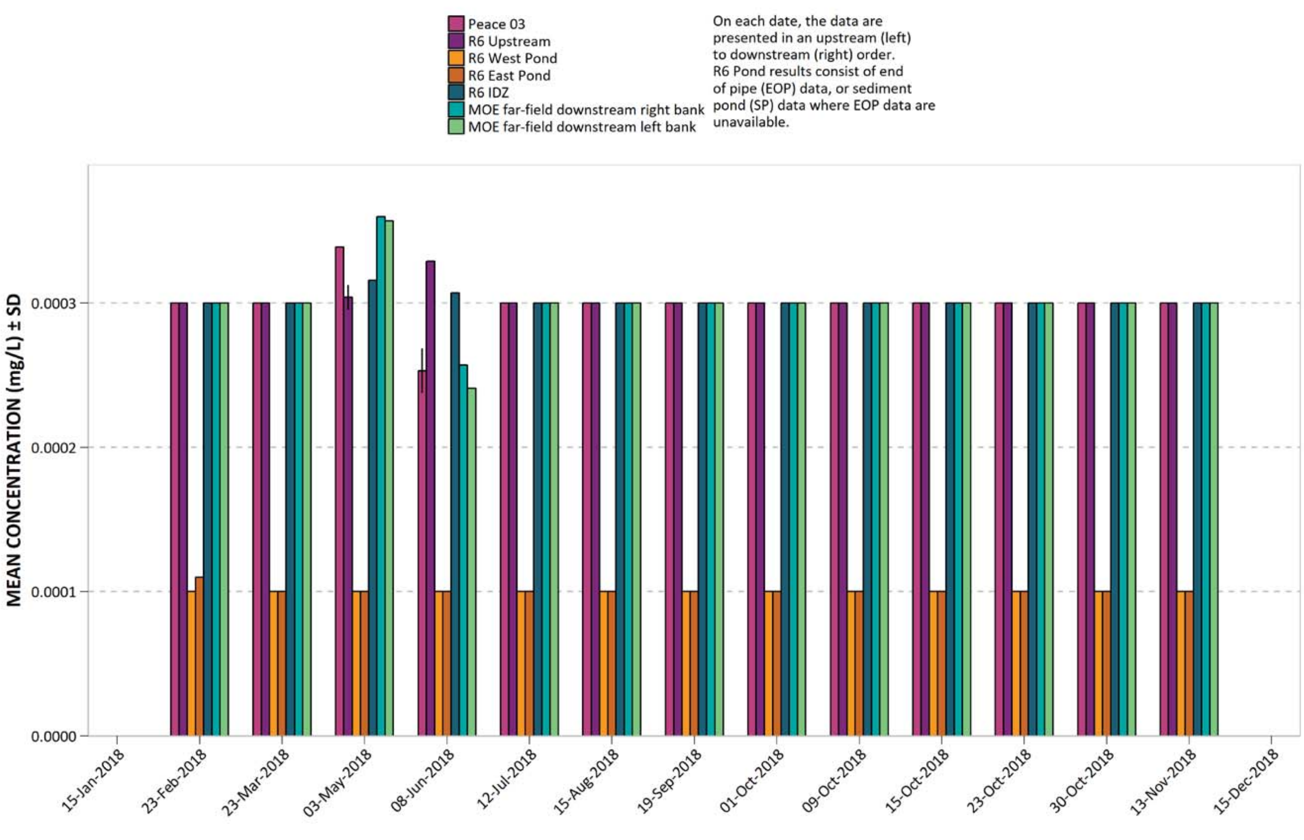
Results less than the MDL were assigned the MDL value of 0.005 mg/L (R5b pond) or 0.0005 mg/L (Peace River).

Figure 176. 2018 Peace River and RSEM R6 pond dissolved zinc (Zn).



Results less than the MDL were assigned the MDL value of 0.005 mg/L (R5b pond) or 0.001 mg/L (Peace River).

Figure 177. 2018 Peace River and RSEM R6 pond dissolved zirconium (Zr).



Results less than the MDL were assigned the MDL value of 0.0003 mg/L (Peace River except June 8) or 0.0001 mg/L (R5b pond).

Appendix D. 2018 Quality Assurance and Quality Control Summary.

Table 32. ALS Environmental hold time exceedance summary for 2018.

Parameter	Date	Hold Time		Number of Samples	Qualifier
		Recommended	Actual	Exceeded[1]	
Diss. Orthophosphate in Water by Colour	30-Mar	3	4	4	EHTL
			5	1	EHTL
	12-Jul	3	4	8	EHT
	24-May	3	4	3	EHT
			5	3	EHT
	8-Jun	3	4	8	EHT
Nitrate in Water by IC (Low Level)	30-Mar	3	4	5	EHTL
	24-May	3	4	6	EHT
	3-May	3	5	6	EHT
			6	2	EHT
	19-Apr	3	4	8	EHT
	23-Mar	3	4	6	EHT
	16-May	3	4	6	EHT
	30-Oct	3	8	1	EHT
Nitrite in Water by IC (Low Level)	30-Mar	3	4	5	EHTL
	24-May	3	4	6	EHT
	3-May	3	5	6	EHT
			6	2	EHT
	19-Apr	3	4	8	EHT
	23-Mar	3	4	6	EHT
	16-May	3	4	6	EHT
	30-Oct	3	8	1	EHT
Turbidity by Meter	30-Mar	3	5	5	EHTL
	31-May	3	4	2	EHT

[1]Specific sample sites where hold time exceedances occurred are provided in ALS laboratory reports.
Hold time exceedances for monthly, 5 in 30 day and TSS/turbidity grab samples collected in 2017.

ALS Legend & Qualifier Definitions

EHT: Exceeded ALS recommended hold time prior to analysis.

EHTL: Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.

Table 33. Field blank and travel blank detections in 2018.

Sample Type	No. of Sampling Dates (2018)	Field Blank QA/QC Objective (≤5.0% Detectable)			
		No. of Parameter Results (n) [1]	No. of Detectable Results (>MDL)	% Detectable Results	QA/QC Objective Met
Field Blanks	20	1847	22	1.19%	Yes
Travel Blanks	20	1096	5	0.46%	Yes

[1] n refers to the total number of parameters analyzed in the field and travel blanks (non-detectable and detectable).
pH is not included in the calculation of detectable results.

The field blank QA/QC objective of ≤5% detectable is applied to the entire data set for the monitoring period (CCME 2011).

Table 34. Summary of cases with relative percent difference >20% for duplicate samples in 2018.

Date (2018)	Clear/ Turbid Flow [1]	Site	Parameter	Relative Percent Difference (%) [2]
23-Feb	Clear	RBPR-7.15	Selenium (Se) - Total	26.1
			Manganese (Mn) - Dissolved	40.5
23-Mar	Clear	RBPR-7.15	Selenium (Se) - Dissolved	20.9
19-Apr	Clear	RBPR-5.69	Chromium (Cr) - Total	25.5
			Manganese (Mn) - Total	21.1
			Selenium (Se) - Total	27.1
			Calcium (Ca) - Total	22.9
8-May	Very Turbid	RBPR-9.34	Aluminum (Al) - Dissolved	24.5
			Titanium (Ti) - Dissolved	50.8
			Total Suspended Solids	23.4
			Manganese (Mn) - Dissolved	21
			Ammonia, Total (as N)	36.9
16-May	Very Turbid	PR-3.88	Titanium (Ti) - Dissolved	21.8
24-May	Very Turbid	RBPR-5.65	Manganese (Mn) - Dissolved	22.1
			Total Organic Carbon	20.1
31-May	Turbid	RBPR-5.81	Aluminum (Al) - Dissolved	23.5
			Arsenic (As) - Dissolved	62.2
			Chromium (Cr) - Total	23.8
			Dissolved Orthophosphate (as P)	183
			Phosphorus (P) - Dissolved	193
			Total Phosphorus (P)	183
			Total Suspended Solids	23.8
			Manganese (Mn) - Dissolved	55.3
			Ammonia, Total (as N)	197
8-Jun	Turbid	PR-3.88	Copper (Cu) - Dissolved	49.7
			Total Phosphorus (P)	23.6
12-Jul	Clear	LBPR-9.34	Cadmium (Cd) - Total	27.6
			Cobalt (Co) - Total	23.7
			Copper (Cu) - Total	30.6
			Lead (Pb) - Total	22.7
			Manganese (Mn) - Total	26
			Total Phosphorus (P)	90.5
			Total Suspended Solids	44.3
			Manganese (Mn) - Dissolved	49.3
1-Oct	Clear	RBPR-5.70	Aluminum (Al) - Total	24.9
			Cadmium (Cd) - Total	27.7
			Cobalt (Co) - Total	24
			Iron (Fe) - Total	29.2
			Lead (Pb) - Total	23.5
			Total Suspended Solids	33.1
			Vanadium (V) - Total	21
9-Oct	Clear	RBPR-5.70	Cadmium (Cd) - Total	26.9
			Total Suspended Solids	33.7
			Nitrate (as N)	138
15-Oct	Clear	RBPR-5.81	Iron (Fe) - Total	20.7
			Titanium (Ti) - Total	20.7
10-Dec	Clear	LBPR-9.34	Dissolved Organic Carbon	22.6
			Cadmium (Cd) - Total	20.9
			Titanium (Ti) - Total	31.8

[1] Clear flow: Peace River sampling site TSS ≤ 25 mg/L; Turbid flow: Peace River TSS > 25 mg/L and ≤ 100 mg/L; Very Turbid: Peace River TSS > 100 mg/L.

[2] RPD was calculated if at least one replicate was > 5 times the MDL.

Grey shading indicates one replicate result was an outlier and was removed from the data set. Data were considered outliers if RPD>>20% and results were not within typical ranges for the parameter.

Table 35. Summary of cases with a relative standard deviation >18% for triplicate samples in 2018.

Date (2018)	Site	Parameter (units)	Average	SD	Relative Standard Deviation (%)[1]
30-Mar	RBPR-9.34	Turbidity (In Situ, NTU)	2.47	0.473	19.2
19-Sep	RBPR-5.81	Turbidity (In Situ, NTU)	50.3	9.59	19.1
9-Oct	RBPR-5.70	Turbidity (In Situ, NTU)	2.23	0.404	18.1

Table 36. Summary of cases where the dissolved metals to total metals ratio was >1.2 in 2018.

Date (2018)	Site	Parameter	Concentration (mg/L)		D-Metal/ T-Metal Ratio
			Total Metal	Dissolved Metal	
23-Mar	RBPR-7.05	Potassium (K)	0.43	0.53	1.23
		Sodium (Na)	1.24	1.52	1.23
24-May	RBPR-5.65	Zirconium (Zr)	0.000243	0.000375	1.54
			0.000244	0.000319	1.31
	RBPR-5.81	Zirconium (Zr)	0.000244	0.000377	1.55
8-Jun	RBPR-5.65	Zirconium (Zr)	0.000163	0.000357	2.19
	RBPR-7.05	Zirconium (Zr)	0.000143	0.000329	2.30
	RBPR-7.15	Zirconium (Zr)	0.000148	0.000307	2.07
19-Sep	RBPR-5.81	Selenium (Se)	0.000237	0.000298	1.26
			0.000239	0.000307	1.28
9-Oct	PR-3.88	Selenium (Se)	0.000283	0.000349	1.23
10-Dec	RBPR-5.70	Selenium (Se)	0.000232	0.000284	1.22
	RBPR-9.34	Molybdenum (Mo)	0.0012	0.00147	1.23

Appendix C

TECHNICAL MEMO

TETRA TECH

ISSUED FOR USE

To:	Greg Scarborough, Molly Brewis BC Hydro	**Date:**	March 22, 2019
c:		**Memo No.:**	
From:	Lara Reggin/James Barr	**File:**	704-ENG.VMIN03021-01
Subject:	Site C Clean Energy Annual Report Site Audits 2018		

1.0 INTRODUCTION

This report presents a summary of field reviews completed during 2018 for the Site C Clean Energy Project related to auditing the acid rock drainage and metal leaching (ARD-ML) materials management on-site in reference to:

- BC Hydro Construction Environmental Management Plan (CEMP rev 04, July 26, 2016);
- Site C Clean Energy Project, Peace River Hydro Partners Main Civil Works Contract, Appendix 6-2 Technical Specifications, Relocated Surplus Excavation Materials and Water Management, Section 13 40 00, revision 4, Dec 4, 2015.
- Peace River Hydro Partners (PRHP) Environmental Management Plan (EMP), Appendix A: Acid Rock Drainage and Metal Leachate Management Plan (Rev 10rev_1, 2016-10-27); and
- PRHP Environmental Protection Plans (EPP), specific to facility or construction area.

Four site audits were completed in 2018 conducted by James Barr, P.Geo., and/or Lara Reggin, P.Geo., both of Tetra Tech, on the following dates: March 26-27, May 29-31, July 24-25, and September 26, 2018. Mr. Barr and Ms. Reggin fulfill the role as BCH QP(ARD) as per the CEMP Appendix E, S. 6.1.2.

- Monday March 26 and Tuesday March 27, 2018: The site audit was conducted by James Barr, P.Geo., and Lara Reggin, P.Geo., of Tetra Tech. Mr. Barr and Ms. Reggin were accompanied by Molly Brewis and Brian Hawes on the Main Civil Works site on Monday, and by Brian Hawes to the Main Civil works on Tuesday. On Wednesday, March 28 Mr. Barr participated in the Monthly Independent Engineer (T.E. Little Consulting) and Independent Environmental Monitor (Environment Dynamics Inc.) site tour accompanied by Steve Abbey (BC Hydro) and several representatives from PRHP, BC Hydro, and Lorax. Time on-site was spent reviewing ARD-ML materials management at various construction areas and RSEM (Relocated Surplus Excavation Material) facilities and designated water discharge points. While on-site, contact and discussions were had with Steve Abbey, Molly Brewis, and Brian Hawes of BC Hydro; Kael Hanak of PRHP and Bruce Mattson of Lorax (ARD-ML QP for PRHP).
- Tuesday May 29 to Thursday May 31, 2018: A site visit to the Main Civil Works site during the afternoon of May 29 by James Barr, P.Geo. On May 30, Mr. Barr attended the monthly IEM Site Tour. On Thursday, May 31, 2018, the Portage Mountain Quarry was visited by Mr. Barr. During the visit, Mr. Barr met with Duz Cho representatives, Jacob (Superintendent), Nick (Site Foreman) and from Plan B Consultants, Jono (QEP for Duz Cho). Communication prior to the site visit was conducted with Vicki Burtt, BC Hydro Environmental Task Manager for Site C.
- Tuesday July 24 and Wednesday July 25, 2018: The site audit was conducted by James Barr, P. Geo. Mr. Barr was accompanied by Brian Hawes and Josh Stoski (both BC Hydro) on July 24, and by Andre Sidorowicz (Tetra

Tetra Tech Canada Inc.
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Tel 250.862.4832 Fax 250.862.2941

Tech) on July 25. Time was spent on the Main Civil Works site both days. On Wednesday, July 25, Mr. Barr contributed to an ARD-ML workshop held at the BC Hydro offices which was organized by Molly Brewis; site Natural Resources Specialists (NRS's), Melissa Mukai and Molly Brewis, were in attendance. Time on-site was spent reviewing ARD-ML materials management at various construction areas and RSEM facilities, and designated water discharge points. While on-site, contact and discussions were had with Steve Abbey, Molly Brewis, Josh Stoski, Ian Kerr and Brian Hawes of BC Hydro.

- Wednesday September 26, 2018: The site audit was conducted by James Barr, P. Geo. Mr. Barr was accompanied by Josh Stoski (NRS, BC Hydro). Time was spent on the Main Civil Works site. Time on-site was spent reviewing ARD-ML materials management at various construction areas and RSEM facilities and designated water discharge points. While on-site, contact and discussions were had with Steve Abbey, Molly Brewis and Josh Stoski. On Tuesday, September 25, 2018, prior to the site visit, Mr. Barr attended a meeting with BC Hydro and representatives from the BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development, Comptroller for Water Rights.

2.0 2018 SITE AUDITS OVERVIEW AND SITE CONDITIONS

Each site visit and ARD-ML audit was comprised of visiting areas on-site with stored or exposed shale rock (PAG), or areas in construction intended for future storage of PAG. In addition, several water conveyances and ponds contact both PAG and non-PAG potentially influenced by PAG materials, were observed and field data collected, as required.

2.1 Weather Conditions

The weather conditions during the four site visits for 2018 varied from snow covered, frozen conditions to dry conditions, with temperatures as low as -10°C in March, to highs of 25°C in July.

Some flowing water or seepages were noted at various locations on-site. Due to either frozen (March) or dry (May and September) conditions, flow was characterized as low within the ditches and on slopes.

Table 1: Weather Conditions and Observations During Site Audits

Site Audit Date	Weather	Observations
March 26 - 27, 2018	Cloudy, intermittent snow fall, -10°C to - 5°C, ground snow covered 24 hr. precipitation: 1.07 mm (snow water equivalent), 7-day trailing precipitation: 18.87mm (North Camp_B_Met60)	The weather conditions experienced during the site visit were considered cold for late March conditions, as cold, cloudy with intermittent snow cover. There was no flowing water or seepages noted within ditches and slopes due to frozen conditions and low 7-day total precipitation measuring 18.87 mm (equivalent to approximately 18.87 cm of snow) prior to March 26, 2018.
May 29 - 31, 2018	Partly sunny, 15-20°C, dry, no rain previous 24-hours.	The weather conditions were considered average for spring, with partly sunny skies and warm temperatures. There was no flowing water in ditches and slopes were generally dry.
July 24 - 25, 2018	Sunny, ~18°C to 25°C, dry ground, 24 hr. precipitation: 0 mm, 7-day trailing precipitation: 58.75 mm (North Camp_B_Met60)	The weather conditions experienced during the site visit were considered warm for late July conditions, as it was sunny with an average temperature of 17 degrees. There was minimal flowing water or seepages noted within ditches and slopes due the persistent warm and dry conditions, with a 7-day total of 58.75 mm prior to July 25th, 2018.

Site Audit Date	Weather	Observations
September 26, 2018	Partly Cloudy with light drizzle, 9°C to 13°C, dry ground, 24 hr. precipitation: 0 mm, 7-day trailing precipitation: 0 mm (North Camp_B_Met60)	The weather conditions experienced during the site visit were considered cool and typical for early Autumn with overcast skies, occasional slight drizzle and temperatures ranging between 9 and 13 degrees Celsius; overnight temperatures remained above the freezing point. Both dry and low flowing water conditions were observed on-site. No precipitation was recorded within the preceding 7-day period.

2.2 Locations Visited

For the site audits, known PAG exposures are listed according to their RSEM or catchment area (Table 2), and are shown in Figure 1.

Table 2: List of Locations Visited During Site Audits

Locations Visited			Site Audit Date			
			March 26-27	July 24-25	May 29-31	September 26
Left Bank Construction Areas	RSEM L6	Sediment Ponds and Drainage Channels		✓		
		Diversion Inlet Portal				
		Diversion Outlet Portal				
		Cofferdam Excavation				
		PAG in RSEM				✓
		LBEx Catchment Pond		✓		
		Diversion for natural drainage around LBEx Sed pond		✓		
	RSEM L5	Garbage Creek (water conveyance to L5)	✓	✓	✓	✓
		Permanent Sediment Ponds		✓	✓	✓
		PAG in RSEM	✓	✓		✓
		LBEx		✓		✓
		Temporary PAG Contact Pond		✓		✓
		LB Diversion Tunnel	✓	✓		✓
	Howe Pit		✓	✓		✓
	Historical Adit 4			✓		
	River Road		✓	✓		✓
	L3 Creek (Natural)		✓			
Right Bank Construction Areas	Water Treatment Plant			✓		
	RSEM R5a	PAG in RSEM	✓	✓	✓	✓
		Up-gradient Cut-off Ditch	✓	✓	✓	
		R5a Sediment Ponds	✓	✓	✓	✓
	RSEM R5b	PAG in RSEM		✓		✓
		Spillway Approach Channel	✓	✓	✓	✓
		Sediment Ponds	✓	✓	✓	✓
	R6	RCC Cofferdam	✓	✓		✓
		SBIAR (east and west cut-slope: ECS, WCS)	✓	✓	✓	✓
		RB Abutment Foundation				✓
		PAG in RSEM	✓	✓		✓

Table 2: List of Locations Visited During Site Audits

Locations Visited			Site Audit Date			
			March 26-27	July 24-25	May 29-31	September 26
	RBDT					✓
	Area 30 / Septimus Rail Siding					✓
	Phase II Crusher		✓			
	Area A					✓
	Area 21			✓		
Off MCW	Portage Mountain Quarry				✓	
	Transmission Line Upper FSR					

RSEM: Relocated Surplus Excavation Material
RBDT: Right Bank Drainage Tunnel

3.0 FIELD DATA

3.1 Rock Sample Analyses

Eight rock samples were collected during the May 2018 site visit from the Portage Mountain Quarry access road. Four composite rock samples (combining various rock types into one representative sample) were collected along a cross-section of the access road between 0+640 and 0+880, three additional composite samples were collected from the access road between approximately 1+600 and 1+385, and one composite sample of the cover material in the stockpile area near to where the water is ponding. The samples were submitted to the laboratory for acid-base accounting and trace element analysis. Six of the eight samples were classified as non-PAG (not potentially acid generating) and two of the eight samples were classified as PAG (potentially acid generating). The proportional volume represented in outcrop of PAG material compared to non-PAG material was considered minor. Sufficient buffering capacity should be provided from non-PAG rocks so that the risk of net acid generation from these combined rocks can be considered low when well blended.

The ABA results are summarized in the following table:

Table 3: Results of Acid-Base Accounting Analyses from Portage Mountain Quarry Access Road

Sample Number	S%	S%	CO2	Sobek NP [1]	MPA [2]	NNP [3]	NPR [4]	NPR [4]	Classification
	(Sulphide)	(Sulphate)	(%)	tCaCO3/1Kt			(Sobek)	(CO3)	
PQ-019	0.02	<0.01	4.2	99.0	0.9	98.0	105.60	106.13	Non-PAG
PQ-021	0.11	<0.01	<0.2	8.0	4.4	4.0	1.83	0.52	PAG
PQ-023	0.19	<0.01	<0.2	-2.0	9.1	-11.0	-0.22	0.25	PAG
PQ-027	0.03	<0.01	2.4	64.0	1.9	62.0	34.13	28.73	Non-PAG
PQ-030	0.03	0.01	2.6	65.0	1.6	63.0	41.60	36.96	Non-PAG
PQ-031	0.19	<0.01	1.2	40.0	7.2	33.0	5.57	3.79	Non-PAG
PQ-032	0.07	<0.01	3.0	75.0	3.1	72.0	24.00	22.01	Non-PAG
PQ-033	0.10	<0.01	2.0	62.0	5.3	57.0	11.67	8.58	Non-PAG

[1] Neutralization Potential (NP)
[2] Maximum Potential Acidity (MPA)
[3] Net Neutralization Potential (NNP)
[4] Neutralization Potential Ratio (NPR)

The results of trace element analysis were compared against both the average crustal abundance values for Earth's crust (Appendix Table A2) and 'sedimentary rocks – shales' (Price, 2009; Appendix Table A3), which may provide identification of anomalous elemental concentrations. The elemental concentrations of the eight samples are either similar to or slightly elevated above or below the average crustal abundance values and shale specific values. There were no concerns related to elevated trace elements and their relation to potential ARD-ML.

3.2 Material Testing

Two samples of sludge were collected during the July site audit from River Road from within the ditch sediment. One sample was located up-gradient of the diversion pipe and the lower chimney ditch (STC-060), and the second was located at the end of the diversion pipe (STC-059). Both samples were saturated during the time of sampling and were sent to a laboratory for ABA and trace element (metals) analysis. The samples were described during the time of collection as being "sand, silt and minor clay, brown to orange colour". The results from these tests have been included in Appendix A. The samples were classified as non-PAG. Their composition was similar, with Sulphur primarily contained as sulphate, and elements noted to be anomalous at less than one order of magnitude relative to average crustal abundance being arsenic and zinc.

Table 4: Results of Acid-Base Accounting Analyses from River Road Ditch Sediments

Sample	Location	Paste pH	Inorganic Carbon, C %	Inorganic Carbon, CO2 %	Total Sulphur, S%	Sulphide Sulphur, S%	Sulphate Sulphur (HCl leachable)	Maximum Potential Acidity (kg CaCO3/tonne)	Sobek NP [1] (kg CaCO3/tonne)	Sobek NNP [2] (kg CaCO3/tonne)	Sobek NPR [3] (NP:MPA)	Carbonate NP [1] (kg CaCO3/tonne)	Carbonate NPR [3] (Carbonate NP:MPA)	Classification
STC-060	LBRR-12+700	7.50	0.99	3.60	0.16	0.03	0.15	5.00	99.00	94.00	19.80	81.87	16.37	Non-PAG
STC-059	LBRR-12+270	7.60	0.56	2.10	0.26	0.04	0.22	8.10	54.00	46.00	6.65	47.76	5.90	Non-PAG

[1] Neutralization Potential (NP)
[2] Net Neutralization Potential (NNP)
[3] Neutralization Potential Ratio (NPR)

3.3 In Situ Water Testing

Frozen site conditions prevented any in situ water pH and alkalinity measurements during the March 2018 site audit. Data collected during the May, July and September 2018 site audits are shown in the table below; they reflect in situ water pH, alkalinity and estimated flow rates.

TETRA TECH

Table 5: List of In Situ Water Quality Measurements by Visit

Location	Estimated Flow (L/s)	pH	Total Alkalinity (ppm)	May 29-31	July 24-25	September 26
LBRR- Upper Chimney Ditch	<0.5	7.8	180		✓	
LBRR-12+800	<0.3	8.2	180		✓	
LBRR-EDP	<0.2	8.0	180		✓	
		8.4	240			✓
Howe Pit: IDL ditch	Standing	6.8	40		✓	
		6.5	200			✓
RSEM L5 – East Pond	Standing	7.2	100		✓	
		7.2	100			✓
LBEx Containment Pond	Standing	<6.2	0		✓	
LBL3C-1.65	4	7.8	180		✓	
RSEM-R5a, Cell C	Standing	7.8	180		✓	
RBSBIAR-US	1.5	8	240		✓	
RBSBIAR-DS	2	8.08	240		✓	
RBSBIAR-EUS	1.5	7.6	240		✓	
RBSBIAR-EDS	1.5	8.36	240		✓	
Treatment Plant Outflow	0.5	8	200		✓	
RBSBIAR (mid-stream)	1.5	6.8	180			✓
Portage Mountain	No flow	8.56	199	✓		

4.0 SUMMARY OF RECOMMENDATIONS AND MITIGATION MEASURES

The following section lists updates observed by Mr. Barr or Ms. Reggin following their site audits completed in 2018.

Observations made by Tetra Tech during site visits were documented in Technical Memos provided to BC Hydro. Where applicable, BC Hydro communicated non-compliance to relevant contractors which were tracked by BC Hydro site personnel using the Active Compliance Management Tool (ACMT).

4.1 Left Bank

4.1.1 RSEM L5

4.1.1.1 Garbage Creek

The Garbage Creek area was inspected during the March, July and September audits. During the March inspection, the Garbage Creek area was inspected including the water conveyance down to L5. The former access to Garbage Creek lined ditch was closed off to vehicles. During the May visit, the upper head pond area was viewed. Construction activities were underway to clear the area following a high precipitation overflow event due to an upstream debris slide which clogged the culvert to the diversion channel. During the July inspection, the diversion channel was not operational, and water was being pumped from the head pond to the temporary effluent channel using two pumps and six inch lay-flat hoses. During the September inspection, the active construction of the diversion ditch resulted in freshly exposed PAG materials adjacent to the ditch, which may potentially generate PAG contact water being introduced into the ditch. The fill material being placed on the TPSA has potential to obstruct overflow from the Head Pond which may be mitigated by contouring and armoured to avoid erosion or scouring of the fill. A small volume of PAG material was observed in the fill.

4.1.1.2 RSEM Sediment Ponds

The RSEM Sediment Ponds were inspected during the July and September audits.

During both inspections, the RSEM L5 sediment ponds were in active construction. The facility is divided into the eastern and western sections. These ponds collect water from the LBEx, Diversion Inlet Portal, Garbage Creek temporary PAG storage area (TPSA) and RSEM L5 areas. The culvert in the eastern pond is galvanized and the culvert in the western pond is lined with high density polyethylene (HDPE). Both ponds are lined with compacted gravel and were holding water at the time of the July inspection; a tan colored biofilm was observed in the eastern end of the west pond. During the September audit, it was observed that no water was being conveyed to the ponds for management, but rather it was being conveyed to the temporary pond. When the river is diverted through the diversion tunnel (Stage 2), these lower ponds will be decommissioned, and water management will be replaced by future sediment ponds located on an upper bench of the RSEM fill.

4.1.1.3 PAG in RSEM

The PAG in the RSEM L5 was inspected in detail during the March and July site audits.

PAG material continued to be placed mainly in the eastern extent or RSEM L5 and NAG materials were being placed in the western extent of RSEM L5 during both site audits. The area was snow covered during the time of inspection in March. The starter dyke was observed to surround the perimeter of the RSEM at an elevation above the river level of greater than 3 m to 5 m. Some ponded water was observed in the ditch between the starter dyke and the RSEM PAG fill, which was not being conveyed to a pond.

During the July site audit, the toe and outboard side of the RSEM fill was partially capped with compacted gravel; areas of exposed PAG were observed on the south eastern portion of the RSEM fill above the eastern end of the east pond.

4.1.1.4 RSEM L5, Temporary PAG Contact Pond (L5-TPSP)

On March 18, water contained within the temporary pond being used to manage PAG contact water (L5-TPSP) PAG Pond was lost reportedly due to underground drainage. In communications with PHRP representatives, it was suggested that the plausible reason for failure was due to the freezing of material below base of the pond and formation of a cavity during early spring melt causing a sink-hole. At the time of the March site visit, water was ponded and holding. There was potential for undercutting due to low flow in the old Peace River side channel however it was considered unlikely as the pond is bordered by compacted engineered fill, RSEM fill and the LBDT. This was never confirmed, and the pond was infilled in late 2018.

During the July audit, the pond water was being held. The pond did not have direct discharge to the Peace River. During the September audit, this temporary Pond was being reduced in size by infilling, some instability was observed on slopes and infiltration was apparent since the pond was not being discharged but remained at an operating level.

4.1.2 LBEx

The LBEx area was inspected during the July and September audits. During the July audit, PAG remained exposed on lower benches at the southwest corner of the Left Bank Excavation (LBEx). PAG contact water collected within the sump was being piped to the temporary containment pond in RSEM L5. During the July audit, active hauling was observed which was noted to be 95% complete at the time of visit.

4.1.2.1 LBEx Shale Exposure

Bedrock was exposed in the LBEx in 2017 and remained uncovered when inspected during the July site visit from between Bench 4 and 5 down to Bench 1. PAG contact water is being collected within a sump at the base of the bedrock exposure before being conveyed to the Diversion Tunnel Inlet Portal area, where it collects with PAG contact water from bedrock exposed at the portal which is then conveyed L5-TPSP.

4.1.3 RSEM L6

4.1.3.1 PAG in RSEM

During the September audit, low river levels allowed for construction of the starter berms in the River to commence for RSEM L6. No new material was observed being placed into the area on September 25 or 26.

4.1.3.2 LBEx Sediment Pond

The LBEx Sediment Pond was observed to be plugged during the July site audit, and thereafter. Seepage and runoff water from the shale-exposed left bank slopes was being captured and diverted to this pond. The pond perimeter was observed to have been vegetated with cattails. The pH of the water was observed to be below 6 (lower limit of pH strips, meter was not used).

During the September visit, a new up-gradient culvert had been installed to capture and convey water from an erosional gully in the northern slope to the pond. Water from this pond was actively being pumped and transported by hydrovac to the Mobile Water Treatment Facility (MWTF).

4.1.4 River Road

The River Road region was inspected during the March, July and September site audits. During the March inspection, ditches and slopes were snow covered.

During the July site visit, minor amounts of flowing or standing water was observed within the River Road ditch, and minor to trace amounts of seepage was observed on the slopes of the Blind Corner PAG slope. Minor rills and erosion into the ditch were also observed in July from within the north bank slope which is comprised of shale and overburden materials. During the September audit, it was observed that a new limestone buttress had been built along the lower portion of Blind Corner and that new erosion and sediment controls (ESC's)were built into the buttress.

4.1.4.1 Hydroseeding Application

The PAG slope at Blind Corner was hydroseeded on March 19, 2018 using standard site ESC seed mix and a suitable tackifier. The hydroseed application was in hope to promote additional vegetation and reduce erosion and mitigate against active ARD-ML processing. During the September audit, the slope had not sprouted but appeared to be holding onto the ground surface. A slow progression of natural vegetation that was also observed during the July site visit continued to progress on bedrock adjacent to the Upper Chimney Ditch.

4.1.4.2 Blind Corner Diversion

An approximately 0.5 m inner diameter pipe was installed on March 19 to convey PAG contact water collected in the River Road ditch down-gradient of Blind Corner to the Peace River and assist with managing sediment loading of ditch waters. The lower ditch drains from culverts RR-9 and RR-8 when there is sufficient volume.

Following the March site audit, it was suggested that this pipe be moved down the ditch by ~10 m to allow for the neutralization of PAG water and to allow for the RR-11 culvert to be used as “overflow” during heavy precipitation events.

At the time of the July site visit, culvert RR-9 was perched with approximately 15 cm of freeboard to the inlet of the culvert and was overall 0.8 to 1 meter of freeboard to the top of the road surface. Evidence of water accumulation was observed between the diversion pipe and RR-9.

In the September inspection, some white liquid was observed at both the inlet and outlet of the diversion pipe. This water was sampled as part of the monthly water quality sampling program.

4.1.4.3 Upper Chimney Drain

During the July audit, the upper chimney drain was inspected. Trace amounts of water was observed to be flowing within the limestone rip-rap material. The limestone rip-rap was intact with very little trace of mineral precipitate or sludge accumulations. Some minor undercutting and/or erosion of the native materials around the rip-rap was observed.

4.1.5 Left Bank Diversion Tunnel Area

The site of the Left Bank Diversion Tunnel (LBDT) area was visited during the March inspection to better understand the pre-existing site conditions and the water management structures that would be required in the future Construction of the left bank cofferdams was complete which permitted collection of water behind the slurry walls in areas which were hydraulically isolated from the Peace River, and from which water could be conveyed to water storage facilities in the RSEM L5 area.

4.1.5.1 Left Bank Diversion Tunnel

During the March inspection, work on the Left Bank Diversion Tunnel (LBDT) had not yet commenced however road headers were on-site and covered with tarps. Tunneling remained on hold during the July inspection as well. In September, tunneling by Road Header was in progress. The excavated materials were being relocated to RSEM L5.

4.1.5.2 Left Bank Diversion Inlet Portal

During the March site visit, though inactive at the time of the site audit, the excavation of the Left Bank Diversion Inlet Portal (LBDTIP) was ongoing and had progressed 15 m vertical down in shale bedrock. By July, it was observed that construction of the LBDTIP was advancing downwards into the floodplain soils. The shale exposure had been fully shotcreted; abundant iron oxide staining was visible on the shotcrete where depressurization/drainage pipes had been installed. PAG contact was being collected within a sump and being pumped to the RSEM L5 temporary containment pond and being allowed to infiltrate.

4.1.5.3 Left Bank Diversion Outlet Portal

Development of the Left Bank Diversion Outlet Portal (LBDOP) had commenced during the time of visit in July. The LBDOP was being excavated directly with an excavator sloping the bedrock exposure instead of by benching. During the September audit, excavation and application of shotcrete on the portal was noted to have been completed with tunneling by the Road Header in progress.

In September, it was observed that the excavation and application of shotcrete on the inlet poral was complete and the steel structure had been installed at the entrance to the tunnels. Ground preparation and slope of bedrock at the portal face was complete and the installation of rock mesh and bolts was underway. As of the September visit, further excavation through colluvium and some bedrock was still required to meet elevation of the tunnel outlet.

Low water was observed at the tunnels and base of excavation behind the slurry wall; this water was assumed to be pumped to RSEM L5 temporary pond.

4.1.5.4 Adit #4

Historical Adit # 4 had been exposed at the east side of the LBDIP as observed during the July site audit. When first exposed, it was noted by PRHP to BC Hydro that high water flow occurred from the adit. Effluent flow had subsided at the time of the July visit, effluent was currently being collected by the LBDIP sump.

Although the adit was not visited during the September audit, it was verbally communicated that the adit located within LBEx was being filled with grout from the LBEx bench. PRHP assessment determined that open adit had potential to store approximately 5,000 cubic meters of residual water. As the adit was filled with grout, this water would be displaced and would be managed using the LBEx sediment pond.

4.1.5.5 Adit #2

Historical Adit #2 is located and exposed on the eastern site of the LBDIP. It is upsloping and was initially drained when exposed. During the September site visit, little to no flow was observed from the adit. Water flow from this adit is collected and conveyed from the LBDIP excavation to the RSEM L5 temporary pond (L5-TPSP).

4.1.6 L3 Creek

The L3 Creek Stilling Basin at the base of the RSEM L3 spillway was observed to be under construction during the July visit. Water quality measurements were collected downstream in the L3 Creek during the routine monthly water quality sampling in March and April 2018, which indicated a weak PAG contact geochemical signature which had not previously been observed in the monthly water quality record. The geochemical signature was not observed during the May and subsequent monthly water quality sampling events, following the Stilling Basin’s discontinued use. The inspection aimed to identify any PAG material which may have been used to construct the Stilling Basin or areas where under cutting to bedrock may have occurred. PAG materials were not observed at this location.

4.1.7 Howe Pit Area

The Howe Pit Area was inspected as part of the March site audit and was noted as being snow covered and frozen. Water that flows through this area was noted to historically flow through exposed bedrock prior to draining into a small natural pond located on the bench below Howe Pit, prior to infiltrating down to L3 Creek. In March, a design concept was proposed for a blanket subdrain system at the base of a new RSEM in Howe Pit to collect groundwater seepage in the Howe Pit Area and to divert this water to a single pipe prior to draining. This design was not completed, and the facility was not built.

4.1.7.1 IDL Warehouse Laydown

The IDL warehouse laydown area was inspected during the July and September audits.

During the July site audit, recent work on the gravel foundation was inspected. It was noted that ditch excavation on the western perimeter of the fill foundation had exposed PAG material. A moderate to strong iron oxide precipitation was observed in the water that was present in this ditch. Additional excavation of overburden material during construction of the laydown area exposed PAG to the west of the ditch. PAG material was exposed at surface during the site inspection in an area that was water saturated. This PAG remained exposed during the September audit and water was pooling. Consequently, water testing showed that the accumulation of limonite and orange algal growth was not indicative of net acid generation from ARD-ML processes and that the water was neutralized by residual alkalinity.

A stockpile of PAG from the IDL work was observed along the southern perimeter of Howe Pit during the July and September audits. The EPP for this construction area states that exposed PAG will be covered with non-PAG overburden, and materials will be disposed of in an approved disposal site.

4.1.7.2 Howe Pit, Historical Shale Quarry

During the September audit, the Pond located at the quarry drainage was holding water which was moderately turbid and coloured orange and green. Water quality testing was not conducted at this site. Ponded water with strong iron oxide precipitation was observed adjacent the pond, on the same bench. This water level fluctuates, with some loss to evaporation and some infiltration to L3 Creek.

4.1.7.3 Tracker Laydown Area

A small pond was observed in the Tracker laydown area which drains water collected from the Gully Road crossing during the July audit. The ponded water is not believed to be PAG contact water, however, weak iron oxide staining was observed. No water quality measurements were collected.

4.1.8 Area 25

A brief inspection was conducted at the Area 25 Stockpile area during the July site audit, following verbal report by site personnel of a possible shale exposure at this facility. No shale was observed.

4.2 Right Bank

4.2.1 RSEM R6

During the March audit, an overview of RSEM R6 was observed from the vantage point of Area 21. RSEM R6 area was covered in snow and it was snowing heavily at the time of the visit. Both the east and west ponds were covered with snow and there was no observed flowing or open water at the time of the audit. During the July audit, the R6 area was visited and, both the east and west cells contained water, and were not discharging. During the September inspection, no significant observations were made. A catchment pond managed by AFDE located at the southwest corner of the RSEM R6 area was observed to be holding some water and seemed underutilized.

4.2.2 RSEM R5b

RSEM R5b was not active at the time of the March site visit and was covered in snow. Site communication with Molly Brewis and Brian Hawes informed that RSEM R5b was actively discharging March 17-20 during early spring melt. The facility was visited again in May and July.

4.2.2.1 RSEM R5b Pond

The pond was frozen at the time of the March audit, however the datalogger in the pond for the real-time collection of pH, EC, and turbidity is contained in an insulated box and was ice free for daily sampling. A flocculant shack is located upstream of pond spanning the inflow ditch, intended for flocculent addition during freshet flows. A shack has also been built over the pond outlet pipe to monitor flow and facilitate collection of samples from discharge from the R5b pond, at the time of the March site audit, was passively discharging, with very low flow <200 mL/s. The flow gauge was not working properly, and the outlet pipe was almost completely frozen. Brief inspection of the toe of RSEM pond was undertaken to check for seeps during the March site visit, however, the area was snow covered and presence of seeps could not be verified. No discolouration of snow was observed.

During the July site visit, the RSEM R5b pond was discharging at a rate of 13 L/s. The main input to the RSEM R5b pond was treated water from the Mobile Water Treatment Facility (MWTF). Ponding of water was observed at the collar location for groundwater hole GW-6. The water is interpreted to have accumulated from recent high precipitation in a ground depression surrounding the collar. Water was again observed to be pooling in this location during the September audit.

4.2.3 RSEM R5a

The RSEM R5a area was not active or receiving PAG material during the time of the March site inspection, hhowever, a hydro vac truck was observed disposing waste materials (unconfirmed material and source, believed to be excess slurry from the roller compacted concrete (RCC) Buttress works) in a small sump located in the upper benches near the southwest end of the RSEM. It is understood that this area was previously receiving RCC/slurry waste. The RSEM was snow covered with no observed flowing water. During the September audit, no active hauling was observed, but recently deposited material prior to the visit were noted in the RSEM along the upper benches. This material appeared to be capped with compacted gravel and fines but was not inspected for impermeability.

A walk around inspection was completed at the eastern end of the RSEM, near the proposed up-gradient cut-off ditch prior to the March visit. Several pickets (assumed to be identifying the line of the ditch) were observed. No equipment was observed in the site and the area has been reportedly cleared of snow previously in preparation for construction, however was covered by significant snow at the time of the site visit during the March audit. In September, the eastern end of the non-contact diversion ditch was observed to be in construction. During this time, it was also observed that PAG had been cut and exposed in this area. This PAG exposure will require cover prior to completion of the ditch.

In this area two drainage gulley's intersect and flow into the RSEM. It is understood that the up-gradient non-construction-contact water from the eastern portion of the RSEM will be diverted to a catchment pond east of RSEM R5a and adjacent to the Moberly River. The cut-off ditch for the western portion of the RSEM has been completed and conveys non-construction-contact water around the RSEM to an outlet up-gradient of the RSEM.

During the September audit, the dumping of slurry into a pond was observed near the western end of the RSEM; the slurry was brown and opaque; the source of the material could not be confirmed. The upper non-contact cut-off ditch had been nearly completed except for the spillway on the eastern side of the ditch.

4.2.3.1 RSEM R5a Sediment Pond

The R5a settlement pond is located along the north side of the RSEM and is divided into four cells, Eastern, East Central, West Central and Western. All four cells of the R5a pond were observed and staff gauges are installed in each pond. When required, water levels within the pond are managed through pumping between ponds and conveying water to RSEM R5b to reduce the chance of discharge occurring from this pond. In September, it was suggested that a redundant backup plan should be in place in the event of failure of the active management system.

During the March site visit, in the eastern ponds, the staff gauge was visible and top of snow was at 30 cm mark. The west and west central pond snow was less than 10 cm on the staff gauge. Four outlet pipes were observed near the staff gauges and appeared to be at approximately the 80 to 90 cm mark of the staff gauge. All four sediment ponds contained low volumes of water during the July and September. The depth gauge in cell A indicated the water was at the 10-gradient marker during the July audit, and indicated depth at gradient 40 in cell B. Pond depth records show elevated levels with near discharge during high precipitation event September 8-10, 2018.

No evidence of pond discharge was observed during the July audit.

During the July audit, some local rilling and erosion through the compacted gravel cover down to shale was observed within the RSEM Pond berms. This local erosion and PAG exposure were observed again in September and visible salts from ARD-ML processes could also be seen. Material replacement and recompaction would reduce potential for ARD-ML processes.

4.2.3.2 PAG Material Stockpile

During the July site audit, it was observed that large tracts of PAG was exposed within RSEM and moderate amounts of white colored mineral precipitation was locally observed. Evidence of active dumping could be seen, and it was understood that PRHP was prioritizing areas for placement of PAG based on Rinse pH sampling, which is conducted and reported by Lorax on a quarterly basis.

4.2.3.3 Non-Contact Cut-off Ditch

A brief inspection was conducted at the non-contact cut-off ditch where construction of the eastern extent of the ditch was underway during the July audit. Lining of the ditch has been completed along the upper elevation, however, construction of the spillway was not complete; the spillway will direct the water to the Moberly River via a cascading and contoured channel.

During the September audit, water was observed in all four ponds with some evidence of water level lowering which may be indicative of infiltration. Some erosion and exposure of PAG along the starter dyke slope was observed with evidence of ARD processes. No active hauling was occurring during time of inspection, however recent material deposition seemed to have occurred. Dumping of slurry into a pond was observed near the western end of the RSEM. The eastern end of the upper non-contact ditch diversion was observed to be constructed.

4.2.4 Right Bank Drainage Tunnel

During the September audit, it was noted that the Right Bank Drainage Tunnel (RBDT) had been advanced laterally to 740 m to the main drainage chamber with a total planned length of approximately 1 km. The temporary stockpile in front of the tunnel portals was full and the perimeter berm was in disrepair.

4.2.5 RCC Cofferdam Excavation

The RCC Cofferdam area was observed during the March, July and September audits. Due to heavy traffic and access restrictions, the excavation was not entered. During the March audit, the RCC Cofferdam area was observed from the vantage points of the South Bank River Road and from the Right Bank Approach Channel. The area was active at the time of the site audit with ongoing construction at the base of the excavation. Shotcrete had been applied to the cut-slope surrounding the excavation. Effluent water from the RCC Cofferdam area was being pumped to RSEM R6. During the July audit, the benched southern cut-slope appeared to be partially covered with shotcrete, or some type of cover, however, much of the slope was uncovered. Some minor seeps were observed in the rock face. Iron staining was visible on shotcrete cover material. In September, there were numerous bedrock exposures that were subject to minor seeping.

4.2.6 Approach Channel

The Approach Channel was inspected during the March, July and September audits.

On March 26, no ongoing excavation activity was observed in the Approach Channel, however exposed PAG prior to the March audit was noted within the excavation benches. Water was being collected at the base of the excavation cut and was partially frozen. It was understood that water from this area was being diverted through a culvert towards RSEM R5b. Pumping of water was not observed during the time of site visit. In July, this pooled water was observed to have moderate to strong iron oxide precipitation and was actively being pumped to the containment pond up-gradient of the MWTF. This water was observed to also be collected and conveyed to the water treatment plant during the September site visit.

During the July audit, no active excavation was underway within the Spillway Approach Channel. Excavation activities are planned but were not underway within the Spillway Approach Channel. Water collecting within ditches was observed to have moderate to strong iron oxide precipitation and was actively being pumped to the MWTF.

4.2.6.1 Mobile Water Treatment Facility

At the time of the March site audit, a mobile water treatment facility (MWTF) was in its final stages of approval to treat water from the Spillway Approach Channel and the LBEx Sediment Pond on the right bank. The pad for the MWTF is located within the Right Bank Approach Channel.

During the July site visit, the MWTF was operating at the time of the visit, and processing approximately 6-7 L/s of PAG contact water collected from the Spillway Approach Channel. Water was pumped from the Approach Channel to a lined containment pond prior to being treated in the plant. This water was observed to have moderate to strong iron oxide precipitations. A polishing pond facility, consisting of three cells, had been built but was not operational due to concerns with potential metal loading from the pond separation berms. The treated water was being pumped into a Baker tank to promote settlement of flocculant and solids prior to being discharge into ditches which convey the water to the RSEM R5b pond.

During the September audit, water was observed being pumped an increased rate of 10L/s from the Spillway Approach Channel, RCC Trial Batch Pond and LBEx sediment ponds. Water continued to be treated through settlement and flocculation before being discharged and was noted to successfully discharge water with depressed metal concentrations.

Following the September audit, a pipe was proposed to divert up-gradient non-PAG water around the PAG exposure to help dilute low pH water before draining into RSEM R5b. Furthermore, a redundant system should be considered for implantation at the facility to manage high flow events or in the situation of mechanical pumping failure. It should be considered that the volume of water being fed to the plant can be reduced by reducing the volume of PAG contact water, such as by diverting up-gradient water around the Spillway Approach Channel and by building berms around the WTP containment pond. Additionally, a redundant backup system could include additional pumping and storage capacity.

4.2.7 South Bank Initial Access Road

The South Bank Initial Access Road (SBIAR) was inspected during all four audits. During the March audit, the western side of SBIAR was inspected. Both the ditch and slope were covered in snow, and no flowing water was observed. Although not observed directly at the time of the site audit due to snow cover, discussion with Anthony Schaefer (Tetra Tech) indicated that significant ice lenses had formed frequently throughout this winter on the SBIAR slope, particularly on the western (east facing) slope. During the May audit, water was flowing in both ditches and in situ water quality tests measured pH of 8.2 and total alkalinity of 180 mg/L. During the July audit, it was observed that minor seeps were occurring on the western and eastern cut-slopes. These seeps were observed to be orange and white colour mineral precipitates indicating progression of active ARD-ML processes. Seepage continued to be observed on both slopes during the September audit, but was more prominent on the eastern cut-slope. Vegetation growth along the contact of bedrock and overburden could also be seen at the time of the September site audit.

4.2.8 Area 21

During the July site audit, it was observed that water from the Area 21 pond HDPE pipe did not appear to be draining into SBIAR and was being piped directly to RSEM R6. A new pipe was observed in the eastern ditch which was understood to be a water supply line going to Area A screening operations. During the September inspection, ponded water was observed at the eastern edge of Area 21. A sump was also noted to be located immediately west of the pond which appeared to be used for dumping of concrete slurry and wash from concrete trucks.

4.2.9 Area 30/Septimius Rail Siding

During the September audit, an erosion and sediment control water infrastructure facility was in construction and a new drainage system was being implemented at the northwest corner of the siding area. There was also active unloading of limestone from West Pine Quarry on September 26.

4.2.10 Area A/Phase II Crusher Operations

The Phase II Crusher Operations area, with Area A, was inspected during the March Audit. The audit team was escorted into the active pit area by a site supervisor (Gerome). Excavation of the materials was observed from a distance as active excavation and truck hauling was ongoing. The materials were being dug out of the slope by excavators and transported to the sorting and crusher area. Although detailed inspection of the material was not possible it was obviously overburden materials and there was no shale or weathered bedrock horizon materials observed. Materials excavated from this area are sorted and crushed with an impact crusher and used in the RCC mix.

During the September audit, it was observed that the excavation was ongoing and there was no visual evidence of bedrock or weathered bedrock material in the pit or stockpiles.

4.3 Locations Off-Site of Main Civil Works

4.3.1 Portage Mountain Quarry

The Portage Mountain Quarry was audited during the May site visit. It was observed that the access road was being widened to accommodate haulage of material from site to highway construction site. The road surfacing on top of the road subbase was planned to be 0.3 m, and the cut-slopes were observed to be meeting their 3:1 specified ratio in both soil and rock.

During the time of the site visit, exposed rock slopes showing iron oxide staining were identified by site personnel to have potential for acid generation and metal leaching. Discussions with the on-site contractor (Duz Cho) at the time of the site visit included methods of monitoring and reducing environmental impact following exposure of these rock slopes. ARD-ML mitigation strategies discussed included methods to identify PAG material, blending, ground cover and bedrock isolation, and water quality monitoring protocols to detect potential onset of acid generating processes. Samples were collected from the road and analyzed for acid-base accounting and trace element concentrations to help characterize the potential for ARD-ML. The results of this work are shown in Table 3 above. It was concluded that the combined risk for net acid generation from the rocks was low and that methods should be considered to mitigate this low risk.

5.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of BC Hydro and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than BC Hydro, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Limitations on the Use of this Document (Appendix C) are attached to this memo.

6.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

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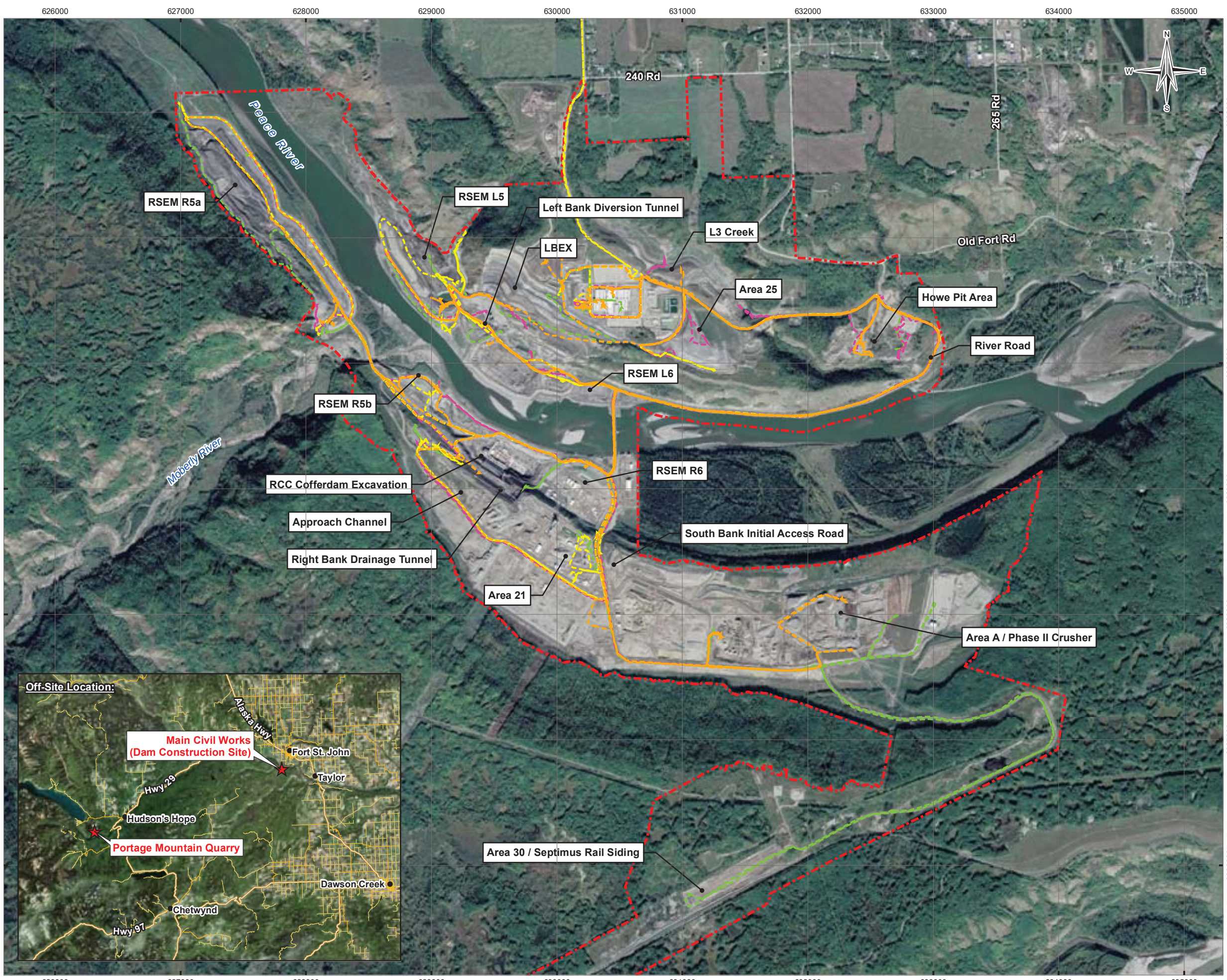
/bi

Attachments:	Figure 1	2018 ARD-ML Site Audit Locations
	Appendix A	Laboratory Analytical Certificates, River Roads Ditch Sediment
	Appendix B	Laboratory Analytical Certificates, Portage Mountain Quarry Access Road Outcrop
	Appendix C	Tetra Tech's Limitations on The Use of This Document

FIGURES



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LEGEND

Site C Project Boundary

Site Audit GPS Tracks

- March 26-28, 2018
- May 29-31, 2018
- July 24-25, 2018
- September 25-26, 2018

NOTES

Base data source:
Imagery from Google Earth; DigitalGlobe (2018).

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT

2018 ARD-ML Site Audit Locations

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:30,000

500 250 0 500
Metres

TETRA TECH

FILE NO.
VMIN03021-01_Figure01_SiteAudit.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	YL	JB	0

DATE
March 21, 2019

PROJECT NO.
ENG.VMIN03021-01

Figure 1

APPENDIX A

LABORATORY ANALYTICAL CERTIFICATES, RIVER ROADS DITCH SEDIMENT

ALS Canada Ltd.

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www.alsglobal.com/geochemistry

To: **TETRA TECH CANADA INC.**
885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Finalized Date: 22-SEP-2018
Account: TGM

CERTIFICATE VA18219634

P.O. No.: 704-ENG.VMIN03021-01 Task B

This report is for 2 Soil samples submitted to our lab in Vancouver, BC, Canada on 4-SEP-2018.

The following have access to data associated with this certificate:

J. BARR	ERICA MASSEY	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
SCR-41	Screen to -180um and save both

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-ICP61	33 element four acid ICP-AES	ICP-AES
Hg-MS42	Trace Hg by ICPMS	ICP-MS
OA-VOL08	Basic Acid Base Accounting	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-IR07	Sulphide Sulphur (Leco)	LECO

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

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VANCOUVER BC V6C 1N5

Finalized Date: 22-SEP-2018
Account: TGM

CERTIFICATE OF ANALYSIS VA18219634

Sample Description	Method	WEI-21	OA-VOL08	OA-VOL08	OA-VOL08	OA-VOL08	OA-ELE07	OA-VOL08	S-IR08	S-GRA06	S-GRA06a	S-IR07	C-GAS05	C-GAS05	ME-ICP61	ME-ICP61
	Analyte	Recvd Wt.	FIZZ RAT	MPA	NNP	NP	pH	Ratio (N	S	S	S	Sulphide	C	CO2	Ag	Al
	Units	kg	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%
	LOD	0.02	1	0.3	1	1	0.1	0.01	0.01	0.01	0.01	0.01	0.05	0.2	0.5	0.01
SC-059		1.00	3	5.0	94	99	7.5	19.80	0.16	0.13	0.15	0.03	0.99	3.6	<0.5	3.72
SC-060		0.72	2	8.1	46	54	7.6	6.65	0.26	0.21	0.22	0.04	0.56	2.1	<0.5	4.23

***** See Appendix Page for comments regarding this certificate *****

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Sample Description	Method	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	Hg-MS42	ME-ICP61	ME-ICP61	ME-ICP61
	Analyte	As	Ba	Be	Bi	Ca	Cd	Co	Cr	Cu	Fe	Ga	Hg	K	La	Mg
	Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	%
	LOD	5	10	0.5	2	0.01	0.5	1	1	1	0.01	10	0.005	0.01	10	0.01
SC-059		10	600	0.9	<2	3.36	<0.5	8	57	17	2.57	10	0.038	0.98	20	1.00
SC-060		28	720	1.2	<2	1.86	0.9	9	59	34	4.02	10	0.046	1.16	20	0.75

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Finalized Date: 22-SEP-2018
Account: TGM

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Sample Description	Method / Analyte / Units / LOD	ME-ICP61 Mn ppm 5	ME-ICP61 Mo ppm 1	ME-ICP61 Na % 0.01	ME-ICP61 Ni ppm 1	ME-ICP61 P ppm 10	ME-ICP61 Pb ppm 2	ME-ICP61 S % 0.01	ME-ICP61 Sb ppm 5	ME-ICP61 Sc ppm 1	ME-ICP61 Sr ppm 1	ME-ICP61 Th ppm 20	ME-ICP61 Ti % 0.01	ME-ICP61 Tl ppm 10	ME-ICP61 U ppm 10	ME-ICP61 V ppm 1
SC-059		450	3	0.53	34	780	11	0.16	<5	8	179	<20	0.29	<10	<10	101
SC-060		296	5	0.47	38	1820	9	0.29	<5	10	158	<20	0.20	<10	<10	108

***** See Appendix Page for comments regarding this certificate *****

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Finalized Date: 22-SEP-2018
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CERTIFICATE OF ANALYSIS VA18219634

Sample Description	Method / Analyte / Units / LOD	ME-ICP61 W ppm 10	ME-ICP61 Zn ppm 2
SC-059		<10	82
SC-060		<10	157

***** See Appendix Page for comments regarding this certificate *****

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Finalized Date: 22-SEP-2018
Account: TGM

CERTIFICATE OF ANALYSIS VA18219634

CERTIFICATE COMMENTS

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:	C-GAS05	Hg-MS42	LOG-22	ME-ICP61
	OA-ELE07	OA-VOL08	SCR-41	S-GRA06
	S-GRA06a	S-IR07	S-IR08	WEI-21

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Finalized Date: 22-SEP-2018
Account: TGM

QC CERTIFICATE VA18219634

P.O. No.: 704-ENG.VMIN03021-01 Task B
This report is for 2 Soil samples submitted to our lab in Vancouver, BC, Canada on 4-SEP-2018.

The following have access to data associated with this certificate:

J. BARR	ERICA MASSEY	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
SCR-41	Screen to -180um and save both

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
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S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-ICP61	33 element four acid ICP-AES	ICP-AES
Hg-MS42	Trace Hg by ICPMS	ICP-MS
OA-VOL08	Basic Acid Base Accounting	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-IR07	Sulphide Sulphur (Leco)	LECO

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

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**Finalized Date: 22-SEP-2018
Account: TGM**

QC CERTIFICATE OF ANALYSIS VA18219634

Sample Description / Method / Analyte / Units / LOD	OA-VOL08 FIZZ RAT Unity 1	OA-VOL08 MPA tCaCO3/1Kt 0.3	OA-VOL08 NNP tCaCO3/1Kt 1	OA-VOL08 NP tCaCO3/1Kt 1	OA-ELE07 pH Unity 0.1	OA-VOL08 Ratio (N Unity 0.01	S-IR08 S % 0.01	S-GRA06 S % 0.01	S-GRA06a S % 0.01	S-IR07 Sulphide % 0.01	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2	ME-ICP61 Ag ppm 0.5	ME-ICP61 Al % 0.01	ME-ICP61 As ppm 5
STANDARDS															
Buffer pH6					6.0										
Buffer pH6					6.0										
Target Range - Lower Bound					5.3										
Upper Bound					6.7										
CDN-CM-34													3.7	6.45	102
Target Range - Lower Bound													2.5	5.88	90
Upper Bound													4.9	7.21	122
CO-ASSAY											0.50	1.8			
Target Range - Lower Bound											0.42	1.5			
Upper Bound											0.64	2.4			
EMOG-17															
Target Range - Lower Bound															
Upper Bound															
EMOG-17													65.7	4.48	571
Target Range - Lower Bound													59.0	4.18	510
Upper Bound													73.2	5.13	634
GS310-10							0.26								
Target Range - Lower Bound							0.25								
Upper Bound							0.29								
KZK-1	2	25.0	34	59		2.36									
Target Range - Lower Bound		22.9	30	54		2.18									
Upper Bound		27.1	38	64		2.54									
MA-1b							1.18								
Target Range - Lower Bound							1.12								
Upper Bound							1.22								
MA-2c											1.56	5.7			
Target Range - Lower Bound											1.50	5.5			
Upper Bound											1.84	6.8			
NBM-1	2	8.8	41	50		5.71									
Target Range - Lower Bound		7.8	37	45		5.26									
Upper Bound		9.7	47	54		6.08									
OREAS 602															
Target Range - Lower Bound															
Upper Bound															
OREAS-75a										11.65					
Target Range - Lower Bound										10.85					
Upper Bound										12.00					
UTS-1								0.89							

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Finalized Date: 22-SEP-2018
Account: TGM

QC CERTIFICATE OF ANALYSIS VA18219634

Method	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	Hg-MS42	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61
Analyte	Ba	Be	Bi	Ca	Cd	Co	Cr	Cu	Fe	Ga	Hg	K	La	Mg	Mn
Units	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	%	ppm
Sample Description / LOD	10	0.5	2	0.01	0.5	1	1	1	0.01	10	0.005	0.01	10	0.01	5
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CDN-CM-34	490	1.0	2	2.01	1.0	42	241	5760	4.66	20		2.74	10	3.57	437
Target Range - Lower Bound	430	<0.5	<2	1.83	<0.5	37	217	5370	4.26	<10		2.51	<10	3.29	399
Upper Bound	610	2.1	8	2.25	2.0	47	267	6190	5.23	40		3.09	40	4.05	499
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
EMOG-17											0.537				
Target Range - Lower Bound											0.490				
Upper Bound											0.610				
EMOG-17	280	1.7	7	1.79	19.5	723	55	8060	4.62	10		1.58	20	0.91	709
Target Range - Lower Bound	<10	0.7	<2	1.72	17.7	685	49	7740	4.42	<10		1.49	<10	0.86	670
Upper Bound	20	2.9	10	2.12	22.7	839	62	8910	5.42	30		1.85	40	1.08	830
GS310-10															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-1b															
Target Range - Lower Bound															
Upper Bound															
MA-2c															
Target Range - Lower Bound															
Upper Bound															
NBM-1															
Target Range - Lower Bound															
Upper Bound															
OREAS 602											0.801				
Target Range - Lower Bound											0.706				
Upper Bound											0.874				
OREAS-75a															
Target Range - Lower Bound															
Upper Bound															
UTS-1															

***** See Appendix Page for comments regarding this certificate *****

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Finalized Date: 22-SEP-2018
Account: TGM

QC CERTIFICATE OF ANALYSIS VA18219634

Sample Description	Method	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61
	Analyte	Mo	Na	Ni	P	Pb	S	Sb	Sc	Sr	Th	Ti	Tl	U	V	W
	Units	ppm	%	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
	LOD	1	0.01	1	10	2	0.01	5	1	1	20	0.01	10	10	1	10
								STANDARDS								
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CDN-CM-34		290	0.72	243	1240	23	3.05	6	16	223	<20	0.48	<10	<10	163	30
Target Range - Lower Bound		269	0.66	220	1110	19	2.70	<5	14	204	<20	0.43	<10	<10	149	<10
Upper Bound		331	0.83	271	1370	29	3.32	17	19	251	40	0.55	20	20	184	50
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
EMOG-17																
Target Range - Lower Bound																
Upper Bound																
EMOG-17		1040	1.04	7250	800	6990	3.14	764	8	201	<20	0.30	<10	<10	71	<10
Target Range - Lower Bound		996	0.99	6820	700	6570	2.91	638	6	184	<20	0.28	<10	<10	67	<10
Upper Bound		1220	1.23	8330	880	8030	3.57	874	10	227	50	0.36	20	20	84	20
GS310-10																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-1b																
Target Range - Lower Bound																
Upper Bound																
MA-2c																
Target Range - Lower Bound																
Upper Bound																
NBM-1																
Target Range - Lower Bound																
Upper Bound																
OREAS 602																
Target Range - Lower Bound																
Upper Bound																
OREAS-75a																
Target Range - Lower Bound																
Upper Bound																
UTS-1																

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

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To: TETRA TECH CANADA INC.
885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Finalized Date: 22-SEP-2018
Account: TGM

QC CERTIFICATE OF ANALYSIS VA18219634

Sample Description	Method / Analyte / Units / LOD	ME-ICP61 Zn ppm 2
STANDARDS		
Buffer pH6		
Buffer pH6		
Target Range - Lower Bound		
	Upper Bound	
CDN-CM-34		192
Target Range - Lower Bound		176
	Upper Bound	219
CO-ASSAY		
Target Range - Lower Bound		
	Upper Bound	
EMOG-17		
Target Range - Lower Bound		
	Upper Bound	
EMOG-17		7050
Target Range - Lower Bound		6800
	Upper Bound	8320
GS310-10		
Target Range - Lower Bound		
	Upper Bound	
KZK-1		
Target Range - Lower Bound		
	Upper Bound	
MA-1b		
Target Range - Lower Bound		
	Upper Bound	
MA-2c		
Target Range - Lower Bound		
	Upper Bound	
NBM-1		
Target Range - Lower Bound		
	Upper Bound	
OREAS 602		
Target Range - Lower Bound		
	Upper Bound	
OREAS-75a		
Target Range - Lower Bound		
	Upper Bound	
UTS-1		

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QC CERTIFICATE OF ANALYSIS VA18219634

Sample Description / Method / Analyte / Units / LOD	OA-VOL08 FIZZ RAT Unity 1	OA-VOL08 MPA tCaCO3/1Kt 0.3	OA-VOL08 NNP tCaCO3/1Kt 1	OA-VOL08 NP tCaCO3/1Kt 1	OA-ELE07 pH Unity 0.1	OA-VOL08 Ratio (N Unity 0.01	S-IR08 S % 0.01	S-GRA06 S % 0.01	S-GRA06a S % 0.01	S-IR07 Sulphide % 0.01	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2	ME-ICP61 Ag ppm 0.5	ME-ICP61 Al % 0.01	ME-ICP61 As ppm 5
STANDARDS															
Target Range - Lower Bound								0.83							
Upper Bound								0.93							
UTS-1									0.90						
Target Range - Lower Bound									0.81						
Upper Bound									0.95						
UTS-1										0.12					
Target Range - Lower Bound										0.10					
Upper Bound										0.14					
UTS-4								1.70							
Target Range - Lower Bound								1.64							
Upper Bound								1.84							
UTS-4									1.66						
Target Range - Lower Bound									1.61						
Upper Bound									1.87						
BLANKS															
BLANK											<0.05	<0.2			
Target Range - Lower Bound											<0.05	<0.2			
Upper Bound											0.10	0.4			
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK													<0.5	<0.01	<5
Target Range - Lower Bound													<0.5	<0.01	<5
Upper Bound													1.0	0.02	10
BLANK					6.0										
Target Range - Lower Bound					5.5										
Upper Bound					6.9										
BLANK								<0.01							
Target Range - Lower Bound								<0.01							
Upper Bound								0.02							
BLANK									<0.01						
Target Range - Lower Bound									<0.01						
Upper Bound									0.02						
BLANK										0.02					
Target Range - Lower Bound										<0.01					
Upper Bound										0.02					
BLANK							0.01								
Target Range - Lower Bound							<0.01								
Upper Bound							0.02								

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QC CERTIFICATE OF ANALYSIS VA18219634

Sample Description	Method Analyte Units LOD	

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QC CERTIFICATE OF ANALYSIS VA18219634

Sample Description	Method	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	Hg-MS42	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61
	Analyte	Ba	Be	Bi	Ca	Cd	Co	Cr	Cu	Fe	Ga	Hg	K	La	Mg	Mn
	Units	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	%	ppm
	LOD	10	0.5	2	0.01	0.5	1	1	1	0.01	10	0.005	0.01	10	0.01	5
STANDARDS																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
BLANKS																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK												<0.005				
Target Range - Lower Bound												<0.005				
Upper Bound												0.010				
BLANK		<10	<0.5	<2	<0.01	<0.5	<1	<1	<1	<0.01	<10		<0.01	<10	<0.01	<5
Target Range - Lower Bound		<10	<0.5	<2	<0.01	<0.5	<1	<1	<1	<0.01	<10		<0.01	<10	<0.01	<5
Upper Bound		20	1.0	4	0.02	1.0	2	2	2	0.02	20		0.02	20	0.02	10
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																

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QC CERTIFICATE OF ANALYSIS VA18219634

Sample Description	Method Analyte Units LOD	

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QC CERTIFICATE OF ANALYSIS VA18219634

Sample Description — Method / Analyte / Units / LOD	ME-ICP61 Mo ppm 1	ME-ICP61 Na % 0.01	ME-ICP61 Ni ppm 1	ME-ICP61 P ppm 10	ME-ICP61 Pb ppm 2	ME-ICP61 S % 0.01	ME-ICP61 Sb ppm 5	ME-ICP61 Sc ppm 1	ME-ICP61 Sr ppm 1	ME-ICP61 Th ppm 20	ME-ICP61 Ti % 0.01	ME-ICP61 Tl ppm 10	ME-ICP61 U ppm 10	ME-ICP61 V ppm 1	ME-ICP61 W ppm 10
STANDARDS															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<1	<0.01	<1	<10	<2	<0.01	<5	<1	<1	<20	<0.01	<10	<10	<1	<10
Target Range - Lower Bound	<1	<0.01	<1	<10	<2	<0.01	<5	<1	<1	<20	<0.01	<10	<10	<1	<10
Upper Bound	2	0.02	2	20	4	0.02	10	2	2	40	0.02	20	20	2	20
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															

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VANCOUVER BC V6C 1N5

Finalized Date: 22-SEP-2018
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QC CERTIFICATE OF ANALYSIS VA18219634

Sample Description	Method Analyte Units LOD	

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QC CERTIFICATE OF ANALYSIS VA18219634

Sample Description / Method / Analyte / Units / LOD	ME-ICP61 / Zn / ppm / 2
STANDARDS	
Target Range - Lower Bound	
Upper Bound	
UTS-1	
Target Range - Lower Bound	
Upper Bound	
UTS-1	
Target Range - Lower Bound	
Upper Bound	
UTS-4	
Target Range - Lower Bound	
Upper Bound	
UTS-4	
Target Range - Lower Bound	
Upper Bound	
BLANKS	
BLANK	
Target Range - Lower Bound	
Upper Bound	
BLANK	
Target Range - Lower Bound	
Upper Bound	
BLANK	<2
Target Range - Lower Bound	<2
Upper Bound	4
BLANK	
Target Range - Lower Bound	
Upper Bound	
BLANK	
Target Range - Lower Bound	
Upper Bound	
BLANK	
Target Range - Lower Bound	
Upper Bound	
BLANK	
Target Range - Lower Bound	
Upper Bound	
BLANK	
Target Range - Lower Bound	
Upper Bound	

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QC CERTIFICATE OF ANALYSIS VA18219634

Sample Description	Method Analyte Units LOD	

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QC CERTIFICATE OF ANALYSIS VA18219634

Sample Description / Method	OA-VOL08	OA-VOL08	OA-VOL08	OA-VOL08	OA-ELE07	OA-VOL08	S-IR08	S-GRA06	S-GRA06a	S-IR07	C-GAS05	C-GAS05	ME-ICP61	ME-ICP61	ME-ICP61
Analyte	FIZZ RAT	MPA	NNP	NP	pH	Ratio (N	S	S	S	Sulphide	C	CO2	Ag	Al	As
Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
LOD	1	0.3	1	1	0.1	0.01	0.01	0.01	0.01	0.01	0.05	0.2	0.5	0.01	5
DUPLICATES															
ORIGINAL													<0.5	4.24	50
DUP													<0.5	4.41	53
Target Range - Lower Bound													<0.5	4.10	44
Upper Bound													1.0	4.55	59
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL							0.24								
DUP							0.25								
Target Range - Lower Bound							0.23								
Upper Bound							0.26								
SC-060										0.04					
DUP										0.05					
Target Range - Lower Bound										0.03					
Upper Bound										0.06					
ORIGINAL								<0.01	<0.01						
DUP								0.01	0.02						
Target Range - Lower Bound								<0.01	<0.01						
Upper Bound								0.02	0.02						
ORIGINAL											<0.05	<0.2			
DUP											<0.05	<0.2			
Target Range - Lower Bound											<0.05	<0.2			
Upper Bound											0.10	0.4			
ORIGINAL	1	0.9	16	17	9.4	18.13									
DUP	1	0.9	15	16	9.4	17.07									
Target Range - Lower Bound	<1	0.6	14	15	8.8	16.71									
Upper Bound	2	1.2	17	18	10.0	18.49									

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Finalized Date: 22-SEP-2018
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QC CERTIFICATE OF ANALYSIS VA18219634

Sample Description / Method / Analyte / Units / LOD	ME-ICP61 Ba ppm 10	ME-ICP61 Be ppm 0.5	ME-ICP61 Bi ppm 2	ME-ICP61 Ca % 0.01	ME-ICP61 Cd ppm 0.5	ME-ICP61 Co ppm 1	ME-ICP61 Cr ppm 1	ME-ICP61 Cu ppm 1	ME-ICP61 Fe % 0.01	ME-ICP61 Ga ppm 10	Hg-MS42 Hg ppm 0.005	ME-ICP61 K % 0.01	ME-ICP61 La ppm 10	ME-ICP61 Mg % 0.01	ME-ICP61 Mn ppm 5
							DUPLICATES								
ORIGINAL	1900	2.4	<2	0.46	4.5	1	3	30	1.30	20		2.08	50	0.41	115
DUP	1790	2.5	<2	0.49	4.7	1	3	31	1.35	20		2.15	50	0.42	121
Target Range - Lower Bound	1700	1.8	<2	0.44	3.9	<1	2	28	1.25	<10		2.00	40	0.38	107
Upper Bound	1990	3.1	4	0.51	5.3	2	4	33	1.40	30		2.23	60	0.45	129
ORIGINAL											<0.005				
DUP											0.005				
Target Range - Lower Bound											<0.005				
Upper Bound											0.010				
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
SC-060															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															

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QC CERTIFICATE OF ANALYSIS VA18219634

Sample Description	Method	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61	ME-ICP61
	Analyte	Mo	Na	Ni	P	Pb	S	Sb	Sc	Sr	Th	Ti	Tl	U	V	W
	Units	ppm	%	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
	LOD	1	0.01	1	10	2	0.01	5	1	1	20	0.01	10	10	1	10
DUPLICATES																
ORIGINAL		7	0.08	1	20	119	0.92	<5	<1	46	<20	0.04	<10	<10	3	<10
DUP		7	0.09	1	20	123	0.95	<5	<1	48	<20	0.04	10	<10	3	<10
Target Range - Lower Bound		6	0.07	<1	<10	113	0.88	<5	<1	44	<20	0.03	<10	<10	2	<10
Upper Bound		8	0.10	2	30	129	0.99	10	2	50	40	0.05	20	20	4	20
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
SC-060																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																

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Finalized Date: 22-SEP-2018
Account: TGM

QC CERTIFICATE OF ANALYSIS VA18219634

Sample Description	Method / Analyte / Units / LOD	ME-ICP61 / Zn / ppm / 2
		DUPLICATES
ORIGINAL		1005
DUP		1050
Target Range - Lower Bound		974
Upper Bound		1080
ORIGINAL		
DUP		
Target Range - Lower Bound		
Upper Bound		
ORIGINAL		
DUP		
Target Range - Lower Bound		
Upper Bound		
SC-060		
DUP		
Target Range - Lower Bound		
Upper Bound		
ORIGINAL		
DUP		
Target Range - Lower Bound		
Upper Bound		
ORIGINAL		
DUP		
Target Range - Lower Bound		
Upper Bound		
ORIGINAL		
DUP		
Target Range - Lower Bound		
Upper Bound		

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QC CERTIFICATE OF ANALYSIS VA18219634

CERTIFICATE COMMENTS

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:	C-GAS05	Hg-MS42	LOG-22	ME-ICP61
	OA-ELE07	OA-VOL08	SCR-41	S-GRA06
	S-GRA06a	S-IR07	S-IR08	WEI-21

APPENDIX B

LABORATORY ANALYTICAL CERTIFICATES, PORTAGE MOUNTAIN QUARRY ACCESS ROAD OUTCROP

ALS Canada Ltd.

