

Memo

To:	Shelley Potter, TMAC	Client:	TMAC Resources Inc.
From:	Eduardo Marquez, SRK Lisa Barazzuol, SRK	Project No:	1CT022.009
Cc:	Oliver Curran, TMAC John Roberts, TMAC	Date:	March 27, 2017
Subject:	Boston Ephemeral Stream Monitoring 2016 - FINAL		

1 Introduction

1.1 Project Background

At the Boston site, ore and waste rock were generated as part of a 1996/1997 BHP Billiton underground exploration program. The ore was placed in a number of stockpiles on the camp pad and the waste rock was used to construct a camp pad, roads and an airstrip at Boston. The ore/waste rock and associated runoff are managed as part of Water License 2BB-BOS1217 (Nunavut Water Board (NWB) 2012), and the Water and Ore/Waste Rock Management Plan for the Boston Site (SRK 2009).

As recommended in the management plan (SRK 2009), ephemeral streams downgradient of the waste rock pile have been monitored during spring freshet since 2009 to monitor the attenuation capacity of the tundra and to provide an indication of whether leachable constituents from the ore and waste rock piles are reaching the shoreline of Aimaokatalok Lake. This memo presents the results of the 2016 monitoring program.

1.2 Brief Summary

The results indicate that over the period from 2009 to 2016, concentrations of leachable constituents have been low, and trends over time are stable in the ephemeral streams downstream of the Boston ore stockpiles and camp. The results suggest that the tundra continues to effectively attenuate these constituents, ensuring that there is no impact along the shore line of Aimaokatalok Lake.

2 Methods

2.1 Sample Collection

Five ephemeral streams have been identified in previous surveys at the site, as shown in Figure 1. Each of these areas was surveyed for flow by SRK Consulting (SRK) on June 12, 2016. Flow

was observed at stations C2 and D2 only and may be related to peak freshet occurring prior to the site visit. Samples were collected from station C2 and D2 for laboratory analysis. Field measurements included pH, electrical conductivity (EC), ORP and temperature. The water quality samples were submitted by SRK for laboratory testing at ALS Environmental (ALS) in Burnaby, British Columbia for pH, hardness, conductivity, total dissolved solids, alkalinity and species, anions, nutrients and dissolved metals (field filtered).

