Environmental Applied Science Technology

2018 Report on the Ecological Health of the Ponds in Charlottetown, Prince Edward Island, Canada

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1 INTRODUCTION AND OBJECTIVES

During the summer of 2018, Holland College Environmental Applied Science Technology students and faculty examined the ecological health of eleven (11) ponds within the City of Charlottetown and one (1) reference pond outside the City, in Prince Edward Island (PEI), Canada. The project collected data on surface water quality, sediment chemistry and through macro-invertebrate surveys using the Hilsenhoff's Family Biotic Index (FBI), delineated the overall ecological health of the ponds sampled.

The information collected will help determine the underlying issues responsible for the relatively poor ecological health of some of the ponds surveyed. It will allow the City of Charlottetown and local watershed groups to develop action plans to improve or preserve the ecological health of the ponds studied.

1.1 SCOPE OF WORK

The scope of work included the following activities:

- Collection, identification and classification of 36 macroinvertebrates samples using the biotic index card,
- Field testing of water including physicochemical parameters such as dissolved oxygen (DO), pH, temperature, and conductivity,
- Collection of 36 surface water samples for water quality and chemical analyses,
- Analysis of surface water samples for Hardness, Ammonia and Nitrates were performed at Environmental Applied Science Technology (EAST) Lab Laboratory, Holland College,

- Chemical Analysis of surface water samples by the PEI Analytical Lab for the following: Barium (Ba), Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Nickel (Ni), Magnesium (Mg), Phosphorus (P), Potassium (K), Sodium (Na), Sulfate (SO_4), Lead (Pb), Zinc (Zn), Manganese (Mn), Arsenic (As), Cobalt (Co), and Calcium (Ca),
- Collection and preparation of twelve sediment samples for analyses,
- Analyses of the sediment samples by the PEI Analytical Laboratory for the following: Carbon (C), C:N ratio, Nitrogen (N), Potassium (K), Calcium (Ca), Magnesium (Mg), Copper (Cu), Zinc (Zn), Boron (B), Cobalt (Co), Chromium (Cr), Iron (Fe), Manganese (Mn), and pH,
- and Interpretation of the results and preparation of this report.

2 *DESCRIPTION OF SITES*

In total, twelve different sites were assessed:

Governor's Pond (GOP)

The pond occupies an approximate area of 4,002 square meters (m^2) and is located at the intersection between Terry Fox Drive and Kent Street, beside the parking lot of the Government Building. The site is in a commercial and residential area. It is surrounded by the parking lot and the two roads as mentioned above. It connects directly into Charlottetown Harbour through an underground storm drain. Historically, the Governor's Pond was part of a tidal estuary.

Dead Man's Pond (DMP)

Dead Man's Pond located in Victoria Park has an estimated area of 737 m^2. The pond area is a tranquil area surrounded by forest and a popular stop on a trail system that passes adjacent to the pond.

Lower Slick's Pond (LSP)

Part of the Hazards Creek system, the Lower Slick's Pond is visible from the Malpeque Rd (Route 2) behind Princess Auto. The pond occupies an approximate area of 1,424 m². It is surrounded by commercial and industrial development. It is the lower of two connected ponds constructed in the sixties to provide water for cattle. The ponds do not appear to have any official name. ECWG provided the name, Slick's Ponds, after a lifelong resident of area, Alexander (Slick) Rhynes.

MacNeill's Pond (MNP)

MacNeill's Pond is also part of Hazards Creek system. It is located at the intersection of Capital Drive and Lower Malpeque Road. MacNeill's Pond has an estimated area of 10,261 m². It is surrounded by commercial and residential development.

Hermitage Pond (HEP)

Hermitage Pond (also referred to as the Tremploy Pond) is situated in a residential area off Raiders Road adjacent to the Charlottetown Rural High School. It has an estimated area of 3,820 m². The dam creating the pond is an extension of Raiders Road which ends in a cul-de-sac at Tremploy Inc. A drop culvert outlet under the road connects the pond to Hermitage Creek, and the Ellen's Creek Estuary.

Farmers Market Pond (FMP)

Delimited by the Charlottetown Farmers Market parking lot in the North and a wetland and agricultural land in the South, Farmers Market Pond is located off Belvedere Avenue with an estimated area of 1,086 m².

Ag. Canada Pond (ACP)

The Ag. Canada Pond is located behind the Charlottetown Research and Development Centre of Agriculture and Agri-Food Canada Building of University Avenue. It occupies around 7,203 m². It is one in a series of man-made wetlands.

Jardine's Pond (JAP)

The Jardine's Pond occupies approximately 405 m² and its principal means of access is via a farm field behind a residential area on MacRae Drive. The site is in a wooded area surrounded by agricultural land. Upstream in the Northwest, there is an excavation pit and the Charlottetown Airport.

Barbour's Pond (BAP)

Barbour's Pond has an estimated area of 1,096 m² and is located downstream from Jardine's Pond. Access is off MacRae Drive through a path beside the Elmer MacFadyen Memorial Recreational Complex. There is a public walking trail along the lower end of the pond.

Andrew's Pond North (APN)

Andrew's Pond North is in a high-density residential area downstream from Barbour's Pond. It has an estimated area of 42,089 m². Access is off Elena Court. or St. Peters Road.

Andrew's Pond South (APS)

Andrew's Pond South is across St. Peters Road, downstream from Andrew's Pond North. It has an estimated area of 18,769 m² and its access is by St. Peters Road.

Cappers Pond (CAP)

Cappers Pond occupies approximately 6379 m². The pond is in a heavily wooded area with limited access year-round. The pond is located between New Haven and Strathgartney. The main means of access is via a trail off the Churchill Road.

Figures 1 to 3 (Appendix A) include some photographs of the ponds cited above.

3 MATERIAL AND METHODS

The following materials and methods were used to conduct the sampling and the analysis:

Dissolved Oxygen was tested using the Pasco Optical Dissolved Oxygen Sensor model number PS-2196.

pH was measured using the Pasco wireless pH meter model number PS-3204.

Conductivity was determined using the HACH sensION5 portable conductivity meter.

Nitrate was determined using HACH Method 10206, Nitrate TNTplus® Vial Test 835 (Range 0.2-13.5 mg/L NO_3-N).

Ammonia-N was determined using HACH Method 10205, Ammonia TNTplus® Vial Test 832 (Range: 2-47 mg/L NH_3-N).

Hardness was analyzed following the Standard Method by Clesceri et. al (1988). In the first round, the titration was done in triplicates, and for the other two rounds, a duplicated was done after every 10 samples. Hardness was calculated using the following equation:

$$Hardness\ (\mathbf{mg\ CaCO3/L}) = \frac{(reading\ in\ mL) \times (1000 \frac{mg}{L})}{25\ mL}$$

Hardness materials and reagents:

- 1000ml Volumetric Flasks, Fisherbrand.
- 100-1000µl Pipette, Fisherbrand.
- 0.01M EDTA
- 0.1% Calmagite Indicator Catalog 1830-4, Ricca
- 125ml Erlenmeyer Flasks, Fisherbrand.
- 250ml Beakers, Kimax Kumble.
- 250ml Erlenmeyer Flasks, Fisherbrand.
- 25ml Graduated Cylinder, Kimax Kumble.
- 25ml Volumetric Flasks, Fisherbrand.
- 500µl and 1000µl Pipette, Eppendorf.
- 50ml Burette, Kimax Kumble.
- Isotemp Oven Fisherbrand.

Family Biotic Index. The Hilsenhoff's Family Biotic Index (FBI) was used to assess the water quality condition (Hilsenhoff 1988).

FBI materials and reagents:

- Fisher brand 0.5mm mesh
- Microscope Stereo Master II, Model SPT-ITH manufactured by Fisher Scientific
- 70% Isopropyl alcohol

First, the samples were washed very gently in a fine sieve, removing as much mud and fine detritus as possible. Small amounts of each sample were placed in a white tray with approximately 10mm depth of water, and the material was spread out across the tray. The invertebrates were carefully sorted using tweezers and placed in beakers. To sort the next portion of the sample, the material was discarded, and the tray filled with clean water, and the process was repeated until the entire sample was sorted.

The animals were identified to their family level by using the keys by Voshell (2002) and Chu (1949). The results were recorded and prior to sorting the next sample, all the equipment used was thoroughly cleaned.

A microscope (Stereo Master II, Model SPT-ITH manufactured by Fisher Scientific) was used to help with the identification. Some specimens were preserved in 70% isopropanol and stored in the fridge at a temperature around $0^{o}C$ for further use in the EAST program at Holland College.

The Hilsenhoff's Family Biotic Index (FBI) was used to assess the water quality condition (Hilsenhoff 1988). Tolerance values for the invertebrate families were assigned based on Bode et al (1996); Hauer & Lamberti (1996); Hilsenhoff (1988); Plafkin et al (1989); and Barbour et al. (1999). The following formula was used to obtain the FBI and the results were evaluated using Table 1.

$$FBI = \sum \frac{(xi \times ti)}{n}$$

x = the number of individual taxa, t = tolerance value, and n = total number of invertebrates in the sample.

Table 1 Evaluation of water quality using Hilsenhoff's Family Biotic Index (Hilsenhoff, 1998)

Family Biotic Index	Water Quality	Degree of Organic Pollution
0.00 - 3.75	Excellent	Organic pollution unlikely
3.76 - 4.25	Very Good	Possible slight organic pollution
4.26 - 5.00	Good	Some organic pollution probable
5.01 - 5.75	Fair	Fairly substantial pollution likely
5.76 - 6.50	Fairly Poor	Substantial pollution likely
6.51 - 7.25	Poor	Very substantial pollution likely
7.26 - 10.00	Very Poor	Severe organic pollution likely

4 SAMPLING

4.1 FIELD ACTIVITIES

Field activities were performed in three different rounds. The first round started on May 30, 2018 and ended June 2, 2018. The second round was during July 3 to July 26, 2018 and the last round was completed between August 8 to August 23, 2018.

Each day, three ponds would be selected to be sampled based upon the location of the ponds and the watershed they are located in. Three separate sets of equipment were brought to the ponds to avoid contamination of samples and to avoid introducing a species from another watershed.

A total of eleven (11) ponds were sampled around the City of Charlottetown. The ponds were grouped as follows; Group One - Lower Slick's Pond, MacNeill's and Hermitage Ponds located in Ellen's Creek Watershed; Group Two - Jardine's, Barbour's, Andrew's Pond North and South located in Wrights Creek Watershed; Group Three - Governor's and Dead Man's Ponds located in or near Victoria Park; and Group Four - Farmers Market and Ag. Canada Ponds. Both group three and four were grouped based on location and not watershed. The reference pond outside Charlottetown, Cappers Pond, was sampled separately. The pond is surrounded by forest and was selected as a reference pond to examine if freshwater ponds within Charlottetown are uniquely different from ponds outside the City.

Invertebrate samples and surface water samples were collected for analyses at relatively the same location in each pond for each round. Dissolved oxygen, conductivity, and pH measurements were also completed in the field at each pond. Sediment samples were collected once at each pond ranging over the rounds of sampling.

At the end of the three rounds, a total of 36 invertebrate samples, 12 sediment samples and 36 surface water samples were collected. See Table 1 in Appendix A for sampling locations.

During the field activities, the Holland College Health & Safety Plan was

followed. Prior to initiating any activities, an evaluation was performed to detect any possible danger. It was decided that the collection of all samples would be performed from the edges of the ponds because the depth of water in some ponds, and the risk of entrapment in soft sediment.

4.2 MACROINVERTEBRATES SAMPLING

Invertebrates were sampled three times (May/June, July, and August) at the twelve (12) different sites.

The samples were collected at each site using a 400µm mesh net. Each pond was sampled for 3 minutes in total, where the 3 minutes refers to net-in-the-water time and it did not include the time moving between netting spots. Then, the samples were placed in 10.5 liter plastic buckets, labeled, and brought to the Environmental Applied Science Technology (EAST) Laboratory at Holland College where they were sorted and processed.

4.3 SURFACE WATER SAMPLING

Three surface water samples were collected at each pond between May 30, 2018 and August 15, 2017. See Table 1 (Appendix A) for the sampling coordinates.

The water quality was assessed by measuring several physicochemical parameters. Field measurements of pH, temperature, conductivity, and dissolved oxygen (DO) were recorded. Dissolved oxygen and temperature were measured using a Pasco Optical Dissolved Oxygen Sensor (Model No. PS-

2196). pH levels were measured using a Pasco Wireless pH meter (Model No. PS-3204). Conductivity was measured using handheld HACH sensION5. For all measurements, the sensors were placed directly in the pond.

The equipment used for the surface water sampling was calibrated in accordance with the manufacturer's recommendation prior to starting the field measurements.

Surface water samples were collected using a dip sampler. The device was extended to the sample location and sample was collected by dipping the sampler into the water 15 cm. The pond water was transferred from the sampler to two (2) clean 500 ml home canning glass jars (commonly referred to as Mason jars) that were filled to the top without leaving an air space. The jars were labeled, stored in coolers with ice at temperatures below 4 ^{o}C (± 2 ^{o}C), and brought to the EAST lab.

At the EAST lab, 250 ml of each sample was placed into a plastic bottle provided by the PEI Analytical Laboratory, labeled and stored at 0^{o}C. Following the PEI Analytical Lab recommendation, 50ml of each sample was filtered through 0.45 µm (white gridded 47mm), then placed into polypropylene screw top tubes, acidified with concentrated nitric acid to a final concentration of 1% (by volume), and labeled. Both were stored in a refrigerator at a temperature around 4^{o}C. Samples were delivered in batches to PEI Analytical Lab. In total, twelve samples, one for each pond, were analysed for Barium (Ba), Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Nickel (Ni), Magnesium (Mg), Phosphorus (P), Potassium (K), Sodium (Na), Sulfate (SO_4), Lead (Pb), Zinc (Zn), Manganese (Mn), Arsenic (As), Cobalt (Co), and Calcium (Ca).

Additionally, samples were analyzed at the EAST Lab for Hardness, Ammonia, Phosphate, and Nitrate.

4.4 SEDIMENT SAMPLING

One sediment sample was collected at each pond between July 17 and August 20, 2018. Location of samples are presented in Table 1 at Appendix A.

Samples were collected using a shovel and they were stored in 10.5 liter-buckets, labeled, and brought to the EAST Laboratory at Holland College. At the Lab, the samples were placed on a metallic tray and dried in the Fisher Scientific Isotemp oven at 105°C for 48 hours. The dry samples were stored in airtight sealed plastic bags and placed in the refrigerator.

A portion of each sample (approximately 300g to 500g) was placed in bags provided by the PEI Analytical Lab, and delivered in batches to the lab where samples were analyzed for Carbon (C), C:N ratio, Nitrogen (N), Potassium (K), Calcium (Ca), Magnesium (Mg), Copper (Cu), Zinc (Zn), Boron (B), Cobalt (Co), Chromium (Cr), Iron (Fe), Manganese (Mn), and pH. The remaining samples collected were kept in the EAST lab fridge to be used for further analyses.

4.5 DATA VALIDATION

4.5.1 Equipment Calibration

Prior to initiating fieldwork activities, equipment used for recording physicochemical data was calibrated on a weekly basis in accordance with the manufacturer's instructions.

4.5.2 Equipment Decontamination

All non-disposable lab equipment was decontaminated before and after each sample collection event using the following procedure: washing and rinsing of equipment with fresh water and Fisherbrand™ Sparkleen™ Detergent with disposable sponges and brushes; rinsing with fresh water; and re-rinsing with de-ionized water.

