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Item No. 1
North West Community Council
June 11, 2018

TO: Chair and Members of North West Community Council

Original Signed

SUBMITTED BY:

Kelly Denty, Acting Director, Planning & Development

Original Signed

Jacques Dubé, Chief Administrative Officer

DATE: May 17, 2018

SUBJECT: **Bedford West Water Quality Status Update – Fall 2017**

INFORMATION REPORT

ORIGIN

Bedford Municipal Planning Strategy, Bedford West Secondary Planning Strategy, Policies BW-3, BW-4, and BW-5.

Development Agreements between Halifax Regional Municipality and West Bedford Holdings Ltd, and between Halifax Regional Municipality and Cresco Ltd.

LEGISLATIVE AUTHORITY

The Halifax Regional Municipality Charter, Part VIII, Planning and Development, Section 240, Development Agreements.

BACKGROUND

Monitoring Event Reporting

The Bedford West Secondary Planning Strategy, Policy BW-3, requires that a water quality monitoring program be undertaken for the Paper Mill Lake watershed to track the eutrophication process. Eutrophication is the process by which lakes naturally accumulate nutrients and biological material. The eutrophication process is typically accelerated through the impacts of human activities, resulting in relatively rapid changes in trophic state, from lower states (fewer nutrients) to higher states (more nutrients), with corresponding changes in appearance, functional uses, and amenity values.

The water quality monitoring program was specified in the Planning Strategy in response to the Municipality's stated desire to "stem the decline of lakes from the accelerated process of eutrophication, and sedimentation and inputs from other urban runoff", as published in the former Regional Municipal Planning Strategy.¹

The terms of the monitoring program are specified within Development Agreements that have been negotiated in consultation with the Bedford Watershed Advisory Board² The Bedford Watershed Advisory Board was dissolved in 2013 and all development agreements for the Bedford West subdivision negotiated since 2013 have been negotiated instead with the Regional Watersheds Advisory Board (RWAB).

All such development agreements have identified the value of 10 micrograms per Litre ($\mu\text{g/L}$) of Total Phosphorus as a "trigger value", representing the transition point between the second-lowest trophic state (oligotrophic) to the next-highest trophic state (mesotrophic) per Environment Canada criteria (Table 1).

Trophic Status	TP ($\mu\text{g/L}$)
Ultra-oligotrophic	< 4
Oligotrophic	4-10
Mesotrophic	10-20
Meso-eutrophic	20-35
Eutrophic	35-100
Hypereutrophic	> 100

Table 1. Summary of Canadian trophic state trigger ranges. Environment Canada (2004).

In accordance with the terms of Bedford West development agreements, the municipality is required to submit test results to the Developer, the Community Council, and RWAB within three months of being received from the consultant, or immediately, if total phosphorus ("TP") or bacterial results exceed management thresholds identified therein.

Assessment

Contractor reports submitted from spring 2012 through fall 2014 indicated that a high proportion of water quality samples had TP results exceeding the trigger value of $10\mu\text{g/L}$ (equivalent to 0.01 mg/L), as shown in Table 2.

¹ The current Regional Municipal Planning Strategy states this objective as follows: "This Plan will seek to ... maintain the existing trophic status of our lakes and waterways to the extent possible".

² RWAB assumed the functions previously performed by BWAB since 2013.

Sites	2012	2012	2012	2013	2013	2013	2014	2014	2014	# Exceedences 2013-2014	% Exceedences 2012-2014	
	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Fall			
KL1	0.037	0.043	0.007	0.007	0.011	0.008	0.011	0.026	0.013	6	66.67%	
KL2	0.021	0.059	0.013	0.010	0.020	0.029	0.013	0.039	0.025	8	88.89%	
KL3	0.019	0.045	0.007	0.006	0.006	0.012	0.009	0.023	0.148	5	55.56%	
KL4	0.022	0.043	0.007	0.006	2.390	0.016	0.022	0.031	0.015	5	55.56%	
KL5	0.018	0.040	0.006	0.005	0.013	0.010	0.010	0.026	0.135	5	55.56%	
HWY102-1	0.019	0.039	0.020	0.006	0.021	0.022	0.013	0.038	0.031	8	88.89%	
HWY102-2	0.021	0.054	0.030	0.014	0.028	0.199	0.028	--	0.201	8	100.00%	
LSD	0.022	0.063	0.003	0.007	0.015	0.078	0.100	--	0.031	6	75.00%	
LU	0.043	0.036	0.030	0.006	0.027	0.046	0.260	0.028	0.039	8	88.89%	
PML1	0.019	--	0.030	0.006	0.007	0.047	0.012	0.030	0.021	6	75.00%	
PML2	0.025	--	--	0.006	--	0.026	0.011	0.026	0.018	5	83.33%	
										Overall	70	75.27%

Table 2. Summary of Total Phosphorus results and exceedances from Spring 2012 through Fall 2014 (mg/L)

Community Council has subsequently adopted a 3-phase assessment to understand these observations and recommend changes to the Municipality's approach to watershed management in the subject lands as follows:

Phase 1:

Report and discuss the TP exceedance findings with the developer and conduct a detailed assessment of existing water quality data from the Paper Mill Lake watershed to identify trends in Total Phosphorus measurements observed since 2009, considering CCME Guidelines.

Phase 2:

Investigate cause(s) of high Total Phosphorus measurements, considering all significant land uses and activities that have occurred in the Paper Mill Lake watershed since the inception of the monitoring program.

Phase 3:

Determine a course of action with respect to watershed management and future land use development in the area.

DISCUSSION

The purpose of this report is to report the results of the fall 2017 monitoring even to Council. The monitoring event held in October 2017 found that TP concentrations exceeded the trigger value of 10 10ug/L at three of eleven stations monitored.

A summary of TP results observed at all stations during these events is presented below in Table 3. It is important to note that these results only represent water quality at the time that the samples were collected. Notwithstanding, the results indicate whether water quality is trending towards a mesotrophic (or higher) trophic state, and indicate possible sources of excess nutrient contributions.

Sample Station	October 2017 Concentration (µg/L)	Exceedance	Trophic State
KL1	5	No	Oligotrophic
KL2	10	No	Oligotrophic
KL3	7	No	Oligotrophic
KL4	6	No	Oligotrophic
KL5	5	No	Oligotrophic
HWY 102-1	8	No	Oligotrophic
HWY 102-2	11	Yes	Mesotrophic
LSD	15	Yes	Mesotrophic
LU	8	No	Oligotrophic
PML1	99	Yes	Eutrophic
PML2	6	No	Oligotrophic

Table 3. Summary of TP results and exceedances October 2017.

Development Agreements in effect for areas now undergoing development authorize the Municipality to direct the selected water quality monitoring contractor to undertake follow-up testing if threshold levels are exceeded. As noted above, three sample stations yielded exceedances of the TP trigger value in October 2017. A follow-up assessment process is underway regarding previous test results exceeding the 10µg/L trigger value. The results of the sampling cannot be attributed to any one source, and these agreements do not establish the authority for the Municipality to halt development activities.

As previously reported, staff are contemplating a revision to the water quality monitoring requirements in current and future Development Agreements to align with the recommendations from Dalhousie University's Centre for Water Resource Studies report.

FINANCIAL IMPLICATIONS

There are no financial implications for this report.

COMMUNITY ENGAGEMENT

No community engagement was required for this report.

ATTACHMENTS

Attachment A. Bedford West Water Quality Report Fall 2017

A copy of this report can be obtained online at <http://www.halifax.ca/commcoun/index.php> then choose the appropriate Community Council and meeting date, or by contacting the Office of the Municipal Clerk at 902.490.4210, or Fax 902.490.4208.

Report Prepared by: Cameron Deacoff, Environmental Performance Officer, 902.490.1926

Original Signed

Report Approved by: Shannon Miedema, Program Manager, Energy & Environment, 902.490.3665

Appendix A



SNC • LAVALIN

SNC-Lavalin Inc.

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December 8, 2017

SENT VIA EMAIL: deacofc@halifax.ca

Halifax Regional Municipality

Halifax, Nova Scotia

Attention: Mr. Cameron Deacoff
Environmental Performance Officer
Planning and Development

Dear Mr. Deacoff:

**RE: Final Report: Water Quality Monitoring Program, Fall 2017 Sampling Event
Bedford West, Bedford, Nova Scotia**

SNC-Lavalin Inc. (SLI) is pleased to submit one electronic copy of the final report presenting the results of the 2017 fall surface water quality sampling event for the Bedford West Water Quality Monitoring Program in Bedford, Nova Scotia.