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To: TETRA TECH CANADA INC.
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VANCOUVER BC V6C 1N5

Finalized Date: 13-JUN-2018
Account: TGM

CERTIFICATE VA18132683

Project: 704-ENG.VMIN03021-01

This report is for 12 Rock samples submitted to our lab in Vancouver, BC, Canada on 1-JUN-2018.

The following have access to data associated with this certificate:

J. BARR

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
CRU-31	Fine crushing - 70% <2mm
CRU-QC	Crushing QC Test
SPL-21	Split sample - riffle splitter
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	INSTRUMENT
S-IR07	Sulphide Sulphur (Leco)	LECO
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS61	48 element four acid ICP-MS	
pXRF-30	Semi-Quantitative pXRF Scan	PXRF
OA-VOL08	Basic Acid Base Accounting	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:

Colin Ramshaw, Vancouver Laboratory Manager

ALS Canada Ltd.

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Project: 704-ENG.VMIN03021-01

CERTIFICATE OF ANALYSIS VA18132683

Sample Description	Method Analyte Units LOD	WEI-21 Recvd Wt. kg 0.02	OA-VOL08 FIZZ RAT Unity 1	OA-VOL08 MPA tCaCO3/1Kt 0.3	OA-VOL08 NNP tCaCO3/1Kt 1	OA-VOL08 NP tCaCO3/1Kt 1	OA-ELE07 pH Unity 0.1	OA-VOL08 Ratio (N Unity 0.01	S-IR08 S % 0.01	S-GRA06 S % 0.01	S-GRA06a S % 0.01	S-IR07 Sulphide % 0.01	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2	ME-MS61 Ag ppm 0.01	ME-MS61 Al % 0.01
PQ-019		1.80	3	0.9	98	99	8.2	105.60	0.03	<0.01	<0.01	0.02	1.14	4.2	0.32	3.63
PQ-021		0.92	1	4.4	4	8	7.1	1.83	0.14	<0.01	<0.01	0.11	<0.05	<0.2	0.35	4.88
PQ-023		0.78	1	9.1	-11	-2	4.8	-0.22	0.29	<0.01	<0.01	0.19	<0.05	<0.2	0.25	4.20
PQ-027		2.70	2	1.9	62	64	7.7	34.13	0.06	<0.01	<0.01	0.03	0.66	2.4	0.29	4.60
PQ-030		1.06	2	1.6	63	65	7.7	41.60	0.05	<0.01	0.01	0.03	0.71	2.6	0.30	4.51
PQ-031		0.68	2	7.2	33	40	6.6	5.57	0.23	<0.01	<0.01	0.19	0.32	1.2	0.25	3.37
PQ-032		1.22	2	3.1	72	75	6.7	24.00	0.10	<0.01	<0.01	0.07	0.81	3.0	0.30	5.11
PQ-033		1.10	2	5.3	57	62	7.2	11.67	0.17	<0.01	<0.01	0.10	0.54	2.0	0.31	5.09
SC-001		0.42	1	13.4	-3	10	5.1	0.74	0.43	0.22	0.24	0.09	0.29	1.1	0.29	8.36
SC-002		0.18	1	126.6	-115	12	7.4	0.09	4.05	3.12	3.12	0.67	0.07	0.2	0.36	7.12
SC-003		0.52	1	43.1	-39	4	5.4	0.09	1.38	0.21	0.18	0.90	<0.05	<0.2	0.42	8.21
SC-004		0.46	1	45.3	-40	5	4.5	0.11	1.45	0.12	0.16	0.98	0.05	0.2	0.45	8.37

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To: TETRA TECH CANADA INC.
885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Finalized Date: 13-JUN-2018
Account: TGM

Project: 704-ENG.VMIN03021-01

CERTIFICATE OF ANALYSIS VA18132683

Sample Description	Method / Analyte / Units / LOD	ME-MS61 As ppm 0.2	ME-MS61 Ba ppm 10	ME-MS61 Be ppm 0.05	ME-MS61 Bi ppm 0.01	ME-MS61 Ca % 0.01	ME-MS61 Cd ppm 0.02	ME-MS61 Ce ppm 0.01	ME-MS61 Co ppm 0.1	ME-MS61 Cr ppm 1	ME-MS61 Cs ppm 0.05	ME-MS61 Cu ppm 0.2	ME-MS61 Fe % 0.01	ME-MS61 Ga ppm 0.05	ME-MS61 Ge ppm 0.05	ME-MS61 Hf ppm 0.1
PQ-019		4.4	1560	0.57	0.07	2.63	1.07	47.5	4.2	58	1.89	10.0	1.35	8.19	0.20	2.7
PQ-021		6.1	1230	1.04	0.09	0.35	1.46	56.0	6.6	88	3.50	13.4	1.07	11.70	0.19	2.6
PQ-023		8.2	880	1.09	0.10	0.38	0.15	44.2	4.0	70	3.69	10.4	0.78	10.00	0.07	1.9
PQ-027		6.7	990	0.95	0.12	1.63	0.98	51.1	8.8	83	3.20	18.8	2.27	11.15	0.22	2.1
PQ-030		7.8	900	1.02	0.13	2.27	1.08	57.8	8.8	77	3.14	17.2	2.22	10.70	0.24	2.4
PQ-031		4.5	870	1.38	0.09	2.22	0.90	38.3	6.7	51	2.67	12.8	1.97	8.03	0.05	2.1
PQ-032		5.6	710	1.19	0.14	2.87	1.31	50.8	5.5	77	3.41	13.0	2.08	11.85	0.23	2.3
PQ-033		3.0	790	1.21	0.14	2.63	0.83	59.3	5.9	69	3.42	20.3	1.40	12.65	0.06	2.1
SC-001		10.9	1010	2.73	0.27	0.23	5.77	79.1	4.4	100	9.50	70.4	6.66	20.0	0.22	3.3
SC-002		14.4	120	1.72	0.24	1.07	0.77	72.3	10.3	94	8.48	33.6	2.83	18.80	0.28	3.0
SC-003		16.2	1140	1.95	0.29	0.41	0.60	82.0	10.3	108	9.57	36.3	3.09	21.4	0.21	3.4
SC-004		17.2	1180	1.93	0.29	0.36	0.65	85.1	9.6	110	10.25	36.1	3.25	22.3	0.26	3.5

***** See Appendix Page for comments regarding this certificate *****

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885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Finalized Date: 13-JUN-2018
Account: TGM

Project: 704-ENG.VMIN03021-01

CERTIFICATE OF ANALYSIS VA18132683

Sample Description	Method / Analyte / Units / LOD	ME-MS61 In ppm 0.005	ME-MS61 K % 0.01	ME-MS61 La ppm 0.5	ME-MS61 Li ppm 0.2	ME-MS61 Mg % 0.01	ME-MS61 Mn ppm 5	ME-MS61 Mo ppm 0.05	ME-MS61 Na % 0.01	ME-MS61 Nb ppm 0.1	ME-MS61 Ni ppm 0.2	ME-MS61 P ppm 10	ME-MS61 Pb ppm 0.5	ME-MS61 Rb ppm 0.1	ME-MS61 Re ppm 0.002	ME-MS61 S % 0.01
PQ-019		0.025	1.25	24.7	10.9	1.08	296	0.58	0.12	9.0	17.0	1410	7.0	49.7	<0.002	0.03
PQ-021		0.036	1.63	31.0	29.7	0.27	207	1.14	0.06	11.4	28.8	1090	9.7	73.0	<0.002	0.12
PQ-023		0.024	1.24	23.9	39.7	0.29	38	2.27	0.08	7.7	24.3	620	12.1	65.4	0.006	0.22
PQ-027		0.032	1.61	28.3	18.9	0.87	442	1.79	0.13	9.6	44.0	1010	11.5	68.6	0.003	0.05
PQ-030		0.035	1.33	32.3	28.0	0.81	350	1.77	0.26	9.9	35.2	1180	11.9	64.2	0.002	0.05
PQ-031		0.022	0.77	20.5	30.2	0.37	268	2.30	0.12	6.5	32.5	800	10.9	46.9	0.002	0.17
PQ-032		0.029	1.28	28.3	33.6	0.58	246	1.71	0.14	9.4	30.5	740	12.4	59.9	0.002	0.09
PQ-033		0.038	1.33	30.7	37.4	0.80	271	1.47	0.08	9.4	31.0	600	13.3	71.3	<0.002	0.14
SC-001		0.064	2.16	43.0	115.5	0.75	227	5.06	0.17	18.0	44.4	640	17.2	129.0	0.009	0.48
SC-002		0.071	2.01	37.3	65.8	1.63	118	4.08	2.69	16.6	40.1	820	16.3	125.0	0.010	4.44
SC-003		0.070	2.28	43.4	55.5	0.78	85	4.25	0.27	18.6	41.2	900	20.0	139.0	0.008	1.45
SC-004		0.081	2.35	44.8	56.8	0.78	88	5.28	0.29	19.6	38.7	940	19.6	146.0	0.007	1.57

***** See Appendix Page for comments regarding this certificate *****

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To: TETRA TECH CANADA INC.
885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Finalized Date: 13-JUN-2018
Account: TGM

Project: 704-ENG.VMIN03021-01

CERTIFICATE OF ANALYSIS VA18132683

Sample Description	Method	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61
	Analyte	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W	Y	Zn
	Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
	LOD	0.05	0.1	1	0.2	0.2	0.05	0.05	0.01	0.005	0.02	0.1	1	0.1	0.1	2
PQ-019		0.62	4.8	1	0.9	96.9	0.57	<0.05	6.89	0.266	0.43	2.7	82	0.8	17.3	90
PQ-021		0.73	7.3	3	1.3	115.0	0.73	<0.05	8.05	0.331	0.59	3.3	123	1.1	19.0	102
PQ-023		0.74	6.8	2	1.1	127.0	0.48	0.05	5.95	0.193	0.78	2.0	115	0.7	11.3	58
PQ-027		0.95	7.2	2	1.1	95.2	0.62	<0.05	7.36	0.267	0.56	2.6	126	0.9	18.0	128
PQ-030		1.16	7.2	2	1.2	183.0	0.60	<0.05	8.16	0.273	0.63	2.7	133	0.8	19.9	108
PQ-031		1.34	8.0	2	0.8	133.5	0.40	<0.05	5.22	0.159	0.53	2.9	101	0.7	16.4	91
PQ-032		1.00	6.5	2	1.4	142.0	0.66	<0.05	7.89	0.282	0.58	3.1	141	0.9	18.1	99
PQ-033		0.82	7.8	2	1.4	106.0	0.70	0.06	8.14	0.274	0.60	3.5	120	0.9	17.5	98
SC-001		0.96	14.7	3	2.3	140.5	1.05	0.09	9.37	0.400	0.88	6.9	222	1.5	18.8	122
SC-002		0.93	13.0	9	2.0	245	0.97	0.09	10.05	0.362	0.89	3.4	200	1.3	23.8	155
SC-003		0.92	14.1	1	2.4	160.0	1.09	0.14	12.10	0.422	1.08	3.8	231	1.6	24.2	134
SC-004		0.95	15.1	4	2.6	175.5	1.17	0.14	12.25	0.430	1.07	3.8	236	1.6	25.8	174

***** See Appendix Page for comments regarding this certificate *****

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Finalized Date: 13- JUN- 2018
Account: TGM

Project: 704- ENG.VMIN03021- 01

CERTIFICATE OF ANALYSIS VA18132683

Sample Description	Method	ME- MS61	pXRF- 30	pXRF- 30	pXRF- 30	pXRF- 30	pXRF- 30	pXRF- 30	pXRF- 30	pXRF- 30	pXRF- 30	pXRF- 30	pXRF- 30	pXRF- 30	pXRF- 30	pXRF- 30
	Analyte	Zr	As	Ca	Cr	Cu	Fe	Mn	Ni	Pb	S	Zn	Ag	Mo	Sn	U
	Units	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
	LOD	0.5	50	0.5	100	50	0.5	100	50	50	0.1	50	100	50	100	50
PQ- 019		98.6	<50	3.1	100	<50	1.8	400	<50	<50	<0.1	100	<100	<50	<100	<50
PQ- 021		100.0	<50	<0.5	100	<50	1.4	300	<50	<50	0.2	110	<100	<50	<100	<50
PQ- 023		74.5	<50	0.5	100	<50	1.2	100	<50	<50	0.7	60	<100	<50	<100	<50
PQ- 027		82.1	<50	1.8	<100	<50	3.1	500	70	<50	<0.1	160	<100	<50	<100	<50
PQ- 030		87.8	<50	2.5	<100	<50	2.8	400	<50	<50	<0.1	120	<100	<50	<100	<50
PQ- 031		94.8	<50	2.6	<100	<50	2.8	300	<50	<50	0.5	110	<100	<50	<100	<50
PQ- 032		87.5	<50	3.1	<100	<50	2.7	300	<50	<50	0.2	110	<100	<50	<100	<50
PQ- 033		77.1	<50	2.9	<100	<50	1.9	300	<50	<50	0.3	120	<100	<50	<100	<50
SC- 001		123.0	<50	<0.5	100	60	7.6	200	50	<50	0.5	130	<100	<50	<100	<50
SC- 002		111.5	<50	0.8	100	<50	3.2	100	50	<50	5.0	150	<100	<50	<100	<50
SC- 003		123.5	<50	<0.5	100	<50	3.7	100	60	<50	1.3	150	<100	<50	<100	<50
SC- 004		129.0	<50	<0.5	100	<50	3.8	100	<50	<50	1.4	180	<100	<50	<100	<50

***** See Appendix Page for comments regarding this certificate *****

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To: TETRA TECH CANADA INC.
885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Finalized Date: 13- JUN- 2018
Account: TGM

Project: 704- ENG.VMIN03021- 01

CERTIFICATE OF ANALYSIS VA18132683

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

REE's may not be totally soluble in this method.
Applies to Method: ME- MS61

pXRF- 30 is a semi- quantitative scan with precision and accuracy in the order of 20% depending of sample type.
Applies to Method: pXRF- 30

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:			
C- GAS05	CRU- 31	CRU- QC	LOG- 22
ME- MS61	OA- ELE07	OA- VOL08	PUL- 31
pXRF- 30	S- GRA06	S- GRA06a	S- IR07
S- IR08	SPL- 21	WEI- 21	

Tetra Tech Canada Inc.
ATTN: James Barr
150 - 1715 Dickson Avenue
KELOWNA BC V1Y 9G6

Date Received: 31-MAY-18
Report Date: 13-JUN-18 11:30 (MT)
Version: FINAL

Client Phone: 250-862-4832

Certificate of Analysis

Lab Work Order #: L2104218

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers: 17-682632
Legal Site Desc:

Brent Mack, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2104218-1 WATER 31-MAY-18 12:30 PQ-WQ-001				
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	336				
	Hardness (as CaCO3) (mg/L)	201				
	pH (pH)	8.56				
	Total Suspended Solids (mg/L)	15.7				
	Total Dissolved Solids (mg/L)	265				
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	183				
	Alkalinity, Carbonate (as CaCO3) (mg/L)	15.6				
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Total (as CaCO3) (mg/L)	199				
	Ammonia, Total (as N) (mg/L)	0.0110				
	Chloride (Cl) (mg/L)	<0.50				
	Nitrate (as N) (mg/L)	0.0514				
	Nitrite (as N) (mg/L)	<0.0010				
	Total Kjeldahl Nitrogen (mg/L)	0.770				
	Total Nitrogen (mg/L)	0.823				
	Sulfate (SO4) (mg/L)	3.06				
Total Metals	Aluminum (Al)-Total (mg/L)	1.27				
	Antimony (Sb)-Total (mg/L)	0.00028				
	Arsenic (As)-Total (mg/L)	0.00128				
	Barium (Ba)-Total (mg/L)	0.176				
	Beryllium (Be)-Total (mg/L)	<0.00010				
	Bismuth (Bi)-Total (mg/L)	<0.000050				
	Boron (B)-Total (mg/L)	<0.010				
	Cadmium (Cd)-Total (mg/L)	0.000111				
	Calcium (Ca)-Total (mg/L)	55.3				
	Cesium (Cs)-Total (mg/L)	0.000295				
	Chromium (Cr)-Total (mg/L)	0.00321				
	Cobalt (Co)-Total (mg/L)	0.00107				
	Copper (Cu)-Total (mg/L)	0.00391				
	Iron (Fe)-Total (mg/L)	2.03				
	Lead (Pb)-Total (mg/L)	0.000998				
	Lithium (Li)-Total (mg/L)	0.0015				
	Magnesium (Mg)-Total (mg/L)	14.9				
	Manganese (Mn)-Total (mg/L)	0.0428				
	Mercury (Hg)-Total (mg/L)	DLM <0.000050				
	Molybdenum (Mo)-Total (mg/L)	0.00144				
	Nickel (Ni)-Total (mg/L)	0.00656				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2104218-1				
	Description	WATER				
	Sampled Date	31-MAY-18				
	Sampled Time	12:30				
	Client ID	PQ-WQ-001				
Grouping	**Analyte**					
WATER						
Total Metals	Phosphorus (P)-Total (mg/L)	0.100				
	Potassium (K)-Total (mg/L)	2.13				
	Rubidium (Rb)-Total (mg/L)	0.00334				
	Selenium (Se)-Total (mg/L)	0.000440				
	Silicon (Si)-Total (mg/L)	3.41				
	Silver (Ag)-Total (mg/L)	0.000065				
	Sodium (Na)-Total (mg/L)	0.994				
	Strontium (Sr)-Total (mg/L)	0.0729				
	Sulfur (S)-Total (mg/L)	1.26				
	Tellurium (Te)-Total (mg/L)	<0.00020				
	Thallium (Tl)-Total (mg/L)	0.000049				
	Thorium (Th)-Total (mg/L)	0.00028				
	Tin (Sn)-Total (mg/L)	<0.00010				
	Titanium (Ti)-Total (mg/L)	0.0184				
	Tungsten (W)-Total (mg/L)	<0.00010				
	Uranium (U)-Total (mg/L)	0.00139				
	Vanadium (V)-Total (mg/L)	0.00570				
	Zinc (Zn)-Total (mg/L)	0.0112				
	Zirconium (Zr)-Total (mg/L)	0.000431				
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD				
	Dissolved Metals Filtration Location	FIELD				
	Aluminum (Al)-Dissolved (mg/L)	0.0194				
	Antimony (Sb)-Dissolved (mg/L)	0.00016				
	Arsenic (As)-Dissolved (mg/L)	0.00037				
	Barium (Ba)-Dissolved (mg/L)	0.138				
	Beryllium (Be)-Dissolved (mg/L)	<0.00010				
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050				
	Boron (B)-Dissolved (mg/L)	<0.010				
	Cadmium (Cd)-Dissolved (mg/L)	0.0000181				
	Calcium (Ca)-Dissolved (mg/L)	55.7				
	Cesium (Cs)-Dissolved (mg/L)	<0.000010				
	Chromium (Cr)-Dissolved (mg/L)	0.00087				
	Cobalt (Co)-Dissolved (mg/L)	0.00030				
	Copper (Cu)-Dissolved (mg/L)	0.00156				
	Iron (Fe)-Dissolved (mg/L)	<0.010				
	Lead (Pb)-Dissolved (mg/L)	<0.000050				
	Lithium (Li)-Dissolved (mg/L)	<0.0010				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2104218-1				
	Description	WATER				
	Sampled Date	31-MAY-18				
	Sampled Time	12:30				
	Client ID	PQ-WQ-001				
Grouping	**Analyte**					
WATER						
Dissolved Metals	Magnesium (Mg)-Dissolved (mg/L)	15.0				
	Manganese (Mn)-Dissolved (mg/L)	0.00332				
	Mercury (Hg)-Dissolved (mg/L)	0.0000070				
	Molybdenum (Mo)-Dissolved (mg/L)	0.00130				
	Nickel (Ni)-Dissolved (mg/L)	0.00285				
	Phosphorus (P)-Dissolved (mg/L)	<0.050				
	Potassium (K)-Dissolved (mg/L)	1.84				
	Rubidium (Rb)-Dissolved (mg/L)	0.00027				
	Selenium (Se)-Dissolved (mg/L)	0.000405				
	Silicon (Si)-Dissolved (mg/L)	1.56				
	Silver (Ag)-Dissolved (mg/L)	0.000019				
	Sodium (Na)-Dissolved (mg/L)	1.01				
	Strontium (Sr)-Dissolved (mg/L)	0.0704				
	Sulfur (S)-Dissolved (mg/L)	1.20				
	Tellurium (Te)-Dissolved (mg/L)	<0.00020				
	Thallium (Tl)-Dissolved (mg/L)	<0.000010				
	Thorium (Th)-Dissolved (mg/L)	<0.00010				
	Tin (Sn)-Dissolved (mg/L)	<0.00010				
	Titanium (Ti)-Dissolved (mg/L)	<0.00030				
	Tungsten (W)-Dissolved (mg/L)	<0.00010				
	Uranium (U)-Dissolved (mg/L)	0.00134				
	Vanadium (V)-Dissolved (mg/L)	<0.00050				
	Zinc (Zn)-Dissolved (mg/L)	<0.0010				
	Zirconium (Zr)-Dissolved (mg/L)	0.000261				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
WSMT	Water sample(s) for total mercury analysis was not submitted in glass or PTFE container with HCl preservative. Results may be biased low.

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2104218-1
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2104218-1
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2104218-1
Matrix Spike	Calcium (Ca)-Total	MS-B	L2104218-1
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2104218-1
Matrix Spike	Manganese (Mn)-Total	MS-B	L2104218-1
Matrix Spike	Molybdenum (Mo)-Total	MS-B	L2104218-1
Matrix Spike	Potassium (K)-Total	MS-B	L2104218-1
Matrix Spike	Rubidium (Rb)-Total	MS-B	L2104218-1
Matrix Spike	Sodium (Na)-Total	MS-B	L2104218-1
Matrix Spike	Strontium (Sr)-Total	MS-B	L2104218-1
Matrix Spike	Sulfur (S)-Total	MS-B	L2104218-1
Matrix Spike	Total Nitrogen	MS-B	L2104218-1
Matrix Spike	Total Nitrogen	MS-B	L2104218-1

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Reference Information

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

N-T-COL-VA Water Total Nitrogen in water by Colour APHA4500-P(J)/NEMI9171/USGS03-4174

This analysis is carried out using procedures adapted from APHA Method 4500-P (J) "Persulphate Method for Simultaneous Determination of Total Nitrogen and Total Phosphorus" and National Environmental Methods Index - Nemi method 5735.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA Water Total Dissolved Solids by Gravimetric APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TKN-F-VA Water TKN in Water by Fluorescence APHA 4500-NORG D.

This analysis is carried out using procedures adapted from APHA Method 4500-Norg D. "Block Digestion and Flow Injection Analysis". Total Kjeldahl Nitrogen is determined using block digestion followed by Flow-injection analysis with fluorescence detection.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

17-682632

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2104218-COFC

COC Number: 17 - 682632

Page of

Report To — Contact and company name below will appear on the final report

Company:	TETRA TECH
Contact:	JAMES BARR
Phone:	778-940-1233

Company address below will appear on the final report

Street:	150-1715 DICKSON AV
City/Province:	KELOWNA, BC
Postal Code:	V1Y 9G6

Invoice To

Same as Report To	☑ YES ☐ NO
Copy of Invoice with Report	☑ YES ☐ NO
Company:	
Contact:	

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: james.barr@tetratech.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: james.barr@tetratech.com

Email 2: EBA.AccountsPayable@tetratech.com

Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)

Regular [R] ☐ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4-20%] ☒; 3 day [P3-25%] ☐; 2 day [P2-50%] ☐

EMERGENCY: 1 Business day [E-100%] ☐; Same Day, Weekend or Statutory holiday [E2-200% (Laboratory opening fees may apply)] ☐

dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:	
Job #:	
PO / AFE:	
LSD:	

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	
ALS Contact:	Sampler:

ALS Lab Work Order # (lab use only): L2104218

Analysis Request — Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Alkalinity (Species)	Chloride	Conductivity	Hardness	Diss Metals	Tot Metals	N Species	pH	Sulphate	TDS	TSS	SAMPLES ON HOLD	Sample is hazardous (please provide further details)	NUMBER OF CONTAINERS
	PQ-WQ-001	31-05-18	12:30pm	H_2O	/	/	/	/	/	/	/	/	/	/	/			
		Total	1 sample															

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☐ NO

Are samples for human consumption/ use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

compare to BC-AWQG. (Short Term Max)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C: 10°C

FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)

Released by: [signature] Date: May 31/18 Time: 4:30

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: [signature] Date: May 31/18 Time: 4:30

FINAL SHIPMENT RECEPTION (lab use only)

Received by: Date: Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees ... specified

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: TETRA TECH CANADA INC.
885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Finalized Date: 13-JUN-2018
Account: TGM

QC CERTIFICATE VA18132683

Project: 704-ENG.VMIN03021-01

This report is for 12 Rock samples submitted to our lab in Vancouver, BC, Canada on 1-JUN-2018.

The following have access to data associated with this certificate:

J. BARR

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
CRU-31	Fine crushing - 70% <2mm
CRU-QC	Crushing QC Test
SPL-21	Split sample - riffle splitter
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	INSTRUMENT
S-IR07	Sulphide Sulphur (Leco)	LECO
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS61	48 element four acid ICP-MS	
pXRF-30	Semi-Quantitative pXRF Scan	PXRF
OA-VOL08	Basic Acid Base Accounting	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

ALS Canada Ltd.

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To: TETRA TECH CANADA INC.
885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Finalized Date: 13- JUN- 2018
Account: TGM

Project: 704- ENG.VMIN03021- 01

QC CERTIFICATE OF ANALYSIS VA18132683

Sample Description / Method	OA- VOL08	OA- VOL08	OA- VOL08	OA- VOL08	OA- ELE07	OA- VOL08	S- IR08	S- GRA06	S- GRA06a	S- IR07	C- GAS05	C- GAS05	ME- MS61	ME- MS61	ME- MS61
Analyte	FIZZ RAT	MPA	NNP	NP	pH	Ratio (N	S	S	S	Sulphide	C	CO2	Ag	Al	As
Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
LOD	1	0.3	1	1	0.1	0.01	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.2
STANDARDS															
Buffer pH6					6.1										
Buffer pH6					6.0										
Target Range - Lower Bound					5.3										
Upper Bound					6.7										
CALSTD															
Target Range - Lower Bound															
Upper Bound															
CO- ASSAY											0.49	1.8			
Target Range - Lower Bound											0.42	1.5			
Upper Bound											0.64	2.4			
GS310- 10							0.27								
Target Range - Lower Bound							0.25								
Upper Bound							0.29								
KZK- 1	2	25.0	31	56		2.24									
Target Range - Lower Bound		22.9	30	54		2.18									
Upper Bound		27.1	38	64		2.54									
MA- 1b							1.18								
Target Range - Lower Bound							1.12								
Upper Bound							1.22								
MA- 2c											1.53	5.6			
Target Range - Lower Bound											1.50	5.5			
Upper Bound											1.84	6.8			
MRGeo08													4.13	7.29	33.4
Target Range - Lower Bound													4.00	6.64	29.5
Upper Bound													4.92	8.14	36.5
NBM- 1	2	8.8	40	49		5.60									
Target Range - Lower Bound		7.8	37	45		5.26									
Upper Bound		9.7	47	54		6.08									
OGGeo08													20.3	6.74	128.0
Target Range - Lower Bound													18.15	6.07	106.0
Upper Bound													22.2	7.44	130.0
OREAS 36															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

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www.alsglobal.com/geochemistry

To: TETRA TECH CANADA INC.
885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Finalized Date: 13-JUN-2018
Account: TGM

Project: 704-ENG.VMIN03021-01

QC CERTIFICATE OF ANALYSIS VA18132683

Sample Description	Method / Analyte / Units / LOD	ME-MS61 Ba ppm 10	ME-MS61 Be ppm 0.05	ME-MS61 Bi ppm 0.01	ME-MS61 Ca % 0.01	ME-MS61 Cd ppm 0.02	ME-MS61 Ce ppm 0.01	ME-MS61 Co ppm 0.1	ME-MS61 Cr ppm 1	ME-MS61 Cs ppm 0.05	ME-MS61 Cu ppm 0.2	ME-MS61 Fe % 0.01	ME-MS61 Ga ppm 0.05	ME-MS61 Ge ppm 0.05	ME-MS61 Hf ppm 0.1	ME-MS61 In ppm 0.005
		STANDARDS														
Buffer pH6																
Buffer pH6																
Target Range -	Lower Bound															
	Upper Bound															
CALSTD																
Target Range -	Lower Bound															
	Upper Bound															
CO-ASSAY																
Target Range -	Lower Bound															
	Upper Bound															
GS310-10																
Target Range -	Lower Bound															
	Upper Bound															
KZK-1																
Target Range -	Lower Bound															
	Upper Bound															
MA-1b																
Target Range -	Lower Bound															
	Upper Bound															
MA-2c																
Target Range -	Lower Bound															
	Upper Bound															
MRGeo08		1120	2.99	0.61	2.66	2.35	67.0	21.2	95	11.65	637	4.00	20.4	0.26	3.3	0.189
Target Range -	Lower Bound	920	2.98	0.60	2.35	2.00	66.2	17.7	81	11.20	587	3.55	17.50	<0.05	2.8	0.155
	Upper Bound	1270	3.76	0.76	2.90	2.48	81.0	21.9	102	13.80	675	4.37	21.5	0.27	3.6	0.201
NBM-1																
Target Range -	Lower Bound															
	Upper Bound															
OGGeo08		920	3.13	9.70	2.28	20.7	63.6	104.0	92	11.15	8540	5.51	19.40	0.12	3.2	1.595
Target Range -	Lower Bound	700	2.59	9.44	1.98	16.70	64.8	87.2	78	9.85	7800	4.81	16.05	0.25	2.5	1.320
	Upper Bound	980	3.27	11.55	2.44	20.5	79.2	107.0	98	12.15	8980	5.91	19.75	0.49	3.3	1.620
OREAS 36																
Target Range -	Lower Bound															
	Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

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To: TETRA TECH CANADA INC.
885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Finalized Date: 13-JUN-2018
Account: TGM

Project: 704-ENG.VMIN03021-01

QC CERTIFICATE OF ANALYSIS VA18132683

Sample Description	Method / Analyte / Units / LOD	ME-MS61 K % 0.01	ME-MS61 La ppm 0.5	ME-MS61 Li ppm 0.2	ME-MS61 Mg % 0.01	ME-MS61 Mn ppm 5	ME-MS61 Mo ppm 0.05	ME-MS61 Na % 0.01	ME-MS61 Nb ppm 0.1	ME-MS61 Ni ppm 0.2	ME-MS61 P ppm 10	ME-MS61 Pb ppm 0.5	ME-MS61 Rb ppm 0.1	ME-MS61 Re ppm 0.002	ME-MS61 S % 0.01	ME-MS61 Sb ppm 0.05
								STANDARDS								
Buffer pH6																
Buffer pH6																
Target Range -	Lower Bound															
	Upper Bound															
CALSTD																
Target Range -	Lower Bound															
	Upper Bound															
CO-ASSAY																
Target Range -	Lower Bound															
	Upper Bound															
GS310-10																
Target Range -	Lower Bound															
	Upper Bound															
KZK-1																
Target Range -	Lower Bound															
	Upper Bound															
MA-1b																
Target Range -	Lower Bound															
	Upper Bound															
MA-2c																
Target Range -	Lower Bound															
	Upper Bound															
MRGeo08		3.18	32.3	30.1	1.32	573	15.85	2.03	21.4	719	1090	1120	173.0	0.006	0.32	4.73
Target Range -	Lower Bound	2.79	31.1	29.5	1.17	497	13.65	1.76	19.0	622	930	971	173.5	0.005	0.27	3.89
	Upper Bound	3.43	39.1	36.5	1.45	619	16.75	2.18	23.4	760	1160	1185	212	0.013	0.35	5.39
NBM-1																
Target Range -	Lower Bound															
	Upper Bound															
OGGeo08		3.01	29.0	36.0	1.27	530	934	1.91	18.2	9030	870	7560	171.0	1.480	2.93	28.9
Target Range -	Lower Bound	2.59	31.0	29.7	1.11	447	841	1.62	15.4	8000	760	6520	164.5	1.285	2.51	22.8
	Upper Bound	3.19	39.0	36.7	1.38	557	1030	2.00	19.0	9770	950	7970	201	1.575	3.09	31.0
OREAS 36																
Target Range -	Lower Bound															
	Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

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To: TETRA TECH CANADA INC.
885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Finalized Date: 13- JUN- 2018
Account: TGM

Project: 704- ENG.VMIN03021- 01

QC CERTIFICATE OF ANALYSIS VA18132683

Sample Description — Method / Analyte / Units / LOD	ME- MS61 Sc ppm 0.1	ME- MS61 Se ppm 1	ME- MS61 Sn ppm 0.2	ME- MS61 Sr ppm 0.2	ME- MS61 Ta ppm 0.05	ME- MS61 Te ppm 0.05	ME- MS61 Th ppm 0.01	ME- MS61 Ti % 0.005	ME- MS61 Tl ppm 0.02	ME- MS61 U ppm 0.1	ME- MS61 V ppm 1	ME- MS61 W ppm 0.1	ME- MS61 Y ppm 0.1	ME- MS61 Zn ppm 2	ME- MS61 Zr ppm 0.5
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CALSTD															
Target Range - Lower Bound															
Upper Bound															
CO- ASSAY															
Target Range - Lower Bound															
Upper Bound															
GS310- 10															
Target Range - Lower Bound															
Upper Bound															
KZK- 1															
Target Range - Lower Bound															
Upper Bound															
MA- 1b															
Target Range - Lower Bound															
Upper Bound															
MA- 2c															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	10.8	1	4.1	314	1.54	<0.05	16.80	0.513	1.09	4.9	113	5.0	24.1	830	116.0
Target Range - Lower Bound	11.1	<1	3.5	277	1.39	<0.05	17.90	0.443	0.89	4.9	97	4.1	23.8	722	92.2
Upper Bound	13.7	4	4.7	339	1.81	0.14	21.9	0.553	1.25	6.2	121	5.8	29.3	886	126.0
NBM- 1															
Target Range - Lower Bound															
Upper Bound															
OGGeo08	10.2	12	15.5	264	1.42	0.18	14.90	0.414	1.86	4.8	91	5.1	23.2	7390	103.0
Target Range - Lower Bound	9.2	8	12.5	224	1.19	0.09	16.90	0.353	1.43	4.5	77	3.9	21.1	6500	78.6
Upper Bound	11.4	14	15.7	274	1.57	0.31	20.7	0.443	1.98	5.8	97	5.4	26.0	7950	107.5
OREAS 36															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

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To: TETRA TECH CANADA INC.
885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Finalized Date: 13-JUN-2018
Account: TGM

Project: 704-ENG.VMIN03021-01

QC CERTIFICATE OF ANALYSIS VA18132683

Sample Description	Method / Analyte / Units / LOD	pXRF-30 As ppm 50	pXRF-30 Ca % 0.5	pXRF-30 Cr ppm 100	pXRF-30 Cu ppm 50	pXRF-30 Fe % 0.5	pXRF-30 Mn ppm 100	pXRF-30 Ni ppm 50	pXRF-30 Pb ppm 50	pXRF-30 S % 0.1	pXRF-30 Zn ppm 50	pXRF-30 Ag ppm 100	pXRF-30 Mo ppm 50	pXRF-30 Sn ppm 100	pXRF-30 U ppm 50
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range -	Lower Bound														
	Upper Bound														
CALSTD		<50	<0.5	137000	4220	58.4	17500	69300	440	1.7	<50	<100	>10000	100	100
Target Range -	Lower Bound	<50	<0.5	109000	3540	50.2	15400	61500	440	1.4	<50	<100	7950	<100	<50
	Upper Bound	100	1.2	>150000	5430	70.0	23300	92400	830	2.4	100	200	>10000	200	100
CO-ASSAY															
Target Range -	Lower Bound														
	Upper Bound														
GS310-10															
Target Range -	Lower Bound														
	Upper Bound														
KZK-1															
Target Range -	Lower Bound														
	Upper Bound														
MA-1b															
Target Range -	Lower Bound														
	Upper Bound														
MA-2c															
Target Range -	Lower Bound														
	Upper Bound														
MRGeo08															
Target Range -	Lower Bound														
	Upper Bound														
NBM-1															
Target Range -	Lower Bound														
	Upper Bound														
OGGeo08															
Target Range -	Lower Bound														
	Upper Bound														
OREAS 36		580	<0.5	<100	120	18.2	9900	<50	5080	17.1	36300	<100	<50	<100	<50
Target Range -	Lower Bound	510	<0.5	<100	<50	16.0	8500	<50	4580	14.9	33800	<100	<50	<100	<50
	Upper Bound	930	1.0	200	270	25.3	13100	100	7000	22.7	50800	200	100	200	100

***** See Appendix Page for comments regarding this certificate *****

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To: TETRA TECH CANADA INC.
885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Finalized Date: 13-JUN-2018
Account: TGM

Project: 704-ENG.VMIN03021-01

QC CERTIFICATE OF ANALYSIS VA18132683

Sample Description / Method / Analyte / Units / LOD	OA-VOL08 FIZZ RAT Unity 1	OA-VOL08 MPA tCaCO3/1Kt 0.3	OA-VOL08 NNP tCaCO3/1Kt 1	OA-VOL08 NP tCaCO3/1Kt 1	OA-ELE07 pH Unity 0.1	OA-VOL08 Ratio (N Unity 0.01	S-IR08 S % 0.01	S-GRA06 S % 0.01	S-GRA06a S % 0.01	S-IR07 Sulphide % 0.01	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2	ME-MS61 Ag ppm 0.01	ME-MS61 Al % 0.01	ME-MS61 As ppm 0.2
STANDARDS															
OREAS 905													0.56	7.56	35.3
Target Range - Lower Bound													0.46	6.67	31.0
Upper Bound													0.58	8.17	38.4
OREAS 920													0.11	7.70	5.1
Target Range - Lower Bound													0.08	6.91	4.4
Upper Bound													0.13	8.47	5.8
OREAS-96															
Target Range - Lower Bound															
Upper Bound															
UTS-1								0.83							
Target Range - Lower Bound								0.83							
Upper Bound								0.93							
UTS-1									0.86						
Target Range - Lower Bound									0.81						
Upper Bound									0.95						
UTS-1										0.11					
Target Range - Lower Bound										0.10					
Upper Bound										0.14					
UTS-2										2.98					
Target Range - Lower Bound										2.78					
Upper Bound										3.10					
UTS-4								1.69							
Target Range - Lower Bound								1.64							
Upper Bound								1.84							
UTS-4									1.69						
Target Range - Lower Bound									1.61						
Upper Bound									1.87						
BLANKS															
BLANK											<0.05	<0.2			
Target Range - Lower Bound											<0.05	<0.2			
Upper Bound											0.10	0.4			

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Finalized Date: 13-JUN-2018
Account: TGM

Project: 704-ENG.VMIN03021-01

QC CERTIFICATE OF ANALYSIS VA18132683

Sample Description	Method Analyte Units LOD	ME-MS61 Ba ppm 10	ME-MS61 Be ppm 0.05	ME-MS61 Bi ppm 0.01	ME-MS61 Ca % 0.01	ME-MS61 Cd ppm 0.02	ME-MS61 Ce ppm 0.01	ME-MS61 Co ppm 0.1	ME-MS61 Cr ppm 1	ME-MS61 Cs ppm 0.05	ME-MS61 Cu ppm 0.2	ME-MS61 Fe % 0.01	ME-MS61 Ga ppm 0.05	ME-MS61 Ge ppm 0.05	ME-MS61 Hf ppm 0.1	ME-MS61 In ppm 0.005
							STANDARDS									
OREAS 905		2830	2.86	5.46	0.61	0.33	102.0	15.9	20	6.81	1535	4.10	26.5	0.33	7.2	0.650
Target Range -	Lower Bound	2280	2.69	5.14	0.52	0.30	82.8	13.2	16	6.05	1425	3.66	22.5	<0.05	6.1	0.571
	Upper Bound	3110	3.39	6.30	0.66	0.42	101.0	16.4	22	7.51	1640	4.50	27.7	0.27	7.6	0.709
OREAS 920		550	2.97	0.78	0.49	0.02	99.2	16.1	87	8.72	105.5	4.06	21.6	0.07	4.8	0.087
Target Range -	Lower Bound	450	2.54	0.61	0.44	0.04	84.6	13.9	70	7.72	104.0	3.72	18.65	0.06	4.0	0.070
	Upper Bound	640	3.22	0.77	0.56	0.12	103.5	17.3	88	9.54	120.0	4.56	22.9	0.28	5.2	0.098
OREAS-96																
Target Range -	Lower Bound															
	Upper Bound															
UTS-1																
Target Range -	Lower Bound															
	Upper Bound															
UTS-1																
Target Range -	Lower Bound															
	Upper Bound															
UTS-1																
Target Range -	Lower Bound															
	Upper Bound															
UTS-2																
Target Range -	Lower Bound															
	Upper Bound															
UTS-4																
Target Range -	Lower Bound															
	Upper Bound															
UTS-4																
Target Range -	Lower Bound															
	Upper Bound															
							BLANKS									
BLANK																
Target Range -	Lower Bound															
	Upper Bound															

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Finalized Date: 13-JUN-2018
Account: TGM

Project: 704-ENG.VMIN03021-01

QC CERTIFICATE OF ANALYSIS VA18132683

Sample Description	Method / Analyte / Units / LOD	ME-MS61 K % 0.01	ME-MS61 La ppm 0.5	ME-MS61 Li ppm 0.2	ME-MS61 Mg % 0.01	ME-MS61 Mn ppm 5	ME-MS61 Mo ppm 0.05	ME-MS61 Na % 0.01	ME-MS61 Nb ppm 0.1	ME-MS61 Ni ppm 0.2	ME-MS61 P ppm 10	ME-MS61 Pb ppm 0.5	ME-MS61 Rb ppm 0.1	ME-MS61 Re ppm 0.002	ME-MS61 S % 0.01	ME-MS61 Sb ppm 0.05
STANDARDS																
OREAS 905		2.98	51.6	18.9	0.27	381	3.48	2.46	18.4	9.8	280	28.9	144.5	<0.002	0.07	1.96
Target Range -	Lower Bound	2.58	40.9	17.8	0.24	333	2.89	2.15	16.2	8.4		26.9	124.0	<0.002	0.04	1.61
	Upper Bound	3.18	51.1	22.2	0.31	418	3.65	2.65	20.0	10.7		33.9	152.0	0.004	0.09	2.29
OREAS 920		2.83	47.3	31.9	1.33	592	0.46	0.64	17.3	42.4	760	23.4	180.0	<0.002	0.03	1.59
Target Range -	Lower Bound	2.59	41.0	26.0	1.23	535	0.34	0.56	15.6	37.4		20.7	158.5	<0.002	<0.01	1.22
	Upper Bound	3.19	51.2	32.2	1.53	665	0.58	0.71	19.2	46.2		26.4	193.5	0.004	0.05	1.76
OREAS-96																
Target Range -	Lower Bound															
	Upper Bound															
UTS-1																
Target Range -	Lower Bound															
	Upper Bound															
UTS-1																
Target Range -	Lower Bound															
	Upper Bound															
UTS-1																
Target Range -	Lower Bound															
	Upper Bound															
UTS-2																
Target Range -	Lower Bound															
	Upper Bound															
UTS-4																
Target Range -	Lower Bound															
	Upper Bound															
UTS-4																
Target Range -	Lower Bound															
	Upper Bound															
BLANKS																
BLANK																
Target Range -	Lower Bound															
	Upper Bound															

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Finalized Date: 13- JUN- 2018
Account: TGM

Project: 704- ENG.VMIN03021- 01

QC CERTIFICATE OF ANALYSIS VA18132683

Sample Description	Method Analyte Units LOD	ME- MS61 Sc ppm 0.1	ME- MS61 Se ppm 1	ME- MS61 Sn ppm 0.2	ME- MS61 Sr ppm 0.2	ME- MS61 Ta ppm 0.05	ME- MS61 Te ppm 0.05	ME- MS61 Th ppm 0.01	ME- MS61 Ti % 0.005	ME- MS61 Tl ppm 0.02	ME- MS61 U ppm 0.1	ME- MS61 V ppm 1	ME- MS61 W ppm 0.1	ME- MS61 Y ppm 0.1	ME- MS61 Zn ppm 2	ME- MS61 Zr ppm 0.5
							STANDARDS									
OREAS 905		5.0	3	4.0	163.0	1.34	0.08	15.00	0.127	0.75	4.8	10	3.0	16.2	143	273
Target Range -	Lower Bound	4.3	<1	3.4	141.0	1.16	<0.05	13.15	0.105	0.59	4.4	8	2.3	14.0	122	214
	Upper Bound	5.5	5	4.6	173.0	1.52	0.19	16.05	0.139	0.85	5.6	13	3.3	17.4	154	290
OREAS 920		14.5	1	5.3	82.9	1.42	<0.05	17.75	0.474	0.94	3.8	98	3.5	34.8	116	159.5
Target Range -	Lower Bound	12.8	<1	4.3	73.6	1.08	<0.05	17.35	0.434	0.76	3.3	86	2.5	29.8	102	128.0
	Upper Bound	15.8	2	5.7	90.4	1.43	0.10	21.2	0.542	1.08	4.2	108	3.7	36.6	130	174.0
OREAS- 96																
Target Range -	Lower Bound															
	Upper Bound															
UTS- 1																
Target Range -	Lower Bound															
	Upper Bound															
UTS- 1																
Target Range -	Lower Bound															
	Upper Bound															
UTS- 1																
Target Range -	Lower Bound															
	Upper Bound															
UTS- 2																
Target Range -	Lower Bound															
	Upper Bound															
UTS- 4																
Target Range -	Lower Bound															
	Upper Bound															
UTS- 4																
Target Range -	Lower Bound															
	Upper Bound															
								BLANKS								
BLANK																
Target Range -	Lower Bound															
	Upper Bound															

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Finalized Date: 13-JUN-2018
Account: TGM

Project: 704-ENG.VMIN03021-01

QC CERTIFICATE OF ANALYSIS VA18132683

Sample Description	Method / Analyte / Units / LOD	pXRF-30 As ppm 50	pXRF-30 Ca % 0.5	pXRF-30 Cr ppm 100	pXRF-30 Cu ppm 50	pXRF-30 Fe % 0.5	pXRF-30 Mn ppm 100	pXRF-30 Ni ppm 50	pXRF-30 Pb ppm 50	pXRF-30 S % 0.1	pXRF-30 Zn ppm 50	pXRF-30 Ag ppm 100	pXRF-30 Mo ppm 50	pXRF-30 Sn ppm 100	pXRF-30 U ppm 50
STANDARDS															
OREAS 905															
Target Range - Lower Bound															
Upper Bound															
OREAS 920															
Target Range - Lower Bound															
Upper Bound															
OREAS-96		<50	<0.5	100	43900	10.5	900	<50	120	5.1	580	<100	<50	100	<50
Target Range - Lower Bound		<50	<0.5	<100	31400	7.6	500	<50	<50	3.4	290	<100	<50	<100	<50
Upper Bound		100	1.0	300	47200	12.7	1100	100	220	5.3	630	200	100	200	100
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-2															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															

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Finalized Date: 13-JUN-2018
Account: TGM

Project: 704-ENG.VMIN03021-01

QC CERTIFICATE OF ANALYSIS VA18132683

Sample Description — Method / Analyte / Units / LOD	OA-VOL08 FIZZ RAT Unity 1	OA-VOL08 MPA tCaCO3/1Kt 0.3	OA-VOL08 NNP tCaCO3/1Kt 1	OA-VOL08 NP tCaCO3/1Kt 1	OA-ELE07 pH Unity 0.1	OA-VOL08 Ratio (N Unity 0.01	S-IR08 S % 0.01	S-GRA06 S % 0.01	S-GRA06a S % 0.01	S-IR07 Sulphide % 0.01	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2	ME-MS61 Ag ppm 0.01	ME-MS61 Al % 0.01	ME-MS61 As ppm 0.2
BLANKS															
BLANK													<0.01	<0.01	0.4
BLANK													<0.01	<0.01	<0.2
Target Range - Lower Bound													<0.01	<0.01	<0.2
Upper Bound													0.02	0.02	0.4
BLANK					6.1										
Target Range - Lower Bound					5.5										
Upper Bound					6.9										
BLANK								<0.01							
Target Range - Lower Bound								<0.01							
Upper Bound								0.02							
BLANK									<0.01						
Target Range - Lower Bound									<0.01						
Upper Bound									0.02						
BLANK										<0.01					
Target Range - Lower Bound										<0.01					
Upper Bound										0.02					
BLANK							0.01								
Target Range - Lower Bound							<0.01								
Upper Bound							0.02								
DUPLICATES															
ORIGINAL													0.01	0.15	0.8
DUP													0.01	0.14	0.6
Target Range - Lower Bound													<0.01	0.13	0.5
Upper Bound													0.02	0.16	0.9
ORIGINAL													<0.01	0.17	<0.2
DUP													<0.01	0.18	0.6
Target Range - Lower Bound													<0.01	0.16	<0.2
Upper Bound													0.02	0.19	0.6
SC-002	1	126.6	-115	12	7.4	0.09	4.05	3.12	3.12	0.67	0.07	0.2			
DUP	1	125.6	-114	12	7.3	0.10	4.02	3.19	3.17	0.69	0.07	0.2			
Target Range - Lower Bound	<1	119.5	-121	10	6.9	0.08	3.92	3.03	2.98	0.65	<0.05	<0.2			
Upper Bound	2	132.7	-108	14	7.8	0.11	4.15	3.28	3.31	0.71	0.10	0.4			

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Finalized Date: 13-JUN-2018
Account: TGM

Project: 704-ENG.VMIN03021-01

QC CERTIFICATE OF ANALYSIS VA18132683

Sample Description / Method / Analyte / Units / LOD	ME-MS61 Ba ppm 10	ME-MS61 Be ppm 0.05	ME-MS61 Bi ppm 0.01	ME-MS61 Ca % 0.01	ME-MS61 Cd ppm 0.02	ME-MS61 Ce ppm 0.01	ME-MS61 Co ppm 0.1	ME-MS61 Cr ppm 1	ME-MS61 Cs ppm 0.05	ME-MS61 Cu ppm 0.2	ME-MS61 Fe % 0.01	ME-MS61 Ga ppm 0.05	ME-MS61 Ge ppm 0.05	ME-MS61 Hf ppm 0.1	ME-MS61 In ppm 0.005
BLANKS															
BLANK	<10	<0.05	0.01	<0.01	<0.02	0.01	<0.1	<1	<0.05	<0.2	<0.01	0.07	<0.05	<0.1	<0.005
BLANK	<10	<0.05	<0.01	<0.01	<0.02	<0.01	<0.1	<1	<0.05	0.4	<0.01	<0.05	<0.05	<0.1	<0.005
Target Range - Lower Bound	<10	<0.05	<0.01	<0.01	<0.02	<0.01	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05	<0.1	<0.005
Upper Bound	20	0.10	0.02	0.02	0.04	0.02	0.2	2	0.10	0.4	0.02	0.10	0.10	0.2	0.010
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
ORIGINAL	<10	<0.05	0.02	<0.01	<0.02	0.70	0.8	38	<0.05	3.5	0.79	0.52	<0.05	<0.1	<0.005
DUP	<10	<0.05	0.02	<0.01	<0.02	0.63	0.9	37	<0.05	3.3	0.78	0.53	<0.05	<0.1	<0.005
Target Range - Lower Bound	<10	<0.05	<0.01	<0.01	<0.02	0.62	0.7	35	<0.05	3.1	0.74	0.45	<0.05	<0.1	<0.005
Upper Bound	20	0.10	0.03	0.02	0.04	0.71	1.0	40	0.10	3.7	0.83	0.60	0.10	0.2	0.010
ORIGINAL	<10	0.07	0.01	<0.01	<0.02	37.4	0.2	24	<0.05	0.8	0.33	0.59	0.08	0.4	<0.005
DUP	10	0.08	0.01	<0.01	<0.02	39.3	0.2	18	<0.05	0.9	0.30	0.70	0.08	0.5	<0.005
Target Range - Lower Bound	<10	<0.05	<0.01	<0.01	<0.02	36.4	<0.1	19	<0.05	0.6	0.29	0.56	<0.05	0.3	<0.005
Upper Bound	20	0.10	0.02	0.02	0.04	40.3	0.3	23	0.10	1.1	0.34	0.73	0.10	0.6	0.010
SC-002															
DUP															
Target Range - Lower Bound															
Upper Bound															

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Finalized Date: 13-JUN-2018
Account: TGM

Project: 704-ENG.VMIN03021-01

QC CERTIFICATE OF ANALYSIS VA18132683

Sample Description	Method / Analyte / Units / LOD	ME-MS61 K % 0.01	ME-MS61 La ppm 0.5	ME-MS61 Li ppm 0.2	ME-MS61 Mg % 0.01	ME-MS61 Mn ppm 5	ME-MS61 Mo ppm 0.05	ME-MS61 Na % 0.01	ME-MS61 Nb ppm 0.1	ME-MS61 Ni ppm 0.2	ME-MS61 P ppm 10	ME-MS61 Pb ppm 0.5	ME-MS61 Rb ppm 0.1	ME-MS61 Re ppm 0.002	ME-MS61 S % 0.01	ME-MS61 Sb ppm 0.05
								BLANKS								
BLANK		<0.01	<0.5	0.2	<0.01	<5	<0.05	<0.01	<0.1	<0.2	<10	<0.5	<0.1	<0.002	<0.01	0.05
BLANK		<0.01	<0.5	0.3	<0.01	<5	<0.05	<0.01	<0.1	<0.2	<10	<0.5	<0.1	<0.002	<0.01	0.05
Target Range - Lower Bound		<0.01	<0.5	<0.2	<0.01	<5	<0.05	<0.01	<0.1	<0.2	<10	<0.5	<0.1	<0.002	<0.01	<0.05
Upper Bound		0.02	1.0	0.4	0.02	10	0.10	0.02	0.2	0.4	20	1.0	0.2	0.004	0.02	0.10
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
								DUPLICATES								
ORIGINAL		0.01	<0.5	<0.2	<0.01	93	4.66	0.09	0.8	9.6	10	<0.5	0.3	<0.002	<0.01	0.14
DUP		<0.01	<0.5	0.9	<0.01	92	4.65	0.09	0.7	9.7	10	<0.5	0.2	<0.002	<0.01	0.15
Target Range - Lower Bound		<0.01	<0.5	0.3	<0.01	83	4.37	0.08	0.6	9.0	<10	<0.5	<0.1	<0.002	<0.01	0.08
Upper Bound		0.02	1.0	0.8	0.02	102	4.94	0.10	0.9	10.3	20	1.0	0.4	0.004	0.02	0.21
ORIGINAL		0.02	16.5	7.5	<0.01	35	0.15	<0.01	0.3	1.1	20	<0.5	0.8	<0.002	<0.01	0.06
DUP		0.02	17.5	7.9	<0.01	32	0.12	0.01	0.3	1.0	30	0.5	1.0	<0.002	<0.01	0.05
Target Range - Lower Bound		<0.01	15.7	7.1	<0.01	27	0.08	<0.01	0.2	0.8	<10	<0.5	0.8	<0.002	<0.01	<0.05
Upper Bound		0.03	18.4	8.3	0.02	40	0.19	0.02	0.4	1.3	40	1.0	1.0	0.004	0.02	0.10
SC-002																
DUP																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

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Finalized Date: 13-JUN-2018
Account: TGM

Project: 704-ENG.VMIN03021-01

QC CERTIFICATE OF ANALYSIS VA18132683

Sample Description	Method / Analyte / Units / LOD	ME-MS61 Sc ppm 0.1	ME-MS61 Se ppm 1	ME-MS61 Sn ppm 0.2	ME-MS61 Sr ppm 0.2	ME-MS61 Ta ppm 0.05	ME-MS61 Te ppm 0.05	ME-MS61 Th ppm 0.01	ME-MS61 Ti % 0.005	ME-MS61 Tl ppm 0.02	ME-MS61 U ppm 0.1	ME-MS61 V ppm 1	ME-MS61 W ppm 0.1	ME-MS61 Y ppm 0.1	ME-MS61 Zn ppm 2	ME-MS61 Zr ppm 0.5
BLANKS																
BLANK		<0.1	1	<0.2	<0.2	<0.05	<0.05	<0.01	<0.005	<0.02	<0.1	<1	<0.1	<0.1	<2	<0.5
BLANK		<0.1	1	<0.2	<0.2	<0.05	<0.05	<0.01	<0.005	<0.02	<0.1	<1	<0.1	<0.1	<2	<0.5
Target Range -	Lower Bound	<0.1	<1	<0.2	<0.2	<0.05	<0.05	<0.01	<0.005	<0.02	<0.1	<1	<0.1	<0.1	<2	<0.5
	Upper Bound	0.2	2	0.4	0.4	0.10	0.10	0.02	0.010	0.04	0.2	2	0.2	0.2	4	1.0
BLANK																
Target Range -	Lower Bound															
	Upper Bound															
BLANK																
Target Range -	Lower Bound															
	Upper Bound															
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Target Range -	Lower Bound															
	Upper Bound															
BLANK																
Target Range -	Lower Bound															
	Upper Bound															
BLANK																
Target Range -	Lower Bound															
	Upper Bound															
DUPLICATES																
ORIGINAL		0.1	1	0.2	3.5	<0.05	0.14	0.03	<0.005	<0.02	<0.1	3	0.1	0.2	<2	1.3
DUP		0.1	1	0.2	3.3	<0.05	0.13	0.03	<0.005	<0.02	<0.1	3	0.1	0.2	<2	1.3
Target Range -	Lower Bound	<0.1	<1	<0.2	3.0	<0.05	0.08	0.02	<0.005	<0.02	<0.1	2	<0.1	<0.1	<2	0.7
	Upper Bound	0.2	2	0.4	3.8	0.10	0.19	0.04	0.010	0.04	0.2	4	0.2	0.3	4	1.9
ORIGINAL		0.1	1	<0.2	0.8	<0.05	<0.05	2.39	0.021	<0.02	0.2	2	0.6	4.1	<2	15.8
DUP		0.2	1	<0.2	1.1	<0.05	<0.05	2.53	0.022	<0.02	0.2	2	0.6	4.4	<2	18.0
Target Range -	Lower Bound	<0.1	<1	<0.2	0.7	<0.05	<0.05	2.33	0.015	<0.02	<0.1	<1	0.5	3.9	<2	15.1
	Upper Bound	0.2	2	0.4	1.2	0.10	0.10	2.59	0.028	0.04	0.3	3	0.7	4.6	4	18.7
SC-002																
DUP																
Target Range -	Lower Bound															
	Upper Bound															

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VANCOUVER BC V6C 1N5

Finalized Date: 13- JUN- 2018
Account: TGM

Project: 704- ENG.VMIN03021- 01

QC CERTIFICATE OF ANALYSIS VA18132683

Sample Description	Method / Analyte / Units / LOD	pXRF- 30 As ppm 50	pXRF- 30 Ca % 0.5	pXRF- 30 Cr ppm 100	pXRF- 30 Cu ppm 50	pXRF- 30 Fe % 0.5	pXRF- 30 Mn ppm 100	pXRF- 30 Ni ppm 50	pXRF- 30 Pb ppm 50	pXRF- 30 S % 0.1	pXRF- 30 Zn ppm 50	pXRF- 30 Ag ppm 100	pXRF- 30 Mo ppm 50	pXRF- 30 Sn ppm 100	pXRF- 30 U ppm 50
							BLANKS								
BLANK															
BLANK															
Target Range -	Lower Bound														
	Upper Bound														
BLANK															
Target Range -	Lower Bound														
	Upper Bound														
BLANK															
Target Range -	Lower Bound														
	Upper Bound														
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Target Range -	Lower Bound														
	Upper Bound														
BLANK															
Target Range -	Lower Bound														
	Upper Bound														
BLANK															
Target Range -	Lower Bound														
	Upper Bound														
							DUPLICATES								
ORIGINAL															
DUP															
Target Range -	Lower Bound														
	Upper Bound														
ORIGINAL															
DUP															
Target Range -	Lower Bound														
	Upper Bound														
SC- 002															
DUP															
Target Range -	Lower Bound														
	Upper Bound														

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Project: 704-ENG.VMIN03021-01

QC CERTIFICATE OF ANALYSIS VA18132683

Sample Description	Method / Analyte / Units / LOD	OA-VOL08 FIZZ RAT Unity 1	OA-VOL08 MPA tCaCO3/1Kt 0.3	OA-VOL08 NNP tCaCO3/1Kt 1	OA-VOL08 NP tCaCO3/1Kt 1	OA-ELE07 pH Unity 0.1	OA-VOL08 Ratio (N Unity 0.01	S-IR08 S % 0.01	S-GRA06 S % 0.01	S-GRA06a S % 0.01	S-IR07 Sulphide % 0.01	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2	ME-MS61 Ag ppm 0.01	ME-MS61 Al % 0.01	ME-MS61 As ppm 0.2
		DUPLICATES														
SC-003																
DUP																
Target Range - Lower Bound																
Upper Bound																

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QC CERTIFICATE OF ANALYSIS VA18132683

Sample Description	Method Analyte Units LOD	ME- MS61 Ba ppm 10	ME- MS61 Be ppm 0.05	ME- MS61 Bi ppm 0.01	ME- MS61 Ca % 0.01	ME- MS61 Cd ppm 0.02	ME- MS61 Ce ppm 0.01	ME- MS61 Co ppm 0.1	ME- MS61 Cr ppm 1	ME- MS61 Cs ppm 0.05	ME- MS61 Cu ppm 0.2	ME- MS61 Fe % 0.01	ME- MS61 Ga ppm 0.05	ME- MS61 Ge ppm 0.05	ME- MS61 Hf ppm 0.1	ME- MS61 In ppm 0.005
							DUPLICATES									
SC- 003																
DUP																
Target Range - Lower Bound																
Upper Bound																

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Project: 704-ENG.VMIN03021-01

QC CERTIFICATE OF ANALYSIS VA18132683

Sample Description	Method Analyte Units LOD	ME-MS61 K % 0.01	ME-MS61 La ppm 0.5	ME-MS61 Li ppm 0.2	ME-MS61 Mg % 0.01	ME-MS61 Mn ppm 5	ME-MS61 Mo ppm 0.05	ME-MS61 Na % 0.01	ME-MS61 Nb ppm 0.1	ME-MS61 Ni ppm 0.2	ME-MS61 P ppm 10	ME-MS61 Pb ppm 0.5	ME-MS61 Rb ppm 0.1	ME-MS61 Re ppm 0.002	ME-MS61 S % 0.01	ME-MS61 Sb ppm 0.05
								DUPLICATES								
SC-003																
DUP																
Target Range - Lower Bound																
Upper Bound																

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Project: 704-ENG.VMIN03021-01

QC CERTIFICATE OF ANALYSIS VA18132683

Sample Description	Method Analyte Units LOD	ME-MS61 Sc ppm 0.1	ME-MS61 Se ppm 1	ME-MS61 Sn ppm 0.2	ME-MS61 Sr ppm 0.2	ME-MS61 Ta ppm 0.05	ME-MS61 Te ppm 0.05	ME-MS61 Th ppm 0.01	ME-MS61 Ti % 0.005	ME-MS61 Tl ppm 0.02	ME-MS61 U ppm 0.1	ME-MS61 V ppm 1	ME-MS61 W ppm 0.1	ME-MS61 Y ppm 0.1	ME-MS61 Zn ppm 2	ME-MS61 Zr ppm 0.5
								DUPLICATES								
SC-003																
DUP																
Target Range - Lower Bound																
Upper Bound																

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QC CERTIFICATE OF ANALYSIS VA18132683

Sample Description	Method Analyte Units LOD	pXRF- 30 As ppm 50	pXRF- 30 Ca % 0.5	pXRF- 30 Cr ppm 100	pXRF- 30 Cu ppm 50	pXRF- 30 Fe % 0.5	pXRF- 30 Mn ppm 100	pXRF- 30 Ni ppm 50	pXRF- 30 Pb ppm 50	pXRF- 30 S % 0.1	pXRF- 30 Zn ppm 50	pXRF- 30 Ag ppm 100	pXRF- 30 Mo ppm 50	pXRF- 30 Sn ppm 100	pXRF- 30 U ppm 50
							DUPLICATES								
SC- 003		<50	<0.5	100	<50	3.7	100	60	<50	1.3	150	<100	<50	<100	<50
DUP		<50	<0.5	100	<50	3.8	100	50	<50	1.3	150	<100	<50	<100	<50
Target Range - Lower Bound		<50	<0.5	<100	<50	2.9	<100	<50	<50	1.1	90	<100	<50	<100	<50
Upper Bound		100	1.0	200	100	4.6	200	100	100	1.5	220	200	100	200	100

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Project: 704- ENG.VMIN03021- 01

QC CERTIFICATE OF ANALYSIS VA18132683

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

REE's may not be totally soluble in this method.
Applies to Method: ME- MS61

pXRF- 30 is a semi- quantitative scan with precision and accuracy in the order of 20% depending of sample type.
Applies to Method: pXRF- 30

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C- GAS05	CRU- 31	CRU- QC	LOG- 22
ME- MS61	OA- ELE07	OA- VOL08	PUL- 31
pXRF- 30	S- GRA06	S- GRA06a	S- IR07
S- IR08	SPL- 21	WEI- 21	

APPENDIX C

TETRA TECH'S LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the “Professional Document”).

The Professional Document is intended for the sole use of TETRA TECH’s Client (the “Client”) as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the “Contract” herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

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The Professional Document and any other form or type of data or documents generated by TETRA TECH during the performance of the work are TETRA TECH’s professional work product and shall remain the copyright property of TETRA TECH.

The Professional Document is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of TETRA TECH. Additional copies of the Document, if required, may be obtained upon request.

1.2 ALTERNATIVE DOCUMENT FORMAT

Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH’s “Instruments of Professional Service”), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH’s Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH’s Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by persons other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

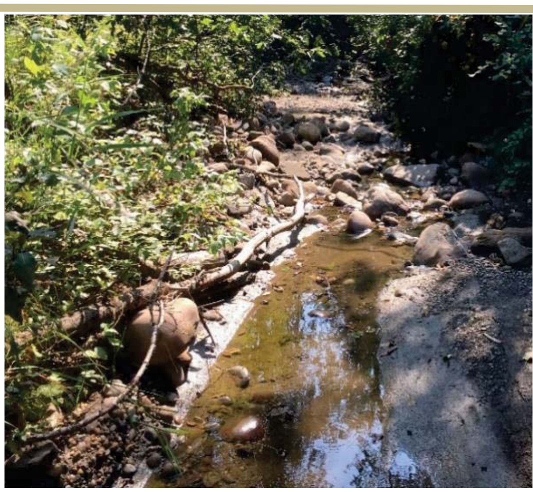
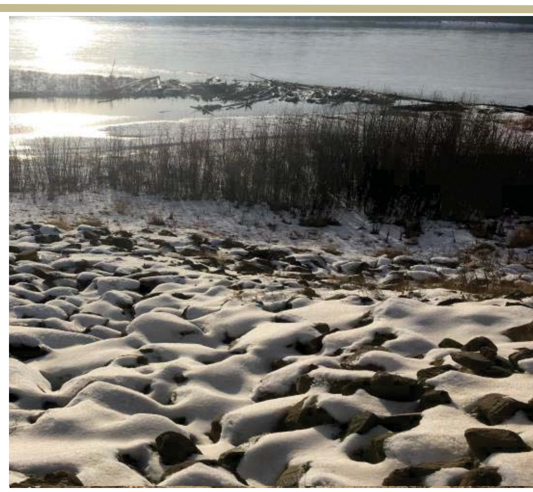
The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary investigation and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

Appendix D

Site C Clean Energy Project
Water Quality Monitoring for
River Road, South Bank Initial Access Road and L3 Creek
2018 Annual Report


PRESENTED TO

BC Hydro

MARCH 15, 2019
ISSUED FOR USE
FILE: 704-ENG.VMIN03021-01

Tetra Tech Canada Inc.
150, 1715 Dickson Avenue
Kelowna, BC V1Y 9G6 CANADA
Tel 250.862.4832 Fax 250.862.2941

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EXECUTIVE SUMMARY

Tetra Tech Canada Inc. (Tetra Tech) was retained by BC Hydro (the client) to develop and implement a surface water quality monitoring program for discharge locations along River Road ditch near Blind Corner and below Howe Pit, in proximity to the South Bank Initial Access Road (SBIAR), and along the L3 Creek catchment. Monitoring locations were also established upstream from the discharge to characterize variation to water chemistry within the catchment due to mixing and inflow of water from multiple sources. Water sampling locations are shown in the attached maps in Figures 1 through 3.

Requirements for the development and implementation of the water quality monitoring programs are mandated under the Environmental Assessment Certificate – Condition 3, and the Federal Decision Statement – Condition 7. Reporting of the program results are required on an annual basis. The requirements described in the BC Hydro Site C Clean Energy Project Construction Environmental Management Plan (CEMP), Revision 4, Appendix E Acid Rock Drainage and Metal Leachate Management Plan, Revision 5.2 (App E) are consistent with the requirements listed.

In accordance with the CEMP App E Section 5.2.1.7, results for the River Road and SBIAR locations were evaluated against the British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife and Agriculture (March 2018) (BCAWQG) freshwater short term maximum (FSTM) values. Water quality measurements recorded at the discharge, or downstream, locations which were in exceedance to the BCAWQG-FSTM were reported to BC Hydro. Results were also evaluated against the British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife and Agriculture (March 2018) (BCAWQG) freshwater long term average (LTA) values, due to acquiring two years of monthly data.

The water conveyance facilities at River Road ditch near Blind Corner and SBIAR are identified as having potential for direct ARD-ML impacts due to exposure of shale bedrock during construction related activities. The catchment for L3 Creek includes RSEM L3 which is currently not considered, nor permitted, for placement of construction related PAG material. Due to potential influence on discharge water quality from the Howe Pit area and inflow from L4 Creek, the water quality within the L3 Creek catchment is being monitored in context of ARD-ML management.

Monitoring Locations

Monitoring locations were established by Tetra Tech in conjunction with BC Hydro personnel. Where possible, they are coincident with the locations and station names used in 2016 by Lorax Environmental Services Ltd. (Lorax) on behalf of Peace River Hydro Partners (PRHP). The monitoring locations are shown in the maps shown in Figures 1 through 3 and photos of the water sampling locations are included in Photographs (1 through 20) section of the Appendix.

River Road

A total of twelve (12) monitoring locations have been established in the River Road catchment near Blind Corner to monitor the effectiveness of the limestone rip-rap, and to observe longer term influences from the PAG outcrop at Blind Corner and run-off/seepage from Howe Pit on the water collected in the River Road ditch. In 2017, nine monitoring locations were established along the River Road ditch between road stations 12+400 and 12+920 and within the lower chimney ditch draining surface water from a cut-off ditch on the Howe Pit bench. On April 19, 2018, three additional monitoring locations were added to this catchment, these were: LBRR-EDP, -RR8, and -RR9. LBRR-EDP is located at the end of a diversion pipe installed on March 19, 2018, that connects up-gradient within the River Road ditch at station 12+430 to divert water down-gradient into the River Road ditch below L3 Creek and up-gradient from culverts RR-9 and RR-8. The pipe bypasses the lower chimney drain (LBRR-LC), which continues to discharge from culvert RR-11, and bypasses L3 Creek, which continues to discharge from culvert RR-10. The purpose of the diversion pipe is to address erosion and sediment control by transport of run-off water into an elongated ditchline for reducing flow velocities and to promote settlement of suspended sediment. Inlets to culverts RR-9 and RR-8 are slightly elevated from the ditch base which will allow water to pond within the ditch and infiltrate and will permit discharge via the culverts only if water levels reach sufficient height. Both culverts are made of HDPE materials. The monitoring program includes collection of discharge from these LBRR-RR8 and -RR9 culverts, however, no discharge was observed to be coincident with the scheduled 2018 sampling events.

