Enos Lake 2017 Annual Water Quality Technical Report

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Introduction

In late February 2017, FW Developments Ltd. contracted BC Conservation Foundation (BCCF) to undertake the first quarter of 2017 water sampling based on parameters and sampling procedures outlined in the *Enos Lake Protection and Monitoring Program* (ELPMP [PGL 2016]). Sampling was completed on March 2, 8, 13, 16 and 23, 2017.

In late May, BCCF received a contract to complete the second quarter component of the program. Sampling was completed on June 2, 2017.

In mid-August, BCCF was awarded a third contract to complete the remainder of the 2017 sampling program in partnership with a local stewardship group, *Friends of Enos Lake*. The third quarter component was completed on August 24 and 29, and September 5, 11 and 14, 2017. The fourth quarter component was completed on November 20, 2017.

This report presents a summary of the findings from the 2017 water sampling program. The report includes the suggestions for reporting outlined in the ELPMP including, but not limited to:

- A summary of work performed, including dates, individuals, weather conditions, methods, QA/QC protocols, and any challenges encountered during the work
- A presentation of the water quality results presented in graphical form compared against the targets listed in the ELPMP
- A summary of preventative actions taken with respect to aquatic invasive species undertaken in the past year (e.g. signage, educational materials for residents or visitors, etc.)
- Any anecdotal observations related to Enos Lake ecology, including but not limited to aquatic invasive species
- An interpretation of the results of the program for the past year, conducted by an experienced, qualified limnologist provided in report form, including but not limited to input provided for storm water management practices or new phases of construction (included as an appendix)
- Recommendations for augmentation to the program, if relevant.
- Laboratory certificates and raw data for the year, as appendices.

Methods

Scope of Work

BCCF conducted water quality sampling in Enos Lake as described in the ELPMP (Table 1). All sampling outlined in the program was completed in 2017. During each field session, samples were collected from site SWMP-03 (Figure 1), located in the deepest part of the lake. In August, *E. Coli* and surface sediment samples were also collected in shallow water at the north

and south ends of the lake, sites SWMP-04 and SWMP-06, respectively (Figure 1). All sites were accessed by boat.

Table 1: Overview of the 2017 Enos Lake Protection and Monitoring Program

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Dissolved Oxygen		F			F			F			F	
Temperature		F			F			F			F	
Redox potential		F			F			F			F	
pH		F			F			F			F	
Secchi Depth		F			F			F			F	
Chlorophyll a		L			L			L			L	
Phosphorus		L			L			L			L	
E. Coli								E				
Metals		M						M				
Hardness		M						M				
PAH								P				

Legend:
L= Water sample from three depths at SWMP-03
F = 1m in-situ profiles from SWMP-03
E = Five samples in 30 days, from SWMP-03 and any two shoreline locations
M = Five samples in 30 days, from SWMP-03
P = Surface sediment from SWMP-03, SWMP-06 and SWMP-04
Source: Table 3.1 of the Enos Lake Protection and Monitoring Program (PGL 2016)