All non-disposable field equipment and personal equipment such as nets, samplers, and waders were cleaned and inspected between different pond groups. All plants, animals, and mud were removed using high pressure and hot tap water. Eventually, the equipment was decontaminated with bleach following the Occupational Safety and Health Administration (OSHA) recommendations.

4.5.3 Applicable Environmental Guidelines

The federal guidelines were used to detect exceedances in water and sediment quality parameters under baseline conditions. The guidelines used to assess baseline water and sediment quality were:

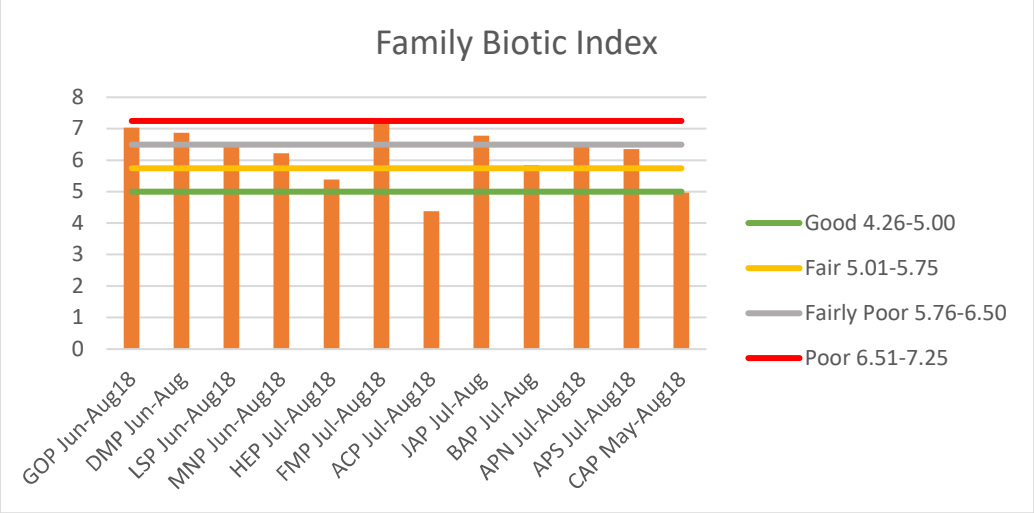
- Canadian Council of the Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines (CEQG) for the Protection of Aquatic Life,
- and the CCME Canadian Sediment Quality Guidelines (CSQG).

5 RESULTS

5.1 MACROINVERTEBRATES

The results of the macroinvertebrates sorted and identified, as well as the FBI results are included in Table 1 of the Appendix B. Figure 1 presents a summary of the evaluation of water quality for each pond using Hilsenhoff's Family Biotic Index. The FBI is a scale for showing the quality of an environment by indicating the types of organisms present in it. It is often used to assess the quality of water in rivers.

Figure 1. Hasselhoff's Family Biotic Index.



Using this index, the ecological health of four pounds, Governor's Pond, Dead Man's Pond, Farmers Market Pond, and Jardine's Pond was classified as "Poor". Lower Slick Pond, MacNeil's Pond, Barbour's Pond, Andrew Pond North, and Andrew Pond North are classified as "Fairly Poor". Hermitage Pond was

classified as "Fair". Cappers Pond and Ag. Canada Pond were classified as "Good".

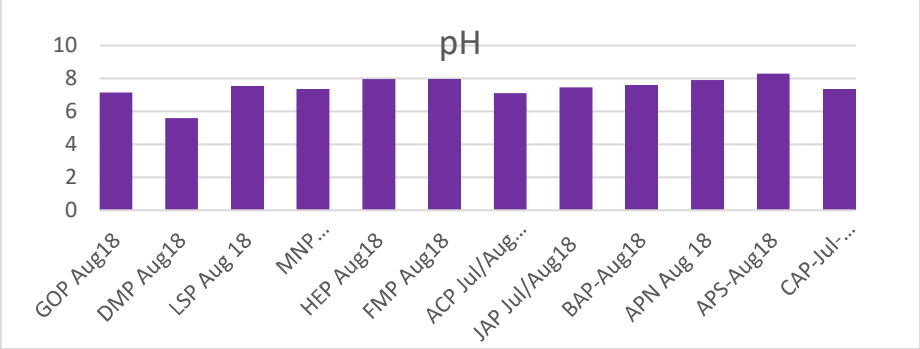
5.2 Surface Water Quality

5.2.1 Physicochemical Parameters

During the sampling of surface water, field measurements of pH, temperature, conductivity, and dissolved oxygen (DO) were recorded. The results are presented in Figure 2, 3, 4 and 4 below. All sampling took place on August 18, 2018. See raw data in Appendix C.

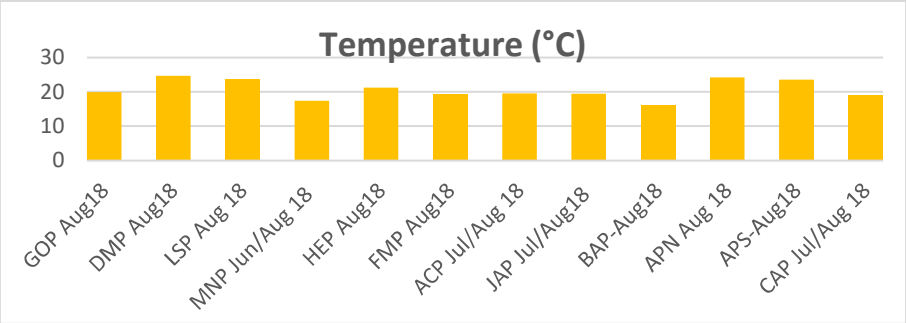
The pH values ranged from 5.58 in Dead Man's Pond to 8.29 in Andrew Pond South. See Figure 2.

Figure 2. pH in surface water



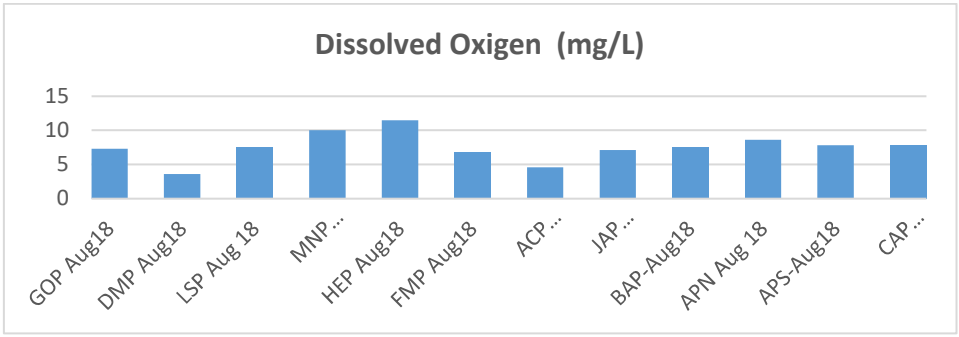
Temperature ranges from 16.2 °C in Barbour's Pond to 24.6 °C in Dead Man's Pond. See Figure 3.

Figure 3. Temperature in surface water



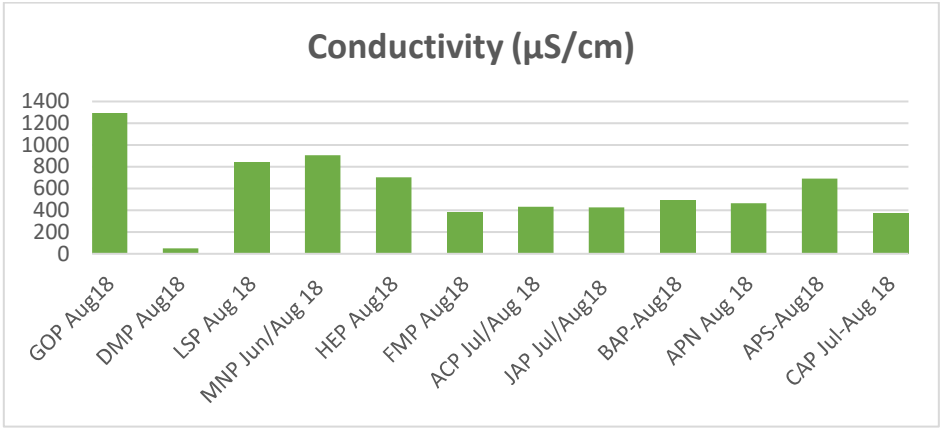
With regards to dissolved oxygen, readings ranged from 3.62 mg/L in Dead Man's Pond to 11.45 mg/L in Hermitage Pond. See Figure 4.

Figure 4. Dissolved Oxygen



Conductivity values ranged from 49.7 µS/cm at Dead Man's Pond to 1292µS/cm at Governor's Pond. See Figure 5.

Figure 5. Conductivity



5.2.2 Hardness, Ammonia, and Nitrate

Hardness is caused by compounds of calcium and magnesium, and by a variety of other metals. Hardness is measured as milligrams per liter of Calcium Carbonate (mg/L CaCO3). The general guidelines for classification of water hardness by USGS are as follows:

0 to 60 (mg/L CaCO3) is classified as soft

61 to 120 mg/L CaCO3 is moderately hard

121 to 180 mg/L CaCO3 is Hard

> 180 mg/L CaCO3 is Very hard

Hardness measurements are represented in Figure 5. According to the results, most of the ponds, Governor's Pond, Lower Slick Pond, MacNeil's Pond, Hermitage Pond, Jardine's Pond, Barbour's Pond, Andrew Pond North, and Andrew Pond South, contained very hard water. Only Dead Man's Pond and the Ag. Canada Pond have soft water. See raw data in Table 2, Appendix C.

Figure 5. Hardness in surface water

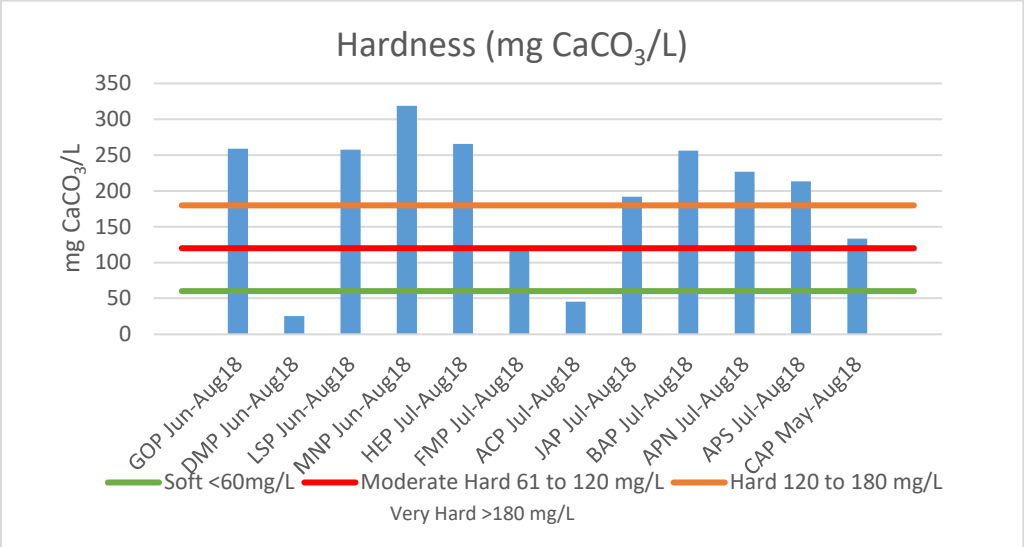
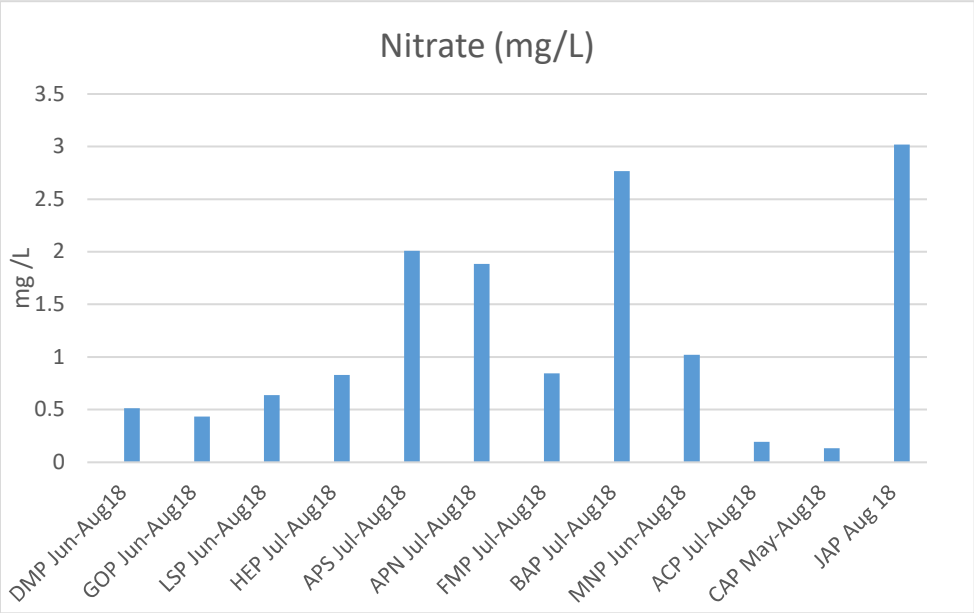


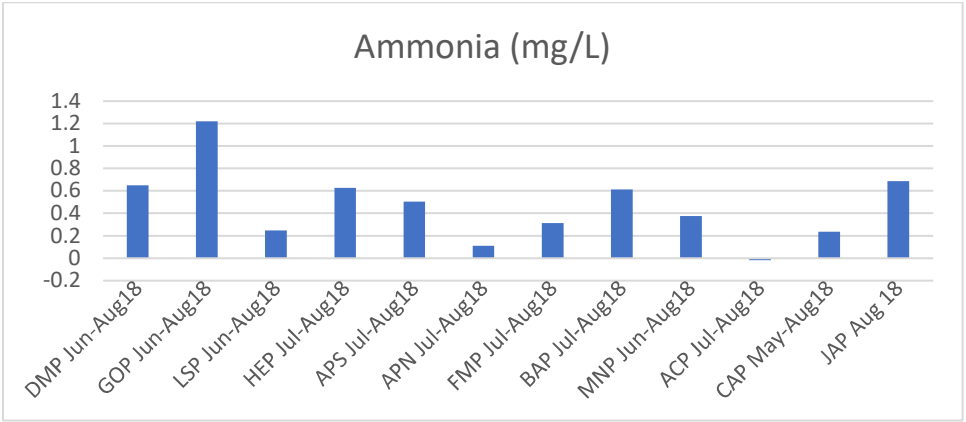
Figure 7 shows higher concentrations of Nitrate were found in Barbour's Pond, Jardine's Pond, Andrew Pond South and Andrew Pond North.

Figure 7. Nitrate in surface water



Concentrations of Total Ammonia were highest in Governor's Pond. See Figure 8.