Sampling was attempted on a routine monthly basis from four of the River Road catchment locations, and laboratory analyses were conducted on samples collected when flowing water was observed. The analyses results were used to understand water quality prior to mixing and discharging into the Peace River. These four locations are located: in the lower chimney drain (LBRR-LC), upstream of the lower chimney drain within the River Road ditch (LBRR-12+500), at the end of the diversion pipe (LBRR-EDP), and at the discharge of culvert RR-11 (LBRR-DD). Due to seasonally dry conditions with low to non-flowing water observed in the ditch, water sampling was only conducted in two (2) months (LBRR-DD, -LC, -12+500) or four (4) months (LBRR-EDP) of ten (10) available months in 2018.

In situ measurements were routinely collected at all eleven locations within the River Road ditch when flowing water was observed. Due to seasonally dry or frozen conditions and having a relatively dry year, low to non-flowing water was observed in the ditch, thus in situ testing was only conducted in, at the most, seven (7) months of ten (10) available months in 2018.

SBIAR

A total of five (5) monitoring locations have been established in and with proximity to the SBIAR road cut. In 2017, two monitoring locations were established to monitor water quality flowing within the western ditch of the SBIAR road cut (RBSBIAR-DS and -US), and in 2018, two additional monitoring locations were added within the eastern ditch of the SBIAR road cut (RBSBIAR-EDS and -EUS). These locations allow for monitoring of water quality and potential impacts of the exposed PAG cut-slope by comparison of the downstream locations (RBSBIAR-DS and -EDS) to the upstream locations (RBSBIAR-US and -EUS). A fifth monitoring location established in 2017 continued to be sampled in 2018 within a preserved portion of the Peace River side channel down-gradient of the SBIAR facility (RBSC-DS), to monitor for potential long term influence of the side channel water quality from construction of the SBIAR facility. The side channel remains hydraulically connected to the Peace River. Effluent water from SBIAR is conveyed to RSEM R6 for management prior to being discharged to the Peace River.

Sampling was attempted on a routine quarterly basis from the SBIAR catchment locations, with samples collected during four (4) sampling events of four possible quarterly events. Sufficient water was available for lab testing in four (4) months at RBSBIAR-US and RBSC-DS, three (3) months at RBSBIAR-DS and -EUS, and two (2) months at RBSBIAR-EDS of four (4) available quarterly sampling months in 2018. In situ testing was attempted on a monthly basis, with sufficient water available for, at the most, seven (7) months of ten (10) available months in 2018.

L3 Creek

The catchment for L3 Creek includes RSEM L3 which is currently not considered, nor permitted, for placement of construction related PAG material. Due to the potential influence on L3 Creek discharge water quality from impacted water originating in the Howe Pit area and inflow from L4 Creek, the water quality within the L3 Creek catchment is being monitored in context of ARD-ML management.

A total of five (5) monitoring locations have been established in the L3 Creek catchment. In April 2017, three monitoring locations were re-established by Tetra Tech personnel within the L3 Creek catchment to be coincident with locations monitored by Lorax in 2016, that were selected to characterize water quality along the creek and at the discharge location. A baseline location up-gradient of RSEM L3 (LBL3C-3.32) and a midstream location below the confluence of L4 Creek and below the Gulley Road box culvert (LBL3C-1.43), were monitored to characterize water quality at the downstream discharge location at culvert RR-10 (LBL3C-0.02). In 2018, monitoring in L3 Creek expanded to include a location slightly upstream from the L4 Creek confluence, LBL3C-1.65, and sampling commenced along L4 Creek, LBL4C-0.18.

Sampling was attempted on a routine monthly basis from the L3 Creek catchment locations, with lab samples collected during ten (10) months of ten (10) available months in 2018. Due to low to non-flowing conditions or inaccessibility during construction related activities, sufficient water was available for lab testing in ten (10) months at LBL3C-1.43, nine (9) months at LBL3C-0.02, six (6) months at LBL4C-0.18, four (4) months at LBL3C-3.32, and three (3) months at LBL3C-1.65 of ten (10) sampling months in 2018. In situ testing was attempted on a monthly basis, with sufficient water available for, at the most, ten (10) months of ten (10) available months in 2018.

Sample Event Records and Analysis

Field notes documented at each monitoring location included date and time of field observations including estimate flow rate and water clarity, and a list of in situ tests completed with record of measurements for water temperature, hardness, alkalinity, pH, and electrical conductivity collected using a hand-held meter.

An off-site laboratory analytical program was designed to measure a suite of parameters suitable for screening the water quality against the BCAWQG-FSTM for surface water. The sampling and analytical procedures were implemented to be commensurate with Tetra Tech's 2017 monitoring period and the program previously implemented in 2016 by Lorax, in regards to parameters, analytical methods and detection limits. Lab analysis was conducted for total and dissolved elements (metals), hardness, pH, alkalinity, acidity, total suspended and total dissolved solids, and anions including sulphate, nitrogen species and chloride. Samples were collected in a set of clean bottles provided by the lab and were submitted for analysis.

Quality Assurance and Quality Control

The Quality Control (QC) program included sample collection by experienced field staff who were familiar with the water quality monitoring program. Samples were collected using a method consistent with the British Columbia Field Sampling Manual, Part E: Water and Wastewater Sampling (Clark, 2003).

The Quality Assurance (QA) program incorporated the use of a Travel Blank, Field Blank, and a replicate sample to test for potential contamination during sample collection, handling or laboratory preparation, and to evaluate the precision of laboratory analysis. Tetra Tech also reviewed the data for more general anomalies and inconsistencies, assessed on a case by case basis. Travel Blanks were prepared by the laboratory and field blanks were prepared in the field at sample collection sites by field staff using the same source water as was used for the travel blank.

The analytical results of these samples were reviewed by Tetra Tech, and if potential contamination or concerns with analytical results were identified, they were discussed with the laboratory and the samples were reanalyzed for verification. Blank samples were considered to 'fail' where any measured value was in concentrations above the reported detection limits for that parameter.

ALS Laboratories was used as the principle laboratory for sample analysis. The lab implements a detailed QC program into the sample analysis which includes a series of checks and evaluations for consistency in the sample analysis. The QC program includes method blanks, certified reference materials, laboratory control samples and duplicates. Tetra Tech reviewed the results of each QC Lot reported on Assay Certificates to verify that the program consistently met internal ALS Data Quality Objectives.

Any concerns were identified, communicated to ALS Laboratories. The data used for reporting is believed to be representative and reliable.

Monitoring Program

River Road

Sufficient flowing water permitted samples to be collected in March and April 2018 at the LBRR-DD, LBRR-LC, and LBRR-12+500 locations, and in April, May, June, and July at the LBRR-EDP location, thus sampling was limited in the River Road catchment during the 2018 monitoring period. Dry conditions prevailed in August at all locations, and low flow to dry or frozen conditions prevented reliable sampling at all locations in September, October, November, and December 2018. Field observations were documented each month.

At the discharge location (LBRR-DD), exceedances were reported at least once during the 2018 sampling period for total and dissolved iron, dissolved aluminum, and total arsenic and zinc. Throughout the River Road catchment in 2018, concentrations of total and dissolved iron, dissolved aluminum, cadmium, arsenic, cobalt, copper, and zinc were measured above the BCAWQG-FSTM at least once. A summary of water quality exceedances relative to BCAWQG-FSTM listed by monitoring location and month are listed in Table 7, and the screening results based on the laboratory data are tabulated in Appendix B2.

Results for each monthly sampling event were plotted on time series charts for trend and qualitative correlation analysis, noting minimal sampling for interpretive purposes. Throughout the monitoring period, water quality at the discharge location was variable with pH both below and within the BCAWQG-FSTM guideline and dissolved elements both above and within the BCAWQG-FSTM guidelines. TSS concentrations were elevated during high flow events, and TDS measurements were generally negatively correlated having concentrations proportionally higher during periods of low flow. Variable concentrations of dissolved sulphate was observed. BCAWQG-FSTM exceedances of total aluminum and total iron suggest that active ARD-ML processes on exposed PAG at Blind Corner and within Howe Pit are influencing water quality.

Elevated concentrations of dissolved aluminum were measured from the LBRR-DD location in March, LBRR-EDP in May, June, and July, and LBRR-12+500 in March and April 2018. Investigation into the potential cause concluded the likely source as clay size aluminum hydroxide particles in suspension were passing the field filters and reporting to the dissolved fraction rather than the total aluminum fraction. Presence of fine grained white and orange minerals (interpreted as gibbsite and limonite) on shale exposed in the upper cut-off ditch, on the Howe Pit bench as well as seepage from shallow or exposed bedrock along the River Road cut-bank may be a potential source as water from the upper cut-off ditch drains into midstream, LBRR-12+500, and downstream, LBRR-EDP and -DD, locations.

Limestone rip-rap lines the River Road ditch between monitoring locations LBRR-12+920 and LBRR-DD and is effective at mitigating the pH of the baseline drainage water. The limestone material used as rip-rap along this road section has become progressively coated with a mineral precipitate (visually estimated as hydroxides containing iron, calcium and aluminum) due to chemical neutralization reactions and has become encased by sludge due to settlement of suspended solids within the water and encroachment of sand and gravel sediment from grading activities on River Road. The effectiveness of the limestone to provide the neutralizing potential is considered to be negatively compromised by these coatings.

SBIAR

Sufficient flowing water permitted quarterly samples to be collected in March, June, and September, from two monitoring locations RBSBIAR-US and RBSBIAR-DS, and March, June, and November for RBSC-DS. The new east ditch locations, RBSBIAR-EUS and -EDS monitoring locations were sampled in June and September 2018.

Due to prevailing frozen conditions, sampling in December 2018 was limited to the RBSC-DS, RBSBIAR-US and RBSBIAR-EUS locations.

Concentrations of total and dissolved iron, dissolved aluminum, and total arsenic, copper, and zinc were measured on occasion above the BCAWQG-FSTM guidelines within the catchment during 2018 sampling events. At the downstream locations (RBSBIAR-DS and -EDS), exceedances were reported for total iron and dissolved aluminum. The water flowing from RBSBIAR-DS and -EDS do not have a direct downstream receptor. The exceedance in metals, total arsenic, copper, and zinc occurred solely at the upstream west ditch location, RBSBIAR-US, in March 2018.

Prior to July 2017, water passing the downstream monitoring location (RBSBIAR-DS) flowed directly into a temporary polyethylene lined pond via a limestone rip-rap spillway prior to being transported to the RSEM R6 pond by hydrovac truck for management prior to discharge. From September 2017, water passing the RBSBIAR-DS location was channeled into a ditch at the base of the limestone spillway and conveyed directly to the RSEM pond for management prior to discharge. In a July 24-25, 2018 site visit, it was observed that water from the Area 21 pond HDPE pipe did not appear to be draining into SBIAR and was being piped directly to RSEM R6. A new pipe was observed in the eastern ditch which is understood to be a water supply line going to Area A screening operations. Additionally, the ponded water in Area 21 is an unlined facility permitting infiltration though the shale resulting in seeps through the western cut-slope. This moist and oxygenated seepage is likely to accelerate ARD processes.

Results for each monthly sampling event were plotted on time series charts for trend and qualitative correlation analysis. Throughout the 2018 monitoring period, water quality at the downstream monitoring locations (RBSBIAR-DS and -EDS) showed exceedances to the BCAWQG-FSTM guidelines for total iron and dissolved aluminum, whereas the upstream monitoring locations (RBSBIAR-US and -EUS) showed exceedances for total iron, arsenic, copper, and zinc. Measurements for pH remained consistent throughout 2018. The water samples measured slight alkalinity, although total alkalinity (as bicarbonate) values show a variable and general increasing trend, suggesting increased acidity loading within the SBIAR ditch due to ARD-ML processes on the exposed PAG cut-slopes within the facility.

Total and dissolved iron were in exceedance of BCAWQG-FSTM guidelines in March, November, and December 2018, at RBSC-DS which is in the Peace River side channel at the base of SBIAR. This location was sampled in March, June, November, and December as a verification point to check for potential leakage from, or direct connectivity with, the SBIAR PAG contact water with the side channel. There does not appear to be hydraulic connectivity between SBIAR and the side channel, and this exceedance is not considered to be influenced by construction related PAG contact water but rather related to natural turbidity.

A summary of water quality exceedances at SBIAR relative to BCAWQG-FSTM listed by monitoring location and month are listed in Table 9, and the screening results based on the laboratory data are tabulated in Appendix B3.

L3 Creek

Sufficient flowing water permitted a total of ten samples to be collected during monthly events from March through December at monitoring location LBL3C-1.43; nine samples March through November at LBL3C-0.02; three samples (April, July, and December) from location LBL3C-1.65; and four samples in April, May, June and July from location LBL3C-3.32. Field observations were documented each month.

At the discharge location (LBL3C-0.02) and on various occasions throughout the L3 catchment, exceedances were reported for total iron and dissolved aluminum during the 2018 monitoring period. The December 2018 sampling event showed an exceedance to the BCAWQG-FSTM for concentrations of total cobalt, zinc, manganese, and pH measured below the guideline at the LBL3C-1.65 location. A summary of water quality exceedances relative to BCAWQG-FSTM listed by monitoring location and month are listed in Table 12, and the screening results based on the laboratory data are tabulated in Appendix B4.

Results for each monthly sampling event were plotted on time series charts for trend and qualitative correlation analysis. Throughout the monitoring period, water quality at the discharge location a consistent pH and, with an exception to dissolved aluminum, dissolved metals remained low.

Influence of ARD-ML processes on water within the catchment are limited to natural occurrences within L4 Creek and previous disturbance within Howe Pit. Input volume from L4 Creek is low and is generally diluted by L3 Creek water. Influent water volume from the Howe Pit area is uncertain, however, water quality between monitoring locations LBL3C-1.43 and LBL3C-0.02 is believed to be influenced by groundwater that has been impacted from Howe Pit.

L4 Creek

Sufficient flowing water permitted a total of six samples to be collected in March, April, May, June, July, and October from the L4 Creek monitoring location, LBL4C-0.18. Concentrations of total and dissolved iron, dissolved aluminum and cadmium, and total cobalt, zinc, copper, and arsenic were measured above BCAWQG-FSTM guidelines, and pH measured below BCAWQG-FSTM guidelines at the LBL4C-0.18 sampling location in L4 Creek.

Reconnaissance investigation of L4 Creek conducted prior to 2018, in September 2017, revealed naturally exposed shale bedrock at the base of the incised creek valley in contact with flowing creek water. In 2018, pH values measured between 4.39 and 4.46 in the months of May, June, and October 2018, and between 7.88 and 8.06 in the months of March, April, and July 2018. No pH value measured outside of the BCAWQG-FSTM guideline at L3 Creek sampling locations below or above the L4 Creek confluence, and only at the LBL4C-0.18 sampling location in L4 Creek.

Investigations aim to explain the occurrence of dissolved aluminum and total iron measured above detectible concentrations in the downstream location LBL3C-0.02 but not at comparable concentrations in the upstream L3 Creek locations, LBL3C-1.43 or -3.32. Evidence of PAG outcrop in L4 Creek, reduced pH levels, and the occurrence of anomalous metal concentrations at the LBL4C-0.018 location, exemplify background water quality of local naturally occurring PAG contact waterways. L4 Creek waters are eventually diluted, or attenuated, by L3 Creek waters and PAG related metal concentrations are significantly reduced by the monitoring location LBL3C-0.02.

General Conclusions

Across all sampling events in 2018, moderate to high hardness values (258 to 1310 mg/L) were observed in all waters sampled, although more consistently high in the L3 catchment and moderate in the RR and SBIAR catchments. The River Road ditch and SBIAR catchments are generally ephemeral. Monthly water quality monitoring measures instantaneous water quality and may not be reflective of longer term baseline conditions. Flow volumes are highly susceptible to precipitation, and water quality is influenced by whether flow is derived from precipitation, run-off, shallow groundwater or regional groundwater flow. PAG signatures that are influencing water quality indicative of active ARD-ML processes are observed at River Road on exposed PAG at Blind Corner and within Howe Pit, exposed bedrock related to construction activities within the L3 Creek drainage at LBL3C-1.65, at L4 Creek (LBL4C-0.18) from local naturally occurring PAG contact waterways, and in the shale exposed in the east and west ditch within SBIAR (although significant impacts on water quality are not apparent at SBIAR).

Recommendations for River Road

The sediment source for elevated TSS measured at LBRR-DD is mainly attributed to scouring of accumulated sediment within the ditch from road grading and run-off from previous events, which includes washing, or flushing, of the exposed shale, colluvium and overburden cut-banks. Continued management of the drainage system is required to reduce the amount of sediment infilling to the ditch from road grading operations as this sediment encases the limestone which reduces chemical efficiency for ARD mitigation and prematurely fills the cistern, which limits its performance to capture TSS which may be present from erosion of cut-banks.

Additionally, it was also noted from in situ pH measurements within the ditch that acidic waters are collected in the upper portions of the ditch underlying the exposed shale cut-bank. The pH values progressively return to circumneutral levels at the discharge location in part due to contact with limestone rip-rap in the ditch, and potential alkalinity input from groundwater or outflow from the upper cut-off ditch. Orange coating, or mineral precipitate, continued to be observed in the visible limestone. Chemical efficiency of the limestone to buffer acidic water is decreased when coated in precipitate. The formation of mineral scale can concentrate metals from solution as a result of the aqueous acid-base reactions. The mineral scale and sludge is susceptible to scouring and being washed during heavier rain events which has potential to reduce overall water quality being discharged into the Peace River.

The limestone must be regularly maintained through cleaning and descaling. Interim mitigation includes cleaning the limestone rip-rap material within the River Road ditch in a controlled facility where the sludge can be recovered and relocated to an approved RSEM area, and placement of the refreshed limestone in the ditch. Sludge should also be removed from the cistern and transported to an approved RSEM area.

Identification of the source of dissolved aluminum in previous sampling events is hypothesized to be related to fine mineral particulate (<45 µm) that is passing through the field filter as colloid or fine microcrystalline form. Aluminum hydroxide mineral species (e.g., polymorphs of gibbsite or hydrargillite) can form on rock surfaces and can be indicators of acid generating processes under base flow conditions. Locally impacted groundwater may also be seeping into the lower chimney ditch and may contribute to the measured dissolved aluminum concentrations. Similar water quality characteristics are observed in the lower L3 Creek catchment which may indicate that locally impacted groundwater from the exposed shale in the legacy Howe Pit area may be a common contributing factor. BC Hydro is considering options for remediation of this facility.

Continued management of the limestone rip-rap and mitigation of the active ARD-ML processes from the shale exposure at Blind Corner along River Road are recommended, such as implementing hydroseeding on the shale slope for erosion control, in addition to monitoring the effectiveness of controlling sedimentation into the River Road drainage system by the end-of-diversion pipe (LBRR-EDP).

Water quality measurements along River Road indicate that run-off water quality is influenced by active ARD-ML processes within the ditch catchment. Although flows are generally low and ephemeral, there is some potential for run-off to impact downstream water quality. As per CEMP Appendix E Section 5.2.1.7, it is recommended that water quality monitoring is continued on a monthly basis at the established locations within the River Road catchment. Continuous monitoring will enable the effectiveness of mitigation strategies that are implemented on the shale at Blind Corner.

Recommendations for SBIAR Water Quality Monitoring

Recommendations for future sampling include collection of water samples from the pooled water in Area 21. The collection of one up-gradient and one down-gradient water sample from both the western and eastern SBIAR ditch is suggested to continue through 2019 for comparative purposes.

In December 2017, BC Hydro had completed an options study and design for the installation of a cover system over the exposed shale at SBIAR which was installed in 2018.

Evidence of active ARD-ML processes were observed in the shale exposed in the east and west ditch within SBIAR, however, the water quality measured throughout 2018 did not indicate significant impacts due to these processes. Downstream water is collected within the RSEM R6 pond for management prior to discharge into the Peace River. As per CEMP Section 5.2.1.7, since there is low risk of negative downstream effects on water quality, monitoring of water quality within SBIAR may be continued on a quarterly frequency although to acquire for more thorough data trends, BC Hydro may choose to continue monitoring water quality in 2019 on a monthly frequency.

Recommendations for L3 Creek Water Quality Monitoring

The L3 Creek is not identified as a PAG management area in the CEMP. No PAG materials have been authorized for storage and bedrock is not being exposed or excavated within the catchment as part of the planned construction activities. Monthly water quality monitoring within the L3 Creek catchment was conducted by BC Hydro to maintain a continuous record of water quality within the catchment. Naturally occurring PAG was identified in L4 Creek upstream from construction activities in L3 Creek. Additionally, influence from ARD-ML processes at Howe Pit are observed in the lower portions of L3 Creek between locations LBL3C-1.43 and LBL3C-0.02. Water quality at the creek discharge remained below the BCAWQG-FSTM guidelines.

In December 2017, design was in progress to construct a RSEM facility at Howe Pit to provide additional storage capacity for NAG fill and to cover the exposed shale in Howe Pit. The design received input from Tetra Tech in regards to ARD-ML considerations and for long term monitoring options following placement of fill material.

Based on the 2017 and 2018 water quality monitoring program there is low risk of significant negative downstream effects on water quality due to ARD-ML processes. As per CEMP Appendix E Section 5.2.1.7, monitoring of water quality for ARD-ML parameters within the L3 Creek catchment may be continued on a monthly or quarterly basis. BC Hydro may choose to continue monitoring water quality on a monthly frequency in order to measure the influence of the RSEM construction and filling of Howe Pit. An additional monitoring location should be added to any subdrain outlet of the Howe Pit RSEM. Sampling at location LBL3C-1.65 may need continued adjustment to monitor possible ARD-ML processes related to disturbance from construction activities in the area.

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ACRONYMS & ABBREVIATIONS

Acronyms/Abbreviations	Definition
ARD	Acid Rock Drainage
ARD-ML	Acid Rock Drainage and Metal Leaching
BCAWQG	British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife and Agriculture
FSTM	Freshwater Short Term Maximum
LTA	Long Term Maximum
ML	Metal Leaching
NAG	Not Potentially Acid Generating
PAG	Potentially Acid Generating
RPD	Relative Percent Difference
RSEM	Relocated Surplus Excavation Material
WQG	Water Quality Guideline

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of BC Hydro and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than BC Hydro, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on the Use of this Document attached in the Appendix or Contractual Terms and Conditions executed by both parties.

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by BC Hydro (the client) to develop and implement a surface water quality monitoring program at midstream and discharge locations along River Road ditch near Blind Corner and below Howe Pit, in proximity to the South Bank Initial Access Road (SBIAR), and along the L3 Creek catchment. Water sampling locations are shown in the attached maps in Figures 1 through 3 and summarized with UTM coordinates in Table 1.

This report documents the establishment of the water sampling locations and summarizes the sampling events conducted monthly between March and December of 2018. Results of the monitoring program are discussed in the context of acid rock drainage and metal leaching (ARD-ML) management and mitigation.

Requirements for the development and implementation of the water quality monitoring programs are mandated under the Environmental Assessment Certificate – Condition 3, and the Federal Decision Statement – Condition 7. Reporting of the program results are required on an annual basis. The requirements described in the BC Hydro Site C Clean Energy Project Construction Environmental Management Plan (CEMP), Revision 4, Appendix E Acid Rock Drainage and Metal Leachate Management Plan, Revision 5.2 (App E) is consistent with the requirements listed,

In accordance with the CEMP App E Section 5.2.1.7, results for the River Road and SBIAR locations were evaluated against the British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife and Agriculture (March 2018) (BCAWQG) freshwater short term maximum (FSTM) values. Water quality measurements recorded at the discharge, or downstream, locations which were in exceedance to the BCAWQG-FSTM were reported to BC Hydro. The water conveyance facilities at River Road ditch near Blind Corner and SBIAR are identified as having potential for direct ARD-ML impacts due to exposure of shale bedrock during construction related activities.

The L3 Creek catchment is not identified as a waterway with potential for ARD-ML impacts arising from construction related activities. Water quality monitoring has been conducted within this catchment to monitor discharge water quality and to maintain a record for potential future use. The BCAWQG-FSTM values were also used as a benchmark for monitoring the water quality at the discharge location (LBL3C-0.02) from L3 Creek.

2.0 BACKGROUND

Sampling locations were first established in April 2017 by Tetra Tech in conjunction with BC Hydro personnel. Where possible, they are coincident with the locations and nomenclature used in 2016 by Lorax Environmental Services Ltd. (Lorax) on behalf of Peace River Hydro Partners (PRHP). Nomenclature for sampling locations begins with the applicable bank of the Peace River, e.g. Right Bank (RB) and Left Bank (LB).

Water quality sampling was conducted during the third week of each month through 2017 and 2018 to support a continuous monitoring record for reportable water quality compliance. The 2018 program was initiated on March 21, 2018, by Tetra Tech and BC Hydro personnel following seasonal frozen conditions to be consistent with the 2016 and 2017 sampling timing and was completed on December 17, 2018. Each sampling event was documented by field notes and photographs, including during dry and frozen conditions.

Field notes documented at each monitoring location included date and time of field observations including estimate flow rate and water clarity, and a list of in situ tests completed with record of measurements for water temperature, hardness, alkalinity, pH, and electrical conductivity collected using a hand-held meter. (Tables 6, 8, and 11).

The off-site laboratory analytical program was designed to screen water quality against the BCAWQG-FSTM for surface water and to be commensurate with the Lorax 2016 and Tetra Tech 2017 program with regards to the analytical methods and detection limits. Analysis was conducted for the following parameters:

- Total Metals, Low Level (including Hg);
- Dissolved Metals, Low Level (including Hg);
- Hardness;
- pH;
- Alkalinity: Total/Species (CO_3^{2-} , HCO_3^-, OH^-);
- Acidity;
- Solids: Total Suspended (TSS) and Total Dissolved (TDS); and
- Anions: Nitrogen species (nitrite, nitrate, ammonia), Sulphate, Chloride.

2.1 Summary of Parameters of Interest

Some of the key indicators that were monitored during this program are described below. Although these parameters do not have BCAWQG-FSTM guidelines, they can be useful indicators to potential changes in water chemistry related to ARD-ML processes.

Alkalinity and pH are important water quality parameters to indicate the ratio between residual alkalinity and acidity in solution and are key indicators for onset of acidic conditions within neutral to alkaline waters when monitored over time. Neutralization of acidity by carbonate minerals can temporarily increase alkalinity through release of the bicarbonate ion into solution. Bicarbonate will continue to react, and deplete, with any residual acidity. Once all carbonate and bicarbonate sources are depleted, alkalinity no longer is available to neutralize acidity and pH will drop. An indicator for accelerating acid generating processes is when increasing alkalinity is observed without proportional change to pH. The BCAWQG-FSTM guideline for pH ranges from 6.5-9.0. There is no guideline for alkalinity or acidity.

Water clarity is measured as turbidity (nephelometric turbidity units, NTU) or as total suspended solids (TSS), which is an indicator of the amount of sediment (generally accepted as silt sized particles and coarser, or >0.45 µm in diameter), contained within the water column. TSS can increase if sediment loading occurs due to erosion, or due to rapid precipitation of secondary minerals from chemical reactions such as neutralization of acidic water. The bulk chemistry of water with high TSS tends to mimic the chemical composition of the source sediment being eroded, or in the case of mineral precipitation tends to be high in iron as iron-oxide minerals are the most common secondary mineral to form. Rapid temporal changes to TSS measurements within a catchment due to formation of secondary minerals can indicate presence of active ARD-ML reactions. The BCAWQG-FSTM guideline is based on deviations to background TSS.

Measurements such as total dissolved solids (TDS), electrical conductivity (EC) and salinity are indicators for the concentration of dissolved components and/or ions in solution. Sudden or gradual increases in these parameters can indicate changes in water chemistry such as an increase in reactive ions or dissolved metals as a result of potential metal leaching processes. Changes to these parameters in association with changes to pH or alkalinity may also indicate active metal leaching processes. BCAWQG-FSTM guidelines are not specifically stated for these parameters.

Sulphate concentration can originate from anthropogenic sources, microbial processes and through chemical processes related to degradation of rock forming minerals in environments with potential for acid generation through the oxidation of primary sulphide (e.g., pyrite) or dissolution of sulphate minerals (e.g., gypsum). Elevated sulphate concentrations may indicate oxidation, or weathering, of potentially acid generating (PAG) materials in proximity to sample collection locations. Elevated sulphate with pH > 7.0 may indicate ARD-ML processes with sufficient acid neutralizing materials, whereas sulphate with decreasing pH may indicate a shortage of acid neutralizing materials.

Marine shales such as the local Shaftsbury Formation commonly contain sulphide minerals (mainly pyrite, FeS_2) and may also have primary sulphate minerals such as anhydrite ($CaSO_4$), gypsum ($CaSO_4 \cdot 2H_2O$), or barite ($BaSO_4$), and/or other sulphate minerals. Preliminary characterization determined that the primary sulphur species in the shale was sulphide with some detectable sulphate (Klohn Crippen Berger, 2015). Based on this mineral association and site observations, it is possible that groundwater contacting fractured bedrock would contain naturally elevated sulphate concentrations. Baseline groundwater sampling conducted as part of the project's Environmental Impact Statement (Hemmera Envirochem Inc. and BGC Engineering Inc., 2012) did not indicate groundwater within bedrock at these project locations contained elevated sulphate, however, samples from bedrock within the Main Civil Works area was limited. The Site C Clean Energy Project's 2018 Q4 Groundwater Quality monitoring report for RSEM Areas R5a and R5b indicate elevated results for sulphate that exceed the Trigger 2 Compliance Target at some locations (Lorax Environmental Services, 2019). The guideline value for sulphate is not stated in the BCAWQG-FSTM, however, a long term average guideline value is stated (variable with hardness) and is referenced in this report.

Water hardness (the concentration of calcium and magnesium ions in solution) is known to mitigate the effect of certain metals on aquatic organisms, and the guidelines are presented with equations derived from experimental data for sulphate and numerous metals (cadmium, copper, fluoride, lead, manganese, silver and zinc that tests a range of hardness specific to each metal or sulphate). Water hardness classification on-site is Hard to Very Hard and is often measured above the guideline threshold used to calculate BCAWQG-FSTM guideline values. Where the ambient hardness values exceed the guideline limited listed for BCAWQG, the exceedance criteria has been calculated using the upper limit value instead of the measured ambient hardness. The BC Approved WQG Summary Report (2018) states that a site-specific assessment may be necessary when ambient hardness values are outside the range tested in BC's Approved WQGs.

Water quality screening efforts have focused on elements with BCAWQG-FSTM guidelines, which include total concentrations of arsenic, boron, cobalt, copper, iron, lead, manganese, molybdenum, selenium, silver, and zinc, and dissolved concentrations of aluminum, cadmium, and iron.

Changes in concentrations of some elements or metals, reported as both total and dissolved, can have various implications for water quality under ARD-ML conditions. The solubility of individual elements can vary with pH. Geochemical modelling completed by Klohn Crippen Berger (2015) identified copper, cobalt, cadmium and zinc as having high probability of leaching into solution of site water during oxidation of the local shale bedrock under oxic acid rock generating and metal leaching conditions.

Formation of iron-oxide precipitate is the most widely recognized indicator of active ARD-ML processes. Total iron concentrations are associated with ARD-ML due to liberation of ferric iron from the oxidation of primary iron bearing sulphides. Subsequent formation of iron-oxide or iron hydroxide minerals can precipitate when acidic waters are neutralized and may be present as suspended solids or can form scaling on reactive surfaces such as limestone.

Aluminum concentration is abundant in rock forming minerals and can be released as part of oxidation and degradation of rocks during ARD-ML processes. Aluminum is soluble in acidic water and is typically not soluble in neutral and alkaline waters. Aluminum, as Al^{3+} can also contribute to the acidity along with H^+. When concentrations of aluminum are measured in detectible concentrations in neutral or alkaline water, it is possible that the formation of very fine aluminum hydroxide clays may occur in previously acidic waters that have been neutralized. Aluminum hydroxide mineral species (e.g., polymorphs of gibbsite or hydrargillite) can form on rock surfaces and are indicators of acid generating conditions.

Concentrations of aluminum, iron and copper are typically low in neutral pH drainage, however, elements such as antimony, arsenic, cadmium, molybdenum, selenium, and zinc can be present in neutral pH drainage.

Under BC's Approved WQG's, the intention of long term average (LTA; i.e., "chronic") WQG's are for the protection of the most sensitive species and life stage against sub-lethal and lethal effects for indefinite explores, and uses an averaging period, whereas the short term maximum (STM; i.e., "acute") WQG's are intended to protect against severe effects, e.g., lethality, to the most sensitive species and life stage over a defined short term exposure period approach (BC Approved WQG Summary Report, 2018). Working water quality guidelines (WWQG) have not been assessed as part of this monitoring program.

The sampling program in each area is briefly described in the following sections.

2.2 Description of River Road Sample Locations

A total of twelve (12) monitoring locations have been established in the River Road catchment near Blind Corner.

Sample locations have been established along the River Road ditch for in situ testing, primarily as a means of monitoring the effectiveness of the limestone rip-rap and to observe longer term trends related to the PAG outcrop at Blind Corner and run-off/seepage from Howe Pit. Laboratory and in situ testing are conducted at three main locations, including 1) the lower chimney drain (LBRR-LC), 2) upstream of the lower chimney drain within the River Road ditch (LBRR-12+500), and 2) at the discharge of culvert RR-11 (LBRR-DD). In situ samples are only conducted at locations LBRR-12+430, LBRR-12+600, LBRR-12+700, LBRR-12+810 and LBRR-12+920.

The April 19, 2018, water sampling event included establishment of three additional locations: LBRR-EDP, LBRR RR9 and LBRR-RR8. LBRR-EDP is located at the end of a diversion pipe installed on March 19, 2018, with inlet within the River Road ditch at station 12+430 to divert water down-gradient into the River Road ditch between culverts RR-9 and RR-8. The pipe bypasses the lower chimney drain (LBRR-LC), which continues to discharge from culvert RR-11, and bypasses L3 Creek, which continues to discharge from culvert RR-10. The purpose of the diversion pipe is to address erosion and sediment control by transport of run-off water into an elongated ditchline to reduce flow velocities and to promote settlement of suspended sediment. Inlets to culverts RR-9 and RR-8 are slightly elevated from the ditch base which will allow water to pond within the ditch and infiltrate or discharge via the culverts only if water levels reach sufficient height. Both culverts are made of HDPE materials. The monitoring program includes collection of discharge from these LBRR-RR8 and -RR9 culverts, however, no discharge was observed to be coincident with the scheduled 2018 sampling events. Sampling was attempted on a routine monthly basis from four of the River Road catchment locations, and laboratory analyses were conducted on samples collected when flowing water was observed. The analyses results were used to understand water quality prior to mixing and discharging into the Peace River. These four locations are located: in the lower chimney drain (LBRR-LC), upstream of the lower chimney drain within the River Road ditch (LBRR-12+500), at the end of the diversion pipe (LBRR-EDP), and at the discharge of culvert RR-11 (LBRR-DD).

In situ observations and measurements were routinely collected at all eleven locations within the River Road ditch when flowing water was observed.

The established River Road monitoring locations are shown in Figure 1 and photos of the locations are included in the Photographs (Photos 1 to 6) section of the Appendix.

2.3 Description of South Bank Initial Access Road Locations

A total of five (5) monitoring locations have been established in and with proximity to the SBIAR catchment. The sample locations have been established to monitor water quality flowing through the SBIAR road cut. The sample locations will also monitor the potential changes to water quality in the side channel down-gradient of the SBIAR construction (RBSC-DS). Sample locations allow for data collection of long term characterization of SBIAR water management from the upstream location in the west ditch (RBSBIAR-US) and the downstream location in the west ditch (RBSBIAR-DS). Upstream and downstream sampling locations (RBSBIAR-EUS and RBSBIAR-EDS, respectively) were added during the June 2018, sampling event. In situ and laboratory analysis are conducted at all five locations.

It is noted that the water flowing from RBSBIAR-DS does not have a direct downstream receptor; the water flows from SBIAR into a limestone armoured spillway into a ditch which conveys to the RSEM R6 pond. Water quality monitoring is not conducted from within the spillway or ditch.

The RBSC-DS location is sampled as a verification point to check for potential influence from, or direct connectivity with, the PAG contact water that is collected within the SBIAR facility and diverted to the RSEM R6 pond. Groundwater and local surface run-off contribute to the local water quality; however, this location remains hydraulically connected to the Peace River which is interpreted as the primary influence of local water quality, particularly TSS measurements.

The SBIAR sampling locations are being monitored on a quarterly basis and have occurred on March 21, 2018, June 19, 2018, September 27, 2018, and December 17, 2018. One sample was collected on November 19, 2018 at the RBSC-DS location in lieu of sampling here in September.

The established monitoring locations are shown in Figure 2 and photos of the locations are included in the Photographs (Photos 7 to 11) section of the Appendix.

2.4 Description of L3 Catchment Sample Locations

The catchment for L3 Creek includes RSEM L3 which is currently not considered, nor permitted, for placement of construction related PAG material. Due to potential influence on discharge water quality from the Howe Pit area and inflow from L4 Creek, the water quality within the L3 Creek catchment is being monitored in context of ARD-ML management.

Five monitoring locations are established within the L3 and L4 Creek catchment to characterize water quality along the creeks and at the discharge location. A baseline location up-gradient of RSEM L3 (LBL3C-3.32) is 3.32 km from the L3 Creek discharge location. One midstream location, LBL3C-1.65, is above and one midstream location, LBL3C-1.43, is below the confluence of L4 Creek and Gulley Road box culvert. The LBL3C-1.65 and -1.43 locations are 1.65 km and 1.43 km, respectively, from the L3 Creek discharge location, and are monitored to characterize water quality at the downstream discharge location at culvert RR-10 (LBL3C-0.02), located 20 metres from the L3 Creek discharge location, which is used as a proxy for discharge water quality. Due to construction at LBL3C-1.65, minimal sampling was done at this location in 2018.

L4 Creek is a naturally incised gully which is located at the downstream extremity of the catchment where the future 85th Avenue Industrial Lands gravel quarry will be constructed for the project. The one monitoring location established in L4 Creek, LBL4C-0.18, is 180 metres upstream from the confluence with L3 Creek. Comparison of the measurements from the L3 and L4 Creek monitoring locations are used to characterize the mixed waters monitored at the L3 Creek midstream location, LBL3C-1.43.

The L3 Catchment monitoring locations are shown in Figure 3 and a representative photo is included in the Photographs (Photos 12-19) section of the Appendix.

2.5 Description of Additional Sampling Locations

Periodically, water samples are collected from new locations to evaluate water quality on a single event or recurring event basis.

2.5.1 Gully Road Ditch

On April 27, 2018, site observations were made of a small shale exposure in the northern cut-bank of the River Road ditch and the presence of iron-oxide staining on the sandstone rip-rap lining the ditch near road station 72+900. Water in the ditch flows to the east under Upper River Road into an overburden pit located approximately 150 m southeast of security Gate B. The Gully Road ditch was established as a temporary monitoring location along the ditch just west of Gate B with UTM coordinate 630,286 E and 6,230,555 N (map in Figure 1). In situ measurements and lab samples were collected from the ditch flow during the May 24, June 19, July 26, August 21, September 27, and October 22, 2018 sampling events. A representative photo of Gully Road ditch is included in the Photographs (Photo 20) section of the Appendix. Water quality lab data results are provided in Appendix B, Table B5 and discussed in Section 4.5.1.

2.5.2 Wiley C.

On the September 27, 2018 sampling event, pooled water with a white milky colour was observed next to the River Road diversion pipe, LBRR-EDP (map in Figure 1). Although the water was not flowing, an in situ field sample and lab sample was collected and labelled as "Wiley C." The results of these samples are discussed in Section 4.5.2, and lab results provided in Appendix B, Table B5. The water originates up-gradient where a known PAG exposure exists in the River Road ditch approximately between road stations 12+725 and 12+875. The water collected within the ditch is channeled into the diversion pipe from LBRR-12+430, then drains into the lower River Road ditch where it infiltrates or discharges to the Peace River through culvert RR-9 and or RR-8, although both culverts remained dry or frozen throughout the 2018 monitoring period.

3.0 LOCAL CONDITIONS

3.1 Weather Conditions – Temperature and Precipitation

The minimum, maximum, and average daily and preceding seven-day temperature range, and the mean precipitation measured for the preceding seven days, day prior to, and day of each sampling event between March and December 2018, was collected from BC Hydro's Site C Meteorological and Air Quality Station (Figure 4; BC Hydro, 2018), Station 7C Site C North Camp, with results summarized in Table 2. Mean temperatures on sampling events ranged from -8.4 °C (December 17) to +24.6 °C (June 19). The range of minimum temperatures on sampling events ranged from -9.4 °C (December 17) to +15.6 °C (June 19), whereas range of maximum temperatures on sampling events ranged from -7.5 °C (December 17) to +32.4 °C (June 19). Sampling events in March, July, September, and December 2018 coincident with minimal precipitation between 0.39 mm, 0.14 mm, 0.27 mm, and 0.26 mm, respectively. The March and October 2018 sampling events followed no precipitation in the preceding seven days to sampling, whereas the July 2018 sampling event had the highest precipitation of 55.29 mm in the preceding seven days to sampling.

Residence time for water is low in the SBIAR and River Road ditches due to their small catchment size. The climate data was used to evaluate water availability and potential water source for flows that were observed in the ditches.

3.1.1 Classification of Seasonal Flows in Ditch

The flows in ditches at SBIAR and River Road are susceptible to seasonal change and flow rate is highly influenced by local precipitation events, thus the classification of flow in ditches can assist to interpret the source and subsequent chemical fluctuations in water sampled (Table 3). For example, seasonal flows in ditches can be attributed to shallow or regional groundwater, spring freshet or surface run-off, dependant on the season and amount of precipitation recorded in the previous 24-hours and 7-days to the sampling event. This association may be less apparent in L3 Creek due to a larger catchment size and residence time for water within the drainage, however, it is interpreted that similar trends may be observed.

Regional bedrock groundwater in locations sampled are suspected to have elevated concentrations of dissolved sulphates due to groundwater interaction with local pyritic-shale bedrock, and may, to some degree, be responsible for the high sulphate-content pervasive in water sampled following minimal precipitation during the previous 7-day and 24-hours to the sampling event (e.g., May 24, August 21, and September 27, 2018). When significant precipitation has occurred in the previous 7-days, but minimal precipitation within the prior 24-hour period to the sampling event, the flows in ditches can result from shallow groundwater flow, mainly through unconsolidated overburden (e.g., July 26, 2018). During spring freshet and snow melt, sampling events (e.g., March 21 and April 19, 2018) can be classified as such to have a ‘dilution’ effect to the water chemistry sampled in this season. To the contrary, during more arid seasons with little to no precipitation occurring in the previous 7-days and 24-hours (e.g., August 21, September 27, October 22, 2018), flows in ditches can be attributed to surface run-off. In this event, when precipitation and sampling occur following dry periods, the surface chemistry of the rocks will be washed into the ditches and be concentrated. Heavy rainfall events coincident to sampling events did not occur in 2018, although its occurrence would produce increased turbidity and flow in the ditches, having short term effects on measurements such as TDS, TSS and potentially total metal concentrations from flushing of exposed slopes and ditch fill material.

The classification of seasonal flows in ditches (Table 3), therefore, are important to consider when interpreting fluctuations and exceedances in parameters measured in water quality guidelines over the period of one year.

3.2 Peace River Turbidity and TSS (Total Suspended Sediment)

Turbidity of the Peace River is monitored by BC Hydro through a series of data loggers situated both upstream and downstream of the Main Civil Works (MCW) construction area. Time series data collected on the left and right banks of the Peace River up-gradient of the Moberly River (stations PAM-LB and PAM-RB, respectively) were provided to Tetra Tech by Ecofish Research Ltd. (Ecofish) to provide general understanding of influence by precipitation on natural sediment concentration within the Peace River upflow from the construction area during and following water quality monitoring events.

The data include turbidity measurements for the day prior, during, and day following the March through December sampling events in 2018 (Table 4). The turbidity data is converted to a value representing total suspended solids (TSS) using a preliminary factor developed by Ecofish using calibration of field measurements with laboratory data. Although the data have undergone initial verification and review for quality assurance, measurements may still have drift corrections applied, therefore, the TSS-turbidity relationship will continue to be updated following sample collection over time and all ranges of river conditions. Subsequent quality assurance and verification procedures may result in differences between what is currently provided and what will become the official record.

4.0 WATER QUALITY MONITORING PROGRAM

A summary of each water quality sampling event and corresponding analytical results were reported monthly to BC Hydro in a routine memo for ten sampling events in 2018: March 21, April 19, May 24, June 19, July 26, August 21, September 27, October 22, November 19, 2018, and December 17, 2018. Water quality sampling and development of a routine memo were not completed for January or February 2018, due to frozen conditions on-site. Laboratory results reported from the discharge or final downstream monitoring location in each catchment were evaluated against the BCAWQG-FSTM guidelines (Appendix B, Table B1) on a monthly basis for River Road and L3 Creek, and on a quarterly basis for SBIAR. Laboratory results for each upstream and midstream locations were used to evaluate ambient conditions and to characterize the results at the discharge or downstream locations; laboratory results for each location (River Road, South Bank Initial Access Road, and L3 Creek) are provided in Appendix B (Tables B2 to B4).

4.1 Quality Control and Quality Assurance Program

4.1.1 Tetra Tech QA/QC

The Quality Control (QC) program included experienced field staff familiar with the water quality monitoring program adhering to the British Columbia Field Sampling Manual, Part E: Water and Wastewater Sampling (Clark, 2003). New sample containers were acquired from the laboratory the day preceding the sampling event and all handling of the containers, sampling devices and equipment during sample collection was completed wearing new nitrile gloves to minimize potential for contamination of the samples. A new disposable syringe and 0.45 µm filter were used for each sample being submitted for dissolved metals, except when the concentration of TSS was observed as being high and field filtration was not possible. Samples not filtered and preserved in the field were identified and filtered at the laboratory. All samples were stored in a cooler filled with ice packs at a temperature between approximately 4°C and 8°C.

Analytical results were received monthly from ALS labs. No external lab was contracted during the 2018 monitoring period.

The Quality Assurance (QA) program incorporated use of a Travel Blank (TB), Field Blank (FB) and replicate sample to test for potential contamination during sample collection, handling or laboratory preparation, and to evaluate the precision of laboratory analysis. Table 5 lists the results of the QA program.

The analytical results of these samples were reviewed by Tetra Tech, and if potential contamination or concerns with analytical results were identified, they were discussed with the laboratory and the samples were reanalyzed for verification. Blank samples were considered to ‘fail’ where any measured value was in concentrations above the reported detection limits for that parameter.

Replicate samples were evaluated using relative percent difference (RPD), where an RPD value of less than 30% is considered an acceptable threshold for variation of surface waters.

Tetra Tech also reviewed the data for more general anomalies and inconsistencies. The total and dissolved concentrations for the full suite of elements were compared and it was noted that there were frequent occurrences where the dissolved concentrations exceeded the total concentration. The results were screened for analytical error, then assessed for expected natural variability of surface waters. Most instances were due to measurements at or near the low detection limit and could be explained by being within an acceptable range of error up to five times the lower detection limit for the respective element. Here, the total concentrations are considered equal to the dissolved concentrations.

Elemental concentrations measured at or slightly above the analytical detection limits in travel and field blanks occurred at times during the 2018 monitoring period, specifically for total chromium (April and May FB), ammonia (June FB), alkalinity (June TB), and dissolved chromium (April TB and September FB), aluminum (October FB), barium (October FB), magnesium (October FB), and mercury (December FB), summarized in Table 5. Consistently, an average low pH of 5.50 is measured across travel and field blanks collected in 2018; this low pH result is typical for distilled water and is not identified to be an issue. The elemental concentrations measured above detection limit could be attributable to field contamination or calibration of analytical instrumentation. The majority of blank samples with elevated concentrations occurred with field blanks, and similar anomalous elemental concentrations were not observed in their corresponding travel blank. Travel blanks were prepared by the laboratory and field blanks were prepared in the field at sample collection sites by field staff using the same source water as was used for the travel blank. If the source distilled water was contaminated, similar elemental anomalies would be expected in both the TB and the FB. The issues have been communicated with both the analytical laboratories and field personnel. Due to anomalous values being so close to detection limits and that particular elements were not recurring throughout the year, the accumulated error was not interpreted as a concern for this monitoring program.

Replicate samples with differences of elemental concentrations above the acceptable threshold of RPD > 30% were noticeable for a variable number of parameters measured in March (2), April (2), May (3), June (5), July (13), August (2), September (4), October (0), November (26), and December (5). Discrepancies are attributed to sediment disturbance during the collection of the first sample.

In the July 26, 2018 sampling event's QAQC program, it was found that the analytical results for dissolved and total element concentrations were inversed, or improperly labelled, at five sampling locations, including Gully Road Ditch, LBL3C-0.02, LBL3C-1.43, LBL3C-1.65, and LBL4C-0.18. A request was submitted to ALS Laboratories to switch the dissolved and total values for these locations, resulting in the revised data set and QAQC results presented in this report.

The November 19, 2018, sampling event QAQC check found that the replicate samples (RBSC-DS and RBSC-DS-REPLICATE) had significant occurrences of RPD > 30%, calculated for twenty-six (26) parameters including TSS (RPD = 79.75%), Ammonia (RPD = 120.6%), seven total metals (As, Ba, Cd, Mn, Ni, Rb, S), and seventeen dissolved metals (Al, As, Ba, B, Cd, Fe, Mg, Mn, Hg, Ni, K, Rb, Na, S, U, Zn). Following communication with the field sampling personnel and ALS Laboratories, this discrepancy was attributed to the replicate sample containing sediment from disturbance during collection of the first sample. The replicate sample was therefore not considered a reliable comparison of the in situ conditions and laboratory analysis.

The occurrence of dissolved concentrations exceeding total concentrations in samples was calculated below the acceptable threshold of an RPD<30%, although measurements above the acceptable threshold occurred in the following sampling events: June 19, 2018 (chromium, lead, thorium, and titanium), July 26, 2018 (mercury and titanium), and November 19, 2018 (total iron).

4.1.2 Laboratory QA/QC

ALS Laboratories was used as the principle laboratory for sample analysis. Certificates of Analysis from ALS Laboratories are provided in each monthly, routine memo, during 2018.

The lab implements a detailed QC program into the sample analysis which includes a series of checks and evaluations for consistency in the sample analysis. The QC program includes method blanks, certified reference materials, laboratory control samples and duplicates. The QC Lot reported on Assay Certificates consistently met internal ALS Data Quality Objectives.

4.2 River Road Water Sampling

There was sufficient flowing water for samples to be collected in March and April 2018, at the LBRR-DD, LBRR-LC, and LBRR-12+500 locations, and in April, May, June, and July at the LBRR-EDP location. Dry, freezing and/or low or no flow conditions prevailed from May through December at all locations, preventing reliable sampling at the River Road monitoring locations for much of 2018. In situ measurements were not collected from each station consistently every month due to dry (e.g., July, August) or frozen (e.g., October, November, December) conditions. Field observations were documented each month. A total of seventeen monthly sampling events have been conducted at the River Road catchment locations, ten in 2018 (March to December) and seven in 2017 (April to October) by Tetra Tech; two prior sampling events occurred in 2016 (October and November) by Lorax and are included in the attached time series charts (Figures 5 to 14) for continuity but are not discussed in this report.

4.2.1 In Situ Measurements and Field Observations

Values for water temperature, pH, total alkalinity and electrical conductivity measured at the River Road monitoring locations are included in Table 6. The range in water temperatures at LBRR-DD (0.0 °C), LBRR-LC (0.4 °C), LBRR-UC (0.1 - 20.1 °C), LBRR-12+500 (0.0 °C), and LBRR-EDP (0.0 – 20.3 °C) were recorded during 2018, in addition to 0.0 – 20.9 °C between LBRR-12+600 to +920. The range in pH measured at LBRR-DD was 8.08 to 8.60, at LBRR-LC was 8.15 to 8.20, at LB-12+500 was 3.77 to 6.05, and at LBRR-EDP was 8.13 to 8.74. The range in alkalinity at LBRR-DD was 0 to 80 ppm, at LBRR-LC was 0 to 40 ppm, at LBRR-12+500 was 0.0 ppm, and at LBRR-EDP was 80 to 240 ppm.

The collection ditch on the cut-bank (north) side of River Road between approximately 12+340 and 12+960 (Blind Corner) was lined with limestone rip-rap in 2017 to assist with mitigating the potential effects of acid rock drainage (ARD) and metal leaching (ML) from potentially acid generating (PAG) bedrock that was exposed during the initial road construction in 2015 and early 2016. Potentially acidic leachate generated from the rock cut-slopes reacts with the alkaline limestone to help neutralize water as it passes through the rip-rap lined ditch. The ditch also serves to convey run-off water and fine sediment shed from River Road through the end-of-diversion pipe between 12+430 and LBRR-EDP prior to discharging through culvert RR-8 and RR-9 into the Peace River. Water from the lower chimney ditch, LBRR-LC, is conveyed through culvert RR-11 to the discharge location, LBRR-DD, and Peace River.

Location LBRR-12+920 is located immediately up-gradient of the upper cut-off chimney and PAG exposure, whereas LBRR-12+810 is located immediately down-gradient the upper cut-off chimney and sits below the PAG exposure at Blind Corner. Notable decrease in water pH and alkalinity generally occurs between these stations with a gradual recovery from acidic to circumneutral pH and available alkalinity towards location 12+500. This trend is interpreted to be related to PAG contact waters draining into the ditch from location 12+810 and 12+700, and the increasing trending related to effects of limestone rip-rap within the ditch in additional to influence from alkaline run-off from the lower cut-off chimney near location 12+500.

The limestone is effective at mitigating the pH of the drainage when there are fresh surfaces of limestone available for chemical reactions. The limestone material used as rip-rap along this road section has become progressively coated with a mineral precipitate (visually estimated as hydroxides containing calcium, iron and aluminum) due to chemical neutralization reactions and encased by sludge due to settlement of suspended solids within the water. Additionally, the roadside portion of the ditch, particularly from LBRR-12+600 downstream to the discharge at LBRR-DD, is being encroached with sand and gravel sediment from grading activities on River Road which covers the limestone, further reducing its exposure. The effectiveness of the limestone to provide the neutralizing potential is considered to be negatively compromised by these coatings.

Limestone rip-rap within the ditch between road stations 12+600 and 12+900 continued to be maintained in 2018, including completion of a hydroseeding program on the shale slope at blind corner to support long term erosion control and slope stability in March 2018. The hydroseed appeared to remain in place on the slope, however, germination was not successful at year's end.

Flows within the River Road ditch are ephemeral and baseline flow observed at the discharge is generally contributed by outflow from LBRR-LC. At the discharge location, LBRR-DD, flows ranged between 0.4 L/s (March 21) to 5.0 L/s (April 18), with dry or frozen conditions prevailing for the remainder of the 2018 monitoring period. Flow in the discharge (LBRR-DD) and lower chimney (-LC) are exceptionally low. At the end-of-diversion pipe location LBRR-EDP, flows ranged between none (September 27) to 0.5 L/s (April 19) that originate from LBRR-12+430 and further up the River Road ditch, e.g., LBRR-12+500. In the River Road catchment, water temperatures ranged between 0.0°C (April 18) to 20.9°C (June 19). At the LBRR-DD location, water was cloudy on the April 18, 2018 sampling event with total suspended sediment (TSS) measurements ranging between 50.7 to 97.6 mg/L between March and April 2018. The source of TSS is primarily from River Road run-off, scouring of sediment deposited within the River Road ditch and washing from the cut-slopes. Elevated total metal concentrations were measured from the March and April 2018, sampling events are interpreted to be directly related to washing, or flushing, of sediment and secondary mineral precipitant during freshet as water contacted accumulated sediment within the ditch in addition to the exposed shale, colluvium and overburden cut-banks. These conditions are interpreted to have been temporary in the early season of 2018. During March and April 2018 sampling events, neutral pH values were measured at the LBRR-DD discharge as slightly alkaline with an in situ pH of 8.08 and 8.60 (laboratory pH 6.51 to 7.78, respectively, with an average pH of 7.15).

4.2.2 Short Term Maximum Exceedances

Concentrations of total iron, arsenic, cobalt, copper, zinc, and dissolved iron, aluminum, and cadmium, and pH were measured on occasion to be above the BCAWQG-FSTM within the catchment. At the discharge location (LBRR-DD) sampled in March and April 2018, exceedances were reported at least once for total iron, arsenic, copper, zinc, and dissolved iron, cadmium, and aluminum. A summary of water quality exceedances relative to BCAWQG-FSTM listed by monitoring location and month are listed in Table 7, and the screening results based on the laboratory data are tabulated in Appendix B2.

4.2.3 Trend Monitoring

Monthly water quality monitoring measures instantaneous ambient conditions at the time of sampling and as discussed in Section 3.1 the measurements are highly susceptible to temporal climate conditions due to the small catchment and short residence time of water within the River Road ditch. In addition to BCAWQG-FSTM (short term maximum) screening, commencing for the 2018 annual report, the 2017-18 laboratory results have been screened against the BCAWQG-LTA (long term average) guideline values, shown in Appendices A1 to A5, although it references preliminary results of a minimal two annual monitoring periods. Event data characterizes the influences of seasonal conditions at the site. Recurring trends at River Road over the 2017 and 2018 monitoring period may be indicative of long term trends, and are discussed below for alkalinity and pH (Figure 5), TSS and TDS (Figure 6), sulphate (Figure 7), aluminum (Figure 8), and iron (Figure 9), in addition to trends in specific metals such as arsenic (Figure 10), cadmium (Figure 11), cobalt, (Figure 12), copper (Figure 13), and zinc (Figure 14).

4.2.3.1 Alkalinity and pH

Alkalinity and pH values indicated relatively consistent values of slightly alkaline water during 2018 sampling events at three River Road locations (LBRR-DD, LBRR-EDP, LBRR-LC) and acidic water during freshet in March and April 2018, at the LBRR-12+500 location (Figure 5). At the discharge location, LBRR-DD, pH measurements ranged between 6.51 and 7.78 with a mean pH of 7.15, and total alkalinity ranged between 5.0 and 91.4 mg/L $CaCO_3$ equivalent with a mean value of 48.2 mg/L $CaCO_3$ equivalent. Including the four River Road catchment sampling locations, pH measurements ranged between 2.90 (LBRR-12+500) and 8.20 (LBRR-EDP) with a mean pH of 7.01, whereas total alkalinity in 2018 ranged between below detection limit, <1.0, and 220 mg/L $CaCO_3$ equivalent with a mean value of 90 mg/L $CaCO_3$ equivalent.

Limited measurements collected at the midstream LBRR-12+500 station indicate pH measurements below the BCAWQG-FSTM guideline, whereas the upstream (LBRR-LC) and downstream (LBRR-DD and -EDP) locations show a neutral pH and alkalinity, although the LBRR-LC and -DD locations show low alkalinity. These trends indicate increased acidity midstream (LBRR-12+500), low alkalinity at upstream, midstream, and the discharge location, and within normal range of pH and alkalinity primarily measured at the LBRR-EDP location over the 2018 monitoring period.

Both the alkalinity and pH at LBRR-LC and LBRR-DD measure an increase in pH and alkalinity from March to April 2018. Due to no correlating months of data collection between 2017 and 2018, and limited sampling during 2018, seasonal trends are not clearly apparent, although a noticeable slightly lower pH in spring and fall (freshet/wetter seasons) compares to more neutral, increased pH/alkalinity during summer (dry season) (Figure 5). The new sampling location, LBRR-EDP, measures neutral pH and within range alkalinity relative to other LBRR sampling locations and events over the four sampling events (April to July 2018).

Following relatively consistent trends in 2017 (with exception of alkalinity measured in October 2017) at the LBRR-DD location, pH either decreased or remained relatively consistent and alkalinity decreased in 2018. This resulted from less alkalinity being provided from LBRR-12+500 and LBRR-LC and increased acidity from LBRR-12+500 relative to previous sampling events.

4.2.3.2 Hardness

Water hardness measured at LBRR-DD was often above the upper threshold used by the BCAWQG-FSTM (250 mg/L) to guide criteria for numerous specific metal or element concentrations (e.g., total sulphate, copper, lead, manganese, silver, zinc; dissolved cadmium) with values ranging between 258 and 821 mg/L with mean value of 540 mg/L (Appendix B, Table B2). This value is based on toxicity tests and adapted by the Canadian Council of Ministers of the Environment (BCAWQG Summary Report, 2018). When the maximum hardness value is reached for elements that are hardness-dependent for BCAWQG-FSTM guideline calculations, the respective maximum hardness values for zinc, copper, and cadmium were used as capped hardness values in guideline calculations, rather than the measured ambient hardness. A site-specific assessment may be required since the water hardness exceeds the highest hardness tested for Cu, Cd, and Zn in BC (BCAWQG Summary Report, 2018, pg. 32).

4.2.3.3 Total Suspended Sediment and Total Dissolved Sediment

The annual trend for TSS values at LBRR-DD indicate a variable trend through 2017 and 2018, with a slight increase occurring between March and April 2018. TSS measured at LBRR-DD ranged between 50.7 to 97.5 mg/L with a mean value of 74.1 mg/L.

TDS values at LBRR-DD shows a sharp decrease between March and April 2018, and a decreasing trend in 2018 relative to 2017. TDS measured at LBRR-12+500 and LBRR-LC also followed a decreasing trend in 2018, with

LBRR-DD and -LC having similar TDS concentrations that are lower to TDS measured at LBRR-12+500 and LBRR-EDP. TDS measurements at LBRR-DD ranged between 1,190 to 362 mg/L with mean value of 776 mg/L.

TSS and TDS values measure higher in 2018 overall than in 2017 (Figure 6). Measurements of elevated TSS and TDS within the River Road ditch, as observed at the LBRR-12+500 location, are attributed primarily to surface run-off from River Road, scouring of sediment deposited within the River Road ditch, and washing from the cut-slopes.

4.2.3.4 Sulphate

Sulphate concentration data collected in 2018 was variable within the River Road catchment, showing similar concentrations of sulphate at LBRR-DD and -LC in March and April 2018. Sulphate concentrations measure higher at LBRR-12+500 and LBRR-EDP, relative to LBRR-DD and -LC, although a decreasing trend occurred at LBRR12+500, -DD, and -LC between March and April 2018. Sulphate concentrations generally measure above the BCAWQG-LTA guideline value during 2018, but minimal sampling in the River Road catchment does not provide sufficient seasonal trend observations (Figure 7). Sulphate concentrations measured at the LBRR-DD location during 2018 ranged from 161 to 751 mg/L with mean value of 456 mg/L.

The correlation of a similar, lower concentration of sulphate at LBRR-LC and -DD relative to a higher concentration of sulphate measured at LBRR-12+500 and -EDP, confirm the similarity between locations connected either on each end of the end-of-diversion pipe (LBRR-12+500 and -EDP) or the culvert RR-11 (LBRR-LC and -DD). Thus, the constructing of the end-of-diversion pipe from LBRR-12+500 for sediment control is illustrated in the trend charts. The origin of sulphate is not confirmed but is interpreted to originate from influent seepage water with high background levels of sulphate in the groundwater and/or local oxidation of sulphide minerals in exposed shale.

4.2.3.5 Total and Dissolved Aluminum

Total and dissolved aluminum concentrations show monthly variability during the 2018 sampling events, however, total aluminum concentrations measure higher during freshet, March and April, in 2018 than in 2017 (Figure 8). Between March and April 2018, the LBRR-DD and -12+500 locations decreased in measurements of total and dissolved aluminum, whereas the LBRR-LC location showed a slight increase in total aluminum and decrease in dissolved aluminum. Total aluminum concentrations measured at LBRR-DD ranged from 2,980 to 3,670 µg/L with mean value of 3,325 µg/L and dissolved aluminum ranged from 28 to 392 µg/L with mean value of 210 µg/L.

Dissolved aluminum concentrations at LBRR-DD showed an exceedance above the BCAWQ-FSTM guideline (100 µg/L) in March 2018, prior to decreasing to below the BCAWQG-FSTM guideline in April 2018. At LBRR-LC, dissolved aluminum concentrations remained below the BCAWQG-FSTM guideline, yet remained above the BCAWQG-FSTM guideline at LBRR-12+500 in March and April 2018, and at LBRR-EDP between May, June, July, and September 2018 sampling events.

During dry conditions from June to September 2018, groundwater seepage and run-off into the River Road ditch upstream from the LBRR-12+500 midstream location may be contributing to the dissolved aluminum concentrations. Similar water quality characteristics are observed in the lower L3 Creek catchment which may indicate that locally impacted groundwater from the exposed shale in the legacy Howe Pit area may be a common contributing factor to the downstream water quality.

4.2.3.6 Total and Dissolved Iron

Total iron concentrations at LBRR-DD and -LC measured above the BCAWQG-FSTM guideline (1.0 mg/L) and increased between March and April 2018 (Figure 9), with concentrations at the LBRR-DD location measuring 7.2 and 22.8 mg/L, respectively, with mean value 15.0 mg/L. Total iron concentrations measured highest at

LBRR-12+500 location in 2018, although decreased between March and April 2018. A decreasing trend in total iron concentrations were measured between May and July 2018, at LBRR-EDP.

Dissolved iron concentrations measured at LBRR-DD decreased between March and April 2018, transitioning from exceeding the BCAWQG-FSTM guideline (350 µg/L) in March 2018 to decreasing below the BCAWQG-FSTM in April 2018. Dissolved iron concentrations at the LBRR-EDP location transitioned from exceeding the BCAWQG-FSTM guideline in April 2018, to remaining below detection limit of 20 µg/L between May, June, and July 2018. In 2018, elevated concentrations of dissolved iron were most prominent at the LBRR-12+500 location.

4.2.3.7 Metals: Arsenic, Cadmium, Cobalt, Copper, and Zinc

Metals such as arsenic, cadmium, cobalt, copper, and zinc have been identified to have potential for released in elevated concentrations from minerals during oxidation and weathering processes and are therefore important indicators of ARD-ML processes and environmental changes in the water supply. The concentrations of these elements were assessed from limited sampling during 2018.

Total arsenic concentrations during 2018 measured at LBRR-DD ranged from 6.2 to 16.3 µg/L with mean value of 11.3 µg/L, whereas dissolved arsenic ranged from 0.14 to 0.22 µg/L with mean value of 0.18 µg/L. Total arsenic during March and April 2018 (the only two months sampled at LBRR-DD in 2018) exceeded the BCAWQG-FSTM guideline (5.0 µg/L) but measured lower than in September to October 2017 and higher than from October 2016 to July 2017 (Figure 10).

Total cadmium concentrations during 2018 measured at LBRR-DD ranged from 17.6 to 90.6 µg/L with mean value of 54.1 µg/L, whereas dissolved cadmium ranged from 0.44 to 4.49 µg/L with mean value of 2.46 µg/L. Total and dissolved cadmium show similar, slightly lower concentrations in April 2018 relative to April 2017 (Figure 11), during freshet. Dissolved cadmium measured above the calculated BCAWQG-FSTM guideline in March 2018 and below the calculated guideline in April 2018, when capping the hardness value at 455 mg/L, at LBRR-DD.

Total cobalt concentrations during 2018 measured at LBRR-DD ranged from 6.2 to 16.3 µg/L with mean value of 11.3 µg/L, whereas dissolved cobalt ranged from 13.6 to 88.4 µg/L with mean value of 51.0 µg/L. Total and dissolved cobalt show similar, slightly higher concentrations in April 2018 relative to April 2017 (Figure 12), during freshet. Total cobalt remained below the BCAWQG-FSTM guideline at LBRR-DD in March and April 2018.

Total copper concentrations during 2018 measured at LBRR-DD ranged from 26.3 to 26.7 µg/L with mean value of 26.5 µg/L, whereas dissolved copper ranged from 1.41 to 13.1 µg/L with mean value of 7.26 µg/L. Total copper measures higher in April 2018 than April 2017, whereas dissolved copper measures similar, slightly lower concentrations in April 2018 than April 2017 (Figure 13), during freshet. Total copper in April 2018 (26.30 µg/L) reaches the BCAWQG-FSTM exceedance guideline (26.25 µg/L), when capping the hardness value at 400 mg/L.

Total zinc concentrations during 2018 measured at LBRR-DD ranged from 210 to 585 µg/L with mean value of 397.5 µg/L, whereas dissolved zinc ranged from 35.8 to 546 µg/L with mean value of 290.9 µg/L. Total zinc measures slightly higher in April 2018 than April 2017, and dissolved zinc measures lower in April 2018 than April 2017 (Figure 14). When capping the hardness value at 500 mg/L in March (585 µg/L) and April (210 µg/L), 2018, total zinc slightly exceeds the BCAWQG-FSTM guideline values, 581 and 159 µg/L, respectively.

Minimal sampling along the River Road ditch occurred during the 2018 monitoring period, impeding the ability to observe long term trends between 2017 and 2018. It is notable that although the new LBRR-EDP location measures exceedances to the BCAWQG-FSTM at least once for total zinc, copper, cobalt, arsenic, and dissolved cadmium, that at LBRR-ECP, measurements have generally lower concentrations of copper, zinc, cobalt, cadmium, and arsenic than at LBRR-12+500 (the source of the end-of-diversion pipe). Conversely, the LBRR-DD and -US locations are correlated to measure very similar concentrations of the same five metals and throughout all sampling parameters (e.g., aluminum, iron, TDS, sulphate).

4.2.4 Long Term Average Exceedances

At the discharge location, LBRR-DD, minimal occurrences of measured concentrations during 2018 exceed the BCAWQG-LTA guidelines. Total cobalt in March (90.6 µg/L) and April 2018 (17.6 µg/L) exceed the BCAWQG-LTA (4.0 µg/L) and not the BCAWQG-FSTM (110 µg/L). Dissolved cadmium in April 2018 (0.439 µg/L) slightly exceeds the calculated BCAWQG-LTA (0.425 µg/L) but not the BCAWQG-FSTM (1.561 µg/L). Similarly, total copper measured in March 2018 (26.7 µg/L) slightly exceeds the BCAWQG-LTA (10 µg/L) and total selenium measured in March 2018 (2.86 µg/L) slightly exceeds the BCAWQG-LTA (2.0 µg/L), but both do not exceed the BCAWQG-FSTM.

4.3 SBIAR Water Sampling

Sufficient flowing water permitted samples to be collected quarterly on March 21, June 19, September 27, and December 17, 2018 throughout the SBIAR monitoring locations, specifically RBSBIAR-US, RBSBIAR-DS (except December), and RBSC-DS (March, June, November, December). The new monitoring locations in the east ditch, RBSBIAR-EUS and -EDS, were sampled in June and September 2018 (RBSBIAR-EUS/-EDS) and also December 2018 (-EDS). Field observations were documented each month.

4.3.1 In Situ Measurements and Field Observations

Values for water temperature, pH, total alkalinity and electrical conductivity measured at the SBIAR monitoring locations are included in Table 8. Flows in the SBIAR ditch system can vary between upstream (-US and -EUS) and downstream (-DS and -EDS) locations, with flows of approximately 0.10 L/s to 3.0 L/s, respectively (Table 8). Seepage in the western cut-slope ditch is received partly from ponded water from Area 21 RBSC-DS is located in the side channel with connectivity to the Peace River where stagnant to minimal “flow” is usually observed. Water levels at RBSC-DS are coincident with the actual levels of the Peace River. Table 4 shows the measured upstream turbidity, and converted TSS concentrations, within the Peace River. Increased turbidity measured in the Peace River results from precipitation events which can be correlated with TSS measurements collected from RBSC-DS. Thus, TSS measured at the RBSC-DS location (Figure 10) are interpreted to be attributable to, or directly influenced by, the in-river turbidity measurements (Table 4). Algae was occasionally observed in the water during 2018 at RBSC-DS (June), RBSBIAR-US (August and December), RBSBIAR-EUS (December 2018). The range in water temperatures at RBSBIAR-US (1.1–14.4 °C), RBSBIAR-EUS (1.0–15.4 °C), RBSBIAR-DS (1.1–17.7 °C), RBSBIAR-EDS (0.6-16.8 °C), and RBSC-DS (0.3–18.0 °C), were recorded in 2018.

4.3.2 Short Term Maximum Exceedances

At the downstream locations, (RBSBIAR-DS and -EDS), exceedances were reported for total iron and dissolved aluminum. At the upstream locations, (RBSBIAR-US- and -EUS), exceedances were reported for total iron, arsenic, copper, and zinc (RBSBIAR-US) on March 21, 2018, and total iron (RBSBIAR-EUS) in the September and December 2018 sampling events.

Total and dissolved iron were in exceedance of BCAWQG-FSTM guidelines in March, November, and December 2018, at RBSC-DS which is in the Peace River side channel at the base of SBIAR. This location is sampled as a verification point to check for potential leakage from, or direct connectivity with, the SBIAR PAG contact water with the side channel. This exceedance is not considered to be influenced by construction related PAG contact water.

A summary of water quality exceedances relative to BCAWQG-FSTM listed by monitoring location and month are listed in Table 9, and the screening results based on the laboratory data are tabulated in Appendix B, Table B3.

4.3.3 Trend Monitoring

Monthly water quality monitoring measures instantaneous ambient conditions at the time of sampling and, as discussed in Section 3.1, the measurements are highly susceptible to temporal climate conditions due to the small catchment and short residence time of water with the SBIAR ditch. Recurring trends at SBIAR over the 2017 and 2018 monitoring period may be indicative of long term trends, and are discussed below for alkalinity and pH (Figure 15), TSS and TDS (Figure 16), sulphate (Figure 17), aluminum (Figure 18), and iron (Figure 19), in addition to trends in specific metals such as arsenic (Figure 20), cadmium (Figure 21), cobalt, (Figure 22), copper (Figure 23), and zinc (Figure 24).

4.3.3.1 Alkalinity and pH

Alkalinity and pH values indicate that waters have remained alkaline during 2017 and 2018 (Figure 15). In 2018, values for pH measured at RBSBIAR-DS range closely between 8.23 and 8.31 with a mean pH value of 8.26 (Table 10). Alkalinity trends between the upstream and downstream monitoring location are variable yet show a positive correlation at between upstream (RBSBIAR-US/-EUS) and downstream (RBSBIAR-DS/-EDS), and east (-EUS/-EDS) and west (-US/-DS) ditches. There is an increasing trend in alkalinity in both upstream and downstream (east and west) ditches between June and September 2018. Values for alkalinity at RBSBIAR-DS range between 188 mg/L and 233 mg/L $CaCO_3$ equivalent with mean value of 213 mg/L $CaCO_3$ equivalent (Table 10).

Measured pH at the side channel location RBSC-DS range between 7.74 and 8.26 with mean value of 8.04, and alkalinity range between 234 and 404 mg/L $CaCO_3$ equivalent with mean value of 334 mg/L $CaCO_3$ equivalent. The RBSC-DS location generally measures higher alkalinity values and similar to slightly lower pH values relative to the other SBIAR sampled locations, and there is low to negligible correlation observed between pH and alkalinity between the side channel and the SBIAR waters.

4.3.3.2 Hardness

Water hardness measured at RBSBIAR-DS was generally slightly above the upper threshold used by the BCAWQG-FSTM (250 mg/L) to guide criteria for various metal or element concentrations (e.g., total sulphate, copper, lead, manganese, silver, zinc; dissolved cadmium) with values ranging between 275 and 298 mg/L, and a mean value of 285 mg/L. When the maximum hardness value is reached for elements that are hardness-dependent for BCAWQG-FSTM guideline calculations, the respective maximum hardness values for zinc, copper, and cadmium were used as capped hardness values in guideline calculations. Ambient water hardness values are consistent with measurements collected from other catchments on-site and are likely characteristic of background conditions.