It should be noted that this Final Report (version C02) addressed the comments received on the draft report (version C01) from Mr. Deacoff and dated November 21, 2017.

If you have any questions, please contact the undersigned or in his absence, please contact Maria Gutierrez, MSc. at 902.492.4544 Ext 308

Yours truly,

SNC • LAVALIN INC.

Michael Smith, AScT, B.Tech

Area Lead, Environmental Engineering

Infrastructure Engineering – Eastern Canada

(709) 368-0118 Ext. 54957

631477-0001-T-4E-REP-000-0010_C02.docx



Surface Water Quality Monitoring Program, Bedford West. Bedford, Nova Scotia, Canada

Halifax Regional Municipality

Final Report - 2017 Fall Monitoring Report



Infrastructure Engineering

08/12/2017

Final Report > Internal ref. C01 > SLI ref. 631477-0001-T-4E-REP-000-0010 Revision C02

EXECUTIVE SUMMARY

On October 18, 2017 SNC-Lavalin Inc. (SNCL) completed the Bedford West water quality monitoring program (2017 fall event) on behalf of Halifax Regional Municipality (HRM). The sampling program consisted of collecting surface water samples from eleven (11) water quality sampling stations. Field parameters were recorded and surface water samples were collected for laboratory analyses. The laboratory analysis included the following analysis: inorganics, calculated parameters, standard elements and microbiological.

The applicable water quality assessment standards included:

- Canadian Council of Ministers of the Environment (CCME) guidelines for the Protection of Aquatic Life Freshwater (PAL-F);
- Health Canada guidelines for Canadian Recreational Water Quality (2012, Third Edition); and
- Nova Scotia Environment (NSE) Environmental Quality Standards (EQS) for Surface Water, EQS for Contaminated Sites (NSE 2014) Table A2, Reference for Pathway Specific Standards for Surface Water – Fresh Water.

During this water quality monitoring event, four (4) stations reported concentrations that exceeded the Total Phosphorous management threshold criteria of 10 µg/L (0.01 mg/L) listed in the HRM RFP14-338. Exceedances were in µg/L were as follows:

- > KL2: 10
- > HWY-101-2: 11
- > LSD: 15
- > PML-1: 99

The following parameters exceeded the CCME and/or Heath Canada water quality guidelines:

- > Dissolved Oxygen (In situ): CCME guideline of 5.5 - 9.5 mg/L was exceeded at HWY-102-1 (5.3 mg/L) and PML-2 (11.3 mg/L) ;
- > Chloride: CCME guideline of 120 mg/L was exceeded at LU (143 mg/L);
- > Total Aluminum: CCME guideline of 100 µg/L was exceeded at KL2 (240 µg/L); HWY-102-2 (542 µg/L); LSD (401 µg/L) and PML-1 (4,190 µg/L). All eleven (11) stations exceeded the NSE EQS guideline of 5 µg/L.
- > Total Copper: CCME guideline of 2 µg/L was exceeded at stations HWY-102-2 (3 µg/L); LU (3 µg/L) and PML-1 (8 µg/L)
- > Total Iron: CCME guideline of 300 µg/L was exceeded at stations KL2 (572 µg/L); HWY-102-2 (4,760 µg/L); LSD (874 µg/L); and PML-1 (12,600 µg/L).

- › Total Lead: CCME guideline of 1 µg/L was exceeded at stations HWY-102-2 (3.3 µg/L) and PML1 (9.1 µg/L).

In terms of microbiological analyses, E. Coli exceeded the Heath Canada Guideline of 400 CFU /100 mL at one sampling station: KL5 (517 MPN). In addition, Total Coliforms concentrations in MPN/100 mL were reported above the laboratory RDL of 1 MPN/100 mL in all eleven stations as follows:

- | | |
|--------------------|--------------------|
| › KL1: 154 | › HWY-102-2: >2420 |
| › KL2: 659 | › LU: 1990 |
| › KL3: 411 | › LSD: 641 |
| › KL4: >2420 | › PML-1: 166 |
| › KI5: >2420 | › PML-2: 1,730 |
| › HWY-102-1: >2420 | |

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Appendix B	Field Reports
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Appendix D	Summary Table Results
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	Table D2 - Historical Data (Sites: KL1, KL2, KL3, KL4 and KL5)
	Table D3 - Historical Data (Sites: HWY102-1, HWY102-2, LSD, LU, PML1 and PML2)
Appendix E	Laboratory Certificates of Analysis
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1 INTRODUCTION AND BACKGROUND

SNC-Lavalin Inc. (SNCL) has prepared this report to provide Halifax Regional Municipality (HRM) with water quality data for eleven (11) surface water stations throughout the Bedford West development area.

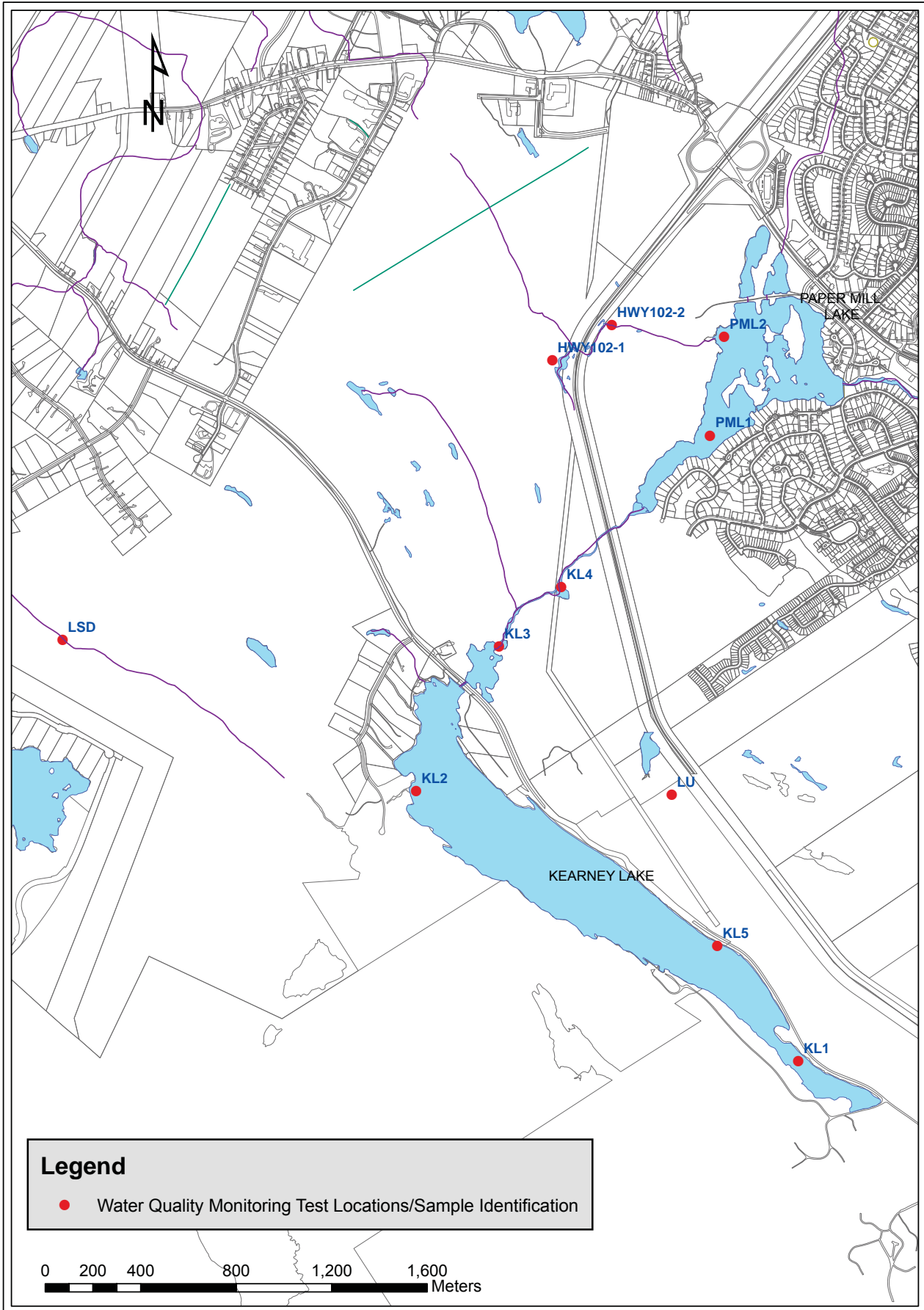
Water quality monitoring in the Bedford West development area has been ongoing since 2009. SNCL was retained by HRM to complete water quality monitoring programs each spring, summer and fall for two years beginning in 2015. The results of the 2017 fall monitoring program are detailed herein.