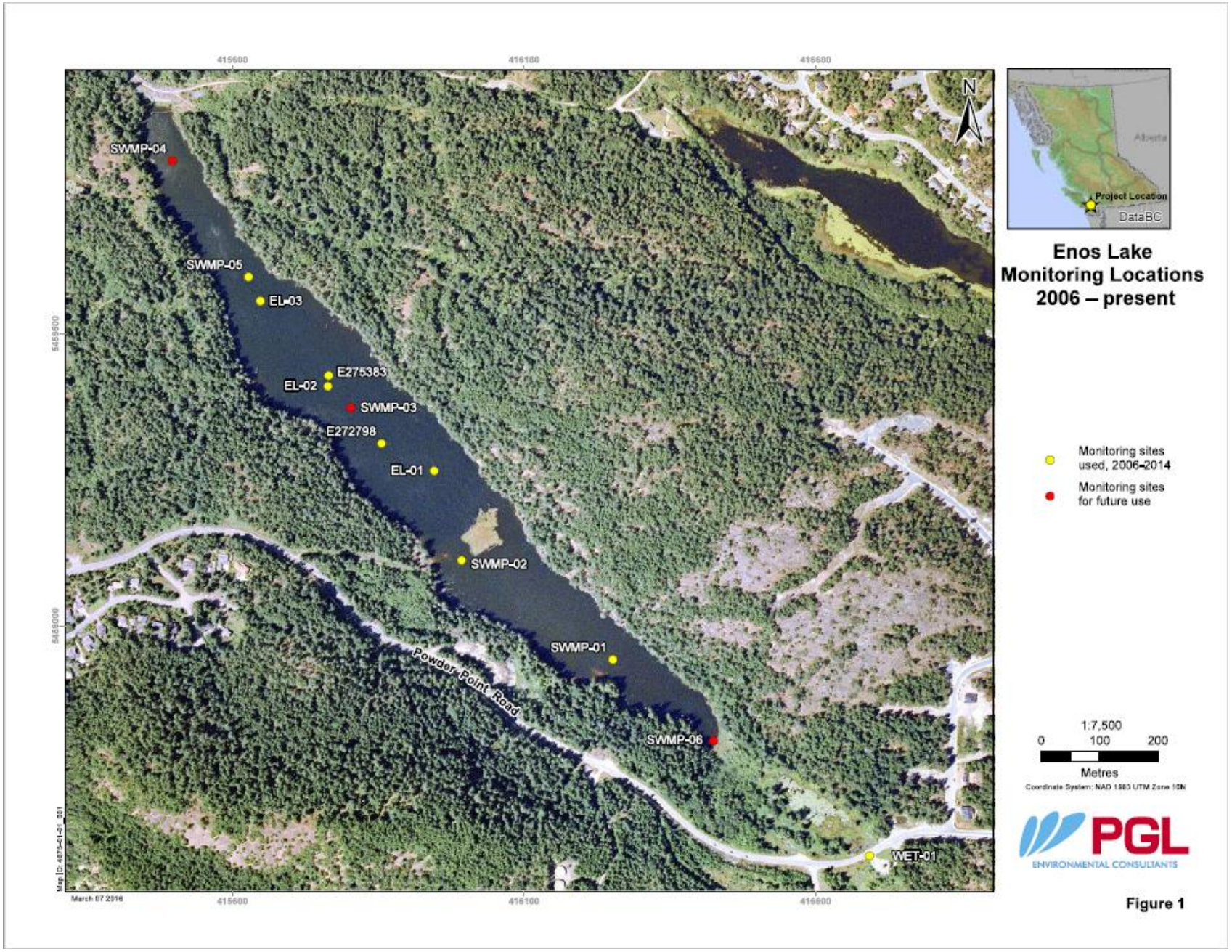

Figure 1: **Enos Lake Sampling Locations (PGL 2016).**

Field Equipment

The following equipment was utilized for sampling:

- YSI multi-parameter water quality meter (model Professional Plus)
- Notebook and pencil
- Secchi disk
- 1 L Van Dorn water sampler
- Boat (with electric motor)
- Personal Flotation Devices (PFDs)
- Sample bottles and jars provided by Maxxam Analytics
- Chain of Custody (COC) form to send to Maxxam with samples
- Cooler with ice
- Ekman grab sampler (for sediment sampling in August only)

Data Collection

In-situ Field Parameters

In-situ water quality parameters were collected once per sampling quarter at site SWMP-03. Readings were recorded at 1 m intervals throughout the water column. In-situ parameters included:

- Dissolved oxygen (mg/L)
- Temperature (°C)
- Conductivity (µS/cm)
- Redox potential (mV)
- pH

A Secchi depth (water clarity) measurement was also recorded once per quarter using a Secchi disk.

Water Samples

Water samples were collected at 1, 5 and 10 m depths. Surface (1 m) samples were collected by hand, and the deep water samples were collected using a 1 L Van Dorn water sampler. Water sampling procedures followed guidelines provided by Maxxam Analytics in addition to the guidelines outlined in the Ambient Freshwater and Effluent Sampling Manual (BC Ministry of Water, Land and Air Protection 2003). Water samples were placed in bottles provided by Maxxam and packed in a cooler with ice and completed COC form. Samples were shipped to Maxxam Analytics in Burnaby for analysis.

Sediment Samples

Sediment samples were collected on August 29th, 2017 using an Ekman grab sampler.

Analysis

Testing of all water and soil samples was conducted by Maxxam Analytics. Maxxam is a laboratory accredited facility for conducting water quality testing. All of their procedures, including Quality Assurance/ Quality Control (QA/QC), are based upon recognized Provincial and Federal methodologies. Water quality reports were sent to BCCF within one week of sample collection. As 2017 sampling was completed, results were compiled and sent to limnologist Rick Nordin (Victoria, BC) for analysis and comparison to water quality guidelines and to data collected previously on Enos Lake.

Results

Results for all parameters were below water quality targets outlined in the ELPMP apart from total phosphorus and dissolved oxygen concentrations in the hypolimnion. The annual average for total phosphorus in 2017 was 19 µg/L, which far exceeds the water quality target of 12 µg/L. Total phosphorus during spring overturn was 12.4 mg/L which only slightly exceeds the target. The water quality target for dissolved oxygen (DO) is greater than 2 mg/L in the hypolimnion. DO values were below this target in deep waters during the summer (June through August [Nordin 2017]). No signs of aquatic invasive species were observed during any of the sampling sessions.

Complete laboratory results are provided in Table 2. Field photos from the sampling program are provided in Appendix A. In-situ field parameter results from each quarter, including weather conditions and field personnel, are provided in Appendix B. Laboratory reports provided by Maxxam for each sampling event are provided in Attachment I. Rick Nordin's analysis of the 2017 water sampling results is summarized in his report titled, *Enos Lake Protection and Monitoring Program: Review of 2017 Water Quality Data*, provided in Attachment II.