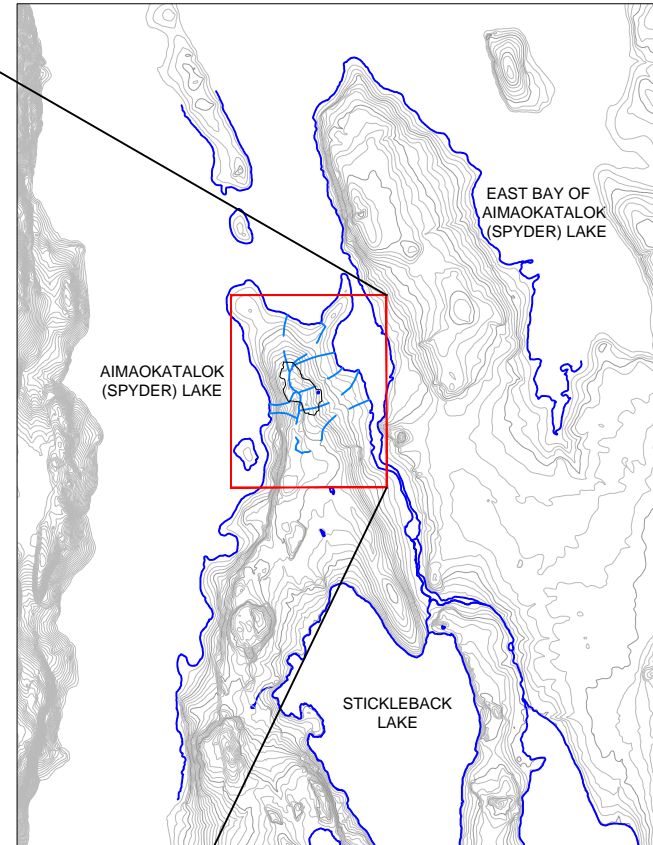
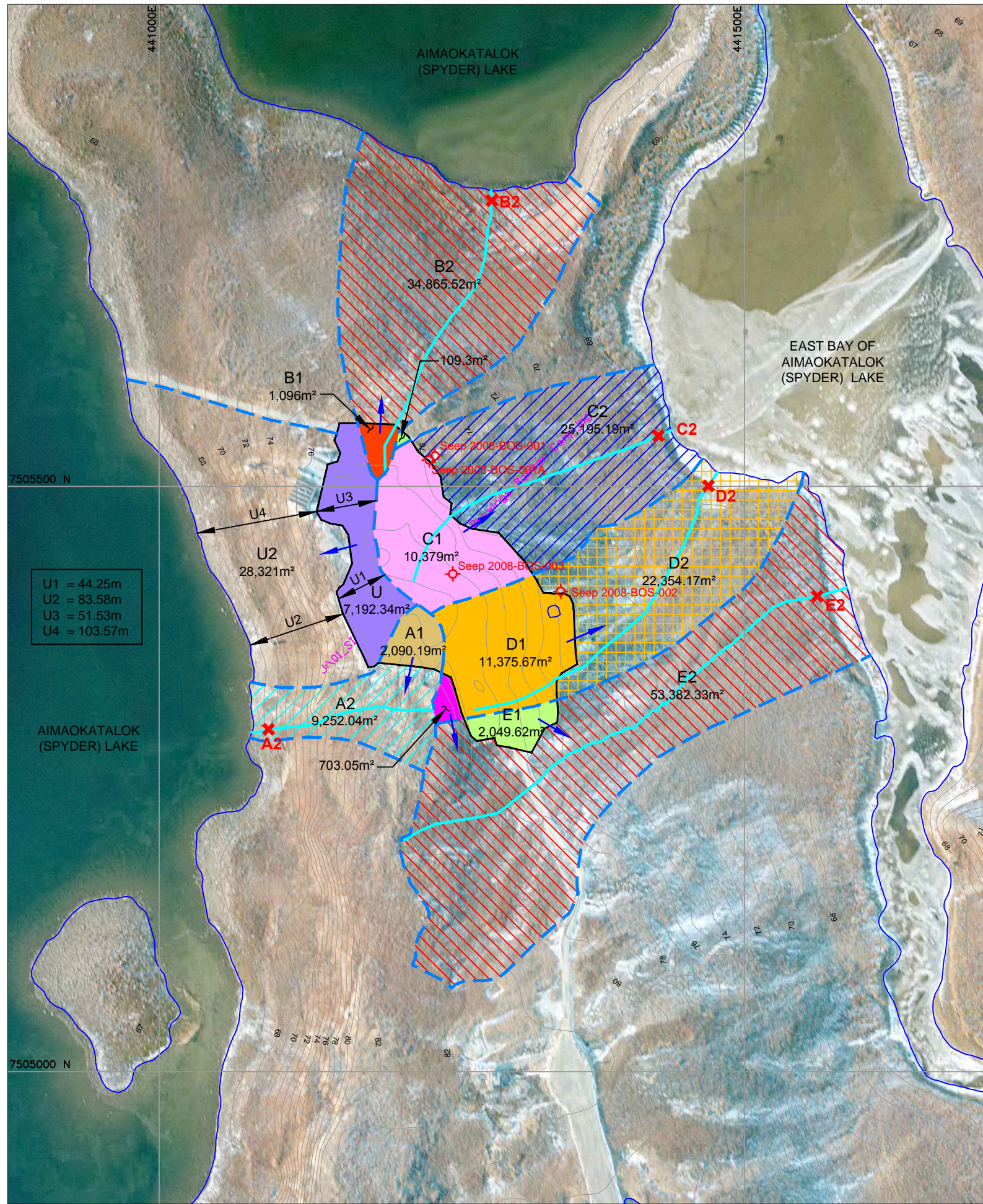
3 Quality Assurance and Control

One field duplicate, one field blank and one travel blank were collected as part of the quality assurance and control (QA/QC) program recommended by SRK. The QA/QC review of all data was conducted by SRK and deemed acceptable. In addition, ALS carried out its own QA/QC checks which were also deemed acceptable.