4.3.3.3 Total Suspended Sediment (TSS) and Total Dissolved Sediment (TDS)

TSS measurements at the downstream RBSBIAR-DS/-EDS and upstream RBSBIAR–US/-EUS locations are variable both between upstream and downstream, and between west and east ditches, thus lacking correlation over the 2018 sampling period (Figure 16). The overall variability in TSS is attributable to the relative small catchment and short residence time of waters within both the west and east SBIAR ditches and sensitivity to flux in surface water inputs from precipitation or seepage inputs from Area 21. TSS concentrations measured at RBSBIAR-DS range between <3.0 and 75.5 mg/L with mean value of 36.8 mg/L, and measured TDS concentrations ranged between 344 and 502 mg/L with mean value of 428 mg/L. In the March 2018 sampling event, the upstream

RBSBIAR-US location shows the highest TSS values measured during 2017 and 2018 at all locations, then decreases consistently over the remainder of 2018, which differs significantly from the 2017 trend. Conversely, at the downstream RBSBIAR-DS location, TSS measured in March and September 2018, were elevated relative to June 2018, showing a similar trend between April, June, and August 2017.

Measured TSS values within the RBSC-DS ranged between 6.7 and 32.7 mg/L with mean value of 18.4 mg/L, peaking in the June 19, 2018 sampling event, which is somewhat comparable to the 2017 seasonal timing of a TSS peak (May 2017). TSS does not appear to have a direct correlation with the SBIAR monitoring and follows a much more subdued range of variability. Measured TDS values within the RBSC-DS ranged between 539 and 2,500 mg/L with mean value of 1,185 mg/L showing a wide variability with peak values observed in the June 19, 2018 sampling event. Notably, TDS values peaked in July of 2017, therefore may occur seasonally yet there is insufficient data to determine the trend. TDS does not appear to have a direct correlation with the SBIAR monitoring.

4.3.3.4 Sulphate

Sulphate values measured at RBSBIAR-DS and –US locations remained consistently low (Figure 17). Sulphate concentrations measured at RBSBIAR-DS ranged between 51.1 and 111 mg/L with mean value of 79.5 mg/L. It can be observed that sulphate concentrations at the downstream (–DS/-EDS) locations are slightly higher relative to the upstream (–US/-EUS) locations for each 2018 sampling event, indicating a net increase in sulphate from groundwater seepage, and local shale run-off. The downstream RBSBIAR-DS location appears to have a seasonal trend, with sulphate concentration peaking in June of both 2017 and 2018 followed by a decrease in sulphate to August (2017) and September (2018). The upstream RBSBIAR-US location show more consistent sulphate concentrations over 2017 and 2018, although a moderate peak occurs also in June of 2018 relative to early and late seasons.

Measured sulphate concentrations at the RBSC-DS location varied widely within range between 182 and 1,460 mg/L with mean value of 568 mg/L. A seasonal trend may be evident whereby concentration peaked in June 2018 relative to early spring (March 2018) and autumn/winter (September, November, and December 2018). This seasonal trend is also apparent at the RBSC-DS location with sulphate concentration peaking in July 2017. Sulphate concentrations at RBSC-DS appear to have a moderate correlation with the SBIAR monitoring with a peak measured in June.

The BCAWQG-LTA guideline for sulphate is variable with ambient hardness for each sample location. The RBSC-DS location is the only sampling location that measures sulphate above the BCAWQG-LTA guideline in both 2017 and 2018. The LTA is plotted on Figure 17 for the RBSBIAR-DS location, for reference.

4.3.3.5 Total and Dissolved Aluminum

Total aluminum concentrations at RBSBIAR-DS peak in early (March 2018) and late (September 2018) seasons, relative to mid-season, June 2018), of the 2018 monitoring period (Figure 18). Total aluminum concentrations measured at RBSBIAR-DS ranged from 0.0459 to 1.12 mg/L with mean value of 0.578 mg/L. At RBSBIAR-DS, dissolved aluminum concentrations remained below the BCAWQ-FSTM guideline value (0.10 mg/L) in March (0.0515 mg/L) and June (0.0157 mg/L) 2018, and slightly above the guideline value in September (0.106 mg/L) 2018, thus measurements ranged from 0.0157 to 0.106 mg/L with a mean value of 0.0577 mg/L. A decreasing trend or 'dip' in both total and dissolved aluminum measured at RBSBIAR-DS is apparent in both June of 2017 and 2018, preceded and followed by an increase in total and dissolved aluminum during March/April and August/September.

The downstream RBSBIAR-DS and -EDS locations show correlating trends between June and September for both total and dissolved aluminum concentrations, whereas the RBSBIAR-US and -EUS locations show correlating trends between June, September, and December only for total aluminum and not dissolved aluminum.

An overall decrease of total aluminum at RBSBIAR-US is observed throughout the monitoring period of 2018 (March to December), which is a similar observation in 2017. Dissolved aluminum concentrations at RBSBIAR-US varied between below detection limit, <1.0 µg/L, to 10.6 µg/L during the 2018 monitoring period, whereas during 2017, dissolved aluminum remained consistently below detection limit of 5.0 µg/L. During 2017 and 2018, dissolved aluminum concentrations measure significantly below the BCAWQ-FSTM guideline value of 100 µg/L for the RBSBIAR-US location and between June and December 2018 for the new east RBSBIAR-EUS ditch location.

A slight overall increase in total aluminum is measured at the RBSC-DS location during the monitoring period of 2018, a similar trend to 2017. Dissolved aluminum concentrations at RBSC-DS remained significantly below the BCAWQ-FSTM guideline value of 100.0 µg/L for the duration of sampling events in 2017 and 2018.

It was noted that dissolved aluminum was the most variable at RBSBIAR-DS in 2017, but all RBSBIAR sample locations were variable during 2018.

4.3.3.6 Total and Dissolved Iron

Total iron concentrations are variable during the monitoring period (Figure 19), with concentrations at the RBSBIAR-DS location ranging between 0.091 to 2.77 mg/L with mean value 1.21 mg/L. Exceedances to the BCAWQG-FSTM guideline (1.0 mg/L) for total iron concentration occurred at RBSBIAR-DS in March 2018 (2.77 mg/L), then significantly decreased to below guideline levels in June and September 2018. In the SBIAR catchment, exceedances to the BCAWQG-FSTM guideline for total iron concentration also occurred at RBSBIAR-US (March 2018), RBSBIAR-EDS (September 2018), and -EUS (September and December 2018).

Dissolved iron concentrations measured well below the BCAWQG-FSTM guideline at RBSBIAR-DS/-EDS and RBSBIAR-US/-EUS, and at RBSBIAR-DS dissolved iron concentrations remained below detection limit of 10 µg/L (June and September 2018), except for slightly above detection limit in March 2018 (12.0 µg/L).

In 2018, at the RBSC-DS location, elevated concentrations of dissolved iron above the BCAWQG-FSTM guideline (0.35 mg/L) were measured in March (0.474 mg/L), November (2.15 mg/L), and December (0.725 mg/L), with a significant decrease to below the guideline value (0.101 mg/L) occurring in June 2018. Measured dissolved iron concentrations at the RBSC-DS location ranged between 0.101 and 2.15 mg/L with mean value of 0.863 mg/L.

4.3.3.7 Metals: Arsenic, Cadmium, Cobalt, Copper, and Zinc

Metals such as arsenic, cadmium, cobalt, copper, and zinc are important indicators of ARD-ML processes and environmental changes in the water supply. Three sampling events (March, June, and September 2018) occurred during the quarterly sampling at the downstream location, RBSBIAR-DS, discussed below.

Total arsenic concentrations during 2018 measured at RBSBIAR-DS ranged from 0.50 to 1.93 µg/L with mean value of 0.99 µg/L, whereas dissolved arsenic ranged from 0.17 to 0.45 µg/L with mean value of 0.29 µg/L. No BCAWQG-FSTM guideline exceedances in total arsenic occurred at RBSBIAR-DS during 2018, and values remained within the same general range of concentrations measured during 2017 (Figure 20).

Total cadmium concentrations during 2018 measured at RBSBIAR-DS ranged from 0.02 and 0.21 µg/L with mean value of 0.12 µg/L, whereas dissolved cadmium ranged from 0.02 and 0.11 µg/L with mean value of 0.06 µg/L. No BCAWQG-FSTM guideline exceedances in dissolved cadmium occurred at RBSBIAR-DS during 2018, and values remained within the same general range of concentrations measured during 2017 (Figure 21).

Total cobalt concentrations during 2018 measured at RBSBIAR-DS ranged from 0.39 and 4.3 µg/L with mean value of 2.9 µg/L, whereas dissolved cobalt ranged from 0.32 and 4.6 µg/L with mean value of 2.6 µg/L. No BCAWQG-

FSTM guideline exceedances in total cobalt occurred at RBSBIAR-DS during 2018, and values remained within the same general range of concentrations measured during 2017 (Figure 22).

Total copper concentrations during 2018 measured at RBSBIAR-DS ranged from 1.00 to 4.99 µg/L with mean value of 3.25 µg/L, whereas dissolved copper ranged from 0.75 and 1.57 µg/L with mean value of 1.04 µg/L. No BCAWQG-FSTM guideline exceedances in total copper occurred at RBSBIAR-DS during 2018, and values remained within the same general range of concentrations measured during 2017 (Figure 23), although an increase in total copper shows in both March and September 2018 relative to June 2018 and all of 2017.

Total zinc concentrations during 2018 measured at RBSBIAR-DS ranged from 3.1 to 50.7 µg/L with mean value of 32.2 µg/L, whereas dissolved zinc ranged from 2.0 to 26.1 µg/L with mean value of 15.1 µg/L. No BCAWQG-FSTM guideline exceedances in total zinc occurred at RBSBIAR-DS during 2018 (based on calculations that include hardness values at RBSC-DS), shown in Figure 24). Total and dissolved zinc concentrations follow a different trend in 2018 than in 2017, reaching slightly higher concentrations in March and September, and slightly lower concentration in June 2018.

Notably, the quarterly sampling in 2018 results in a similar trend showing for zinc, cobalt, copper, cadmium, iron, aluminum, and TSS, with an inverse trend for sulphate.

Quarterly sampling in the SBIAR catchment occurred during the 2018 monitoring period, somewhat preventing as clear a trend that shows for the 2017 monthly monitoring system.

4.3.4 Long Term Average Exceedances

At the discharge location, RBSBIAR-DS, minimal occurrences of measured concentrations during 2018 exceed the BCAWQG-LTA guidelines. Measured nitrite concentrations on September 27, 2018 (27.4 µg/L) slightly exceeds the BCAWQG-LTA (20 µg/L) and not the BCAWQG-FSTM (60 µg/L). Similarly, total cobalt measured on March 21, 2018 (4.01 µg/L) and September 27, 2018 (4.3 µg/L) slightly exceeds the BCAWQG-LTA (4.0 µg/L) and dissolved aluminum measured on March 21, 2018 (51.5 µg/L) slightly exceeds the BCAWQG-LTA (50 µg/L), but both do not exceed the BCAWQG-FSTM.

4.4 L3 Creek Catchment Water Sampling

Sufficient flowing water permitted samples to be collected each month from March through to November 2018 at the downstream monitoring location LBL3C-0.02; March through to December for LBL3C-1.43; April, July, and December for LBL3C-1.65; April through to July for LBL3C-3.32; and March through to October for LBL4C-0.18. Frozen conditions prevailed in January and February 2018. During 2018, minimal samples were collected at LBL3C-1.65 due to ongoing construction at this location. Field observations were documented each month.

The L3 Creek catchment is not being monitored as a construction related PAG waterway. Water quality monitoring has been conducted within this catchment to monitor discharge water quality and to maintain a record for potential future use. The BCAWQG-FSTM values were also used as benchmark for monitoring water quality at the discharge location (LBL3C-0.02) from L3 Creek.

4.4.1 In Situ Measurements and Field Observations

Water flow estimated during water sampling events in 2018 range between 1.0 L/s (September 27) and 50.0 L/s (April 19) from the LBL3C-0.02 location into the RR-10 culvert. Upstream water flow was estimated to range between 0.10 and 5.0 L/s at the LBL3C-1.43 site (Table 11). The range in water temperatures at LBL3C-0.02

(0.0-15.4 °C), LBL3C-1.43 (0.5-18.0 °C), LBL3C-1.65 (0.3-30.8 °C), LBL3C-3.32 (0.0-23.7 °C), and LBL4C-0.18 (0.0-14.9 °C), were recorded during 2018 (Table 11).

Turbidity was found to be clear within the LBL3C locations throughout the 2018 monitoring program, although the water was observed to be milky at the LBL4C location in the April 19 and June 19, 2018 sampling events. During the December 17, 2018, sampling event, orange staining was noted in the field observations at LBL3C-1.65, and algae was noted at the LBL3C-1.43 location.

A field observation during the November 19, 2018 sampling event noted a dark orange-ish seep coming from under the Stilling Basin in L3 Creek, near to the LBL3C-1.65 sampling location (Photo 19). In situ measurements were collected for hardness (120 ppm), alkalinity (120 ppm), pH (6.5), conductivity (3730 µS), and temperature (4 °C), at a location in the L3 Creek a few metres upstream of the confluence with the L4 Creek. November 2018 was the first month since construction began in the Stilling Basin that flow was observed in the L3 Creek upstream from the confluence with L4 Creek. The observations may help to explain the PAG-type signature measured in L3 Creek above L4 Creek in the early part of the year prior to re-arrangement of the stilling basin facility. No evidence of exposed shale was found during a site visit in July 2018. The deep red colour observed in the seepage may be related to tannins in the water due to the pH range (6.0-6.5) of tannic acid. Further monitoring was recommended including checking if there was bark mulch on the ground and how water is conveyed from the stilling basin to the lower L3 Creek channel, such as flowing under pallets for a short section.

4.4.1.1 Reconnaissance Investigation of L4 Creek

Reconnaissance investigation and sampling of L3 Creek reveals naturally occurring ARD-ML processes such as elevated metals, and that dilution occurs in L3 Creek. In June 2018, a dilution factor was estimated to be 7:1 using the following method:

- Data collected from instream flow gauges was reviewed to estimate a dilution factor for L4 Creek within the L3 Creek flow using a dataset for the previous May 24, 2018, sampling event. The data was provided by Ecofish Research Ltd. and is an estimate unless verified by actual discharge measurements. Discharge measurements were not completed on May 24, 2018. Flow gauges were installed at locations Upper L3 (coincident with LBL3C-3.32), L3 Above the Drainage Ditch (L3 ADD) (coincident with LBL3C-1.65), L3 Below Box Culvert (L3 BBC) (coincident with LBL3C-1.43), and L4 (coincident with LBL4C-0.18).
- Flow at these locations were reported as 0.002 m^3/s (2 L/s) at Upper L3, 0.001 m^3/s (1 L/s) at L3 ADD, 0.006 m^3/s (6L/s) at L3 BC and 0.001 m^3/s (1 L/s) at L4. Based on the estimated flows, L4 Creek was diluted at a factor of 6:1 in the upper portion of L3 Creek during the May 2018 sampling event. As flow data was not available at LBL3C-0.02, the dilution factor cannot be calculated. However, using mass balance of conservative elements (Cl, or Li), the data suggests that additional water is received into L3 Creek between LBL3C-1.43 and LBL3C-0.02, and is comprised mainly of groundwater, based on Cl- concentrations.

Limitations to the assessment include:

- Estimated flows were very low on May 24, 2018 and margin of measurement error is proportionally higher than for periods when there is higher flow.
- Flow data was not provided for the mouth of L3 Creek (location LBL3C-0.02).
- A sample for water chemistry was not collected at LBL3C-1.43 in May (approximate flow gauge location L3 ADD).
- A mass balance using conservative elements (Cl, or Li) could not be used to verify the dilution factor without chemistry at L3 ADD, or flow at LBL3C-0.02.

- Flow and estimated dilution is expected to change monthly and no further checks could be made during other months due to unreliable flow data.
- L4 Creek waters are eventually diluted by L3 Creek waters and PAG related metal concentrations are significantly reduced at monitoring location LBL3C-0.02.

4.4.2 Short Term Maximum Exceedances

At the discharge location of L3 Creek, LBL3C-0.02, exceedances were reported for total iron and dissolved aluminum. Within the entire L3 Creek catchment, total iron, cobalt, zinc, copper, arsenic, and manganese, and dissolved iron, aluminum, and cadmium, were measured on occasion above BCAWQG-FSTM guidelines, and pH below BCAWQG-FSTM guidelines during 2018. A summary of water quality exceedances relative to BCAWQG-FSTM listed by monitoring location and month are provided in Table 12, and the screening results based on the laboratory data are tabulated in Appendix B, Table B4.

The total iron exceedances in the samples collected from the LBL3C-0.02 and LBL3C-1.43 locations in March, April, and August 2018, are interpreted to be directly related to TSS concentrations within the creek. Management of TSS originating from RSEM L3 was under active monitoring, management and mitigation through 2017 and 2018. Minimal iron was measured in the dissolved phase at LBL3C-0.02 between March and September 2018 (<20 to 78 µg/L), followed by a significant increase in dissolved iron measured in October (168 µg/L) and November (162 µg/L) 2018, which remained below BCAWQG-FSTM guidelines, yet the increase is noted and may be the result of ARD-ML related processes.

The dissolved aluminum exceedances in the samples from May through October 2018 (not occurring in March, April, or November 2018) from LBL3C-0.02 are interpreted to be related to water inputs to L3 Creek between sample location LBL3C-1.43 and LBL3C-0.02. Dissolved aluminum is potentially measurable as concentrations of aluminum hydroxide complexes in solution. Groundwater seepage from the Howe Pit area is interpreted as the main input to this portion of the L3 Creek, with secondary inputs as surface run-off from the Howe Pit area.

4.4.3 Trend Monitoring

Recurring trends within the L3 catchment over the 2017 and 2018 monitoring period may be indicative of long term trends, and are discussed below for alkalinity and pH (Figure 25), TSS and TDS (Figure 26), sulphate (Figure 27), aluminum (Figure 28), and iron (Figure 29), in addition to trends in specific metals such as arsenic (Figure 30), cadmium (Figure 31), cobalt, (Figure 32), copper (Figure 33), and zinc (Figure 34).

4.4.3.1 Alkalinity and pH

Alkalinity and pH values measured in L3 Creek indicate that the waters have remained alkaline between March and December, 2018, with exception to 1) low pH (below the BCAWQG-FSTM guideline) and alkalinity levels measured in LBL4C-0.18 (May, June, and October 2018), and 2) low pH (below BCAWQG-FSTM guideline) coupled with elevated alkalinity measured at LBL3C-1.65 in December 2018, that indicate variable acidic waters within the L3 catchment (Figure 25). Measured pH at location LBL3C-0.02 ranged between 8.1 and 8.2 with mean value of 8.1, and alkalinity ranging between 121 and 301 mg/L $CaCO_3$ equivalent with mean value of 210.6 mg/L $CaCO_3$ equivalent. Generally, pH remained consistently neutral (with exception to the above-mentioned occurrences at LBL4C-0.18 and LBL3C-1.65), while alkalinity gradually increased between March and December 2018, at all L3 Creek sampling locations, not LBL4C-0.18, indicating lack of correlation between the L3 Creek monitoring locations and the L4 Creek.

The trends in pH for 2017 and 2018 similarly show more variability at LBL3C-1.65 and LBL4C-0.18 locations and more consistency of neutral pH at LBL3C-0.02, -1.43, and 3.32 locations. There are no similar trends in alkalinity values between 2017 and 2018, since 2017 shows more variability in contrast to generally a gradual increase in alkalinity values at L3 Creek locations (excluding LBL4C-0.18) over the monitoring period of 2018.

4.4.3.2 Hardness

Water hardness measured at LBL3C-0.02 was consistently above the upper bound (250 mg/L) used by the BCAWQG-FSTM to guide criteria for metal concentrations, with values ranging between 279 and 1,310 mg/L with mean value of 984 mg/L (Table 10). This value is based on toxicity tests and adapted by the Canadian Council of Ministers of the Environment (BCAWQG Summary Report, 2018). When the maximum hardness value is reached for elements that are hardness-dependent for BCAWQG-FSTM guideline calculations, the respective maximum hardness values for zinc, copper, and cadmium were used as capped hardness values in guideline calculations, instead of the measured ambient hardness. A site-specific assessment may be required since the water hardness continues to exceed the highest hardness tested (250 mg/L) in BC (BCAWQG Summary Report, 2018, pg. 32).

4.4.3.3 Total Suspended Sediment (TSS) and Total Dissolved Sediment (TDS)

TSS concentrations measured within L3 Creek varied on a monthly basis between monitoring locations (Figure 26). Concentrations were generally observed to be either similar or reduced at the discharge location (LBL3C-0.02) relative to the immediate upstream location (LBL3C-1.43) due to settlement, except for measurements in August and November 2018. TSS concentrations measured at LBL3C-0.02 ranged between 7.5 and 173 mg/L with a mean value of 33.3 mg/L.

TDS concentrations show moderate to high correlation between monitoring locations with overall variability on a monthly basis. TDS concentrations measured at the LBL3C-0.02 location ranged between 454 and 2,100 mg/L with a mean value of 1,546 mg/L.

The increasing trend observed for TDS appears to be inverse to the decreasing trend for TSS only for the 2018 monitoring period (Figure 26). As discussed in Section 3.1, the role of dominant input waters to flow conditions in L3 Creek strongly influences the measured water quality. Events resulting in high TSS measurements may be related to precipitation or recent precipitation in the form of shallow groundwater flow, whereas events resulting with high TDS and low TSS measurements may be related to low precipitation and high groundwater inflow. As spring freshet wanes and the dominant influent water transitions to regional groundwater, trends in TDS and TSS are influenced. In 2018, it is observed that freshet is related to low concentrations of TDS.

4.4.3.4 Sulphate

Sulphate measurements have remained highly variable between March and December 2018, for the LBL3C-0.02 and LBL3C-1.43 locations, spiking in June, August and October 2018, which also occurred in 2017 although more prominently at both locations in 2017 (Figure 27). Sulphate concentrations measured at LBL3C-0.02 ranged between 187 and 1,320 mg/L with mean value of 871 mg/L.

Monthly variability in measured sulphate generally correlates with a similar trend observed for TDS including the overall increase in both sulphate and TDS over the monitoring period of 2018, notably more gradual for TDS and more variable for sulphate. A correlation between TDS and sulphate was also recognized from the 2017 monitoring period. The correlation between TDS and sulphate suggests that possibly during 2018, elevated sulphate concentrations represent months where groundwater inputs dominate flow in L3 Creek and relate to the transition from freshet early in the season to regional groundwater input throughout the remainder of the year, especially during the dry summer and autumn months as was the case in the region for 2018.

The BCAWQG-LTA guideline for sulphate is variable with ambient hardness for each sample. The LTA is plotted on Figure 27 at the LBL3C-0.02 location, for reference.

4.4.3.5 Total and Dissolved Aluminum

Total aluminum concentrations measured at the LBL3C-0.02 location ranged between 558 and 4,340 µg/L with mean value of 1,304 µg/L and shows variability (Figure 28a).

Dissolved aluminum also shows variability throughout 2018 (Figure 28b), with six (May through October 2018) of nine measurements at LBL3C-0.02 exceeding the BCAWQG-FSTM guideline (100 µg/L). Concentrations of dissolved aluminum measured at the LBL3C-0.02 location ranged between 37.3 and 199 µg/L with mean value of 121 µg/L. It is observed that dissolved aluminum concentrations are generally higher at the discharge location LBL3C-0.02 relative to the LBL3C-1.43 location, likely due to input from impacted waters in the Howe Pit area. In December 2018, an anomalous dissolved aluminum concentration was measured at the midstream LBL3C-1.65 location, that exceeds the BCAWQG-FSTM guideline and measures higher than the downstream LBL3C-1.43 location.

The LBL3C-0.02 and -1.43 locations generally have similar trends for dissolved aluminum in 2017 and 2018, with the discharge location, LBL3C-0.02, measuring higher values than the upstream LBL3C-1.43 location, and LBL3C-0.02 exceeding the BCAWQG-FSTM guideline for dissolved aluminum in the majority of sampling events. The LBL4C-0.18 location consistently measures the highest dissolved and total aluminum concentrations in the L3 catchment throughout the 2017 and 2018 monitoring periods, whereas the most upstream location LBL3C-3.32, generally measures the lowest dissolved and total aluminum concentrations.

4.4.3.6 Total and Dissolved Iron

Total iron values were measured at elevated concentrations throughout 2018, as was the case in 2017 (Figure 29a), with concentrations in 2018 measured at LBL3C-0.02 ranging between 0.539 and 7.95 mg/L with mean value 1.93 mg/L, resulting in three (March, April, and August 2018) of nine sampling events measuring above the BCAWQG-FSTM guideline (Table 12). Locations within the L3 catchment that had total iron concentrations measured above the BCAWQG-FSTM guideline during 2018 were the downstream LBL3C-0.02 and -1.43 locations (generally early season of March and April 2018), and midstream and above the L4 Creek confluence, LBL3C-1.65 and LBL4C-0.18 (all months sampled between March and October/December, 2018), whereas the upstream LBL3C-3.32 location did not exceed the BCAWQG-FSTM guideline for total iron in 2018.

For all sampling events in 2018 at LBL3C-0.02 and LBL3C-1.43, minimal iron was measured in the dissolved phase except for during September and December 2018 at LBL3C-0.02 (Figure 19b). At the LBL3C-0.02 location, dissolved iron was measured in low concentrations with values ranging from below the detection limit of <20 to 78 µg/L between March and September 2018, and elevated concentrations in October (168 µg/L) and November (162 µg/L), 2018. Dissolved iron concentrations were measured above the BCAWQG-FSTM guideline (350 µg/L) at the LBL4C-0.18 (May, June, September 2018) and LBL3C-1.65 (December 2018) locations, however, no exceedance to the BCAWQG-FSTM guideline was measured for dissolved iron concentrations at LBL3C-0.02. Notably, during 2017 and 2018, the same two LBL3C-1.65 and LBL4C-0.18 locations measured dissolved iron concentrations above the BCAWQG-FSTM guideline, although there was only one occurrence in 2017 (May), and four occurrences in 2018 (May, June, September, and December).

4.4.3.7 Metals: Arsenic, Cadmium, Cobalt, Copper, and Zinc

Metals such as arsenic, cadmium, cobalt, copper, and zinc are important indicators of ARD-ML processes and environmental changes in the water supply. Nine sampling events (March through to November 2018) occurred during the monthly sampling at the downstream location, LBL3C-0.02, discussed below.

Total arsenic concentrations during 2018 measured at LBL3C-0.02 ranged from 0.36 to 4.03 µg/L with mean value of 1.05 µg/L, whereas dissolved arsenic ranged from 0.10 to 0.39 µg/L with mean value of 0.22 µg/L. No BCAWQG-FSTM guideline exceedances in total arsenic occurred at LBL3C-0.02 during 2018, an overall decreasing trend occurs through the 2018 monitoring period, and values remained within the same general range of concentrations measured during 2017 (Figure 30a).

Total cadmium concentrations during 2018 measured at LBL3C-0.02 ranged from 0.21 to 0.58 µg/L with mean value of 0.46 µg/L, whereas dissolved cadmium ranged from 0.10 to 0.49 µg/L with mean value of 0.32 µg/L. No BCAWQG-FSTM guideline exceedances in dissolved cadmium occurred at LBL3C-0.02 during 2018, and an overall very slight increasing trend shows through the 2018 monitoring period although values remained within the same general range of concentrations measured during 2017 (Figure 31b).

Total cobalt concentrations during 2018 measured at LBL3C-0.02 ranged from 1.98 to 9.57 µg/L with mean value of 7.14 µg/L, whereas dissolved cobalt ranged from 0.76 to 8.83 with mean value of 6.19 µg/L. No BCAWQG-FSTM guideline exceedances in total cobalt occurred at LBL3C-0.02 during 2018, an overall slight increasing trend shows through the 2018 monitoring period and values remained within the same general range of concentrations measured during 2017 (Figure 32a).

Total copper concentrations during 2018 measured at LBL3C-0.02 ranged from 1.5 to 11.1 µg/L with mean value of 3.37 µg/L, whereas dissolved copper ranged from 0.80 to 1.81 µg/L with mean value of 1.15 µg/L. No BCAWQG-FSTM guideline exceedances in total copper occurred at LBL3C-0.02 during 2018, an overall decreasing trend occurs through the 2018 monitoring period, and values remained within the same general range of concentrations measured during 2017 (Figure 33a).

Total zinc concentrations during 2018 measured at LBL3C-0.02 ranged from 28.1 to 89.3 µg/L with mean value of 67.3 µg/L, whereas dissolved zinc ranged from 9.1 to 54 µg/L with mean value of 39.1 µg/L. No BCAWQG-FSTM guideline exceedances in total zinc occurred at LBL3C-0.02 during 2018 and values remained within the same general range of concentrations measured during 2017, shown in Figure 34a).

The continuation of monthly sampling in the L3 catchment occurred during the 2018 monitoring period, providing a useful reference for observing clearer seasonal trends.

4.4.4 Long Term Average Exceedances

At the discharge location, LBL3C-0.02, minimal occurrences of measured concentrations during 2018 exceed the BCAWQG-LTA guidelines. Total cobalt concentrations slightly exceeded the BCAWQG-LTA (4.0 µg/L) on a monthly basis between April and November 2018 (eight events) with measured values between 5.92 to 9.18 µg/L, but do not exceed the BCAWQG-STM (100 µg/L). Similarly, slight exceedances to the BCAWQG-LTA occur for a) total copper measured on April 19, 2018 (11.1 µg/L), b) total and dissolved selenium concentrations in September, October, and November, 2018 (2.05 to 3.10 µg/L), c) total zinc measured on March 21, 2018 (49.5 µg/L), d) dissolved cadmium concentration on May 24, 2018 (0.489 µg/L), and 3) dissolved aluminum measured on April 19, 2018 (62.8µg/L) and November 19, 2018 (88.8 µg/L), but do not exceed the BCAWQG-STM.

4.5 Other Locations

Due to on-site field observations, two additional locations were sampled for temporary monitoring at 1) Gully Road ditch through six sampling events from May through October 2018, and 2) the Wiley C. sample collected next to the LBRR-EDP location on September 27, 2018. The screening results based on the laboratory data are tabulated in Appendix B, Table B5.

4.5.1 Gully Road Ditch

During the June 19, 2018, sampling event, a sample location was established as a temporary monitoring location along the Gully Road ditch, just west of Gate B and UTM coordinate 630,286 E and 6,230,555 N (map in Figure 1), following site observation of a small shale exposure in the northern cut-bank of the ditch and presence of iron-oxide staining on the rip-rap lining the ditch (Photo 20). In situ and laboratory results were collected from Gully Road Ditch during six sampling events including May 24, June 19, July 26, August 21, September 27, and October 22, 2018.

At Gully Road ditch, exceedances to the BCAWQG-FSTM for total iron (1.0 mg/L) were measured in three of the six sampling events, July 26 (17.2 mg/L), September 27 (1.47 mg/L), and October 22 (1.65 mg/L), 2018. Dissolved aluminum concentrations (0.259 mg/L) measured above the BCAWQG-FSTM (0.100 mg/L) on July 26, 2018. Total zinc concentration (0.414 mg/L) measured above the BCAWQG-FSTM (0.3405 mg/L) on July 26, 2018. Although chloride was not measured to exceed the BCAWQG-FSTM (600 mg/L) at Gully Road ditch, elevated concentrations were noted to exceed the BCAWQG-LTA (150 mg/L) in each of the six sampling events (May through October 2018), with chloride concentrations ranging between 115 and 320 mg/L, with a mean value of 244 mg/L.

4.5.2 Wiley C.

During the September 27, 2018 sampling event an additional sampling location, Wiley C., was added near LBRR-EDP (map in Figure 1), to assess the observed presence of a white milky substance in pooled water within the ditch.

In situ standing water temperature measured 7.7 ºC with a pH of 8.13. Lab results measured a pH of 7.83 with four BCAWQG-FSTM exceedances in the Wiley C. sample, including total cobalt (179 µg/L), total zinc (1190 µg/L), dissolved cadmium (5.94 µg/L), and dissolved aluminum (181 µg/L) concentrations above the BCAWQG-FSTM guideline values of 110 µg/L, 340.50 µg/L, 2.80 µg/L, and 100 µg/L, respectively.

An investigation included review of in situ and lab water quality samples collected on September 27, 2018, from both the Wiley C. and nearby LBRR-EDP location, and the geochemistry of a nearby soil sample, SC-059, collected during the July 2018 site visit. No exceedances were measurable in the soil sample against the Contaminated Sites Regulations (CSR) guidelines. The white milky substance sampled at Wiley C. on September 27, 2018, is the only observation recorded in the catchment, although during the October 22, 2018 sampling event it is noted that a white milky substance is found along the L4 channel including the LBL4C-0.18 sampling location.

Seepage water from groundwater is known to be enriched in sulphate ($SO_4{}^{2-}$) and hardness (as $CaCO_3$), based on the consistent high background levels of sulphate concentration and hardness values measured in water quality samples over the 2017 and 2018 monitoring periods. It is notable that sulphate and specific metal concentrations (total copper, lead, manganese, silver, zinc, and dissolved cadmium) are dependent on hardness values for their respective BCAWQG-FSTM and -LTA guideline values. Cooling temperatures decreases the solubility of sulphate, resulting in sulphate reaching supersaturation as $CaSO_4$ (s). It is thought that the temperature of the groundwater containing high concentrations of sulphate dropped once exposed to the cooler air temperatures thereby rapidly reducing the solubility of sulphate. Gypsum ($CaSO_4 \cdot 2H_2O$) and/or anhydrite ($CaSO_4$), are soluble in water and can produce a white turbid milky substance. Within the shale outcrop further up the River Road bend, sulphur (S^{2-}) in the weathering of pyrite (FeS_2) oxidizes to sulphate ($SO_4{}^{2-}$) and ferrous (Fe^{2+}) iron is released. If groundwater seepage occurs, especially in cooler seasonal temperatures, supersaturation of $SO_4{}^{2-}$ shifts the reaction ($CaSO_4$ (s) → Ca^{2+} + $SO_4{}^{2}$) to the left to form calcium sulphate and a colloidal $CaSO_4$ forms. Continued observations will check for seasonal trends.

5.0 CONCLUSIONS AND RECOMMENDATIONS

A water quality monitoring program was implemented on behalf of BC Hydro to monitor the water quality at discharge locations from River Road at Blind Corner, SBIAR, and L3 Creek. Upstream and midstream monitoring locations were established to characterize water quality at the discharge location and to maintain a continuous monitoring record commensurate with previous sampling completed in 2016 by Lorax on behalf of PRHP.

The program has incorporated monthly in situ water quality measurements and observations with laboratory analysis throughout 2017 and 2018. Field observations were recorded monthly regardless of weather conditions or ability to collect measurements.

5.1 River Road Water Quality Monitoring

Water quality data was collected from four locations and in situ measurements were collected at an additional six locations along the River Road catchment from March to December 2018, in continuation of the 2017 monitoring period.

Water quality monitoring continues to show that active ARD-ML process are progressing on shale slopes shown in observed trends, such as elevated and increasing trends for copper and zinc. Minor seepage observed at the base of the LBRR-LC above the main ditch channel suggests groundwater with high sulphate concentrations is providing additional input to River Road ditch.

Screening of analytical data for the River Road catchment resulted in the identification of eight parameters (total iron, arsenic, cobalt, copper, and zinc, and dissolved iron, aluminum, cadmium) that exceeded the BCAWQG-FSTM guidelines and a pH that measured below the BCAWQG-FSTM guideline at LBRR-12+500 twice during 2018.

Sampling at the LBRR-DD locations in March and April 2018 coincided with minimal precipitation (0.39 mm) the morning of, and no precipitation the preceding seven days of the March 21, 2018 sampling event, and no precipitation the previous 24-hours and minimal precipitation (6.49 mm) the preceding seven days to the April 19, 2018 event. The minimal (0.4 L/s; March 21, 2018) and moderate (5.0 L/s; April 19, 2018) estimated water flow at LBRR-DD coinciding with the increasing onset of freshet, resulted in more exceedances to the BCAWQG-FSTM during the lower flow on March 21, 2018 (five, including total iron, arsenic, zinc, and dissolved iron and aluminum) than during the increased flow and dilution of water on April 19, 2018 (three, including total iron, arsenic, and zinc). Although the two data results are real and suggest active ARD-ML processes, it is believed to represent water quality from either near-frozen minimal flow in March 2018 (more concentration of surface materials) to increased flow with dilution, thus decreased concentrations of parameters measured in April 2018, as opposed to being representative of longer term steady flow conditions. The concentration of TSS measured along River Road ditch and at the discharge location was variable and generally high (Figure 6) and considered to be the main contributing factor to the elemental exceedances observed.

The chemical correlation between the LBRR-12+500 and LBRR-EDP location vs. the LBRR-LC and LBRR-DD are very apparent, e.g., sulphate, aluminum, iron, arsenic, cadmium, cobalt, and zinc.

The sediment source is mainly attributed to scouring of accumulated sediment within the ditch from road grading and run-off from previous events, in addition to washing, or flushing, of the exposed shale, colluvium and overburden cut-banks. Continued management of the effectiveness of the end-of-diversion pipe installed between LBRR-12+430 and LBRR-EDP, and plant germination with survival from hydroseeding efforts on the shale slope above the ditch is required to monitor erosion control and the amount of sediment infilling to the ditch from road grading operations.

Additionally, it was also noted from in situ pH measurements within the ditch that acidic waters are collected in the upper portions of the ditch underlying the exposed shale cut-bank. The pH values progressively return to circumneutral levels at the discharge and end-of-diversion pipe locations in part due to contact with limestone rip-rap in the ditch, settling of sediment/solids and potential alkalinity input from groundwater or outflow from the upper cut-off ditch. Orange coating, or mineral precipitate, continued to be observed on the visible limestone. Chemical efficiency of the limestone to buffer acidic water is decreased when coated in precipitate or sediment. The formation of mineral scale can concentrate metals from solution as a result of the aqueous acid-base reactions. The mineral scale and sludge is susceptible to scouring and being washed during heavier rain events which has potential to reduce overall water quality being discharged into the Peace River.

The diversion pipe has successfully reduced the amount of direct high TSS discharge into the Peace River by allowing the water to be collected and slowly infiltrate into the River Road ditch. It is anticipated that sediment in the ditch may now also be accumulating a small amount of secondary mineral formed by ARD-ML processes up-gradient. These minerals commonly contain an elevated concentration of metals related to ML and acid-neutralizing reactions. The sediment should be monitored on a quarterly basis for metal accumulation. Additionally, the monitoring program includes collection of discharge from the LBRR-RR8 and -RR9 culverts, however, since no discharge was observed to be coincident with the scheduled 2018 sampling events, it is recommended that in situ water quality measurements are collected from any discharge observed from culvert RR-8 and/or RR-9 during high flow events.

The limestone contained in the ditch must continue to be regularly maintained through cleaning and descaling. This procedure would include cleaning the limestone rip-rap material within the River Road ditch in a controlled facility where the sludge can be recovered and relocated to an approved RSEM area, and placement of the refreshed limestone in the ditch. Sludge should also be removed from the cistern and transported to an approved RSEM area. Control of sediment erosion was responded to by BC Hydro during 2018, in efforts to reduce sedimentation into the River Road drainage system from shale slopes and road grading operations. A limestone buttress was added at the base of the shale slope at Blind Corner in approximately June of 2018. Continued regular monitoring of the limestone is recommended as an ongoing effort on all sections of the road down to the discharge location LBRR-DD.

Identification of the source of dissolved aluminum in previous sampling events is hypothesized to be related to fine mineral particulate (<45um) that is passing through the field filter as colloid or fine microcrystalline form. Aluminum hydroxide mineral species (e.g., polymorphs of gibbsite or hydrargillite) can form on rock surfaces and can be indicators of acid generating processes under base flow conditions. Locally impacted groundwater may also be seeping into the lower chimney ditch and may contribute to the measured dissolved aluminum concentrations. Similar water quality characteristics are observed in the lower L3 Creek catchment which may indicate that locally impacted groundwater from the exposed shale in the legacy Howe Pit area may be a common contributing factor. BC Hydro should consider options for remediation of this facility.

Water quality measurements along River Road indicate that run-off water quality is influenced by active ARD-ML processes within the ditch catchment. Although flows are generally low and ephemeral, there is some potential for run-off to impact downstream water quality. As per CEMP Appendix E Section 5.2.1.7, it is recommended that water quality monitoring is continued on a monthly basis at the established locations within the River Road catchment.

Continuous monitoring will enable the effectiveness of mitigation strategies that are implemented on the shale at Blind Corner.

5.2 SBIAR Water Quality Monitoring

Water quality data was collected from five established sampling locations, four of which measure water directly from within the SBIAR facility and one which measures water outside of the SBIAR facility at the closet water receptor as a verification check for potential influence from, or direct connectivity with, the PAG contact water that is collected and diverted within the SBIAR facility.

Water flowing through the SBIAR ditch has no direct downstream receptor, and all water in the east and west ditches is currently conveyed directly to the RSEM R6 pond which is an approved PAG contact water management facility.

Based on water quality monitoring results collected within SBIAR and the downstream side channel, there does not appear to be correlation in trends and it is concluded that there is currently no hydraulic connectivity between SBIAR and the side channel.

Alkalinity and pH indicate that the waters in SBIAR have consistently remained alkaline during the 2017 and 2018 monitoring period. Screening of analytical data for the RBSBIAR-DS location resulted in identification of six parameters (total iron, arsenic, copper, and zinc, and dissolved iron and aluminum) that exceeded BCAWQG-FSTM guidelines during 2018.

Evidence of active ARD-ML process are observed on the shale slopes in SBIAR through rinse pH and observation of secondary iron hydroxide mineral formation. Although water quality measurements remain below the BCAWQG-FSTM guidelines, some upward trends are observed for various metal concentrations (i.e., dissolved arsenic, total copper and zinc) over time in the ditches. BC Hydro should consider increasing the sampling frequency to monthly and implementing a shale slope monitoring program to assess the weathering profile and rate of acid production to help predict changes to run-off quality and assess whether the slopes have potential to self-exhaust the active ARD-ML processes. This program will be used to provide recommendation for long term mitigation of this facility.

The RBSBIAR-DS discharge location shows minimal occurrences of parameters (nitrite, total cobalt, and dissolved aluminum) that slightly exceed the BCAWQG-LTA guidelines during 2018, but do not exceed the BCAWQG-STM.

Evidence of active ARD-ML processes were observed in the shale exposed in the east and west ditch within SBIAR, however, the water quality measured throughout 2018 did not indicate significant impacts due to these processes. Downstream water is collected within the RSEM R6 pond for management prior to discharge into the Peace River.

5.3 L3 Creek Water Quality Monitoring

Water quality data was collected from five established sampling locations within the L3 Creek catchment to maintain a continuous record of water quality within the catchment and to monitor potential changes to water chemistry related to construction related activities within the catchment.

Screening of analytical data for the LBL3C-0.02 location resulted in identification of two parameters (total iron and dissolved aluminum) that exceeded BCAWQG-FSTM guidelines at variable times during the 2018 monitoring period.

Alkalinity and pH values measured in L3 Creek indicate that the waters have remained alkaline, with exception to the LBL3C-1.65 location on December 17, 2018, and highly variable pH above and below the BCAWQG-FSTM guideline range in L4 Creek at LBL4C-0.18. There is more variability in alkalinity than pH during 2017 and 2018.

Sulphate, TDS, dissolved iron and aluminum concentrations were observed to increase slightly from the up-gradient LBL3C-1.43 location to the discharge LBL3C-0.02 location. Conversely, total and dissolved cobalt decreased at the discharge LBL3C-0.02 location relative to the upstream LBL3C-1.43 location, although most other parameters show variability between the location of increased concentrations between LBL3C-1.43 and -0.02.

PAG indicator elements have been observed in water quality from the LBL3C-1.65 sampling location in 2018 which were not previously present in 2017. Construction activities within the L3 Creek drainage may have exposed bedrock material. Investigation into the source should be conducted, and mitigation efforts implemented if necessary.

Water quality in L3 Creek between LBL3C-1.43 and the discharge LBL3C-0.02 is influenced by influent waters originating in the Howe Pit areas. This is more evident from sulphate, dissolved aluminum, and total and dissolved iron, which increase throughout this portion of the creek bed. Concentrations of cobalt, cadmium and dissolved zinc and iron, appear to have increased in the catchment in 2018, most prominently at LBL3C-1.43 driven by effluent from L4 Creek, and one sample at the LBL3C-1.65 location, which collectively have increased overall concentrations at the LBL3C-0.02 discharge. Monthly assessment for these metals should be conducted as part of the regular monitoring program in 2019.

L3 Creek is not being managed as a PAG contact water facility, however, the occurrence of a naturally occurring PAG outcrop identified in L4 Creek is monitored by sampling at the LBL4C-0.18 location. At LBL4C-0.18, signatures of ARD-ML processes are prevalent, such as elevated metal concentrations (total iron, cobalt, zinc, copper, arsenic, manganese, and dissolved iron, aluminum, and cadmium) and low pH measured in three of the six samples collected during monthly monitoring in 2018. Water mixing from L4 Creek with L3 Creek is generally diluted.

As discussed for River Road, the source of elevated dissolved aluminum concentration is believed to be related to fine mineral particulate (<45um) that is passing through the field filter as colloid or fine microcrystalline form (i.e., gibbsite, or equivalent polymorph) from secondary mineral precipitation within Howe Pit area, or locally impacted groundwater. Trend observations from sulphate, TDS, and dissolved iron and aluminum data also support interpretation of additional water input to L3 Creek between the up-gradient LBL3C-1.43 and LBL3C-0.02 discharge location. These inputs may be related to Howe Pit surface run-off, and or local impacted shallow groundwater seepage.

Based on the 2018 water quality monitoring program there is risk of negative downstream effects on water quality due to ARD-ML processes. As per CEMP Appendix E Section 5.2.1.7, monitoring of water quality for ARD-ML parameters within the L3 Creek catchment should continue. BC Hydro may choose to continue monitoring water quality on a monthly frequency in order to measure the influence of the construction at LBL3C-1.65 and filling of Howe Pit. An additional monitoring location should be added to any subdrain outlet of the Howe Pit RSEM. Monitoring at location LBL3C-1.65 may need adjustment to accommodate construction activities in the area.

6.0 CLOSURE

We trust this document meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
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TABLES

Table 1: Water Sampling Locations and Events with UTM Coordinates

Catchment	Sample Site	UTM Coordinates (WGS 84)		Elevation	21-Mar-18		19-Apr-18		24-May-18		19-Jun-18		26-Jul-18		21-Aug-18		27-Sep-18		22-Oct-18		19-Nov-18		17-Dec-18	
		Easting	Northing		In-Situ	Lab	In-Situ	Lab	In-Situ	Lab	In-Situ	Lab	In-Situ	Lab	In-Situ	Lab	In-Situ	Lab	In-Situ	Lab	In-Situ	Lab	In-Situ	Lab
Right Bank - South Bank Initial Access Road [1]	RBSBIAR_US	630,327	6,228,397	468.0	✓	✓					✓	✓			✓		✓	✓	✓		✓		✓	✓
	RBSBIAR_DS	630,320	6,228,645	445.2	✓	✓					✓	✓			✓		✓	✓	✓		✓			
	RBSBIAR_EUS	630,376	6,228,399	-							✓	✓			✓		✓	✓	✓		✓		✓	✓
	RBSBIAR_EDS	630,370	6,228,635	-							✓	✓			✓		✓	✓	✓		✓			
	RBSC_DS	630,475	6,228,672	418.6	✓	✓					✓	✓									✓	✓	✓	✓
Left Bank River Road [2]	LBRR_DD	632,853	6,229,862	422.0	✓	✓	✓	✓																
	LBRR_EDP	632,715	6,229,832	-			✓	✓	✓	✓	✓	✓	✓	✓			✓	✓						
	LBRR_LC	632,856	6,229,899	427.2	✓	✓	✓	✓																
	LBRR_UC	633,018	6,230,253	463.2					✓		✓		✓		✓		✓		✓		✓			
	LBRR_12+430	632,857	6,229,885	426.0																				
	LBRR_12+500	632,914	6,229,921	432.0	✓	✓	✓	✓																
	LBRR_12+600	632,948	6,229,983	436.0	✓		✓						✓											
	LBRR_12+700	632,992	6,230,078	442.8	✓		✓						✓											
	LBRR_12+810	633,039	6,230,195	454.0			✓		✓		✓		✓		✓				✓					
	LBRR_12+920	633,000	6,230,282	463.0					✓		✓		✓		✓		✓		✓		✓			
L3 Creek [2]	LBL3C_0.02	632,767	6,229,860	418.0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	LBL3C_1.43	631,728	6,230,210	486.6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	LBL3C_1.65	631,504	6,230,417	493.0			✓	✓					✓	✓									✓	✓
	LBL3C_3.32	630,248	6,231,262	579.0			✓	✓	✓	✓	✓	✓	✓	✓										
L4 Creek [2]	LBL4C-0.18	631,524	6,230,578	507.0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓	✓				
Additional Location	Gully Road Ditch	630,286	6,230,555						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				

[1] Quarterly Sampling.
[2] Monthly Sampling.
Note: In any months of the calendar year not listed (e.g. January, February, and December), frozen/dry conditions persisted at all sampling locations (verified by field staff).

Table 2: Daily and 7-Day Mean Temperature and Precipitation

Date	Time	Precipitation[1]		Temperature[1]			Summary
Sample Event Date Bolded	Time Period	Precipitation Event	Total (mm)	Mean (°C)	Minimum (°C)	Maximum (°C)	24 Hr and 7 Day Precipitation
March 14-20, 2018	7 days	none	0	2.3	-4.6	9.7	No precipitation in preceding 7 days
March 20, 2018	24 hrs.	none	0	2	-1.3	5	No precipitation
March 21, 2018	24 hrs.	4:00 - 9:00 am	0.39	0.8	-0.7	1.7	Minimal precipitation (0.39 mm)
April 12-18, 2018	7 days	April 12, 16-17	6.49	1.9	-4.5	10.4	Minimal (6.49 mm) precipitation in preceding 7 days
April 18, 2018	24 hrs.	none	0	4.5	-3.3	9.9	No precipitation
April 19, 2018	24 hrs.	none	0	6.6	3.8	10	No precipitation
May 17-23, 2018	7 days	23-May	1.47	18.3	7.4	29.7	Minimal (1.47 mm) precipitation in preceding 7 days
May 23, 2018	24 hrs.	22:00	1.47	22	13.5	29.7	Minimal (1.47 mm) precipitation in previous 24 hrs.
May 24, 2018	24 hrs.	none	0	19.4	14.1	25.4	No precipitation
June 12-18, 2018	7 days	June 12, 13, 14	10.8	16.1	6.8	30.7	Moderate (10.8 mm) precipitation in preceding 7 days
June 18, 2018	24 hrs.	none	0	23.4	14	30.7	No precipitation
June 19, 2018	24 hrs.	none	0	24.6	15.6	32.4	No precipitation
July 19-25, 2018	7 days	July 19-20, 22	55.29	15.7	9.5	25.5	Significant (55.3 mm) precipitation in preceding 7 days
July 25, 2018	24 hrs.	none	0	17.8	10.4	25.5	No precipitation
July 26, 2018	24 hrs.	8:00 AM	0.14	20	14	28	Minimal (0.14 mm) precipitation morning of day of sampling event
August 14-20, 2018	7 days	18-Aug	0.48	17.8	6.5	27.3	Minimal (0.48 mm) precipitation in preceding 7 days
August 20, 2018	24 hrs.	none	0	15.4	6.5	25	No precipitation
August 21, 2018	24 hrs.	none	0	18.7	9.1	28.7	No precipitation
September 20-26, 2018	7 days	26-Sep	0.09	6.6	-3.2	17.5	Minimal (0.09 mm) precipitation in preceding 7 days
September 26, 2018	24 hrs.	13:00	0.09	9.9	6.4	13.6	Minimal (0.09 mm) precipitation in previous 24 hrs.
September 27, 2018	24 hrs.	8:00 AM	0.27	5.9	2.9	11.4	Minimal precipitation (0.27 mm) morning of sampling event
October 15-21, 2018	7 days	none	0	10.8	-0.2	19.4	No precipitation in preceding 7 days
October 21, 2018	24 hrs.	none	0	5.8	2	10.6	No precipitation
October 22, 2018	24 hrs.	none	0	3.5	-2.4	10.2	No precipitation
November 12-18, 2018	7 days	Nov. 15, 17	3.97	-3.1	-16.9	8.2	Minimal (3.97 mm) precipitation in preceding 7 days
November 18, 2018	24 hrs.	none	0	4.4	1.5	5.7	No precipitation
November 19, 2018	24 hrs.	none	0	5.1	1.4	9.8	No precipitation
December 10-16, 2018	7 days	Dec. 14, 15	8.81	-2.2	-12.4	5.3	Moderate (8.81 mm) precipitation in preceding 7 days
December 16, 2018	24 hrs.	none	0	-9.6	-11.4	-8.1	No precipitation
December 17, 2018	24 hrs.	4:00 AM	0.26	-8.4	-9.4	-7.5	Minimal (0.26 mm) precipitation on morning of sampling event

[1] BC Ministry of Environment, BC Air quality data: Fort St John North Camp C_Met_60 weather station. https://envistaweb.env.gov.bc.ca/.

Table 3: Classification of Flows in Ditch

Date	Time	Precipitation		Summary	Classification
Sample Event Date Bolded	Time Period	Precipitation Event	Precipitation (mm)	24 hr. & 7 day Precipitation	Flows in Ditch
March 14-20, 2018	7 days	none	0	No precipitation in preceding 7 days	
March 20, 2018	24 hrs.	none	0	No precipitation in prior 24 hrs.	Spring freshet.
March 21, 2018	24 hrs.	4:00-9:00 am	0.39	Minimal precipitation (0.39mm) early morning of sampling event.	Regional groundwater flow; near frozen conditions.
April 12-18, 2018	7 days	April 12, 16-17	6.49	Minimal precipitation (6.49mm) in preceding 7 days	
April 18, 2018	24 hrs.	none	0	No precipitation in prior 24 hrs.	
April 19, 2018	24 hrs.	none	0	No precipitation on day of sampling	Spring freshet; regional groundwater flow.
May 17-23, 2018	7 days	May 23rd	1.47	Minimal precipitation (1.47mm) in preceding 7 days	
May 23, 2018	24 hrs.	22:00	1.47	Minimal precipitation (1.47mm) in prior 24 hrs. to sampling	
May 24, 2018	24 hrs.	none	0	No precipitation on day of sampling	Regional groundwater flow and/or surface runoff.
June 12-18, 2018	7 days	June 12, 13, 14	10.8	Moderate precipitation (10.8mm) in preceding 7 days.	
June 18, 2018	24 hrs.	none	0	No precipitation in prior 24 hrs.	
June 19, 2018	24 hrs.	none	0	No precipitation on day of sampling	Regional groundwater flow.
July 19-25, 2018	7 days	July 19-20, 22	55.29	Significant (55.29mm) precipitation in preceding 7 days	
7/25/2018	24 hrs.	none	0	No precipitation in prior 24 hrs.	
7/26/2018	24 hrs.	8:00 AM	0.14	Minimal precipitation (0.14mm) on the morning of sampling	Shallow groundwater flow.
August 14-20, 2018	7 days	August 18th	0.48	Minimal (0.48mm) precipitation in preceding 7 days	
8/20/2018	24 hrs.	none	0	No precipitation in prior 24 hrs.	
8/21/2018	24 hrs.	none	0	No precipitation on day of sampling	Regional groundwater flow; surface runoff.
September 20-26, 2018	7 days	September 26th	0.09	Minimal (0.09mm) precipitation in preceding 7 days	
September 26, 2018	24 hrs.	13:00	0.09	Minimal (0.09mm) precipitation in prior 24 hrs.	Near frozen conditions.
September 27, 2018	24 hrs.	8:00 AM	0.27	Minimal precipitation (0.27 mm) on morning of sampling	Regional groundwater flow; surface runoff
October 15-21, 2018	7 days	none	0	No precipitation in preceding 7 days	
October 21, 2018	24 hrs.	none	0	No precipitation in prior 24 hrs.	
October 22, 2018	24 hrs.	none	0	No precipitation on day of sampling	Regional groundwater flow; near frozen conditions.
November 12-18, 2018	7 days	Nov. 15, 17	3.97	Minimal precipitation (3.97 mm) in preceding 7 days	
November 18, 2018	24 hrs.	none	0	No precipitation in prior 24 hrs.	
November 19, 2018	24 hrs.	none	0	No precipitation on day of sampling	Regional groundwater flow; near frozen conditions.
December 10-16, 2018	7 days	Dec. 14, 15	8.81	Moderate (8.81 mm) precipitation in preceding 7 days	
December 16, 2018	24 hrs.	none	0	No precipitation in prior 24 hrs.	
December 17, 2018	24 hrs.	4:00 AM	0.26	Minimal precipitation (0.26 mm) on morning of sampling.	Regional groundwater flow; frozen to near frozen conditions.

Table 4: Daily Mean Turbidity and TSS Measurements with the Peace River 2018

Date	Turbidity (Daily Mean) and TSS Measurements and Calculations Peace River above Moberly River			
Sampling Event Date Bolded	**Left Bank**		**Right Bank**	
	NTU [1]	TSS [1] (mg/L)	NTU [1]	TSS [1] (mg/L)
March 15-20, 2018	4.8	3.5	9.1	6.6
March 20, 2018	5.0	3.6	9.2	6.8
March 21, 2018	5.5	4.0	10.9	7.9
March 22, 2018	4.7	3.4	9.5	7.0
April 12-18, 2018	12.1	8.8	11.0	8.0
April 18, 2018	12.0	8.7	10.5	7.6
April 19, 2018	25.9	18.9	10.5	7.7
April 20, 2018	210.7	153.8	9.8	7.2
May 17-23, 2018	91.7	66.9	75.8	55.3
May 23, 2018	91.2	66.6	63.2	46.1
May 24, 2018	90.9	66.4	62.1	45.3
May 25, 2018	78.2	57.1	47.0	34.3
June 12-18, 2018	41.4	30.2	34.8	25.4
June 18, 2018	34.0	24.8	28.2	20.6
June 19, 2018	31.7	23.1	25.3	18.5
June 20, 2018	53.0	38.7	46.2	33.7
July 19-25, 2018	208.2	152.0	274.6	200.4
July 25, 2018	168.8	123.2	213.9	156.2
July 26, 2018	105.3	76.9	138.3	100.9
July 27, 2018	69.1	50.4	91.4	66.7
August 14-20, 2018	9.1	6.6	9.0	6.5
August 20, 2018	5.1	3.7	7.6	5.6
August 21, 2018	4.1	3.0	5.4	3.9
August 22, 2018	2.7	2.0	4.6	3.4
September 20-26, 2018	5.4	4.0	4.6	3.4
September 26, 2018	4.2	3.1	3.6	2.7
September 27, 2018	4.1	3.0	3.4	2.5
September 28, 2018	4.0	2.9	3.3	2.4
October 15-21, 2018	9.8	7.1	6.9	5.1
October 21, 2018	8.7	6.4	6.5	4.7
October 22, 2018	7.1	5.2	5.3	3.9
October 23, 2018	5.7	4.2	4.4	3.2
November 12-18, 2018	6.9	5.1	6.2	4.5
November 18, 2018	7.6	5.5	7.4	5.4
November 19, 2018	10.8	7.9	10.0	7.3
November 20, 2018	12.4	9.1	10.5	7.7
December 10-16, 2018	6.8	4.9	6.7	4.9
December 16, 2018	5.4	3.9	5.7	4.1
December 17, 2018	4.4	3.2	4.5	3.3
December 18, 2018	5.5	4.0	6.0	4.4

[1] NTU (Nephelometric Turbidity Unit) and TSS (total suspended sediment) data provided by Ecofish Ltd., January 8, 2019.

NTU: to some extent, measures (scattered light at 90 degrees from the incident light beam) how much light reflects for a given amount of particulates dependent upon properties of the particles, e.g. their shape, color, and reflectivity.

Note: 7-day average turbidity values are calculated as the average turbidity measured during the prior seven days to the sampling event.

Table 5: Surface Water Quality Assurance/Quality Control Sample Results

Parameter	Unit	RDL	Field Blank	Travel Blank	Travel Blank	Field Blank	Travel Blank	Field Blank	Field Blank	Travel Blank	Field Blank	Travel Blank
			21-Mar-18	21-Mar-18	19-Apr-18	19-Apr-18	24-May-18	24-May-18	19-Jun-18	19-Jun-18	26-Jul-18	26-Jul-18
Physical Parameters												
Electrical Conductivity (EC)	µS/cm	2.0	<2	<2	<2	<2	<2	<2	<2	no value	<2	<2
Hardness as $CaCO_3$	µg/L	500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500
pH	pH Units	0.1	5.33	5.33	5.27	5.41	5.5	5.47	5.41	6.12	5.24	5.38
Total Dissolved Solids (TDS)	µg/L	10000	<10000	<10,000	<10000	<10000	<10,000	<10,000	<10000	<10000	<10000	<10000
Total Suspended Solids (TSS)	µg/L	3000	<3000	<3000	<3000	<3000	<3000	<3000	<3000	<3000	<3000	<3000
Anions and Nutrients												
Acidity (as $CaCO_3$)	µg/L	1000	-	-	-	-	-	-	-	-	-	-
Alkalinity (Bicarbonate as $CaCO_3$)	µg/L	1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	1000	<1000	<1000
Alkalinity (Carbonate as $CaCO_3$)	µg/L	1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Hydroxide as $CaCO_3$)	µg/L	1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Total as $CaCO_3$)	mg/L	1.0	<1	<1	<1	<1	<1	<1	<1.0	**1.0**	<1	<1
Ammonia (NH_4 as N)	µg/L	5.0	<5	<5	<5	<5	<5	<5	**16.6**	<5	<5	<5
Chloride (Cl^-)	µg/L	500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500
Nitrate (NO_3^- as N)	µg/L	5.0	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Nitrite (NO_2^- as N)	µg/L	1.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sulphate (SO_4)	µg/L	300	<300	<300	<300	<300	<300	<300	<300	<300	<300	<300
Metals, Total												
Aluminum	µg/L	3.0	<3	<3	<3	<3	<3	<3	An	<3	<3	<3
Antimony	µg/L	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	µg/L	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Barium	µg/L	0.10	0.073	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beryllium	µg/L	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bismuth	µg/L	0.05	-	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05
Boron	µg/L	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cadmium	µg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Calcium	µg/L	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cesium	µg/L	0.01							<0.01	<0.01	<0.01	<0.01
Chromium	µg/L	0.10	<0.1	<0.1	<0.1	**0.16**	<0.1	**0.26**	<0.1	<0.1	<0.1	<0.1
Cobalt	µg/L	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	µg/L	0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Iron	µg/L	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Lead	µg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lithium	µg/L	1.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Magnesium	µg/L	5.0	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Manganese	µg/L	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mercury	µg/L	0.005	0.0099	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Molybdenum	µg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Phosphorus	µg/L	50.0							<50	<50	<50	<50
Potassium	µg/L	50.0	<50	<50	<0.05	<0.05	<50	<50	<50	<50	<50	<50
Rubidium	µg/L	0.2							<0.2	<0.2	<0.2	<0.2
Selenium	µg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Silicon	µg/L	100							<100	<100	<100	<100
Silver	µg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	µg/L	50.0	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Strontium	µg/L	0.2							<0.2	<0.2	<0.2	<0.2
Sulfur	µg/L	500							<500	<500	<500	<500
Tellurium	µg/L	0.2							<0.2	<0.2	<0.2	<0.2
Thallium	µg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thorium	µg/L	0.10							<0.1	<0.1	<0.1	<0.1
Tin	µg/L	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Titanium	µg/L	0.30	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Tungsten	µg/L	0.10							<0.1	<0.1	<0.1	<0.1
Uranium	µg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	µg/L	0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc	µg/L	3.0	<3	<3	<3	<3	<3	<3	<3.0	<3.0	<3	<3
Zirconium	µg/L	0.06							<0.06	<0.06	<0.06	<0.06
Metals, Dissolved												
Aluminum	µg/L	1.0	-	-	<1.0	-	-	-	-	-	<1.0	-
Antimony	µg/L	0.10	-	-	<0.1	-	-	-	-	-	<0.1	-
Arsenic	µg/L	0.10	-	-	<0.1	-	-	-	-	-	<0.1	-
Barium	µg/L	0.10	-	-	<0.1	-	-	-	-	-	<0.1	-
Beryllium	µg/L	0.10	-	-	<0.1	-	-	-	-	-	<0.1	-
Bismuth	µg/L	0.05			<0.05				-	-	<0.05	-
Boron	µg/L	10.0	-	-	<10	-	-	-	-	-	<10	-
Cadmium	µg/L	0.005	-	-	<0.005	-	-	-	-	-	<0.005	-
Calcium	µg/L	50.0	-	-	<50	-	-	-	-	-	<50	-
Cesium	µg/L	0.01			<0.01				-	-	<0.01	-
Chromium	µg/L	0.10	-	-	**0.24**	-	-	-	-	-	<0.1	-
Cobalt	µg/L	0.10	-	-	<0.1	-	-	-	-	-	<0.1	-
Copper	µg/L	0.20	-	-	<0.2	-	-	-	-	-	<0.2	-
Iron	µg/L	10.0	-	-	<10	-	-	-	-	-	<10	-
Lead	µg/L	0.05	-	-	<0.05	-	-	-	-	-	<0.05	-
Lithium	µg/L	1.0	-	-	<1	-	-	-	-	-	<1	-
Magnesium	µg/L	5.0	-	-	<5	-	-	-	-	-	<5	-
Manganese	µg/L	0.10	-	-	<0.1	-	-	-	-	-	<0.1	-
Mercury	µg/L	0.005	-	-	<0.005	-	-	-	-	-	<0.005	-
Molybdenum	µg/L	0.05	-	-	<0.05	-	-	-	-	-	<0.05	-
Nickel	µg/L	0.50	-	-	<0.5	-	-	-	-	-	<0.5	-
Phosphorus	µg/L	50.0			<50				-	-	<50	-
Potassium	µg/L	50.0	-	-	<50	-	-	-	-	-	<50	-
Rubidium	µg/L	0.20			<0.2				-	-	<0.2	-
Selenium	µg/L	0.05	-	-	<0.05	-	-	-	-	-	<0.05	-
Silicon	µg/L	50.0			<50				-	-	<50	-
Silver	µg/L	0.01	-	-	<0.01	-	-	-	-	-	<0.01	-
Sodium	µg/L	50.0	-	-	<50	-	-	-	-	-	<50	-
Strontium	µg/L	0.2			<0.2				-	-	<0.2	-
Sulfur	µg/L	500			<500				-	-	<500	-
Tellurium	µg/L	0.20			<0.2				-	-	<0.2	-
Thallium	µg/L	0.01	-	-	<0.01	-	-	-	-	-	<0.01	-
Thorium	µg/L	0.10			<0.1				-	-	<0.1	-
Tin	µg/L	0.10	-	-	<0.1	-	-	-	-	-	<0.1	-
Titanium	µg/L	0.30	-	-	<0.3	-	-	-	-	-	<0.3	-
Tungsten	µg/L	0.10			<0.1				-	-	<0.1	-
Uranium	µg/L	0.01	-	-	<0.01	-	-	-	-	-	<0.01	-
Vanadium	µg/L	0.50	-	-	<0.5	-	-	-	-	-	<0.5	-
Zinc	µg/L	1.0	-	-	<1	-	-	-	-	-	<1	-
Zirconium	µg/L	0.06			<0.06				-	-	<0.06	-
Laboratory Work Order Number			L2071158	L2071158	L2082450	L2082450	L2100153	L2100153	L2115118	L2115119	L2136868	L2136818
Laboratory Identification Number			L2071158-11	L2071158-10	L2082450-10	L2082450-11	L2100153-6	L2100153-7	L2115118-1	L2115119-8	L2136868-9	L2136818-8

Notes:

RDL - Reportable detection limit

RPD - Relative percent difference calculated as (ABS[(difference between two values)]/((sum of two values/2))*100

"-" Indicates RPD not calculated. RPD cannot be calculated if one or more of the analytical results is less than detection limits or within 5 times the RDL.

BOLD - RPD greater than 30%

Shaded gray only - exceeds BCAWQG-FSTM guideline.

Blank - not analyzed.

Note: When one value is below detection limit and the other has a measured value, RPD is calculated on the DL and measured value.

Table 5: Surface Water Quality Assurance/Quality Contro

Parameter	Unit	RDL	Field Blank	Travel Blank	Field Blank	Travel Blank	Field Blank	Travel Blank	Field Blank	Travel Blank	Field Blank	Travel Blank
			21-Aug-18	21-Aug-18	27-Sep-18	27-Sep-18	22-Oct-18	22-Oct-18	19-Nov-18	19-Nov-18	17-Dec-18	17-Dec-18
Physical Parameters												
Electrical Conductivity (EC)	µS/cm	2.0	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Hardness as $CaCO_3$	µg/L	500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500
pH	pH Units	0.1	5.59	5.54	5.6	5.71	5.3	5.51	5.75	5.72	5.48	5.43
Total Dissolved Solids (TDS)	µg/L	10000	<10000	<10000	<10000	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Total Suspended Solids (TSS)	µg/L	3000	<3000	<3000	<3000	<3000	<3000	<3000	<3000	<3000	<3000	<3000
Anions and Nutrients												
Acidity (as $CaCO_3$)	µg/L	1000	-	-	1900	2000	-	-	2200	2200	2300	2300
Alkalinity (Bicarbonate as $CaCO_3$)	µg/L	1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Carbonate as $CaCO_3$)	µg/L	1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Hydroxide as $CaCO_3$)	µg/L	1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Total as $CaCO_3$)	mg/L	1.0	<1000	<1000	<1	<1	<1	<1	<1	<1	<1	<1
Ammonia (NH_4 as N)	µg/L	5.0	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chloride (Cl^-)	µg/L	500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500
Nitrate (NO_3^- as N)	µg/L	5.0	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Nitrite (NO_2^- as N)	µg/L	1.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sulphate (SO_4)	µg/L	300	<300	<300	<300	<300	<300	<300	<300	<300	<300	<300
Metals, Total												
Aluminum	µg/L	3.0	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Antimony	µg/L	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	µg/L	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Barium	µg/L	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beryllium	µg/L	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bismuth	µg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Boron	µg/L	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cadmium	µg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Calcium	µg/L	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cesium	µg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	µg/L	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	µg/L	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	µg/L	0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Iron	µg/L	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Lead	µg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lithium	µg/L	1.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Magnesium	µg/L	5.0	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Manganese	µg/L	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mercury	µg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Molybdenum	µg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Phosphorus	µg/L	50.0	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Potassium	µg/L	50.0	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Rubidium	µg/L	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Selenium	µg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Silicon	µg/L	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Silver	µg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	µg/L	50.0	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Strontium	µg/L	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Sulfur	µg/L	500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500
Tellurium	µg/L	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thallium	µg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thorium	µg/L	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	µg/L	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Titanium	µg/L	0.30	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Tungsten	µg/L	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	µg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	µg/L	0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc	µg/L	3.0	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Zirconium	µg/L	0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Metals, Dissolved												
Aluminum	µg/L	1.0	-	-	<1.0	-	**2.3**		<1.0		<1.0	
Antimony	µg/L	0.10	-	-	<0.1	-	<0.1		<0.1		<0.1	
Arsenic	µg/L	0.10	-	-	<0.1	-	<0.1		<0.1		<0.1	
Barium	µg/L	0.10	-	-	<0.1	-	**0.39**		<0.1		<0.1	
Beryllium	µg/L	0.10	-	-	<0.1	-	<0.1		<0.1		<0.1	
Bismuth	µg/L	0.05	-	-	<0.05	-	<0.05		<0.05		<0.05	
Boron	µg/L	10.0	-	-	<10	-	<10		<10		<10	
Cadmium	µg/L	0.005	-	-	<0.005	-	<0.005		<0.005		<0.005	
Calcium	µg/L	50.0	-	-	<50	-	<50		<50		<50	
Cesium	µg/L	0.01	-	-	<0.01	-	<0.01		<0.01		<0.01	
Chromium	µg/L	0.10	-	-	**0.12**	-	<0.1		<0.1		<0.1	
Cobalt	µg/L	0.10	-	-	<0.1	-	<0.1		<0.1		<0.1	
Copper	µg/L	0.20	-	-	<0.2	-	<0.2		<0.2		<0.2	
Iron	µg/L	10.0	-	-	<10	-	<10		<10		<10	
Lead	µg/L	0.05	-	-	<0.05	-	<0.05		<0.05		<0.05	
Lithium	µg/L	1.0	-	-	<1	-	<1		<1		<1	
Magnesium	µg/L	5.0	-	-	<5	-	**6.4**		<5		<5	
Manganese	µg/L	0.10	-	-	<0.1	-	<0.1		<0.1		<0.1	
Mercury	µg/L	0.005	-	-	<0.005	-	<0.005		<0.005		**0.0055**	
Molybdenum	µg/L	0.05	-	-	<0.05	-	<0.05		<0.05		<0.05	
Nickel	µg/L	0.50	-	-	<0.5	-	<0.5		<0.5		<0.5	
Phosphorus	µg/L	50.0	-	-	<50	-	<50		<50		<50	
Potassium	µg/L	50.0	-	-	<50	-	<50		<50		<50	
Rubidium	µg/L	0.20	-	-	<0.2	-	<0.2		<0.2		<0.2	
Selenium	µg/L	0.05	-	-	<0.05	-	<0.05		<0.05		<0.05	
Silicon	µg/L	50.0	-	-	<50	-	<50		<50		<50	
Silver	µg/L	0.01	-	-	<0.01	-	<0.01		<0.01		<0.01	
Sodium	µg/L	50.0	-	-	<50	-	<50		<50		<50	
Strontium	µg/L	0.2	-	-	<0.2	-	<0.2		<0.2		<0.2	
Sulfur	µg/L	500	-	-	<500	-	<500		<500		<500	
Tellurium	µg/L	0.20	-	-	<0.2	-	<0.2		<0.2		<0.2	
Thallium	µg/L	0.01	-	-	<0.01	-	<0.01		<0.01		<0.01	
Thorium	µg/L	0.10	-	-	<0.1	-	<0.1		<0.1		<0.1	
Tin	µg/L	0.10	-	-	<0.1	-	<0.1		<0.1		<0.1	
Titanium	µg/L	0.30	-	-	<0.3	-	<0.3		<0.3		<0.3	
Tungsten	µg/L	0.10	-	-	<0.1	-	<0.1		<0.1		<0.1	
Uranium	µg/L	0.01	-	-	<0.01	-	<0.01		<0.01		<0.01	
Vanadium	µg/L	0.50	-	-	<0.5	-	<0.5		<0.5		<0.5	
Zinc	µg/L	1.0	-	-	<1	-	<1		<1		<1	
Zirconium	µg/L	0.06	-	-	<0.06	-	<0.06		<0.06		<0.06	
Laboratory Work Order Number			L2150694	L2150694	L2172306	L2172306	L2185138	L2185138	L2198555	L2198555	L2211507	L211507
Laboratory Identification Number			L2150694-4	L2150694-5	L2172306-5	L2172306-4	L2185138-6	L2185138-5	L2198555-3	L2198555-4	L2211507-3	L211507-4

Notes:

RDL - Reportable detection limit

RPD - Relative percent difference calculated as (ABS[(difference between two values)]/((sum of two values/2))*100

"-" Indicates RPD not calculated. RPD cannot be calculated if one or more of the analytical results is less than detection limits or within 5 times the RDL.