Table 2: Summary of Water Quality Results from 2017 Sampling Program

2017 WATER QUALITY MONITORING PROGRAM LAB RESULTS			1st Quarter Sampling															2nd Quarter Sampling		
Sampling Date			2-Mar-17			8-Mar-17			13-Mar-17			15-Mar-17			Mar-23-17			2-Jun-17		
Site			SWMP-03			SWMP-03			SWMP-03			SWMP-03			SWMP-03			SWMP-03		
Depth			1 m	5 m	10 m	1 m	5 m	10 m	1 m	5 m	10 m	1 m	5 m	10 m	1 m	5 m	10 m	1 m	5 m	10 m
Water Quality Parameters	Units	RDL																		
Chlorophyll a	ug/L	0.50	11.4	13.5	10.8	-	-	-	-	-	-	-	-	-	-	-	-	3.76	14.2	11.5
Calculated Parameters																				
Total Hardness (CaCO3)	mg/L	0.5	49.1	44.8	43.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Inorganics																				
Dissolved Hardness (CaCO3)	mg/L	0.5	41.9	42.2	42.1	46.6	46.5	44.3	43.5	43.8	42.7	43.7	44	43.1	42.3	42.7	42.7	-	-	-
Microbiological Parameters																				
E. coli	CFU/100mL	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anions																				
Orthophosphate	mg/L	0.001	0.007	0.0065	0.0063	-	-	-	-	-	-	-	-	-	-	-	-	0.015	0.0015	0.0011
Nutrients																				
Total Phosphorus (P)	mg/L	0.002	0.012	0.0129	0.0123	-	-	-	-	-	-	-	-	-	-	-	-	0.0419	0.0218	0.0389
Dissolved Metals by ICPMS																				
Dissolved Aluminum (Al)	ug/L	3.0	-	-	-	21.4	22.3	24	21.5	22	22	21.4	22.3	24	18.2	18.4	18.2	-	-	-
Dissolved Antimony (Sb)	ug/L	0.50	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-
Dissolved Arsenic (As)	ug/L	0.10	-	-	-	0.14	0.13	0.13	0.14	0.14	0.13	0.14	0.13	0.13	0.14	0.15	0.14	-	-	-
Dissolved Barium (Ba)	ug/L	1.0	-	-	-	14.6	15.1	14.4	15.6	15.5	15.1	14.6	15.1	14.4	13.9	14.6	14.9	-	-	-
Dissolved Beryllium (Be)	ug/L	0.10	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	-	-	-
Dissolved Bismuth (Bi)	ug/L	1.0	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	-	-
Dissolved Boron (B)	ug/L	50	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-	-	-
Dissolved Cadmium (Cd)	ug/L	0.010	-	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.018	-	-	-
Dissolved Chromium (Cr)	ug/L	1.0	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	-	-
Dissolved Cobalt (Co)	ug/L	0.20	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	-	-	-
Dissolved Copper (Cu)	ug/L	0.20	-	-	-	0.76	1.30	1.00	0.61	0.60	0.82	0.76	1.3	1	0.76	1.70	1.03	-	-	-
Dissolved Iron (Fe)	ug/L	5	-	-	-	120	120	118	105	109	108	120	120	118	102	105	107	-	-	-
Dissolved Lead (Pb)	ug/L	0.20	-	-	-	<0.20	1.13	1.61	<0.20	0.48	1.63	<0.20	1.13	1.61	<0.20	1.73	0.63	-	-	-
Dissolved Lithium (Li)	ug/L	2.0	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	-	-	-
Dissolved Manganese (Mn)	ug/L	1.0	-	-	-	24.7	25.6	24.5	24.2	23.8	23.5	24.7	25.6	24.5	19.5	18.9	20.5	-	-	-
Dissolved Molybdenum (Mo)	ug/L	1.0	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	-	-
Dissolved Nickel (Ni)	ug/L	1.0	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	-	-
Dissolved Selenium (Se)	ug/L	0.10	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	-	-	-
Dissolved Silicon (Si)	ug/L	100	-	-	-	3930	3920	3630	3450	3460	3290	3930	3920	3630	3050	2970	3150	-	-	-
Dissolved Silver (Ag)	ug/L	0.020	-	-	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-	-	-
Dissolved Strontium (Sr)	ug/L	1.0	-	-	-	44.2	45.4	42.6	45	44.3	43	44.2	45.4	42.6	40.8	39.5	41	-	-	-
Dissolved Thallium (Tl)	ug/L	0.010	-	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	-	-
Dissolved Tin (Sn)	ug/L	5.0	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	-	-	-
Dissolved Titanium (Ti)	ug/L	5.0	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	-	-	-
Dissolved Tungsten (W)	ug/L	1.0	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	-	-
Dissolved Uranium (U)	ug/L	0.10	-	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	-	-	-
Dissolved Vanadium (V)	ug/L	5.0	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	-	-	-
Dissolved Zinc (Zn)	ug/L	5.0	-	-	-	<5.0	5.5	8.4	<5.0	<5.0	5.8	<5.0	5.5	8.4	<5.0	18.7	<5.0	-	-	-
Dissolved Zirconium (Zr)	ug/L	0.50	-	-	-	<0.50	<0.50	<0.50	0.12	<0.10	<0.10	<0.50	<0.50	<0.50	<0.10	0.1	0.1	-	-	-
Dissolved Calcium (Ca)	mg/L	0.05	-	-	-	16.1	16	15.2	14.7	14.9	14.5	16.1	16	15.2	14.3	14.6	14.5	-	-	-
Dissolved Magnesium (Mg)	mg/L	0.05	-	-	-	1.53	1.61	1.52	1.64	1.61	1.57	1.53	1.61	1.52	1.63	1.55	1.61	-	-	-
Dissolved Potassium (K)	mg/L	0.050	-	-	-	0.252	0.273	0.262	0.264	0.253	0.247	0.252	0.273	0.262	0.243	0.238	0.245	-	-	-
Dissolved Sodium (Na)	mg/L	0.05	-	-	-	7.09	7.07	7.22	7.24	7.12	7.01	7.09	7.07	7.22	7.29	6.97	7.11	-	-	-
Dissolved Sulphur (S)	mg/L	3.0	-	-	-	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	-	-	-
Additional Dissolved Metals by ICPMS																				
Dissolved Calcium (Ca)	ug/L	50	14200	14400	14300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Magnesium (Mg)	ug/L	50	1550	1530	1540	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Metals by ICPMS																				
Total Calcium (Ca)	ug/L	50	16800	15300	14700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Magnesium (Mg)	ug/L	50	1760	1600	1580	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CCME PAH IN SEDIMENTS BY GC-MS (SOIL)																				
Calculated Parameters																				
Index of Additive Cancer Risk(IARC)	N/A	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polycyclic Aromatics																				
Naphthalene	mg/kg	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2-Methylnaphthalene	mg/kg	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acenaphthylene	mg/kg	0.0051	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acenaphthene	mg/kg	0.0051	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluorene	mg/kg	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenanthrene	mg/kg	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anthracene	mg/kg	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluoranthene	mg/kg	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyrene	mg/kg	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(a)anthracene	mg/kg	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chrysene	mg/kg	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(b)fluoranthene	mg/kg	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(k)fluoranthene	mg/kg	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(a)pyrene	mg/kg	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	mg/kg	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dibenz(a,h)anthracene	mg/kg	0.0051	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	mg/kg	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Low Molecular Weight PAH`s	mg/kg	0.51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
High Molecular Weight PAH`s	mg/kg	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total PAH	mg/kg	0.51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Surrogate Recovery (%)																				
D10-ANTHRACENE (sur.)	%	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D8-ACENAPHTHYLENE (sur.)	%	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D8-NAPHTHALENE (sur.)	%	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TERPHENYL-D14 (sur.)	%	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Physical Properties																				
Moisture	%	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