Ion charge imbalances ranged from -2.3 to -1.8% for the two samples taken at C2 and D2 and the field duplicate. These were deemed acceptable as they comply with SRK's criteria of $\pm 10\%$.

The field duplicate (16-EPH-F2) was taken at the sampling site C2 and compared to sample 16-EPH-C2. As per SRK's criteria, less than 10% of the parameters (with concentrations above 10 times the detection limit) had relative percent difference (RPD) values of over 30%, indicating a high reproducibility of sampling and low heterogeneity in the stream.

Field blanks typically indicate field contamination either due to sampling or environmental influences such as dust and ambient water. Three parameters (barium, sodium and tin) were detected in concentrations above two times the detection limit in the field blank (16-EPH-G2). Sodium and tin concentrations were low and did not indicate a significant bias in the data. The barium concentration in the field blank was comparable to concentrations at the C2 site and could indicate sample contamination for barium during sampling. All parameter concentrations were below the detection limits for the travel blank.



Legend

- Contours (1m)
- Ephemeral streams
- Camp pad perimeter
- A2, B2, C2, D2, E2, U2
- Dilution Zone (Hatch)
- Catchment Boundary
- Flow direction
- Seepage Sampling Station
- 25,195.19m²
- Catchment Areas
- Ephemeral Stream Sampling Station

1:4000 0 50 100 150 200 Metres



TMAC Resources

Hope Bay Project

Boston Ephemeral Stream Monitoring

Ephemeral Stream Monitoring Locations

SRK JOB NO.: 1CT022.009.100
FILE NAME: Boston_Catchments_20160324.dwg

DATE: March 2016 APPROVED: FIGURE: 1

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4 Results

4.1 Field Observations

Field parameters for the two ephemeral streams sampled in 2016 are presented in Table 1. Flow at C2 was lower than in previous years and could be due to peak freshet occurring earlier than the field sampling. EC levels in stream D2 was higher than C2. Compared to previous years, EC levels for C2 and D2 were at least four times lower than in 2015 but consistent with 2012 to 2013 levels. Field pH values were neutral, consistent with previous years.

Table 1: 2016 Field Observations

Sample ID	Field pH <i>s.u.</i>	Field EC $\mu\text{S/cm}$	ORP <i>mV</i>	Temperature $^{\circ}\text{C}$	Flow <i>L/s</i>	Comments
16-EPH-C2	7.4	98	70	20	0.94	Shallow with low flow. Low damp areas with willow shrubs throughout. Leaves and lichen on bottom.
16-EPH-D2	7.3	370	120	16	0.38	Shallow with low flow. Low damp areas with willow shrubs throughout. Leaves and lichen on bottom. Channel splits into many channels that enter the lake.

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4.2 Laboratory Results

A summary of water quality results for 2016 is provided in Table 2. Full results of the 2016 water quality data are presented in Attachment A. A summary of the 2016 water quality data is as follows:

- Sulphate concentrations in both C2 and D2 streams are either the lowest or among the lowest concentrations measured to date at those streams.
- Alkalinity levels were equivalent to previous years.
- Compared to the respective historical averages, iron concentrations were 3 times higher at C2 stream and may be related to iron colloids passing through the filter. Results for D2 were consistent with previous years.
- Chloride concentrations in both C2 and D2 streams were low relative to previous years.
- Nitrate was below analytical detection in the 2016 samples.
- Concentrations of the remaining dissolved metals presented in Table 2 were either consistent with previous years or decreased between 2015 and 2016.