The overall purpose of the program is to conduct water quality sampling and testing prior to and during construction activities related to the development project in order to detect any impacts on and/or changes to water quality.

The 2017 fall sampling stations are summarized in Table 1 and shown in Figure 1.

Table 1: Bedford West Water Quality Sampling Stations

Water Course	Sample Location Name	Updated Coordinates (UTM NAD 83)	
		Easting	Northing
Kearney Lake	KL-1	20T445718E	4948496N
Kearney Lake	KL-2	20T0443859	4949738N
Kearney Run	KL-3	20T444390E	4950406N
Kearney Run	KL-4	20T444463E	4950571N
Kearney Lake	KL-5	20T4949142E	445280N
Creek Above Highway	HWY 102-1	20T444708E	4951644N
Creek Below Highway	HWY 102-2	20T444829E	4951778N
Lake Shore Drive	LSD	20T442583E	4950431N
Larry Uteck Off-Ramp	LU	20T444954E	4949891N
Paper Mill Lake	PML-1	20T445129E	4951154N
Paper Mill Lake	PML-2	20T445363E	4951740N



Legend

- Water Quality Monitoring Test Locations/Sample Identification

SNC-LAVALIN
 SNC-LAVALIN Inc.
 Halifax, Nova Scotia, Canada
 Telephone: (902) 492-4544
 Fax: (902) 492-4540
 Member of the SNC-LAVALIN Group

HALIFAX
 REGIONAL MUNICIPALITY

PROJECT: WATER QUALITY MONITORING WITHIN BEDFORD WEST
 TITLE: WATER QUALITY MONITORING TEST LOCATIONS

DESIGNED:	CH	DATE:	21-09-2015
DRAWN:	CH	PROJECT #:	631477-0001
CHECKED:	DH	DRAWING #:	1
SCALE:	AS SHOWN		

2 METHODOLOGY

The 2017 fall water quality sampling event included the collection of Field Parameters (Group A) and surface water for laboratory analysis of:

- › Inorganics (Group B);
- › Calculated Parameters (Group C);
- › Standard Elements/Metals (Group D); and
- › Microbiological Analyses (Group E)

Table 2 below summarizes the water quality parameters measured in the field or analyzed by the laboratory.

Table 2: Analytical Parameter Groups

Field Parameters (A)	Inorganic (B)	Calculated Parameters (C)	Standard Metals (D)	Microbiological (E)
<ul style="list-style-type: none"> · pH · TDS · Dissolved Oxygen · Temperature · Secchi Depth · Conductance · Air Temperature · Cloud Cover · Incidental Wildlife Sightings 	<ul style="list-style-type: none"> · Total Alkalinity (as CaCO₃) · Dissolved Chloride · Colour · Total Kjeldahl Nitrogen · Nitrate + Nitrite · Nitrate · Nitrite · Nitrogen (as NH₄) · Total Organic Carbon · Orthophosphate (P) · pH · Low Total Phosphorus · Reactive Silica · Total Suspended Solids · Dissolved Sulphate · Turbidity · Conductivity 	<ul style="list-style-type: none"> · Anion Sum · Cation Sum · Ion Balance · Bicarbonate Alkalinity(as CaCO₃) · Carbonate Alkalinity (as CaCO₃) · Hardness · Total Dissolved Solids · Saturation pH (@4°C & 20°C) · Langelier Index (@4°C & 20°C) 	<ul style="list-style-type: none"> · Calcium · Copper · Iron · Magnesium · Manganese · Potassium · Sodium · Zinc 	<ul style="list-style-type: none"> · Chlorophyll A · E. coli · Most Probable Number (MPN) or CFU per 100 mL

All surface water samples, associated field parameters and secchi depth measurements were collected on October 18, 2017.

Field measurements of pH, dissolved oxygen, specific conductivity, water temperature and air temperature were taken at each station using an YSI Professional Plus multi meter probe (serial number 12G102936). The instrument is calibrated annually by the manufacturer and a pre-calibration was

conducted by the provider (Open Road Environmental Limited on October 16, 2017) prior to conducting the water quality sampling event. See Appendix A, Instrument Calibration Report.

Site conditions (i.e. weather, air temperature, cloud cover, site accessibility and wildlife sightings) and field parameters for each sampling location were recorded on a field report sheet. Each sample station was photographed during the sample event.

Water samples and field parameter readings were collected where possible within a depth of 1.0 m below surface. Samples were collected from the shore at all sample locations. Surface water sampling followed SNCL's Standard Operating Procedures (SOP) for surface water sampling. A new pair of nitrile gloves was used at each sample location.

Surface water samples were collected and placed in clean laboratory-supplied jars and stored in a chilled container together with a chain of custody record for transport to the laboratory. All surface water samples were submitted to AGAT Laboratories in Dartmouth, NS.

3 ASSESSMENT STANDARDS

- › There is currently no national environmental quality guideline for total phosphorus in freshwater aquatic environments. In the Canadian framework, trigger ranges are based on the trophic classification of the baseline condition. A trigger range is a desired concentration range for phosphorus; if the upper limit of the range is exceeded, it indicates potential for environmental quality issues, which “triggers” the need for further investigation. According to the Canadian Council of Ministers of the Environment (CCME) 10 µg/L of total phosphorous is the threshold between oligotrophic and mesotrophic trophic classifications. For this water quality monitoring program, HRM defined a Total Phosphorous management threshold value of 10 µg/L or 0.01 mg/L.
- › The Canadian Council of Ministers of the Environment (CCME) Guidelines for the Protection of Aquatic Life – Freshwater (PAL-F) (Version 2015) were used for parameter such as Dissolved Oxygen, pH (in situ and Laboratory analysis), Chloride, Nitrate, Nitrite, Nitrogen, as well as for total metals (i.e. Aluminum, Arsenic, Boron, Cadmium, Cooper, Iron, Lead, Molybdenum, Nickel, Selenium, Silver, Thallium, Uranium, and Zinc).
- › For Total Suspended Solids (TSS), the CCME PAL-F at high flow conditions was applied. The TSS guideline value is equal to a maximum increase of 25 mg/L from background levels at any time when background levels are between 25 and 250 mg/L. When background concentrations are greater than 250 mg/L, the concentration should not increase more than 10% from background levels.
- › The Health Canada guidelines for Canadian Recreational Water Quality (2012, Third Edition) were used for parameters such as Secchi Depth (i.e. the guidelines indicate that the clarity of the

water should be sufficiently clear such that a Secchi disk is visible at a minimum depth of 1.2 metres); pH (guideline of 5.0-9.0 pH); Turbidity (limit of 50 Nephelometric Turbidity Units); E. coli (400 MPN/100mL) and Fecal Coliform (400 MPN/mL).

- › The Nova Scotia Environment (NSE) Environmental Quality Standards (EQS) for Contaminated Sites (NSE 2014) Table A2, Reference for Pathway Specific Standards for Surface Water ($\mu\text{g/L}$) for Fresh Water were used for assessment of total metals (i.e. Aluminum, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Molybdenum, Nickel, Selenium, Silver, Strontium, Thallium, Uranium, Vanadium and Zinc).

4 FIELD OBSERVATIONS

The 2017 fall site conditions were recorded for all eleven (11) surface water quality monitoring stations and are included in the field data sheets in Appendix B. Site condition observations include weather, cloud cover, air temperature, wildlife sightings and site accessibility.

In addition, site photographs are included in Appendix C.

5 FIELD MEASUREMENTS

Field parameters such as in situ pH, Dissolved Oxygen, water temperature, conductivity and Secchi depth (where applicable) were recorded on field data sheets. Collected data is enclosed in Appendix B.

Field measurements are also presented in Appendix D - Summary Tables 1 and 1A.

Situ pH

All eleven (11) stations were within the CCME-PAL-F recommended range of 6.5 - 9.0 pH, as well as the Health Canada Guideline for Recreational Water Quality of 5.0 - 9.0 pH.