2017 WATER QUALITY MONITORING PROGRAM LAB RESULTS	Third Quarter Sampling												
Sampling Date	24-Aug-17					29-Aug-17							
Site	SWMP-03			SWMP-4	SWMP-06		SWMP-03			SWMP-06		SWMP-04	
Depth	1 m	5 m	10 m	1 m	1 m	Sediment	1 m	5 m	10 m	1 m	Sediment	1 m	Sediment
Water Quality Parameters													
Chlorophyll a	4.88	8.16	28.3	-	-			-	-	-	-	-	-
Calculated Parameters													
Total Hardness (CaCO3)	-	-	-	-	-			-	-	-	-	-	-
Misc. Inorganics													
Dissolved Hardness (CaCO3)	54.3	48.7	49.8	-	-		49.2	45.5	45.7	-	-	-	-
Microbiological Parameters													
E. coli	1	-	-	5	9		1	-	-	7	-	7	-
Anions													
Orthophosphate	0.0032	0.0049	0.0011	-	-			-	-	-	-	-	-
Nutrients													
Total Phosphorus (P)	0.0118	0.0145	0.033	-	-			-	-	-	-	-	-
Dissolved Metals by ICPMS													
Dissolved Aluminum (Al)	29.4	9.8	12.9	-	-		26.3	8.3	12.7	-	-	-	-
Dissolved Antimony (Sb)	<0.50	<0.50	<0.50	-	-		<0.50	<0.50	<0.50	-	-	-	-
Dissolved Arsenic (As)	0.19	0.14	0.18	-	-		0.17	0.14	0.16	-	-	-	-
Dissolved Barium (Ba)	18.9	17.6	15.5	-	-		19	17.8	16.4	-	-	-	-
Dissolved Beryllium (Be)	<0.10	<0.10	<0.10	-	-		<0.10	<0.10	<0.10	-	-	-	-
Dissolved Bismuth (Bi)	<1.0	<1.0	<1.0	-	-		<1.0	<1.0	<1.0	-	-	-	-
Dissolved Boron (B)	<50	<50	<50	-	-		<50	<50	<50	-	-	-	-
Dissolved Cadmium (Cd)	<0.010	<0.010	<0.010	-	-		<0.010	<0.010	<0.010	-	-	-	-
Dissolved Chromium (Cr)	<1.0	<1.0	<1.0	-	-		<1.0	<1.0	<1.0	-	-	-	-
Dissolved Cobalt (Co)	<0.20	<0.20	0.27	-	-		<0.20	<0.20	0.23	-	-	-	-
Dissolved Copper (Cu)	0.54	0.66	0.35	-	-		0.97	0.65	0.24	-	-	-	-
Dissolved Iron (Fe)	16.1	26	1160	-	-		12	27.9	1420	-	-	-	-
Dissolved Lead (Pb)	<0.20	0.28	0.29	-	-		<0.20	<0.20	<0.20	-	-	-	-
Dissolved Lithium (Li)	<2.0	<2.0	<2.0	-	-		<2.0	<2.0	<2.0	-	-	-	-
Dissolved Manganese (Mn)	<1.0	2.8	537	-	-		<1.0	2.3	489	-	-	-	-
Dissolved Molybdenum (Mo)	<1.0	<1.0	<1.0	-	-		<1.0	<1.0	<1.0	-	-	-	-
Dissolved Nickel (Ni)	<1.0	<1.0	<1.0	-	-		<1.0	<1.0	<1.0	-	-	-	-
Dissolved Selenium (Se)	<0.10	<0.10	<0.10	-	-		<0.10	<0.10	<0.10	-	-	-	-
Dissolved Silicon (Si)	2140	2740	4180	-	-		1980	2600	3890	-	-	-	-
Dissolved Silver (Ag)	<0.020	<0.020	<0.020	-	-		<0.020	<0.020	<0.020	-	-	-	-
Dissolved Strontium (Sr)	55.1	47.2	48.8	-	-		53.1	46.7	47.6	-	-	-	-
Dissolved Thallium (Tl)	<0.010	<0.010	<0.010	-	-		<0.010	<0.010	<0.010	-	-	-	-
Dissolved Tin (Sn)	<5.0	<5.0	<5.0	-	-		<5.0	<5.0	<5.0	-	-	-	-
Dissolved Titanium (Ti)	<5.0	<5.0	<5.0	-	-		<5.0	<5.0	<5.0	-	-	-	-
Dissolved Tungsten (W)	<1.0	<1.0	<1.0	-	-		<1.0	<1.0	<1.0	-	-	-	-
Dissolved Uranium (U)	<0.10	<0.10	<0.10	-	-		<0.10	<0.10	<0.10	-	-	-	-
Dissolved Vanadium (V)	<5.0	<5.0	<5.0	-	-		<5.0	<5.0	<5.0	-	-	-	-