Table 2: Summary of Water Quality Results for Stations C2 and D2, 2009 – 2016

Sample ID	Year	Anions and Nutrients					Dissolved Metals								
		Alkalinity, Total (as CaCO ₃)	Ammonia	Chloride	Nitrate	Sulphate	Aluminum	Arsenic	Cadmium	Copper	Iron	Lead	Nickel	Selenium	Zinc
		mg/L as CaCO ₃	mg/L as N	mg/L	mg/L as N	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
C2	2009	42	<0.02	170	<0.005	48	0.014	<0.0015	<0.000017	0.0017	<0.03	<0.00005	0.003	<0.001	0.0014
	2010	44	0.083	200	3	220	0.011	0.0021	<0.00005	0.002	0.071	0.0002	0.0084	0.0018	0.0071
	2011	29	0.05	42	1.2	85	0.02	0.006	<0.00005	0.001	<0.03	<0.00005	0.0049	<0.001	<0.003
	2012	44	0.01	110	1.4	220	0.012	0.0017	0.000012	0.0016	0.033	<0.00005	0.006	0.00038	0.0021
	2013	64	0.0093	140	1.5	300	0.014	0.0026	0.00002	0.002	0.035	<0.00005	0.0076	0.0004	0.0028
	2014	61	0.0078	66	0.46	230	0.016	0.0038	0.000013	0.0025	0.012	<0.00005	0.0097	0.00033	0.0025
	2015	53	0.014	61	0.42	270	0.014	0.0023	0.0000056	0.002	0.027	<0.00005	0.0079	0.00035	0.0022
	2016	40	0.0097	16	<0.005	12	0.021	0.00048	<0.000005	0.0018	0.12	<0.00005	0.0013	<0.00005	0.0023
D2	2009	25	0.024	460	4	200	0.012	<0.002	<0.000085	0.0016	<0.03	<0.00025	0.0053	<0.006	<0.005
	2010	30	0.03	550	2.1	220	0.0057	<0.003	<0.00025	0.0014	<0.03	<0.00025	0.0083	<0.005	<0.005
	2011	29	0.12	190	1	63	0.0063	0.0024	<0.000050	0.00076	<0.030	<0.000050	0.0058	0.0015	<0.0030
	2012	31	0.0065	370	0.3	160	0.0067	0.00093	0.000016	0.001	<0.010	<0.000050	0.006	0.00077	0.0025
	2013	35	0.0069	420	0.12	190	0.0066	0.0012	0.000026	0.00092	0.021	<0.000050	0.0069	0.00056	0.0034
	2014	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2015	42	0.018	250	0.31	250	0.0031	0.0014	0.0000094	0.0011	0.011	<0.00005	0.0085	0.00062	0.0043
	2016	49	0.0075	83	<0.005	85	0.017	0.0010	<0.000005	0.0011	0.020	<0.00005	0.0034	0.000063	0.0024

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5 Discussion

Seepage chemistry predictions were made as part of the Water and Ore/Waste Rock Management Plan (SRK 2009). The report calculated predicted and maximum predicted concentrations of sulphate, chloride, nitrate, arsenic, copper, iron, nickel and selenium that were expected to discharge from the ore stockpile. Table 3 presents these model predictions compared to the 2016 reported concentrations of these parameters. A comparison of the 2016 data with the model predictions shows that all parameter concentrations were below both the predicted values and the maximum predicted values at streams C2 and D2.

It is unclear if the high dissolved iron concentration in the C2 stream is a reflection of natural variation in the stream and/or presence of colloids which can pass through the filter. This concentration was approximately four times lower than the predicted value and 10 times lower than the maximum predicted concentration.

Table 3: Comparison of 2016 Water Quality Results to Model Predictions (SRK 2009)

Parameters	Units	Predicted Value		Max Predicted Value		2016	
		C2	D2	C2	D2	C2	D2
Chloride	mg/L	140	160	560	640	16	83
Nitrate (as N)	mg/L	5.4	6.3	15	17	<0.005	<0.005
Sulphate	mg/L	110	130	190	220	12	85
Arsenic	mg/L	0.048	0.056	0.1	0.1	0.00048	0.001
Copper	mg/L	0.0026	0.0028	0.004	0.005	0.0018	0.0011
Iron	mg/L	0.43	0.44	1.2	1.3	0.12	0.02
Nickel	mg/L	0.15	0.17	0.51	0.59	0.0013	0.0034
Selenium	mg/L	0.0021	0.0024	0.0053	0.0061	<0.00005	0.000063

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6 Conclusions and Recommendations

Monitoring of the ephemeral streams A2, B2, C2, D2 and E2 (Figure 1) was initiated in 2009. In 2016, flow was observed and samples were collected from C2 and D2.