BOLD - RPD greater than 30%

Shaded gray only - exceeds BCAWQG-FSTM guideline.

Blank - not analyzed.

Note: When one value is below detection limit and the other has a measured value, RPD is calculated on the DL and measured value.

TETRA TECH

Table 5: Surface Water Quality Assurance/Quality Contro

Parameter	Unit	RDL	LBL3C- 1.43	Field Duplicate	Relative % Difference (RPD)	LBL3C-1.43	Field Duplicate	Relative % Difference (RPD)	LBL4C-0.18	Field Duplicate	Relative % Difference (RPD)
			21-Mar-18			19-Apr-18			24-May-18		
Physical Parameters											
Electrical Conductivity (EC)	µS/cm	2.0	478	487	1.9	348	426	20.2	2160	2190	1.38
Hardness as $CaCO_3$	µg/L	500	138000	142000	2.9	159000	159000	0.0	1010000	1010000	0.00
pH	pH Units	0.1	7.98	8.03	0.6	7.68	7.62	0.8	4.45	4.47	0.45
Total Dissolved Solids (TDS)	µg/L	10000	362000	348000	3.9	303000	305000	0.7	2070000	2100000	1.44
Total Suspended Solids (TSS)	µg/L	3000	383000	545000	34.9	129000	136000	5.3	11,500	230,000	**180.95**
Anions and Nutrients											
Acidity (as $CaCO_3$)	µg/L	1000									
Alkalinity (Bicarbonate as $CaCO_3$)	µg/L	1000	74400	88400	17.2	74300	75500	1.6	<1000	<1000	-
Alkalinity (Carbonate as $CaCO_3$)	µg/L	1000	<1000	<1000	-	<1000	<1000	-	<1000	<1000	-
Alkalinity (Hydroxide as $CaCO_3$)	µg/L	1000	<1000	<1000	-	<1000	<1000	-	<1000	<1000	-
Alkalinity (Total as $CaCO_3$)	mg/L	1.0	74.4	88.4	17.2	74.3	75.5	1.6	<1	<1	-
Ammonia (NH_4 as N)	µg/L	5.0	79.5	81.1	2.0	76.9	70	9.4	171	172	0.58
Chloride (Cl^-)	µg/L	500	60700	61300	1.0	25600	27300	6.4	28,900	28,600	1.04
Nitrate (NO_3^- as N)	µg/L	5.0	887	738	18.3	595	595	0.0	75	51	**38.10**
Nitrite (NO_2^- as N)	µg/L	1.0	18.8	18.3	2.7	11.7	11.5	1.7	<10	<10	-
Sulphate (SO_4)	µg/L	300	66500	66000	0.8	85000	87200	2.6	1380000	1390000	0.72
Metals, Total											
Aluminum	µg/L	3.0	4610	5680	20.8	5120	5140	0.4	34,300	33,200	3.26
Antimony	µg/L	0.10	0.64	0.71	10.4	0.52	0.5	3.9	<0.2	<0.2	-
Arsenic	µg/L	0.10	4.61	5.73	21.7	4.3	4.15	3.6	2.05	2.03	0.98
Barium	µg/L	0.10	281	324	14.2	237	159	**39.4**	47.2	43.7	7.70
Beryllium	µg/L	0.10	0.28	0.36	25.0	0.28	0.28	0.0	4.54	4.55	0.22
Bismuth	µg/L	0.05									
Boron	µg/L	10	20	20	0.0	21	21	0.0	118	117	0.85
Cadmium	µg/L	0.005	0.394	0.559	34.6	0.453	0.419	7.8	8.04	8.11	0.87
Calcium	µg/L	50	51,000	64,400	23.2	48900	47500	2.9	257,000	257,000	0.00
Cesium	µg/L	0.01									
Chromium	µg/L	0.10	9.96	12.1	19.4	9.36	9.63	2.8	5.2	5.05	2.93
Cobalt	µg/L	0.10	4.39	5.78	27.3	6.63	6.3	5.1	138	137	0.73
Copper	µg/L	0.50	13.8	17.5	23.6	13.6	13.1	3.7	32.3	32	0.93
Iron	µg/L	10	9570	12,200	24.2	9320	9040	3.1	5650	5380	4.90
Lead	µg/L	0.05	5.82	7.07	19.4	5.05	4.76	5.9	0.31	0.23	29.63
Lithium	µg/L	1.0	8.7	10.5	18.8	9.9	10	1.0	206	206	0.00
Magnesium	µg/L	5.0	14,100	15,400	8.8	16200	14900	8.4	106,000	103,000	2.87
Manganese	µg/L	0.10	323	387	18.0	376	349	7.4	4810	4710	2.10
Mercury	µg/L	0.005	<0.05	0.068	**30.5**	<0.005	<0.005	-	<0.005	<0.005	-
Molybdenum	µg/L	0.05	3.13	3.38	7.7	2.82	2.78	1.4	0.29	0.25	14.81
Nickel	µg/L	0.5	17.1	21.4	22.3	22.1	21.5	2.8	469	462	1.50
Phosphorus	µg/L	50.0									
Potassium	µg/L	50.0	3380	3510	3.8	3.84	3.88	1.0	6880	6730	2.20
Rubidium	µg/L	0.2									
Selenium	µg/L	0.05	1.58	1.62	2.5	1.74	1.68	3.5	1.2	1.23	2.47
Silicon	µg/L	100									
Silver	µg/L	0.01	0.103	0.122	16.9	0.086	0.085	1.2	<0.02	<0.02	-
Sodium	µg/L	50.0	36,900	35,900	2.7	19100	18700	2.1	102,000	98,500	3.49
Strontium	µg/L	0.2									
Sulfur	µg/L	500									
Tellurium	µg/L	0.2									
Thallium	µg/L	0.01	0.125	0.144	14.1	0.102	0.104	1.9	0.057	0.059	3.45
Thorium	µg/L	0.10									
Tin	µg/L	0.10	0.12	0.12	0.0	<0.1	<0.1	-	<0.2	<0.2	-
Titanium	µg/L	0.30	76.7	94.8	21.1	68.5	66.3	3.3	3.27	1.8	**57.99**
Tungsten	µg/L	0.10									
Uranium	µg/L	0.01	1.87	1.99	6.2	1.61	1.59	1.3	5.09	4.97	2.39
Vanadium	µg/L	0.50	17.7	22.4	23.4	17.8	17.9	0.6	<1	<1	-
Zinc	µg/L	3.0	49.5	60.7	20.3	53.4	52.1	2.5	945	951	0.63
Zirconium	µg/L	0.06									
Metals, Dissolved											
Aluminum	µg/L	1.0	15.2	7	73.9	40.7	41.1	1.0	25,300	24,900	1.59
Antimony	µg/L	0.10	0.21	0.21	0.0	0.19	0.18	5.4	<0.2	<0.2	-
Arsenic	µg/L	0.10	0.27	0.22	20.4	0.22	0.22	0.0	1.72	1.8	4.55
Barium	µg/L	0.10	53.9	42.5	23.7	43.7	43.9	0.5	41.4	42	1.44
Beryllium	µg/L	0.10	<0.1	<0.1	-	<0.1	<0.1	-	3.84	3.72	3.17
Bismuth	µg/L	0.05									
Boron	µg/L	10.0	13	14	7.4	16	17	6.1	122	122	0.00
Cadmium	µg/L	0.005	0.0599	0.0413	36.8	0.1	0.101	1.0	7.81	8.04	2.90
Calcium	µg/L	50.0	38,800	41,300	6.2	42300	42400	0.2	235,000	237,000	0.85
Cesium	µg/L	0.01									
Chromium	µg/L	0.10	0.34	0.54	45.5	0.24	0.2	18.2	2.61	2.44	6.73
Cobalt	µg/L	0.10	0.42	0.34	21.1	1.96	2.01	2.5	137	138	0.73
Copper	µg/L	0.20	1.61	1.39	14.7	1.66	1.64	1.2	29.5	29.2	1.02
Iron	µg/L	10.0	33	20	49.1	26	23	12.2	3800	3730	1.86
Lead	µg/L	0.05	<0.05	<0.05	-	<0.05	<0.05	-	0.16	0.15	6.45
Lithium	µg/L	1.0	2.4	2.9	18.9	4.9	5	2.0	198	192	3.08
Magnesium	µg/L	5.0	10,100	9360	7.6	13000	12900	0.8	103,000	103,000	0.00
Manganese	µg/L	0.10	154	135	13.1	217	215	0.9	4620	4560	1.31
Mercury	µg/L	0.005	0.0088	0.0115	26.6	<0.005	<0.005	-	<0.005	<0.005	-
Molybdenum	µg/L	0.05	2.39	2.49	4.1	2.47	2.52	2.0	0.11	0.11	0.00
Nickel	µg/L	0.50	2.89	2.39	18.9	7.11	7.22	1.5	460	455	1.09
Phosphorus	µg/L	50.0									
Potassium	µg/L	50.0	2360	2040	14.5	2.87	2.84	1.1	6680	6760	1.19
Rubidium	µg/L	0.20									
Selenium	µg/L	0.05	1.25	1.31	4.7	1.27	1.32	3.9	1.23	1.3	5.53
Silicon	µg/L	50.0									
Silver	µg/L	0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.02	<0.02	-
Sodium	µg/L	50.0	34,800	30,600	12.8	17400	17300	0.6	97,900	98,200	0.31
Strontium	µg/L	0.2									
Sulfur	µg/L	500									
Tellurium	µg/L	0.20									
Thallium	µg/L	0.01	<0.01	<0.01	-	<0.01	<0.01	-	0.054	0.058	7.14
Thorium	µg/L	0.10									
Tin	µg/L	0.10	<0.1	<0.1	-	<0.1	<0.1	-	<0.2	<0.2	-
Titanium	µg/L	0.30	0.64	0.55	15.1	0.89	0.59	**40.5**	<0.6	<0.6	-
Tungsten	µg/L	0.10									
Uranium	µg/L	0.01	1.19	1.15	3.4	1.34	1.33	0.7	4.46	4.43	0.67
Vanadium	µg/L	0.50	<0.5	<0.5	-	<0.5	<0.5	-	<1	<1	-
Zinc	µg/L	1.0	2.2	1.4	44.4	3.7	3.8	2.7	923	917	0.65
Zirconium	µg/L	0.06									
Laboratory Work Order Number			L2071158	L2071158		L2082450	L2082450		L2100153	L2100153	
Laboratory Identification Number			L2071158-1	L2071158-12		L2082450-3	L2082450-12		L2100153-4	L2100153-8	

Notes:

RDL - Reportable detection limit

RPD - Relative percent difference calculated as (ABS[(difference between two values)]/((sum of two values/2))*100

"-" Indicates RPD not calculated. RPD cannot be calculated if one or more of the analytical results is less than detection limits or within 5 times the RDL.

BOLD - RPD greater than 30%

Shaded gray only - exceeds BCAWQG-FSTM guideline.

Blank - not analyzed.

Note: When one value is below detection limit and the other has a measured value, RPD is calculated on the DL and measured value.

Table 5: Surface Water Quality Assurance/Quality Contro

Parameter	Unit	RDL	LBL3C-3.32	Field Duplicate	Relative % Difference (RPD)	LBL3C-1.43	Field Duplicate	Relative % Difference (RPD)	LBL3C-0.02	Field Duplicate	Relative % Difference (RPD)
			19-Jun-18			26-Jul-18			21-Aug-18		
Physical Parameters											
Electrical Conductivity (EC)	µS/cm	2.0	1300	1180	9.68	1240	1240	0.00	2200	2190	0.46
Hardness as $CaCO_3$	µg/L	500	683000	676000	1.03	616000	540000	13.15	1,310,000	1,330,000	1.52
pH	pH Units	0.1	8.2	8.21	0.12	8.29	8.25	0.48	8.18	8.17	0.12
Total Dissolved Solids (TDS)	µg/L	10000	1050000	999000	4.98	1020000	968000	5.23	2,020,000	2,080,000	2.93
Total Suspended Solids (TSS)	µg/L	3000	7500	21100	**95.10**	31000	44400	**35.54**	16,300	18,700	13.71
Anions and Nutrients											
Acidity (as $CaCO_3$)	µg/L	1000									
Alkalinity (Bicarbonate as $CaCO_3$)	µg/L	1000	314000	316000	0.63	198000	204000	2.99	245,000	246,000	0.41
Alkalinity (Carbonate as $CaCO_3$)	µg/L	1000	<1000	<1000	-	<1000	<1000	-	<1000	<1000	-
Alkalinity (Hydroxide as $CaCO_3$)	µg/L	1000	<1000	<1000	-	<1000	<1000	-	<1000	<1000	-
Alkalinity (Total as $CaCO_3$)	mg/L	1.0	314000	316000	0.63	198	204	2.99	245000	246000	0.41
Ammonia (NH_4 as N)	µg/L	5.0	14.2	12.3	14.34	25.7	35.0	**30.64**	38.2	34.1	11.34
Chloride (Cl^-)	µg/L	500	53300	54300	1.86	42600	41900	1.66	55,000	48,000	13.59
Nitrate (NO_3^- as N)	µg/L	5.0	<25	54	**199.14**	546.0	554.0	1.45	200	180	10.53
Nitrite (NO_2^- as N)	µg/L	1.0	<5	<5	-	<5	<5	-	<20	<20	-
Sulphate (SO_4)	µg/L	300	404000	410000	1.47	454000	449000	1.11	1,320,000	1,150,000	13.77
Metals, Total											
Aluminum	µg/L	3.0	57.8	46.8	21.03	1650	1960	17.17	1300	1160	11.38
Antimony	µg/L	0.10	0.3	0.3	0.00	0.30	0.35	15.38	0.21	0.2	4.88
Arsenic	µg/L	0.10	0.63	0.62	1.60	0.85	1.14	29.15	0.92	0.68	**30.0**
Barium	µg/L	0.10	137	136	0.73	109	114	4.48	54.7	54.6	0.18
Beryllium	µg/L	0.10	<0.1	<0.1	-	0.24	0.26	8.00	0.22	0.20	9.52
Bismuth	µg/L	0.05	<0.05	<0.05	-	<0.05	<0.05	-	<0.1	<0.1	-
Boron	µg/L	10	83	83	0.00	92	98	6.32	154	158	2.56
Cadmium	µg/L	0.005	0.051	0.0517	1.36	0.489	0.500	2.22	0.514	0.552	7.13
Calcium	µg/L	50	176000	173000	1.72	141000	159000	12.00	358,000	356,000	0.56
Cesium	µg/L	0.01	0.012	<0.01	18.18	0.031	0.112	**113.29**	0.090	0.068	27.85
Chromium	µg/L	0.10	<0.3	<0.2	-	0.72	1.36	**61.54**	0.64	0.54	16.95
Cobalt	µg/L	0.10	0.23	0.22	4.44	22.2	22.0	0.90	9.57	9.12	4.82
Copper	µg/L	0.50	2.27	2.23	1.78	3.59	4.33	18.69	2.7	2.3	16.00
Iron	µg/L	10	145.00	124.00	15.61	770	1520	**65.50**	1740	1500	14.81
Lead	µg/L	0.05	0.074	0.067	9.93	0.286	0.576	**67.29**	0.33	0.32	3.08
Lithium	µg/L	1.0	18.70	18.80	0.53	29.30	32.10	9.12	70.8	71.6	1.12
Magnesium	µg/L	5.0	58000.00	58100.00	0.17	51000.00	53600.00	4.97	101,000	98,000	3.02
Manganese	µg/L	0.10	42.70	42.70	0.00	2200.00	2230.00	1.35	417	395	5.42
Mercury	µg/L	0.005	<0.005	<0.005	-	<0.005	<0.005	-	<0.005	<0.005	-
Molybdenum	µg/L	0.05	1.72	1.74	1.16	1.85	1.98	6.79	2.48	2.37	4.54
Nickel	µg/L	0.5	4.26	4.15	2.62	61.8	62.3	0.81	48.2	45.4	5.98
Phosphorus	µg/L	50.0	<50	<50	-	<50	58.0	14.81	<100	<100	-
Potassium	µg/L	50.0	13500.00	13400.00	0.74	8810	8310	5.84	6630	6400	3.53
Rubidium	µg/L	0.2	1.27	1.19	6.50	1.43	1.92	29.25	2.98	2.62	12.86
Selenium	µg/L	0.05	0.62	0.60	3.59	3.12	2.71	14.07	1.33	1.34	0.75
Silicon	µg/L	100	4030.00	4140.00	2.69	4820.00	5370.00	10.79	5350	5310	0.75
Silver	µg/L	0.01	<0.01	<0.01	-	0.011	0.016	**37.04**	<0.02	<0.02	-
Sodium	µg/L	50.0	46700.00	46500.00	0.43	44000	42400	3.70	79,600	77,400	2.80
Strontium	µg/L	0.2	662.00	659.00	0.45	496	514	3.56	1,020	1,010	0.99
Sulfur	µg/L	500	145000.00	147000.00	1.37	165000	163000	1.22	408,000	408,000	0.00
Tellurium	µg/L	0.2	<0.2	<0.2	-	<0.2	<0.2	-	<0.4	<0.4	-
Thallium	µg/L	0.01	<0.01	<0.01	-	0.021	0.029	**32.00**	0.042	0.044	4.65
Thorium	µg/L	0.10	<0.1	<0.1	-	0.120	0.220	**58.82**	<0.2	<0.2	-
Tin	µg/L	0.10	<0.1	<0.1	-	<0.1	<0.1	-	<0.2	<0.2	-
Titanium	µg/L	0.30	0.96	0.77	21.97	6.06	11.10	**58.74**	<6.3	4.85	26.01
Tungsten	µg/L	0.10	<0.1	<0.1	-	<0.1	<0.1	-	<0.2	<0.2	-
Uranium	µg/L	0.01	8.23	8.33	1.21	4.11	3.96	3.72	6.83	7.01	2.60
Vanadium	µg/L	0.50	0.60	0.57	5.13	1.00	2.62	**89.50**	1.4	1.1	24.00
Zinc	µg/L	3.0	3.30	<3.0	9.52	68.60	66.90	2.51	89.3	85.9	3.88
Zirconium	µg/L	0.06	0.258	0.285	9.94	0.320	0.375	15.83	0.15	<0.12	22.22
Metals, Dissolved											
Aluminum	µg/L	1.0	4.00	5.90	**38.38**	180.00	175.00	2.82	142	141	0.71
Antimony	µg/L	0.10	0.27	0.27	0.00	0.31	0.29	6.67	0.19	0.18	5.41
Arsenic	µg/L	0.10	0.55	0.56	1.80	0.49	0.51	4.00	0.23	0.23	0.00
Barium	µg/L	0.10	144.00	141.00	2.11	94.80	95.80	1.05	45.1	45.9	1.76
Beryllium	µg/L	0.10	<0.1	<0.1	-	<0.1	<0.1	-	<0.1	<0.1	-
Bismuth	µg/L	0.05	<0.05	<0.05	-	<0.05	<0.05	-	<0.05	<0.05	-
Boron	µg/L	10.0	73.00	74.00	1.36	99.00	89.00	10.64	135	133	1.49
Cadmium	µg/L	0.005	0.0335	0.0442	27.54	0.360	0.338	6.30	0.216	0.222	2.74
Calcium	µg/L	50.0	175000.00	177000.00	1.14	155000.00	135000.00	13.79	362,000	367,000	1.37
Cesium	µg/L	0.01	<0.01	<0.01	-	<0.010	0.017	**51.85**	0.017	0.018	5.71
Chromium	µg/L	0.10	<0.1	<0.1	-	0.26	0.22	16.67	<0.1	<0.1	-
Cobalt	µg/L	0.10	0.18	0.19	5.41	20.70	19.10	8.04	8.18	8.37	2.30
Copper	µg/L	0.20	2.25	2.09	7.37	2.39	2.06	14.83	0.91	0.9	1.10
Iron	µg/L	10.0	28.00	40.00	**35.29**	11.00	11.00	0.00	14	14	0.00
Lead	µg/L	0.05	<0.05	<0.05	-	<0.05	<0.05	-	<0.05	<0.05	-
Lithium	µg/L	1.0	16.20	18.20	11.63	30.70	27.20	12.09	62.3	62.3	0.00
Magnesium	µg/L	5.0	60000.00	57000.00	5.13	55500	49500	11.43	99,000	99,700	0.70
Manganese	µg/L	0.10	43.40	44.40	2.28	2240	2010	10.82	387	389	0.52
Mercury	µg/L	0.005	<0.005	<0.005	-	0.0067	<0.005	29.06	<0.005	<0.005	-
Molybdenum	µg/L	0.05	1.74	1.78	2.27	1.98	1.85	6.79	2.35	2.35	0.00
Nickel	µg/L	0.50	4.10	4.14	0.00	58.0	54.2	6.77	41	42	2.41
Phosphorus	µg/L	50.0	<50	<50	-	<50	<50	-	<50	<50	-
Potassium	µg/L	50.0	14200.00	13500.00	5.05	8550	8220	3.94	6580	6750	2.55
Rubidium	µg/L	0.20	1.29	1.24	3.95	1.20	1.24	3.28	2.35	2.52	6.98
Selenium	µg/L	0.05	0.602	0.696	14.48	2.830	2.960	4.49	1.31	1.35	3.01
Silicon	µg/L	50.0	4100.00	4240.00	3.36	4370	4280	2.08	4400	4450	1.13
Silver	µg/L	0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	-
Sodium	µg/L	50.0	47100.00	44400.00	5.90	45300	42800	5.68	75,800	77,100	1.70
Strontium	µg/L	0.2	703.00	694.00	1.29	508	489	3.81	1,020	1,050	2.90
Sulfur	µg/L	500	134000.00	149000.00	10.60	169000	165000	2.40	370,000	362,000	2.19
Tellurium	µg/L	0.20	<0.2	<0.2	-	<0.2	<0.2	-	<0.2	<0.2	-
Thallium	µg/L	0.01	<0.01	<0.01	-	0.018	0.019	5.41	0.033	0.033	0.00
Thorium	µg/L	0.10	<0.1	<0.1	-	<0.1	<0.1	-	<0.1	<0.1	-
Tin	µg/L	0.10	<0.1	<0.1	-	<0.1	<0.1	-	<0.1	<0.1	-
Titanium	µg/L	0.30	<0.3	<0.6	-	<0.3	<0.3	-	0.76	<0.3	**86.79**
Tungsten	µg/L	0.10	<0.1	<0.1	-	<0.1	<0.1	-	<0.1	<0.1	-
Uranium	µg/L	0.01	7.96	8.44	5.85	3.80	3.91	2.85	6.55	6.56	0.15
Vanadium	µg/L	0.50	<0.5	<0.5	-	0.53	<0.50	5.83	<0.5	<0.5	-
Zinc	µg/L	1.0	2.10	3.40	**47.27**	19.70	16.20	19.50	41.4	40.7	1.71
Zirconium	µg/L	0.06	0.221	0.237	6.99	0.096	0.142	**38.66**	<0.06	<0.06	-
Laboratory Work Order Number			L2115119	L2115118		L2136818	L2136818		L2150694	L2150694	
Laboratory Identification Number			L2115119-1	L2115118-6		L2136818-3	L2136818-10		L2150694-2	L2150694-6	

Notes:

RDL - Reportable detection limit

RPD - Relative percent difference calculated as (ABS[(difference between two values)]/((sum of two values/2))*100

"-" Indicates RPD not calculated. RPD cannot be calculated if one or more of the analytical results is less than detection limits or within 5 times the RDL.

BOLD - RPD greater than 30%

Shaded gray only - exceeds BCAWQG-FSTM guideline.

Blank - not analyzed.

Note: When one value is below detection limit and the other has a measured value, RPD is calculated on the DL and measured value.

TETRA TECH

Table 5: Surface Water Quality Assurance/Quality Contro

Parameter	Unit	RDL	LBL3C-0.02	Field Duplicate	Relative % Difference (RPD)	LBL3C-0.02	Field Duplicate	Relative % Difference (RPD)	RBSC-DS	Field Duplicate	Relative % Difference (RPD)
			27-Sep-18			22-Oct-18			19-Nov-18		
Physical Parameters											
Electrical Conductivity (EC)	µS/cm	2.0	2150	2150	0.00	2110	2140	1.41	1330	1490	11.35
Hardness as $CaCO_3$	µg/L	500	1,190,000	1,190,000	0.00	1,180,000	1,220,000	3.33	606,000	786,000	25.86
pH	pH Units	0.1	8.23	8.21	0.24	8.26	8.26	0.00	8.04	8.00	0.50
Total Dissolved Solids (TDS)	µg/L	10000	1,880,000	1,900,000	1.06	1,890,000	1,940,000	2.61	989,000	1,110,000	11.53
Total Suspended Solids (TSS)	µg/L	3000	9000	12200	**30.19**	7500	7700	2.63	9800	22800	**79.75**
Anions and Nutrients											
Acidity (as $CaCO_3$)	µg/L	1000	2400	3700	**42.62**				8500	10600	21.99
Alkalinity (Bicarbonate as $CaCO_3$)	µg/L	1000	249,000	255,000	2.38	254,000	253,000	0.39	369,000	378,000	2.41
Alkalinity (Carbonate as $CaCO_3$)	µg/L	1000	<1000	<1000	-	<1000	<1000	-	<1000	<1000	-
Alkalinity (Hydroxide as $CaCO_3$)	µg/L	1000	<1000	<1000	-	<1000	<1000	-	<1000	<1000	-
Alkalinity (Total as $CaCO_3$)	mg/L	1.0	249	255	2.38	254	253	0.39	369000	378000	2.41
Ammonia (NH_4 as N)	µg/L	5.0	25.9	51.7	**66.49**	24.4	24.2	0.82	13.7	55.3	**120.58**
Chloride (Cl^-)	µg/L	500	45,300	42,200	7.09	44,300	43,500	1.82	15,400	17,000	9.88
Nitrate (NO_3^- as N)	µg/L	5.0	301	278	7.94	348	341	2.03	<25	<25	-
Nitrite (NO_2^- as N)	µg/L	1.0	<10	<10	-	<10	<10	-	<5	<5	-
Sulphate (SO_4)	µg/L	300	1,080,000	1,000,000	7.69	1,050,000	1,030,000	1.92	368,000	497,000	29.83
Metals, Total											
Aluminum	µg/L	3.0	789	767	2.83	701	647	8.01	16.6	19.3	15.04
Antimony	µg/L	0.10	<0.2	<0.2	-	<0.2	<0.2	-	<0.1	<0.1	-
Arsenic	µg/L	0.10	0.47	<0.4	16.09	0.36	0.36	0.00	1.75	0.78	**76.68**
Barium	µg/L	0.10	54.3	55.5	2.19	46.2	44.6	3.52	36.5	26.4	**32.11**
Beryllium	µg/L	0.10	<0.2	<0.2	-	<0.2	<0.2	-	<0.1	<0.1	-
Bismuth	µg/L	0.05	<0.1	<0.1	-	<0.1	<0.1	-	<0.05	<0.05	-
Boron	µg/L	10	124	120	3.28	113	109	3.60	86	103	17.99
Cadmium	µg/L	0.005	0.555	0.544	2.00	0.458	0.434	5.38	0.0053	0.0447	**157.60**
Calcium	µg/L	50	337,000	321,000	4.86	325,000	320,000	1.55	179,000	211,000	16.41
Cesium	µg/L	0.01	<0.02	<0.02	-	<0.02	<0.02	-	<0.01	<0.01	-
Chromium	µg/L	0.10	0.39	<0.5	24.72	<0.2	<0.2	-	<0.1	<0.1	-
Cobalt	µg/L	0.10	8.27	8.30	0.36	8.25	8.02	2.83	2.00	1.63	20.39
Copper	µg/L	0.50	1.9	1.7	11.11	1.5	1.5	0.00	<0.5	<0.5	-
Iron	µg/L	10	939	916	2.48	957	874	9.07	1550	1260	20.64
Lead	µg/L	0.05	<0.1	<0.1	-	<0.1	<0.1	-	<0.05	<0.05	-
Lithium	µg/L	1.0	56.5	50.1	12.01	51.7	49.8	3.74	49.4	58.6	17.04
Magnesium	µg/L	5.0	99,700	97,300	2.44	102,000	100,000	1.98	50,800	62,900	21.28
Manganese	µg/L	0.10	428	425	0.70	401	396	1.25	606	1350	76.07
Mercury	µg/L	0.005	<0.005	<0.005	-	<0.005	<0.005	-	0.0151	0.0122	21.25
Molybdenum	µg/L	0.05	1.61	1.72	6.61	1.59	1.61	1.25	0.846	0.832	1.67
Nickel	µg/L	0.5	41.2	41.2	0.00	40.6	40.6	0.00	6.02	9.32	**43.02**
Phosphorus	µg/L	50.0	<100	<100	-	<100	<100	-	54	<50	7.69
Potassium	µg/L	50.0	5580	5740	2.83	5700	5570	2.31	1540	2060	28.89
Rubidium	µg/L	0.2	1.89	1.92	1.57	1.74	1.79	2.83	0.78	1.52	**64.35**
Selenium	µg/L	0.05	2.05	1.98	3.47	2.75	2.52	8.73	<0.05	0.05	0.00
Silicon	µg/L	100	4510	4470	0.89	4490	4320	3.86	4590	4480	2.43
Silver	µg/L	0.01	<0.02	<0.02	-	<0.02	<0.02	-	<0.01	<0.01	-
Sodium	µg/L	50.0	68,900	66,600	3.39	76,800	73,600	4.26	59,400	80,200	29.80
Strontium	µg/L	0.2	862	917	6.18	918	920	0.22	441	487	9.91
Sulfur	µg/L	500	380,000	384,000	1.05	411,000	395,000	3.97	150,000	206,000	**31.46**
Tellurium	µg/L	0.2	<0.4	<0.4	-	<0.4	<0.4	-	<0.2	<0.2	-
Thallium	µg/L	0.01	0.027	0.025	7.69	0.025	0.024	4.08	<0.01	0.012	18.18
Thorium	µg/L	0.10	<0.2	<0.2	-	<0.2	<0.2	-	<0.1	<0.1	-
Tin	µg/L	0.10	<0/2	<0.2	-	<0.2	<0.2	-	<0.1	<0.1	-
Titanium	µg/L	0.30	1.25	0.83	**40.38**	<0.6	0.78	26.09	<0.6	<0.6	-
Tungsten	µg/L	0.10	<0.2	<0.2	-	<0.2	<0.2	-	<0.1	<0.1	-
Uranium	µg/L	0.01	6.14	5.99	2.47	6.33	6.20	2.08	2.26	2.67	16.63
Vanadium	µg/L	0.50	<1.0	<1.0	-	<1	<1	-	<0.5	<0.5	-
Zinc	µg/L	3.0	80.1	77.1	3.82	71.6	68.3	4.72	<3	<3	-
Zirconium	µg/L	0.06	<0.12	<0.12	-	<0.12	<0.12	-	<0.06	<0.06	-
Metals, Dissolved											
Aluminum	µg/L	1.0	132	137	3.72	102	104	1.94	1.2	2.3	**62.86**
Antimony	µg/L	0.10	<0.2	<0.2	-	<0.2	<0.2	-	<0.1	<0.2	-
Arsenic	µg/L	0.10	0.24	0.21	13.33	<0.2	<0.2	-	1.58	0.55	**96.71**
Barium	µg/L	0.10	49.9	49.8	0.20	41.4	41.6	0.48	35	24.1	**36.89**
Beryllium	µg/L	0.10	<0.2	<0.2	-	<0.2	<0.2	-	<0.1	<0.2	-
Bismuth	µg/L	0.05	<0.1	<0.1	-	<0.1	<0.1	-	<0.05	<0.1	-
Boron	µg/L	10.0	129	132	2.30	124	119	4.12	76	113	**39.15**
Cadmium	µg/L	0.005	0.429	0.418	2.60	0.387	0.404	4.30	<0.005	0.029	**141.18**
Calcium	µg/L	50.0	324,000	328,000	1.23	312,000	322,000	3.15	167,000	204,000	19.95
Cesium	µg/L	0.01	<0.02	<0.02	-	<0.02	<0.02	-	<0.01	<0.02	-
Chromium	µg/L	0.10	<0.2	<0.2	-	<0.2	<0.2	-	<0.1	<0.2	-
Cobalt	µg/L	0.10	7.99	7.64	4.48	8.03	7.95	1.00	1.82	1.58	14.12
Copper	µg/L	0.20	0.87	0.94	7.73	0.91	0.95	4.30	<0.2	<0.4	-
Iron	µg/L	10.0	68	65	4.51	168	150	11.32	2150	1190	**57.49**
Lead	µg/L	0.05	<0.1	<0.1	-	<0.1	<0.1	-	<0.05	<0.1	-
Lithium	µg/L	1.0	57.9	58.4	0.86	54.3	54.0	0.55	42.6	56.2	**27.53**
Magnesium	µg/L	5.0	93,100	90,400	2.94	97,900	102,000	4.10	45,700	67,400	**38.37**
Manganese	µg/L	0.10	434	434	0.00	397	391	1.52	657	1300	**65.71**
Mercury	µg/L	0.005	<0.005	<0.005	-	<0.005	<0.005	-	<0.005	0.0098	**64.86**
Molybdenum	µg/L	0.05	1.7	1.77	4.03	1.65	1.63	1.22	0.614	0.77	22.54
Nickel	µg/L	0.50	39.8	38.2	4.10	38.2	39.0	2.07	5.12	10.1	**65.44**
Phosphorus	µg/L	50.0	<100	<100	-	<100	<100	-	<50	<100	-
Potassium	µg/L	50.0	5350	5520	3.13	5760	5400	6.45	1580	2750	**54.04**
Rubidium	µg/L	0.20	1.63	1.72	5.37	1.55	1.71	9.82	0.76	1.71	**76.92**
Selenium	µg/L	0.05	2.15	2.27	5.43	2.41	2.85	16.73	0.063	<0.1	**45.40**
Silicon	µg/L	50.0	4210	4180	0.72	4010	4300	6.98	4200	4560	8.22
Silver	µg/L	0.01	<0.02	<0.02	-	<0.02	<0.02	-	<0.01	<0.02	-
Sodium	µg/L	50.0	68,900	68,900	0.00	72,400	73,900	2.05	52,600	84,700	**46.76**
Strontium	µg/L	0.2	930	947	1.81	920	928	0.87	434	543	22.31
Sulfur	µg/L	500	381,000	378,000	0.79	391,000	420,000	7.15	112,000	213,000	**62.15**
Tellurium	µg/L	0.20	<0.4	<0.4	-	<0.4	<0.4	-	<0.2	<0.4	-
Thallium	µg/L	0.01	0.027	0.028	3.64	0.024	0.026	8.00	<0.01	<0.02	-
Thorium	µg/L	0.10	<0.2	<0.2	-	<0.2	<0.2	-	<0.1	<0.2	-
Tin	µg/L	0.10	<0.2	<0.2	-	<0.2	<0.2	-	<0.1	<0.2	-
Titanium	µg/L	0.30	<0.6	<0.6	-	<0.6	<0.6	-	<0.3	<0.6	-
Tungsten	µg/L	0.10	<0.2	<0.2	-	<0.2	<0.2	-	<0.1	<0.2	-
Uranium	µg/L	0.01	5.89	6.00	1.85	6.52	6.72	3.02	1.97	2.94	**39.51**
Vanadium	µg/L	0.50	<1.0	<1.0	-	<1.0	<1.0	-	<0.5	<1.0	-
Zinc	µg/L	1.0	50.6	45.6	10.40	54.0	54.7	1.29	1.1	2.1	**62.50**
Zirconium	µg/L	0.06	<0.12	<0.12	-	<0.12	<0.12	-	<0.06	<0.12	-
Laboratory Work Order Number			L2172306	L2172306		L2185138	L2185138		L2198555	L2198555	
Laboratory Identification Number			L2172306-2	L2172306-6		L2185138-2	L2185138-7		L2198555-6	L2198555-5	

Notes:

RDL - Reportable detection limit

RPD - Relative percent difference calculated as (ABS[(difference between two values)]/((sum of two values/2))*100

"-" Indicates RPD not calculated. RPD cannot be calculated if one or more of the analytical results is less than detection limits or within 5 times the RDL.

BOLD - RPD greater than 30%

Shaded gray only - exceeds BCAWQG-FSTM guideline.

Blank - not analyzed.

Note: When one value is below detection limit and the other has a measured value, RPD is calculated on the DL and measured value.

Table 5: Surface Water Quality Assurance/Quality Contro

Parameter	Unit	RDL	RBSBIAR-US	Field Duplicate	Relative % Difference (RPD)
			17-Dec-18		
Physical Parameters					
Electrical Conductivity (EC)	µS/cm	2.0	639	641	0.31
Hardness as $CaCO_3$	µg/L	500	338,000	332,000	1.79
pH	pH Units	0.1	8.06	8.06	0.00
Total Dissolved Solids (TDS)	µg/L	10000	357,000	350,000	1.98
Total Suspended Solids (TSS)	µg/L	3000	4200	7200	**52.63**
Anions and Nutrients					
Acidity (as $CaCO_3$)	µg/L	1000	4300	4500	4.55
Alkalinity (Bicarbonate as $CaCO_3$)	µg/L	1000	243,000	245,000	0.82
Alkalinity (Carbonate as $CaCO_3$)	µg/L	1000	<1000	<1000	-
Alkalinity (Hydroxide as $CaCO_3$)	µg/L	1000	<1000	<1000	-
Alkalinity (Total as $CaCO_3$)	mg/L	1.0	243	245	0.82
Ammonia (NH_4 as N)	µg/L	5.0	6.6	<5	27.59
Chloride (Cl^-)	µg/L	500	39,800	40,100	0.75
Nitrate (NO_3^- as N)	µg/L	5.0	1240	1240	0.00
Nitrite (NO_2^- as N)	µg/L	1.0	<1	<1	-
Sulphate (SO_4)	µg/L	300	25,400	25,400	0.00
Metals, Total					
Aluminum	µg/L	3.0	6.3	8.4	28.57
Antimony	µg/L	0.10	<0.1	0.11	9.52
Arsenic	µg/L	0.10	<0.1	0.11	9.52
Barium	µg/L	0.10	192	194	1.04
Beryllium	µg/L	0.10	<0.1	<0.1	-
Bismuth	µg/L	0.05	<0.05	<0.05	-
Boron	µg/L	10	14	15	6.90
Cadmium	µg/L	0.005	0.0143	0.0159	10.60
Calcium	µg/L	50	85,000	89,700	5.38
Cesium	µg/L	0.01	<0.01	<0.01	-
Chromium	µg/L	0.10	0.14	0.15	6.90
Cobalt	µg/L	0.10	<0.1	<0.1	-
Copper	µg/L	0.50	<0.5	<0.5	-
Iron	µg/L	10	14	18	25.00
Lead	µg/L	0.05	<0.05	<0.05	-
Lithium	µg/L	1.0	6.4	6.5	1.55
Magnesium	µg/L	5.0	19,400	19,500	0.51
Manganese	µg/L	0.10	0.70	1.04	**39.08**
Mercury	µg/L	0.005	<0.005	<0.005	-
Molybdenum	µg/L	0.05	0.992	1.09	9.41
Nickel	µg/L	0.5	<0.5	<0.5	-
Phosphorus	µg/L	50.0	<50	<50	-
Potassium	µg/L	50.0	3220	3110	3.48
Rubidium	µg/L	0.2	0.34	0.41	18.67
Selenium	µg/L	0.05	1.02	1.01	0.99
Silicon	µg/L	100	4100	4060	0.98
Silver	µg/L	0.01	<0.01	<0.01	-
Sodium	µg/L	50.0	7,740	7,660	1.04
Strontium	µg/L	0.2	263	274	4.10
Sulfur	µg/L	500	8,860	9,450	6.44
Tellurium	µg/L	0.2	<0.2	<0.2	-
Thallium	µg/L	0.01	<0.01	<0.01	-
Thorium	µg/L	0.10	<0.1	<0.1	-
Tin	µg/L	0.10	<0.1	<0.1	-
Titanium	µg/L	0.30	<0.3	<0.3	-
Tungsten	µg/L	0.10	<0.1	<0.1	-
Uranium	µg/L	0.01	1.18	1.21	2.51
Vanadium	µg/L	0.50	<0.5	<0.5	-
Zinc	µg/L	3.0	<3	<3	-
Zirconium	µg/L	0.06	<0.06	<0.06	-
Metals, Dissolved					
Aluminum	µg/L	1.0	<1	1	0.00
Antimony	µg/L	0.10	<0.1	<0.1	-
Arsenic	µg/L	0.10	<0.1	<0.1	-
Barium	µg/L	0.10	222	230	3.54
Beryllium	µg/L	0.10	<0.1	<0.1	-
Bismuth	µg/L	0.05	<0.05	<0.05	-
Boron	µg/L	10.0	15	15	0.00
Cadmium	µg/L	0.005	0.0081	0.0113	**32.99**
Calcium	µg/L	50.0	99,400	96,900	2.55
Cesium	µg/L	0.01	<0.01	<0.01	-
Chromium	µg/L	0.10	0.17	0.19	11.11
Cobalt	µg/L	0.10	<0.1	<0.1	-
Copper	µg/L	0.20	0.23	0.28	19.61
Iron	µg/L	10.0	<10	<10	-
Lead	µg/L	0.05	<0.05	<0.05	-
Lithium	µg/L	1.0	7.3	7.2	1.38
Magnesium	µg/L	5.0	21,700	22,000	1.37
Manganese	µg/L	0.10	0.32	0.51	**45.78**
Mercury	µg/L	0.005	<0.005	0.0085	**51.85**
Molybdenum	µg/L	0.05	1.06	1.07	0.94
Nickel	µg/L	0.50	<0.5	<0.5	-
Phosphorus	µg/L	50.0	<50	<50	-
Potassium	µg/L	50.0	3300	3230	2.14
Rubidium	µg/L	0.20	0.43	0.39	9.76
Selenium	µg/L	0.05	0.938	1.02	8.38
Silicon	µg/L	50.0	4160	4110	1.21
Silver	µg/L	0.01	<0.01	<0.01	-
Sodium	µg/L	50.0	7,970	7,980	0.13
Strontium	µg/L	0.2	295	291	1.37
Sulfur	µg/L	500	8,380	8,580	2.36
Tellurium	µg/L	0.20	<0.2	<0.2	-
Thallium	µg/L	0.01	<0.01	<0.01	-
Thorium	µg/L	0.10	<0.1	<0.1	-
Tin	µg/L	0.10	<0.1	<0.1	-
Titanium	µg/L	0.30	<0.3	<0.3	-
Tungsten	µg/L	0.10	<0.1	<0.1	-
Uranium	µg/L	0.01	1.15	1.15	0.00
Vanadium	µg/L	0.50	<0.5	<0.5	-
Zinc	µg/L	1.0	<1	<1	-
Zirconium	µg/L	0.06	<0.06	<0.06	-
Laboratory Work Order Number			L2211507	L2211507	
Laboratory Identification Number			L2211507-6	L2211507-5	

Notes:

RDL - Reportable detection limit

RPD - Relative percent difference calculated as (ABS[(difference between two values)]/((sum of two values/2))*100

"-" Indicates RPD not calculated. RPD cannot be calculated if one or more of the analytical results is less than detection limits or within 5 times the RDL.

BOLD - RPD greater than 30%

Shaded gray only - exceeds BCAWQG-FSTM guideline.

Blank - not analyzed.

Note: When one value is below detection limit and the other has a measured value, RPD is calculated on the DL and measured value.

TETRA TECH

Table 6: In Situ Water Quality Sampling Along the River Road Ditch

Sample Site	Date	Time	In-Situ Tests - 2018						
			Water Temp (°C)	Hardness (ppm)	pH	EC (µS)	Alkalinity (ppm)	Turbidity	Flow (L/sec)
LBRR-DD (Discharge)	March 21, 2018		No reading	425	8.08	1340	0		0.40
	April 18, 2018	9:50	0.0	425	8.60	560	80	cloudy	5.00
LBRR-LC (Mid-stream)	March 21, 2018		No reading	425	8.15	1155	0		0.20
	April 19, 2018	10:05	0.4	425	8.20	512	40	cloudy	5.00
LBRR-UC	May 24, 2018	10:56	16.4	425	8.42	1003	240	clear	0.20
	June 19, 2018	11:10	20.1	425	8.24	840	240	clear	0.10
	July 26, 2018	11:56	18.0	425	8.49	838	240	clear	0.05
	August 21, 2018	11:19	14.2	425	8.30	901	240	clear	0.10
	September 27, 2018	11:40	7.7	425	8.23	870	180	standing	none
	October 22, 2018	12:35	0.8	425	8.43	865	120	clear	0.10
	November 19, 2018	12:55	0.1	425	8.51	1113	120	clear	0.20
LBRR-EDP	April 19, 2018	9:05	0.0	425	8.50	1850	80	cloudy	0.50
	May 24, 2018	9:06	15.8	425	8.47	3390	120	clear	0.10
	June 19, 2018	10:23	20.3	425	8.31	255	180	clear	0.10
	July 26, 2018	10:02	17.1	425	8.74	2180	240	clear	0.25
	September 27, 2018	10:55	7.7	425	8.13	2760	180	water	none
LBRR-12+500	March 21, 2018		No reading	425	3.77	3460	0		0.30
	April 19, 2018	10:25	0.0	425	6.05	2050	0	cloudy	0.50
LBRR-12+600	March 21, 2018		No reading	425	3.71	3180	0		0.20
	April 19, 2018	11:02	0.0	425	6.08	1850	0	cloudy	0.50
	July 26, 2018	11:18	18.7	425	8.82	950	240	clear	0.05
LBRR-12+700	March 21, 2018		No reading	425	3.56	4560	0		0.20
	April 19, 2018	11:07	0.0	425	6.68	1700	40	cloudy	0.50
	July 26, 2018	11:26	19.4	425	8.83	220	240	clear	0.10
LBRR-12+810	April 19, 2018	11:13	0.0	425	4.70	1410	0	cloudy	0.20
	May 24, 2018	10:50	17.7	425	8.70	1240	240	clear	0.01
	June 19, 2018	11:00	20.9	425	8.41	885	240	clear	0.10
	July 26, 2018	11:38	20.5	425	8.51	950	240	clear	0.10
	August 21, 2018	10:58	16.5	425	8.60	918	180	clear	0.10
	October 22, 2018	12:18	2.8	425	8.80	856	120	clear	0.10
LBRR-12+920	May 24, 2018	11:00	10.3	425	8.15	1046	240	clear	0.50
	June 19, 2018	11:12	15.2	425	8.24	968	240	clear	0.10
	July 26, 2018	11:50	16.2	425	8.40	1067	240	clear	0.05
	August 21, 2018	11:13	15.3	425	8.16	1349	240	clear	0.20
	September 27, 2018	11:48	8.7	425	8.31	1435	180	clear	0.50
	October 22, 2018	12:29	3.6	425	8.53	1360	240	clear	0.20
	November 19, 2018	13:00	0.5	425	8.46	1600	120	clear	0.25

Table 7: Summary of Water Quality Exceedances (BCAWQG-FSTM) Along River Road from Water Sampling Events in 2018

	Sampling Dates	Total Iron (Fe)	Dissolved Iron (Fe)	Dissolved Aluminum (Al)	Dissolved Cadmium	Total Arsenic (As)	Total Cobalt (Co)	Total Copper (Cu)	Total Zinc (Zn)	pH
LBRR-DD (discharge)	March 21, 2018	✓	✓	✓	✓	✓			✓	
	April 19, 2018	✓				✓		✓	✓	
LBRR-EDP	April 19, 2018	✓	✓		✓	✓	✓	✓	✓	
	May 24, 2018			✓	✓				✓	
	June 19, 2018			✓	✓				✓	
	July 26, 2018			✓	✓				✓	
LBRR-LC (midstream)	March 21, 2018	✓	✓						✓	
	April 19, 2018	✓	✓			✓			✓	
LBRR 12+500 (midstream)	March 21, 2018	✓	✓	✓	✓	✓	✓	✓	✓	✓
	April 19, 2018	✓	✓	✓	✓	✓	✓	✓	✓	✓

[1] British Columbia Ministry of Environment, Water Protection & Sustainability Branch. 2018. British Columbia Approved Water Quality Guidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture Summary Report. Referenced Guidelines are for Freshwater Aquatic Life (FWAL) water use and Short Term Maximum (STM) WQG. Exceedances denoted by a check mark.

Table 8: In Situ Water Quality Measurements Along the South Bank Initial Access Road

Sample Site	Date	Time	In-Situ Tests - 2018						
			Water Temp (°C)	Hardness (ppm)	pH	EC (µS)	Alkalinity (ppm)	Turbidity	Flow (L/sec)
RBSBIAR-US	March 21, 2018	-	No reading	425	9.75	505	80	-	0.5
	June 19, 2018	8:41	12.7	425	7.57	680	240	clear	0.3
	August 21, 2018	8:56	14.4	425	8.05	543	180	clear/algae	0.2
	September 27, 2018	9:21	11.0	425	7.63	614	180	clear	0.5
	October 22, 2018	10:43	7.2	425	7.74	524	120	clear	0.1
	November 19, 2018	10:30	4.9	425	7.85	688	80	clear	0.1
	December 17, 2018	10:34	1.1	425	8.35	723	120	clear/algae	0.1
RBSBIAR-DS	March 21, 2018	-	No reading	425	8.20	582	80	-	2.0
	June 19, 2018	8:34	17.7	425	8.08	646	240	clear	1.0
	August 21, 2018	8:48	14.2	425	7.63	589	120	clear	2.5
	September 27, 2018	8:58	7.8	425	7.96	742	240	clear	3.0
	October 22, 2018	10:38	3.4	425	8.61	668	120	clear	2.0
	November 19, 2018	10:23	1.1	425	8.27	847	120	clear	0.5
RBSBIAR-EUS	June 19, 2018	9:01	12.4	425	7.63	590	240	clear	0.3
	August 21, 2018	9:02	15.4	425	7.54	764	240	clear	0.3
	September 27, 2018	9:52	12.1	425	7.39	785	180	clear	0.5
	October 22, 2018	10:49	8.2	425	7.56	705	120	clear	0.1
	November 19, 2018	10:35	4.5	425	7.74	894	180	clear	0.2
	December 17, 2018	11:41	1.0	425	7.8	910	240	clear/algae	0.1
RBSBIAR-EDS	June 19, 2018	9:10	16.8	425	8.23	672	240	clear	0.3
	August 21, 2018	9:08	14.1	425	8.51	863	180	clear	2.0
	September 27, 2018	10:06	7.8	425	8.47	929	240	clear	1.0
	October 22, 2018	10:53	1.6	425	8.86	790	120	clear	1.0
	November 19, 2018	10:41	0.6	425	8.39	1093	180	clear	0.5
RBSC-DS	March 21, 2018	-	0.3	425	8.52	665	120	-	none
	June 19, 2018	9:28	18.0	425	6.92	2240	240	clear/algae	none
	November 19, 2018	10:58	3.9	425	7.85	1148	180	clear	none
	December 17, 2018	12:19	2.2	425	8.03	1060	240	clear	none

Table 9: Summary of Water Quality Exceedances (BCAWQG-FSTM) Along SBIAR from Water Sampling Events in 2018

	Sampling Dates	Total Iron (Fe)	Dissolved Iron (Fe)	Dissolved Aluminum (Al)	Total Arsenic (As)	Total Copper (Cu)	Total Zinc (Zn)
RBSBIAR-DS (West ditch; downstream)	March 21, 2018	✓					
	June 19, 2018						
	September 27, 2018			✓			
RBSBIAR-US (West ditch; upstream)	March 21, 2018	✓			✓	✓	✓
	June 19, 2018						
	September 27, 2018						
	December 17, 2018						
RBSBIAR-EDS (East ditch; downstream)	June 19, 2018						
	September 27, 2018	✓		✓			
RBSBIAR-EUS (East ditch; upstream)	June 19, 2018						
	September 27, 2018	✓					
	December 17, 2018	✓					
RBSC-DS (side channel)	March 21, 2018	✓	✓				
	June 19, 2018						
	November 19, 2018	✓	✓				
	December 17, 2018	✓	✓				

[1] British Columbia Ministry of Environment, Water Protection & Sustainability Branch. 2018. British Columbia Approved Water Quality Guidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture Summary Report. Referenced Guidelines are for Freshwater Aquatic Life (FWAL) water use and Short Term Maximum (STM) WQG. Exceedances denoted by a check mark.

Table 10: Minimum, Maximum and Mean Values for Measurements at Discharge and Downstream Locations

Discharge/Downstream Locations	Unit	LBRR-DD [a]			RBSBIAR-DS [b]			LBL3C-0.02 [c]		
		Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Hardness as $CaCO_3$	mg/L	258.0	821.0	539.5	275.0	298.0	285.3	279.0	1310.0	984.1
pH	pH	6.51	7.78	7.15	8.23	8.31	8.26	7.86	8.31	8.17
Total Dissolved Solids (TDS)	mg/L	362.0	1190.0	776.0	344.0	502.0	428.3	454.0	2100.0	1545.6
Total Suspended Solids (TSS)	mg/L	50.7	97.5	74.1	<3.0	75.5	[d] 36.8	7.5	173.0	33.3
Anions and Nutrients										
Alkalinity (Total as $CaCO_3$)	mg/L	5.0	91.4	48.2	188.0	233.0	211.3	86.9	254.0	207.9
Sulphate (SO_4)[3]	mg/L	161.0	751.0	456.0	51.1	111.0	79.5	187.0	1320.0	871.3
Metals, Total										
Aluminum	mg/L	2.98	3.67	3.33	0.0459	1.12	0.578	0.558	4.34	1.30
Iron	mg/L	7.20	22.80	15.00	0.091	2.77	1.207	0.539	7.95	1.926
Arsenic	mg/L	0.00620	0.01630	0.01125	0.00050	0.00193	0.00099	0.00036	0.00403	0.00105
Cadmium	mg/L	0.00146	0.00481	0.00314	0.00002	0.00021	0.00012	0.00021	0.00058	0.00046
Cobalt	mg/L	0.01760	0.09060	0.05410	0.00039	0.00430	0.00290	0.00198	0.00957	0.00714
Copper	mg/L	0.02630	0.02670	0.02650	0.00100	0.00499	0.00325	0.00150	0.01110	0.00337
Zinc	mg/L	0.21000	0.58500	0.39750	0.00310	0.05070	0.03217	0.02810	0.08930	0.06730
Metals, Dissolved										
Aluminum	mg/L	0.028	0.392	0.210	0.0157	0.106	0.0577	0.0373	0.199	0.121
Iron	mg/L	0.290	0.765	0.528	<0.01	0.0120	[d] 0.0107	0.0140	0.168	0.0658
Arsenic	mg/L	0.00014	0.00022	0.00018	0.00017	0.00045	0.00029	0.00010	0.00039	0.00022
Cadmium	mg/L	0.00044	0.00449	0.00246	0.00002	0.00011	0.00006	0.00010	0.00049	0.00032
Cobalt	mg/L	0.01360	0.08840	0.05100	0.00032	0.00460	0.00259	0.00076	0.00883	0.00619
Copper	mg/L	0.00141	0.01310	0.00726	0.00075	0.00157	0.00104	0.00080	0.00181	0.00115
Zinc	mg/L	0.03580	0.54600	0.29090	0.00200	0.02610	0.01510	0.00910	0.05400	0.03913

[a] Calculations from the period March to December, 2018: based on two sampling events, March and April, 2018, due to dry or freezing conditions.

[b] Quarterly sampling completed in March, June, and September, 2018.

[c] Calculations from the period March to November, 2018: based on nine sampling events.

[d] Mean value calculated between the detection limit and all other values.

Table 11: In Situ Water Quality Measurements Along L3 Creek

Sample Site	Date	Time	In-Situ Tests - 2018						
			Water Temp (°C)	Hardness (ppm)	pH	EC (µS)	Alkalinity (ppm)	Turbidity	Flow (L/sec)
LBL3C-0.02 (Discharge)	March 21, 2018	-	0.2	425	9.11	790	120	-	5.00
	April 19, 2018	9:30	0.0	425	9.05	568	40	cloudy	100
	May 24, 2018	9:17	10.5	425	8.46	2200	180	clear	4.00
	June 19, 2018	10:27	15.2	425	8.12	1870	180	clear	5.00
	July 26, 2018	10:47	15.4	425	8.62	1452	180	clear	5.00
	August 21, 2018	10:04	12.9	425	8.36	2250	180	clear	4.00
	September 27, 2018	11:01	8.3	425	8.27	1856	180	clear	1.00
	October 22, 2018	11:22	3.3	425	8.34	1990	120	clear	4.00
	November 19, 2018	11:52	1.7	425	8.16	2370	120	clear	2.50
LBL3C-1.43	March 21, 2018	-	2.7	425	8.48	585	40	-	3.00
	April 19, 2018	11:45	0.5	425	8.10	396	40	cloudy	100
	May 24, 2018	12:04	11.5	425	7.98	2020	120	clear	2.00
	June 19, 2018	12:00	14.4	425	7.85	1500	240	clear	2.00
	July 26, 2018	12:55	18.0	425	8.31	1000	120	clear	5.00
	August 21, 2018	12:43	12.9	425	8.11	1721	180	clear	5.00
	September 27, 2018	13:20	8.0	425	8.00	1814	240	clear	3.00
	October 22, 2018	14:15	4.2	425	8.29	1663	120	slightly cloudy	3.00
	November 19, 2018	13:48	3.1	425	8.30	1947	120	clear	1.00
	December 17, 2018	13:53	1.3	425	8.02	2180	240	clear/algae	2.00
LBL3C-1.65	April 19, 2018	12:40	0.3	250	9.01	330	40	cloudy	100
	July 26, 2018	13:16	30.8	425	8.48	1065	240	clear	0.20
	December 17, 2018	14:25	2.7	250	6.50	4100	120	lear/orange sta	0.10
LBL3C-3.32	April 19, 2018	13:50	0.0	425	8.97	528	40	clear, brown	5.00
	May 24, 2018	13:10	12.2	425	7.55	1223	180	clear	0.50
	June 19, 2018	13:32	23.7	425	7.93	907	240	clear	0.10
	July 26, 2018	14:18	15.2	425	8.63	965	180	clear	2.00
LBL4C-0.18	March 21, 2018	-	No reading	425	9.20	1132	40	-	0.20
	April 19, 2018	12:22	0.0	250	8.23	2000	40	milky	10.00
	May 24, 2018	12:23	11.8	425	4.53	2320	0	clear	2.00
	June 19, 2018	12:15	14.9	425	5.58	1980	0	milky	1.00
	July 26, 2018	13:26	14.5	425	8.55	1070	40	cloudy	2.50
	October 22, 2018	15:00	2.5	425	4.86	2150	0	clear	0.05

Table 12: Summary of Water Quality Exceedances (BCAWQG-FSTM) Along L3 Creek From Water Sampling Events in 2018

	Sampling Dates	Total Iron (Fe)	Dissolved Iron (Fe)	Dissolved Aluminum (Al)	Dissolved Cadmium (Cd)	Total Cobalt (Co)	Total Zinc (Zn)	Total Copper (Cu)	Total Arsenic (As)	Total Manganese (Mn)	pH
LBL3C-0.02 (discharge)	21-Mar-18	✓									
	19-Apr-18	✓									
	24-May-18			✓							
	19-Jun-18			✓							
	26-Jul-18			✓							
	21-Aug-18	✓		✓							
	27-Sep-18			✓							
	22-Oct-18			✓							
	November 19, 2018										
LBL3C-1.43 (midstream)	March 21, 2018	✓									
	April 19, 2018	✓									
	May 24, 2018										
	June 19, 2018										
	July 26, 2018			✓							
	August 21, 2018	✓									
	September 27, 2018										
	October 22, 2018										
	November 19, 2018										
	December 17, 2018										
LBL3C-1.65	April 19, 2018	✓									
	July 26, 2018	✓									
	December 17, 2018	✓	✓	✓	✓	✓	✓			✓	✓
LBL3C-3.32 (upstream)	April 19, 2018										
	May 24, 2018										
	June 19, 2018										
	July 26, 2018			✓							
LBL4C-0.18	March 21, 2018	✓									
	April 19, 2018	✓					✓	✓	✓		
	May 24, 2018	✓	✓	✓	✓	✓	✓				✓
	June 19, 2018	✓	✓	✓	✓	✓	✓				✓
	July 26, 2018	✓		✓							
	October 22, 2018	✓	✓	✓	✓	✓	✓				✓

[1] British Columbia Ministry of Environment, Water Protection & Sustainability Branch. 2018. British Columbia Approved Water Quality Guidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture Summary Report. Referenced Guidelines are for Freshwater Aquatic Life (FWAL) water use and Short Term Maximum (STM) WQG. Exceedances denoted by a check mark.

Note: L3 and L4 Creek are not considered a construction-related PAG management facility and are not monitored under requirement of the CEMP.

FIGURES

O:\Vancouver\GIS\ENGINEERING\VMIN\VMIN03021-01\Maps\VMIN03021-01_Map01_WaterSamplesLBRR_v3.mxd modified 1/17/2019 by stephanie.leusink

LEGEND

- Water Sample (Insitu Testing Only)
- Water Sample (Insitu Testing & External Lab Testing)
- Culvert
- Ditch
- Ditch Diversion
- Howe Pit
- Blind Corner Outcrop
- Site C Project Boundary
- Original Watercourse

NOTES
Base data source:
Imagery provided by the client (Oct 2017).

STATUS
ISSUED FOR REVIEW

WATER QUALITY MONITORING PLAN

Left Bank - River Road

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:3,500
50 25 0 50
Metres

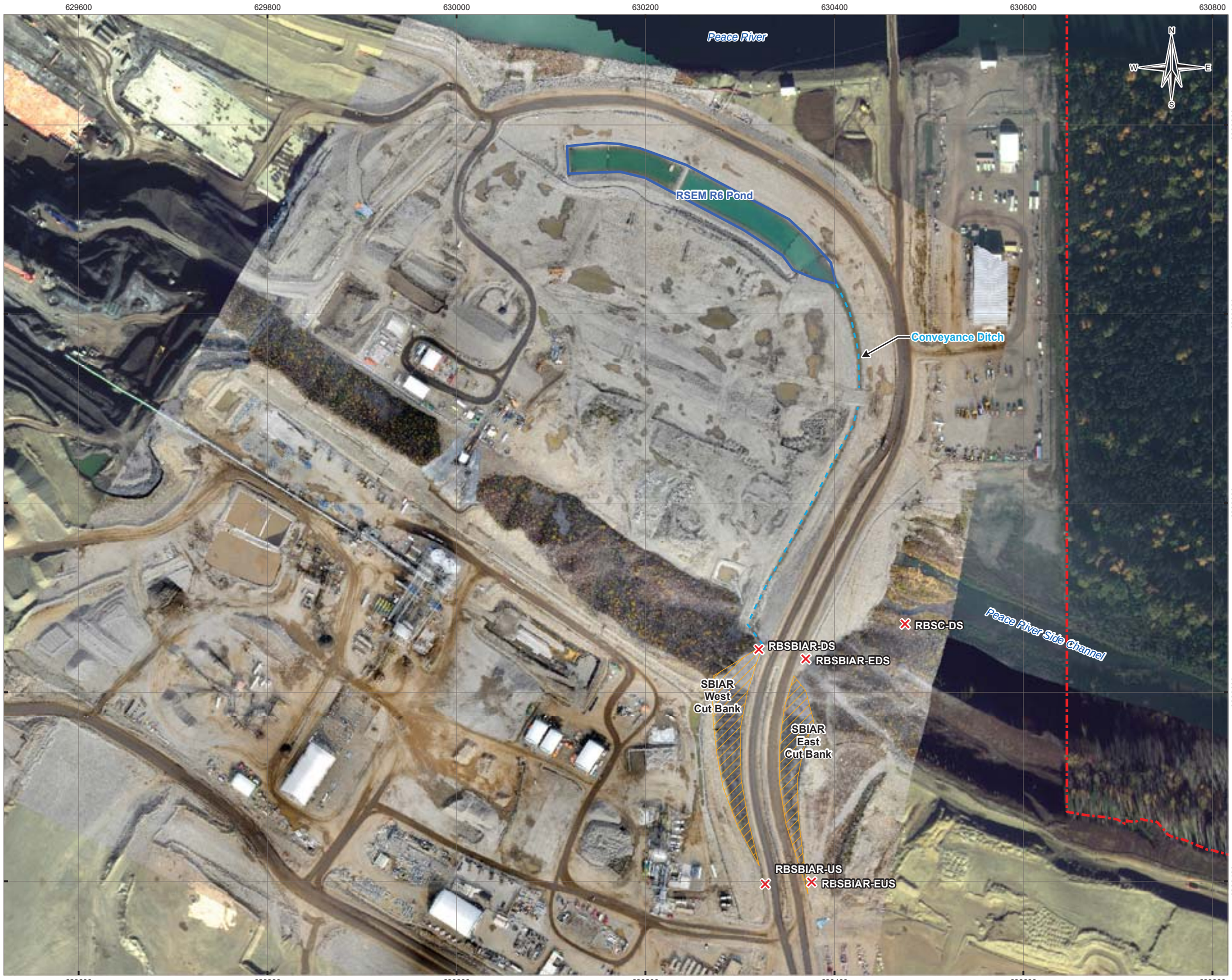
TETRA TECH

FILE NO.
VMIN03021-01_Map01_WaterSamplesLBRR_v3.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	BB	JB	0

DATE	PROJECT NO.
January 17, 2019	ENG.VMIN03021-01

Map 1



LEGEND

- Water Sample (Insitu Testing & External Lab Testing)
- Ditch
- Cut Bank
- RSEM RG Pond
- Site C Project Boundary

NOTES
Base data source:
Imagery provided by the client (Oct 2017).

STATUS
ISSUED FOR USE

WATER QUALITY MONITORING PLAN

Right Bank - SBIAR

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:4,000
80 40 0 80
Metres

FILE NO.
VMIN03021-01_Map02_WaterSamplesRB.mxd

TETRA TECH

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	BB	JB	0

DATE
July 23, 2018

PROJECT NO.
ENG.VMIN03021-01

Map 2

O:\Vancouver\GIS\ENGINEERING\VMIN\VMIN03021-01\Maps\VMIN03021-01_Map03_WaterSamplesLBL3.mxd modified 5/30/2018 by stephanie.leusink

LEGEND

- Water Sample (Insitu Testing & External Lab Testing)
- Culvert
- Ditch
- Ditch Diversion
- Howe Pit
- Blind Corner Outcrop
- Site C Project Boundary
- Original Watercourse

NOTES
Base data source:
Imagery provided by the client (Oct 2017).