Figure 8. Total Ammonia in surface water

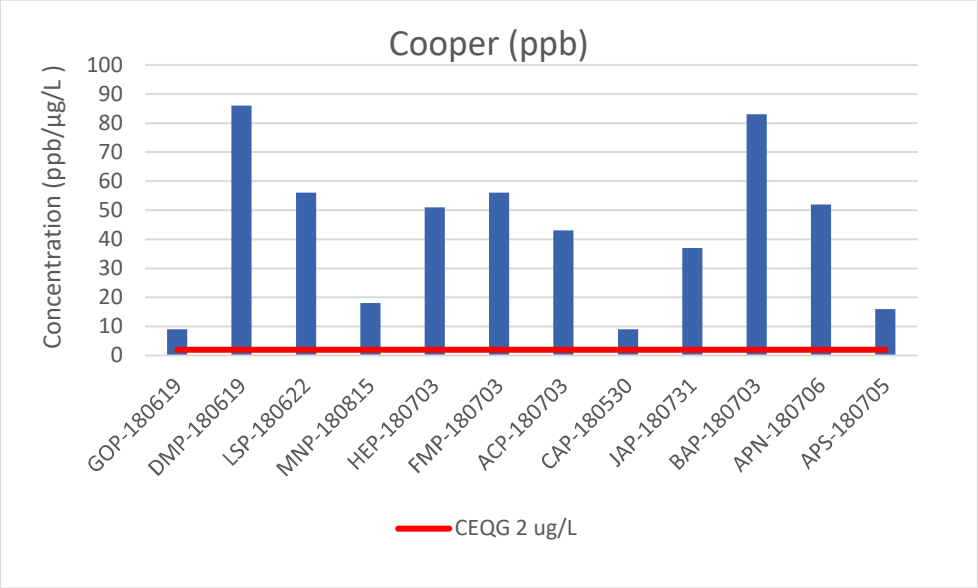


5.2.3 Analytical Results

One round of samples was analyzed at PEI Analytical Laboratories. Table 1 in Appendix D summarizes the analytical data. Copies of the reports are in Appendix D. The PEI Analytical Laboratories reports results in ppb. One (1) ppb is almost equivalent to one (1) µg/l which is the measurement used by Canadian Environmental Quality Guidelines (CEQG). CEQG guidelines are shown using their unit of measurement. Some elements were detected above the Canadian Environmental Quality Guidelines (CEQG) for the Protection of Aquatic Life.

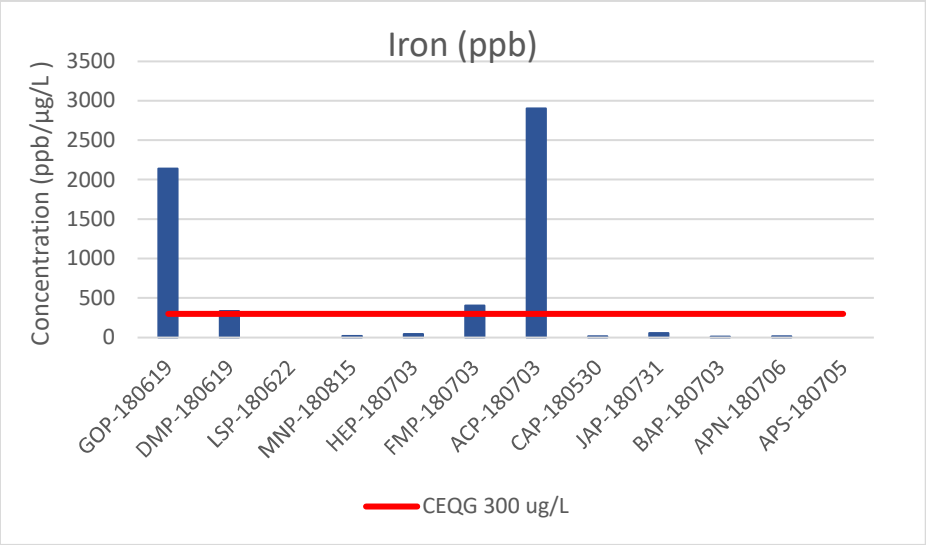
Concentrations of Copper were detected above the CEQG (2 µg/L) in all ponds. The highest concentration was detected in Dead Man's Ponds, followed by Barbour's Andrew's Pond. See Figure 9.

Figure 9. Concentration of Copper in surface water



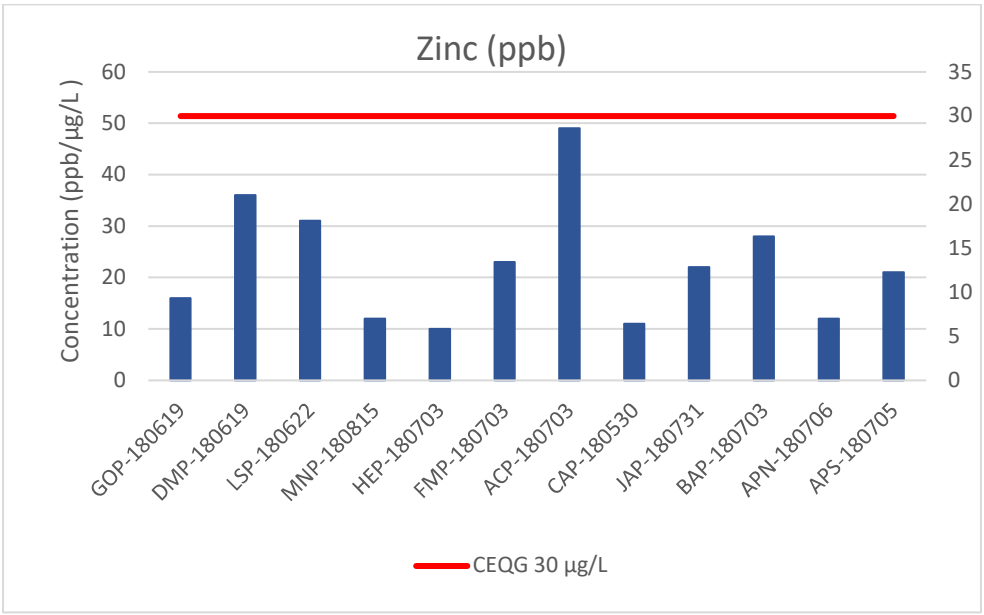
Concentrations of Iron were detected above the CEQG (300 µg/L) in Governor's Pond, Ag. Canada and Farmers Market Pond. See Figure 10.

Figure 10. Concentration of Iron in surface water



Concentrations of Zinc were detected above the CEQG (30 µg/L) in Dead Man's Pond, Lower Slick Pond, and Ag. Canada Pond. See Figure 11.

Figure 11. Concentration of Zinc in surface water



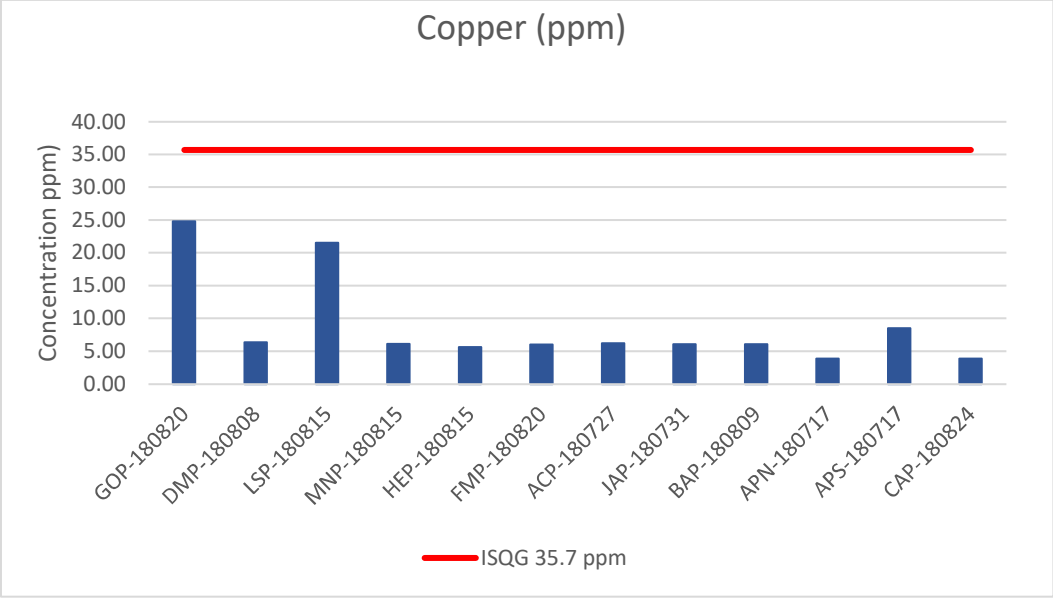
5.3 *SEDIMENT QUALITY*

5.3.1 *Analytical Results*

The first round of the sediment samples was sent to the PEI Analytical Lab. Lab reports are included in Appendix D, as well as the summary of the sediment results (Table2).

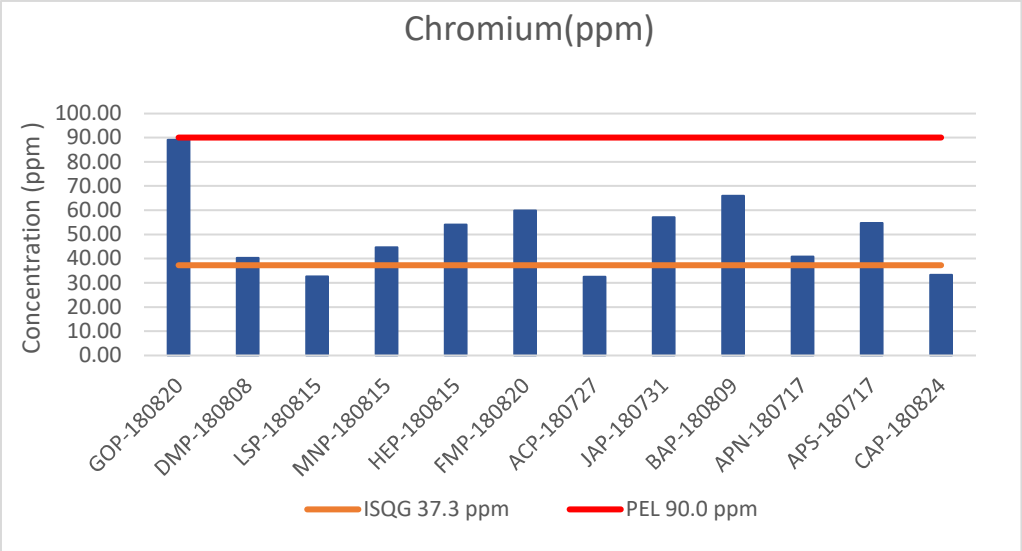
Concentrations of Copper were found below the Interim Sediment Quality Guidelines for aquatic life (ISQC) value. See Figure 12. However, concentrations of Zinc and Chromium were found above the guideline values.

Figure 12. Concentration of Copper in sediments



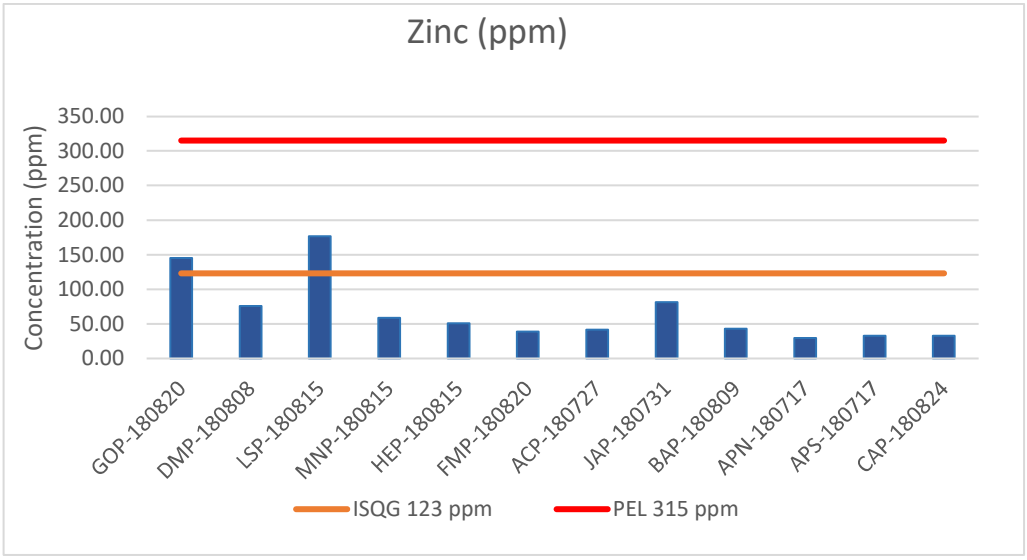
Chromium results were above the ISQG (37.3 ppm) for aquatic life in most all the ponds except for Lower Slick Pond, Ag. Canada Pond, and Cappers Pond. See Figure 13. The Permissible Exposure Limit (PEI) for the element is label in red.

Figure 13. Concentration of Chromium in sediments



Concentrations of Zinc were detected above the ISQG for aquatic life (123 ppm) in two of the 12 ponds analyzed but below the PEL. The highest concentration of Zinc was detected in Lower Slick Pond followed by Governor's Pond.

Figure 14. Concentration of Zinc in sediments



6 DISCUSSION

Regarding the macroinvertebrates indicators, using the Family Biotic Index (FBI), the water quality of most of the ponds was considered "Poor" or "Fairly poor", which indicates that the pounds are under substantial pollution except for Ag. Canada Pond and Cappers Pond, which were ranked as "Good". It is important to note that FBI is an indicator of pollution, primarily applied in streams, and the index can be affected by low natural biological potential such as poor habitat condition.

The pH values ranged from 5.58 at Dead Man's Pond to 8.29 at Andrew Pond South which indicates a slightly acidic and a slightly basic environment respectively.

With regards to dissolved oxygen, Dead Man's Pond had very low DO readings. Low dissolved oxygen is primarily related to excessive algae growth. As the algae die and decompose, the process consumes dissolved oxygen. However, this does not seem to be the cause of the very low DO readings in Dead Man's Pond. This requires more exploration.

Copper were detected above the guideline values in all ponds. However, water hardness had a significant effect on Cu and Zn toxicity on fish. Copper and Zn are more toxic in the soft water than in the hard water. Only Dead Man's Pond and the Ag. Canada Pond contain what is classified as soft water.

Electrical conductivity ranged from 49.7 µS/cm (Dead Man's Pond) to 1292 µS/cm (Governor's pond). Higher electrical conductivity readings were detected in those ponds in urban areas due proximity to roads and parking lots where salt

is used as a de-icer.

Regarding Total Ammonia concentration, Canadian Water Quality Guidelines for Protection of Aquatic Life vary by temperature and pH. They decrease as temperature and pH rises. None of the levels reported exceed guidelines.

Nitrate testing was performed 48 hours after sampling, therefore there is a potential error in the tests. The results may not be accurate because over time organic forms of nitrogen are converted by ammonification to different forms of ammonia by microorganisms in the sample.

Concentrations of iron were detected above the CEQG in Governor's Pond and in the Ag. Canada Pond. The presence of iron in fresh water can occur naturally.

Chromium was detected in most of the sediment samples except for Lower Slick's Pond, the Ag. Canada Pond, and Capper's Pond. Chromium can be released naturally from rock and topsoil. Other possible environmental sources of chromium within these watersheds could include airborne emissions from incineration facilities, cement dust, road dust from catalytic converter erosion and asbestos brakes, contaminated landfill, and airport runoff.

Appendix E compares results from 2017 and 2018 and are included for discussion purposes but no conclusions are made.