The analysis of the water quality trends for ephemeral streams C2 and D2 indicated that concentrations of most of the potential contaminants of concern (nitrate, aluminum, arsenic, cadmium, copper, iron, nickel and selenium), as identified by the water and load balance (SRK 2009), are either decreasing or at stable in the ephemeral streams downstream of the Boston ore stockpiles and camp area. Only iron in stream C2 showed anomalously high concentrations in 2016 which may either be natural variation in the streams or colloids passing through the filter.

The lower concentrations as well as the low variation in concentrations indicate that the tundra continues to effectively attenuate contaminants of concern and the breakthrough of the effectiveness of the attenuation process has not occurred. Sulphate and chloride levels are not attenuated by the tundra and the low levels measured in 2016 validate the 2009 water and load balance. Overall, the water quality from the ephemeral streams is stable. Ongoing monitoring is recommended for the routine ephemeral stream sampling sites.

SRK Consulting (Canada) Inc.

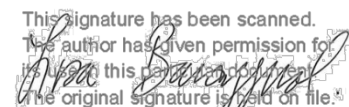
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7 References

Nunavut Water Board, 2012. Water Licence No: 2BB-BOS1217. August 7, 2012.

SRK Consulting (Canada) Inc., 2009. Water and Ore/Waste Rock Management Plan for the Boston Site Hope Bay Project, Nunavut. Report 1CH008.022 for Hope Bay Mining Ltd. July 2009.

Attachment A – 2016 Field Observations and Water Quality Results

Date	Time	Sampled	Station	Easting	Northing	Description	pH	Temperature	Conductivity	ORP	Flow	ALS Sample ID	Conductivity	Hardness (as CaCO3)	pH	Total Suspended Solids	Total Dissolved Solids	Acidity (as CaCO3)	Alkalinity, Bicarbonate (as CaCO3)	Alkalinity, Carbonate (as CaCO3)
Unit				UTM 13			pH units	°C	µS/cm	mV	L/s		uS/cm	mg/L	pH	mg/L	mg/L	mg/L	mg/L	mg/L
Lowest Detection Limit													2	0.5	0.1	3	1	1	1	1
12-Jun-16	10:07	No	16-EPH-A2	441104	7505317	Dry, wide channel with shallow depth. Ground moist.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12-Jun-16	-	No	16-EPH-B2	-	-	Could not pinpoint outlet location	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12-Jun-16	11:47	Yes	16-EPH-C2	441500	7505376	Shallow with low flow. Low damp areas with willow shrubs throughout. Leaves and lichen on bottom.	7.4	20	98	70	0.94	L1784702-1	160	56	7.6	<3	78	2.3	40	<1
12-Jun-16	13:15	Yes	16-EPH-D2	441676	7505413	Shallow with low flow. Low damp areas with willow shrubs throughout. Leaves and lichen on bottom. Channel splits into many channels that enter the lake.	7.3	16	370	120	0.38	L1784702-2	550	220	7.6	<3	300	3.1	49	<1
12-Jun-16	-	No	16-EPH-E2	-	-	Could not pinpoint outlet location	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12-Jun-16	-	Yes	Duplicate of 16-EPH-C2	-	-	-	-	-	-	-	-	L1784702-3	120	45	7.7	<3	61	1.9	31	<1
-	-	-	Field Blank	-	-	-	-	-	-	-	-	L1784702-4	<2	<0.5	6.4	<3	<1	1	<1	<1