STATUS
ISSUED FOR USE

WATER QUALITY MONITORING PLAN

Left Bank - L3 Creek

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:10,000

200 100 0 200

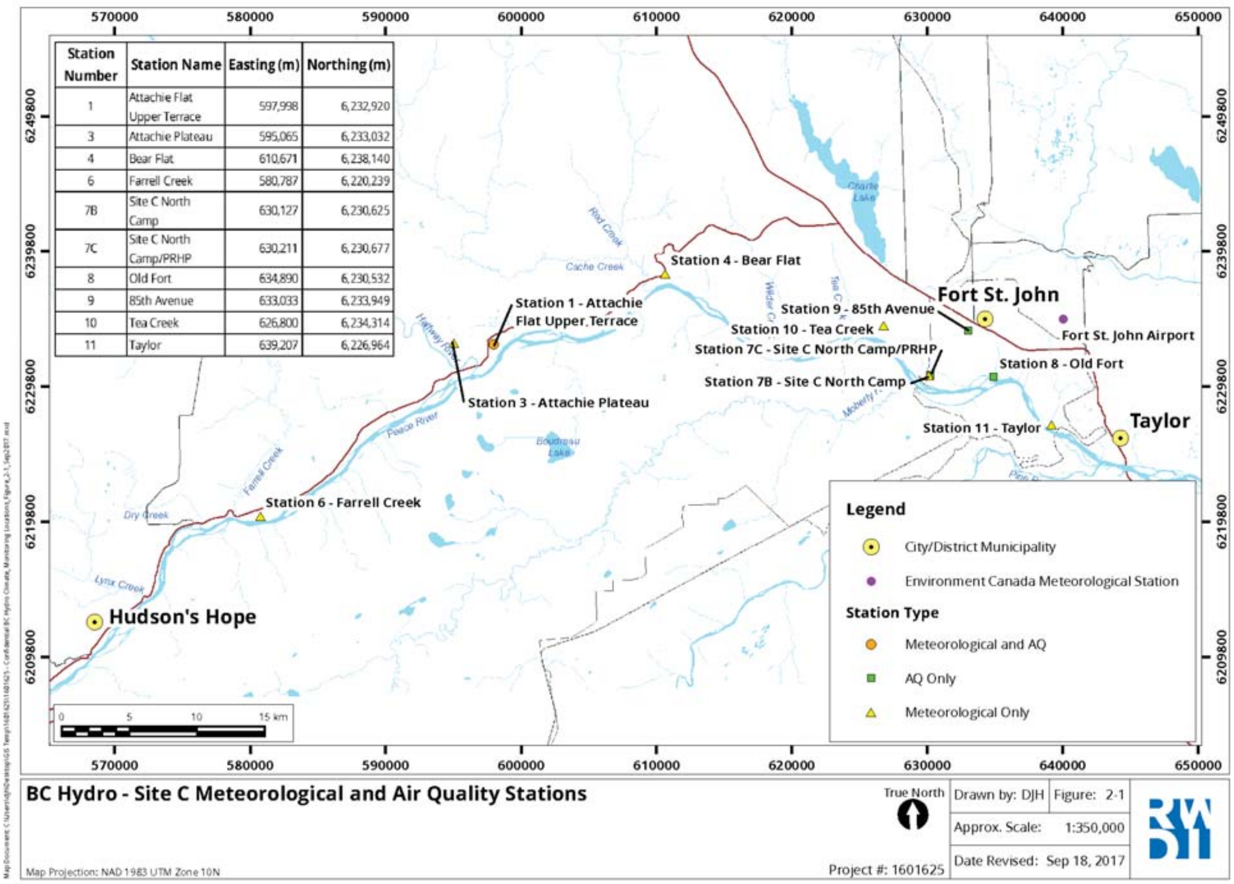
Metres

TETRA TECH

FILE NO.				
VMIN03021-01_Map03_WaterSamplesLBL3.mxd				
OFFICE	**DWN**	**CKD**	**APVD**	**REV**
Tt-VANC	SL	BB	JB	0
DATE	**PROJECT NO.**			
May 30, 2018	ENG.VMIN03021-01			

Map 3

Figure 4: BC Hydro – Site C Meteorological and Air Quality Stations



Station Number	Station Name	Easting (m)	Northing (m)
1	Attachie Flat Upper Terrace	597,998	6,232,920
3	Attachie Plateau	595,065	6,233,032
4	Bear Flat	610,671	6,238,140
6	Farrell Creek	580,787	6,220,239
7B	Site C North Camp	630,127	6,230,625
7C	Site C North Camp/PRHP	630,211	6,230,677
8	Old Fort	634,890	6,230,532
9	85th Avenue	633,033	6,233,949
10	Tea Creek	626,800	6,234,314
11	Taylor	639,207	6,226,964