7 CONCLUSIONS

Based on the results of the assessment, it can be concluded that:

- Based on the macroinvertebrate surveys, the water quality of most of the ponds was considered "Poor" or "Fairly poor", which indicates that the pounds are under substantial pollution, except for the Ag. Canada Pond, and Capper's Pond that were ranked as "Good".
- The water in most of the ponds was hard or very hard, except for the water in Dead Man's and Ag. Canada Ponds which were soft, and Farmers Market Pond that was moderately hard.
- Based on the surface water analyses, copper, iron, and zinc were detected above the guideline values.
- Based on the sediment analyses, zinc and chromium have concentrations detected above the guideline values.

It is recommended that the monitoring program continue as more data is needed to assess factors impacting the ecological health of the ponds in the Charlottetown area.

Improvements in testing techniques, such storage conditions, and preservation of samples before lab analysis, will be beneficial to insure accurate results.

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APPENDIX A

SAMPLE DATES AND GPS COORDINATES/PICTURES

Table 1. Sampling Location

Round	Sample ID	Coordinates of sampling (decimal degrees)
1st	DMP-20180619	46.13775, -63.08394
2nd	DMP-20180711	
3rd	DMP-20180808	
1st	GOP-20180619	46.13908, -63.08075
2nd	GOP-20180712	
3rd	GOP-20180821	
1st	LSP-20180622	46.13853, -63.07769.
2nd	LSP-20180712	
3rd	LSP-20180815	
1st	HEP-20180703	46.14419, -63.07286.
2nd	HEP-20180712	
3rd	HEP-20180815	
1st	APS-20180705	46.14416, -63.07243.
2nd	APS-20180716	
3rd	APS-20180814	
1st	APN-20180706	46.16405, -63.06685.
2nd	APN-20180716	
3rd	APN-20180814	
1st	FMP-20180703	46.14856, -63.08040.
2nd	FMP-20180724	
3rd	FMP-20180821	
1st	BAP-20180703	46.16582, -63.06687.
2nd	BAP-20180710	
3rd	BAP-20180809	
1st	MNP-20180626	46.16243, -63.09013
2nd	MNP-20180712	
3rd	MNP-20180815	
1st	ACP-20180703	46.14856, -63.08040.
2nd	ACP-20180727	
3rd	ACP-20180821	
1st	CAP-20180530	46.12891, -63.18395.
2nd	CAP-20180726	
3rd	CAP-20180822	

1st	JAP-N/A	Not sampled
2nd	JAP-20180731	46.12892, -63.18396.
3rd	JAP-20180823	

Figure 1. View of Jardine's Pond July 2018 by Chris Doyle

Figure 2. View of Hermitage Pond August 2018 by Chris Doyle

Figure 3. View of Lower Slick's Pond August 2018 by Chris Doyle

Figure 4. Collecting samples. Photo by Bryan Grimmelt

Figure 5. Macroinvertebrates sampling. Photo by Bryan Grimmelt

Figure 6. Macroinvertebrates sampling. Photo by Bryan Grimmelt

APPENDIX B

FBI RAW DATA

Table 1 Summary of Family Biotic Index Results

ROUND	SAMPLE ID	FBI	FBI MEAN	WATER QUALITY	DEGREE OF ORGANIC POLLUTION
1st	GOP-20180619	5.2	7.03	Poor	Very substantial pollution likely
2nd	GOP-20180712	8			
3rd	GOP-20180821	7.9			
1st	DMP-20180619	6.66	6.87	Poor	Very substantial pollution likely
2nd	DMP-20180711	7.25			
3rd	DMP-20180808	6.71			
1st	LSP-20180622	7	6.49	Fairly Poor	Substantial pollution likely
2nd	LSP-20180712	7.03			
3rd	LSP-20180815	5.44			
1st	MNP-20180626	5.74	6.22	Fairly Poor	Substantial pollution likely
2nd	MNP-20180712	7.18			
3rd	MNP-20180815	5.72			
1st	HEP-20180703	5	5.38	Fair	Fairly substantial pollution likely
2nd	HEP-20180712	4.125			
3rd	HEP-20180815	7			
1st	FMP-20180703	8	7.17	Poor	Very substantial pollution likely
2nd	FMP-20180724	8			
3rd	FMP-20180821	5.5			
1st	ACP-20180703	5.42	4.38	Good	Some organic pollution probable
2nd	ACP-20180727	4.71			
3rd	ACP-20180821	3			
1st	JAP-N/A	N/A	6.78	Poor	Very substantial pollution likely
2nd	JAP-20180731	6.67			
3rd	JAP-20180823	6.89			
1st	BAP-20180703	5.93	5.84	Fairly Poor	Substantial pollution likely
2nd	BAP-20180710	5.78			
3rd	BAP-20180809	5.83			

1st	APN-20180706	6.56	6.43	Fairly Poor	Substantial pollution likely
2nd	APN-20180716	6.23			
3rd	APN-20180814	6.5			
1st	APS-20180705	6.84	6.35	Fairly Poor	Substantial pollution likely
2nd	APS-20180716	6.31			
3rd	APS-20180814	5.92			
1st	CAP-20180530	4.68	4.97	Good	Some organic pollution probable
2nd	CAP-20180726	4.67			
3rd	CAP -20180822	5.56			

Table 2. Raw Data Family Biotic Index (FBI)

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
1st	GOP-20180619	Gastropoda	Pulmonata	Physidae	2	8	16
		Insecta	Diptera	Chironomidae	3	8	24
		Insecta	Odonata	Libellulidae	4	2	8
		Insecta		Zygoptera	1	4	4
				Total	**10**		**52**
						FBI	**5.2**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
2nd	GOP-20180712	Gastropoda	Pulmonata	Physidae	1	8	8
			Prosobranchia	Bithyniidae	1	8	8
					2		**16**
						FBI	**8**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
1st	DMP-20180619	Insecta	Coleoptera	Dyticidae	2	8	16
		Insecta	Megaloptera	Coridalidae	1	4	4
					3		**20**
					FBI	**6.66**	**FBI**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
2nd	DMP-20180711	Gastropoda	Pulmonata	Planorbidae	3	6	18
		Insecta	Diptera	Chironomidae	5	8	40
					8		58
						FBI	**7.25**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
3rd	DMP-20180808	Insecta	Coleoptera	Dyticidae	3	5	15
			Diptera	Chironomidae	4	8	32
					7		**47**
						FBI	6.71

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
1st	LSP-20180618	Gastropoda	Pulmonata	Planorbidae	4	8	32
			Pulmonata	Hydrobiidae	6	6	36
			Pulmonata	Physidae	3	8	24
		Bivalvia	Spaheriidae		1	6	6
					14		**98**
						FBI	**7**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
2nd	LSP-20180713	Gastropoda	Pulmonata	Planorbidae	12	7	84
				Hydrobiidae	11	6	66
				Physidae	8	8	64
		Insecta	Diptera	Chironomidae	4	8	32
					35		**246**
						FBI	**7.03**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
3rd	LSP-20180815	Gastropoda	Pulmonata	Planorbidae	4	7	28
			Prosobranchia	Hydrobiidae	1	6	6
			Prosobranchia	Pleuroceridae	1	6	6
		Insecta	Trichoptera	Limnephilidae	1	3	3
		Insecta	Odonata	Gomphidae	2	3	6
					9		**49**
						FBI	**5.44**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
1st	HEP-20180703	Gastropoda	Pulmonata	Physidae	2	8	16
		Insecta	Trichoptera	Limnephilidae	3	3	9
					5		**25**
						FBI	**5**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
2nd	HEP-20180712	Insecta	Trichoptera	Limnephilidae	5	3	15
		Bivalvia	Spaheriidae		3	6	18
					8		**33**
						FBI	**4.125**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
3rd	HEP-20180815	Gastropoda	Pulmonata	Physidae	1	8	8
		Insecta	Diptera	Chironomidae	3	8	24
			Trichoptera	Limnephilidae	1	3	3
					5		**35**
						FBI	**7**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
1st	MNP-20180626	Gastropoda	Prosobranchia	Hydrobiidae	23	6	138
		Gastropoda	Prosobranchia	Viviparidae	5	6	30
		Insecta	Diptera	Chironomidae	6	8	48
			Hemiptera	Corixidae	2	5	10
			Trichoptera	Limnephilidae	7	3	21
					43		**247**
						FBI	**5.74**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
2nd	MNP-20180713	Gastropoda	Prosobranchia	Hydrobiidae	3	6	18
		Gastropoda	Pulmonata	Physidae	9	8	72
		Insecta	Diptera	Chironomidae	6	8	48
			Hemiptera	Corixidae	4	5	20
					22		**158**
						FBI	**7.18**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
3rd	MNP-20180815		Pulmonata	Planorbidae	1	8	8
			Pulmonata	Physidae	5	8	40
		Gastropoda	Pulmonata	Lymnaidae	2	6	12
		Insecta	Trichoptera	Limnephilidae	1	3	3
			Hemiptera	Corixidae	16	5	80
					25		**143**
						FBI	**5.72**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
1st	APN-20180706	Gastropoda	Pulmonata	Physidae	101	8	808
		Gastropoda	Pulmonata	Lymnaeidae	2	6	12
		Insecta	Odonata	Gomphidae	3	3	9
		Insecta	Odonata	Aeshnidae	1	3	3
		Insecta	Trichoptera	Limnephilidae	23	3	69
		Bivalvia	Spaheriidae		85	6	510
					215		**1411**
						FBI	**6.56**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
2nd	APN-20180716	Gastropoda	Pulmonata	Physidae	11	8	88
		Gastropoda	Pulmonata	Lymnaeidae	1	6	6
		Insecta	Trichoptera	Limnephilidae	3	3	9
		Insecta	Coleoptera	Dytiscidae	6	5	30
		Bivalvia	Spaheriidae		10	6	60
					31		**193**
						FBI	**6.23**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
3rd	APN-20180814	Gastropoda	Pulmonata	Physidae	23	8	184
		Gastropoda	Prosobranchia	Bithyniidae	22	8	176
		Insecta	Trichoptera	Limnephilidae	6	3	18
		Insecta	Odonata	Aeshnidae	1	3	3
		Bivalvia	Spaheriidae		85	6	510
					137		**891**
						FBI	**6.5**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
1st	APS-20180705	Gastropoda	Pulmonata	Physidae	43	8	344
		Insecta	Coleoptera	Hydrophilidae	14	6	84
			Diptera	Tipulidae	4	3	12
			Trichoptera	Limnephilidae	6	3	18
					67		**458**
						FBI	**6.84**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
2nd	APS-20180716	Gastropoda	Pulmonata	Physidae	27	8	216
		Gastropoda	Pulmonata	Planorbidae	10	7	70
		Gastropoda	Prosobranchia	Pleuroceridae	13	6	78
		Insecta	Odonata	Aeshnidae	7	3	21
		Insecta	Trichoptera	Limnephilidae	11	3	33
		Crustaccea	Amphipoda		9	6	54
		Insecta	Diptera	Chironomidae	8	8	64
					85		**536**
						FBI	**6.31**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
3rd	APS-20180814	Gastropoda	Pulmonata	Physidae	10	8	80
		Gastropoda	Pulmonata	Planorbidae	5	7	35
		Insecta	Odonata	Aeshnidae	4	3	12
		Insecta	Diptera	Tipulidae	3	3	9
		Insecta	Trichoptera	Limnephilidae	2	3	6
					24		**142**
						FBI	**5.92**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
1st	FMP-20180703	Gastropoda	Pulmonata	Physidae	1	8	8
					1		**8**
						FBI	**8**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
2nd	FMP-20180724	Gastropoda	Prosobranchia	Bithyniidae	1	8	8
					1		**8**
						FBI	**8**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
3rd	FMP-20180821	Insecta	Coleoptera	Hydrophilidae	4	6	24
		Insecta	Coleoptera	Dytiscidae	4	5	20
					8		**44**
						FBI	**5.5**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
1st	BAP-20180703	Gastropoda	Prosobranchia	Pleuroceridae	3	6	18
		Gastropoda	Prosobranchia	Hydrobiidae	1	6	6
		Gastropoda	Pulmonata	Physidae	4	8	32
		Insecta	Coleoptera	Hydrophilidae	1	6	6
		Insecta	Coleoptera	Dytiscidae	3	5	15
		Insecta	Trichoptera	Limnephilidae	2	3	6
					14		**83**
						FBI	**5.93**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
2nd	BAP-20180710	Gastropoda	Pulmonata	Physidae	5	8	40
		Gastropoda	Pulmonata	Planorbidae	1	7	7
		Gastropoda	Pulmonata	Lymnaeidae	3	3	9
		Insecta	Trichoptera	Limnephilidae	3	6	18
		Insecta	Coleoptera	Haliphidae	6	5	30
					18		**104**
						FBI	**5.78**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
3rd	BAP-20180819	Gastropoda	Pulmonata	Physidae	20	8	160
		Gastropoda	Pulmonata	Planorbidae	11	7	77
		Insecta	Trichoptera	Limnephilidae	6	3	18
		Insecta	Coleoptera	Hydrophilidae	27	5	135
		Insecta	Diptera	Tipulidae	1	3	3
		Insecta	Odonata	Aeshnidae	5	3	15
					70		**408**
						FBI	**5.83**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
1st	ACP-20180703	Insecta	Coleoptera	Dytiscidae	2	5	10
		Insecta	Diptera	Tipulidae	5	3	15
		Insecta	Diptera	Chaboridae	5	8	40
					12		**65**
						FBI	**5.42**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
2nd	ACP-20180727	Gastropoda	Pulmonata	Physidae	1	8	8
		Gastropoda	Prosobranchia	Pleuroceridae	2	6	12
		Insecta	Trichoptera	Limnephilidae	2	3	6
		Insecta	Trichoptera	Rhyacophilidae	1	1	1
		Bivalvia	Spaheriidae		1	6	6
					7		**33**
						FBI	**4.71**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
3rd	ACP-20180821	Insecta	Onodata	Gomphidae	1	3	3
					1		**3**
						FBI	**3**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
2nd	JAP-20180731	Insecta	Coleoptera	Dytiscidae	2	5	10
		Insecta	Coleoptera	Hydrophilidae	2	5	10
		Insecta	Diptera	Chironomidae	23	8	184
		Insecta	Odonata	Zygoptera	9	4	36
					36		**240**
						FBI	6.67

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
3rd	JAP-20180823	Gastropoda	Pulmonata	Physidae	2	8	16
		Insecta	Coleoptera	Dytiscidae	1	5	5
		Insecta	Diptera	Chironomidae	4	8	32
		Insecta	Odonata	Aeshnidae	1	3	3
		Insecta	Coleoptera	Hydrophilidae	1	6	6
					9		**62**
						FBI	**6.89**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
1st	CAP-20180530	Gastropoda	Pulmonata	Lymnaeidae	9	6	54
		Insecta	Coleoptera	Hydrophilidae	4	5	20
		Insecta	Diptera	Ptychopteridae	4	9	36
		Insecta	Ephemeroptera	Baetidae	49	5	245
			Odonata	Libellulidae	1	2	2
			Trichoptera	Limnephilidae	26	3	78
					93		**435**
						FBI	**4.68**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
2nd	CAP-20180726	Gastropoda	Pulmonata	Physidae	2	8	16
		Insecta	Diptera	Chironomidae	4	8	32
		Insecta	Trichoptera	Limnephilidae	12	3	36
		Insecta	Odonata	Zygoptera	5	4	20
		Insecta	Ephemeroptera	Baetidae	10	5	50
					33		**154**
						FBI	**4.67**

Round	Sample Id	Class	Subclass or order	Family	Total	Tolerance value	Total X Tolerance
3rd	CAP-20180822	Gastropoda	Pulmonata	Physidae	4	8	32
		Insecta	Coleoptera	Dytiscidae	3	5	15
			Diptera	Chironomidae	4	8	32
		Insecta	Trichoptera	Limnephilidae	7	3	21
					18		**100**
						FBI	**5.56**
						Average	**4.97**