Dissolved Zinc (Zn)	<5.0	15	6.6	-	-		<5.0	<5.0	<5.0	-	-	-	-
Dissolved Zirconium (Zr)	<0.10	<0.10	<0.10	-	-		<0.10	<0.10	<0.10	-	-	-	-
Dissolved Calcium (Ca)	18.6	16.7	17.2	-	-		16.6	15.4	15.7	-	-	-	-
Dissolved Magnesium (Mg)	1.92	1.7	1.67	-	-		1.86	1.69	1.57	-	-	-	-
Dissolved Potassium (K)	1.93	0.31	0.364	-	-		0.337	0.289	0.312	-	-	-	-
Dissolved Sodium (Na)	1.94	7.73	7.38	-	-		8.42	7.39	7.05	-	-	-	-
Dissolved Sulphur (S)	1.95	<3.0	<3.0	-	-		<3.0	<3.0	<3.0	-	-	-	-
Additional Dissolved Metals by ICPMS													
Dissolved Calcium (Ca)	-	-	-	-	-		-	-	-	-	-	-	-
Dissolved Magnesium (Mg)	-	-	-	-	-		-	-	-	-	-	-	-
Total Metals by ICPMS													
Total Calcium (Ca)	-	-	-	-	-		-	-	-	-	-	-	-
Total Magnesium (Mg)	-	-	-	-	-		-	-	-	-	-	-	-
CCME PAH IN SEDIMENTS BY GC-MS (SOIL)													
Calculated Parameters													
Index of Additive Cancer Risk(IARC)	-	-	-	-	-		1.1	-	-	-	0.25	-	0.59
Polycyclic Aromatics													
Naphthalene	-	-	-	-	-	<0.017 (1)	-	-	-	-	<0.012 (1)	-	<0.010 (1)
2-Methylnaphthalene	-	-	-	-	-	<0.017 (1)	-	-	-	-	<0.012 (1)	-	<0.010 (1)
Acenaphthylene	-	-	-	-	-	<0.0084 (1)	-	-	-	-	<0.0058 (1)	-	<0.0051 (1)
Acenaphthene	-	-	-	-	-	<0.0084 (1)	-	-	-	-	<0.0058 (1)	-	0.0055 (1)
Fluorene	-	-	-	-	-	<0.017 (1)	-	-	-	-	0.021 (2)	-	0.011 (1)
Phenanthrene	-	-	-	-	-	0.041 (2)	-	-	-	-	0.030 (2)	-	0.037 (2)
Anthracene	-	-	-	-	-	0.039 (1)	-	-	-	-	<0.012 (1)	-	0.012 (1)
Fluoranthene	-	-	-	-	-	0.11 (1)	-	-	-	-	0.051 (1)	-	0.067 (1)
Pyrene	-	-	-	-	-	0.098 (1)	-	-	-	-	0.035 (1)	-	0.045 (1)
Benzo(a)anthracene	-	-	-	-	-	0.022 (1)	-	-	-	-	<0.012 (1)	-	<0.010 (1)
Chrysene	-	-	-	-	-	0.041 (1)	-	-	-	-	0.030 (1)	-	0.015 (1)
Benzo(b)fluoranthene	-	-	-	-	-	0.076 (1)	-	-	-	-	0.023 (2)	-	0.044 (1)
Benzo(k)fluoranthene	-	-	-	-	-	0.028 (1)	-	-	-	-	<0.012 (1)	-	0.014 (1)
Benzo(a)pyrene	-	-	-	-	-	0.031 (2)	-	-	-	-	<0.012 (1)	-	0.012 (2)
Indeno(1,2,3-cd)pyrene	-	-	-	-	-	0.067 (1)	-	-	-	-	<0.023 (1)	-	0.033 (1)
Dibenz(a,h)anthracene	-	-	-	-	-	<0.0084 (1)	-	-	-	-	<0.0058 (1)	-	0.0055 (2)
Benzo(g,h,i)perylene	-	-	-	-	-	0.091 (1)	-	-	-	-	<0.023 (1)	-	0.046 (1)
Low Molecular Weight PAH`s	-	-	-	-	-	<0.84	-	-	-	-	<0.58	-	<0.51
High Molecular Weight PAH`s	-	-	-	-	-	0.61	-	-	-	-	0.14	-	0.3
Total PAH	-	-	-	-	-	<0.84	-	-	-	-	<0.58	-	<0.51
Surrogate Recovery (%)													
D10-ANTHRACENE (sur.)	-	-	-	-	-	91	-	-	-	-	95	-	95
D8-ACENAPHTHYLENE (sur.)	-	-	-	-	-	85	-	-	-	-	86	-	89
D8-NAPHTHALENE (sur.)	-	-	-	-	-	78	-	-	-	-	88	-	80
TERPHENYL-D14 (sur.)	-	-	-	-	-	95	-	-	-	-	99	-	102
Physical Properties													
Moisture	-	-	-	-	-		95	-	-	92	-	91	-