Figure 5: Total Alkalinity and pH at River Road Locations

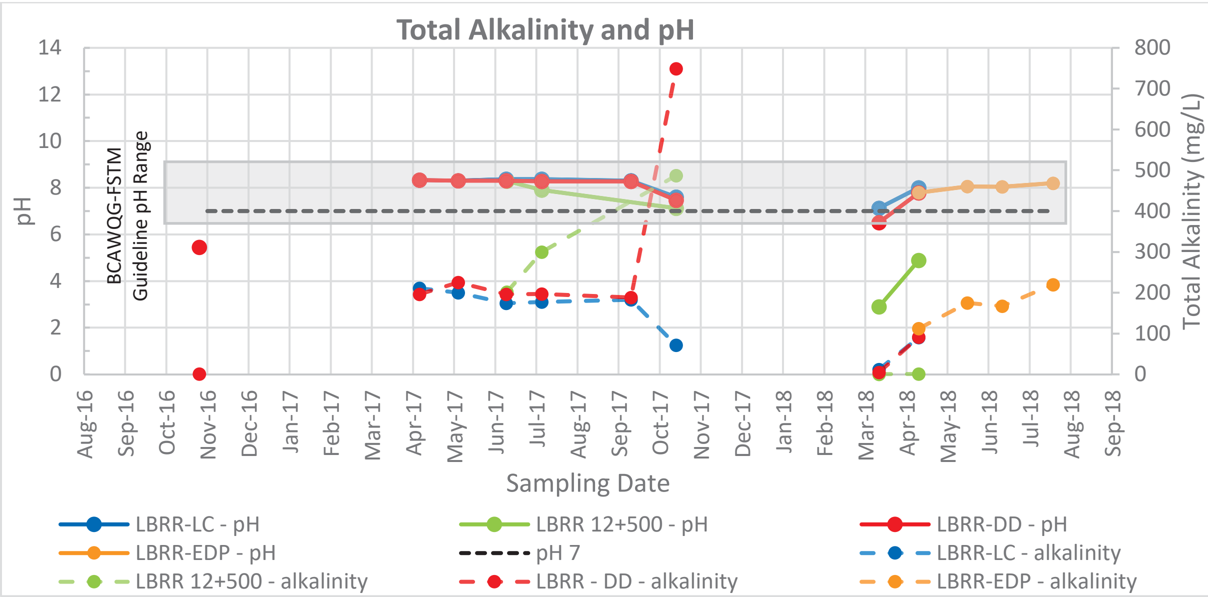


Figure 6: Total Dissolved and Total Suspended Solids at River Road Locations

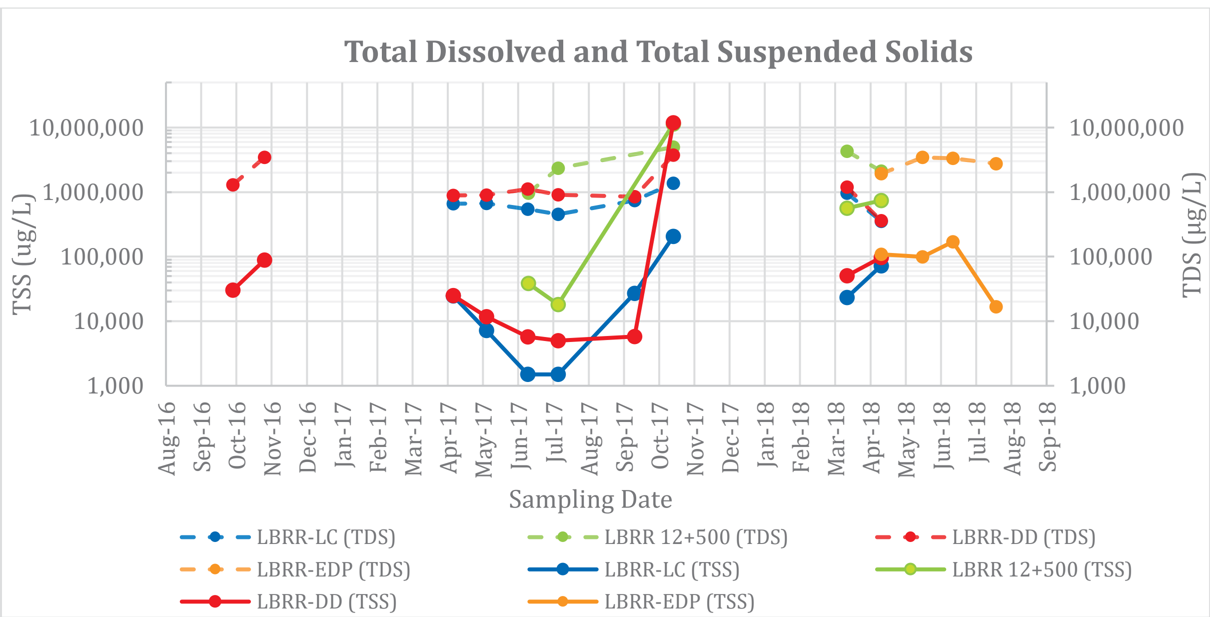


Figure 7: Sulphate at River Road Locations

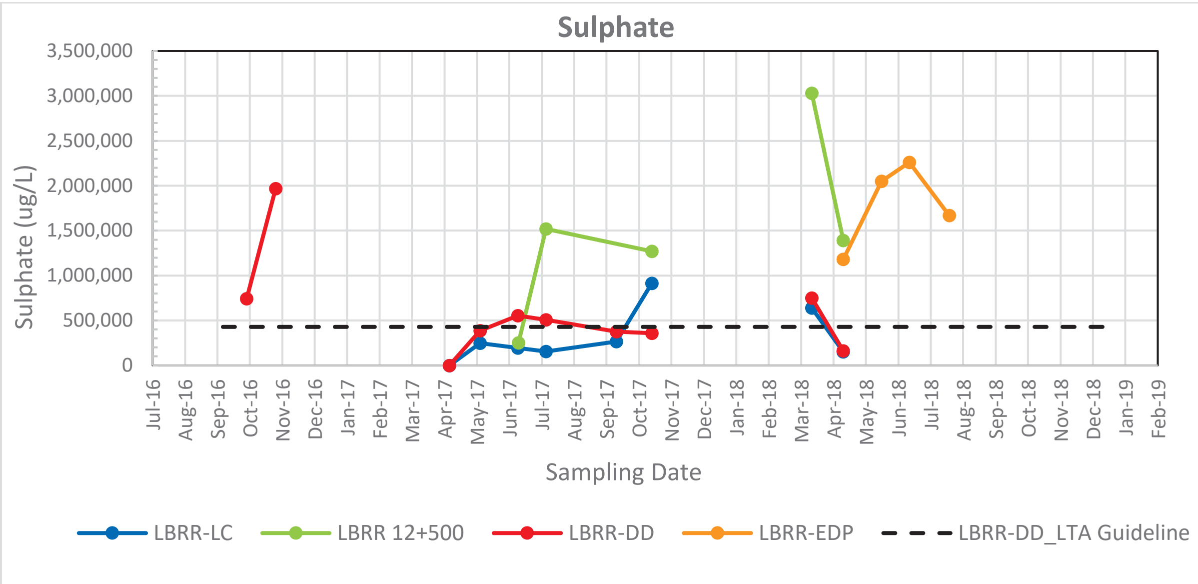


Figure 8: Aluminum (Total and Dissolved) at River Road Locations

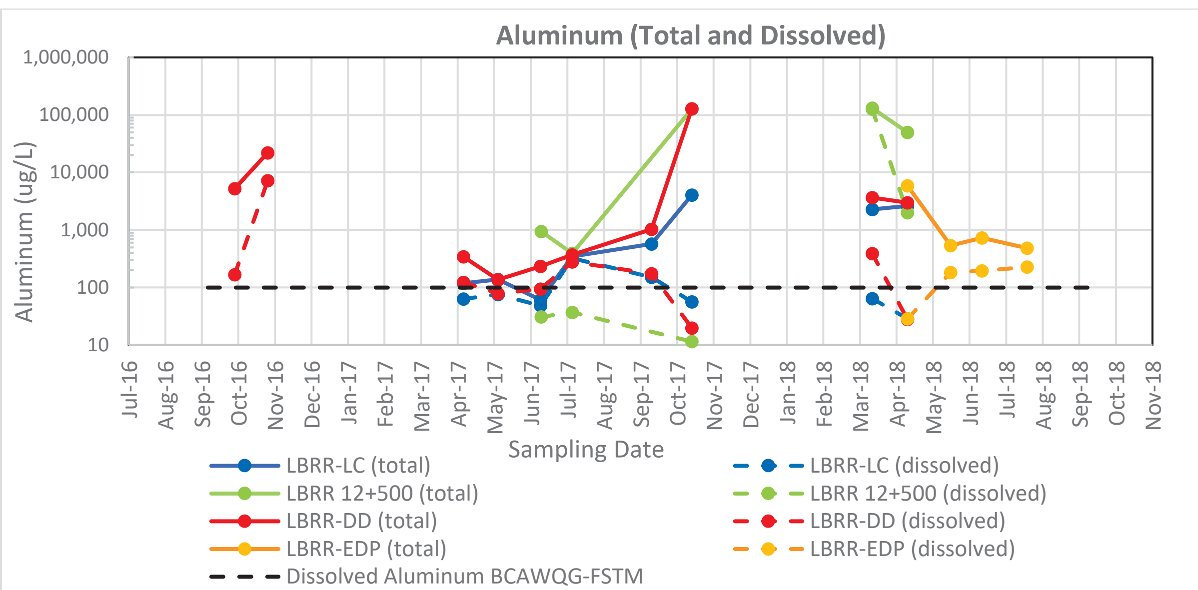


Figure 9: Iron (Total and Dissolved) at River Road Locations

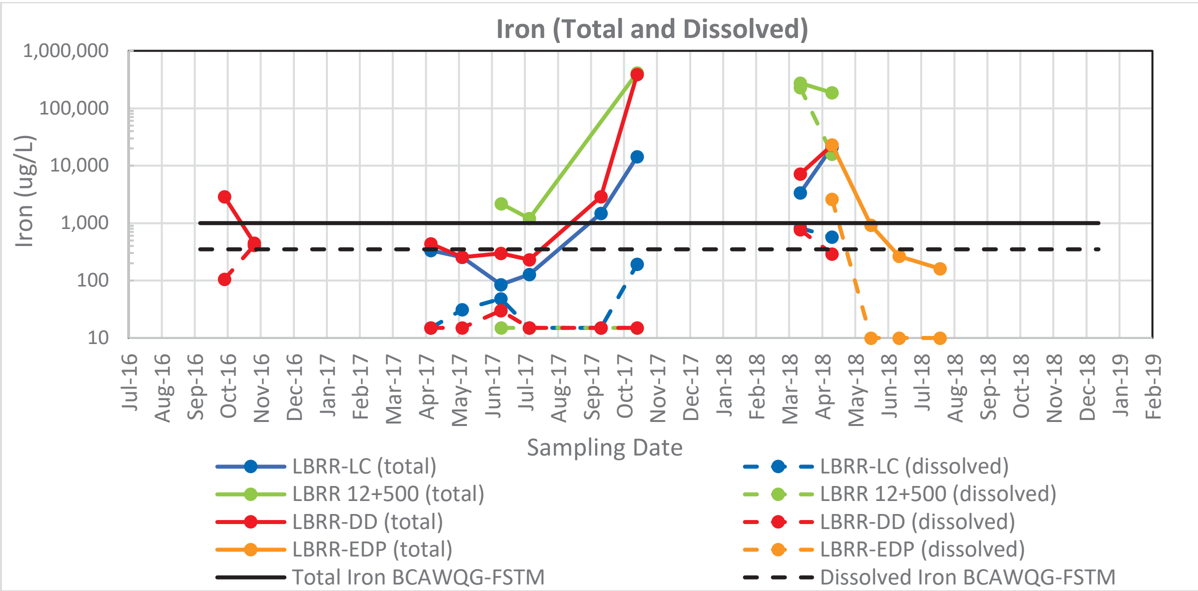


Figure 10: Arsenic (Total and Dissolved) at River Road Locations

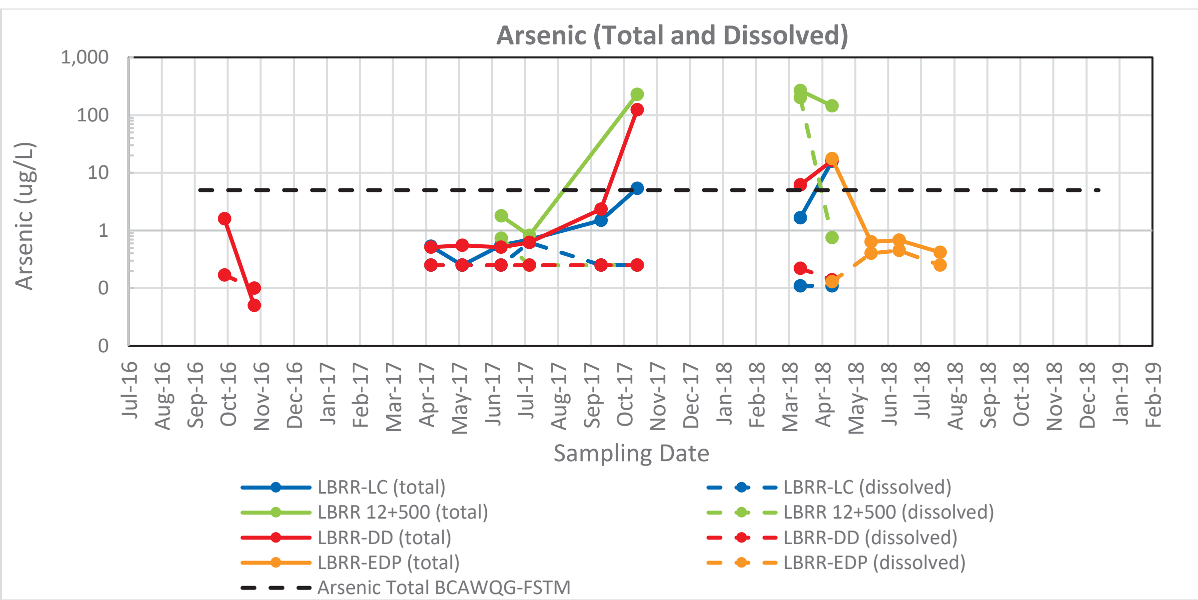


Figure 11: Cadmium (Total and Dissolved) at River Road Locations

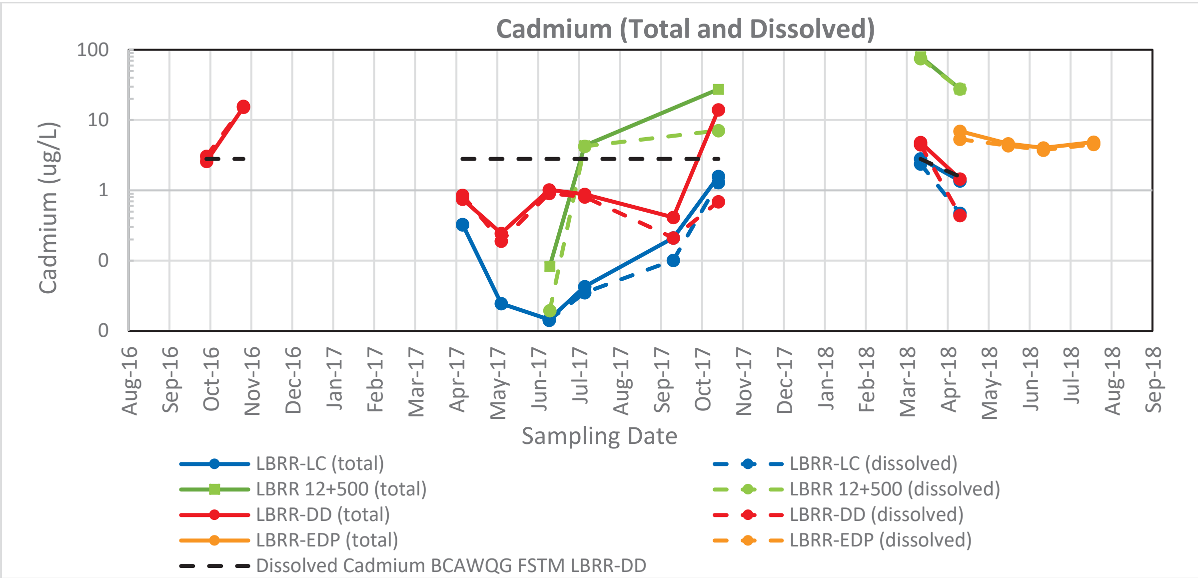


Figure 12: Cobalt (Total and Dissolved) at River Road Locations

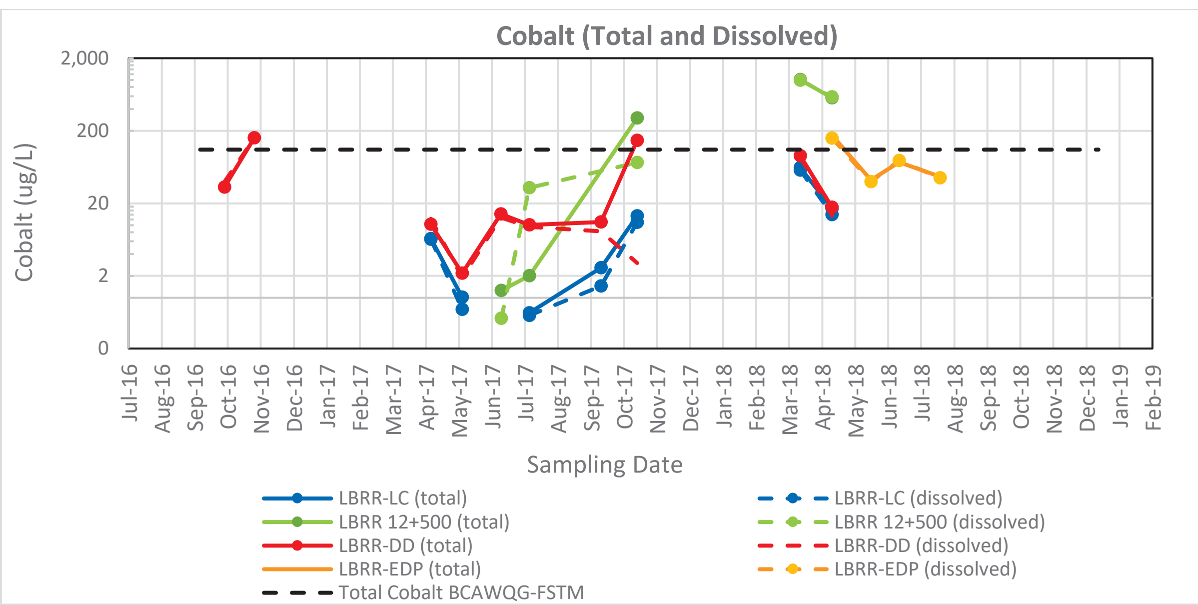


Figure 13: Copper (Total and Dissolved) at River Road Locations

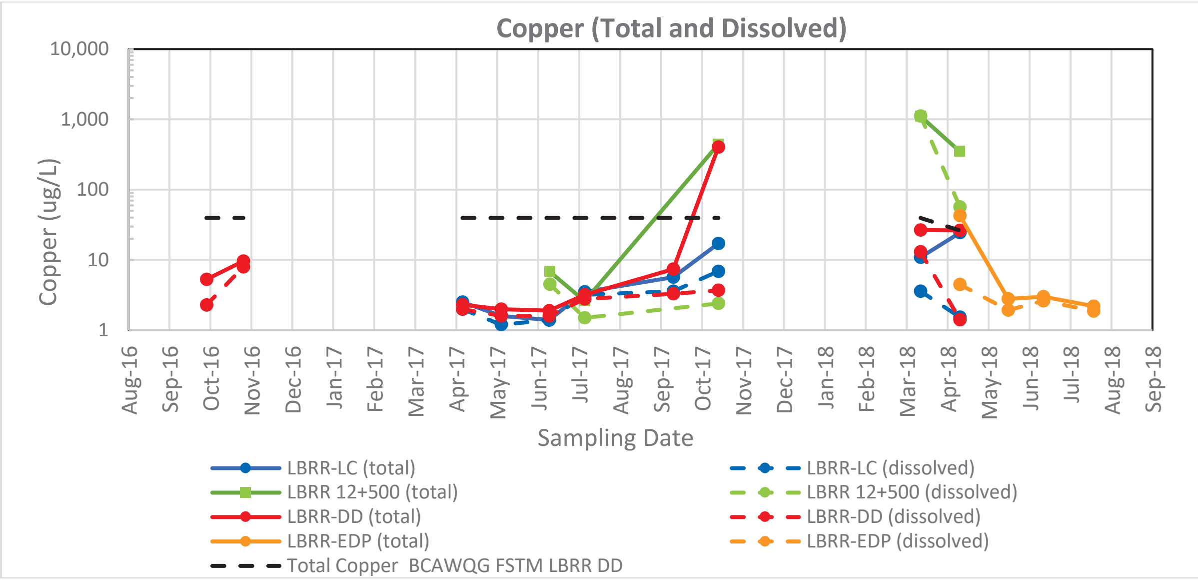


Figure 14: Zinc (Total and Dissolved) at River Road Locations

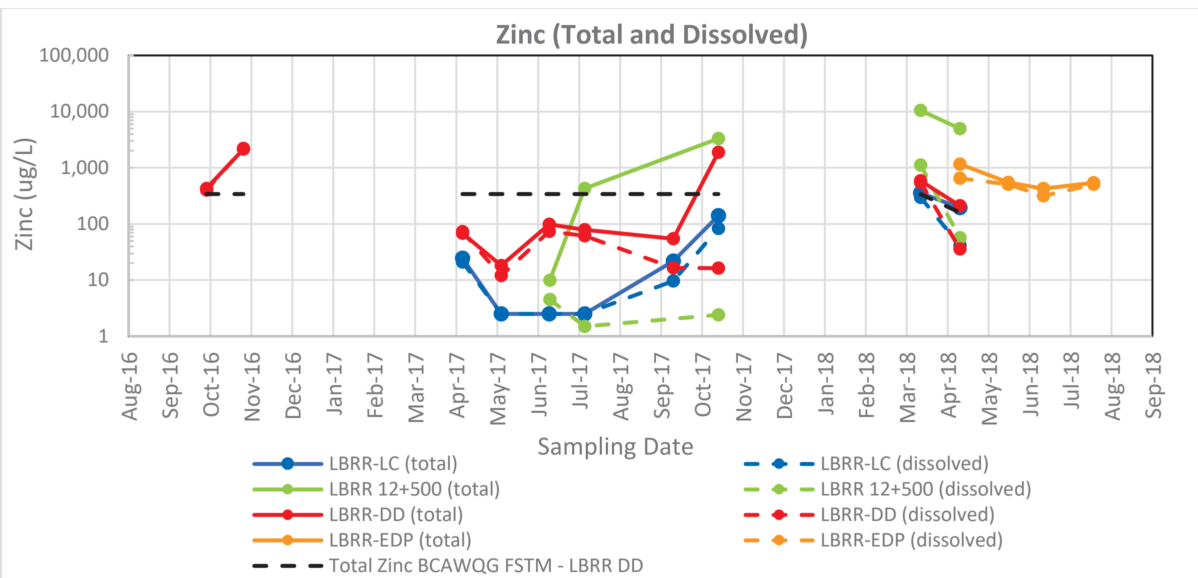


Figure 15a: pH at SBIAR Locations

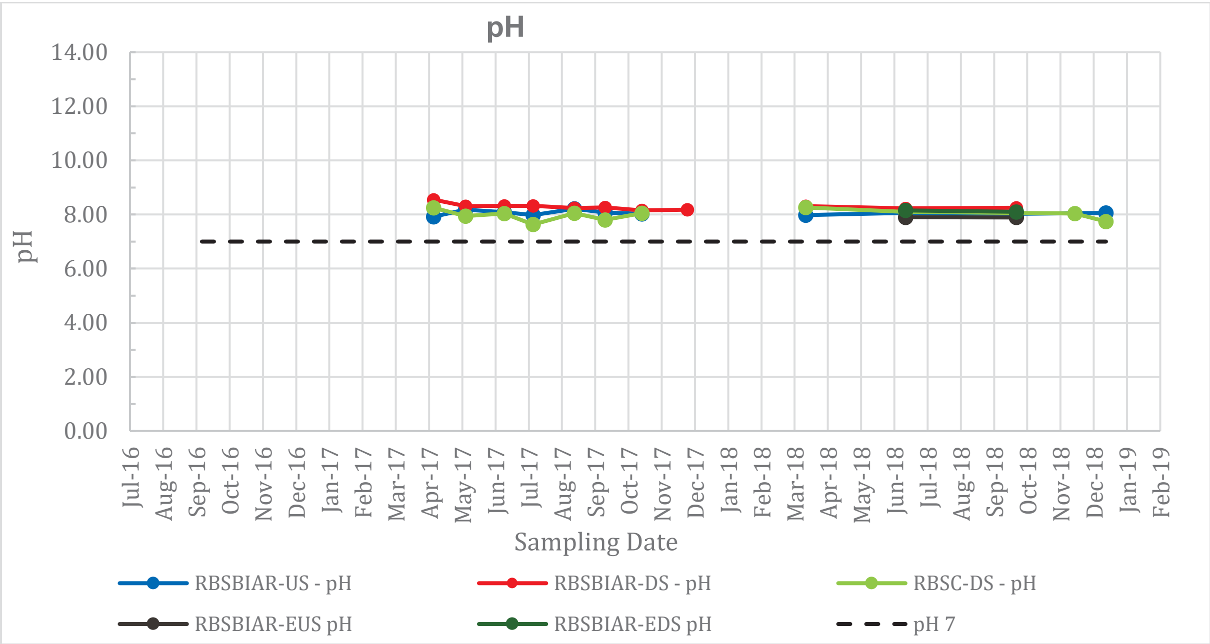


Figure 15b: Alkalinity at SBIAR Locations

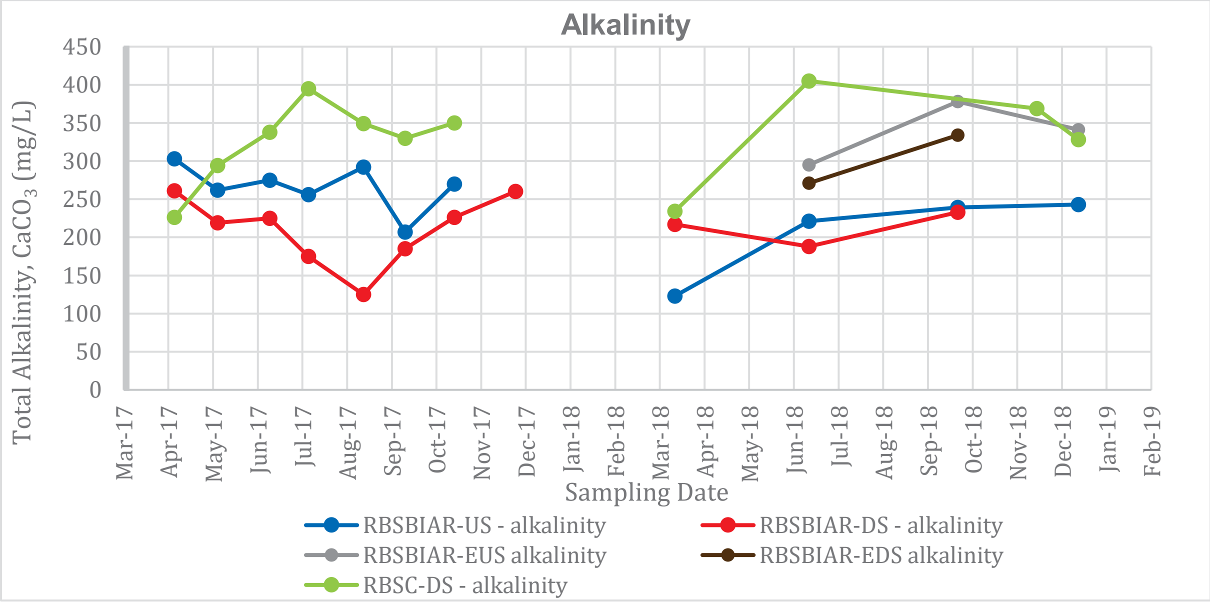


Figure 16a: Total Dissolved Solids at SBIAR Locations

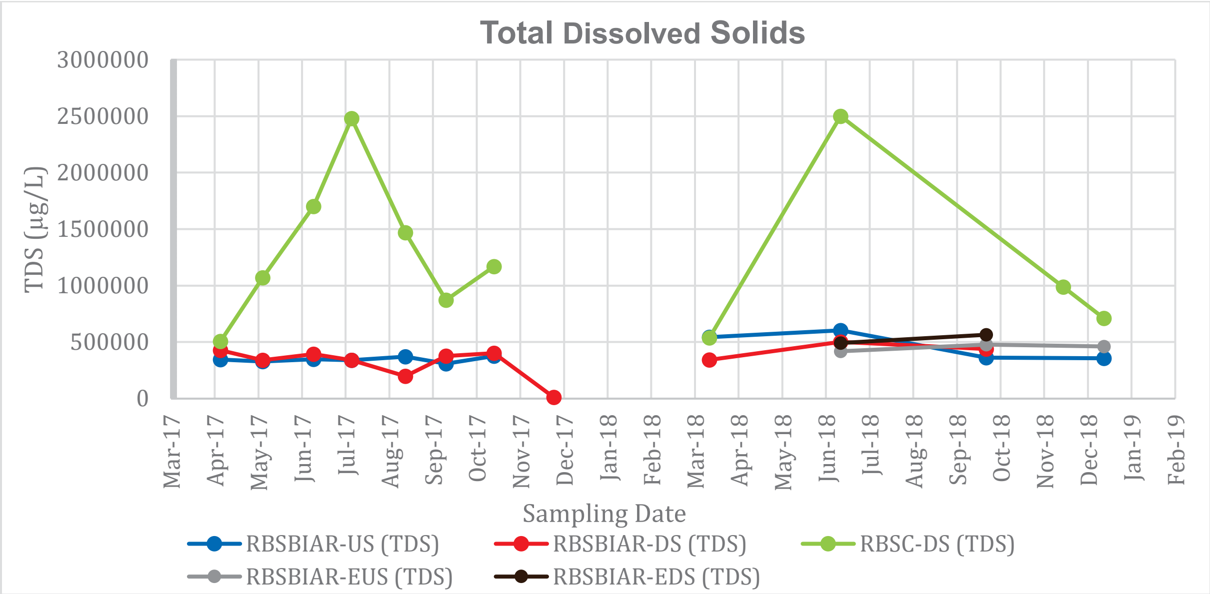


Figure 16b: Total Suspended Solids at SBIAR Locations

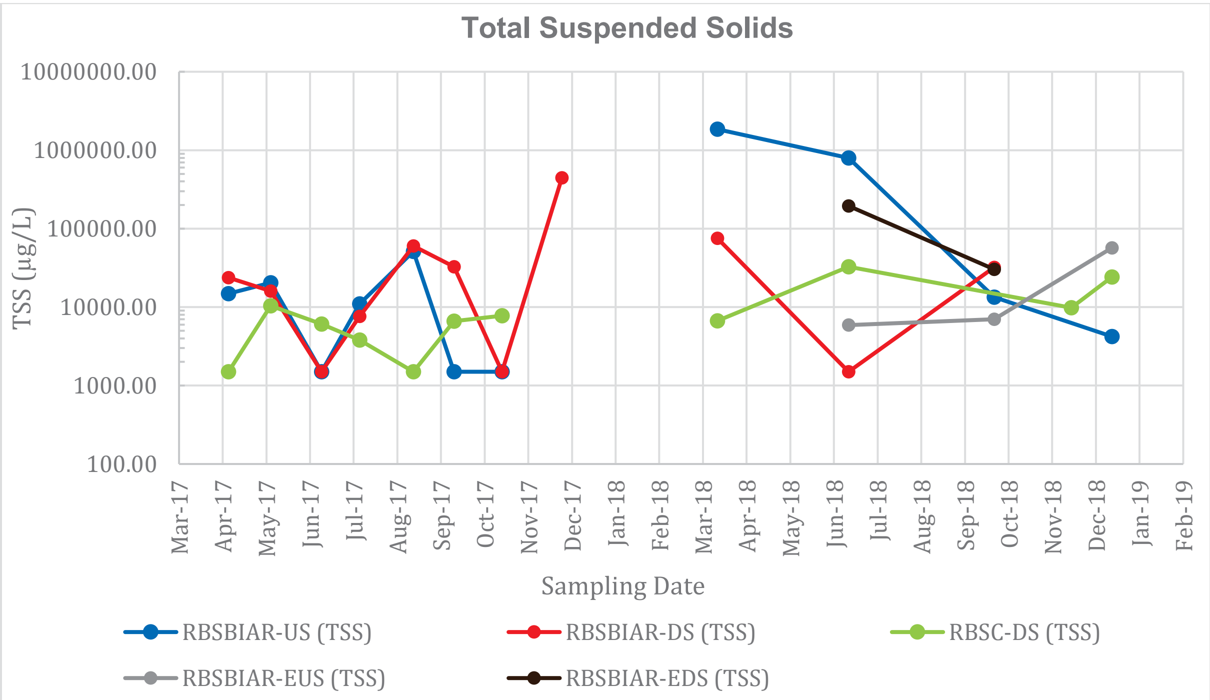


Figure 17: Sulphate at SBIAR Locations

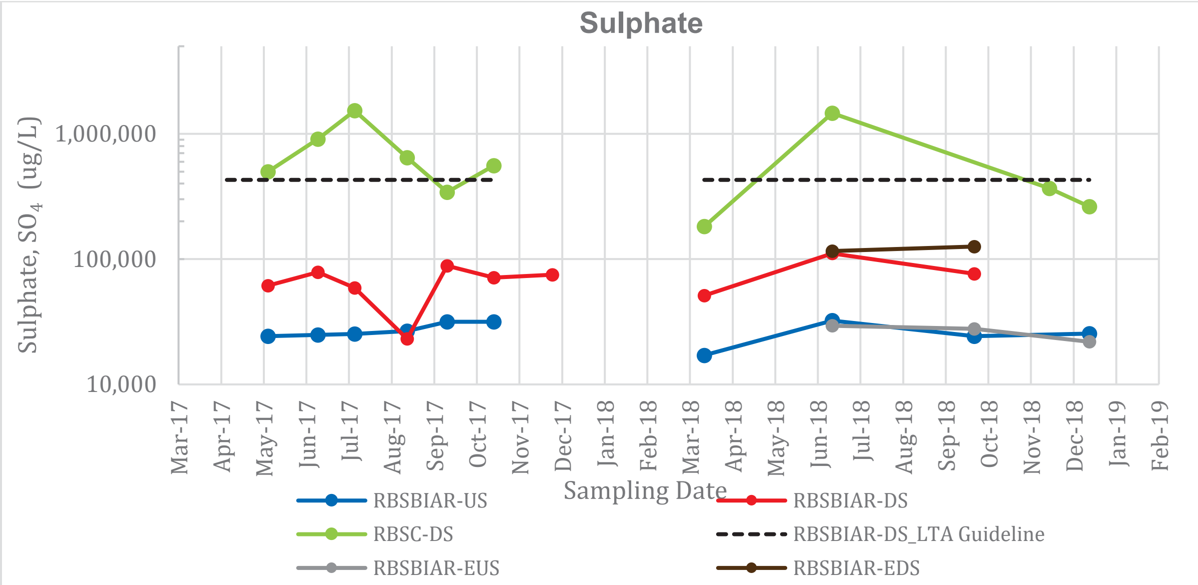


Figure 18: Aluminum (Total and Dissolved) at SBIAR Locations

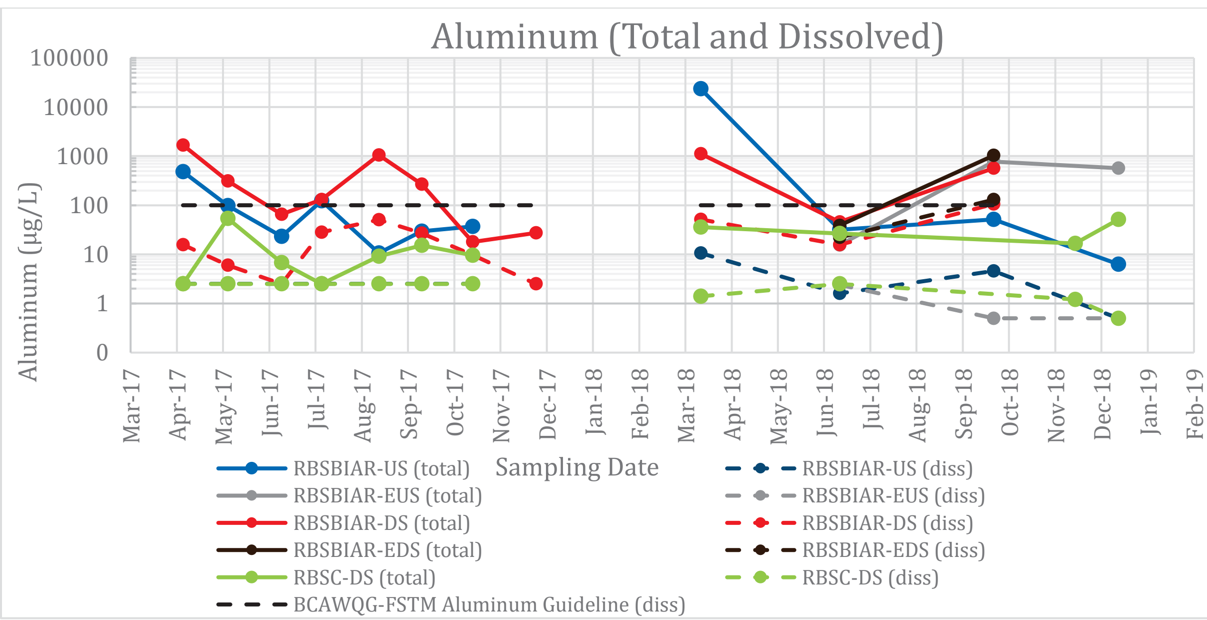


Figure 19: Iron (Total and Dissolved) at SBIAR Locations

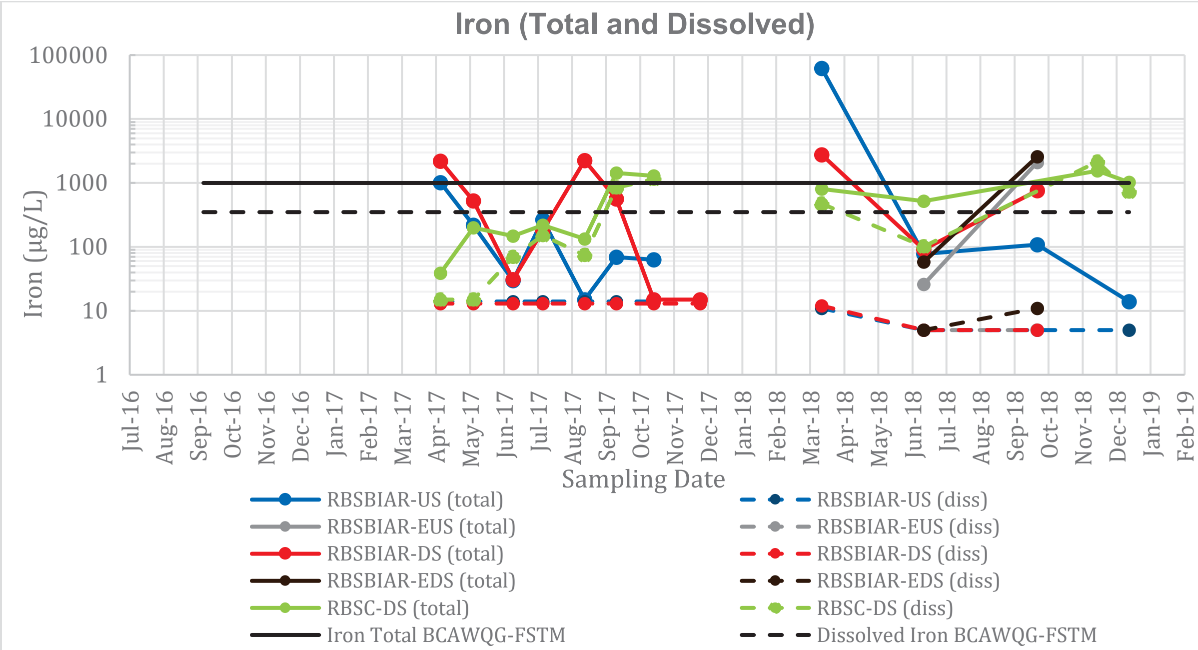


Figure 20: Arsenic (Total and Dissolved) at SBIAR Locations

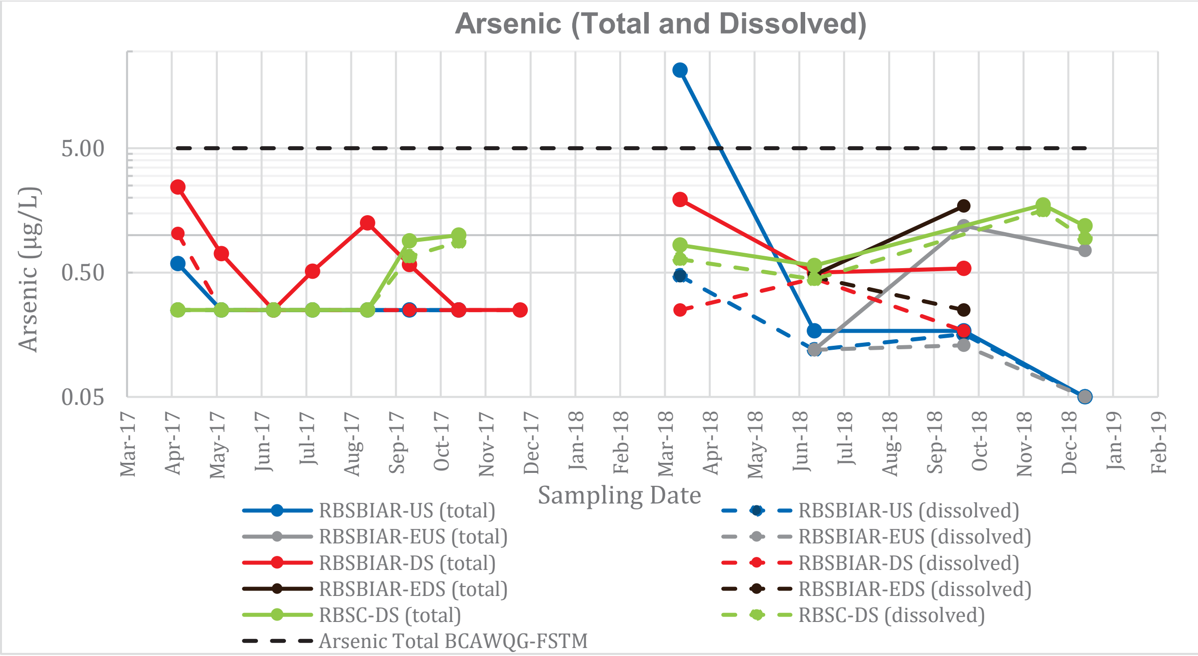


Figure 21: Cadmium (Total and Dissolved) at SBIAR Locations

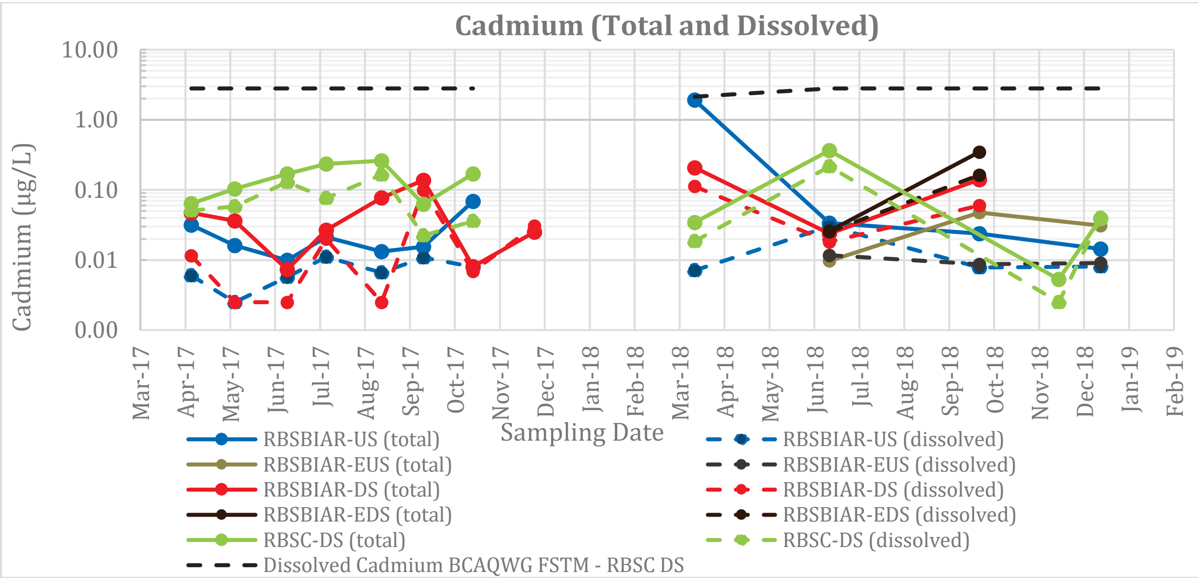


Figure 22: Cobalt (Total and Dissolved) at SBIAR Locations

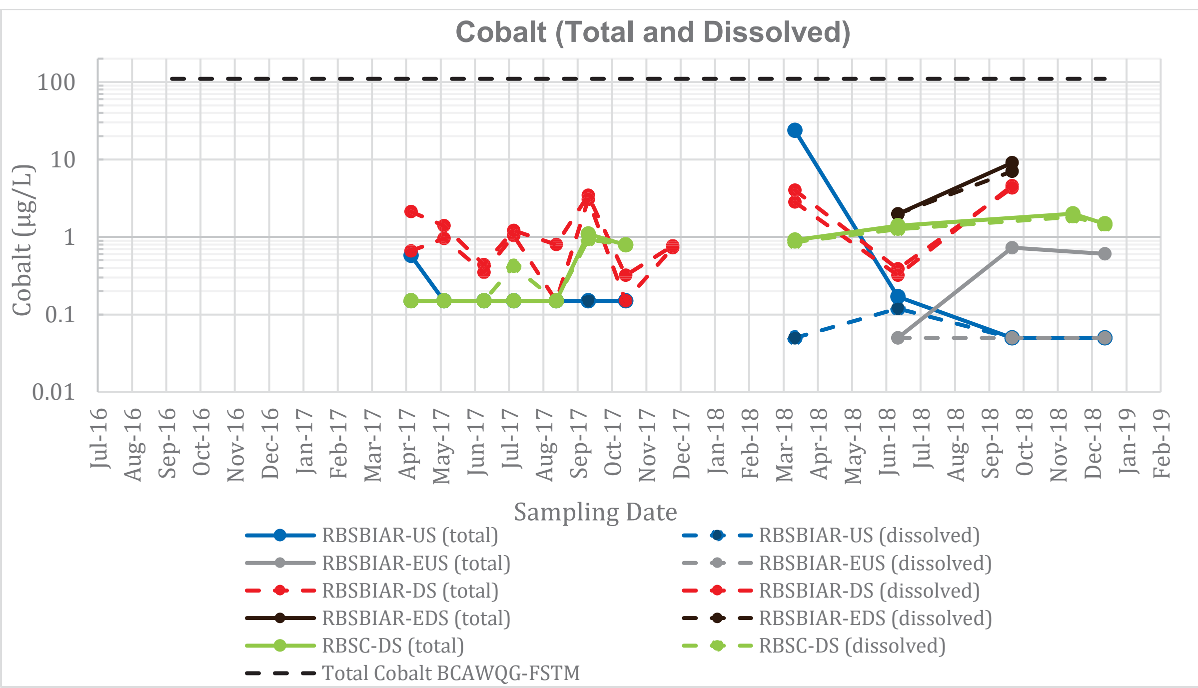


Figure 23: Copper (Total and Dissolved) at SBIAR Locations

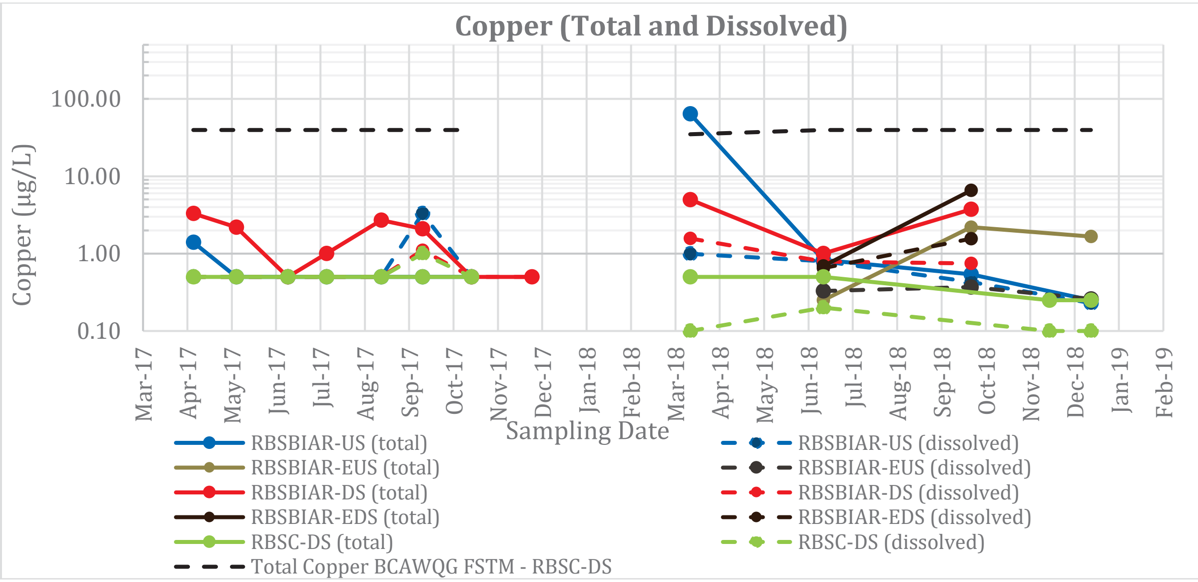


Figure 24: Zinc (Total and Dissolved) at SBIAR Locations

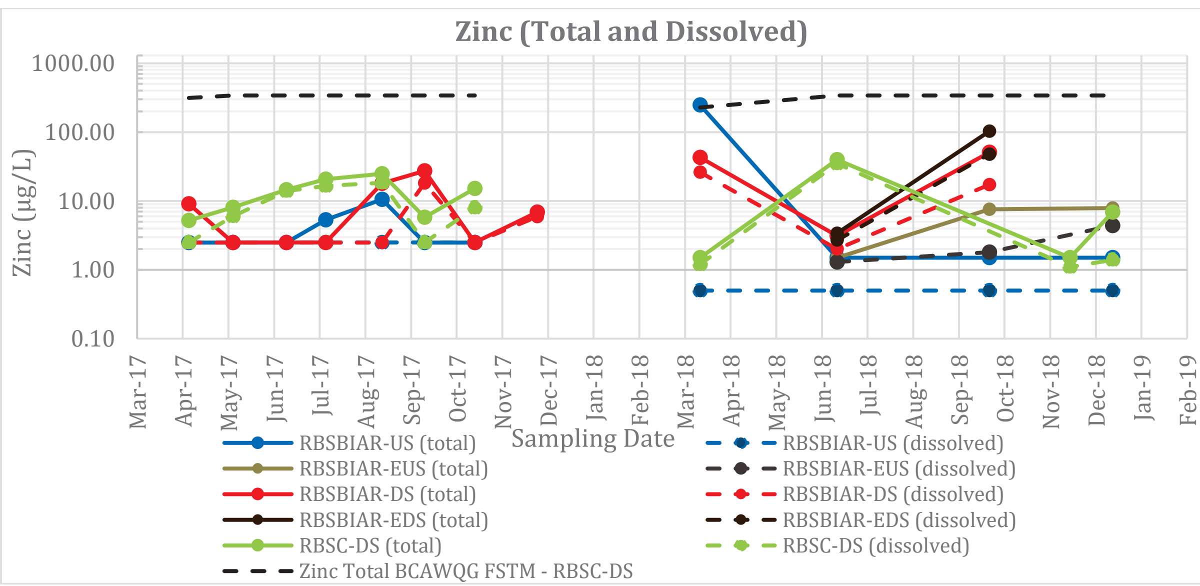


Figure 25: Total Alkalinity and pH at L3 Creek Locations

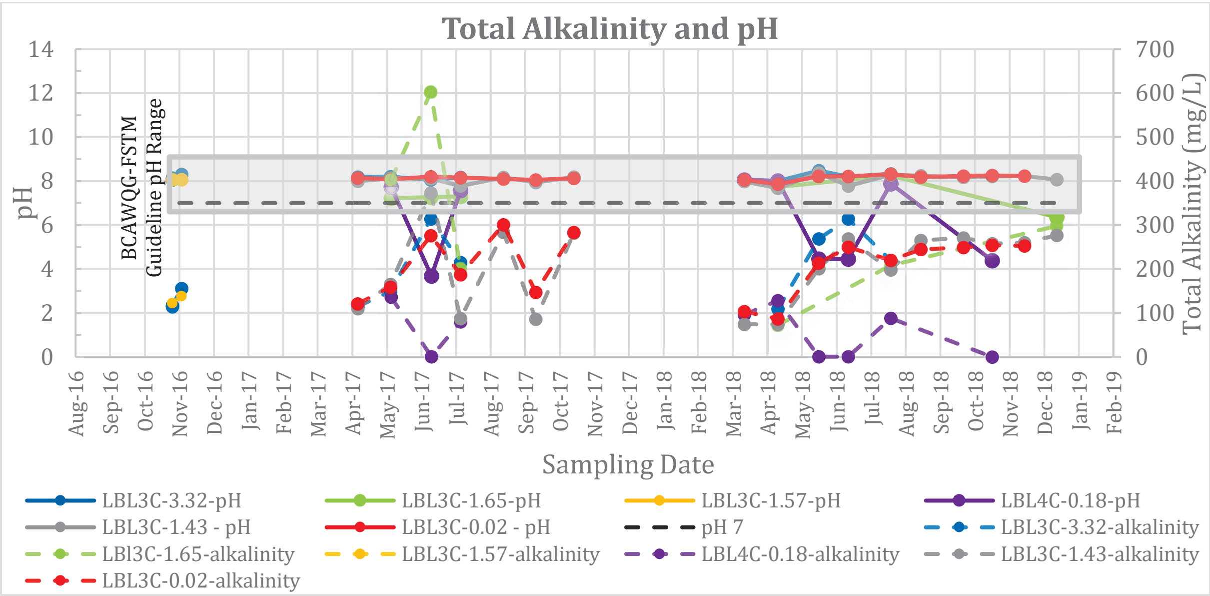


Figure 26: Total Dissolved and Total Suspended Solids at L3 Creek Locations

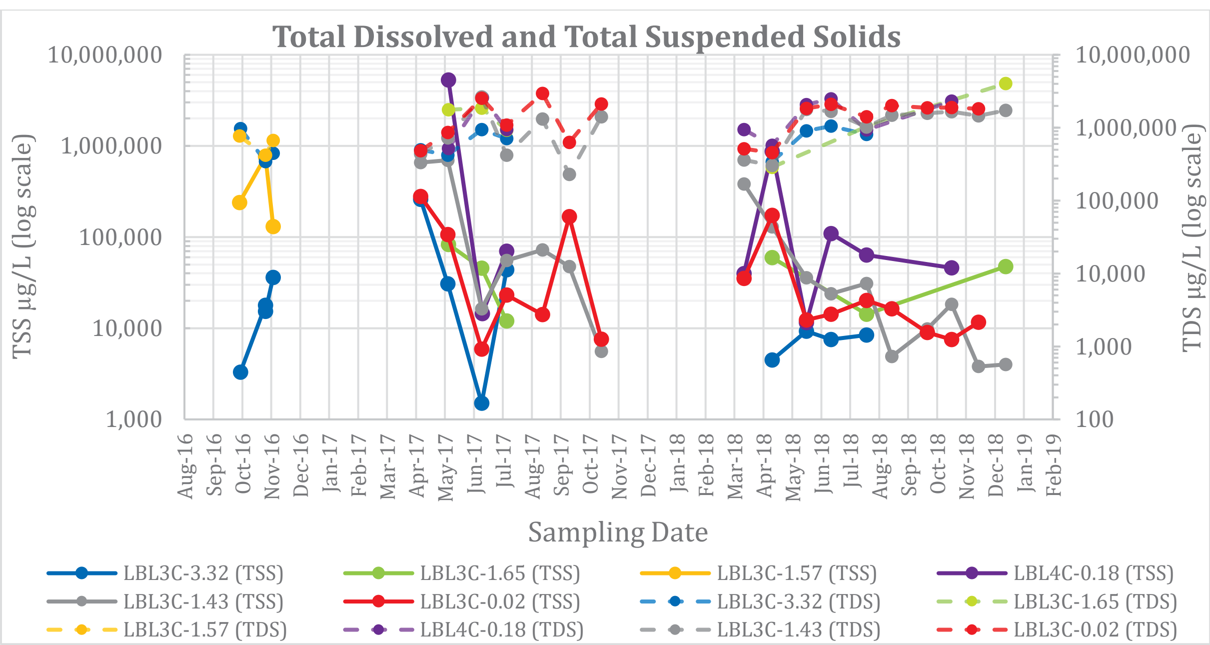


Figure 27: Sulphate at L3 Creek Locations

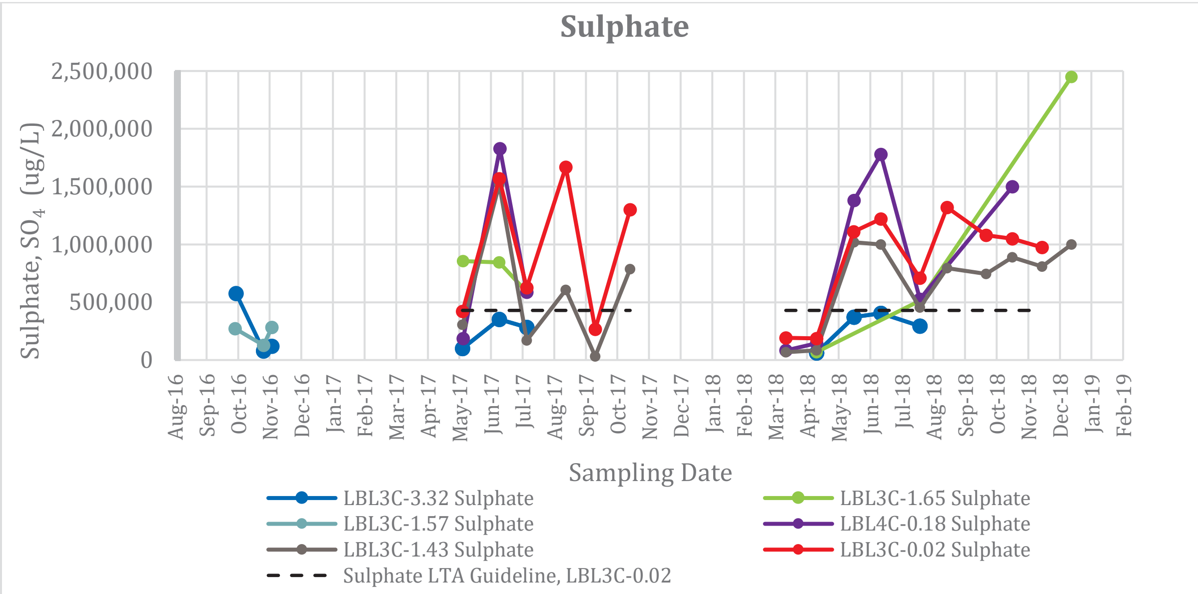


Figure 28a: Aluminum (Total) at L3 Creek Locations

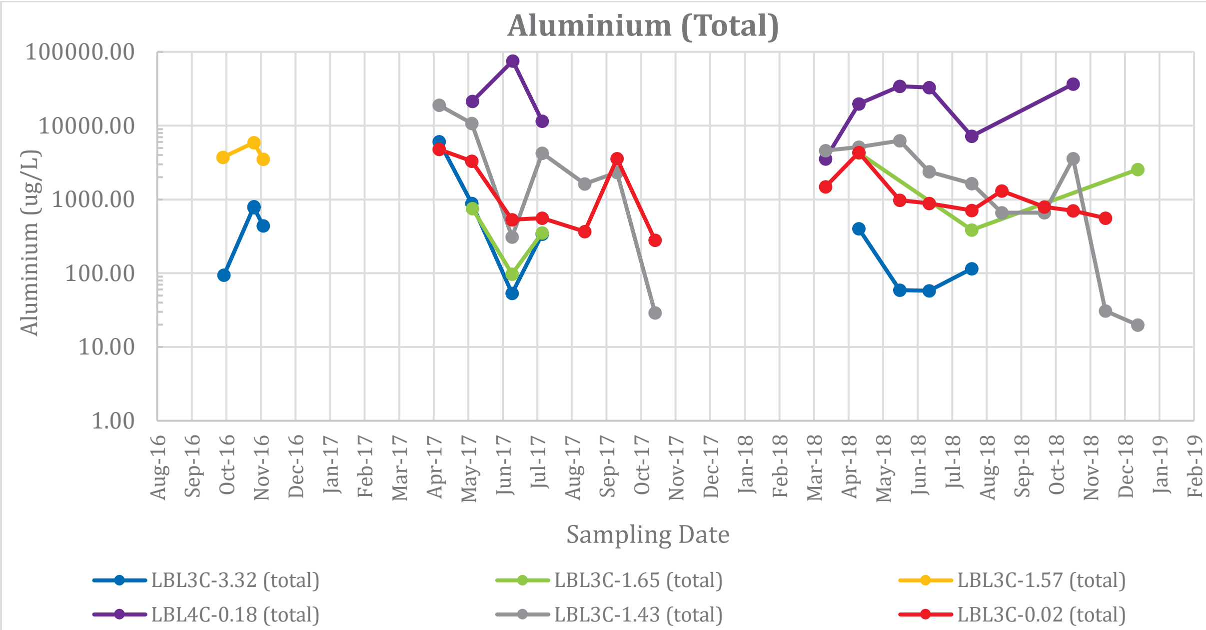


Figure 28b: Aluminium (Dissolved) at L3 Creek Locations

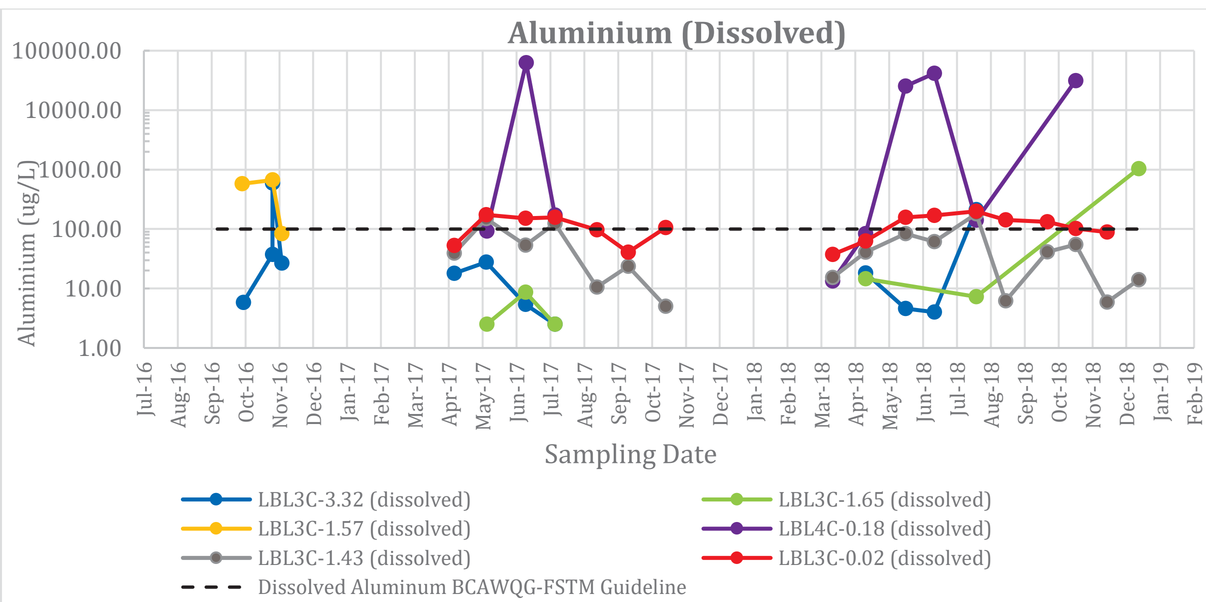


Figure 29a: Iron (Total) at L3 Creek Locations

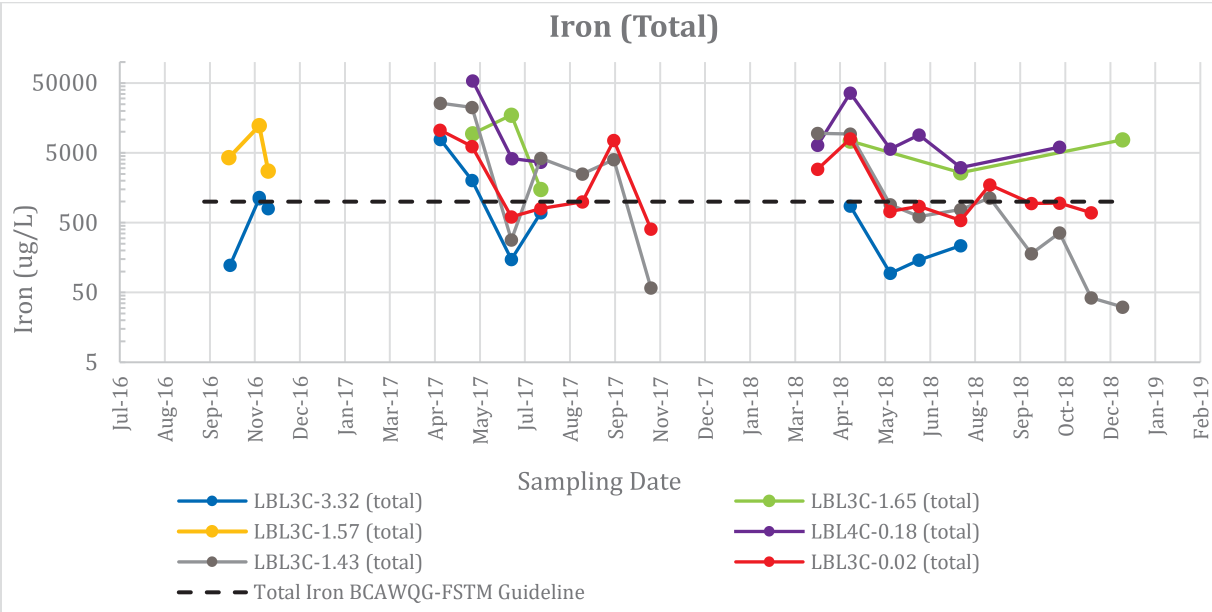


Figure 29b: Iron (Dissolved) at L3 Creek Locations

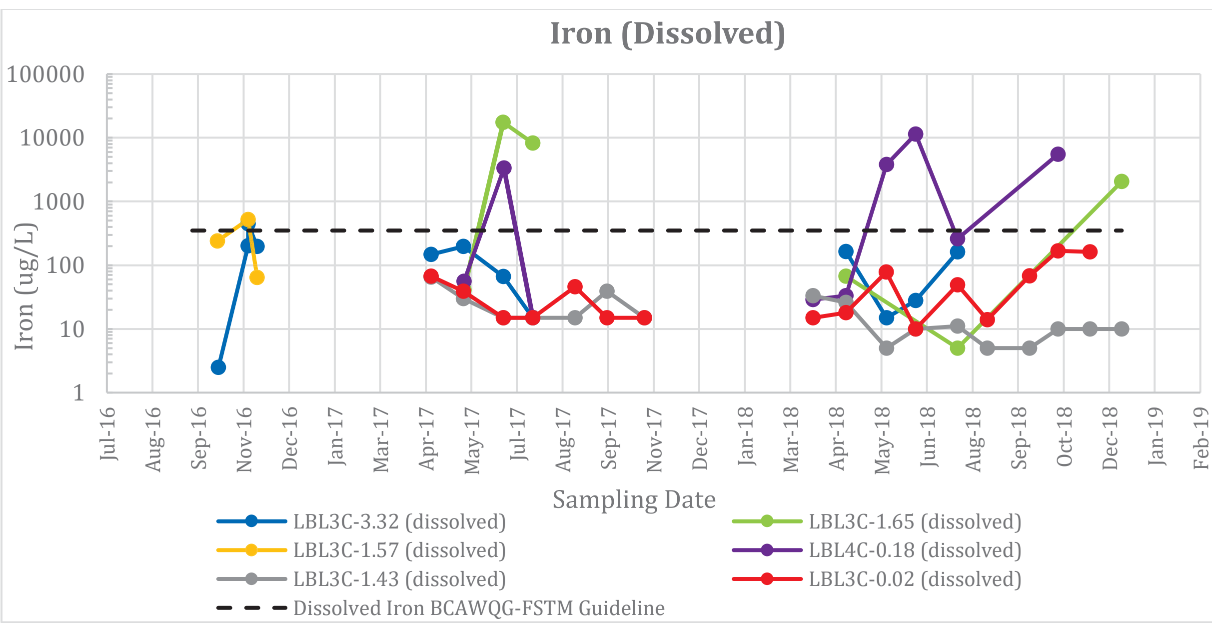


Figure 30a: Arsenic (Total) at L3 Creek Locations

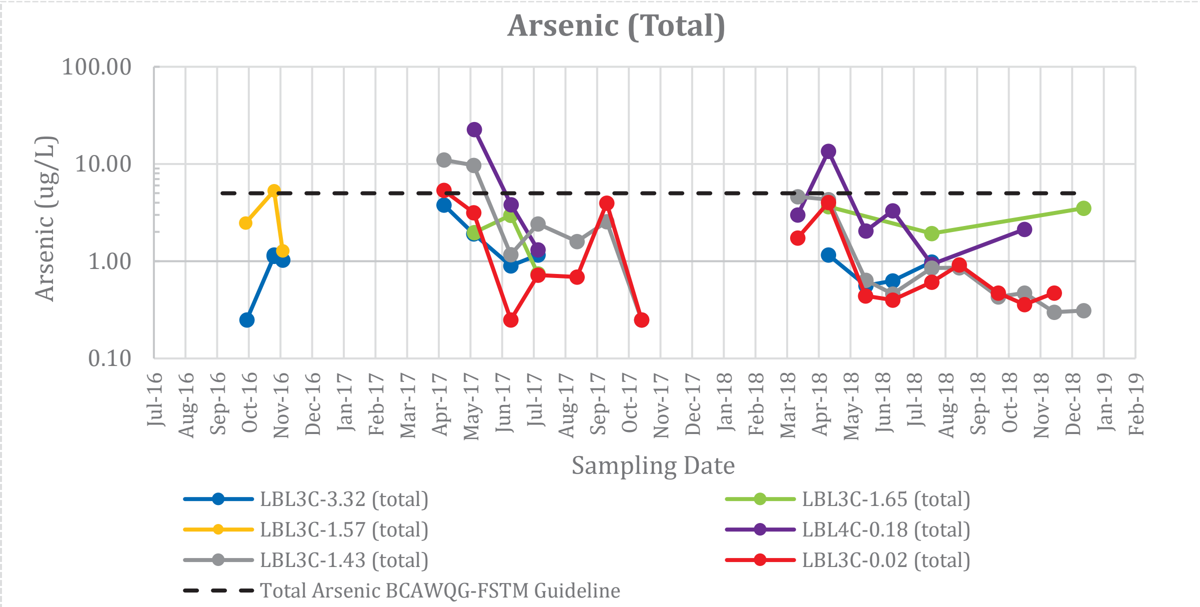


Figure 30b: Arsenic (Dissolved) at L3 Creek Locations

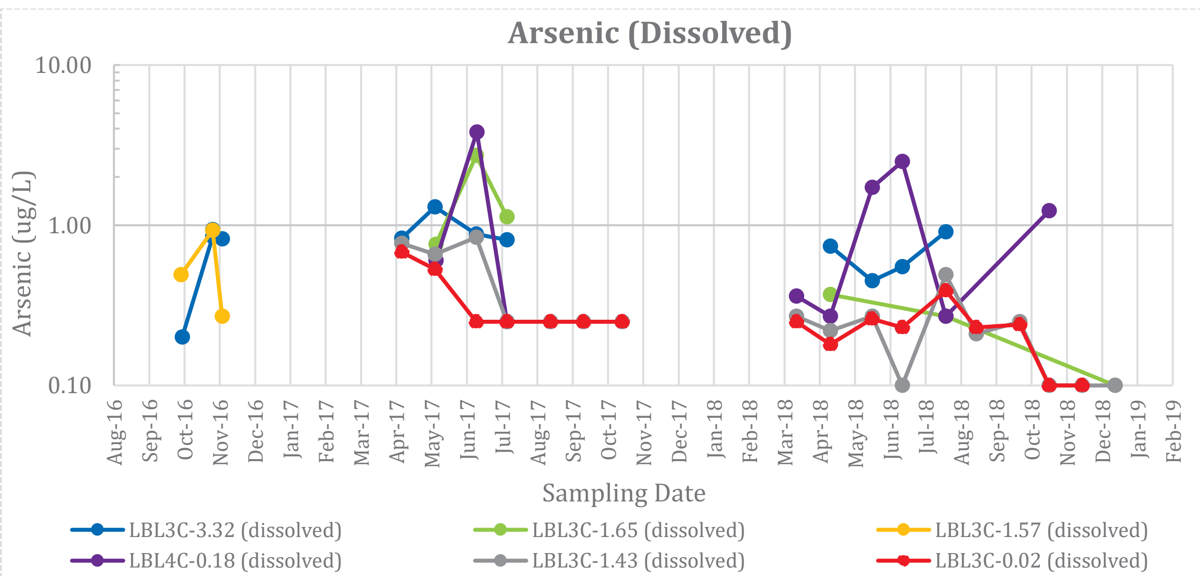


Figure 31a: Cadmium (Total) at L3 Creek Locations

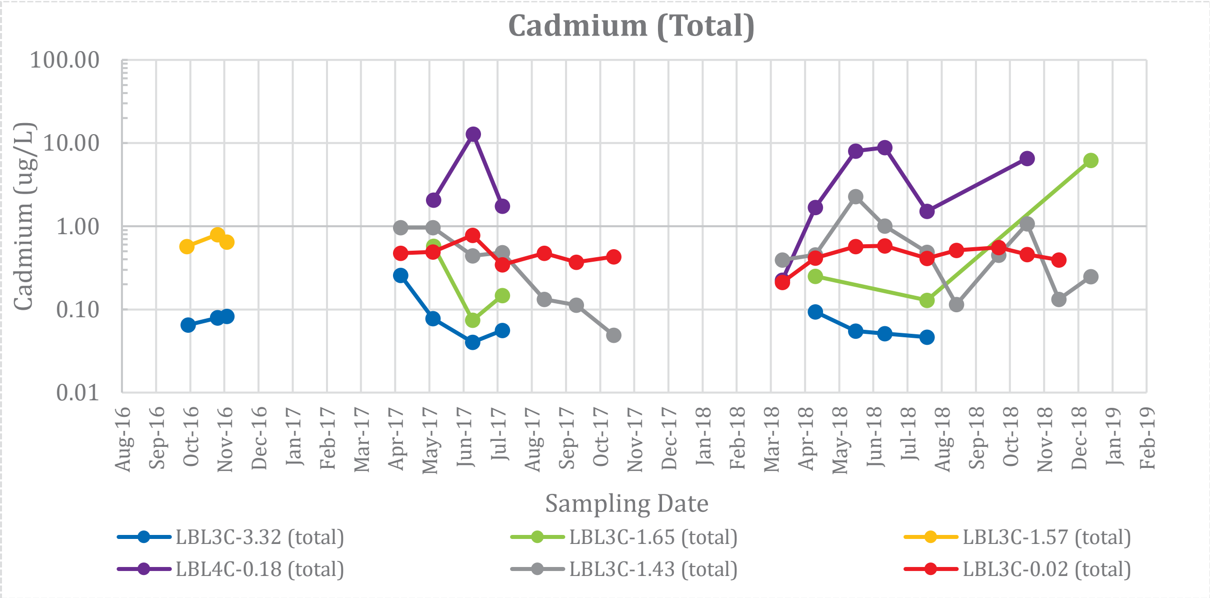


Figure 31b: Cadmium (Dissolved) at L3 Creek Locations

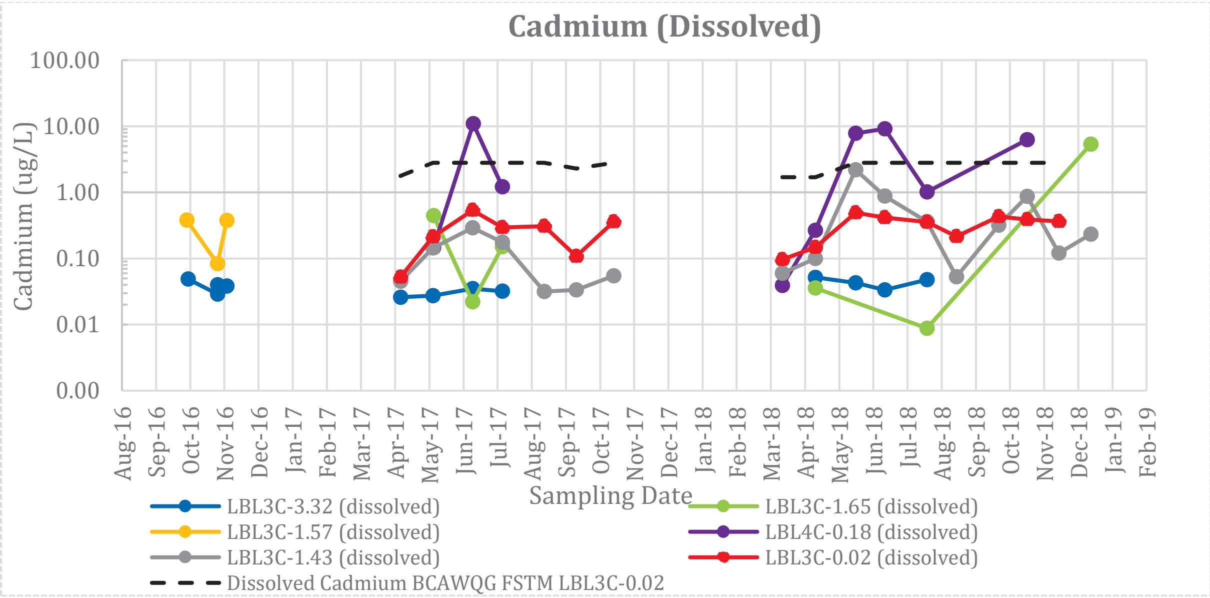


Figure 32a: Cobalt (Total) at L3 Creek Locations

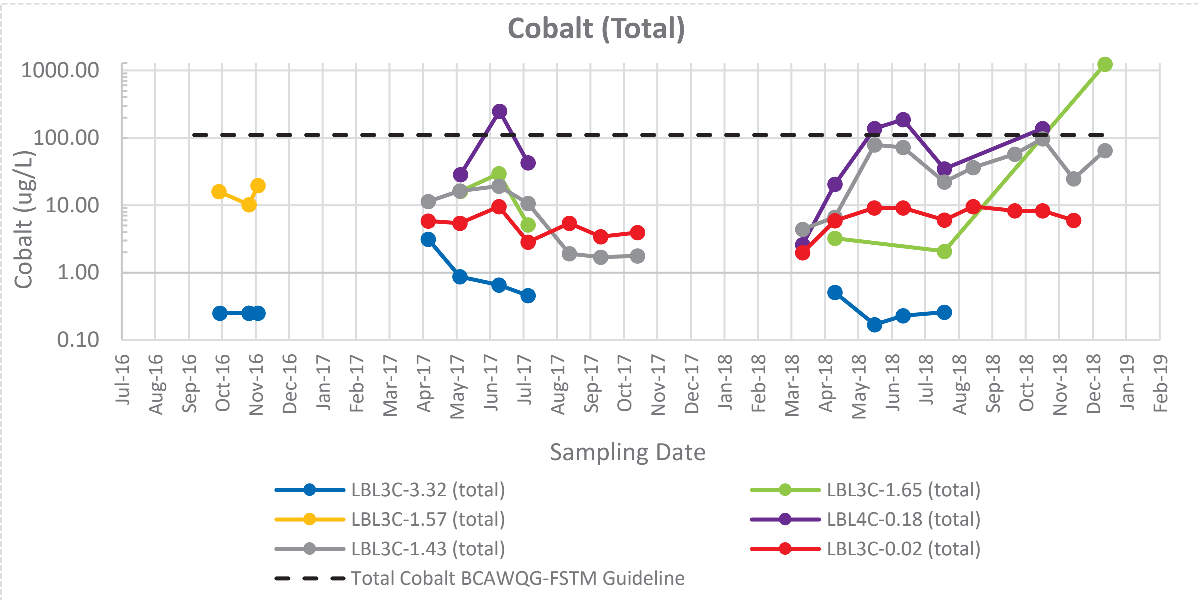


Figure 32b: Cobalt (Dissolved) at L3 Creek Locations

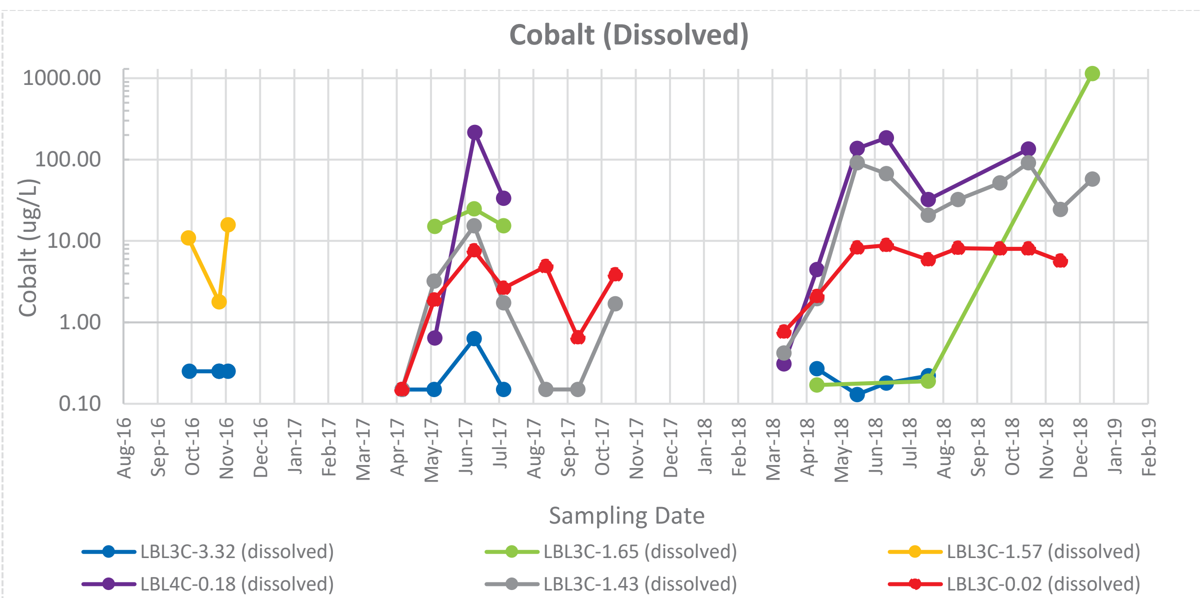


Figure 33a: Copper (Total) at L3 Creek Locations

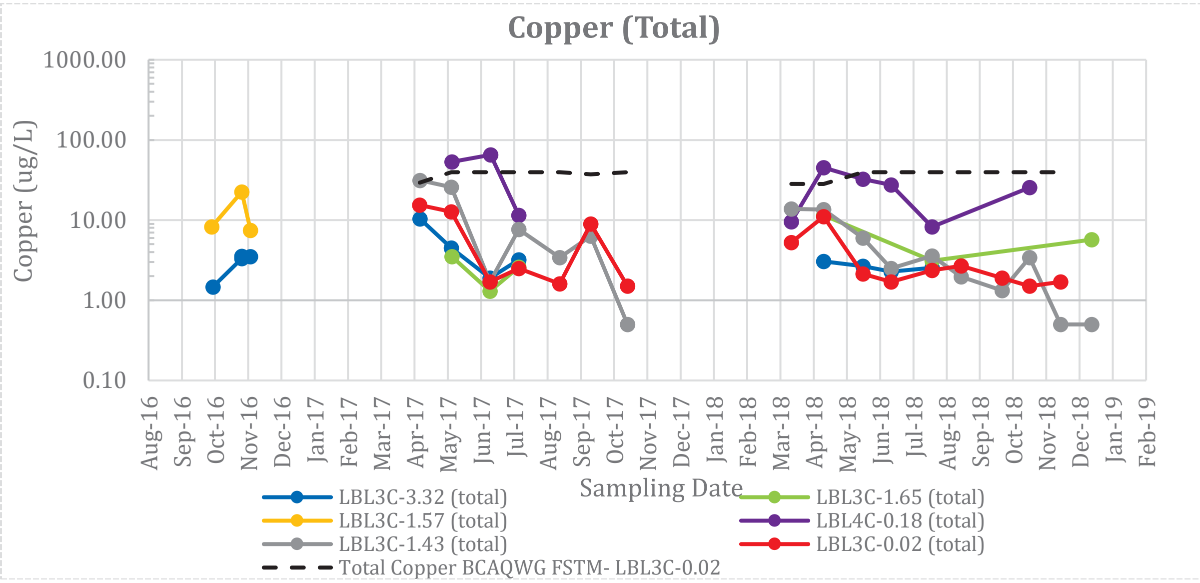


Figure 33b: Copper (Dissolved) at L3 Creek Locations

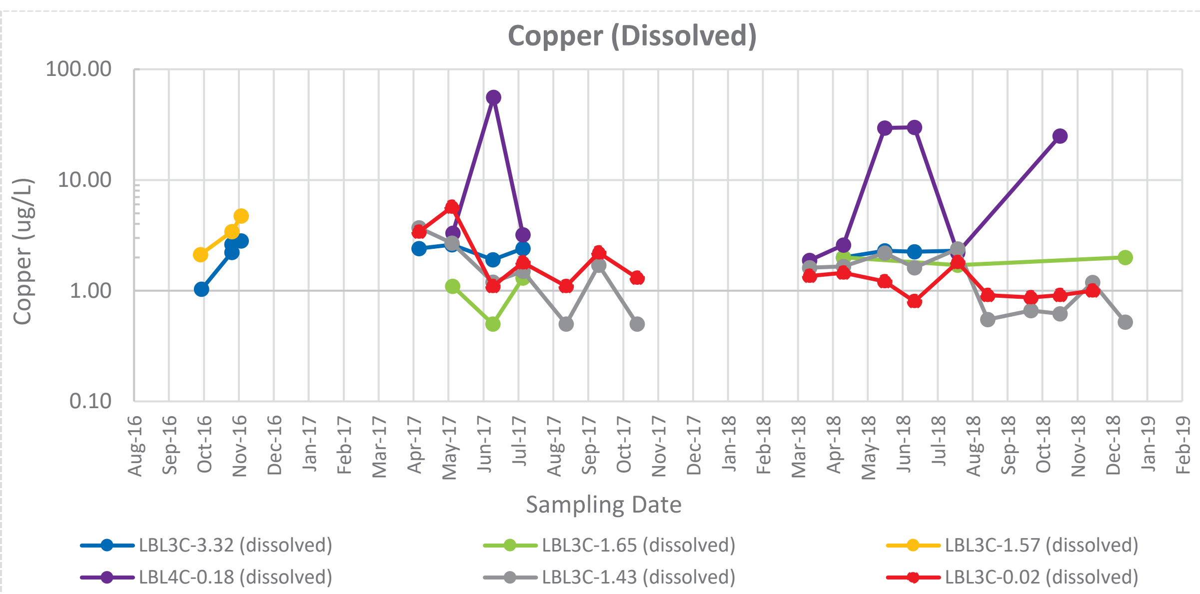


Figure 34a: Zinc (Total) at L3 Creek Locations

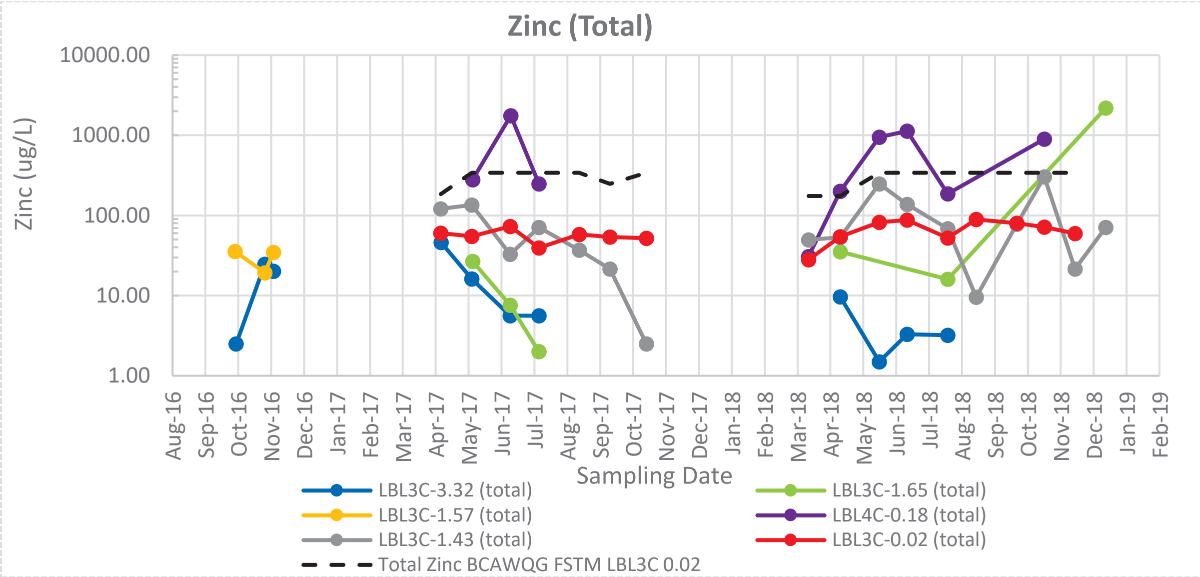
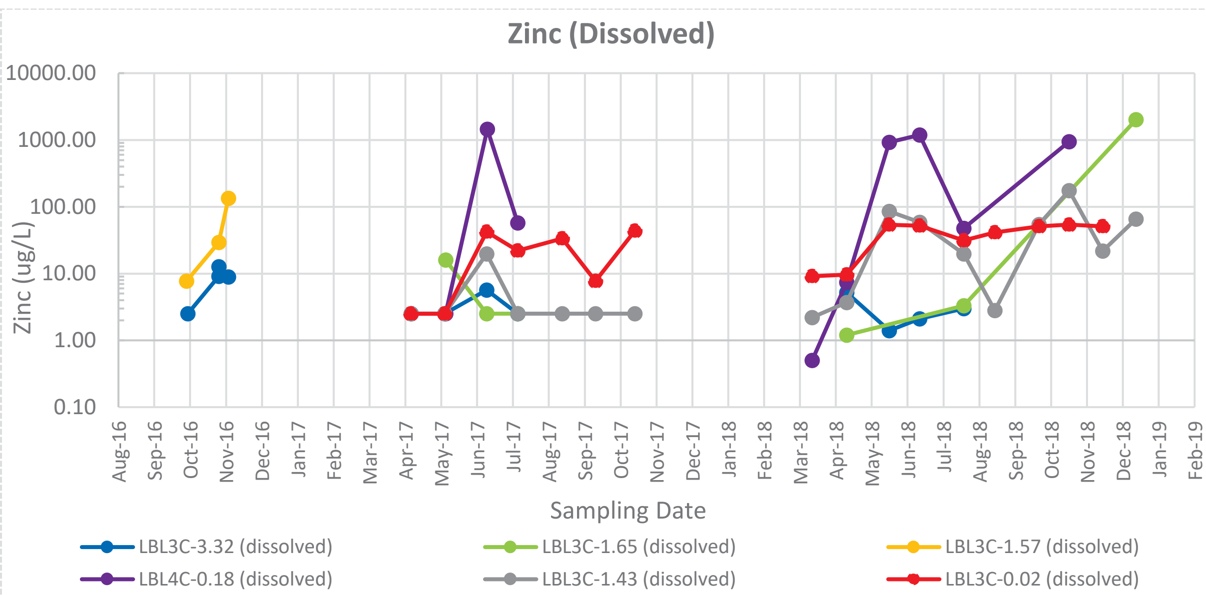


Figure 34b: Zinc (Dissolved) at L3 Creek Locations



PHOTOGRAPHS

Photo 1: River Road water sample location LBRR-DD, dated August 21, 2018

Photo 2: River Road water sample location LBRR-EDP, dated April 19, 2018

Photo 3: River Road water sample location LBRR-LC, dated April 19, 2018

Photo 4: River Road water sample location LBRR-UC, dated August 21, 2018

Photo 5: River Road water sample location RR8, dated April 19, 2018

Photo 6: River Road water sample location RR9, dated August 21, 2018

Photo 7: RBSBIAR water sample location SBIAR-DS, dated August 21, 2018

Photo 8: RBSBIAR water sample location SBIAR-EDS, dated August 21, 2018

Photo 9: RBSBIAR water sample location SBIAR-US, dated August 21, 2018

Photo 10: RBSBIAR water sample location SBIAR-EUS, dated August 21, 2018

Photo 11: RBSBIAR water sample location RBSC-DS, dated November 19, 2018

Photo 12: L3 Creek water sample location LBL3C-0.02, dated August 21, 2018

Photo 13: L3 Creek water sample location LBL3C-1.43, dated August 21, 2018

Photo 14: L3 Creek water sample location LBL3C-1.65, dated April 19, 2018

Photo 15: L3 Creek water sample location LBL3C-1.65, dated August 21, 2018

Photo 16: L3 Creek water sample location LBL3C-1.65, dated December 17, 2018

Photo 17: L3 Creek water sample location LBL3C-3.32, dated August 21, 2018

Photo 18: L3 Creek water sample location LBL4C-0.18, dated August 21, 2018

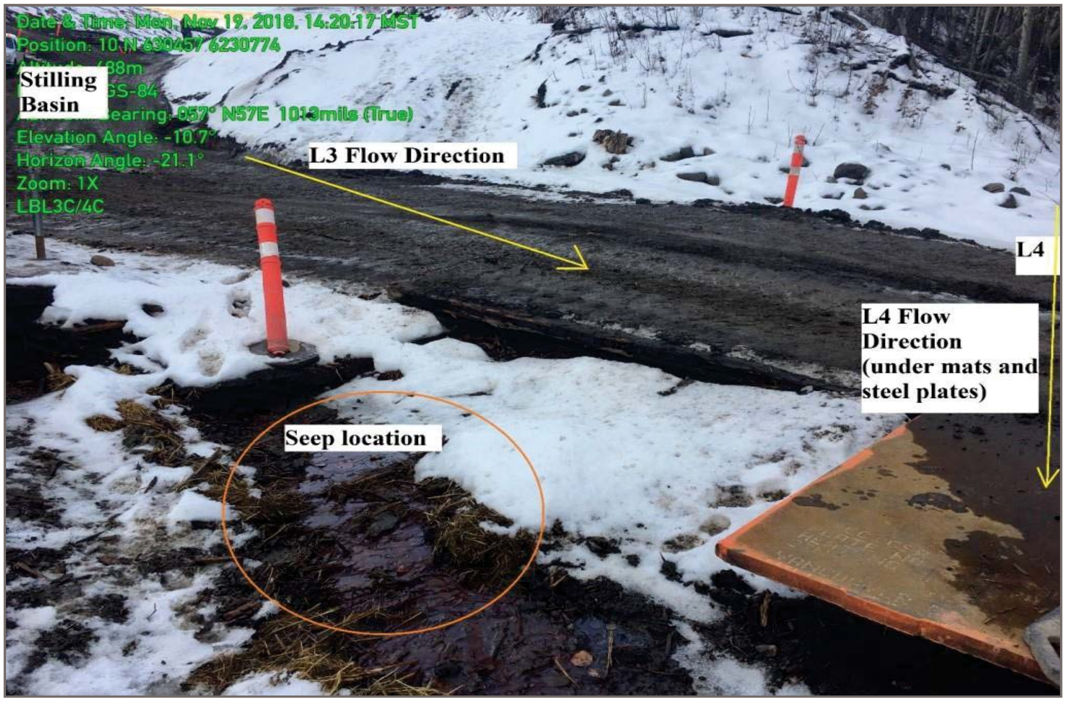


Photo 19: L3 Creek water sample collected slightly upstream from the L3 and L4 Creek confluence observed to be orange coloured, dated November 19, 2018

Photo 20: Gully Road Ditch water sample location, August 21, 2018

APPENDIX A

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LIMITATIONS ON USE OF THIS DOCUMENT

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APPENDIX B

SURFACE WATER ANALYTICAL LABORATORY RESULT TABLES

B1 – 2018 Surface Water Analytical Laboratory Results from Discharge and Downstream Locations at River Road, SBIAR, and L3 Creek Evaluated against the BCAWQG-FSTM Guidelines

B2 – 2018 Surface Water Laboratory Analytical Results from River Road Monitoring Locations Evaluated against the BCAWQG-FSTM Guidelines

B3 – 2018 Surface Water Laboratory Analytical Results from SBIAR Monitoring Locations Evaluated against the BCAWQG-FSTM Guidelines

B4 – 2018 Surface Water Laboratory Analytical Results from L3 Creek Monitoring Locations Evaluated against the BCAWQG-FSTM Guidelines

B5 – 2018 Surface Water Laboratory Analytical Results from Other Sampling Locations Evaluated against the BCAWQG-FSTM Guidelines

Appendix B1: Surface Water Analytical Results Discharge and Downstream Locations

Parameter	Unit	RDL	BC AWQG - FWAL STM [1]	BC AWQG-FWAL LTA [2]	LBRR-DD		RBSBIAR-DS			LBL3C-0.02								
					21-Mar-18	19-Apr-18	21-Mar-18	19-Jun-18	27-Sep-18	21-Mar-18	19-Apr-18	24-May-18	19-Jun-18	26-Jul-18	21-Aug-18	27-Sep-18	22-Oct-18	19-Nov-18
Physical Parameters											9:30							
					21-Mar-18	19-Apr-18												
						9:50												
Flow Rate (L/s)	L/sec				0.4	5.0	2.0	1.0	3.0	5.0	100.0		5.0	5.0		1.0	4.0	2.5
Electrical Conductivity (EC)	µS/cm	2.0	NG	NG	1320	549	542	731	714	779	530	2040	2180	1660	2200	2150	2110	2100
Hardness as $CaCO_3$	µg/L	500	NG (Acceptable ranges exist when calculating exceedances for Cd, Cu, Pb, Mn, Zn, F)	NG (Acceptable ranges exist when calculating exceedances for Cd, Cu, Pb, Mn, Zn, F)	821000	258,000	275,000	298,000	283000	280,000	279,000	1270000	1280000	908000	1310000	1190000	1180000	1160000
pH	pH Units	0.10	6.5 - 9	6.5-9.0	6.51	7.78	8.31	8.23	8.25	8.06	7.86	8.21	8.21	8.31	8.18	8.23	8.26	8.23
Total Dissolved Solids (TDS)	µg/L	10000	NG	NG	1190000	362,000	344000.00	502000	439000	516,000	454,000	1830000	2100000	1410000	2020000	1880000	1890000	1810000
Total Suspended Solids (TSS)	µg/L	3000	NG	NG	50700	97,500	75500.00	1500	32000	35,100	173,000	12,300	14,300	20200	16300	9000	7500	11600
Anions and Nutrients																		
Acidity (Total as $CaCO_3$)	µg/L	1000	NG	NG					1800							2400		2400
Alkalinity (Bicarbonate as $CaCO_3$)	µg/L	1000	NG	NG	5000	91,400	213,000	188,000	233000	103,000	86,900	213,000	250,000	217000	245000	249000	254000	253000
Alkalinity (Carbonate as $CaCO_3$)	µg/L	1000	NG	NG	<1000	<1000	3600	<1000	<1000	<1000	<1000	<1000	<1000	3800	<1000	<1000	<1000	<1000
Alkalinity (Hydroxide) as $CaCO_3$	µg/L	1000	NG	NG	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Total as $CaCO_3$)	mg/L	1.0	NG	NG	5	91.40	217.00	188	233	103	86.9	213	250	220	245	249	254	253
Ammonia (NH_4 as N)	µg/L	5.0	pH dependent (6.5-9.0)	pH dependent (6.5-9.0)	189	70.8	62.5	83.7	197	35	41.9	24.4	36.3	25.3	38.2	25.9	24.4	26.8
	µg/L		pH dependent (at Temp 4 ·C)		27200	8770	3150	3950	3150	4950	7420	3950	3950	3150	3950	3950	3150	3950
	µg/L			pH dependent (at Temp 4 ·C)	1970	1690	606	759	606	952	1430	759	759	606	759	759	606	759
Chloride (Cl^-)	µg/L	500	600,000	150,000	8800	21,000	26,600	60,000	32100	67,500	20,700	26,800	31,500	48300	55000	45300	44300	34000
Nitrate (NO_3^- as N)	µg/L	5.0-100	NG	NG	507	247	691	4000	2230	696	571	227	148	247	200	301	348	547
Nitrite (NO_2^- as N)	µg/L	1.0-20	60	20	8.8	8.2	14.1	**79.9**	27.4	14.6	11	<10	<10	<5.0	<20	<10	<10	<10
Sulphate (SO_4) [3]	µg/L	300.00	NG	309,000 - 429,001	751000	161,000	51100	111000	76400	191000	187000	1110000	1220000	710000	1320000	1080000	1050000	974000
SO_4 STM & LTA Guideline Calc (Based on Hardness as CaCO3)	µg/L		NG	Hardness 76,000-180,000 = 309,000 Hardness 181,000-250,000 = 429,000; Hardness > 250,000 site-specific	429000	429000	429000	429000	429000	429000	429000	429000	429000	429000	429000	429000	429000	429000
Metals, Total																		
Aluminum	µg/L	3.00	NG	NG	3670	2980	1120.00	45.9	569	1480.00	4340.00	980.00	885	707	1300	789	701	558
Antimony	µg/L	0.1-0.2	NG	NG	0.11	0.12	0.7	0.63	0.23	0.37	0.47	0.2	<0.2	0.24	0.21	<0.2	<0.2	<0.2
Arsenic	µg/L	0.10	5.0	5.0	**6.20**	**16.3**	1.93	0.50	0.54	1.74	4.03	0.44	0.40	0.61	0.92	0.47	0.36	0.47
Barium	µg/L	0.10	NG	NG	51.3	88.4	179	139	167	90.7	158	55.4	47.5	67	54.7	54.3	46.2	39.4
Beryllium	µg/L	0.10	NG	NG	0.61	0.43	0.12	<0.1	0.17	0.11	0.25	0.18	<0.2	0.11	0.22	<0.2	<0.2	<0.2
Bismuth	µg/L	0.05-0.10		NG					<0.05					<0.05	<0.1	<0.1	<0.1	<0.1
Boron	µg/L	10.0	1200	1200	25.0	16	39	162	98	35	29	113	142	112	154	124	113	113
Cadmium	µg/L	0.005	NG	NG	4.81	1.46	0.208	0.0239	0.141	0.21	0.416	0.57	0.583	0.413	0.514	0.555	0.458	0.393
Calcium	µg/L	50	NG	NG	250,000	70,800	84,800	79,300	80700	84,800	79,800	344,000	359,000	225000	358000	337000	325000	313000
Cesium	µg/L	0.01		NG					0.06					0.03	0.09	<0.02	<0.02	0.022
Chromium [4]	µg/L	0.1-0.7	NG	NG	4.43	4.45	3.28	<0.4	<1.0	3.27	7.79	0.32	<0.2	0.32	0.64	0.39	<0.2	<0.2
Cobalt	µg/L	0.10	110	4.0	90.6	17.6	4.01	0.39	4.3	1.98	5.92	9.18	9.11	6.01	9.57	8.27	8.25	5.95
Copper [3]	µg/L	0.50	Calc. based on Hardness	2 to 10	26.70	**26.30**	4.99	1.00	3.75	5.24	11.10	2.14	1.70	2.36	2.7	1.9	1.5	1.7
Cu STM Guideline Calc.	µg/L		Hardness 13,000 - 400,000 : calc.; Hardness ≥ 400,000 is Capped Value of 400,000		39.60	26.25	27.85	30.01	28.60	28.32	28.23	39.60	39.60	39.6	39.6	39.6	39.6	39.6
Cu LTA Guideline Calc.	µg/L			Hardness 50,000 - 250,000: calc.; Hardness > 250,000, Cu = 10	10	10	10.00	10.00	10.00	10	10	10	10	10	10	10	10	10
Iron	µg/L	10	1000	NG	**7200**	**22800**	**2770**	91	759	**2930**	**7950**	725	858	539	**1740**	939	957	697
Lead [3]	µg/L	0.05-0.1	Calc. based on Hardness	Calc. based on Hardness	0.562	0.997	1.55	<0.05	0.217	1.81	4.18	0.12	0.05	0.128	0.33	<0.1	<0.1	<0.1
Pb STM Guideline Calc (Based on Hardness as $CaCO_3$)	µg/L		Applies to Hardness 8000-360,000 Hardness ≤ 8000: 3 Hardness > 8000 : calc.		1191	273	295.9	327.8	306.9	303	301	2075	2096.08	1353.9	2158.8	1910.3	1889.9	1849.2
Pb LTA Guideline Calc (Based on Hardness as $CaCO_3$)	µg/L			Applies to Hardness 8000-360,000 Hardness ≤ 8000, NG Hardness > 8000 : calc.	50	14	14.9	16.1	15.3	15	15	84	85	56	87	78	77	75
Lithium	µg/L	1.0	NG	NG	75.8	13.2	10.4	27.9	22.7	12.2	14.9	55.1	66.6	44.1	70.8	56.5	51.7	49.7
Magnesium	µg/L	5.0	NG	NG	49,900	17,400	19,300	24,100	22900	23,000	22,500	94,400	105,000	62400	101000	99700	102000	103000
Manganese [3]	µg/L	0.10	Calc. based on hardness	Calc. based on Hardness	1940	334	119.0	6.78	51.8	167	280	467	411	441	417	428	401	223
Mn STM Guideline Calc (Based on Hardness as $CaCO_3$)	µg/L		Applies to Hardness 25000-259000 µg/L Mn : calc.		9587	3383	3570.5	3824	3659.0	3626	3615	14535	14645.6	10546	14976	13654	13544	13323
Mn LTA Guideline Calc (Based on Hardness as $CaCO_3$)	µg/L			Applies to Hardness 37000-450000 µg/L Mn : calc.	4217	1740	1815.0	1916.2	1850.2	1837	1833	6193	6237	4600	6369	5841	5797	5709
Mercury (Based on methyl Hg & total mass Hg)	µg/L	0.005	NG	Calc.	<0.05	0.0136	<0.05	<0.005	<0.005	<0.05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0062
Molybdenum	µg/L	0.05	2000	≤ 1000	1.24	4.13	3.16	4.3	2.46	2.53	3.05	1.59	1.65	2.2	2.48	1.61	1.59	1.85
Nickel	µg/L	0.5	NG	NG	289	63	13.9	6.51	17.9	11.7	22.8	44.9	48.3	30.2	48.2	41.2	40.6	32.7
Phosphorus	µg/L	50-100	NG	NG					51					<50	<100	<100	<100	<100
Potassium	µg/L	50.0	NG	NG	4350	3610	2650	3850	3680	3440	3610	6370	6220	6810	6630	5580	5700	5440
Rubidium	µg/L	0.2	NG	NG					2					1.9	2.98	1.89	1.74	1.62
Selenium	µg/L	0.05	NG	2.0	2.86	0.831	1.32	1.23	0.7	1.61	1.66	1.51	0.94	1.53	1.33	2.05	2.75	2.97
Silicon	µg/L	100		NG					4340					4470	5350	4510	4490	4050
Silver [3] (Based on Hardness < or > 100000)	µg/L	0.01-0.02	0.10 - 3.0	0.05 - 1.5	0.014	0.025	0.027	0.005	0.005	0.037	0.083	0.005	0.01	<0.01	<0.02	<0.02	<0.02	<0.02
Ag STM Guideline Calc	µg/L		Hardness ≤ 100,000 Ag = 0.10 Hardness > 100,000 Ag = 3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3	3	3	3	3	3

Appendix B1: Surface Water Analytical Results Discharge and Downstream Locations

Parameter	Unit	RDL	BC AWQG - FWAL STM [1]	BC AWQG-FWAL LTA [2]	LBRR-DD		RBSBIAR-DS			LBL3C-0.02								
					21-Mar-18	19-Apr-18	21-Mar-18	19-Jun-18	27-Sep-18	21-Mar-18	19-Apr-18	24-May-18	19-Jun-18	26-Jul-18	21-Aug-18	27-Sep-18	22-Oct-18	19-Nov-18
Ag LTA Guideline Calc	µg/L			Hardness ≤ 100,000 Ag = 0.05 Hardness > 100,000 Ag = 1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Sodium	µg/L	50.0	NG	NG	7880	9950	16,400	47,700	37300	50,200	21,100	65,100	79,500	53200	79600	68900	76800	71200
Strontium	µg/L	0.2	NG	NG					435					680	1020	862	918	913
Sulfur	µg/L	500	NG	NG					34600					265000	408000	380000	411000	382000
Tellerium	µg/L	0.2-0.4	NG	NG					<0.2					<0.2	<0.4	<0.4	<0.4	<0.4
Thallium	µg/L	0.01-0.055	NG	NG	0.039	0.035	0.048	0.022	0.015	0.053	0.093	0.034	0.034	0.031	0.042	0.027	0.025	<0.02
Thorium	µg/L	0.1-0.2	NG	NG					0.23					<0.1	<0.2	<0.2	<0.2	<0.2
Tin	µg/L	0.1-0.2	NG	NG	<0.1	<0.1	0.11	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.2	<0.2	<0.2	<0.2
Titanium	µg/L	0.3-1.2	NG	NG	7.33	5.19	23.2	0.52	<4.5	23	52.1	1.65	<0.6	2.47	<6.3	1.25	<0.6	<1.2
Tungsten	µg/L	0.1-0.2	NG	NG					<0.1					<0.1	<0.2	<0.2	<0.2	<0.2
Uranium	µg/L	0.01	NG	NG	4.67	6.13	1.72	1.41	1.19	2.23	1.89	6.52	7.08	4.95	6.83	6.14	6.33	6.49
Vanadium	µg/L	0.5-1.0	NG	NG	1.85	5.86	4.17	<0.5	0.73	5.55	14.7	0.51	<1	<0.5	1.4	<1.0	<1.0	<1.0
Zinc [3] (Based on Hardness < or > 90,000)	µg/L	3.0	Calc. based on Hardness	Calc. based on Hardness	**585.00**	**210.00**	42.7	3.1	50.7	28.10	54.20	82.40	88.10	52.3	89.3	80.1	71.6	59.6
Zn STM Guideline Calc.	µg/L		Hardness 90,000 - 500,000, Calc. Hardness > 500,000, is Capped Value of 500,000		340.50	159.00	172	189	177.75	175.50	174.75	340.50	340.50	340.5	340.5	340.5	340.5	340.5
Zn LTA Guideline Calc.	µg/L			Hardness 90,000 - 330,000, Calc. Hardness > 330,000, is Capped Value of 330,000	187.50	133.50	146	164	152	150.0	149.3	187.5	187.5	187.5	187.5	187.5	187.5	187.5
Zirconium	µg/L	0.06-0.12	NG	NG					0.095					0.158	0.15	<0.12	<0.12	<0.12
Metals, Dissolved																		
Aluminum [5]	µg/L	1.0	100	50	**392.0**	28.0	51.5	15.7	**106**	37.30	62.80	**158.00**	**169**	**199**	**142**	**132**	**102**	88.8
Al STM Guideline Calc (based on pH)	µg/L		pH < 6.5 : calc. Al pH ≥ 6.5 : 100.0 Al		100.0	100.0	100	100	100	100.00	100.00	100.00	100	100	100	100	100	100
Al LTA Guideline Calc (based on median pH)	µg/L			median pH < 6.5 : calc. Al median pH ≥ 6.5 : 50.0 Al	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Antimony	µg/L	0.1-0.2	NG	NG	<0.1	<0.1	0.44	0.59	0.19	0.17	0.17	0.2	<0.2	0.26	0.19	<0.2	<0.2	<0.2
Arsenic	µg/L	0.10	NG	NG	0.22	0.14	0.25	0.45	0.17	0.25	0.18	0.26	0.23	0.39	0.23	0.24	0.1	0.1
Barium	µg/L	0.10	NG	NG	30.6	39.5	137	145	160	49.5	40.6	50.1	48.4	62.1	45.1	49.9	41.4	36.9
Beryllium	µg/L	0.1-0.2	NG	NG	0.21	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.2	<0.2	<0.2
Bismuth	µg/L	0.05-0.1	NG	NG					<0.05					<0.05	<0.05	<0.1	<0.1	<0.1
Boron	µg/L	10.0	NG	NG	24	15	37	156	95	31	23	111	129	119	135	129	124	107
Cadmium [3] (Based on Hardness as $CaCO_3$)	µg/L	0.005	Calc. based on Hardness	Calc. based on hardness	**4.49**	0.439	0.112	0.0182	0.0601	0.10	0.147	0.489	0.415	0.356	0.216	0.429	0.387	0.362
Cd STM Guideline Calc.	µg/L		Hardness 7,000 - 455,000, Calc. Hardness > 455,000, is Capped Value of 455,000		2.801	1.561	1.667	1.811	1.717	1.699	1.692	2.801	2.801	2.801	2.801	2.801	2.801	2.801
Cd LTA Guideline Calc.	µg/L			Hardness 3,400 - 285,000, Calc. Hardness > 285,000, is Capped Value of 285,000	0.457	0.425	0.445	0.457	0.455	0.451	0.450	0.457	0.457	0.457	0.457	0.457	0.457	0.457
Calcium	µg/L	50.0	NG	NG	255,000	73,300	80,300	78,900	75200	78,400	77,100	373,000	342,000	252000	362000	324000	312000	315000
Cesium	µg/L	0.01	NG	NG					0.015					0.018	0.017	<0.02	<0.02	<0.02
Chromium	µg/L	0.10	NG	NG	0.26	<0.1	1.02	0.19	0.13	0.46	0.21	0.14	<0.2	0.15	<0.1	<0.2	<0.2	<0.2
Cobalt	µg/L	0.10	NG	NG	88.40	13.60	2.84	0.32	4.6	0.76	2.09	8.24	8.83	5.89	8.18	7.99	8.03	5.66
Copper	µg/L	0.20	NG	NG	13.10	1.41	1.57	0.79	0.75	1.36	1.45	1.21	0.80	1.81	0.91	0.87	0.91	1.0
Iron	µg/L	10.0-20.0	350	NG	**765.0**	290.0	12.0	5.0	5.0	15	18	78	10	49	14	68	168	162
Lead	µg/L	0.05-0.1	NG	NG	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	<0.05	<0.05	<0.1	<0.1	<0.1
Lithium	µg/L	1.0	NG	NG	69	14.4	10.1	24.8	26.1	10.9	10.7	58.9	56.5	47.3	62.3	57.9	54.3	45.6
Magnesium	µg/L	5.0	NG	NG	45,000	18,200	18,100	24,600	23100	20,500	21,100	82,400	105,000	67700	99000	93100	97900	90800
Manganese	µg/L	0.10	NG	NG	1770	307	59.6	5.29	56	117	167	411	423	435	387	434	397	207
Mercury	µg/L	0.005	NG	NG	0.0055	<0.005	<0.005	<0.005	<0.005	0.0072	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Molybdenum	µg/L	0.05	NG	NG	0.315	1.86	2.62	4.35	2.63	1.9	2.41	1.71	1.74	2.39	2.35	1.7	1.65	1.83
Nickel	µg/L	0.50	NG	NG	281	48.4	9.98	6.45	18.1	6.72	10.2	40.1	47.5	30.1	41	39.8	38.2	31.1
Phosphorus	µg/L	50.0-100.0	NG	NG					<50					<50	<50	<100	<100	<100
Potassium	µg/L	50.0	NG	NG	4130	3590	2420	4020	3590	3030	2730	6090	6290	6530	6580	5350	5760	5100
Rubidium	µg/L	0.20	NG	NG					1.51					1.85	2.35	1.63	1.55	1.52
Selenium	µg/L	0.05	NG	2.0	2.81	0.291	1.26	1.32	0.754	1.53	1.25	1.34	0.88	1.26	1.31	2.15	2.41	3.1
Silicon	µg/L	50.0	NG	NG					3960					4260	4400	4210	4010	3680
Silver	µg/L	0.01-0.02	NG	NG	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.02	<0.02	<0.02
Sodium	µg/L	50.0	NG	NG	7800	9750	16,300	47,900	38400	47,500	20,200	58,600	78,600	54500	75800	68900	72400	68400
Strontium	µg/L	0.20	NG	NG					420					701	1020	930	920	913
Sulfur	µg/L	500	NG	NG					37400					266000	370000	381000	391000	366000
Tellerium	µg/L	0.2-0.4	NG	NG					<0.2					<0.2	<0.2	<0.4	<0.2	<0.4
Thallium	µg/L	0.01	NG	NG	0.023	<0.01	<0.01	0.023	0.014	<0.01	<0.01	0.033	0.032	0.03	0.033	0.027	0.024	0.022
Thorium	µg/L	0.1-0.2	NG	NG					<0.1					<0.1	<0.1	<0.2	<0.2	<0.2
Tin	µg/L	0.1-0.2	NG	NG	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.2	<0.2	<0.2
Titanium	µg/L	0.3-0.6	NG	NG	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.49	<0.3	<0.6	<0.9	0.76	<0.6	<0.6	<0.6
Tungsten	µg/L	0.1-0.2	NG	NG					<0.1					<0.1	<0.1	<0.2	<0.2	<0.2
Uranium	µg/L	0.01	NG	NG	0.999	1.5	1.36	1.37	0.931	1.73	1.74	6.58	6.86	4.9	6.55	5.89	6.52	6.27
Vanadium	µg/L	0.5-1.0	NG	NG	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<1.0	<1.0	<1.0
Zinc	µg/L	1.00	NG	NG	546.00	35.80	26.1	2	17.2	9.10	9.60	53.80	51.8	31.2	41.4	50.6	54	50.7
Zirconium	µg/L	0.06-0.12	NG	NG					<0.06					0.064	<0.06	<0.12	<0.12	<0.12
Laboratory Work Order Number					L2071158	L2082450	L2071158	L2115119	L2172306	L2071158	L2082450	L2100153	L2115119	L2136818	L2150694	L2172306	L2185138	L2198555
Laboratory Identification Number					L2071158-6	L2082450-8	L2071158-9	L2115119-7	L2172306-8	L2071158-2	L2082450-4	L2100153-3	L2115119-3	L2136818-4	L2150694-2	L2172306-2	L2185138-2	L2198555-2

Notes:

Screening completed on BC AWQG-FWAL STM [1] and LTA [2] guideline values.

[1] BC Ministry of Environment, Water Protection & Sustainability Branch (2018). British Columbia Approved Water Quality Guidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture

[2] BC Ministry of Environment, Water Protection & Sustainability Branch. 2018. British Columbia Approved Water Quality Guidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture Summary Report. 36 pp. Referencedfor Freshwater Aquatic Life (FWAL) water use and Long Term Average (LTA) guidelines.

[3] Guideline is hardness dependant. Where results are above laboratory reportable detection limits, guideline limits have been evaluated based on individual sample hardness. Sample-specific guideline values are listed in

[4] Guideline is for Chromium (IV) cation. Analytical results are for unspeciated Chromium. Where analytical results exceed the guideline, speciated analysis may be warranted.

[5] Guideline is pH dependant.

NG - No Guideline

Detection limit can vary as described in the COA. Detection limit can be raised when dilutation is requited due to high Dissolved Solids/Electrical Conductivity (DLDS), e.g. nitrite.

BOLD and shaded dark gray: Exceeds BCAWQG-FSTM (Short-term Maximum) guideline.

Shaded Light Gray: Exceeds BCAWQG-LTA (Long-term Average) guideline.

RED - Measured value is below detection limit (DL); value shown is 50% of DL

Blank - Not analyzed

Table B2: LBRR Surface Water Analytical Results

Parameter	Unit	RDL	BC AWQG - FWAL STM [1]	BC AWQG-FWAL LTA [2]	LBRR-DD		LBRR-LC		LBRR-12+500	LBRR-12+500		LBRR-EDP			
					21-Mar-18	19-Apr-18	21-Mar-18	19-Apr-18	1-Jan-18	21-Mar-18	19-Apr-18	19-Apr-18	24-May-18	19-Jun-18	26-Jul-18
Physical Parameters															
					21-Mar-18	19-Apr-18	21-Mar-18	19-Apr-18		21-Mar-18	19-Apr-18	19-Apr-18			10:02
						9:50		10:05			10:25	9:05			
Flow Rate (L/s)	L/sec				0.4	5.0	0.2			0.3	0.5	0.5		0.1	0.25
Electrical Conductivity (EC)	μS/cm	2.0	NG	NG	1320	549	1140	529		3780	2310	2120	3250	2970	2810
Hardness as $CaCO_3$	μg/L	500	NG (Acceptable ranges exist when calculating exceedances for Cd, Cu, Pb, Mn, Zn, F)	NG (Acceptable ranges exist when calculating exceedances for Cd, Cu, Pb, Mn, Zn, F)	821000	258,000	661000	254,000		1650000	1330000	1,290,000	2270000	2280000	1690000
pH	pH Units	0.10	6.5 - 9	6.5-9.0	6.51	7.78	7.13	8.00		**2.90**	**4.89**	7.79	8.05	8.04	8.2
Total Dissolved Solids (TDS)	μg/L	10000	NG	NG	1190000	362,000	961000	354,000		4310000	2110000	1920000	3440000	3350000	2750000
Total Suspended Solids (TSS)	μg/L	3000	NG	NG	50700	97,500	23300	71,900		564,000	739,000	109,000	99,300	170,000	16,800
Anions and Nutrients															
Acidity (Total as $CaCO_3$)	μg/L	1000	NG	NG											
Alkalinity (Bicarbonate as $CaCO_3$)	μg/L	1000	NG	NG	5000	91,400	12,100	89,900		<1000	1000	112,000	175,000	167,000	220,000
Alkalinity (Carbonate as $CaCO_3$)	μg/L	1000	NG	NG	<1000	<1000	<1000	<1000		<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Hydroxide) as $CaCO_3$	μg/L	1000	NG	NG	<1000	<1000	<1000	<1000		<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Total as $CaCO_3$)	mg/L	1.0	NG	NG	5	91.40	12.1	89.9		0.5	1.00	112	175	167	220
Ammonia (NH_4 as N)	μg/L	5.0	pH dependent (6.5-9.0)	pH dependent (6.5-9.0)	189	70.8	222	44.2		347	298	100	14	14.5	6.1
			pH dependent (at Temp 4 C)		27200	8770	20400	6220		-	-	8770	6220	6220	3950
				pH dependent (at Temp 4 C)	1970	1690	1970	1200		-	-	1690	1200	1200	759
Chloride (Cl^-)	μg/L	500	600,000	150,000	8800	21,000	5000	20,800		39,000	90,600	60,000	46,000	40000	35000
Nitrate (NO_3^- as N)	μg/L	5.0-100	NG	NG	507	247	512	245		220	182	359	180	<100	<100
Nitrite (NO_2^- as N)	μg/L	1.0-20	60	20	8.8	8.2	9.1	8.6		<20	<10	<10	<20	<20	<20
Sulphate (SO_4) [3]	μg/L	300.00	NG	309,000 - 429,001	751000	161,000	638,000	153,000		3030000	1,390,000	1,180,000	2050000	2260000	1670000
SO_4 STM & LTA Guideline Calc (Based on Hardness as CaCO3)	μg/L		NG	Hardness 76,000-180,000 = 309,000 Hardness 181,000-250,000 = 429,000; Hardness > 250,000 site-specific	429000	429000	429000	429000		429000	429000	429000	429000	429000	429000
Metals, Total															
Aluminum	μg/L	3.00	NG	NG	3670	2980	2280	2610		131,000	49,700	5910	535	731	486
Antimony	μg/L	0.1-0.2	NG	NG	0.11	0.12	0.11	0.1		0.5	0.53	0.16	0.24	<0.5	0.2
Arsenic	μg/L	0.10	5.0	5.0	**6.20**	**16.3**	1.66	**15.9**		**267**	**145**	**17.6**	0.64	0.68	0.42
Barium	μg/L	0.10	NG	NG	51.3	88.4	51.5	93.3		213	150	35.4	40.9	28.2	25.8
Beryllium	μg/L	0.10	NG	NG	0.61	0.43	0.34	0.4		22.9	7.97	0.84	<0.2	<0.5	0.32
Bismuth	μg/L	0.05-0.10		NG											<0.10
Boron	μg/L	10.0	1200	1200	25.0	16	22.0	15		80.0	76	82	157	191	185
Cadmium	μg/L	0.005	NG	NG	4.81	1.46	2.82	1.36		80.0	27.9	6.95	4.62	4.02	4.88
Calcium	μg/L	50	NG	NG	250,000	70,800	221,000	68,100		383,000	271,000	333,000	588,000	566,000	504,000
Cesium	μg/L	0.01		NG											0.031
Chromium [4]	μg/L	0.1-0.7	NG	NG	4.43	4.45	1.64	4.28		152	71.7	8.68	1.06	0.5	0.37
Cobalt	μg/L	0.10	110	4.0	90.6	17.6	62.1	17		**1010**	**568**	**173**	41.9	74	46.6
Copper [3]	μg/L	0.50	Calc. based on Hardness	2 to 10	26.70	**26.30**	10.90	24.40		**1110**	**347**	**42.6**	2.8	3.0	2.2
Cu STM Guideline Calc.	μg/L		Hardness 13,000 - 400,000 : calc.; Hardness > 400,000 is Capped Value of 400,000		39.60	26.25	39.60	25.88		39.60	39.60	39.60	39.60	39.60	39.60
Cu LTA Guideline Calc.	μg/L			Hardness 50,000 - 250,000: calc.; Hardness > 250,000, Cu = 10	10	10	10	10		10	10	10	10	10	10
Iron	μg/L	10	1000	NG	**7200**	**22800**	**3380**	**21200**		**274000**	**186000**	**23000**	916	266	161
Lead [3]	μg/L	0.05-0.1	Calc. based on Hardness	Calc. based on Hardness	0.562	0.997	0.657	0.58		4.34	4.1	0.472	0.32	<0.25	<0.1
Pb STM Guideline Calc (Based on Hardness as $CaCO_3$)	μg/L		Applies to Hardness 8000-360,000 Hardness ≤ 8000: 3 Hardness > 8000 : calc.		1191	273	904	267.5		2896	2201	2117	4347	4371	2986
Pb LTA Guideline Calc (Based on Hardness as $CaCO_3$)	μg/L			Applies to Hardness 8000-360,000 Hardness ≤ 8000, NG Hardness > 8000 : calc.	50	14	39	14		116	89	86	173	174	120
Lithium	μg/L	1.0	NG	NG	75.8	13.2	58.6	12		676	337	125	242	323	221
Magnesium	μg/L	5.0	NG	NG	49,900	17,400	40,200	16900		218,000	147,000	108,000	213,000	211,000	164,000
Manganese [3]	μg/L	0.10	Calc. based on hardness	Calc. based on Hardness	1940	334	1560	319		9890	7560	2480	740	1440	831
Mn STM Guideline Calc (Based on Hardness as $CaCO_3$)	μg/L		Applies to Hardness 25000-259000 μg/L Mn : calc.		9587	3383	7824	3339		18723	15197	14756	25555	25665.6	19164
Mn LTA Guideline Calc (Based on Hardness as $CaCO_3$)	μg/L			Applies to Hardness 37000-450000 μg/L Mn : calc.	4217	1740	3513	1723		7865	6457	6281	10593	10637	8041
Mercury (Based on methyl Hg & total mass Hg)	μg/L	0.005	NG	Calc.	<0.05	0.0136	<0.05	0.0062		0.06	<0.005	0.008	<0.005	0.0101	<0.005
Molybdenum	μg/L	0.05	2000	≤ 1000	1.24	4.13	1.54	3.9		4.96	9.82	1.92	1.18	1.37	0.72
Nickel	μg/L	0.5	NG		289	63	194	59.7		3170	1830	586	702	700	584
Phosphorus	μg/L	50-100	NG	NG											<100
Potassium	μg/L	50.0	NG	NG	4350	3610	4040	3470		4400	4920	6590	13,500	14,100	11,800
Rubidium	μg/L	0.2	NG	NG											4.45
Selenium	μg/L	0.05	NG	2.0	2.86	0.831	2.97	0.893		9.23	4.71	4.87	3.49	2.05	4.31
Silicon	μg/L	100		NG											6890

Table B2: LBRR Surface Water Analytical Results

Parameter	Unit	RDL	BC AWQG - FWAL STM [1]	BC AWQG-FWAL LTA [2]	LBRR-DD		LBRR-LC		LBRR-12+500	LBRR-12+500		LBRR-EDP			
					21-Mar-18	19-Apr-18	21-Mar-18	19-Apr-18	1-Jan-18	21-Mar-18	19-Apr-18	19-Apr-18	24-May-18	19-Jun-18	26-Jul-18
Silver [3] (Based on Hardness < or > 100000)	µg/L	0.01-0.02	0.10 - 3.0	0.05 - 1.5	0.014	0.025	0.016	0.013		0.154	0.114	0.02	<0.02	<0.05	<0.02
Ag STM Guideline Calc	µg/L		Hardness ≤ 100,000 Ag = 0.10 Hardness > 100,000 Ag = 3.0		3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Ag LTA Guideline Calc				Hardness ≤ 100,000 Ag = 0.05 Hardness > 100,000 Ag = 1.5	1.5	1.5	1.5	1.5		1.5	1.5	1.5	1.5	1.5	1.5
Sodium	µg/L	50.0	NG	NG	7880	9950	4650	9570		88,100	69,600	52,100	41,700	47,700	41,600
Strontium	µg/L	0.2	NG	NG											1,350
Sulfur	µg/L	500	NG	NG											626,000
Tellerium	µg/L	0.2-0.4	NG	NG											<0.4
Thallium	µg/L	0.01-0.055	NG	NG	0.039	0.035	0.043	0.023		0.153	0.155	0.037	0.066	0.065	0.055
Thorium	µg/L	0.1-0.2	NG	NG											<0.2
Tin	µg/L	0.1-0.2	NG	NG	<0.1	<0.1	<0.1	<0.1		0.22	<0.5	<0.1	<0.2	<0.5	<0.2
Titanium	µg/L	0.3-1.2	NG	NG	7.33	5.19	5.77	3.54		72.3	27.5	5.72	8.82	<1.8	<1.2
Tungsten	µg/L	0.1-0.2	NG	NG											<0.2
Uranium	µg/L	0.01	NG	NG	4.67	6.13	3.73	6.19		111	49.9	7.17	4.3	4.12	3.15
Vanadium	µg/L	0.5-1.0	NG	NG	1.85	5.86	1.66	4.88		33.6	27.1	3.62	1.4	<2.5	<1.0
Zinc [3] (Based on Hardness < or > 90,000)	µg/L	3.0	Calc. based on Hardness	Calc. based on Hardness	**585.0**	**210.0**	**355.0**	**194.0**		**10500.0**	**4980.0**	**1160.0**	**548.0**	**425.0**	**538.0**
Zn STM Guideline Calc.	µg/L		Hardness 90,000 - 500,000, Calc. Hardness > 500,000, is Capped Value of 500,000		340.5	159.0	340.5	156.0		340.5	340.5	340.5	340.5	340.5	340.5
Zn LTA Guideline Calc.				Hardness 90,000 - 330,000, Calc. Hardness > 330,000, is Capped Value of 330,000	187.5	133.5	187.5	130.5		187.5	187.5	187.5	187.5	187.5	187.5
Zirconium	µg/L	0.06-0.12	NG	NG											
Metals, Dissolved															
Aluminum [5]	µg/L	1.0	100	50	**392.0**	28.0	64.5	28.8		**126000.0**	**2000.0**	28.6	**183.0**	**195.0**	**227.0**
Al STM Guideline Calc (based on pH)	µg/L		pH < 6.5 : calc. Al pH ≥ 6.5 : 100.0 Al		100.0	100.0	100.0	100.0		32.9	22.5	100.0	100.0	100	100
Al LTA Guideline Calc (based on median pH)				median pH < 6.5 : calc. Al median pH ≥ 6.5 : 50.0 Al	50.0	50.0	50.0	50.0		50.0	50.0	50.0	50.0	50.0	50.0
Antimony	µg/L	0.1-0.2	NG	NG	<0.1	<0.1	<0.1	<0.1		<0.5	<0.2	<0.1	0.21	0.38	<0.2
Arsenic	µg/L	0.10	NG	NG	0.22	0.14	0.11	0.11		201.00	0.75	0.13	0.40	0.45	0.25
Barium	µg/L	0.10	NG	NG	30.6	39.5	28.7	41.3		70.9	32.1	16.5	29	25.1	23.5
Beryllium	µg/L	0.1-0.2	NG	NG	0.21	<0.1	<0.1	<0.1		21.5	0.6	<0.1	<0.2	<0.2	<0.2
Bismuth	µg/L	0.05-0.1	NG	NG											<0.1
Boron	µg/L	10.0	NG	NG	24	15	21	14		72	70	83	164	168	174
Cadmium [3] (Based on Hardness as $CaCO_3$)	µg/L	0.005	Calc. based on Hardness	Calc. based on hardness	**4.49**	0.439	2.38	0.475		**75.30**	**27.70**	**5.34**	**4.33**	**3.75**	**4.50**
Cd STM Guideline Calc.	µg/L		Hardness 7,000 - 455,000, Calc. Hardness > 455,000, is Capped Value of 455,000		2.80	1.56	2.80	1.54		2.80	2.80	2.80	2.80	2.80	2.80
Cd LTA Guideline Calc.				Hardness 3,400 - 285,000, Calc. Hardness > 285,000, is Capped Value of 285,000	0.46	0.42	0.46	0.42		0.46	0.46	0.46	0.46	0.46	0.46
Calcium	µg/L	50.0	NG	NG	255,000	73,300	208,000	71,800		340,000	271,000	336,000	584,000	551,000	432,000
Cesium	µg/L	0.01	NG	NG											0.026
Chromium	µg/L	0.10	NG	NG	0.26	<0.1	<0.1	0.11		130	<0.2	0.14	0.23	<0.2	0.42
Cobalt	µg/L	0.10	NG	NG	88.40	13.60	57.40	13.90		997.00	586.00	158.00	39.90	77.50	45
Copper	µg/L	0.20	NG	NG	13.10	1.41	3.57	1.54		1120.00	56.40	4.46	1.93	2.63	1.88
Iron	µg/L	10.0-20.0	350	NG	**765.0**	290.0	**819.0**	**574.0**		**230000.0**	**15800.0**	**2600.0**	10	10	10
Lead	µg/L	0.05-0.1	NG	NG	<0.05	<0.05	<0.05	<0.05		0.64	<0.1	<0.05	<0.1	<0.1	<0.1
Lithium	µg/L	1.0	NG	NG	69	14.4	57.8	13.2		590	334	146	253	330	199
Magnesium	µg/L	5.0	NG	NG	45,000	18,200	34,500	18,100		195,000	159,000	110,000	196,000	219,000	149,000
Manganese	µg/L	0.10	NG	NG	1770	307	1400	305		9200	7590	2430	668	1450	795
Mercury	µg/L	0.005	NG	NG	0.0055	<0.005	0.0134	0.006		0.0183	<0.005	<0.005	<0.005	<0.005	<0.005
Molybdenum	µg/L	0.05	NG	NG	0.315	1.86	0.952	1.75		1.88	<0.1	1.11	1.17	1.44	0.71
Nickel	µg/L	0.50	NG	NG	281	48.4	180	49.6		3170	1820	548	634	717	558
Phosphorus	µg/L	50.0-100.0	NG	NG											<100
Potassium	µg/L	50.0	NG	NG	4130	3590	3750	3600		3500	4510	6350	13,300	15,300	11,700
Rubidium	µg/L	0.20	NG	NG											4.35
Selenium	µg/L	0.05	NG	2.0	2.81	0.291	2.79	0.259		7.67	2.21	3.82	3.5	1.97	4.65
Silicon	µg/L	50.0	NG	NG											6770
Silver	µg/L	0.01-0.02	NG	NG	<0.01	<0.01	<0.01	<0.01		<0.05	<0.02	<0.01	<0.02	<0.02	<0.02
Sodium	µg/L	50.0	NG	NG	7800	9750	4250	9810		83,600	74,000	48,400	40,400	42,100	40,700
Strontium	µg/L	0.20	NG	NG											1,260
Sulfur	µg/L	500	NG	NG											629,000
Tellerium	µg/L	0.2-0.4	NG	NG											<0.4
Thallium	µg/L	0.01	NG	NG	0.023	<0.01	0.021	<0.01		0.059	0.041	0.028	0.058	0.058	0.053
Thorium	µg/L	0.1-0.2	NG	NG											<0.2
Tin	µg/L	0.1-0.2	NG	NG	<0.1	<0.1	<0.1	<0.1		<0.5	<0.2	<0.1	<0.2	<0.2	<0.2
Titanium	µg/L	0.3-0.6	NG	NG	<0.3	<0.3	<0.3	<0.3		<1.5	<0.6	<0.3	<0.6	<0.6	<0.6
Tungsten	µg/L	0.1-0.2	NG	NG											<0.2
Uranium	µg/L	0.01	NG	NG	0.999	1.5	1.18	1.46		110	1.45	2.73	4.34	3.83	3.22
Vanadium	µg/L	0.5-1.0	NG	NG	<0.5	<0.5	<0.5	<0.5		14.5	<1	<0.5	<1	<1	<1.0
Zinc	µg/L	1.00	NG	NG	546.00	35.80	297.00	41.40		10800.00	5090.00	649.00	505.00	315	506
Zirconium	µg/L	0.06-0.12	NG	NG											<0.12
Laboratory Work Order Number					L2071158	L2082450	L2071158	L2082450		L2071158	L2082450	L2082450	L2100153	L2115118	L2136818
Laboratory Identification Number					L2071158-6	L2082450-8	L2071158-5	L2082450-7		L2071158-4	L2082450-6	L2082450-9	L2100153-5	L2115118-2	L2136818-6

Notes:

Screening completed on BC AWQG-FWAL STM [1] and LTA [2] guideline values.

[1] BC Ministry of Environment, Water Protection & Sustainability Branch (2018). British Columbia Approved Water Quality Guidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture Summary Report. 36 pp. Referenced for Freshwater Aquatic Life (FWAL) water use and Short Term Maximum (STM) guidelines.

uidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture Summary Report. 36 pp. Referencedfor Freshwater Aquatic Life (FWAL) water use and Long Term Average (LTA) guidelines.

[3] Guideline is hardness dependant. Where results are above laboratory reportable detection limits, guideline limits have been evaluated based on individual sample hardness. Sample-specific guideline values are listed in parentheses after the laboratory result, where applicable.

[4] Guideline is for Chromium (IV) cation. Analytical results are for unspeciated Chromium. Where analytical results exceed the guideline, speciated analysis may be warranted.

[5] Guideline is pH dependant.

NG - No Guideline

Detection limit can vary as described in the COA. Detection limit can be raised when dilutation is requited due to high Dissolved Solids/Electrical Conductivity (DLDS), e.g. nitrite.

BOLD and shaded dark gray: Exceeds BCAWQG-FSTM (Short-term Maximum) guideline.

Shaded Light Gray: Exceeds BCAWQG-LTA (Long-term Average) guideline.

RED - Measured value is below detection limit (DL); value shown is 50% of DL

Blank - Not analyzed

TETRA TECH

Table B3: SBIAR Surface Water Analytical Results

Parameter	Unit	RDL	BC AWQG - FWAL STM [1]	BC AWQG-FWAL LTA [2]	RBSBIAR-DS			RBSBIAR-US				RBSC-DS				RBSBIAR-EDS		RBSBIAR-EUS		
					21-Mar-18	19-Jun-18	27-Sep-18	21-Mar-18	19-Jun-18	27-Sep-18	17-Dec-18	21-Mar-18	19-Jun-18	19-Nov-18	17-Dec-18	19-Jun-18	27-Sep-18	19-Jun-18	27-Sep-18	17-Dec-18
Flow Rate	L/sec				2.0	1.0	3.0	0.5	0.25	0.50	0.10	n/a	none	none	none	0.25	1.0	0.25	0.5	0.1
Electrical Conductivity (EC)	µS/cm	2.0	NG	NG	542	731	714	496	733	609	639	754	2520	1330	1050	687	887	574	770	777
Hardness as $CaCO_3$	µg/L	500	NG (Acceptable ranges exist when calculating exceedances for Cd, Cu, Pb, Mn, Zn, F)	NG (Acceptable ranges exist when calculating exceedances for Cd, Cu, Pb, Mn, Zn, F)	275,000	298,000	283000	188,000	402,000	255000	338000	350000.00	1460000	606000	504000	265,000	341000	383,000	401000	469000
pH	pH Units	0.10	6.5 - 9	6.5-9.0	8.31	8.23	8.25	7.98	8.06	8.02	8.06	8.26	8.10	8.04	7.74	8.15	8.10	7.90	7.89	7.78
Total Dissolved Solids (TDS)	µg/L	10000	NG	NG	344000.00	502000	439000	543000.00	604000	363000	357000	539000.00	2500000	989000	712000	492000	565000	419000	478000	462000
Total Suspended Solids (TSS)	µg/L	3000	NG	NG	75500.00	1500	32000	1850000.00	799000	13400	4200	6700.00	32700	9800	24200	195000	30400	5900	7000	57000
Anions and Nutrients																				
Acidity (Total as $CaCO_3$)	µg/L	1000	NG	NG			1800			3300	4300			8500	11000		2700		7500	13100
Alkalinity (Bicarbonate as $CaCO_3$)	µg/L	1000	NG	NG	213,000	188,000	233000	123,000	221,000	239000	243000	234000.00	405,000	369,000	328000	271,000	334000	295,000	378000	341000
Alkalinity (Carbonate as $CaCO_3$)	µg/L	1000	NG	NG	3600	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Hydroxide) as $CaCO_3$	µg/L	1000	NG	NG	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Total as $CaCO_3$)	mg/L	1.0	NG	NG	217.00	188	233	123.00	221	239	243	234.00	405	369	328	271	334	295	378	341
Ammonia (NH_4 as N)	µg/L	5.0	pH dependent (6.5-9.0)	pH dependent (6.5-9.0)	62.5	83.7	197	198	6.7	<5.0	6.6	5.1	<5	13.7	17.3	205	184	<5	<5.0	5.8
			pH dependent (at Temp 4 °C)		3150	3950	3150	6220	4950	6220	4950	3150	4950	6220	10300	3950	4950	7420	7420	8770
				pH dependent (at Temp 4 °C)	606	759	606	1200	952	1200	952	606.00	952	1200	1980	759	952	1430	1430	1690
Chloride (Cl^-)	µg/L	500	600000	150,000	26,600	60,000	32100	112,000	89,900	41800	39800	11100	21,000	15,400	17000	21,300	17700	17,900	22800	32400
Nitrate (NO_3^- as N)	µg/L	5.0-25.0	NG	NG	691	4000	2230	565	1320	1170	1240	52	<100	<25	<25	659	490	555	592	565
Nitrite (NO_2^- as N)	µg/L	1.0-5.0	60	20	14.1	**79.9**	27.4	43.4	<5	<1.0	<1	<5	<20	<5	<5	41.2	6.7	<1	<5.0	<5.0
Sulphate (SO_4) [3]	µg/L	300	NG	309,000 - 429,000	51100	111000	76400	17100	32300	24300	25400	182000	1460000	368000	263000	116000	126000	29400	27800	21900
SO_4 STM & LTA Guideline Calc (Based on Hardness as CaCO3)	µg/L		NG	Hardness 76,000-180,000 = 309,000 Hardness 181,000-250,000 = 429,000; Hardness > 250,000 site-specific	429000	429000	429000	309000	429000	429000	429000	429000	429000	429000	429000	429000	429000	429000	429000	429000
Metals, Total																				
Aluminum	µg/L	3.00	NG	NG	1120.00	45.9	569	23400.00	31.9	51.5	6.3	35.70	26.5	16.60	51.3	38.9	1030	15.4	774	568
Antimony	µg/L	0.10	NG	NG	0.7	0.63	0.23	1.59	0.19	0.11	<0.1	<0.1	<0.2	<0.1	<0.1	0.47	0.24	0.16	0.25	0.16
Arsenic	µg/L	0.10	5.00	5.0	1.93	0.50	0.54	**21.20**	0.17	0.17	0.05	0.83	0.57	1.75	1.19	0.48	1.71	0.12	1.19	0.75
Barium	µg/L	0.10	NG	NG	179	139	167	1080	270	240	192	68.9	54.6	36.5	39.4	151	273	244	354	280
Beryllium	µg/L	0.10	NG	NG	0.12	<0.1	0.17	1.55	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	0.17	<0.1	<0.1	<0.1
Bismuth	µg/L	0.05	NG	NG			<0.05			<0.05	<0.05			<0.05	<0.05		<0.05		<0.05	<0.05
Boron	µg/L	10.0	1200	1200	39	162	98	53	24	26	14	34	176	86	42	248	189	22	23	18
Cadmium	µg/L	0.005	NG	NG	0.208	0.0239	0.141	1.91	0.0336	0.0237	0.0143	0.0342	0.364	0.0053	0.0388	0.0259	0.347	0.0097	0.0475	0.0308
Calcium	µg/L	50	NG	NG	84,800	79,300	80700	142,000	112,000	92000	85000	107000.00	377,000	179,000	132000	67,100	104000	109,000	126000	121000
Cesium	µg/L	0.01	NG	NG			0.06			<0.01	<0.01			<0.01	0.011		0.245		0.117	0.102
Chromium [4]	µg/L	0.1-1.0	NG	NG	3.28	<0.4	<1.0	47.6	<0.4	<0.6	0.14	0.21	<0.2	<0.1	0.13	<0.2	2.16	<0.3	1.85	1.06
Cobalt	µg/L	0.10	110	4.0	4.01	0.39	4.3	23.8	0.17	0.05	0.05	0.91	1.4	2.0	1.49	1.98	9.07	0.05	0.73	0.61
Copper [3]	µg/L	0.50	Calc. based on Hardness	2 to 10	4.99	1.00	3.75	**63.90**	0.83	0.54	0.25	0.50	0.50	0.25	0.25	0.69	6.56	0.25	2.20	1.67
Cu STM Guideline Calc.	µg/L		Hardness 13,000 - 400,000 : calc.; Hardness ≥ 400,000 is Capped Value of 400,000		27.85	30.01	28.60	19.67	39.60	25.97	33.77	34.90	39.60	39.60	39.60	26.91	34.05	38.00	39.60	39.60
Cu LTA Guideline Calc.	µg/L			Hardness 50,000 - 250,000: calc.; Hardness > 250,000, Cu = 10	10.00	10.00	10.00	7.52	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Iron	µg/L	10	1000	NG	**2770**	91	759	**62100**	78	109	14	802	519	**1550**	**1030**	58	**2580**	26	**2100**	**1340**
Lead [3]	µg/L	0.05	101 - 348	Calc. based on Hardness	1.55	<0.05	0.217	28.1	0.087	0.084	<0.05	0.062	<0.1	<0.05	0.057	<0.05	1.15	<0.05	0.936	0.744
Pb STM Guideline Calc (Based on Hardness as $CaCO_3$), applies to water hardness 8000-360,000 µg/L	µg/L		Based on Hardness 8000-360,000 Hardness ≤ 8000: 3 Hardness > 8000 : calc.		295.9	327.8	306.9	182.4	479.9	268.8	384.8	402.3	2478.3	809.1	639.9	282.3	389.2	451.2	478.3	583.9
Pb LTA Guideline Calc (Based on Hardness as $CaCO_3$)	µg/L			Applies to Hardness 8000-360,000 Hardness ≤ 8000, NG Hardness > 8000 : calc.	14.9	16.1	15.3	10.4	22.0	13.8	18.3	19.0	99.9	34.9	28.3	14.3	18.5	20.9	22.0	26.1
Lithium	µg/L	1.0	NG	NG	10.4	27.9	22.7	34.5	9.5	8.9	6.4	13.7	113	49.4	23.3	42.7	41.1	9.2	10.1	8.2
Magnesium	µg/L	5.0	NG	NG	19,300	24,100	22900	20,500	25,500	18700	19400	23200.00	130,000	50,800	31300	22,100	29000	25,200	28300	28100
Manganese [3]	µg/L	0.10	Calc. based on Hardness	Calc. based on Hardness	119.0	6.78	51.8	1370.0	3.45	4.28	0.7	254.0	3050	606	475	44.1	126.0	1.89	43.4	24.5
Mn STM Guideline Calc (Based on Hardness as $CaCO_3$)	µg/L		Applies to Hardness 25000-259000 µg/L Mn : calc.		3570.5	3824	3659.0	2611.8	4970.0	3350	4265	4397.0	16629.2	7218	6094	3460.3	4298.0	4760.7	4959.0	5708
Mn LTA Guideline Calc (Based on Hardness as $CaCO_3$)	µg/L			Applies to Hardness 37000-450000 µg/L Mn : calc.	1815.0	1916.2	1850.2	1432.2	2373.8	1727.0	2092.2	2145.0	7029.0	3271.4	2822.6	1771.0	2105.4	2290.2	2369.4	2668.6
Mercury (Based on methyl Hg & total mass Hg)	µg/L	0.005	NG	Calc.	<0.05	<0.005	<0.005	0.23	<0.005	0.0075	<0.005	<0.005	<0.005	0.0151	<0.005	<0.005	<0.005	<0.005	0.0082	0.0146
Molybdenum	µg/L	0.05	2000	≤ 1000	3.16	4.3	2.46	6.06	1.28	1.14	0.992	1.14	0.88	0.846	0.919	3.59	1.47	0.914	0.964	0.797
Nickel	µg/L	0.50	NG		13.9	6.51	17.9	72.2	<0.5	0.52	<0.5	2.82	74.1	6.02	3.92	9.94	31.5	<0.5	2.55	1.8
Phosphorus	µg/L	50.0	NG	NG			51			<50	<50			54	<50		162		161	66
Potassium	µg/L	50.0	NG	NG	2650	3850	3680	8440	4030	3800	3220	1220	3280	1540	1410	3200	3620	3580	4170	3210
Rubidium	µg/L	0.2	NG	NG			2			0.65	0.34			0.78	0.7		3.23		1.77	1.32
Selenium	µg/L	0.05	NG	2.0	1.32	1.23	0.7	1.1	0.485	0.463	1.02	0.1	0.2	<0.05	0.05	1.34	0.66	0.986	0.817	0.668
Silicon	µg/L	100.0	NG	NG			4340			5030	4100			4590	3750		6530		7530	5790
Silver [3] (Based on Hardness < or > 100000)	µg/L	0.01	0.10 - 3.0	0.05 - 1.5	0.027	0.005	0.005	0.518	0.005	0.005	0.005	0.005	0.01	0.005	0.005	0.005	0.022	0.005	0.012	0.011
Ag STM Guideline Calc	µg/L		Hardness ≤ 100,000 Ag = 0.10 Hardness > 100,000 Ag = 3.0		3.0	3.0	3.0	3.0	3.0	3.0	3	3.0	3.0	3.0	3	3.0	3.0	3.0	3.0	3
Ag LTA Guideline Calc				Hardness ≤ 100,000 Ag = 0.05 Hardness > 100,000 Ag = 1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Sodium	µg/L	50.0	NG	NG	16,400	47,700	37300	12,900	12,600	8100	7740	28800.00	167,000	59,400	35200	85,000	74300	5950	5770	5500
Strontium	µg/L	0.2	NG	NG			435			247	263			441	349		422		318	290
Sulfur	µg/L	500.0	NG	NG			34600			8700	8860			150,000	69100		52300		10600	8430
Tellerium	µg/L	0.2	NG	NG			<0.2			<0.2	<0.2			<0.2	<0.2		<0.2		<0.2	<0.2
Thallium	µg/L	0.01	NG	NG	0.048	0.022	0.015	0.597	<0.01	<0.01	<0.01	<0.01	0.022	<0.01	<0.01	0.025	0.03	<0.01	0.019	0.019
Thorium	µg/L	0.10	NG	NG			0.23			<0.1	<0.1			<0.1	<0.1		0.64		0.25	0.17

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Table B3: SBIAR Surface Water Analytical Results

Parameter	Unit	RDL	BC AWQG - FWAL STM [1]	BC AWQG-FWAL LTA [2]	RBSBIAR-DS			RBSBIAR-US				RBSC-DS				RBSBIAR-EDS		RBSBIAR-EUS		
					21-Mar-18	19-Jun-18	27-Sep-18	21-Mar-18	19-Jun-18	27-Sep-18	17-Dec-18	21-Mar-18	19-Jun-18	19-Nov-18	17-Dec-18	19-Jun-18	27-Sep-18	19-Jun-18	27-Sep-18	17-Dec-18
Tin	µg/L	0.10	NG	NG	0.11	<0.1	<0.1	0.38	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Titanium	µg/L	0.3-4.5	NG	NG	23.2	0.52	<4.5	163	0.88	1.36	<0.3	<0.9	<0.6	<0.6	<1.5	0.39	12.6	0.46	24.4	18
Tungsten	µg/L	0.10	NG	NG			<0.1			<0.1	<0.1			<0.1	<0.1		<0.1		<0.1	<0.1
Uranium	µg/L	0.01	NG	NG	1.72	1.41	1.19	4.01	1.45	1.05	1.18	1.64	7.07	2.26	1.72	1.39	1.62	1.58	1.83	1.79
Vanadium	µg/L	0.50	NG	NG	4.17	<0.5	0.73	80.1	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	2.92	<0.5	2.9	2.01
Zinc [3] (Based on Hardness < or > 90,000)	µg/L	3.0	Calc. based on Hardness	Calc. based on Hardness	42.7	3.1	50.7	**247**	1.5	1.5	1.5	1.50	39.8	1.5	6.9	3.4	103	1.5	7.6	7.9
Zn STM Guideline Calc.	µg/L		Hardness 90,000 - 500,000, Calc. Hardness > 500,000, is Capped Value of 500,000		171.8	189.0	177.8	106.5	267.0	156.8	219.0	228.0	340.5	340.5	340.5	164.3	221.3	252.8	266.3	317.3
Zn LTA Guideline Calc.				Hardness 90,000 - 330,000, Calc. Hardness > 330,000, is Capped Value of 330,000	146	164	152	81	188	131	188	188	188	188	188	139	188	188	188	188
Zircronium	µg/L	0.06	NG	NG																
Metals, Dissolved																				
Aluminum [5]	µg/L	1.0	100	50	51.5	15.7	**106**	10.6	1.6	4.6	0.5	1.40	2.5	1.2	0.5	22.1	**130**	2.4	0.5	0.5
Al STM Guideline Calc (based on pH)	µg/L		pH < 6.5 : calc. Al pH ≥ 6.5 : 100.0 Al		100	100	100	100	100	100	100	100.00	100	100	100	100	100	100	100	100
Al LTA Guideline Calc (based on median pH)				median pH < 6.5 : calc. Al median pH ≥ 6.5 : 50.0 Al	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Antimony	µg/L	0.10	NG	NG	0.44	0.59	0.19	1.31	0.17	0.11	<0.1	<0.1	<0.2	<0.1	<0.1	0.45	0.15	0.13	0.13	<0.1
Arsenic	µg/L	0.10	NG	NG	0.25	0.45	0.17	0.47	0.12	0.16	0.05	0.64	0.44	1.58	0.94	0.46	0.25	0.12	0.13	0.05
Barium	µg/L	0.10	NG	NG	137	145	160	89.5	292	191	222	59.2	50.6	35	39.6	163	226	269	313	306
Beryllium	µg/L	0.10	NG	NG	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bismuth		0.05	NG	NG			<0.05			<0.05	<0.05			<0.05	<0.05		<0.05		<0.05	<0.05
Boron	µg/L	10.0	NG	NG	37	156	95	28	22	21	15	32	176	76	41	230	176	19	21	17
Cadmium [3] (Based on Hardness as $CaCO_3$)	µg/L	0.005	Calc. based on Hardness	Calc. based on hardness	0.112	0.0182	0.0601	0.007	0.0302	0.0078	0.0081	0.0185	0.216	0.0025	0.0399	0.0253	0.163	0.0117	0.0087	0.0091
Cd STM Guideline Calc.	µg/L		Hardness 7,000 - 455,000, Calc. Hardness > 455,000, is Capped Value of 455,000		1.667	1.811	1.717	1.127	2.465	1.543	2.062	2.138	2.801	2.801	2.801	1.605	2.081	2.345	2.459	2.801
Cd LTA Guideline Calc.				Hardness 3,400 - 285,000, Calc. Hardness > 285,000, is Capped Value of 285,000	0.445	0.457	0.455	0.337	0.457	0.421	0.457	0.457	0.457	0.457	0.457	0.433	0.457	0.457	0.457	0.457
Calcium	µg/L	50.0	NG	NG	80,300	78,900	75200	65,700	116,000	72000	99400	105000.00	377,000	167,000	143000	68,800	91100	110,000	115000	135000
Cesium		0.01	NG	NG			0.015			<0.01	<0.01			<0.01	<0.01		0.021		<0.01	<0.01
Chromium	µg/L	0.10	NG	NG	1.02	0.19	0.13	2.61	0.15	0.14	0.17	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Cobalt	µg/L	0.10	NG	NG	2.84	0.32	4.6	0.05	0.12	0.05	0.05	0.86	1.26	1.82	1.44	1.99	7.04	0.05	0.05	0.05
Copper	µg/L	0.20	NG	NG	1.57	0.79	0.75	0.99	0.8	0.43	0.23	0.10	0.2	0.1	0.1	0.65	1.56	0.33	0.37	0.26
Iron	µg/L	10.0	350	NG	12.0	5.0	5.0	11.0	5.0	5.0	5.0	**474.0**	101	**2150**	**725**	5.0	11.0	5.0	5.0	5.0
Lead	µg/L	0.05	NG	NG	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lithium	µg/L	1.0	NG	NG	10.1	24.8	26.1	5.6	9.1	7.9	7.3	13.4	109	42.6	24.8	44.3	43.6	9.8	10	8.3
Magnesium	µg/L	5.0	NG	NG	18,100	24,600	23100	5890	27,000	18300	21700	21100.00	126,000	45,700	35900	22,700	27600	26,100	28000	31900
Manganese	µg/L	0.10	NG	NG	59.6	5.29	56	4.93	0.6	1.33	0.32	234	2880	657	495	47.5	86.9	1.38	0.46	1.38
Mercury	µg/L	0.005	NG	NG	<0.005	<0.005	<0.005	0.0077	<0.005	<0.005	<0.005	0.007	<0.005	<0.005	<0.025	<0.005	<0.005	<0.005	<0.005	0.0089
Molybdenum	µg/L	0.05	NG	NG	2.62	4.35	2.63	9.77	1.34	1.11	1.06	1.02	0.93	0.614	0.865	3.65	1.46	0.885	0.96	0.732
Nickel	µg/L	0.50	NG	NG	9.98	6.45	18.1	0.54	<0.5	<0.5	<0.5	2.43	71.3	5.12	3.13	10.2	25.1	<0.5	<0.5	<0.5
Phosphorus	µg/L	50.0	NG	NG			<50			<50	<50			<50	<50		<50		<50	<50
Potassium	µg/L	50.0	NG	NG	2420	4020	3590	3900	4450	3290	3300	1170	3010	1580	1500	3510	3350	3840	4060	3330
Rubidium	µg/L	0.20	NG	NG			1.51			0.4	0.43			0.76	0.68		1.38		0.63	0.4
Selenium	µg/L	0.05	NG	2.0	1.26	1.32	0.754	0.463	0.452	0.617	0.938	0.066	0.17	0.063	<0.05	1.29	0.631	1.18	0.877	0.657
Silicon	µg/L	50.0	NG	NG			3960			3350	4160			4200	3990		5210		6200	5240
Silver	µg/L	0.01	NG	NG	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	µg/L	50.0	NG	NG	16,300	47,900	38400	10,800	13,100	5440	7970	27500.00	163,000	52,600	38300	84,700	76000	5960	5800	5970
Strontium	µg/L	0.20	NG	NG			420			244	295			434	353		384		288	310
Sulfur	µg/L	500	NG	NG			37400			7820	8380			112,000	67000		50900		10400	8100
Tellurium	µg/L	0.20	NG	NG			<0.2			<0.2	<0.2			<0.2	<0.2		<0.2		<0.2	<0.2
Thallium	µg/L	0.01	NG	NG	<0.01	0.023	0.014	<0.01	<0.01	<0.01	<0.01	<0.01	0.021	<0.01	<0.01	0.028	0.011	<0.01	<0.01	<0.01
Thorium	µg/L	0.10	NG	NG			<0.1			<0.1	<0.1			<0.1	<0.1		<0.1		<0.1	<0.1
Tin	µg/L	0.10	NG	NG	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Titanium	µg/L	0.30	NG	NG	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.6	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Tungsten	µg/L	0.10	NG	NG			<0.1			<0.1	<0.1			<0.1	<0.1		<0.1		<0.1	<0.1
Uranium	µg/L	0.01	NG	NG	1.36	1.37	0.931	0.995	1.48	0.915	1.15	1.4	6.96	1.97	1.67	1.42	1.43	1.58	1.68	1.63
Vanadium	µg/L	0.50	NG	NG	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc	µg/L	1.00	NG	NG	26.1	2	17.2	0.5	0.5	0.5	0.5	1.2	34.9	1.1	1.4	2.7	47.9	1.3	1.8	4.4
Zirconium	µg/L	0.06	NG	NG			<0.06			<0.06	<0.06			<0.06	<0.06		<0.06		<0.06	<0.06
Laboratory Work Order Number					L2071158	L2115119	L2172306	L2071158	L2115119	L2172306	L2211507	L2071158	L2115119	L2198555	L2211507	L2115118	L2172306	L2115118	L2172306	L2211507
Laboratory Identification Number					L2071158-9	L2115119-7	L2172306-8	L2071158-8	L2115119-6	L2172306-7	L2211507-6	L2071158-7	L2115119-5	L2198555-6	L2211507-8	L2115118-5	L2172306-10	L2115118-4	L2172306-9	L2211507-7

Notes:

Screening completed on BC AWQG-FWAL STM [1] and LTA [2] guideline values.