APPENDIX C

Raw Data Field Measurements

Table 1. Field Measurements DO, Conductivity, pH and Temperature

Sample ID	DO (mg/L)	Conductivity (uS/cm)	pH	Temperature (c)
GOP-20180821	7.3	1292	7.62	19.9
DMP-20180808	*3.62*	*49.7*	*6.41*	*24.6*
LSP-20180815	7.55	841	7.29	23.7
MNP-20180626	10.06	641	7.14	12.9
MNP-20180815	9.96	1169	7.57	21.9
HEP-20180815	11.45	703	7.95	21.2
FMP-20180821	6.84	386	7.95	19.3
ACP-20180727	2.67	485	6.86	17.8
ACP-20180821	6.45	376	7.36	21.2
JAP-20180731	9.74	521	7.54	18.3
JAP-20180823	4.49	331	7.35	20.5
BAP-20180809	7.6	492	7.59	16.2
APN-20180814	8.6	465	7.9	24.2
APS-20180814	7.81	690	8.29	23.5
CAP-20180726	8.60	363	6.79	17.2
CAP-20180822	7.04	394	7.87	20.8

Table 2. Hardness results in surface water

Groups	Round	Sample ID	Average (mL)	Hardness (mg CaCO3/L)
Group 1	1st	GOP-20180619	4.8	192
	2nd	GOP-20180712	9.2	368
	3rd	GOP-20180821	5.4	216
	1st	DMP-20180619	0.7	28
	2nd	DMP-20180711	0.6	24
	3rd	DMP-20180808	0.6	24
Group 2	1st	LSP-20180622	7.5	300
	2nd	LSP-20180712	5.8	232
	3rd	LSP-20180815	6	240
	1st	MNP-20180626	5.7	228
	2nd	MNP-20180712	8.9	356
	3rd	MNP-20180815	9.3	372
	1st	HEP-20180703	6.8	272
	2nd	HEP-20180712	6.2	248
	3rd	HEP-20180815	6.9	276
Group 3	1st	FMP-20180703	5.3	212
	2nd	FMP-20180724	2.9	100
	3rd	FMP-20180821	1.1	44
	1st	ACP-20180703	1.5	60
	2nd	ACP-20180727	1.3	52
	3rd	ACP-20180821	0.6	24
Group 4	1st	JAP-20180823	NA	NA
	2nd	JAP-20180731	6.2	248
	3rd	JAP-20180823	3.4	136
	1st	BAP-20180703	6.1	244
	2nd	BAP-20180710	6.6	252
	3rd	BAP-20180809	6.8	272
	1st	APN-20180706	6.3	252
	2nd	APN-20180716	6.3	252
	3rd	APN-20180814	4.4	176
	1st	APS-20180705	5.4	216
	2nd	APS-20180716	5.3	212
	3rd	APS-20180814	5.3	212
	1st	CAP-2018030	3.05	140
	2nd	CAP-20180726	3.2	128
	3rd	CAP-20180822	3.3	132

Table 3 Ammonia, Phosphate and Nitrates

Round	Sample ID	Ammonia (mg/L)	Phosphate* (mg/L)	Nitrate* (mg/L)
1st	DMP-20180619	1.83	3.24	0.364
2nd	DMP-20180711	0.367	4.27	0.408
3rd	DMP-20180808	-0.247	8.45	0.769
1st	GOP-20180619	0.976	3.01	0.674
2nd	GOP-20180712	0.343	1.99	0.199
3rd	GOP-20180821	2.34	0.917	0.427
1st	LSP-20180622	0.478	0.468	0.678
2nd	LSP-20180712	0.522	-1.44	0.842
3rd	LSP-20180815	-0.258	-0.672	0.391
1st	HEP-20180703	1.11	-0.44	1.31
2nd	HEP-20180712	0.327	-1.49	0.788
3rd	HEP-20180815	0.447	0.804	0.393
1st	APS-20180705	0.683	-1.25	1.94
2nd	APS-20180716	0.324	-1.26	2.08
3rd	APS-20180814	Not sampled	Not sampled	Not sampled
1st	APN-20180706	0.429	-0.511	1.95
2nd	APN-20180716	0.437	-1.35	2.12
3rd	APN-20180814	-0.534	0.360	1.58
1st	FMP-20180703	0.567	0.394	0.455
2nd	FMP-20180724	0.657	0.524	0.207
3rd	FMP-20180821	-0.284	-0.483	1.87
1st	BAP-20180703	0.560	-1.23	3.15
2nd	BAP-20180710	0.261	-1.33	4.15
3rd	BAP-20180809	1.02	-0.666	0.999
1st	MNP-20180626	0.355	-1.10	1.11
2nd	MNP-20180712	0.577	-1.58	1.13
3rd	MNP-20180815	0.196	-0.434	0.822
1st	ACP-20180703	0.151	0.500	0.263
2nd	ACP-20180727	0.165	0.245	0.154
3rd	ACP-20180821	-0.373	-0.421	0.165
1st	CAP-20180530	0.166	-1.65	0.040
2nd	CAP-20180726	0.140	-1.54	0.197
3rd	CAP-20180822	0.402	0.722	0.165
1st	JAP-20180823	Not sampled	Not sampled	Not sampled
2nd	JAP-20180823	0.354	-1.18	3.89
3rd	JAP-20180823	1.02	0.061	2.15

*Testing was performed after 48 h of sampling.

APPENDIX D

Laboratory Reports

Special Products Test Report
10/ 4/2018

Page 1 of 3

HOLLAND COLLEGE
C/O BRYAN GRIMMELT
140 WEYMOUTH STREET
CHARLOTTETOWN, PEI
C1A 4Z1

PEI Analytical Laboratories
PEI Department of Agriculture and Forestry
23 Innovation Way
PO Box 2000, Charlottetown, PEI, C1A7N8

Fax: (902) 368-6299
Telephone: (902) 620-3300

Client: 6498
Accession: 4911
Samples Reported: 9/11/2018
Samples Received: 8/31/2018

Analysis Performed	Lab #: 4911-1 Sample Type: Pond Sed (48hr) Sample Id: FMP-180820	Lab #: 4911-2 Sample Type: Pond Sed (48hr) Sample Id: HEP-180815	Lab #: 4911-3 Sample Type: Pond Sed (48hr) Sample Id: CAP-180824	Lab #: 4911-4 Sample Type: Pond Sed (48hr) Sample Id: DMP-180808
Dry Matter %	100.00	100.00	100.00	100.00
Carbon %	5.88	4.72	3.64	15.60
C:N Ratio	18.97	15.73	20.22	21.37
Nitrogen %	.31	.30	.18	.73
Potassium %	.12	.15	.16	.13
Calcium %	.10	.13	.09	.18
Magnesium %	.18	.29	.30	.22
Copper ppm	6.00	5.61	3.85	6.34
Zinc ppm	38.89	50.84	32.74	75.96
Boron ppm	< .70	< .70	< .70	< .70
Cobalt ppm	3.68	5.80	5.98	4.34
Chromium ppm	59.85	54.03	33.26	40.27
Iron ppm	8284.45	8306.52	7372.87	6320.19
Manganese ppm	208.08	276.40	237.88	363.92
pH	4.43	5.91	5.60	4.85

Date of analysis available upon request.

Comment:
Samples are reported on an "as received" basis using the dry ash method for analysis.

Copies to:	Test values approved by: JG	**We are members of the following Sample Check Programs: Compost Analysis Proficiency Testing Program and Manure Testing Laboratory Certification Program**

Special Products Test Report
10/ 4/2018

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HOLLAND COLLEGE
C/O BRYAN GRIMMELT
140 WEYMOUTH STREET
CHARLOTTETOWN, PEI
C1A 4Z1

PEI Analytical Laboratories
PEI Department of Agriculture and Forestry
23 Innovation Way
PO Box 2000, Charlottetown, PEI, C1A7N8

Fax: (902) 368-6299
Telephone: (902) 620-3300

Client: 6498
Accession: 4911
Samples Reported: 9/11/2018
Samples Received: 8/31/2018

Analysis Performed	Lab #: 4911-5 Sample Type: Pond Sed (48hr) Sample Id: APN-180717	Lab #: 4911-6 Sample Type: Pond Sed (48hr) Sample Id: GOP-180820	Lab #: 4911-7 Sample Type: Pond Sed (48hr) Sample Id: JAP-180731	Lab #: 4911-8 Sample Type: Pond Sed (48hr) Sample Id: ACP-180727
Dry Matter %	100.00	100.00	100.00	100.00
Carbon %	4.88	9.27	3.84	2.32
C:N Ratio	17.43	17.17	19.20	19.33
Nitrogen %	.28	.54	.20	.12
Potassium %	.10	.10	.13	.21
Calcium %	.11	.45	.17	.04
Magnesium %	.22	.31	.27	.40
Copper ppm	3.86	24.78	6.05	6.22
Zinc ppm	29.57	145.23	81.27	41.79
Boron ppm	< .70	6.25	1.30	1.74
Cobalt ppm	5.11	6.33	5.79	8.40
Chromium ppm	40.89	89.01	57.08	32.49
Iron ppm	6732.57	8370.31	9236.25	20184.11
Manganese ppm	269.68	358.28	358.09	296.54
pH	4.94	6.23	6.88	4.93

Date of analysis available upon request.

Comment:
Samples are reported on an "as received" basis using the dry ash method for analysis.

Copies to:	Test values approved by: JG	**We are members of the following Sample Check Programs:** **Compost Analysis Proficiency Testing Program and Manure Testing Laboratory Certification Program**

Special Products Test Report
10/ 4/2018

Page 3 of 3

HOLLAND COLLEGE
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23 Innovation Way
PO Box 2000, Charlottetown, PEI, C1A7N8

Fax: (902) 368-6299
Telephone: (902) 620-3300

Client: 6498
Accession: 4911
Samples Reported: 9/11/2018
Samples Received: 8/31/2018

Analysis Performed	Lab #: 4911-9 Sample Type: Pond Sed (48hr) Sample Id: MNP-180815	Lab #: 4911-10 Sample Type: Pond Sed (48hr) Sample Id: APS-180717	Lab #: 4911-11 Sample Type: Pond Sed (48hr) Sample Id: BAP-180809	Lab #: 4911-12 Sample Type: Pond Sed (48hr) Sample Id: LSP-180815
Dry Matter %	100.00	100.00	100.00	100.00
Carbon %	4.79	2.13	3.25	13.36
C:N Ratio	18.42	21.30	21.67	16.10
Nitrogen %	.26	.10	.15	.83
Potassium %	.18	.14	.12	.28
Calcium %	.11	.05	.09	.25
Magnesium %	.25	.27	.26	.60
Copper ppm	6.08	8.50	6.05	21.51
Zinc ppm	58.64	32.60	43.12	176.63
Boron ppm	1.45	< .70	< .70	2.42
Cobalt ppm	7.60	6.05	5.65	11.02
Chromium ppm	44.70	54.74	65.98	32.68
Iron ppm	14670.71	10056.91	11796.10	22209.64
Manganese ppm	649.09	219.14	337.36	452.69
pH	4.91	5.82	5.95	5.81

Date of analysis available upon request.

Comment:
Samples are reported on an "as received" basis using the dry ash method for analysis.

Copies to:	Test values approved by: JG	**We are members of the following Sample Check Programs:** **Compost Analysis Proficiency Testing Program and Manure Testing Laboratory Certification Program**

PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Page 1 of 1

Client Name: Holland College: Bryan Grimmelt
Sample Number: SW180831011
Sample Point: Holland College: Bryan Grimmelt
Sample Location: ACP-20180703
Date Sampled: July 03, 2018
Sampler: K.S, C.D
Date Received: August 31, 2018
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Barium, dissolved	53	ppb	2.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M	*	Copper, dissolved	43	ppb	5.00
WCL_07M	*	Iron, dissolved	2904	ppb	9.00
WCL_07M	*	Nickel, dissolved	11	ppb	7.00
WCL_07M	*	Magnesium, dissolved	2.66	ppm	0.10
WCL_07M	*	Phosphorus, dissolved	0.15	ppm	0.02
WCL_07M	*	Potassium, dissolved	1.12	ppm	0.10
WCL_07M	*	Sodium, dissolved	99.36	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	15.93	ppm	0.20
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Zinc, dissolved	49	ppb	6.00
WCL_07M	*	Manganese, dissolved	99	ppb	3.00
WCL_07M		Arsenic, dissolved	<4	ppb	4.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Calcium, dissolved	18.07	ppm	0.20

Approved By: Lori Brine Date: September 28, 2018

Date of Analysis available upon request.

Legend: MPN = Most Probable Number
cfu/100 mls = colony forming unit per 100 millilitres
* = method accredited by Standards Council of Canada;
ppm = parts per million
Ammonia is equivelent to (Ammonia + Ammonium)-N
mg/L = milligrams per litre
nd = not detected; na = not analysed
ppb = parts per billion

End of Report

Standards Council of Canada Accredited Laboratory Scope of Accreditation 424

Conseil canadien des normes Laboratoire accrédité Portée d'accréditation 424 TM

PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Client Name: Holland College: Bryan Grimmelt

Sample Point: Holland College: Bryan Grimmelt

Date Sampled: July 06, 2018

Date Received: August 31, 2018

Sample Number: SW180831010

Sample Location: APN-20180706

Sampler: Chris Doyle

Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Barium, dissolved	276	ppb	2.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M	*	Copper, dissolved	52	ppb	5.00
WCL_07M	*	Iron, dissolved	13	ppb	9.00
WCL_07M	*	Nickel, dissolved	<7	ppb	7.00
WCL_07M	*	Magnesium, dissolved	25.89	ppm	0.10
WCL_07M	*	Phosphorus, dissolved	<0.02	ppm	0.02
WCL_07M	*	Potassium, dissolved	2.11	ppm	0.10
WCL_07M	*	Sodium, dissolved	57.33	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	12.85	ppm	0.20
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Zinc, dissolved	12	ppb	6.00
WCL_07M	*	Manganese, dissolved	39	ppb	3.00
WCL_07M		Arsenic, dissolved	<4	ppb	4.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Calcium, dissolved	53.08	ppm	0.20

Approved By: Lori Brine Date: September 28, 2018

Date of Analysis available upon request.

Legend: MPN = Most Probable Number
cfu/100 mls = colony forming unit per 100 millilitres
* = method accredited by Standards Council of Canada;
ppm = parts per million
Ammonia is equivelent to (Ammonia + Ammonium)-N
mg/L = milligrams per litre
nd = not detected; na = not analysed
ppb = parts per billion

End of Report

PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Page 1 of 1

Client Name: Holland College: Bryan Grimmelt
Sample Number: SW180831009
Sample Point: Holland College: Bryan Grimmelt
Sample Location: APS-20180705
Date Sampled: July 05, 2018
Sampler: Chris Doyle
Date Received: August 31, 2018
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Barium, dissolved	200	ppb	2.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M	*	Copper, dissolved	16	ppb	5.00
WCL_07M	*	Iron, dissolved	<9	ppb	9.00
WCL_07M	*	Nickel, dissolved	<7	ppb	7.00
WCL_07M	*	Magnesium, dissolved	21.36	ppm	0.10
WCL_07M	*	Phosphorus, dissolved	<0.02	ppm	0.02
WCL_07M	*	Potassium, dissolved	2.08	ppm	0.10
WCL_07M	*	Sodium, dissolved	45.45	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	12.50	ppm	0.20
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Zinc, dissolved	21	ppb	6.00
WCL_07M	*	Manganese, dissolved	<3	ppb	3.00
WCL_07M		Arsenic, dissolved	<4	ppb	4.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Calcium, dissolved	45.14	ppm	0.20

Approved By: Lori Brine Date: September 28, 2018

Date of Analysis available upon request.