Dissolved Oxygen

Dissolved oxygen concentrations were outside of the CCME PAL-F recommended range of 5.5-9.5 mg/L at two (2) stations as follows HWY-102-1 (5.3 mg/L) and PML-2 (11.3 mg/L). The other nine (9) surface water sampling stations were within the recommended range of dissolved oxygen.

6 ANALYTICAL RESULTS

Analytical results of the 2017 fall water quality sampling event are summarized in Table 1 enclosed in Appendix C. In addition, historical water quality results since 2009 are summarized in Table 1A enclosed in Appendix C.

Laboratory certificates of analysis for the 2017 fall event are enclosed in Appendix E.

6.1 Total Phosphorous

Four (4) stations reported concentrations that exceeded the management threshold criteria of 10 µg/L (0.01 mg/L) listed in the HRM RFP #14-338. Reported concentrations in µg/L were as follows:

- > KL2: 10
- > HWY-101-2: 11
- > LSD: 15
- > PML-1: 99

6.2 General Chemistry

Chloride: One (1) station exceeded the CCME PAL-F recommended value for Chloride of 120 mg/L. Chloride concentration at LU was reported as 143 mg/L.

6.3 Metals

Aluminum: Four (4) stations exceeded the CCME PAL-F recommended value for aluminum of 100 µg/L (base on pH ≥6.5). Reported exceedances in µg/L were as follows:

- > KL2: 240
- > HWY-102-2: 542
- > LSD: 401
- > PML-1: 4,190

Aluminum concentrations at all eleven (11) stations were above the NSE EQS guideline of 5 µg/L. Exceedances in µg/L were as follows:

- > KL1: 46
- > KL2: 240
- > KL3: 43
- > KL4: 55

- > KL5: 44
- > HWY-102-1: 100
- > HWY-102-2: 542
- > LU: 29
- > LSD: 401
- > PML-1: 4190
- > PML-2: 34

Copper: Three (3) stations exceeded the CCME-PAL-F recommended limit of 2 µg/L (i.e. based on a hardness < 82 mg/L). The NSE EQS guideline is also 2 µg/L. Exceedances reported in µg/L were as follows:

- > HWY102-12: 3
- > LU: 3
- > PML-1: 8

Iron: Four (4) stations exceeded the CCME-PAL-F recommended limit of 300 µg/L. The NSE EQS guideline is also 300 µg/L. Exceedances reported in µg/L were as follows:

- > KL2: 572
- > HWY102-2: 4,760
- > LSD: 874
- > PML-1: 12,600

Lead: Two (2) stations exceeded the CCME-PAL-F recommended limit of 1 µg/L. The NSE EQS guideline is also 1 µg/L. Exceedances reported in µg/L were as follows:

- > HWY102-2: 3.3
- > PML-1: 9.1

6.4 Microbiological

E.coli exceeded the Health Canada Guideline of ≤ 400 E.Coli MPN /100 mL at one (1) of eleven (11) sampling stations as follows:

- > KL5: 517 MPN/100 ml.

Total coliforms concentrations in MPN/100 mL were reported above the laboratory RDL of 1 MPN/100 mL at all eleven (11) stations as follows:

- > KL1: 154
- > KL2: 659
- > KL3: 411
- > KL4: >2,420
- > KI5: >2,420
- > HWY-102-1: >2,420
- > HWY-102-2: >2,420
- > LU: 1,990
- > LSD: 641
- > PML1: 166
- > PML2: 1,730

7 STATISTICAL PRESENTATION

Table 3 attached at the end of this section provides seasonal statistics for below six (6) key water quality parameters at the eleven (11) water quality sampling stations, representing water quality data from 2009 to October 2017:

- > Total Phosphorous
- > Chloride
- > Laboratory measured pH
- > Total Suspended Solids
- > Conductivity
- > Chlorophyll-A

It should be noted where analytical results were found to be less than the laboratory Reportable Detection Limit (<RDL), the statistics (minimum, maximum, media and average) were calculated as half the reportable detection limit (1/2 RDL value) as a conservative approach.

TABLE 3: Statistical Presentation of Key Water Quality Parameters - Fall 2017

KL-1	RDL	Seasonal Results	Seasonal Minimum	Seasonal Maximum	Seasonal Median	Seasonal Mean
Total Phosphorous (mg/L)	0.002	0.005	0.005	0.013	0.008	0.008
Chloride (mg/L)	1	60	33	64	50	51
Lab pH	N/A	7.0	6.4	7.0	6.8	6.8
Total Suspended Solids (mg/L)	5	<5	0.5	5.0	2.5	2.7
Conductivity (uS/cm)	1	249.0	140.0	250.0	230.0	213.0
Chlorophyll-A acidification method (µg/L)	0.05	1.10	0.84	2.08	1.19	1.33

KL-2	RDL	Seasonal Results	Seasonal Minimum	Seasonal Maximum	Seasonal Median	Seasonal Mean
Total Phosphorous (mg/L)	0.002	0.01	0.008	0.029	0.013	0.016
Chloride (mg/L)	1	19	10	48	14	19
Lab pH	N/A	6.7	6.1	6.9	6.3	6.3
Total Suspended Solids (mg/L)	5	<5	1	103	3	15
Conductivity (uS/cm)	1	97	54	212	73	94
Chlorophyll-A acidification method (µg/L)	0.05	0.31	0.07	1.97	0.41	0.61

KL-3	RDL	Seasonal Results	Seasonal Minimum	Seasonal Maximum	Seasonal Median	Seasonal Mean
Total Phosphorous (mg/L)	0.002	0.007	0.002	0.148	0.007	0.022
Chloride (mg/L)	1	59	37	60	49	50
Lab pH	N/A	6.9	6.4	6.9	6.9	6.8
Total Suspended Solids (mg/L)	5	<5	1	3	3	2
Conductivity (uS/cm)	1	247	160	247	216	210
Chlorophyll-A acidification method (µg/L)	0.05	1.34	0.51	2.29	1.23	1.18

KL-4	RDL	Seasonal Results	Seasonal Minimum	Seasonal Maximum	Seasonal Median	Seasonal Mean
Total Phosphorous (mg/L)	0.002	0.006	0.001	0.026	0.007	0.009
Chloride (mg/L)	1	59	37	60	49	50
Lab pH	N/A	7.0	6.5	7.0	6.9	6.8
Total Suspended Solids (mg/L)	5	<5	1	10	3	3
Conductivity (uS/cm)	1	248	160	250	218	213
Chlorophyll-A acidification method (µg/L)	0.05	0.35	0.35	2.18	1.03	0.94

KL-5	RDL	Seasonal Results	Seasonal Minimum	Seasonal Maximum	Seasonal Median	Seasonal Mean
Total Phosphorous (mg/L)	0.002	0.005	0.003	0.135	0.006	0.027
Chloride (mg/L)	1	60	46	60	51	52
Lab pH	N/A	6.9	6.5	7.0	6.9	6.8
Total Suspended Solids (mg/L)	5	<5	3	3	3	3
Conductivity (uS/cm)	1	246	189	246	215	217
Chlorophyll-A acidification method (µg/L)	0.05	1.22	0.64	2.71	1.16	1.48

Note: The number of decimal places presented for each listed parameter is based on the Laboratory RDL.