[1] BC Ministry of Environment, Water Protection & Sustainability Branch (2018), British Columbia Approved Water Quality Guidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture

[2] BC Ministry of Environment, Water Protection & Sustainability Branch (2018). British Columbia Approved Water Quality Guidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture Summary Report. 36 pp. Referencedfor Freshwater Aquatic Life (FWAL) water use and Long Term Average (LTA) guidelines.

[3] Guideline is hardness dependant. Where results are above laboratory reportable detection limits, guideline limits have been evaluated based on individual sample hardness. Sample-specific guideline values are listed in

[4] Guideline is for Chromium (IV) cation. Analytical results are for unspeciated Chromium. Where analytical results exceed the guideline, speciated analysis may be warranted.

[5] Guideline is pH dependant.

NG - No Guideline

Detection limit can vary as described in the COA. Detection limit can be raised when dilution is requited due to high Dissolved Solids/Electrical Conductivity (DLDS), e.g. nitrite.

BOLD and shaded dark gray: Exceeds BCAWQG-FSTM (Short-term Maximum) guideline.

Shaded Light Gray: Exceeds BCAWQG-LTA (Long-term Average) guideline.

RED - Measured value is below detection limit (DL); value shown is 50% of DL

Blank - Not analyzed

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Table B4: L3 Surface Water Analytical Results

Parameter	Unit	RDL	BC AWQG - FWAL STM [1]	BC AWQG-FWAL LTA [2]	LBL3C-0.02									LBL3C-1.43										
					21-Mar-18	19-Apr-18	24-May-18	19-Jun-18	26-Jul-18	21-Aug-18	27-Sep-18	22-Oct-18	19-Nov-18	21-Mar-18	19-Apr-18	24-May-18	19-Jun-18	26-Jul-18	21-Aug-18	27-Sep-18	22-Oct-18	19-Nov-18	17-Dec-18	19-Apr-18
Physical Parameters						9:30									11:45									12:40
Flow Rate	L/sec				5.0	100.0		5.0	5.0		1.0	4.0	2.5	3.0	100.0		2.0	5.0		3.0	3.0	1.0	2.0	100.0
Electrical Conductivity (EC)	µS/cm	2.0	NG	NG	779	530	2040	2180	1660	2200	2150	2110	2100	478	348	1970	1870	1240	1710	1850	1800	1740	2070	303
Hardness as $CaCO_3$	µg/L	500	NG (Acceptable ranges exist when calculating exceedances for Cd, Cu, Pb, Mn, Zn, F)	NG (Acceptable ranges exist when calculating exceedances for Cd, Cu, Pb, Mn, Zn, F)	280,000	279,000	1270000	1280000	908000	1310000	1190000	1,180,000	1,160,000	138,000	159,000	1190000	1050000	616000	1010000	1030000	1090000	990000	1230000	142,000
pH	pH Units	0.10	6.5 - 9.0	6.5-9.0	8.06	7.86	8.21	8.21	8.31	8.18	8.23	8.26	8.23	7.98	7.68	8.37	7.78	8.29	8.25	8.17	8.22	8.23	8.07	7.73
Total Dissolved Solids (TDS)	µg/L	10000	NG	NG	516,000	454,000	1830000	2100000	1410000	2020000	1880000	1890000	1810000	362,000	303,000	1,780,000	1,680,000	1020000	1490000	1580000	1660000	1450000	1720000	287,000
Total Suspended Solids (TSS)	µg/L	3000	NG	NG	35,100	173,000	12,300	14,300	20200	16300	9000	7500	11600	383,000	129,000	35,700	23,900	31000	4900	9800	18300	3800	4000	59,700
Anions and Nutrients																								
Acidity (Total as $CaCO_3$)	µg/L	1000	NG	NG							2400		2400							4800		2400	9100	
Alkalinity (Bicarbonate as $CaCO_3$)	µg/L	1000	NG	NG	103,000	86,900	213,000	250,000	217000	245000	249000	254000	253000	74,400	74,300	192,000	269,000	198000	265000	271000	258000	260000	277000	72,300
Alkalinity (Carbonate as $CaCO_3$)	µg/L	1000	NG	NG	<1000	<1000	<1000	<1000	3800	<1000	<1000	<1000	<1000	<1000	<1000	9000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Hydroxide) as $CaCO_3$	µg/L	1000	NG	NG	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Total as $CaCO_3$)	mg/L	1.0	NG	NG	103	86.9	213	250	220	245	249	254	253	74.4	74.3	201	269	198	265	271	258	260	277	72.3
Ammonia (NH_4 as N)	µg/L	5.0	pH dependent (6.5-9.0)	pH dependent (6.5-9.0)	35	41.9	24.4	36.3	25.3	38.2	25.9	24.4	26.8	79.5	76.9	77.1	43.4	25.7	8.6	15.6	23.8	5.7	10.6	60
			pH dependent (at Temp 4 C)		4950	7420	3950	3950	3150	3950	3950	3150	3950	6220	10300	2520	8770	3150	3150	3950	3950	3950	4950	10300
				pH dependent (at Temp 4 C)	952	1430	759	759	606	759	759	606	759	1200	1980	484	1690	606	606	759	759	759	952	1980
Chloride (Cl^-)	µg/L	500	600000	150,000	67,500	20,700	26,800	31,500	48300	55000	45300	44300	34000	60,700	25,600	17,000	13,500	42600	12900	17600	22000	16600	19100	19,200
Nitrate (NO_3^- as N)	µg/L	5.0-100	NG	NG	696	571	227	148	247	200	301	348	547	887	595	1110	1860	546	1890	1450	1830	2680	3690	837
Nitrite (NO_2^- as N)	µg/L	1.0-20.0	60	20	14.6	11	<10	<10	<5.0	<20	<10	<10	<10	18.8	11.7	<10	<10	<5.0	<10	<5	<10	<10	<10	11.4
Sulphate (SO_4) [3]	µg/L	300	NG	309,000 - 429,000	191000	187000	1110000	1220000	710000	1320000	1080000	1050000	974000	66500	85000	1020000	1000000	454000	795000	746000	889000	809000	1000000	68500
SO_4 STM & LTA Guideline Calc (Based on Hardness as CaCO3)	µg/L		NG	Hardness 76,000-180,000 = 309,000 Hardness 181,000-250,000 = 429,000; Hardness > 250,000 site-specific	429000	429000	429000	429000	429000	429000	429000	429000	429000	309000	309000	429000	429000	429000	429000	429000	429000	429000	429000	309000
Metals, Total																								
Aluminum	µg/L	3.00	NG	NG	1480.00	4340.00	980.00	885	707	1300	789	701	558	4610.00	5120.00	6240.00	2370	1650	664	664	3570	30.8	19.9	4280.00
Antimony	µg/L	0.1-1.0	NG	NG	0.37	0.47	0.2	<0.2	0.24	0.21	<0.2	<0.2	<0.2	0.64	0.52	0.21	0.21	0.3	0.23	0.14	<0.2	<0.2	<0.2	0.48
Arsenic	µg/L	0.10	5.0	5.0	1.74	4.03	0.44	0.40	0.61	0.92	0.47	0.36	0.47	4.61	4.30	0.64	0.46	0.85	0.86	0.43	0.47	0.3	0.31	3.64
Barium	µg/L	0.10	NG	NG	90.7	158	55.4	47.5	67	54.7	54.3	46.2	39.4	281	237	48.2	44.9	109	80.9	69.6	46.6	49.2	44.4	179
Beryllium	µg/L	0.1-1.0	NG	NG	0.11	0.25	0.18	<0.2	0.11	0.22	<0.2	<0.2	<0.2	0.28	0.28	0.84	0.35	0.24	<0.1	<0.1	0.53	<0.2	<0.2	0.22
Bismuth	µg/L	0.05-0.10	NG	NG					<0.05	<0.1	<0.1	<0.1	<0.1					<0.05	<0.05	<0.05	<0.1	<0.1	<0.1	
Boron	µg/L	10.0	1200	1200	35	29	113	142	112	154	124	113	113	20	21	102	124	92	111	110	112	93	108	23
Cadmium	µg/L	0.005	NG	NG	0.21	0.416	0.57	0.583	0.413	0.514	0.555	0.458	0.393	0.39	0.453	2.27	1.01	0.489	0.115	0.448	1.07	0.132	0.248	0.251
Calcium	µg/L	50	NG	NG	84,800	79,800	344,000	359,000	225000	358000	337000	325000	313000	51,000	48,900	276,000	277,000	141000	247000	258000	275000	236000	295000	37,800
Cesium	µg/L	0.01-0.02	NG	NG					0.03	0.09	<0.02	<0.02	0.022					0.031	0.116	0.01	<0.02	<0.02	<0.02	
Chromium [4]	µg/L	0.10	NG	NG	3.27	7.79	0.32	<0.2	0.32	0.64	0.39	<0.2	<0.2	9.96	9.36	1.2	<0.6	0.72	1.5	0.36	0.55	0.24	<0.2	8.27
Cobalt	µg/L	0.10	110.0	4.0	1.98	5.92	9.18	9.11	6.01	9.57	8.27	8.25	5.95	4.39	6.63	78.90	71.90	22.2	36.2	57.2	97.3	24.8	64.5	3.25
Copper [3]	µg/L	0.5-1.0	Calc. based on Hardness	2 to 10	5.24	11.10	2.14	1.70	2.36	2.7	1.9	1.5	1.7	13.80	13.60	6.00	2.50	3.59	1.96	1.32	3.4	0.5	0.5	11.50
Cu STM Guideline Calc.	µg/L		Hardness 13,000 - 400,000 : calc.; Hardness ≥ 400,000 is Capped Value of 400,000		28.32	28.23	39.60	39.60	39.60	39.60	39.60	39.60	39.60	14.97	16.95	39.60	39.60	39.60	39.60	39.60	39.60	39.60	39.60	15.35
Cu LTA Guideline Calc.	µg/L			Hardness 50,000 - 250,000: calc.; Hardness > 250,000, Cu = 10	10	10	10	10	10	10	10	10	10	6	6	10	10	10	10	10	10	10	10	6
Iron	µg/L	10	1000	NG	2930	7950	725	858	539	1740	939	957	697	9570	9320	901	611	770	1130	179	358	42	31	7400
Lead [3]	µg/L	0.05-0.1	Calc. based on Hardness	Calc. based on Hardness	1.81	4.18	0.12	0.05	0.128	0.33	<0.1	<0.1	<0.1	5.82	5.05	0.105	0.15	0.286	0.608	<0.05	<0.1	<0.1	<0.1	3.99
Pb STM Guideline Calc (Based on Hardness as $CaCO_3$)	µg/L		Applies to Hardness 8000-360,000 Hardness ≤ 8000: 3 Hardness > 8000 : calc.		303	301	2075	2096.08	1353.9	2158.8	1910.3	1889.9	1849.2	123	147	1910	1628.94	826.2	1550.4	1589.5	1708.3	1511.4	1992.4	128
Pb LTA Guideline Calc (Based on Hardness as $CaCO_3$)	µg/L			Applies to Hardness 8000-360,000 Hardness ≤ 8000, NG Hardness > 8000 : calc.	15	15	84	85	56	87	78	77	75	8	9	78	67	36	64	65	70	62	81	8
Lithium	µg/L	1.0	NG	NG	12.2	14.9	55.1	66.6	44.1	70.8	56.5	51.7	49.7	8.7	9.9	82.8	62.7	29.3	47.6	45.1	54.3	40.6	46.9	6.1
Magnesium	µg/L	5.0	NG	NG	23,000	22,500	94,400	105,000	62400	101000	99700	102000	103000	14,100	16,200	103,000	106,000	51000	96500	107000	112000	99100	118000	12,900
Manganese [3]	µg/L	0.10	Calc. based on Hardness	Calc. based on Hardness	167	280	467	411	441	417	428	401	223	323	376	7400	7610	2200	2640	6040	8110	2760	6070	117
Mn STM Guideline Calc (Based on Hardness as $CaCO_3$)	µg/L		Applies to Hardness 25000-259000 µg/L Mn : calc.		3626	3615	14535	14645.6	10546	14976	13654	13544	13323	2061	2292	13654	12111	7328	11670	11891	12552	11450	14095	2105
Mn LTA Guideline Calc (Based on Hardness as $CaCO_3$)	µg/L			Applies to Hardness 37000-450000 µg/L Mn : calc.	1837	1833	6193	6237	4600	6369	5841	5797	5709	1212	1305	5841	5225	3315	5049	5137	5401	4961	6017	1230
Mercury (Based on methyl Hg & total mass Hg)	µg/L	0.005	NG	Calc.	<0.05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0062	<0.05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0087	0.008	<0.05
Molybdenum	µg/L	0.05-0.10	2000	≤ 1000	2.53	3.05	1.59	1.65	2.2	2.48	1.61	1.59	1.85	3.13	2.82	0.77	0.75	1.85	1.06	1.04	0.83	0.94	0.87	2.39
Nickel	µg/L	0.5	NG	NG	11.7	22.8	44.9	48.3	30.2	48.2	41.2	40.6	32.7	17.1	22.1	212	175	61.8	100	139	207	56.7	145	12.3
Phosphorus	µg/L	50-500	NG	NG					<50	<100	<100	<100	<100					<50	75	<50	<100	<100	<100	
Potassium	µg/L	50.0	NG	NG	3440	3610	6370	6220	6810	6630	5580	5700	5440	3380	3840	6650	6550	8810	6480	6430	6270	5320	6410	4240
Rubidium	µg/L	0.2	NG	NG					1.9	2.98	1.89	1.74	1.62					1.43	1.87	1.23	1.24	0.69	1.05	
Selenium	µg/L	0.05	NG	2.0	1.61	1.66	1.51	0.94	1.53	1.33	2.05	2.75	2.97	1.58	1.74	5.81	8.91	3.12	12.7	10.7	9.69	10.5	12.9	1.65
Silicon	µg/L	100.0	NG	NG					4470	5350	4510	4490	4050					4820	7000	5700	6440	5240	5750	
Silver [3] (Based on Hardness < or > 100000)	µg/L	0.01-0.02	0.10 - 3.0	0.05 - 1.5	0.037	0.083	0.005	0.01	<0.01	<0.02	<0.02	<0.02	<0.02	0.103	0.086	0.005	0.01	0.011	0.014	<0.01	<0.02	<0.02	<0.02	0.074
Ag STM Guideline Calc	µg/L		Hardness ≤ 100,000 Ag = 0.10 Hardness > 100,000 Ag = 3.0		3.0	3.0	3.0	3	3	3	3	3	3	3.0	3.0	3.0	3	3	3	3	3	3	3	3.0

Table B4: L3 Surface Water Analytical Results

Parameter	Unit	RDL	BC AWQG - FWAL STM [1]	BC AWQG-FWAL LTA [2]	LBL3C-0.02									LBL3C-1.43										
					21-Mar-18	19-Apr-18	24-May-18	19-Jun-18	26-Jul-18	21-Aug-18	27-Sep-18	22-Oct-18	19-Nov-18	21-Mar-18	19-Apr-18	24-May-18	19-Jun-18	26-Jul-18	21-Aug-18	27-Sep-18	22-Oct-18	19-Nov-18	17-Dec-18	19-Apr-18
Ag LTA Guideline Calc	µg/L			Hardness ≤ 100,000 Ag = 0.05 Hardness > 100,000 Ag = 1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Sodium	µg/L	50.0	NG	NG	50,200	21,100	65,100	79,500	53200	79600	68900	76800	71200	36,900	19,100	63,800	60,400	44000	45700	48600	58400	41200	52500	14,600
Strontium	µg/L	0.2	NG	NG					680	1020	862	918	913					496	740	743	777	735	803	
Sulfur	µg/L	500.0	NG	NG					265000	408000	380000	411000	382000					165000	286000	362000	381000	292000	354000	
Tellurium	µg/L	0.2-2.0	NG	NG					<0.2	<0.4	<0.4	<0.4	<0.4					<0.2	<0.2	<0.2	<0.4	<0.4	<0.4	
Thallium	µg/L	0.01-0.02	NG	NG	0.053	0.093	0.034	0.034	0.031	0.042	0.027	0.025	<0.02	0.125	0.102	0.03	0.022	0.021	0.028	0.017	0.021	<0.02	<0.02	0.087
Thorium	µg/L	0.1-1.0	NG	NG					<0.1	<0.2	<0.2	<0.2	<0.2					0.12	0.18	<0.1	<0.2	<0.2	<0.2	
Tin	µg/L	0.1-1.0	NG	NG	<0.1	<0.1	<0.1	<0.2	<0.1	<0.2	<0.2	<0.2	<0.2	0.12	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	<0.1
Titanium	µg/L	0.3-6.3	NG	NG	23	52.1	1.65	<0.6	2.47	<6.3	1.25	<0.6	<1.2	76.7	68.5	1.68	2.49	6.06	16.1	<1.2	0.86	<0.9	<0.6	57.9
Tungsten	µg/L	0.1-1.0	NG	NG					<0.1	<0.2	<0.2	<0.2	<0.2					<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	
Uranium	µg/L	0.01	NG	NG	2.23	1.89	6.52	7.08	4.95	6.83	6.14	6.33	6.49	1.87	1.61	4.24	4.24	4.11	4.84	5.36	5.07	5.07	5.98	1.53
Vanadium	µg/L	0.5-1.0	NG	NG	5.55	14.7	0.51	<1	<0.5	1.4	<1.0	<1.0	<1.0	17.7	17.8	<0.5	<1	1.0	2.54	<0.5	<1.0	<1.0	<1.0	15.6
Zinc [3] (Based on Hardness < or > 90,000)	µg/L	3.0	Calc. based on Hardness	Calc. based on Hardness	28.10	54.20	82.40	88.10	52.3	89.3	80.1	71.6	59.6	49.50	53.40	248.00	137.00	68.6	9.6	77.9	303	21.4	71.2	35.30
Zn STM Guideline Calc.	µg/L		Hardness 90,000 - 500,000, Calc. Hardness > 500,000, is Capped Value of 500,000		175.50	174.75	340.50	340.50	340.50	340.50	340.50	340.50	340.50	69.00	84.75	340.50	340.50	340.50	340.50	340.50	340.50	340.50	340.50	72.00
Zn LTA Guideline Calc.	µg/L			Hardness 90,000 - 330,000, Calc. Hardness > 330,000, is Capped Value of 330,000	150.0	149.3	187.5	187.5	187.5	187.5	187.5	187.5	187.5	43.5	59.3	187.5	187.5	187.5	187.5	187.5	187.5	187.5	187.5	46.5
Zirconium	µg/L	0.06-0.12	NG	NG					0.158	0.15	<0.12	<0.12	<0.12					0.32	0.324	0.065	<0.12	<0.12	<0.12	
Metals, Dissolved																								
Aluminum [5]	µg/L	1.0	100.0	50.0	37.30	62.80	**158.00**	**169**	**199**	**142**	**132**	**102**	88.8	15.20	40.70	83.70	61.1	**180**	6.2	41	54.6	5.9	14.1	14.60
Al STM Guideline Calc (based on pH)	µg/L		pH < 6.5 : calc. Al pH ≥ 6.5 : 100.0 Al		100.00	100.00	100.00	100	100	100	100	100	100	100.00	100.00	100.00	100.00	100	100	100	100	100	100	100.00
Al LTA Guideline Calc (based on median pH)	µg/L			median pH < 6.5 : calc. Al median pH ≥ 6.5 : 50.0 Al	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Antimony	µg/L	0.1-2.0	NG	NG	0.17	0.17	0.2	<0.2	0.26	0.19	<0.2	<0.2	<0.2	0.21	0.19	0.21	<0.2	0.31	0.18	0.13	<0.2	<0.2	<0.2	0.19
Arsenic	µg/L	0.1-2.0	NG	NG	0.25	0.18	0.26	0.23	0.39	0.23	0.24	0.1	0.1	0.27	0.22	0.27	0.10	0.49	0.21	0.25	0.10	0.10	0.10	0.37
Barium	µg/L	0.10	NG	NG	49.5	40.6	50.1	48.4	62.1	45.1	49.9	41.4	36.9	53.9	43.7	45.6	42.5	94.8	59	63.6	44.2	49.5	41.7	48.3
Beryllium	µg/L	0.1-2.0	NG	NG	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	<0.1
Bismuth	µg/L	0.05-1.0	NG	NG					<0.05	<0.05	<0.1	<0.1	<0.1					<0.05	<0.05	<0.05	<0.1	<0.1	<0.1	
Boron	µg/L	10.0	NG	NG	31	23	111	129	119	135	129	124	107	13	16	105	111	99	97	106	120	93	105	18
Cadmium [3] (Based on Hardness as $CaCO_3$)	µg/L	0.005	Calc. based on Hardness	Calc. based on hardness	0.10	0.147	0.489	0.415	0.356	0.216	0.429	0.387	0.362	0.06	0.10	2.20	0.881	0.36	0.0526	0.318	0.867	0.12	0.233	0.0357
Cd STM Guideline Calc.	µg/L		Hardness 7,000 - 455,000, Calc. Hardness > 455,000, is Capped Value of 455,000		1.70	1.69	2.80	2.80	2.80	2.80	2.80	2.80	2.80	0.82	0.95	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	0.84
Cd LTA Guideline Calc.	µg/L			Hardness 3,400 - 285,000, Calc. Hardness > 285,000, is Capped Value of 285,000	0.45	0.45	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.27	0.30	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.27
Calcium	µg/L	50.0	NG	NG	78,400	77,100	373,000	342,000	252000	362000	324000	312000	315000	38,800	42,300	314,000	251,000	155000	247000	254000	261000	248000	290000	37,600
Cesium	µg/L	0.01-0.2	NG	NG					0.018	0.017	<0.02	<0.02	<0.02					<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	
Chromium	µg/L	0.1-2.0	NG	NG	0.46	0.21	0.14	<0.2	0.15	<0.1	<0.2	<0.2	<0.2	0.34	0.24	<0.1	<0.2	0.26	0.14	0.14	<0.2	<0.2	0.21	0.53
Cobalt	µg/L	0.10	NG	NG	0.76	2.09	8.24	8.83	5.89	8.18	7.99	8.03	5.66	0.42	1.96	91.00	67.1	20.7	32.2	51.5	90.9	24.3	57.4	0.17
Copper	µg/L	0.2-4.0	NG	NG	1.36	1.45	1.21	0.80	1.81	0.91	0.87	0.91	1.0	1.61	1.66	2.19	1.61	2.39	0.55	0.66	0.62	1.19	0.52	2.00
Iron	µg/L	10.0	350	NG	15	18	78	10	49	14	68	168	162	33	26	5	10	11	5.0	5.0	10	10	10	67
Lead	µg/L	0.05-1.0	NG	NG	<0.05	<0.05	<0.05	<0.1	<0.05	<0.05	<0.1	<0.1	<0.1	<0.05	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<0.1	<0.1	<0.1	0.067
Lithium	µg/L	1.0	NG	NG	10.9	10.7	58.9	56.5	47.3	62.3	57.9	54.3	45.6	2.4	4.9	101	53.5	30.7	41.8	44.2	53.8	38.9	50.3	2.2
Magnesium	µg/L	5.0	NG	NG	20,500	21,100	82,400	105,000	67700	99000	93100	97900	90800	10,100	13,000	98,800	104,000	55500	94700	95600	107000	90200	123000	11,600
Manganese	µg/L	0.10	NG	NG	117	167	411	423	435	387	434	397	207	154	217	8420	7620	2240	2570	5680	7630	2600	6370	26.5
Mercury	µg/L	0.005-0.1	NG	NG	0.0072	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0088	<0.005	<0.005	<0.005	0.0067	<0.005	<0.005	<0.005	0.0067	<0.025	0.0074
Molybdenum	µg/L	0.05-1.0	NG	NG	1.9	2.41	1.71	1.74	2.39	2.35	1.7	1.65	1.83	2.39	2.47	0.71	0.74	1.98	0.958	1.03	0.72	0.93	0.87	2.04
Nickel	µg/L	0.50	NG	NG	6.72	10.2	40.1	47.5	30.1	41	39.8	38.2	31.1	2.89	7.11	241	162	58	90.4	124	195	55.6	133	1.38
Phosphorus	µg/L	50-1000	NG	NG					<50	<50	<100	<100	<100					<50	<50	<50	<100	<100	<100	
Potassium	µg/L	50.0	NG	NG	3030	2730	6090	6290	6530	6580	5350	5760	5100	2360	2870	6570	6600	8550	6150	5710	6270	4920	6020	3560
Rubidium	µg/L	0.20	NG	NG					1.85	2.35	1.63	1.55	1.52					1.2	0.99	0.94	1.2	0.63	0.92	
Selenium	µg/L	0.05-1.0	NG	2.0	1.53	1.25	1.34	0.88	1.26	1.31	2.15	2.41	3.1	1.25	1.27	5.02	8.81	2.83	11.8	12.4	9.34	11.1	11.1	1.4
Silicon	µg/L	50.0	NG	NG					4260	4400	4210	4010	3680					4370	5470	5130	5210	5190	5750	
Silver	µg/L	0.01-0.2	NG	NG	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.02	<0.02	<0.02	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	<0.01
Sodium	µg/L	50.0	NG	NG	47,500	20,200	58,600	78,600	54500	75800	68900	72400	68400	34,800	17,400	63,600	59,800	45300	43400	46900	54400	37700	51900	14,500
Strontium	µg/L	0.20	NG	NG					701	1020	930	920	913					508	738	763	752	743	857	
Sulfur	µg/L	500	NG	NG					266000	370000	381000	391000	366000					169000	252000	299000	344000	288000	350000	
Tellurium	µg/L	0.2-4.0	NG	NG					<0.2	<0.2	<0.4	<0.2	<0.4					<0.2	<0.2	<0.2	<0.4	<0.4	<0.4	
Thallium	µg/L	0.01-0.2	NG	NG	<0.01	<0.01	0.033	0.032	0.03	0.033	0.027	0.024	0.022	<0.01	<0.01	0.038	0.022	0.018	0.018	0.016	<0.02	<0.02	<0.02	<0.01
Thorium	µg/L	0.1-2.0	NG	NG					<0.1	<0.1	<0.2	<0.2	<0.2					<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	
Tin	µg/L	0.1-2.0	NG	NG	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	<0.1
Titanium	µg/L	0.3-6.0	NG	NG	<0.3	0.49	<0.3	<0.6	<0.9	0.76	<0.6	<0.6	<0.6	0.64	0.89	<0.3	<0.6	<0.3	<0.3	<0.3	<0.6	<0.6	<0.6	2.06
Tungsten	µg/L	0.1-2.0	NG	NG					<0.1	<0.1	<0.2	<0.2	<0.2					<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	
Uranium	µg/L	0.01	NG	NG	1.73	1.74	6.58	6.86	4.9	6.55	5.89	6.52	6.27	1.19	1.34	3.07	3.53	3.8	4.53	4.78	4.67	5.33	5.44	1.38
Vanadium	µg/L	0.5-10	NG	NG	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<1.0	<1.0	<1.0	<0.5	<0.5	<0.5	<1	0.53	<0.5	<0.5	<1.0	<1.0	<1.0	<0.5
Zinc	µg/L	1.00	NG	NG	9.10	9.60	53.80	51.8	31.2	41.4	50.6	54	50.7	2.20	3.70	85.70	58.9	19.7	2.8	54.1	175	21.7	65.5	1.20
Zirconium	µg/L	0.06-1.2	NG	NG					0.064	<0.06	<0.12	<0.12	<0.12					0.096	<0.06	<0.06	<0.12	<0.12	<0.12	
Laboratory Work Order Number					L2071158	L2082450	L2100153	L2115119	L2136818	L2150694	L2172306	L2185138	L2198555	L2071158	L2082450	L2100153	L2115119	L2136818	L2150694	L2172306	L2185138	L2198555	L2211507	L2082450
Laboratory Identification Number					L2071158-2	L2082450-4	L2100153-3	L2115119-3	L2136818-4	L2150694-2	L2172306-2	L2185138-2	L2198555-2	L2071158-1	L2082450-3	L2100153-2	L2115119-2	L2136818-3	L2150694-1	L2172306-1	L2185138-1	L2198555-1	L2211507-2	L2082450-2

Notes:

Screening completed on BC AWQG-FWAL STM [1] and LTA [2] guideline values.

[1] BC Ministry of Environment, Water Protection & Sustainability Branch (2018). British Columbia Approved Water Quality Guidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture Summary Report. 36 pp. Referenced for Freshwater Aquatic Life (FWAL) water use and Short Term Maximum (STM) guidelines.

[2] BC Ministry of Environment, Water Protection & Sustainability Branch. 2018. British Columbia Approved Water Quality Guidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture Summary Report. 36 pp. Referencedfor Freshwater Aquatic Life (FWAL) water use and Long Term Average (LTA) guidelines.

[3] Guideline is hardness dependant. Where results are above laboratory reportable detection limits, guideline limits have been evaluated based on individual sample hardness. Sample-specific guideline values are listed in parentheses after the laboratory result, where applicable.

[4] Guideline is for Chromium (IV) cation. Analytical results are for unspeciated Chromium. Where analytical results exceed the guideline, speciated analysis may be warranted.

[5] Guideline is pH dependant.

NG - No Guideline

Detection limit can vary as described in the COA. Detection limit can be raised when dilutation is requited due to high Dissolved Solids/Electrical Conductivity (DLDS), e.g. nitrite.

BOLD and shaded dark gray: Exceeds BCAWQG-FSTM (Short-term Maximum) guideline.

Shaded Light Gray: Exceeds BCAWQG-LTA (Long-term Average) guideline.

RED - Measured value is below detection limit (DL); value shown is 50% of DL

Blank - Not analyzed

TETRA TECH

Table B4: L3 Surface Water Analytical Results

Parameter	Unit	RDL	BC AWQG - FWAL STM [1]	BC AWQG-FWAL LTA [2]	LBL3C-1.65		LBL3C-3.32				LBL4C-0.18					
					26-Jul-18	17-Dec-18	19-Apr-18	24-May-18	19-Jun-18	26-Jul-18	21-Mar-18	19-Apr-18	24-May-18	19-Jun-18	26-Jul-18	22-Oct-18
Physical Parameters							13:50					12:22				
Flow Rate	L/sec				0.2	0.1	5.0		0.1	2.0	0.2	10.0		1.0	2.5	0.05
Electrical Conductivity (EC)	µS/cm	2.0	NG	NG	1230	3970	550	1180	1300	1110	1540	830	2160	2490	1200	2360
Hardness as $CaCO_3$	µg/L	500	NG (Acceptable ranges exist when calculating exceedances for Cd, Cu, Pb, Mn, Zn, F)	NG (Acceptable ranges exist when calculating exceedances for Cd, Cu, Pb, Mn, Zn, F)	707000	2580000	180,000	628,000	683,000	451000	209,000	286,000	1010000	1180000	506000	986000
pH	pH Units	0.10	6.5 - 9.0	6.5-9.0	8.25	**6.36**	8.00	8.47	8.20	8.33	8.06	8.01	**4.45**	**4.46**	7.88	**4.39**
Total Dissolved Solids (TDS)	µg/L	10000	NG	NG	1030000	4020000	340,000	904,000	1,050,000	812000	943,000	574,000	2,070,000	2,480,000	933000	2310000
Total Suspended Solids (TSS)	µg/L	3000	NG	NG	14200	47400	4500.00	9300	7500	8400	39,700	875,000	11,500	109,000	63400	45900
Anions and Nutrients																
Acidity (Total as $CaCO_3$)	µg/L	1000	NG	NG		115000										
Alkalinity (Bicarbonate as $CaCO_3$)	µg/L	1000	NG	NG	208000	298000	109,000	250,000	314,000	213000	96,000	128,000	<1000	<1000	88300	<1000
Alkalinity (Carbonate as $CaCO_3$)	µg/L	1000	NG	NG	<1000	<1000	<1000	19,200	<1000	6200	<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Hydroxide) as $CaCO_3$	µg/L	1000	NG	NG	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Total as $CaCO_3$)	mg/L	1.0	NG	NG	208	298	109	269	314	219	96.00	128	0.5	0.5	88.3	<1
Ammonia (NH_4 as N)	µg/L	5.0	pH dependent (6.5-9.0)	pH dependent (6.5-9.0)	5.6	275	232	9	14.2	11.8	39.5	21.3	171	284	84.8	232
			pH dependent (at Temp 4 °C)		3150	-	6220	2010	3950	3150	4950	6220	-	-	7420	-
				pH dependent (at Temp 4 °C)	606	-	1200	387	759	606	952	1200	-	-	1430	-
Chloride (Cl^-)	µg/L	500	600000	150,000	10500	15000	62,200	52,400	53,300	67600	375,000	108,000	28,900	34,000	32700	33000
Nitrate (NO_3^- as N)	µg/L	5.0-100	NG	NG	4440	<100	284	<25	<25	<25	244	302	75	<100	<25	<100
Nitrite (NO_2^- as N)	µg/L	1.0-20.0	60	20	<5.0	<20	17.5	<5	<5	<5	20.9	<5	<10	<20	<5.0	<20
Sulphate (SO_4) [3]	µg/L	300	NG	309,000 - 429,000	512000	2450000	62400	371000	404000	295000	83100	145000	1380000	1780000	526000	1500000
SO_4 STM & LTA Guideline Calc (Based on Hardness as CaCO3)	µg/L		NG	Hardness 76,000-180,000 = 309,000 Hardness 181,000-250,000 = 429,000; Hardness > 250,000 site-specific	429000	429000	309000	429000	429000	429000	309000	429000	429000	429000	429000	429000
Metals, Total																
Aluminum	µg/L	3.00	NG	NG	386	2540	403.00	59.00	57.80	115	3560.00	19800	34300	33000	7200	36800
Antimony	µg/L	0.1-1.0	NG	NG	0.3	<1.0	0.19	0.3	0.3	0.3	0.48	0.69	<0.2	<0.2	0.19	<0.2
Arsenic	µg/L	0.10	5.0	5.0	1.93	3.5	1.16	0.56	0.63	0.98	2.99	**13.50**	2.05	3.30	0.93	2.13
Barium	µg/L	0.10	NG	NG	83.5	103	73.5	132	137	101	129	448	47.2	41.6	81.4	23.4
Beryllium	µg/L	0.1-1.0	NG	NG	<0.1	<1.0	<0.1	<0.1	<0.1	<0.1	0.21	1.17	4.54	5.08	1.15	4.75
Bismuth	µg/L	0.05-0.10	NG	NG	<0.05	<0.5				<0.05					<0.05	<0.1
Boron	µg/L	10.0	1200	1200	60	200	43	72	83	118	19	34	118	172	88	166
Cadmium	µg/L	0.005	NG	NG	0.129	6.23	0.094	0.055	0.051	0.0466	0.23	1.69	8.04	8.86	1.51	6.54
Calcium	µg/L	50	NG	NG	145000	566000	48,300	163,000	176,000	129000	63,200	87,600	257,000	300,000	122000	245000
Cesium	µg/L	0.01-0.02	NG	NG	0.042	0.31				0.024					0.083	0.041
Chromium [4]	µg/L	0.10	NG	NG	1.08	3.1	1.07	0.24	<0.3	0.49	7.11	33.2	5.2	2.21	1.58	2.58
Cobalt	µg/L	0.10	110.0	4.0	2.08	**1240**	0.51	0.17	0.23	0.26	2.60	20.60	**138**	**186**	34.8	**138**
Copper [3]	µg/L	0.5-1.0	Calc. based on Hardness	2 to 10	3.1	5.7	3.07	2.66	2.27	2.54	9.59	**45.00**	32.30	27.4	8.24	25.6
Cu STM Guideline Calc.	µg/L		Hardness 13,000 - 400,000 : calc.; Hardness ≥ 400,000 is Capped Value of 400,000		39.60	39.60	18.92	39.60	39.60	39.60	21.65	28.88	39.60	39.60	39.60	39.60
Cu LTA Guideline Calc.	µg/L			Hardness 50,000 - 250,000: calc.; Hardness > 250,000, Cu = 10	10	10	7	10	10	10	8	10	10	10	10	10
Iron	µg/L	10	1000	NG	**2590**	**7720**	867	94	145	233	**6430**	**36100**	**5650**	**9040**	**3080**	**6050**
Lead [3]	µg/L	0.05-0.1	Calc. based on Hardness	Calc. based on Hardness	0.479	2.38	0.514	0.068	0.074	0.141	3.2	15.8	0.31	0.15	0.485	<0.1
Pb STM Guideline Calc (Based on Hardness as $CaCO_3$)	µg/L		Applies to Hardness 8000-360,000 Hardness ≤ 8000: 3 Hardness > 8000 : calc.		984.6	5115.9	173	847	942.21	555.5	209	311	1550	1889.89	643.2	1503.6
Pb LTA Guideline Calc (Based on Hardness as $CaCO_3$)	µg/L			Applies to Hardness 8000-360,000 Hardness ≤ 8000, NG Hardness > 8000 : calc.	42	203	10	36	40	25	11	15	64	77	28	62
Lithium	µg/L	1.0	NG	NG	13.5	142	3.7	17.7	18.7	12.6	10.2	38.9	206	248	63.1	160
Magnesium	µg/L	5.0	NG	NG	59300	264000	16,200	54,100	58,000	45100	20,800	31,800	106,000	130,000	46100	115000
Manganese [3]	µg/L	0.10	Calc. based on Hardness	Calc. based on Hardness	73.4	**80500**	75.6	20.2	42.7	10.9	99.4	736	4810	6860	1620	5730
Mn STM Guideline Calc (Based on Hardness as $CaCO_3$)	µg/L		Applies to Hardness 25000-259000 µg/L Mn : calc.		8331	28972	2524	7461	8066.66	5510	2843	3692	11670	13543.6	6116	11406
Mn LTA Guideline Calc (Based on Hardness as $CaCO_3$)	µg/L			Applies to Hardness 37000-450000 µg/L Mn : calc.	3716	11957	1397	3368	3610	2589	1525	1863	5049	5797	2831	4943
Mercury (Based on methyl Hg & total mass Hg)	µg/L	0.005	NG	Calc.	<0.005	<0.005	0.0075	<0.005	<0.005	<0.005	<0.05	0.0101	<0.005	<0.005	<0.005	<0.005
Molybdenum	µg/L	0.05-0.10	2000	≤ 1000	1.07	1.02	0.948	1.44	1.72	1.63	2.3	2.28	0.29	0.12	0.744	<0.1
Nickel	µg/L	0.5	NG		6.87	2180	2.78	3.96	4.26	5.49	10.8	75.2	469	608	116	472
Phosphorus	µg/L	50-500	NG	NG	151	<500				<50					<50	<100
Potassium	µg/L	50.0	NG	NG	7360	10800	8100	11,800	13,500	10500	5100	8.22	6880	6790	7020	5330
Rubidium	µg/L	0.2	NG	NG	1.74	6.3				1.24					3.4	4.65
Selenium	µg/L	0.05	NG	2.0	3.26	0.57	0.168	1.28	0.624	0.351	2.05	2.42	1.2	0.95	0.613	0.65
Silicon	µg/L	100.0	NG	NG	5160	10100				3940					6040	10100
Silver [3] (Based on Hardness < or > 100000)	µg/L	0.01-0.02	0.10 - 3.0	0.05 - 1.5	<0.01	<0.01	0.015	0.005	0.005	<0.01	0.058	0.328	0.01	0.01	0.012	<0.02
Ag STM Guideline Calc	µg/L		Hardness ≤ 100,000 Ag = 0.10 Hardness > 100,000 Ag = 3.0		3	3	3.0	3.0	3	3	3.0	3.0	3.0	3.0	3	3

Table B4: L3 Surface Water Analytical Results

Parameter	Unit	RDL	BC AWQG - FWAL STM [1]	BC AWQG-FWAL LTA [2]	LBL3C-1.65		LBL3C-3.32				LBL4C-0.18					
					26-Jul-18	17-Dec-18	19-Apr-18	24-May-18	19-Jun-18	26-Jul-18	21-Mar-18	19-Apr-18	24-May-18	19-Jun-18	26-Jul-18	22-Oct-18
Ag LTA Guideline Calc	µg/L			Hardness ≤ 100,000 Ag = 0.05 Hardness > 100,000 Ag = 1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Sodium	µg/L	50.0	NG	NG	25400	143000	35,800	30,200	46,700	43900	230,000	60,600	102,000	138,000	59200	144000
Strontium	µg/L	0.2	NG	NG	603	1320				507					403	673
Sulfur	µg/L	500.0	NG	NG	176000	922000				107000					175000	534000
Tellurium	µg/L	0.2-2.0	NG	NG	<0.2	<2.0				<0.2					<0.2	<0.4
Thallium	µg/L	0.01-0.02	NG	NG	0.062	0.18	<0.01	<0.01	<0.01	0.01	0.08	0.317	0.057	0.073	0.033	0.054
Thorium	µg/L	0.1-1.0	NG	NG	0.92	<1.0				<0.1					0.33	0.33
Tin	µg/L	0.1-1.0	NG	NG	<0.1	<1.0	<0.1	<0.1	<0.1	<0.1	<0.1	0.11	<0.2	<0.2	<0.1	<0.2
Titanium	µg/L	0.3-6.3	NG	NG	6	24.1	8.13	1.37	0.96	<1.8	54.7	110	3.27	<0.6	16.2	<0.6
Tungsten	µg/L	0.1-1.0	NG	NG	<0.1	<1.0				<0.1					<0.1	<0.2
Uranium	µg/L	0.01	NG	NG	7.5	2.84	0.778	8.33	8.23	3.05	1.67	2.43	5.09	5.24	2.18	3.56
Vanadium	µg/L	0.5-1.0	NG	NG	1.24	5.8	1.85	0.54	0.6	1.01	13.6	56.2	<1	<1	1.65	<1.0
Zinc [3] (Based on Hardness < or > 90,000)	µg/L	3.0	Calc. based on Hardness	Calc. based on Hardness	16	**2190**	9.70	1.50	3.30	3.2	30.90	**201.0**	**945**	**1130**	186	**894**
Zn STM Guideline Calc.	µg/L		Hardness 90,000 - 500,000, Calc. Hardness > 500,000, is Capped Value of 500,000		340.50	340.50	100.50	340.50	340.50	303.75	122.25	180.00	340.50	340.50	340.50	340.50
Zn LTA Guideline Calc.	µg/L			Hardness 90,000 - 330,000, Calc. Hardness > 330,000, is Capped Value of 330,000	187.5	187.5	75.0	187.5	187.5	187.5	96.8	154.5	187.5	187.5	187.5	187.5
Zirconium	µg/L	0.06-0.12	NG	NG	0.214	0.95				0.344					0.458	0.12
Metals, Dissolved																
Aluminum [5]	µg/L	1.0	100.0	50.0	7.3	**1040**	18.10	4.60	4.00	**211**	13.30	83.50	**25300**	**41500**	**141**	**31300**
Al STM Guideline Calc (based on pH)	µg/L		pH < 6.5 : calc. Al pH ≥ 6.5 : 100.0 Al		100	0.073	100.00	100.00	100.00	100	100.00	100.00	20.09	20.12	100	19.96
Al LTA Guideline Calc (based on median pH)	µg/L			median pH < 6.5 : calc. Al median pH ≥ 6.5 : 50.0 Al	50.00	36.92	50.00	50.00	50.00	50.00	50.00	50.00	5.28	5.29	50.00	5.20
Antimony	µg/L	0.1-2.0	NG	NG	0.28	<2.0	0.15	0.29	0.27	0.26	0.18	0.13	<0.2	<0.2	0.18	<0.2
Arsenic	µg/L	0.1-2.0	NG	NG	0.27	0.10	0.74	0.45	0.55	0.91	0.36	0.27	1.72	2.50	0.27	1.23
Barium	µg/L	0.10	NG	NG	58.5	20.5	64.4	127	144	103	55.3	54	41.4	46.9	61.1	21.7
Beryllium	µg/L	0.1-2.0	NG	NG	<0.1	<2.0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	3.84	5.36	<0.1	4.85
Bismuth	µg/L	0.05-1.0	NG	NG	<0.05	<1.0				<0.05					<0.05	<0.1
Boron	µg/L	10.0	NG	NG	69	200	38	71	73	105	15	23	122	149	89	177
Cadmium [3] (Based on Hardness as $CaCO_3$)	µg/L	0.005	Calc. based on Hardness	Calc. based on hardness	0.0088	**5.35**	0.0519	0.0427	0.0335	0.0477	0.04	0.267	**7.81**	**9.11**	1.02	**6.23**
Cd STM Guideline Calc.	µg/L		Hardness 7,000 - 455,000, Calc. Hardness > 455,000, is Capped Value of 455,000		2.80	2.80	1.08	2.80	2.80	2.78	1.26	1.74	2.80	2.80	2.80	2.80
Cd LTA Guideline Calc.	µg/L			Hardness 3,400 - 285,000, Calc. Hardness > 285,000, is Capped Value of 285,000	0.46	0.46	0.33	0.46	0.46	0.46	0.36	0.46	0.46	0.46	0.46	0.46
Calcium	µg/L	50.0	NG	NG	175000	566000	47,700	171,000	175,000	114000	54,700	73,300	235,000	267,000	125000	225000
Cesium	µg/L	0.01-0.2	NG	NG	<0.01	<0.2				0.028					0.018	0.043
Chromium	µg/L	0.1-2.0	NG	NG	0.16	<2.0	0.34	<0.1	<0.1	0.55	0.49	0.14	2.61	4.69	<0.1	1.95
Cobalt	µg/L	0.10	NG	NG	0.19	1140	0.27	0.13	0.18	0.22	0.31	4.45	137	185	32.2	135
Copper	µg/L	0.2-4.0	NG	NG	1.7	2.0	1.99	2.29	2.25	2.29	1.88	2.58	29.5	29.8	2.2	24.9
Iron	µg/L	10.0	350	NG	5	**2050**	164	15	28	161	29	33	**3800**	**11,400**	259	**5490**
Lead	µg/L	0.05-1.0	NG	NG	<0.05	<1.0	0.115	<0.05	<0.05	0.126	<0.05	<0.05	0.16	0.8	<0.05	0.1
Lithium	µg/L	1.0	NG	NG	15.3	141	3.2	17.8	16.2	11.1	5.9	18.1	198	226	62.3	171
Magnesium	µg/L	5.0	NG	NG	65400	283000	14,800	48,800	60,000	40100	17,500	25,000	103,000	125,000	47300	103000
Manganese	µg/L	0.10	NG	NG	9.05	83300	61.2	15.9	43.4	10.1	24.5	288	4620	6950	1640	5130
Mercury	µg/L	0.005-0.1	NG	NG	<0.1	<0.005	0.0081	<0.005	<0.005	<0.005	0.0093	0.0087	<0.005	<0.005	<0.005	<0.005
Molybdenum	µg/L	0.05-1.0	NG	NG	1.01	<1.0	0.877	1.52	1.74	1.55	1.66	1.18	0.11	0.18	0.927	<0.1
Nickel	µg/L	0.50	NG	NG	1.87	2020	2	3.69	4.14	5.17	1.93	19.2	460	602	105	455
Phosphorus	µg/L	50-1000	NG	NG	<50	<1000				<50					<50	<100
Potassium	µg/L	50.0	NG	NG	7510	9600	7860	11,200	14,200	10000	4120	5.63	6680	6430	7070	5210
Rubidium	µg/L	0.20	NG	NG	1.45	4.2				1.49					2.6	4.18
Selenium	µg/L	0.05-1.0	NG	2.0	2.72	<1.0	0.158	1.19	0.602	0.484	1.89	1.26	1.23	0.96	0.571	0.69
Silicon	µg/L	50.0	NG	NG	4860	7500				4100					4280	9810
Silver	µg/L	0.01-0.2	NG	NG	<0.01	<0.2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02	<0.01	<0.02
Sodium	µg/L	50.0	NG	NG	27700	138000	32,800	28,000	47,100	41500	216,000	59,400	97,900	133,000	56800	139000
Strontium	µg/L	0.20	NG	NG	606	1340				497					396	662
Sulfur	µg/L	500	NG	NG	180000	879000				100000					191000	546000
Tellurium	µg/L	0.2-4.0	NG	NG	<0.2	<4.0				<0.2					<0.2	<0.4
Thallium	µg/L	0.01-0.2	NG	NG	0.054	<0.2	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	0.054	0.071	0.027	0.055
Thorium	µg/L	0.1-2.0	NG	NG	<0.1	<2.0				<0.1					<0.1	0.25
Tin	µg/L	0.1-2.0	NG	NG	<0.1	<2.0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2	<0.1	<0.2
Titanium	µg/L	0.3-6.0	NG	NG	<0.3	<6.0	2.68	<0.3	<0.3	<12	<1.2	1.27	<0.6	<6	<0.3	<0.6
Tungsten	µg/L	0.1-2.0	NG	NG	<0.1	<2.0				<0.1					<0.1	<0.2
Uranium	µg/L	0.01	NG	NG	7.01	2.33	0.803	8.86	7.96	3.02	1.24	1.59	4.46	5.63	1.58	3.69
Vanadium	µg/L	0.5-10	NG	NG	<0.5	<10.0	<0.5	<0.5	<0.5	1.06	<0.5	<0.5	<1	<1	<0.5	<1.0
Zinc	µg/L	1.00	NG	NG	3.3	2010	5.20	1.40	2.10	3.0	0.50	7.40	923	1190	47.7	942
Zirconium	µg/L	0.06-1.2	NG	NG	<0.06	<1.2				0.568					<0.06	<0.12
Laboratory Work Order Number					L2136818	L2211507	L2082450	L2100153	L2115119	L2136818	L2071158	L2082450	L2100153	L2115119	L2136818	L2185138
Laboratory Identification Number					L2136818-2	L2211507-1	L2082450-1	L2100153-1	L2115119-1	L2136818-1	L2071158-3	L2082450-5	L2100153-4	L2115119-4	L2136818-5	L2185138-3

Notes:

Screening completed on BC AWQG-FWAL STM [1] and LTA [2] guideline values.

[1] BC Ministry of Environment, Water Protection & Sustainability Branch (2018). British Columbia Approved Water Quality Guidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture Summary Report. 36 pp. Referenced for Freshwater Aquatic Life (FWAL) water use and Short Term Maximum (STM) guidelines.

[2] BC Ministry of Environment, Water Protection & Sustainability Branch. 2018. British Columbia Approved Water Quality Guidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture Summary Report. 36 pp. Referencedfor Freshwater Aquatic Life (FWAL) water use and Long Term Average (LTA) guidelines.

[3] Guideline is hardness dependant. Where results are above laboratory reportable detection limits, guideline limits have been evaluated based on individual sample hardness. Sample-specific guideline values are listed in parentheses after the laboratory result, where applicable.

[4] Guideline is for Chromium (IV) cation. Analytical results are for unspeciated Chromium. Where analytical results exceed the guideline, speciated analysis may be warranted.

[5] Guideline is pH dependant.

NG - No Guideline

Detection limit can vary as described in the COA. Detection limit can be raised when dilution is requited due to high Dissolved Solids/Electrical Conductivity (DLDS). e.g. nitrite.

BOLD and shaded dark gray: Exceeds BCAWQG-FSTM (Short-term Maximum) guideline.

Shaded Light Gray: Exceeds BCAWQG-LTA (Long-term Average) guideline.

RED - Measured value is below detection limit (DL); value shown is 50% of DL.

Blank - Not analyzed

TETRA TECH

Table B5: Other Sampling Locations Surface Water Analytical Results

Parameter	Unit	RDL	BC AWQG - FWAL STM [1]	BC AWQG-FWAL LTA [2]	Gully Rd Ditch						Wiley C.
					24-May-18	19-Jun-18	26-Jul-18	21-Aug-18	27-Sep-18	22-Oct-18	27-Sep-18
Physical Parameters											
							12:10		12:01	12:57	10:55
Flow Rate (L/s)	L/sec						0.10		0.10	0.10	0
Electrical Conductivity (EC)	µS/cm	2.0	NG	NG	2050	1610	2330	1520	1890	1690	2850
Hardness as $CaCO_3$	µg/L	500	NG (Acceptable ranges exist when calculating exceedances for Cd, Cu, Pb, Mn, Zn, F)	NG (Acceptable ranges exist when calculating exceedances for Cd, Cu, Pb, Mn, Zn, F)	850,000	582,000	1010000	493000	709000	695000	1800000
pH	pH Units	0.10	6.5 - 9	6.5-9.0	7.90	8.01	8.09	8.20	7.97	7.96	7.83
Total Dissolved Solids (TDS)	µg/L	10000	NG	NG	1540000	1190000	1860000	1060000	1320000	1230000	2830000
Total Suspended Solids (TSS)	µg/L	3000	NG	NG	319,000	70,500	245000	<3000	24000	29900	33400
Anions and Nutrients											
Acidity (Total as $CaCO_3$)	µg/L	1000	NG	NG					7800		4700
Alkalinity (Bicarbonate as $CaCO_3$)	µg/L	1000	NG	NG	234,000	245,000	254000	206000	294000	303000	116000
Alkalinity (Carbonate as $CaCO_3$)	µg/L	1000	NG	NG	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Hydroxide) as $CaCO_3$	µg/L	1000	NG	NG	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Alkalinity (Total as $CaCO_3$)	mg/L	1.0	NG	NG	234	245	254	206	294	303	116
Ammonia (NH_4 as N)	µg/L	5.0	pH dependent (6.5-9.0)	pH dependent (6.5-9.0)	83.8	59.0	358	19.6	335	266	<5.0
			pH dependent (at Temp 4 °C)		6220	6220	4950	3950	6220	6220	8770
				pH dependent (at Temp 4 °C)	1430	1200	952	759	1200	1200	1690
Chloride (Cl^-)	µg/L	500	600,000	150,000	320,000	244,000	284000	185000	212000	221000	38000
Nitrate (NO_3^- as N)	µg/L	5.0-100	NG	NG	290	304	82	208	143	170	<100
Nitrite (NO_2^- as N)	µg/L	1.0-20	60	20	10	17	<10	12	7.9	<5.0	<20
Sulphate (SO_4) [3]	µg/L	300.00	NG	309,000 - 429,001	440,000	363,000	676000	333,000	396000	340000	1850000
SO_4 STM & LTA Guideline Calc (Based on Hardness as CaCO3)	µg/L		NG	Hardness 76,000-180,000 = 309,000 Hardness 181,000-250,000 = 429,000; Hardness > 250,000 site-specific	429000	429000	429000	429000	429000	429000	429000
Metals, Total											
Aluminum	µg/L	3.00	NG	NG	164	76.5	4810	79.7	403	317	6720
Antimony	µg/L	0.1-0.2	NG	NG	0.17	0.16	0.12	<0.1	<0.1	<0.1	<0.2
Arsenic	µg/L	0.10	5.0	5.0	0.43	0.33	3.3	0.27	0.45	0.36	1.12
Barium	µg/L	0.10	NG	NG	57.9	46.8	73.8	38.8	45.8	46.3	16.1
Beryllium	µg/L	0.10	NG	NG	<0.1	<0.1	1.37	<0.1	0.11	0.11	1.74
Bismuth	µg/L	0.05-0.10		NG			<0.05	<0.05	<0.05	<0.05	<0.1
Boron	µg/L	10.0	1200	1200	234	267	266	286	201	153	160
Cadmium	µg/L	0.005	NG	NG	0.472	0.0518	3.53	0.0067	0.578	0.44	6.63
Calcium	µg/L	50	NG	NG	223,000	146,000	232000	114000	187000	169000	464000
Cesium	µg/L	0.01		NG			0.033	0.017	0.011	0.011	0.024
Chromium [4]	µg/L	0.1-0.7	NG	NG	0.36	0.1	3.33	0.12	0.23	0.22	<0.7
Cobalt	µg/L	0.10	110	4.0	2.38	1.64	49.4	1.76	14.6	9.29	**179**
Copper [3]	µg/L	0.50	Calc. based on Hardness	2 to 10	1.66	0.93	28.3	0.94	3.4	2.56	4.5
Cu STM Guideline Calc.	µg/L		Hardness 13,000 - 400,000 : calc.; Hardness ≥ 400,000 is Capped Value of 400,000		39.60	39.60	39.60	39.60	39.60	39.60	39.60
Cu LTA Guideline Calc.	µg/L			Hardness 50,000 -250,000: calc.; Hardness > 250,000, Cu = 10	10	10	10	10	10	10	10
Iron	µg/L	10	1000	NG	419	163	**17100**	61	**1470**	**1650**	61
Lead [3]	µg/L	0.05-0.1	Calc. based on Hardness	Calc. based on Hardness	0.119	0.054	0.335	<0.05	<0.05	<0.05	<0.1
Pb STM Guideline Calc (Based on Hardness as $CaCO_3$)	µg/L		Applies to Hardness 8000-360,000 Hardness ≤ 8000: 3 Hardness > 8000 : calc.		1245	768.5586518	1550.4	622.2	988.1	963.3	3235.1
Pb LTA Guideline Calc (Based on Hardness as $CaCO_3$)	µg/L			Applies to Hardness 8000-360,000 Hardness ≤ 8000, NG Hardness > 8000 : calc.	52	33	64	28	42	41	129
Lithium	µg/L	1.0	NG	NG	72.2	57.6	90.6	59.7	55.1	44.5	325
Magnesium	µg/L	5.0	NG	NG	68,000	53,300	84400	50500	71400	56300	174000
Manganese [3]	µg/L	0.10	Calc. based on hardness	Calc. based on Hardness	185	70.8	1570	32.7	653	412	2350
Mn STM Guideline Calc (Based on Hardness as $CaCO_3$)	µg/L		Applies to Hardness 25000-259000 µg/L Mn : calc.		9907	6953.64	11670	5973	8353	8199	20376
Mn LTA Guideline Calc (Based on Hardness as $CaCO_3$)	µg/L			Applies to Hardness 37000-450000 µg/L Mn : calc.	4345	3166	5049	2774	3725	3663	8525
Mercury (Based on methyl Hg & total mass Hg)	µg/L	0.005	NG	Calc.	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Molybdenum	µg/L	0.05	2000	≤ 1000	2.58	1.77	2.33	1.67	1.63	1.21	0.33
Nickel	µg/L	0.5	NG		22.1	15	150	19	52.4	36.4	1110
Phosphorus	µg/L	50-100	NG	NG			341	<50	<50	<50	<100
Potassium	µg/L	50.0	NG	NG	6510	6930	7760	6510	6680	5960	13800
Rubidium	µg/L	0.2	NG	NG			3.24	2.34	1.97	1.4	4.93
Selenium	µg/L	0.05	NG	2.0	0.427	0.336	0.378	0.199	0.29	0.326	0.92

Table B5: Other Sampling Locations Surface Water Analytical Results

Parameter	Unit	RDL	BC AWQG - FWAL STM [1]	BC AWQG-FWAL LTA [2]	Gully Rd Ditch						Wiley C.
					24-May-18	19-Jun-18	26-Jul-18	21-Aug-18	27-Sep-18	22-Oct-18	27-Sep-18
Silicon	µg/L	100		NG			5680	3980	4590	4650	5980
Silver [3] (Based on Hardness < or > 100000)	µg/L	0.01-0.02	0.10 - 3.0	0.05 - 1.5	<0.01	<0.01	0.014	<0.01	0.012	<0.01	<0.02
Ag STM Guideline Calc	µg/L		Hardness ≤ 100,000 Ag = 0.10 Hardness > 100,000 Ag = 3.0		3.0	3.0	3.0	3	3	3	3
Ag LTA Guideline Calc				Hardness ≤ 100,000 Ag = 0.05 Hardness > 100,000 Ag = 1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Sodium	µg/L	50.0	NG	NG	172,000	177,000	156000	160000	152000	135000	37000
Strontium	µg/L	0.2	NG	NG			1400	896	1140	945	1330
Sulfur	µg/L	500	NG	NG			259000	121000	162000	124000	743000
Tellerium	µg/L	0.2-0.4	NG	NG			<0.2	<0.2	<0.2	<0.4	<0.4
Thallium	µg/L	0.01-0.055	NG	NG	0.039	0.023	0.036	0.014	0.012	0.01	0.063
Thorium	µg/L	0.1-0.2	NG	NG			8.7	<0.1	0.23	0.19	<0.2
Tin	µg/L	0.1-0.2	NG	NG	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2
Titanium	µg/L	0.3-1.2	NG	NG	2.73	0.94	3.27	0.74	0.36	0.63	<0.6
Tungsten	µg/L	0.1-0.2	NG	NG			<0.1	<0.1	<0.1	<0.1	<0.2
Uranium	µg/L	0.01	NG	NG	3.78	2.63	10.8	2.22	3.58	2.37	1.33
Vanadium	µg/L	0.5-1.0	NG	NG	<0.5	<0.5	0.98	<0.5	<0.5	<0.5	<1.0
Zinc [3] (Based on Hardness < or > 90,000)	µg/L	3.0	Calc. based on Hardness	Calc. based on Hardness	17.5	4.30	**414**	1.5	66.6	57.2	**1190**
Zn STM Guideline Calc.	µg/L		Hardness 90,000 - 500,000, Calc. Hardness > 500,000, is Capped Value of 500,000		340.50	340.50	340.50	335.25	340.50	340.50	340.50
Zn LTA Guideline Calc.				Hardness 90,000 - 330,000, Calc. Hardness > 330,000, is Capped Value of 330,000	187.50	187.50	187.50	187.50	187.50	187.50	187.50
Zirconium	µg/L	0.06-0.12	NG	NG			0.139	<0.06	<0.06	<0.06	<0.12
Metals, Dissolved											
Aluminum [5]	µg/L	1.0	100	50	25.4	34.0	**259**	56.1	91.3	53.4	**181**
Al STM Guideline Calc (based on pH)	µg/L		pH < 6.5 : calc. Al pH ≥ 6.5 : 100.0 Al		100.0	100.0	100	100	100	100	100
Al LTA Guideline Calc (based on median pH)				median pH < 6.5 : calc. Al median pH ≥ 6.5 : 50.0 Al	4953.0	4953.0	4953.0	4953.0	4953.0	4953.0	4953.0
Antimony	µg/L	0.1-0.2	NG	NG	0.15	0.12	0.12	<0.1	<0.1	<0.1	<0.2
Arsenic	µg/L	0.10	NG	NG	0.26	0.25	0.24	0.22	0.2	0.2	0.1
Barium	µg/L	0.10	NG	NG	56.8	50.6	53.7	36.7	40.2	42.4	14.4
Beryllium	µg/L	0.1-0.2	NG	NG	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2
Bismuth	µg/L	0.05-0.1	NG	NG			<0.05	<0.05	<0.05	<0.05	<0.1
Boron	µg/L	10.0	NG	NG	226	238	279	259	205	174	159
Cadmium [3] (Based on Hardness as $CaCO_3$)	µg/L	0.005	Calc. based on Hardness	Calc. based on hardness	0.437	0.0441	1.05	<0.005	0.406	0.326	**5.94**
Cd STM Guideline Calc.	µg/L		Hardness 7,000 - 455,000, Calc. Hardness > 455,000, is Capped Value of 455,000		2.80	2.80	2.80	2.80	2.80	2.80	2.80
Cd LTA Guideline Calc.				Hardness 3,400 - 285,000, Calc. Hardness > 285,000, is Capped Value of 285,000	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Calcium	µg/L	50.0	NG	NG	234,000	145,000	255000	116000	182000	181000	444000
Cesium	µg/L	0.01	NG	NG			0.02	0.016	0.013	<0.01	0.022
Chromium	µg/L	0.10	NG	NG	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2
Cobalt	µg/L	0.10	NG	NG	2.22	1.58	36	1.54	12.8	8.33	172
Copper	µg/L	0.20	NG	NG	1.17	0.72	1.51	0.8	1.23	0.99	1.78
Iron	µg/L	10.0-20.0	350	NG	19.0	<10	<10	<10	<10	13	10
Lead	µg/L	0.05-0.1	NG	NG	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1
Lithium	µg/L	1.0	NG	NG	75	53.9	97.7	53.6	56.7	48.8	337
Magnesium	µg/L	5.0	NG	NG	64,500	53,300	90000	49200	62100	58900	167000
Manganese	µg/L	0.10	NG	NG	173	71.8	1470	30	603	382	2290
Mercury	µg/L	0.005	NG	NG	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Molybdenum	µg/L	0.05	NG	NG	2.82	1.84	2.38	1.62	1.66	1.51	0.31
Nickel	µg/L	0.50	NG	NG	21.1	14.6	110	17.3	45.5	31.9	1060
Phosphorus	µg/L	50.0-100.0	NG	NG			<50	<50	<50	<50	<100
Potassium	µg/L	50.0	NG	NG	6720	7340	7480	6420	5870	6180	13000
Rubidium	µg/L	0.20	NG	NG			3.13	2.34	1.76	1.42	4.34
Selenium	µg/L	0.05	NG	2.0	0.407	0.375	0.266	0.184	0.332	0.323	1.11
Silicon	µg/L	50.0	NG	NG			3880	3730	4030	4200	5300
Silver	µg/L	0.01-0.02	NG	NG	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02
Sodium	µg/L	50.0	NG	NG	171,000	172,000	160000	151000	146000	136000	38100
Strontium	µg/L	0.20	NG	NG			1480	921	1140	1010	1240
Sulfur	µg/L	500	NG	NG			260000	112000	149000	123000	701000
Tellerium	µg/L	0.2-0.4	NG	NG			<0.2	<0.2	<0.2	<0.2	<0.4
Thallium	µg/L	0.01	NG	NG	0.041	0.023	0.036	0.015	0.013	<0.01	0.064

Table B5: Other Sampling Locations Surface Water Analytical Results

Parameter	Unit	RDL	BC AWQG - FWAL STM [1]	BC AWQG-FWAL LTA [2]	Gully Rd Ditch						Wiley C.
					24-May-18	19-Jun-18	26-Jul-18	21-Aug-18	27-Sep-18	22-Oct-18	27-Sep-18
Thorium	µg/L	0.1-0.2	NG	NG			<0.1	<0.1	<0.1	<0.1	<0.2
Tin	µg/L	0.1-0.2	NG	NG	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2
Titanium	µg/L	0.3-0.6	NG	NG	0.34	<0.3	<0.3	<0.3	<0.3	<0.3	<0.6
Tungsten	µg/L	0.1-0.2	NG	NG			<0.1	<0.1	<0.1	<0.1	<0.2
Uranium	µg/L	0.01	NG	NG	3.85	2.5	8.77	2.12	3.2	2.56	1.02
Vanadium	µg/L	0.5-1.0	NG	NG	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1.0
Zinc	µg/L	1.00	NG	NG	13.10	4.10	28.2	0.5	30.6	29.3	800
Zirconium	µg/L	0.06-0.12	NG	NG			<0.06	<0.06	<0.06	<0.06	<0.12
Laboratory Work Order Number					L2100153	L2115118	L2136818	L2150694	L2172306	L2185138	L2172306
Laboratory Identification Number					L2100153-9	L2115118-3	L2136818-7	L2150694-3	L2172306-3	L2185138-4	L2172306-11

Notes:

Screening completed on BC AWQG-FWAL STM [1] and LTA [2] guideline values.

[1] BC Ministry of Environment, Water Protection & Sustainability Branch (2018). British Columbia Approved Water Quality Guidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture Summary Report. 36 pp. Referenced for Freshwater Aquatic Life (FWAL) water use and Short Term Maximum (STM) guidelines.

[2] BC Ministry of Environment, Water Protection & Sustainability Branch. 2018. British Columbia Approved Water Quality Guidelines (BCAWQG): Aquatic Life, Wildlife & Agriculture Summary Report. 36 pp. Referencedfor Freshwater Aquatic Life (FWAL) water use and Long Term Average (LTA) guidelines.

[3] Guideline is hardness dependant. Where results are above laboratory reportable detection limits, guideline limits have been evaluated based on individual sample hardness. Sample-specific guideline values are listed in parentheses after the laboratory result, where applicable.

[4] Guideline is for Chromium (IV) cation. Analytical results are for unspeciated Chromium. Where analytical results exceed the guideline, speciated analysis may be warranted.

[5] Guideline is pH dependant.

NG - No Guideline

Detection limit can vary as described in the COA. Detection limit can be raised when dilutation is requited due to high Dissolved Solids/Electrical Conductivity (DLDS), e.g. nitrite.

BOLD and shaded dark gray: Exceeds BCAWQG-FSTM (Short-term Maximum) guideline.

Shaded Light Gray: Exceeds BCAWQG-LTA (Long-term Average) guideline.

RED - Measured value is below detection limit (DL); value shown is 50% of DL

Blank - Not analyzed