2017 WATER QUALITY MONITORING PROGRAM LAB RESULTS	Third Quarter Sampling															4th Quarter Sampling		
Sampling Date	5-Sep-17					11-Sep-17					14-Sep-17					20-Nov-17		
Site	SWMP-03			SWMP-04	SWMP-06	SWMP-03			SWMP-06	SWMP-04	SWMP-03			SWMP-06	SWMP-04	SWMP-03		
Depth	1 m	5 m	10 m	1 m	1m	1 m	5 m	10 m	1 m	1 m	1 m	5 m	10 m	1 m	1 m	1 m	5 m	10 m
Water Quality Parameters																		
Chlorophyll a	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.07	6.16	6.85
Calculated Parameters																		
Total Hardness (CaCO3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Misc. Inorganics																		
Dissolved Hardness (CaCO3)	50.5	45.4	46.5			49.3	46.4	45.2	-	-	52.2	52.5	49.7	-	-			
Microbiological Parameters																		
E. coli	1	-	-	3	21	6	-	-	31	6	9	-	-	5	7			
Anions																		
Orthophosphate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	0.00	0.01
Nutrients																		
Total Phosphorus (P)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01	0.01	0.02
Dissolved Metals by ICPMS																		
Dissolved Aluminum (Al)	27.7	7.3	9.90	-	-	26.1	14.3	11.7	-	-	20.6	17.9	12.9	-	-			
Dissolved Antimony (Sb)	<0.50	<0.50	<0.50	-	-	<0.50	<0.50	<0.50	-	-	<0.50	<0.50	<0.50	-	-			
Dissolved Arsenic (As)	0.18	0.14	0.19	-	-	0.17	0.15	0.15	-	-	0.18	0.18	0.18	-	-			
Dissolved Barium (Ba)	19.1	18.6	15.50	-	-	19.4	21.9	18	-	-	19.8	19.9	17.7	-	-			
Dissolved Beryllium (Be)	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	-	-			
Dissolved Bismuth (Bi)	<1.0	<1.0	<1.0	-	-	<1.0	<1.0	<1.0	-	-	<1.0	<1.0	<1.0	-	-			
Dissolved Boron (B)	<50	<50	<50	-	-	<50	<50	<50	-	-	<50	<50	<50	-	-			
Dissolved Cadmium (Cd)	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	-	-			
Dissolved Chromium (Cr)	<1.0	<1.0	<1.0	-	-	<1.0	<1.0	<1.0	-	-	<1.0	<1.0	<1.0	-	-			
Dissolved Cobalt (Co)	<0.20	<0.20	0.22	-	-	<0.20	<0.20	0.23	-	-	<0.20	<0.20	0.29	-	-			
Dissolved Copper (Cu)	0.56	0.67	0.40	-	-	0.73	1.10	0.39	-	-	0.47	0.63	0.22	-	-			
Dissolved Iron (Fe)	11.6	120	325.00	-	-	14.1	37.8	576	-	-	15.6	20.2	1420	-	-			
Dissolved Lead (Pb)	<0.20	0.22	<0.20	-	-	<0.20	0.25	<0.20	-	-	<0.20	<0.20	<0.20	-	-			
Dissolved Lithium (Li)	<2.0	<2.0	<2.0	-	-	<2.0	<2.0	<2.0	-	-	<2.0	<2.0	<2.0	-	-			
Dissolved Manganese (Mn)	<1.0	57.8	552.00	-	-	<1.0	2.1	558	-	-	<1.0	<1.0	726	-	-			
Dissolved Molybdenum (Mo)	<1.0	<1.0	<1.0	-	-	<1.0	<1.0	<1.0	-	-	<1.0	<1.0	<1.0	-	-			
Dissolved Nickel (Ni)	<1.0	<1.0	<1.0	-	-	<1.0	<1.0	<1.0	-	-	<1.0	<1.0	<1.0	-	-			
Dissolved Selenium (Se)	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	-	-			
Dissolved Silicon (Si)	1930	2740	3580.00	-	-	1980	2520	3900	-	-	1960	2030	4010	-	-			
Dissolved Silver (Ag)	<0.020	<0.020	<0.020	-	-	<0.020	<0.020	<0.020	-	-	<0.020	<0.020	<0.020	-	-			
Dissolved Strontium (Sr)	54.6	45.8	52.70	-	-	53.4	47.8	47.1	-	-	56.5	56.4	52.3	-	-			
Dissolved Thallium (Tl)	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	-	-			
Dissolved Tin (Sn)	<5.0	<5.0	<5.0	-	-	<5.0	<5.0	<5.0	-	-	<5.0	<5.0	<5.0	-	-			
Dissolved Titanium (Ti)	<5.0	<5.0	<5.0	-	-	<5.0	<5.0	<5.0	-	-	<5.0	<5.0	<5.0	-	-			
Dissolved Tungsten (W)	<1.0	<1.0	<1.0	-	-	<1.0	<1.0	<1.0	-	-	<1.0	<1.0	<1.0	-	-			
Dissolved Uranium (U)	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	-	-			
Dissolved Vanadium (V)	<5.0	<5.0	<5.0	-	-	<5.0	<5.0	<5.0	-	-	<5.0	<5.0	<5.0	-	-			
Dissolved Zinc (Zn)	<5.0	6.9	<5.0	-	-	<5.0	15.2	5.4	-	-	<5.0	<5.0	<5.0	-	-			
Dissolved Zirconium (Zr)	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	-	-			
Dissolved Calcium (Ca)	17.2	15.5	15.60	-	-	16.6	15.7	15.3	-	-	17.8	18	17.1	-	-			
Dissolved Magnesium (Mg)	1.81	1.61	1.82	-	-	1.88	1.73	1.67	-	-	1.89	1.86	1.71	-	-			
Dissolved Potassium (K)	0.325	0.282	0.34	-	-	0.346	0.292	0.32	-	-	0.356	0.324	0.358	-	-			
Dissolved Sodium (Na)	7.81	7.14	7.86	-	-	8.35	7.61	7.29	-	-	8.4	8.19	7.54	-	-			
Dissolved Sulphur (S)	<3.0	<3.0	<3.0	-	-	<3.0	<3.0	<3.0	-	-	<3.0	<3.0	<3.0	-	-			
Additional Dissolved Metals by ICPMS																		
Dissolved Calcium (Ca)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Dissolved Magnesium (Mg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Total Metals by ICPMS																		
Total Calcium (Ca)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Total Magnesium (Mg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
CCME PAH IN SEDIMENTS BY GC-MS (SOIL)																		
Calculated Parameters																		
Index of Additive Cancer Risk(IARC)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Polycyclic Aromatics																		
Naphthalene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
2-Methylnaphthalene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Acenaphthylene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Acenaphthene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Fluorene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Phenanthrene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Anthracene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Fluoranthene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Pyrene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Benzo(a)anthracene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Chrysene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Benzo(b)fluoranthene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Benzo(k)fluoranthene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Benzo(a)pyrene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Indeno(1,2,3-cd)pyrene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Dibenz(a,h)anthracene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Benzo(g,h,i)perylene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Low Molecular Weight PAH`s	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
High Molecular Weight PAH`s	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Total PAH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Surrogate Recovery (%)																		
D10-ANTHRACENE (sur.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
D8-ACENAPHTHYLENE (sur.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
D8-NAPHTHALENE (sur.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
TERPHENYL-D14 (sur.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Physical Properties																		
Moisture	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			