HWY 102-1	RDL	Seasonal Results	Seasonal Minimum	Seasonal Maximum	Seasonal Median	Seasonal Mean
Total Phosphorous (mg/L)	0.002	0.008	0.002	0.031	0.011	0.015
Chloride (mg/L)	1	51	12	51	28	31
Lab pH	N/A	6.9	5.3	6.9	6.5	6.3
Total Suspended Solids (mg/L)	5	<5	1	3	3	2
Conductivity (uS/cm)	1	258	88	258	143	159
Chlorophyll-A acidification method (µg/L)	0.05	0.62	0.33	8.45	0.70	1.69

HWY 102-2	RDL	Seasonal Results	Seasonal Minimum	Seasonal Maximum	Seasonal Median	Seasonal Mean
Total Phosphorous (mg/L)	0.002	0.011	0.003	0.201	0.03	0.060
Chloride (mg/L)	1	92	17	92	48	52
Lab pH	N/A	6.5	5.5	6.8	6.3	6.2
Total Suspended Solids (mg/L)	5	8	3	194	8	34
Conductivity (uS/cm)	1	366	94	366	194	219
Chlorophyll-A acidification method (µg/L)	0.05	28.94	0.25	48.17	1.90	12.04

LSD	RDL	Seasonal Results	Seasonal Minimum	Seasonal Maximum	Seasonal Median	Seasonal Mean
Total Phosphorous (mg/L)	0.002	0.015	0.003	0.003	0.014	0.03
Chloride (mg/L)	1	36	22	22	25	27
Lab pH	N/A	7.0	6.4	6.4	6.7	6.7
Total Suspended Solids (mg/L)	5	<5	3	3	8	16
Conductivity (uS/cm)	1	171	105	105	125	127
Chlorophyll-A acidification method (µg/L)	0.05	1.85	0.13	0.13	1.41	1.79

LU	RDL	Seasonal Results	Seasonal Minimum	Seasonal Maximum	Seasonal Median	Seasonal Mean
Total Phosphorous (mg/L)	0.002	0.008	0.008	0.046	0.03	0.026
Chloride (mg/L)	1	143	34	258	92	106
Lab pH	N/A	7.1	6.4	7.2	7.0	6.8
Total Suspended Solids (mg/L)	5	<5	3	13	3	5
Conductivity (uS/cm)	1	610	190	840	394	446
Chlorophyll-A acidification method (µg/L)	0.05	2.47	0.12	4.94	1.80	1.98

PML1	RDL	Seasonal Results	Seasonal Minimum	Seasonal Maximum	Seasonal Median	Seasonal Mean
Total Phosphorous (mg/L)	0.002	0.099	0.002	0.099	0.021	0.0
Chloride (mg/L)	1	59	18	59	48	45
Lab pH	N/A	6.8	6.6	6.9	6.8	6.8
Total Suspended Solids (mg/L)	5	104	1	104	6	19
Conductivity (uS/cm)	1	248	100	248	209	194
Chlorophyll-A acidification method (µg/L)	0.05	4.86	0.07	5.07	0.91	2.08

PML2	RDL	Seasonal Results	Seasonal Minimum	Seasonal Maximum	Seasonal Median	Seasonal Mean
Total Phosphorous (mg/L)	0.002	0.006	0.008	0.046	0.03	0.026
Chloride (mg/L)	1	60	34	258	92	106
Lab pH	N/A	7.0	6.4	7.2	7.0	6.8
Total Suspended Solids (mg/L)	5	<5	3	13	3	5
Conductivity (uS/cm)	1	255	190	840	394	446
Chlorophyll-A acidification method (µg/L)	0.05	1.27	0.12	4.94	1.80	1.98

Note: The number of decimal places presented for each listed parameter is based on the Laboratory RDL.

8 GRAPHS

Appendix F encloses seasonal and annual graphs that illustrate water quality data collected from 2009 to October 2017 of below key water quality parameters at each of the eleven (11) water quality monitoring stations:

- > Dissolved chloride (mg/L),
- > pH,
- > Total phosphorus (mg/L),
- > Total suspended solids (mg/L),
- > Conductivity ($\mu\text{S}/\text{cm}$) and
- > Chlorophyll A ($\mu\text{g}/\text{L}$)

The graphs allow for comparison between water quality sampling stations and identification of concentration increases (i.e. above applicable CCME guidelines). As many parameters show seasonal concentration fluctuations, the water quality data was also graphed showing only the concentrations for a given season (i.e. spring).

It should be noted that where results were found to be less than the laboratory Reportable Detection Limit (<RDL), they were graphed as half the reportable detection limit ($1/2$ RDL value) as a conservative approach.

9 CONCLUSIONS

The 2017 fall water quality monitoring program included collection of surface water samples at eleven (11) water quality sampling stations for the analysis of general chemistry, total metals, total phosphorus, total suspended solids, E.coli, and chlorophyll-A. Additionally, field parameters collected at each station included in situ pH, water temperature, dissolved oxygen, conductivity, Secchi depth (where applicable), air temperature, cloud cover and wildlife sightings.

9.1 Total Phosphorous

The following eight (8) stations meet the HRM management threshold criteria of 10 µg/L.

- > KL1: 5
- > KL2: 10
- > KL3: 7
- > KL4: 6
- > KL5: 5
- > HWY-102-1: 8
- > LU: 8
- > PML-2: 6

The following three (3) stations reported total phosphorous concentrations that exceeded the HRM management threshold criteria of 10 µg/L:

- > HWY 102-2 11 µg/L
- > LSD 15 µg/L
- > PML-1 99 µg/L

9.2 Field Measurements

In situ readings of parameters such as pH, Dissolved Oxygen, water temperature, conductivity and Secchi depth (where applicable) were recorded at all eleven stations.

All stations were within the CCME-PAL-F recommended range of 6.5 - 9.0 pH, as well as the Health Canada Guideline for Recreational Water Quality of 5.0 - 9.0 pH.

Dissolved oxygen concentrations were outside of the CCME PAL-F recommended range of 5.5-9.5 mg/L at two (2) stations HWY-102-1 (5.3 mg/L) and PML-2 (11.3 mg/L)

9.3 General Chemistry and Metals

The following parameters exceeded the recommended Canadian Council of Ministers of the Environment Guidelines for the Protection of Aquatic Life - Freshwater (CCME-PAL-F, edition 2015) and/or the Nova Scotia Environment (NSE) Environmental Quality Standards (EQS) for Surface Water, EQS for Contaminated Sites (NSE 2014):

- › Chloride: One station (LU) exceeded the CCME PAL-F recommended value of 120 mg/L.
- › Aluminum: Four stations (i.e. KL2, HWY-102-2, LSD and PML-1) exceeded the CCME PAL-F recommended value of 100 µg/L. All eleven stations exceeded the NSE EQS guideline of 5 µg/L.
- › Copper: Three stations (HWY-102-2, LU and PML-1) exceeded the CCME-PAL-F and NSE EQS guideline of 2 µg/L
- › Iron: Four stations (KL2, HWY102-2, LSD, PML-1) exceeded the CCME-PAL-F and NSE EQS guideline of 300 µg/L
- › Lead: Two stations (HWY-102-2 and PML-1) exceeded the CCME-PAL-F and NSE EQS guideline of 1 µg/L

9.4 Microbiological

The Heath Canada guideline of ≤ 400 E.Coli /100 mL was exceeded at one station (KL5), which reported 517 MPN of E.Coli /100 ml.

10 REFERENCES

Canadian Environmental Quality Guidelines for the Protection of Aquatic Life, 2004, “Phosphorous: Canadian Guidance Framework for the Management of Freshwater Systems”.

<http://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwj0zdeAjvHXAhVI4oMKHWTjAEgQFggnMAA&url=http%3A%2F%2Fceqg-rcqe.ccme.ca%2Fdownload%2Fen%2F205&usg=AOvVaw1H9Vn3HNCi35IsLSczlvG>

Canadian Council of Ministers of the Environment guidelines for the Protection of Aquatic Life – Freshwater.

<http://st-ts.ccme.ca/en/index.html>

Environment Canada, 2005, The Inspector’s field sampling manual. Second Edition

<http://publications.gc.ca/collections/Collection-R/En40-498-2005-1E.pdf>

Health Canada guidelines for Canadian Recreational Water Quality, 2012, Third Edition.

<https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-recreational-water-quality-third-edition.html>

Nova Scotia Environment, Notification of Contamination Protocol, Table 3 Tier 1 EQS for Surface Water, Revision July 2013

<https://novascotia.ca/nse/contaminatedsites/protocols.asp>

11 LIMITATIONS

This report has been prepared and the work referred to in this report has been undertaken by SNC-Lavalin Inc (SNCL) for Halifax Regional Municipality (HRM), hereafter referred to as the “Client”. It is intended for the sole and exclusive use of Halifax Regional Municipality.