Legend: MPN = Most Probable Number
cfu/100 mls = colony forming unit per 100 millilitres
* = method accredited by Standards Council of Canada;
ppm = parts per million
Ammonia is equivelent to (Ammonia + Ammonium)-N
mg/L = milligrams per litre
nd = not detected; na = not analysed
ppb = parts per billion

End of Report

PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Page 1 of 1

Client Name: Holland College: Bryan Grimmelt
Sample Number: SW180831008
Sample Point: Holland College: Bryan Grimmelt
Sample Location: BAP-20180703
Date Sampled: July 03, 2018
Sampler: Chris Doyle
Date Received: August 31, 2018
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Barium, dissolved	216	ppb	2.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M	*	Copper, dissolved	83	ppb	5.00
WCL_07M	*	Iron, dissolved	10	ppb	9.00
WCL_07M	*	Nickel, dissolved	<7	ppb	7.00
WCL_07M	*	Magnesium, dissolved	25.65	ppm	0.10
WCL_07M	*	Phosphorus, dissolved	<0.02	ppm	0.02
WCL_07M	*	Potassium, dissolved	2.03	ppm	0.10
WCL_07M	*	Sodium, dissolved	27.66	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	10.26	ppm	0.20
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Zinc, dissolved	28	ppb	6.00
WCL_07M	*	Manganese, dissolved	4	ppb	3.00
WCL_07M		Arsenic, dissolved	<4	ppb	4.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Calcium, dissolved	51.86	ppm	0.20

Approved By: Lori Brine Date: September 28, 2018

Date of Analysis available upon request.

Legend: MPN = Most Probable Number
cfu/100 mls = colony forming unit per 100 millilitres
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ppm = parts per million
Ammonia is equivelent to (Ammonia + Ammonium)-N
mg/L = milligrams per litre
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ppb = parts per billion

End of Report

PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Page 1 of 1

Client Name: Holland College: Bryan Grimmelt
Sample Number: SW180831012
Sample Point: Holland College: Bryan Grimmelt
Sample Location: CAP-20180530
Date Sampled: May 30, 2018
Sampler: Chris Doyle
Date Received: August 31, 2018
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Barium, dissolved	116	ppb	2.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M	*	Copper, dissolved	9	ppb	5.00
WCL_07M	*	Iron, dissolved	12	ppb	9.00
WCL_07M	*	Nickel, dissolved	<7	ppb	7.00
WCL_07M	*	Magnesium, dissolved	13.27	ppm	0.10
WCL_07M	*	Phosphorus, dissolved	<0.02	ppm	0.02
WCL_07M	*	Potassium, dissolved	1.99	ppm	0.10
WCL_07M	*	Sodium, dissolved	33.61	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	6.52	ppm	0.20
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Zinc, dissolved	11	ppb	6.00
WCL_07M	*	Manganese, dissolved	<3	ppb	3.00
WCL_07M		Arsenic, dissolved	<4	ppb	4.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Calcium, dissolved	24.80	ppm	0.20

Approved By: Lori Brine Date: September 28, 2018

Date of Analysis available upon request.

Legend: MPN = Most Probable Number
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Ammonia is equivelent to (Ammonia + Ammonium)-N
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End of Report

PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Page 1 of 1

Client Name: Holland College: Bryan Grimmelt
Sample Number: SW180831005
Sample Point: Holland College: Bryan Grimmelt
Sample Location: DMP-20180619
Date Sampled: June 19, 2018
Sampler: K.S, C.D
Date Received: August 31, 2018
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Barium, dissolved	117	ppb	2.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M	*	Copper, dissolved	86	ppb	5.00
WCL_07M	*	Iron, dissolved	335	ppb	9.00
WCL_07M	*	Nickel, dissolved	<7	ppb	7.00
WCL_07M	*	Magnesium, dissolved	1.94	ppm	0.10
WCL_07M	*	Phosphorus, dissolved	0.09	ppm	0.02
WCL_07M	*	Potassium, dissolved	0.94	ppm	0.10
WCL_07M	*	Sodium, dissolved	2.46	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	1.17	ppm	0.20
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Zinc, dissolved	36	ppb	6.00
WCL_07M	*	Manganese, dissolved	271	ppb	3.00
WCL_07M		Arsenic, dissolved	<4	ppb	4.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Calcium, dissolved	5.36	ppm	0.20

Approved By: Lori Brine Date: September 28, 2018

Date of Analysis available upon request.

Legend: MPN = Most Probable Number
cfu/100 mls = colony forming unit per 100 millilitres
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ppm = parts per million
Ammonia is equivelent to (Ammonia + Ammonium)-N
mg/L = milligrams per litre
nd = not detected; na = not analysed
ppb = parts per billion

End of Report

PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Page 1 of 1

Client Name: Holland College: Bryan Grimmelt
Sample Number: SW180831001
Sample Point: Holland College: Bryan Grimmelt
Sample Location: FMP-20180703
Date Sampled: July 03, 2018
Sampler: K.S. C.D
Date Received: August 31, 2018
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Barium, dissolved	119	ppb	2.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M	*	Copper, dissolved	56	ppb	5.00
WCL_07M	*	Iron, dissolved	403	ppb	9.00
WCL_07M	*	Nickel, dissolved	<7	ppb	7.00
WCL_07M	*	Magnesium, dissolved	2.15	ppm	0.10
WCL_07M	*	Phosphorus, dissolved	0.03	ppm	0.02
WCL_07M	*	Potassium, dissolved	1.24	ppm	0.10
WCL_07M	*	Sodium, dissolved	67.92	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	9.88	ppm	0.20
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Zinc, dissolved	23	ppb	6.00
WCL_07M	*	Manganese, dissolved	430	ppb	3.00
WCL_07M		Arsenic, dissolved	<4	ppb	4.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Calcium, dissolved	11.84	ppm	0.20

Approved By: Lori Brine Date: September 28, 2018

Date of Analysis available upon request.

Legend: MPN = Most Probable Number
cfu/100 mls = colony forming unit per 100 millilitres
* = method accredited by Standards Council of Canada;
ppm = parts per million
Ammonia is equivelent to (Ammonia + Ammonium)-N
mg/L = milligrams per litre
nd = not detected; na = not analysed
ppb = parts per billion

End of Report

PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Page 1 of 1

Client Name: Holland College: Bryan Grimmelt
Sample Number: SW180831006
Sample Point: Holland College: Bryan Grimmelt
Sample Location: GOP-20180619
Date Sampled: June 19, 2018
Sampler: K. Singh
Date Received: August 31, 2018
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Barium, dissolved	71	ppb	2.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M	*	Copper, dissolved	9	ppb	5.00
WCL_07M	*	Iron, dissolved	2141	ppb	9.00
WCL_07M	*	Nickel, dissolved	<7	ppb	7.00
WCL_07M	*	Magnesium, dissolved	15.12	ppm	0.10
WCL_07M	*	Phosphorus, dissolved	0.20	ppm	0.02
WCL_07M	*	Potassium, dissolved	4.74	ppm	0.10
WCL_07M	*	Sodium, dissolved	272.70	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	40.89	ppm	0.20
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Zinc, dissolved	16	ppb	6.00
WCL_07M	*	Manganese, dissolved	225	ppb	3.00
WCL_07M		Arsenic, dissolved	<4	ppb	4.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Calcium, dissolved	43.11	ppm	0.20

Approved By: Lori Brine Date: September 28, 2018

Date of Analysis available upon request.

Legend: MPN = Most Probable Number
cfu/100 mls = colony forming unit per 100 millilitres
* = method accredited by Standards Council of Canada;
ppm = parts per million
Ammonia is equivelent to (Ammonia + Ammonium)-N
mg/L = milligrams per litre
nd = not detected; na = not analysed
ppb = parts per billion

End of Report

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Client Name: Holland College: Bryan Grimmelt
Sample Number: SW180831002
Sample Point: Holland College: Bryan Grimmelt
Sample Location: HEP-20180703
Date Sampled: July 03, 2018
Sampler: K.S, C.D
Date Received: August 31, 2018
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Barium, dissolved	402	ppb	2.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M	*	Copper, dissolved	51	ppb	5.00
WCL_07M	*	Iron, dissolved	43	ppb	9.00
WCL_07M	*	Nickel, dissolved	<7	ppb	7.00
WCL_07M	*	Magnesium, dissolved	26.69	ppm	0.10
WCL_07M	*	Phosphorus, dissolved	0.05	ppm	0.02
WCL_07M	*	Potassium, dissolved	2.18	ppm	0.10
WCL_07M	*	Sodium, dissolved	68.95	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	15.50	ppm	0.20
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Zinc, dissolved	10	ppb	6.00
WCL_07M	*	Manganese, dissolved	4	ppb	3.00
WCL_07M		Arsenic, dissolved	<4	ppb	4.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Calcium, dissolved	55.46	ppm	0.20

Approved By: Lori Brine Date: September 28, 2018

Date of Analysis available upon request.

Legend: MPN = Most Probable Number
cfu/100 mls = colony forming unit per 100 millilitres
* = method accredited by Standards Council of Canada;
ppm = parts per million
Ammonia is equivelent to (Ammonia + Ammonium)-N
mg/L = milligrams per litre
nd = not detected; na = not analysed
ppb = parts per billion

End of Report

PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

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Client Name: Holland College: Bryan Grimmelt
Sample Number: SW180831007
Sample Point: Holland College: Bryan Grimmelt
Sample Location: JAP-20180731
Date Sampled: July 31, 2018
Sampler: Chris Doyle
Date Received: August 31, 2018
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Barium, dissolved	130	ppb	2.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M	*	Copper, dissolved	37	ppb	5.00
WCL_07M	*	Iron, dissolved	56	ppb	9.00
WCL_07M	*	Nickel, dissolved	<7	ppb	7.00
WCL_07M	*	Magnesium, dissolved	25.61	ppm	0.10
WCL_07M	*	Phosphorus, dissolved	0.02	ppm	0.02
WCL_07M	*	Potassium, dissolved	11.79	ppm	0.10
WCL_07M	*	Sodium, dissolved	32.26	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	9.69	ppm	0.20
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Zinc, dissolved	22	ppb	6.00
WCL_07M	*	Manganese, dissolved	31	ppb	3.00
WCL_07M		Arsenic, dissolved	<4	ppb	4.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Calcium, dissolved	52.46	ppm	0.20

Approved By: Lori Brine Date: September 28, 2018

Date of Analysis available upon request.

Legend: MPN = Most Probable Number
cfu/100 mls = colony forming unit per 100 millilitres
* = method accredited by Standards Council of Canada;
ppm = parts per million
Ammonia is equivelent to (Ammonia + Ammonium)-N
mg/L = milligrams per litre
nd = not detected; na = not analysed
ppb = parts per billion

End of Report

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Client Name:	Holland College: Bryan Grimmelt	**Sample Number:**	SW180831004
Sample Point:	Holland College: Bryan Grimmelt	**Sample Location:**	LSP-20180622
Date Sampled:	June 22, 2018	**Sampler:**	K.S, C.D
Date Received:	August 31, 2018	**Water Type:**	Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Barium, dissolved	221	ppb	2.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M	*	Copper, dissolved	56	ppb	5.00
WCL_07M	*	Iron, dissolved	<9	ppb	9.00
WCL_07M	*	Nickel, dissolved	<7	ppb	7.00
WCL_07M	*	Magnesium, dissolved	23.89	ppm	0.10
WCL_07M	*	Phosphorus, dissolved	0.02	ppm	0.02
WCL_07M	*	Potassium, dissolved	2.71	ppm	0.10
WCL_07M	*	Sodium, dissolved	88.80	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	15.57	ppm	0.20
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Zinc, dissolved	31	ppb	6.00
WCL_07M	*	Manganese, dissolved	<3	ppb	3.00
WCL_07M		Arsenic, dissolved	<4	ppb	4.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Calcium, dissolved	54.69	ppm	0.20

Approved By: Lori Brine Date: September 28, 2018

Date of Analysis available upon request.

Legend: MPN = Most Probable Number
cfu/100 mls = colony forming unit per 100 millilitres
* = method accredited by Standards Council of Canada;
ppm = parts per million
Ammonia is equivelent to (Ammonia + Ammonium)-N
mg/L = milligrams per litre
nd = not detected; na = not analysed
ppb = parts per billion

End of Report

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Client Name: Holland College: Bryan Grimmelt
Sample Number: SW180831003
Sample Point: Holland College: Bryan Grimmelt
Sample Location: MNP-20180815
Date Sampled: August 15, 2018
Sampler: K.S, C.D
Date Received: August 31, 2018
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Barium, dissolved	440	ppb	2.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M	*	Copper, dissolved	18	ppb	5.00
WCL_07M	*	Iron, dissolved	19	ppb	9.00
WCL_07M	*	Nickel, dissolved	<7	ppb	7.00
WCL_07M	*	Magnesium, dissolved	37.68	ppm	0.10
WCL_07M	*	Phosphorus, dissolved	<0.02	ppm	0.02
WCL_07M	*	Potassium, dissolved	2.95	ppm	0.10
WCL_07M	*	Sodium, dissolved	128.10	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	23.09	ppm	0.20
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Zinc, dissolved	12	ppb	6.00
WCL_07M	*	Manganese, dissolved	9	ppb	3.00
WCL_07M		Arsenic, dissolved	<4	ppb	4.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Calcium, dissolved	73.90	ppm	0.20

Approved By: Lori Brine Date: September 28, 2018

Date of Analysis available upon request.