Notes:

RDL = Reportable Detection Limit

N/A = Not Applicable

- = Parameter not analyzed

*Notes from Maxaam Analytics Laboratory Reports:

"(1) Detection limits raised due to high moisture content, sample contains => 50% moisture.

(2) Qualifying ion outside of acceptance criteria

Results are tentatively identified and potentially biased high

In addition, detection limits raised due to high moisture content, sample contains => 50% moisture."

Discussion

Few water quality issues were identified for Enos Lake. Based on Secchi readings, and chlorophyll a and total phosphorus concentrations, Enos Lake shows characteristics of being mainly a mesotrophic (moderately biologically productive) lake (Nordin 2017). The high concentrations of total phosphorus and DO deficiencies in the hypolimnion indicate that the lake may be more productive than is desirable (Nordin 2017). Nordin (2017) suggests that climate change may pose a serious threat to Enos Lake, as rising water temperatures will likely result in increased productivity and longer stratification times and, in turn, even larger effects on DO levels in the hypolimnion. Nordin (2017) also suggests that the introduction of any aquatic invasive species could have seriously negative effects on the overall ecology of the lake. No preventative actions were taken with respect to aquatic invasive species this year, however, *Friends of Enos Lake* have expressed their interest in installing a sign to inform the public about the monitoring program and potential risks to the lake's unique ecosystem.

Recommendations for Future Monitoring

There was a potential issue with instrument calibration during the March sampling event, as one of the values recorded for pH varies too widely from the other values recorded for it to be correct. Going forward, BCCF will ensure instruments are calibrated properly prior to sampling.

Continued monitoring for invasive species is recommended, in addition to continued monitoring for all water quality parameters, especially total phosphorus and DO concentrations, to monitor general lake productivity and continually assess trends of key parameters.