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Appendix A

Instrument Calibration Report

Open Road Environmental Limited

YSI Professional Plus

Serial Number 12G102936 (Quattro)

Calibration Certificate

<i>3 Point Calibration pH (4.00, 7.00, 10.00)</i>	<i>Calibration solution</i>	<i>Specific Conductivity 12880 uS/cm</i>	<i>DO 100% @22.0 Deg.C</i>
<i>pH 4.00 pass 171.2mV</i>	<i>Lot#S170125012 Exp. Jan-19</i>	<i>pass</i>	<i>pass</i>
<i>pH 7.00 pass 16.2mV</i>	<i>Lot#S170206014 Exp. Feb-19</i>		
<i>pH 10.00 pass -178.2mV</i>	<i>Lot#165882 Exp. Sept-18</i>		

October 16, 2017

Ghislain Pitre, CET

Appendix B

Field Reports

FIELD REPORT –Fall 2017

Project:	Water Quality Monitoring - Bedford West	Sub-Area(s): 2, 3, 4, 5
Client:	Halifax Regional Municipality	
Site: Kearney Lake	Site ID: KL1	
Watercourse: Kearney Lake	Location: Kearney Lake Road	
Monitoring Well <input type="checkbox"/> Pumping Well <input type="checkbox"/> Surface Water <input checked="" type="checkbox"/> Spring/Seep <input type="checkbox"/> Discharge Pipe <input type="checkbox"/> Other:		
GPS Coordinates:	20T 0445718E, 4948496N (UTM, NAD83)	
SNC Field Personnel:	Ryan Flinn / Maria Gutierrez	

Site Conditions

Weather:	Sun and cloud
Air Temperature:	11°
Cloud Cover :	50%
Wildlife Sightings:	N/A
Site Accessibility: Yes, Accessible	Off Kearney Lake Road
Site Access Detail:	Sample taken off the end of dock at Kearney Lake beach. Parked in public parking of Hamshaw Dr. and walked down to beach area.

Field Parameter Data

	Remarks
Date (d.m.y):	18.10.17
Time (hh:mm):	9:35
Sample Depth (m):	1
pH:	7.84
Dissolved Oxygen (mg/L):	8.22
Secchi Depth (meters):	2.2
Water Temperature (degrees Celsius):	14.1°
Conductivity (µs/cm):	312

Additional Comments / Notes

FIELD REPORT –Fall 2017

Project:	Water Quality Monitoring - Bedford West	Sub-Area(s): 2, 3, 4, 5
Client:	Halifax Regional Municipality	
Site: Kearney Lake	Site ID: KL2	
Watercourse: Kearney Lake	Location: Kearney Lake Road	
Monitoring Well <input type="checkbox"/> Pumping Well <input type="checkbox"/> Surface Water <input checked="" type="checkbox"/> Spring/Seep <input type="checkbox"/> Discharge Pipe <input type="checkbox"/> Other:		
GPS Coordinates:	20T 0443942E, 4949803N (UTM, NAD83)	
SNC Field Personnel:	Ryan Flinn / Maria Gutierrez	

Site Conditions

Weather:	Sun and cloud
Air Temperature:	12°
Cloud Cover:	80%
Wildlife Sightings:	Birds
Site Accessibility: Yes, Accessible	Off Colin's Rd.
Site Access Detail:	Sample taken on the lake side of the culvert between residential buildings 20 and 28. Walked down rock to left of culvert. Note: Sample when standing downstream of bottle.

Field Parameter Data

	Remarks
Date (d.m.y):	18.10.17
Time (hh:mm):	10:30
Sample Depth (m):	0.4
pH:	6.29
Dissolved Oxygen (mg/L):	6.23
Secchi Depth (meters):	1.2
Water Temperature (degrees Celsius):	10.6°
Conductivity (µs/cm):	109

Additional Comments / Notes

FIELD REPORT –Fall 2017

Project:	Water Quality Monitoring - Bedford West	Sub-Area(s): 2, 3, 4, 5
Client:	Halifax Regional Municipality	
Site: Kearney Lake Run	Site ID: KL3	
Watercourse: Kearney Lake Run	Location: Kearney Lake Road	
Monitoring Well <input type="checkbox"/> Pumping Well <input type="checkbox"/> Surface Water <input checked="" type="checkbox"/> Spring/Seep <input type="checkbox"/> Discharge Pipe <input type="checkbox"/> Other:		
GPS Coordinates:	20T 0444390E, 4950406N (UTM, NAD83)	
SNC Field Personnel:	Ryan Flinn / Maria Gutierrez	

Site Conditions

Weather:	Sun and cloud
Air Temperature:	13°
Cloud Cover:	60%
Wildlife Sightings:	Birds
Site Accessibility: Yes, Accessible	Off walking trail from Amesbury Gate Rd.
Site Access Detail:	Access to site is via a walking path clearly evident off of Amesbury Gate Rd. (off Larry Uteck Blvd.) roughly 205m down road on left. Walk down path, follow gravel walkway down hill and take sample at the low point facing the dam. Look for large rock outcrop on right.

Field Parameter Data

	Remarks
Date (d.m.y):	18.10.17
Time (hh:mm):	10:15
Sample Depth (m):	0.5
pH:	6.97
Dissolved Oxygen (mg/L):	8.17
Secchi Depth (m):	N/A
Water Temperature (degrees Celsius):	13.8°
Conductivity (µs/cm):	248

Additional Comments / Notes

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FIELD REPORT –Fall 2017

Project:	Water Quality Monitoring - Bedford West	Sub-Area(s): 2, 3, 4, 5
Client:	Halifax Regional Municipality	
Site: Kearney Lake Run	Site ID: KL4	
Watercourse: Kearney Lake Run	Location: Kearney Lake Road	
Monitoring Well <input type="checkbox"/> Pumping Well <input type="checkbox"/> Surface Water <input checked="" type="checkbox"/> Spring/Seep <input type="checkbox"/> Discharge Pipe <input type="checkbox"/> Other:		
GPS Coordinates:	20T 0444463E, 4950571N (UTM, NAD83)	
SNC Field Personnel:	Ryan Flinn / Maria Gutierrez	

Site Conditions

Weather:	Sun and cloud
Air Temperature:	13°
Cloud Cover:	70%
Wildlife Sightings:	Birds
Site Accessibility: Yes, Accessible	Via the extended road at the end of Weybridge Ln.
Site Access Detail:	At Weybridge, go to end of extended road on right and walk and take sample above the rocky area at the base of the wider, slow moving section of the river.

Field Parameter Data

	Remarks
Date (d.m.y):	18.10.17
Time (hh:mm):	10:05
Sample Depth (m):	0.5
pH:	6.84
Dissolved Oxygen (mg/L):	7.32
Secchi Depth (m):	N/A
Water Temperature (degrees Celsius):	13.8°
Conductivity (µs/cm):	252

Additional Comments / Notes

FIELD REPORT –Fall 2017

Project:	Water Quality Monitoring - Bedford West	Sub-Area(s): 9
Client:	Halifax Regional Municipality	
Site: Kearney Lake	Site ID: KL5	
Watercourse: Kearney Lake	Location: Kearney Lake Road	
Monitoring Well <input type="checkbox"/> Pumping Well <input type="checkbox"/> Surface Water <input checked="" type="checkbox"/> Spring/Seep <input type="checkbox"/> Discharge Pipe <input type="checkbox"/> Other:		
GPS Coordinates:	20T 4949142E, 445280N (UTM, NAD83)	
SNC Field Personnel:	Ryan Flinn / Maria Gutierrez	

Site Conditions

Weather:	Sun and cloud
Air Temperature:	12°
Cloud Cover:	50%
Wildlife Sightings:	N/A
Site Accessibility: Yes, Accessible	Along Kearney Lake Road
Site Access Detail:	Easily accessible, sample location is directly off the Kearney Lake Road on a rocky outcrop supporting a power line pole (two pole structure). Slow truck down carefully, turn hazard lights on. Samples were taken on left front of outcrop facing lake.

Field Parameter Data

	Remarks
Date (d.m.y):	18.10.17
Time (hh:mm):	9:50
Sample Depth (m):	0.7
pH:	7.05
Dissolved Oxygen (mg/L):	7.17
Secchi Depth (meters):	2.7
Water Temperature (degrees Celsius):	14.6°
Conductivity (µs/cm):	257

Additional Comments / Notes

FIELD REPORT –Fall 2017

Project:	Water Quality Monitoring - Bedford West	Sub-Area(s): 2, 3, 4, 5
Client:	Halifax Regional Municipality	
Site: Highway 102	Site ID: HWY 102-1	
Watercourse: Marsh area	Location: Highway 102, south of exit 3	
Monitoring Well <input type="checkbox"/> Pumping Well <input type="checkbox"/> Surface Water <input checked="" type="checkbox"/> Spring/Seep <input type="checkbox"/> Discharge Pipe <input type="checkbox"/> Other:		
GPS Coordinates:	20T 0444708E, 4951644N (UTM, NAD83)	
SNC Field Personnel:	Ryan Flinn / Maria Gutierrez	

Site Conditions

Weather:	Sun and cloud
Air Temperature:	13°
Cloud Cover:	40%
Wildlife Sightings:	N/A
Site Accessibility: Yes, Accessible	Off Highway 102 Park before guardrail.
Site Access Detail:	Carefully slow truck down while pulling off highway 102. Park truck with hazard lights on before the start of the guardrail. Walk along outside of guardrail (for approximately 150m). Site is on right fed by a swampy bog area. Samples were taken in front of culvert. There is a concrete pad to step on to take samples. Sample while standing downstream.