Legend: MPN = Most Probable Number
cfu/100 mls = colony forming unit per 100 millilitres
* = method accredited by Standards Council of Canada;
ppm = parts per million
Ammonia is equivelent to (Ammonia + Ammonium)-N
mg/L = milligrams per litre
nd = not detected; na = not analysed
ppb = parts per billion

End of Report

Table 1 Summary of Surface Water results and Canadian Environmental Quality Guidelines

Parameter	Unit	Canadian Environmental Quality Guidelines (CEQG) CCME 2007	GOP-180619	DMP-180619	LSP-180622	MNP-180815	HEP-180703	FMP-180703	ACP-180703	CAP-180530	JAP-180731	BAP-180703	APN-180706	APS-180705
Barium, dissolved	ppb	-	71	117	221	440	402	119	53	116	130	216	276	200
Cadmium, dissolved	ppb	0.09	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Chromium, dissolved	ppb		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Copper, dissolved	ppb	2 to 4 [1]	9	86	56	18	51	56	43	9	37	83	52	16
Iron, dissolved	ppb	300	2141	335	<9	19	43	403	2904	12	56	10	13	<9
Nickel, dissolved	ppb		<7	<7	<7	<7	<7	<7	11	<7	<7	<7	<7	<7
Magnesium, dissolved	ppm	-	15.12	1.94	23.89	37.68	26.69	2.15	2.66	13.27	25.61	25.65	25.89	21.36
Phosphorus, dissolved	ppm	-	0.2	0.09	0.02	<0.02	0.05	0.03	0.15	<0.02	0.02	<0.02	<0.02	<0.02
Potassium, dissolved	ppm	-	4.74	0.94	2.71	2.95	2.18	1.24	1.12	1.99	11.79	2.03	2.11	2.08
Sodium, dissolved	ppm	-	272.7	2.46	88.8	128.1	68.95	67.92	99.36	33.61	32.26	27.66	57.33	45.45
Sulfate, calc from S dissolved	ppm	-	40.89	1.17	15.57	23.09	15.5	9.88	15.93	6.52	9.69	10.26	12.85	12.5
Lead, dissolved	ppb	1 to 7 [2]	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6
Zinc, dissolved	ppb	30	16	36	31	12	10	23	49	11	22	28	12	21
Manganese, dissolved	ppb	-	225	271	<3	9	4	430	99	<3	31	4	39	<3
Arsenic, dissolved	ppb		<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Cobalt, dissolved	ppb	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Calcium, dissolved	ppm	-	43.11	5.36	54.69	73.9	55.46	11.84	18.07	24.8	52.46	51.86	53.08	45.14

Note:

AO - aesthetic objective

CEQG - Canadian Environmental Quality Guidelines

CCME - Canadian Council of Ministers of the Environment

Table 2 Summary of Sediments results and Canadian Environmental Guidelines

Analysis	Unit	CCME 2002		GOP-180820	DMP-180808	LSP-180815	MNP-180815	HEP-180815	FMP-180820	ACP-180727	JAP-180731	BAP-180809	APN-180717	APS-180717	CAP-180824
		ISQG	PEL												
Carbon	%	-	-	9.27	15.60	13.36	4.79	4.72	5.88	2.32	3.84	3.25	4.88	2.13	3.64
C:N Ratio		-	-	17.17	21.37	16.10	18.42	15.73	18.97	19.33	19.20	21.67	17.43	21.67	20.22
Nitrogen	%	-	-	0.54	0.73	0.83	0.26	0.30	0.31	0.12	0.20	0.15	0.28	0.15	0.18
Potassium	%	-	-	0.10	0.13	0.28	0.18	0.15	0.12	0.21	0.13	0.12	0.10	0.12	0.16
Calcium	%	-	-	0.45	0.18	0.25	0.11	0.13	0.10	0.04	0.17	0.09	0.11	0.09	0.09
Magnesium	%	-	-	0.31	0.22	0.60	0.25	0.29	0.18	0.40	0.27	0.26	0.22	0.26	0.30
Copper	ppm	35.7	197	24.78	6.34	21.51	6.08	5.61	6.00	6.22	6.05	6.05	3.86	6.05	3.85
Zinc	ppm	123	315	145.23	75.96	176.63	58.64	50.84	38.89	41.79	81.27	43.12	29.57	43.12	32.74
Boron	ppm	-	-	6.25	<0.7	2.42	1.45	<0.7	<0.7	1.74	1.30	<0.7	<0.7	<0.7	<0.7
Cobalt	ppm	-	-	6.33	4.34	11.02	7.60	5.80	3.68	8.40	5.79	5.65	5.11	5.65	5.98
Chromium	ppm	37.3	90.0	89.01	40.27	32.68	44.70	54.03	59.85	32.49	57.08	65.98	40.89	65.98	33.26
Iron	ppm	-	-	8370	6320	22210	14671	8306	8284	20184	9236	11796	6732	11797	7373
Manganese	ppm	-	-	358.28	363.92	452.69	649.09	276.40	208.08	296.54	358.09	337.36	269.68	337.36	237.88
pH		-	-	6.23	4.85	5.81	4.91	5.91	4.43	4.93	6.88	5.95	4.94	5.95	5.60

Note:

ISQG - Interim Freshwater Sediment Quality Guidelines

PEL – Permissible Exposure Limit

APPENDIX E

Comparison 2017/2018 Data

1. Family Biotic Index 2017 v 2018

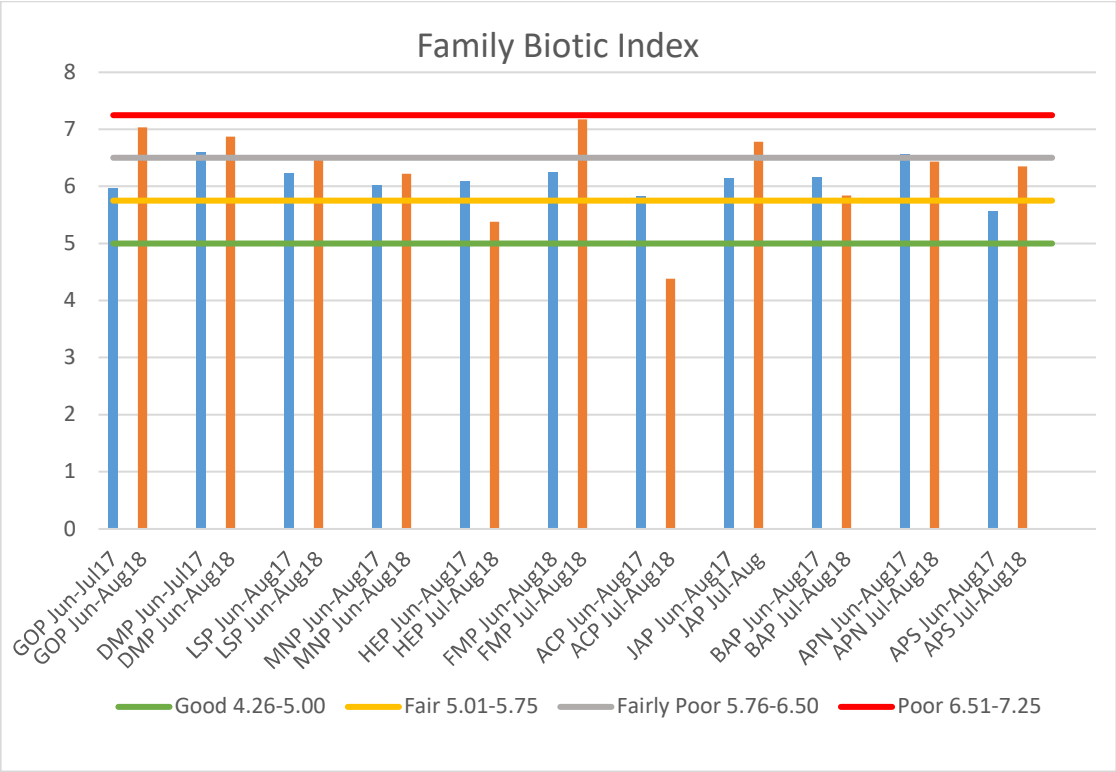


Figure 2. pH 2017 v 2018

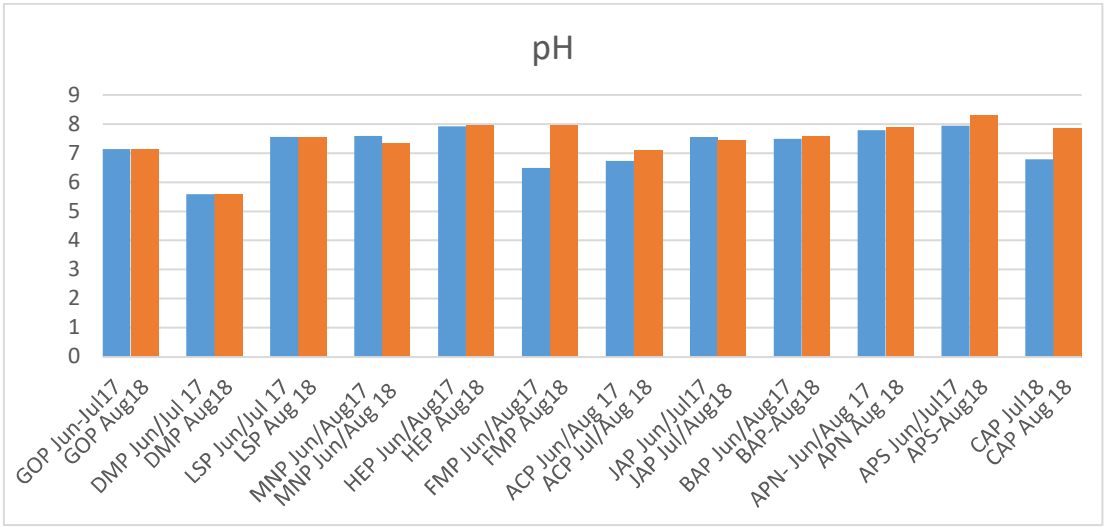


Figure 3. Temperature 2017 v 2018

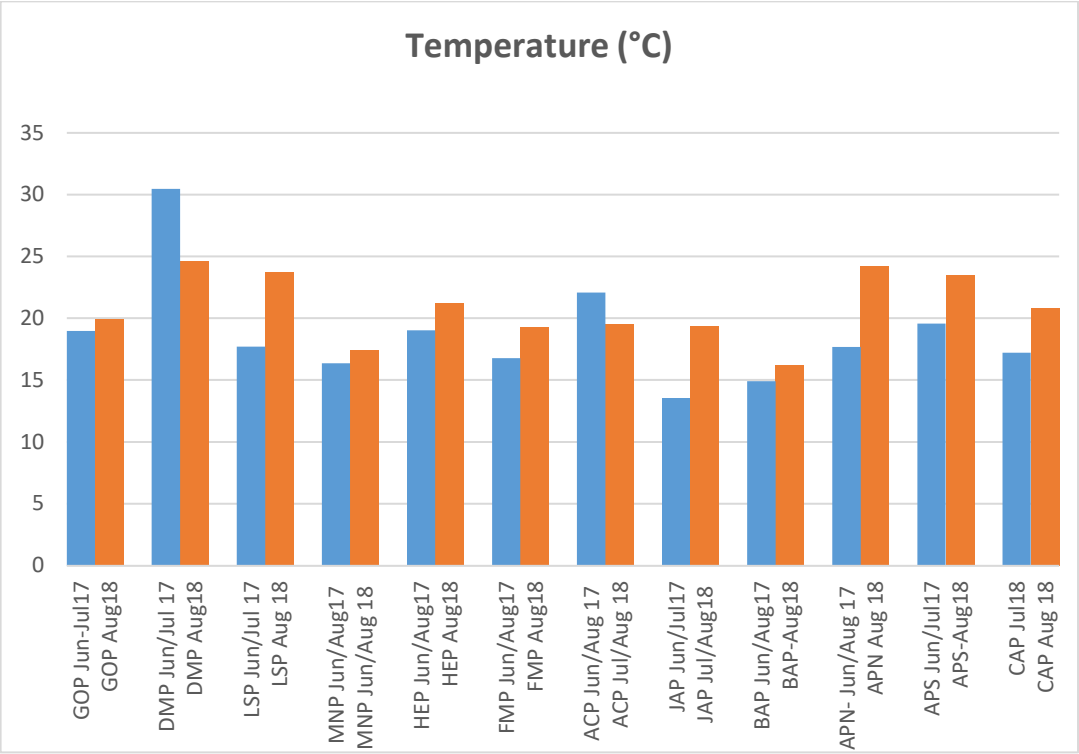


Figure 4. Dissolved Oxygen 2017 v 2018

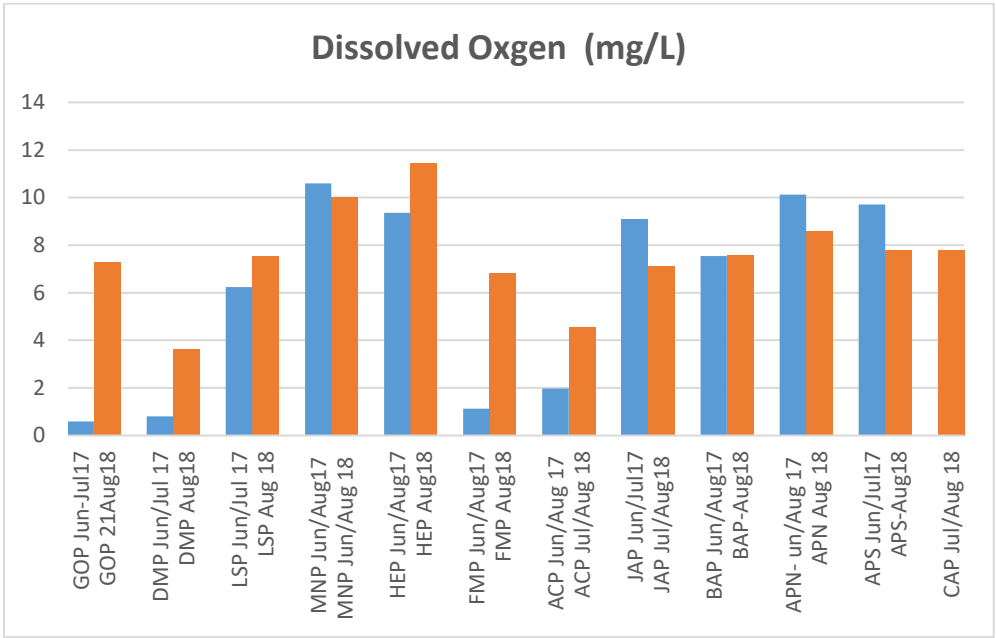


Figure 5. Conductivity 2017 vs 2018

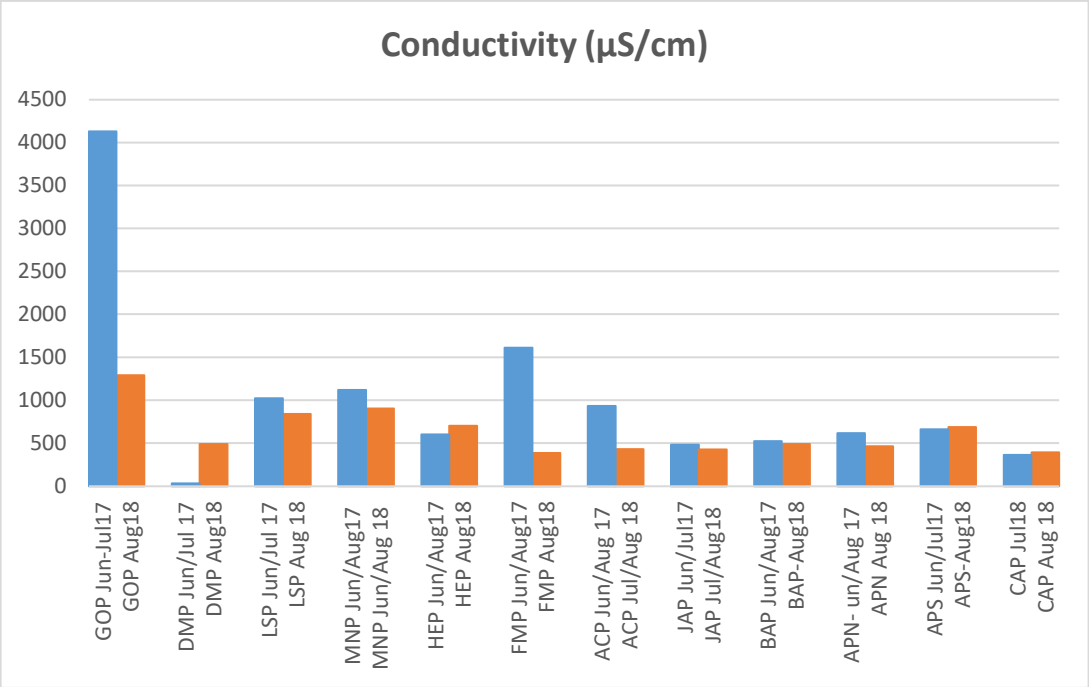


Figure 6. Copper in surface water 2017 v 2018

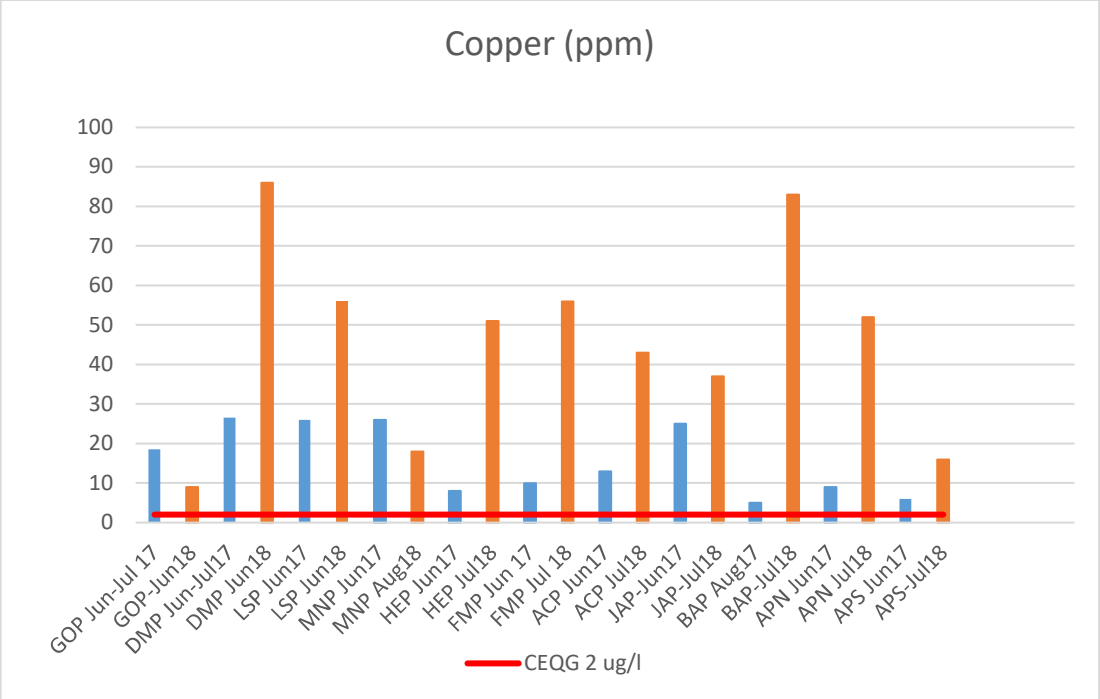


Figure 7. Iron concentration in surface water 2017 v 2018

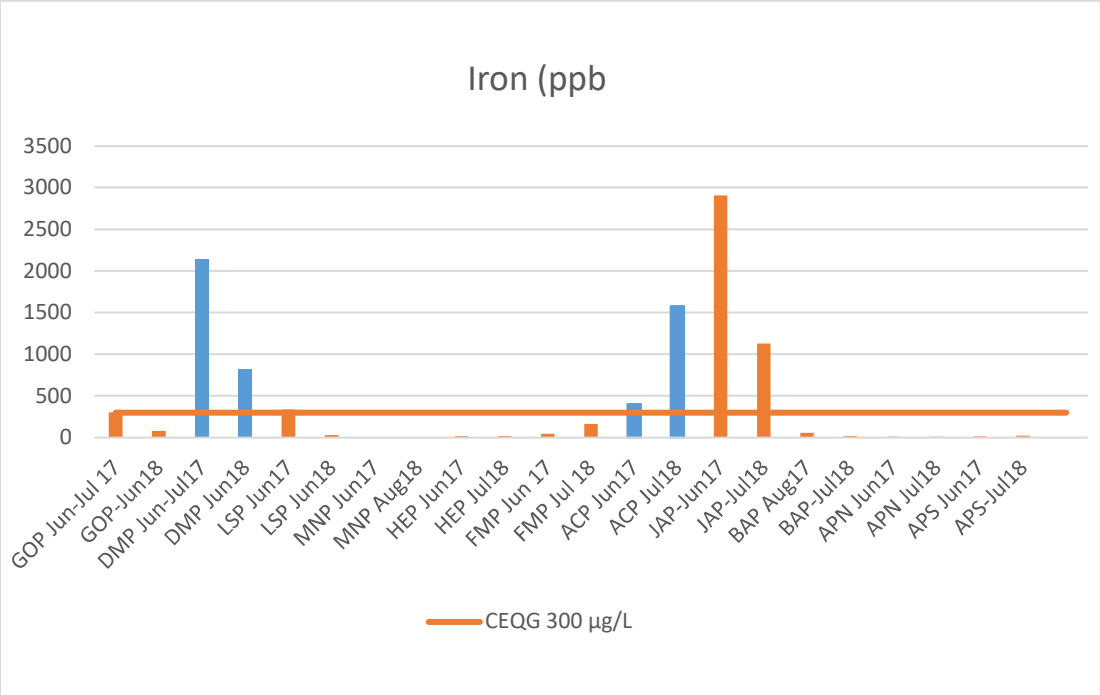


Figure 8. Zinc in surface water 2017 vs 2018

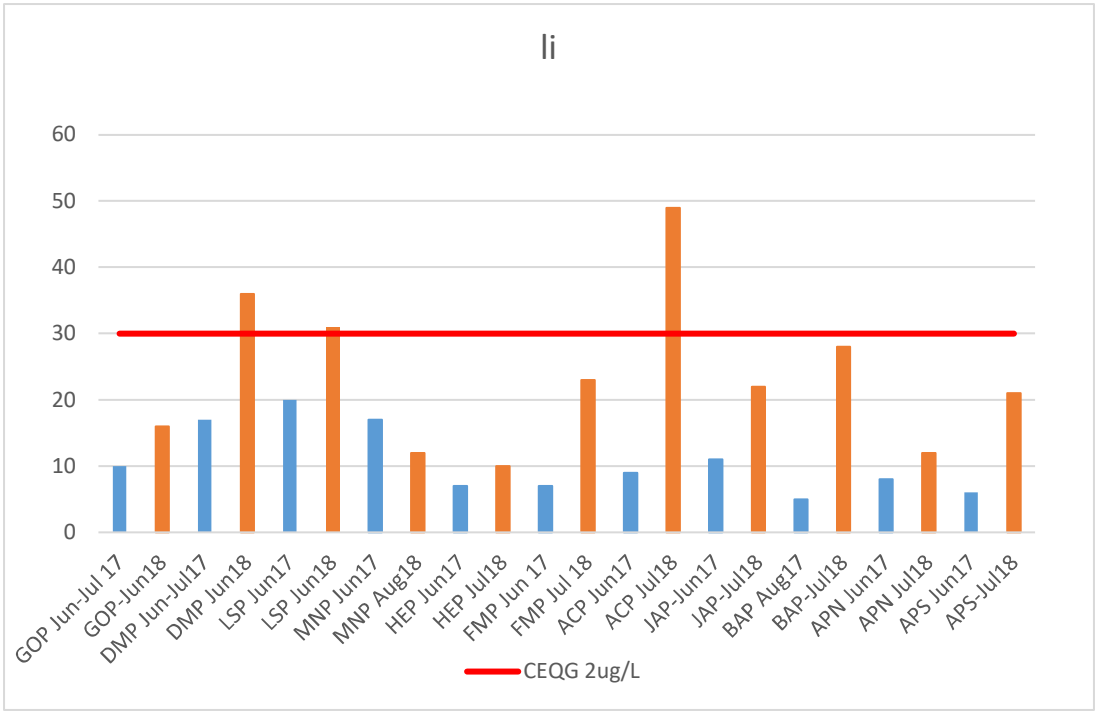


Figure 9. Concentration of Copper in sediments 2017 v 2018

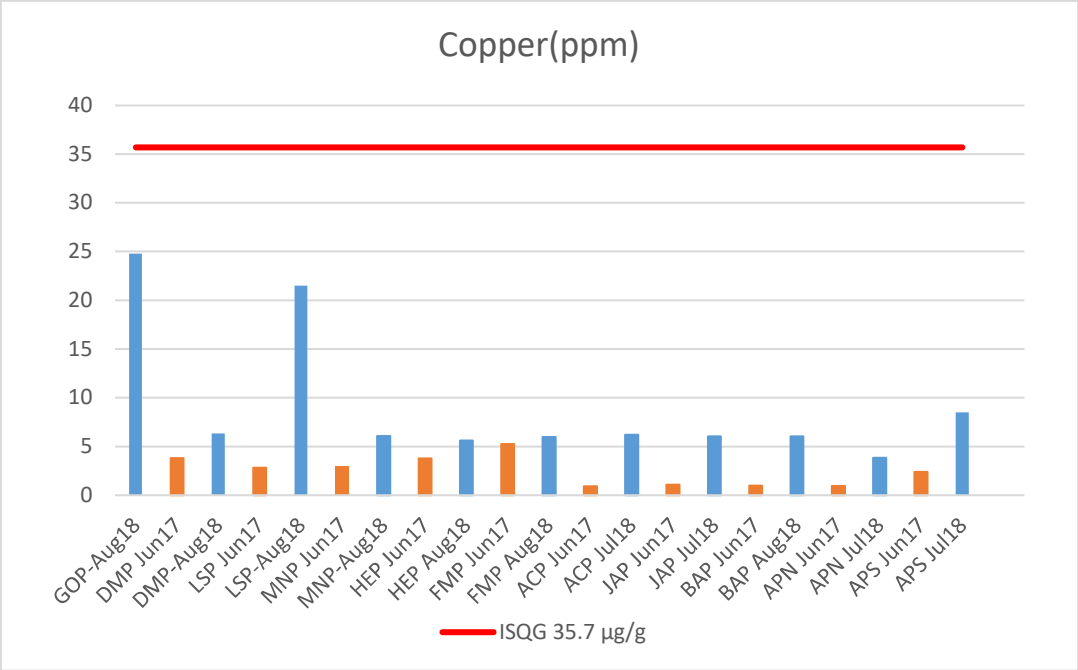


Figure 10. Concentration of Chromium in sediments 2017 v 2018

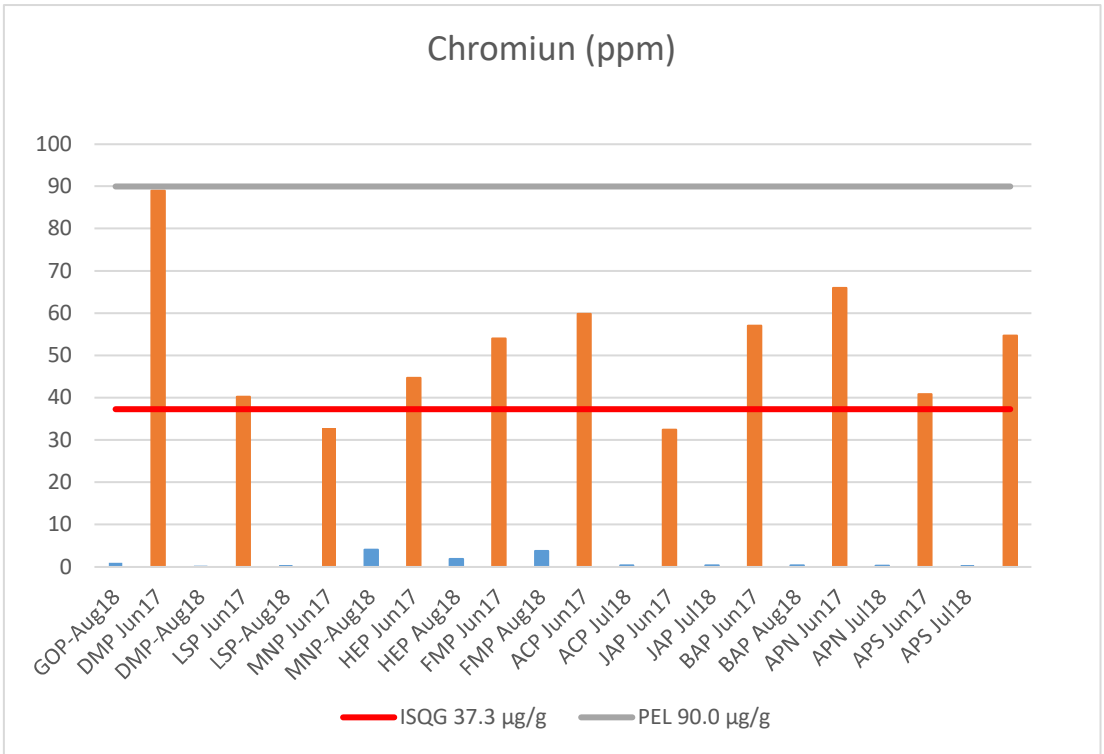
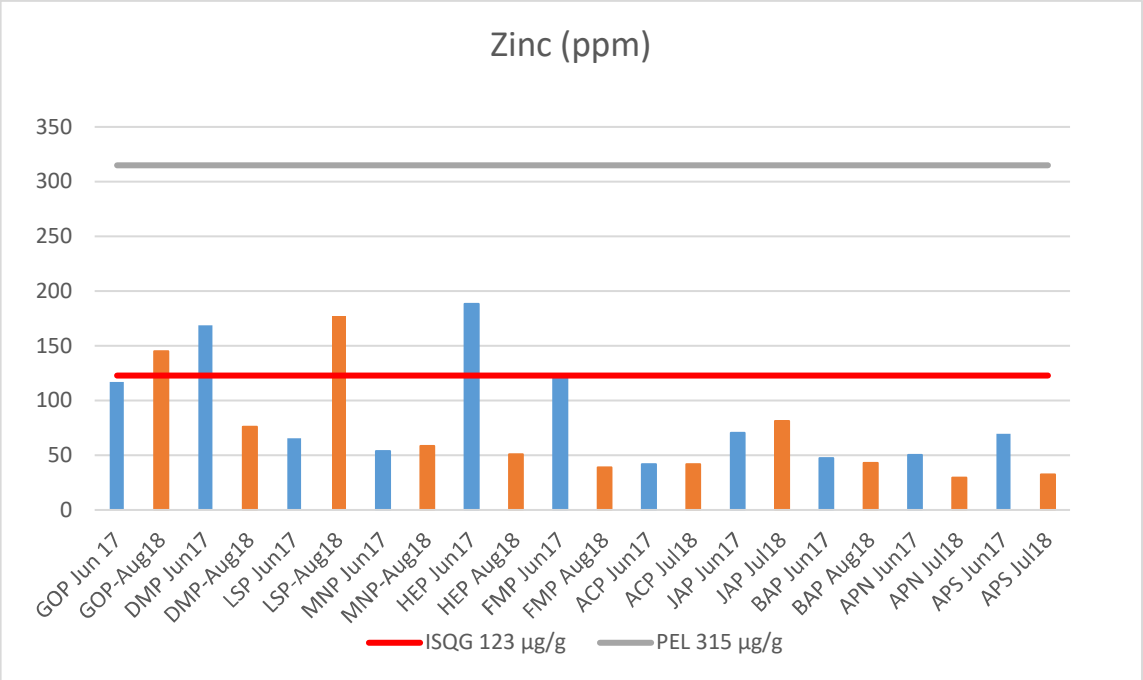


Figure 11. Concentration of Zinc in sediments 2017 v 2018



Note:

1 µg/g = 1 ppm

1 µg/l is comparable to 1 ppb

Guidelines are given in the unit of measurement used, and not converted.

Results are given in the unit used in the laboratory reportss.