Additionally, Nordin (2017) suggests that obtaining a detailed bathymetric map of Enos Lake is important for determining the volume of Enos Lake, which is required for calculation of the lake's water budget. Nordin (2017) recommends that the lake's water budget be considered in the stormwater management plan for construction of the Fairwinds development. Finally,

Finally, Nordin (2017) recommends that Secchi readings be collected at a more frequent interval than is currently recommended in the ELPMP. The lake stewards may be willing to provide additional Secchi measurements, over and above the PGL-recommended frequency.

References

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Appendix A: Field Photos

Photo 1: Looking southwest at typical shoreline habitat along south shore of lake (February 2017).

Photo 2: BCCF staff collecting water samples at SWMP-03 (February 2017).

Photo 3: Volunteer deploying the 1 L Van Dorn water sampler at SWMP-03 (August 24, 2017).

Photo 4: Volunteers deploying the 1 L Van Dorn water sampler at SWMP-03 (August 24, 2017).

Photo 5: Looking northeast at eastern edge of marsh island (June 2017).

Photo 6: Looking southeast towards south end of lake (June 2017).

Photo 7: Looking southeast at south end of lake (November 2017).

Photo 8: Looking northeast at rocky banks on northern lake shore (November 2017).

Appendix B: In-Situ Field Parameter Results

1st Quarter Sampling

Date: March 2, 2017
Time: 13:00
Crew : J.D., J.A., N.R. (all BCCF employees)
Weather: Overcast, light rain, 8°C
Secchi: 1.45 m

Profile - Site SWMP-03				
Depth (m)	Temp. (°C)	D.O. (mg/L)	pH	Conduc. (µS/cm)
0.5	4.8	12.55	2.6*	140.2
1	4.7	12.63	6.0	139.7
2	4.7	12.65	6.0	140.0
3	4.7	12.66	6.0	139.8
4	4.7	12.67	6.1	139.9
5	4.7	12.68	6.15	139.8
6	4.7	12.68	6.45	139.7
7	4.6	12.67	6.75	139.7
8	4.6	12.68	7.1	139.7
9	4.6	12.67	7.41	139.8
10	4.6	12.65	7.59	139.6
11	4.6	12.56	7.0	141.0

NOTES:
*This value is likely the result of a calibration issue or recording error. The differences in pH values between dates are implausible. It would seem unlikely that pH would vary as widely (2 pH units) as the data indicate (Nordin 2017).
-Redox potential was not recorded during this sampling event.
-Enos Lake was iced over for January, February and early March. Sampling was conducted approximately one week after ice came off the lake.

2nd Quarter Sampling

Date: June 2, 2017
Time: 11:00
Crew : S.F., J.S. (BCCF employees)
Weather: Overcast, light breeze, 14°C
Secchi: 2.80 m

Profile - Site SWMP-03				
Depth (m)	Temp. (°C)	D.O. (mg/L)	pH	Conduc. (µS/cm)
1	19.2	6.47	8.01	12.5
2	19.2	6.63	8.41	42.7
3	19.2	6.84	8.50	40.1
4	15.9	7.89	8.42	132.8
5	12.3	9.41	8.44	117.6
6	9.4	10.10	8.55	63.3
7	8.6	9.99	8.51	108.7
8	8.0	8.32	8.40	157.7
9	7.8	7.30	8.34	89.7
10	7.5	1.63	8.23	91.5
11	7.4	1.64	8.11	63.1
NOTES: Redox potential was not recorded during this sampling event.				

3rd Quarter Sampling

Date: August 24, 2017
Time: 11:00
Crew : S.F. (BCCF), P.L. (Friends of Enos Lake Volunteer)
Weather: Sunny, 25°C
Secchi: 4.80 m

Profile - Site SWMP-03					
Depth (m)	Temp. (°C)	D.O. (mg/L)	Conduc. (µS/cm)	pH	Redox (mV)
1	22.6	7.53	143.2	8.13	56.6
2	22.5	7.5	143.2	8.22	56.6
3	22.3	7.7	142.6	8.2	65.2
4	21.7	7.55	141.6	8.05	71.6
5	16.1	7.27	126	7.52	87.4
6	13	5.17	126.3	6.99	91.2
7	10.2	2.25	127.9	6.83	83.1
8	9.6	1.4	133.2	6.76	68.2
9	9.6	1.25	134.4	6.75	59
10	9.6	1.16	134.1	6.75	52.9

4th Quarter Sampling

Date: November 20, 2017
Time: 11:30
Crew : P.L, R.P (Friends of Enos Lake Volunteers)
Weather: Overcast, dry, ~8°C
Secchi: 2.80 m

Profile - Site SWMP-03					
Depth (m)	Temp. (°C)	D.O. (mg/L)	Conduc. (µS/cm)	pH	Redox (mV)
1	7.4	9.3	138.2	6.82	75.5
2	7.3	9.2	138.4	6.94	81
3	7.3	9.3	138.6	6.99	84.7
4	7.3	9.3	138.7	7.03	88.7
5	7.3	9.3	138.8	7.1	90.5
6	7.3	9.15	138.7	7.12	92.6
7	7.2	9.18	138.8	7.14	93.8
8	7.2	9.26	138.7	7.15	94.9
9	7.2	8.85	138.7	7.17	97.9
10	7.2	8.83	138.7	7.17	98.9
NOTES: According to Pete Law's observations, the lake rose between 1.0 and 1.5 m over the past seven days.					