Field Parameter Data

	Remarks
Date (d.m.y):	18.10.17
Time (hh:mm):	11:40
Sample Depth (m):	0.4
pH:	6.32
Dissolved Oxygen (mg/L):	5.56
Secchi Depth (m):	N/A
Water Temperature (degrees Celsius):	10.1°
Conductivity (µs/cm):	266

Additional Comments / Notes

FIELD REPORT –Fall 2017

Project:	Water Quality Monitoring - Bedford West	Sub-Area(s): 2, 3, 4, 5
Client:	Halifax Regional Municipality	
Site: Highway 102	Site ID: HWY 102-2	
Watercourse: Marsh area	Location: HWY 102, south of exit 3	
Monitoring Well <input type="checkbox"/> Pumping Well <input type="checkbox"/> Surface Water <input checked="" type="checkbox"/> Spring/Seep <input type="checkbox"/> Discharge Pipe <input type="checkbox"/> Other:		
GPS Coordinates:	20T 0444829E, 4951778N (UTM, NAD83)	
SNC Field Personnel:	Ryan Flinn / Maria Gutierrez	

Site Conditions

Weather:	Sun and cloud
Air Temperature:	13°
Cloud Cover:	30%
Wildlife Sightings:	N/A
Site Accessibility: Yes, Accessible	Off Highway 102 (Small gravel drive way- *Back in)
Site Access Detail:	Travel along Highway 102 toward Bedford NS. Site is on right easily to identify based on swamp/bog. Carefully slow truck down with hazard lights flashing. There is a small driveway to park truck. Pull a head of driveway and when lanes are clear back truck down into spot. Take samples in water body in front of culvert.

Field Parameter Data

	Remarks
Date (d.m.y):	18.10.17
Time (hh:mm):	12:25
Sample Depth (m):	0.2
pH:	8.32
Dissolved Oxygen (mg/L):	11.32
Secchi Depth (m):	N/A
Water Temperature (degrees Celsius):	15.2°
Conductivity (µs/cm):	338

Additional Comments / Notes

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FIELD REPORT –Fall 2017

Project:	Water Quality Monitoring - Bedford West	Sub-Area(s): 2, 3, 4, 5
Client:	Halifax Regional Municipality	
Site: Lake Shore Drive	Site ID: LSD	
Watercourse: Marsh @ Lakeshore Dr.	Location: Kingswood Subdivision	
Monitoring Well <input type="checkbox"/> Pumping Well <input type="checkbox"/> Surface Water <input checked="" type="checkbox"/> Spring/Seep <input type="checkbox"/> Discharge Pipe <input type="checkbox"/> Other:		
GPS Coordinates:	20T 0442583E, 4950431N (UTM, NAD83)	
SNC Field Personnel:	Ryan Flinn / Maria Gutierrez	

Site Conditions

Weather:	Sun and cloud
Air Temperature:	14°
Cloud Cover:	80%
Wildlife Sightings:	Birds
Site Accessibility: Yes, Accessible	Via Lakeshore Drive in Kingswood Subdivision
Site Access Detail:	Take Kingswood Drive off Hammonds Plains Road. Travel down to Diana Drive on left go to end and take a left on Lakeshore drive. Travel approximately 1.0 km. There will be a clearing on left down to power lines. Drive truck (4X4) down until larger clearing is reached and park. Continue (walk) down hill to ATV pathway on left. Follow pathway for approximately 250m. Sample location is on right (river with a lot of vegetation throughout)

Field Parameter Data

	Remarks
Date (d.m.y):	18.10.17
Time (hh:mm):	11:05
Sample Depth (m):	0.3
pH:	5.91
Dissolved Oxygen (mg/L):	5.34
Secchi Depth (m):	N/A
Water Temperature (degrees Celsius):	9.7°
Conductivity (µs/cm):	92

Additional Comments / Notes

FIELD REPORT –Fall 2017

Project:	Water Quality Monitoring - Bedford West	Sub-Area(s): 9
Client:	Halifax Regional Municipality	
Site: Larry Uteck Blvd.	Site ID: LU	
Watercourse: Pond	Location: Larry Uteck off-ramp	
Monitoring Well <input type="checkbox"/> Pumping Well <input checked="" type="checkbox"/> Surface Water <input type="checkbox"/> Spring/Seep <input type="checkbox"/> Discharge Pipe <input type="checkbox"/> Other:		
GPS Coordinates:	20T 0444954E, 4949891N (UTM, NAD83)	
SNC Field Personnel:	Ryan Flinn / Maria Gutierrez	

Site Conditions

Weather:	Sun and cloud
Air Temperature:	15°
Cloud Cover:	30%
Wildlife Sightings:	Birds
Site Accessibility: Yes, Accessible	From Larry Uteck Blvd.
Site Access Detail:	Take Larry Uteck off ramp and continue down Larry Uteck Blvd. for approximately 320m. Park truck safely on grassy clearing on left. Sample location is at shore line of lake across road. Take walking pathway to wooded area and travel approximately 80m to lake shore. Avoid walking through the bog area on right.

Field Parameter Data

	Remarks
Date (d.m.y):	18.10.17
Time (hh:mm):	12:00
Sample Depth (m):	0.4
pH:	6.90
Dissolved Oxygen (mg/L):	7.43
Secchi Depth (m):	N/A
Water Temperature (degrees Celsius):	13.3°
Conductivity (µs/cm):	590

Additional Comments / Notes

<ul style="list-style-type: none"> • Visible round algae plumes beneath water surface
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FIELD REPORT –Fall 2017

Project:	Water Quality Monitoring - Bedford West	Sub-Area(s): 2, 3, 4, 5
Client:	Halifax Regional Municipality	
Site: Paper Mill Lake	Site ID: PML1	
Watercourse: Paper Mill Lake	Location: Moirs Mill Subdivision	
Monitoring Well <input type="checkbox"/> Pumping Well <input type="checkbox"/> Surface Water <input checked="" type="checkbox"/> Spring/Seep <input type="checkbox"/> Discharge Pipe <input type="checkbox"/> Other:		
GPS Coordinates:	20T 0445129E, 4951154N (UTM, NAD83)	
SNC Field Personnel:	Ryan Flinn / Maria Gutierrez	

Site Conditions

Weather:	Sun and cloud
Air Temperature:	13°
Cloud Cover:	20%
Wildlife Sightings:	N/A
Site Accessibility: Yes, Accessible	Travel down Ahmadi Cr. approximately 340m (around second bend in road). Park truck in front of Halifax Water station and carefully walk down rock wall on left. At the bottom locate the small stream and continue along the left and side facing lake. Sample location is a small clearing to the left at the mouth of the river.

Field Parameter Data

	Remarks
Date (d.m.y):	18.10.17
Time (hh:mm):	13:25
Sample Depth (m):	0.7
pH:	7.31
Dissolved Oxygen (mg/L):	8.19
Secchi Depth (meters):	3.9
Water Temperature (degrees Celsius):	14.4°
Conductivity (µs/cm):	255

Additional Comments / Notes

FIELD REPORT –Fall 2017

Project:	Water Quality Monitoring - Bedford West	Sub-Area(s): 2, 3, 4, 5
Client:	Halifax Regional Municipality	
Site: Paper Mill Lake	Site ID: PML2	
Watercourse: Paper Mill Lake	Location: Moirs Mill Subdivision	
Monitoring Well <input type="checkbox"/> Pumping Well <input checked="" type="checkbox"/> Surface Water <input type="checkbox"/> Spring/Seep <input type="checkbox"/> Discharge Pipe <input type="checkbox"/> Other:		
GPS Coordinates:	20T 0445363E, 4951740N (UTM, NAD83)	
SNC Field Personnel:	Ryan Flinn / Maria Gutierrez	

Site Conditions

Weather:	Sun and cloud
Air Temperature:	14°
Cloud Cover:	35%
Wildlife Sightings:	Birds
Site Accessibility: Yes, Accessible	Via Lake Dr., off Hammonds Plains Rd.
Site Access Detail:	Follow pathway along lake bank to small clearing, use GPS to find exact sample location. Travel over small ridge to reach lake and sample at edge.