Alkalinity, Hydroxide (as CaCO3)	Alkalinity, Phenolphthalein (as CaCO3)	Alkalinity, Total (as CaCO3)	Ammonia, Total (as N)	Bromide (Br)	Chloride (Cl)	Fluoride (F)	Nitrate (as N)	Nitrite (as N)	Phosphorus (P)- Total	Sulfate (SO4)	Anion Sum	Cation Sum	Cation - Anion Balance	Aluminum (Al)- Dissolved	Antimony (Sb)- Dissolved	Arsenic (As)- Dissolved	Barium (Ba)- Dissolved	Beryllium (Be)- Dissolved	Bismuth (Bi)- Dissolved	Boron (B)- Dissolved	Cadmium (Cd)- Dissolved	Calcium (Ca)- Dissolved	Chromium (Cr)- Dissolved	Cobalt (Co)- Dissolved
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	%	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	2	1	0.005	0.05	0.5	0.02	0.005	0.001	0.002	0.3				0.001	0.0001	0.0001	0.00005	0.00002	0.00005	0.01	0.000005	0.05	0.0001	0.0001
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-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<1	<2	40	0.0097	<0.05	16	0.031	<0.005	<0.001	0.021	12	1.5	1.4	-	0.021	<0.0001	0.00048	0.0042	<0.00002	<0.00005	<0.01	<0.000005	14	0.00011	0.00023
<1	<2	49	0.0075	0.12	83	0.049	<0.005	<0.001	0.0094	85	5.1	5.3	1.9	0.017	0.00035	0.001	0.026	<0.00002	<0.00005	0.03	<0.000005	60	0.00027	0.0002
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<1	<2	31	0.0067	<0.05	13	0.029	<0.005	<0.001	0.019	7.4	1.1	1.2	2.8	0.022	<0.0001	0.00037	0.004	<0.00002	<0.00005	<0.01	<0.000005	11	0.00017	0.00017
<1	<2	<1	<0.005	<0.05	<0.5	<0.02	<0.005	<0.001	<0.002	<0.3	<0.1	<0.1	-	<0.001	<0.0001	<0.0001	0.0053	<0.00002	<0.00005	<0.01	<0.000005	<0.05	<0.0001	<0.0001

Copper (Cu)- Dissolved	Iron (Fe)- Dissolved	Lead (Pb)- Dissolved	Lithium (Li)- Dissolved	Magnesium (Mg)-Dissolved	Manganese (Mn)- Dissolved	Mercury (Hg)- Dissolved	Molybdenum (Mo)- Dissolved	Nickel (Ni)- Dissolved	Phosphorus (P)- Dissolved	Potassium (K)- Dissolved	Selenium (Se)- Dissolved	Silicon (Si)- Dissolved	Silver (Ag)- Dissolved	Sodium (Na)- Dissolved	Strontium (Sr)- Dissolved	Sulfur (S)- Dissolved	Thallium (Tl)- Dissolved	Tin (Sn)- Dissolved	Titanium (Ti)- Dissolved	Uranium (U)- Dissolved	Vanadium (V)- Dissolved	Zinc (Zn)- Dissolved	Zirconium (Zr)- Dissolved
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.0002	0.01	0.00005	0.001	0.1	0.0001	0.000005	0.00005	0.0005	0.05	0.1	0.00005	0.05	0.00001	0.05	0.0002	0.5	0.00001	0.0001	0.0003	0.00001	0.0005	0.001	0.0003
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0.0018	0.12	<0.00005	<0.001	5.3	0.044	<0.000005	0.00031	0.0013	<0.05	1	<0.00005	1.2	<0.00001	6.7	0.064	3.8	<0.00001	<0.0001	0.00053	0.000044	<0.0005	0.0023	<0.0003
0.0011	0.02	<0.00005	0.0069	18	0.0018	<0.000005	0.00051	0.0034	<0.05	2.2	0.000063	1.6	<0.00001	19	0.39	29	<0.00001	<0.0001	0.00067	0.000014	<0.0005	0.0024	<0.0003
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.0015	0.13	<0.00005	<0.001	4.1	0.026	<0.000005	0.00022	0.0011	<0.05	1	<0.00005	0.94	<0.00001	6.1	0.05	2.8	<0.00001	<0.0001	0.00054	0.000037	<0.0005	0.0012	<0.0003
<0.0002	<0.01	<0.00005	<0.001	<0.1	<0.0001	<0.000005	<0.00005	<0.0005	<0.05	<0.1	<0.00005	<0.05	<0.00001	0.29	<0.0002	<0.5	<0.00001	0.00023	<0.0003	<0.00001	<0.0005	<0.001	<0.0003