Field Parameter Data

	Remarks
Date (d.m.y):	18.10.17
Time (hh:mm):	14:00
Sample Depth (m):	1
pH:	6.87
Dissolved Oxygen (mg/L):	6.56
Secchi Depth (m):	2.9
Water Temperature (degrees Celsius):	14.0°
Conductivity (µs/cm):	252

Additional Comments / Notes

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Appendix C

Site Photographs



Photo 1: KL1 Kearney Lake Sample Location



Photo 2: KL2 Kearney Lake Sample Location.



Photo 3: KL3 Kearney Lake Sample Location



Photo 4: KL4 Kearney Lake Sample Location



Photo 5: KL5 Kearney Lake Sample Location



Photo 6: HWY 102-1 Sample Location



Photo 7: HWY102-2 Sample Location



Photo 8: LSD Lake Shore Drive Sample Location



Photo 9: LU Larry Uteck Sample Location



Photo 10: PML-1 Paper Mill Lake Sample Location



Photo 11: PML-2 Paper Mill Lake Sample Location

Appendix D

Summary Table Results (Seasonal and Historical)

TABLE 1: 2017 Fall Results and Exceedances, Bedford West Water Quality Sampling Program

Tested Parameters	RDL	KL1	KL2	KL3	KL4	KL5	HWY-102-1	HWY-102-2	LSD	LU	PML-1	PML-2	NSE (EQS for Surface Water Applied)	Health Canada Guideline for Recreational Water Quality (Reference)	CCME Guideline PAL-F (Applied)
Field Data (In Situ)															
Depth	Meters	2.2	1.2	N/A	N/A	3.7	N/A	N/A	3.9	3.9	N/A	N/A		minimum of 1.2	--
Water Temp	Celsius	14.1	10.6	13.8	13.8	14.6	9.7	13.3	14.0	14.4	10.1	15.2		--	--
Dissolved Oxygen	mg/L	8.2	6.2	8.2	7.3	7.2	5.3	7.4	6.6	8.2	5.6	11.3		--	5.5-9.5
pH		7.6	6.4	7.0	6.8	7.1	5.9	6.9	6.9	7.3	6.3	8.3		--	6.5-9.0
Specific Conductance (µs/cm)	µS/cm	312.0	109.0	248.0	252.0	257.0	92.0	990.0	252.0	255.0	266.0	338.0		--	--
Inorganic Parameters															
Alkalinity	mg/L	5	10	9	10	9	16	11	20	20	9	11		--	--
Chloride	mg/L	1	60	19	59	59	60	51	92	96	143	59		--	120
True Color	TCU	5	12	57	15	16	14	29	22	21	8	24		--	--
Nitrate + Nitrite as N	mg/L	0.05	0.10	<0.05	0.24	0.15	0.09	0.58	0.07	0.22	1.72	0.20		--	--
Nitrate as N	mg/L	0.05	0.10	<0.05	0.24	0.15	0.09	0.58	0.07	0.22	1.72	0.20		--	13
Nitrite as N	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		--	0.06
Ammonia as N	mg/L	0.03	0.04	0.04	0.03	0.04	0.04	0.07	0.14	0.04	0.04	0.05		--	18
Total Dissolved Nitrogen as N	mg/L	0.4	<0.4	<0.4	<0.4	<0.4	1.1	0.6	10.0	0.6	1.1	0.4		--	--
Total Organic Carbon	mg/L	0.5	4.8	8.5	4.1	4.0	3.9	6.9	5.9	6.9	5.4	6.3		--	--
Ortho-Phosphate as P	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		--	--
Calcium	mg/L	7.0	6.7	6.9	7.0	6.9	6.9	6.5	7.0	7.1	6.8	7.0		--	5.0-9.0
Potassium	mg/L	0.1	8.3	3.9	8.1	8.6	7.5	14.6	14.7	6.7	22.8	9.5		--	--
Magnesium	mg/L	0.1	1.3	0.9	1.2	1.1	2.2	2.1	1.6	2.5	1.5	1.2		--	--
Total Phosphorus	mg/L	0.002	0.005	0.010	0.007	0.006	0.005	0.008	0.011	0.015	0.008	0.009		--	0.01
Sodium	mg/L	0.1	15.7	13.0	35.9	38.9	37.2	29.6	15.2	23.0	86.9	36.0		--	--
Reactive Silica as SiO2	mg/L	0.5	1.8	4.6	1.9	2.1	1.7	5.6	6.4	4.0	5.9	1.8		--	--
Total Suspended Solids	mg/L	5	<5	<5	<5	<5	<5	8	<5	8	<5	10.4		--	--
Sulphate	mg/L	2	10	3	10	10	10	19	9	4	33	11		--	--
Turbidity	NTU	0.1	0.8	1.6	2.6	1.6	0.9	1.1	12.5	15.1	3.0	31.3		--	50
Conductivity	µmho/cm	1	249	97	247	246	258	366	171	610	248	255		--	--
Calculated Parameters															
Anion Sum	meq/L	2.11	0.78	2.07	2.08	2.09	2.20	3.01	1.51	5.24	2.09	2.15		--	--
Carb. Alkalinity (as CaCO3)	mg/L	5	10	9	10	9	10	11	20	20	9	11		--	--
Calculated TDS	mg/L	1	123	47	122	126	123	131	187	87	311	142		--	--
Carb. Alkalinity (as CaCO3)	mg/L	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10		--	--
Carbonium	mg/L	--	2.12	0.90	2.10	2.27	2.12	2.28	3.60	1.59	5.21	3.15		--	--
Hardness	mg/L	--	26.10	13.40	25.20	26.80	23.30	45.50	46.40	23.30	67.20	29.90		--	--
% Difference / Ion Balance (NS)	%	--	0.20	7.50	0.80	4.30	0.70	1.80	8.90	2.30	0.30	20.30		--	--
Rangelier Index (R20C)	NA	--	2.68	3.25	2.85	2.71	2.84	2.33	2.90	2.44	1.85	2.92		--	--
Rangelier Index (R4C)	NA	--	3.00	3.67	3.17	3.03	3.16	2.65	3.22	2.76	2.17	3.24		--	--
Saturation pH (@ 20C)	NA	--	9.68	10.00	9.73	9.66	9.77	9.23	9.41	9.45	8.88	9.67		--	--
Saturation pH (@ 4C)	NA	--	10.00	10.30	10.10	9.98	10.10	9.55	9.73	9.77	9.30	9.99		--	--
Metals (CP-MS)															
Total Aluminum	ug/L	5	46	240	43	55	44	100	142	401	20	4,190	11	5	100 ug/L (opt 26.5)
Total Antimony	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2		--	20
Total Arsenic	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2		--	5.0
Total Barium	ug/L	5	17	14	20	20	17	77	122	11	111	58		--	1000
Total Beryllium	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2		--	5.3
Total Bismuth	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2		--	--
Total Boron	ug/L	5	26	17	12	11	10	24	12	20	19	12		--	1500
Total Cadmium	ug/L	0.017	<0.017	<0.017	<0.017	<0.017	<0.017	0.048	<0.017	0.052	0.179	<0.017		--	0.09
Total Chromium	ug/L	1	<1	1	<1	<1	<1	1	2	1	1	5		--	1
Total Cobalt	ug/L	1	<1	<1	<1	<1	<1	<1	2	<1	<1	6		--	10
Total Copper	ug/L	1	1	1	1	1	1	1	1	1	1	1		--	2 ug/L (hardness < 82 mg/L)
Total Iron	ug/L	50	116	322	130	141	106	281	4,750	874	289	12,600	145	300	300
Total Lead	ug/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	1.3	0.7	<0.5	2.1		--	1 ug/L (base on hardness)
Total Manganese	ug/L	2	17	64	14	16	13	70	215	250	91	554	36	820	--
Total Molybdenum	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2		--	73
Total Nickel	ug/L	2	<2	<2	<2	<2	<2	<2	3	<2	<2	6		--	25 ug/L (base on hardness)
Total Selenium	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		--	1.0
Total Silver	ug/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		--	0.1
Total Strontium	ug/L	5	40	20	41	40	38	76	80	11	111	47		--	21000
Total Thallium	ug/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		--	0.8
Total Tin	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2		--	--
Total Titanium	ug/L	2	<2	<2	<2	<2	<2	15	7	<2	75	<2		--	--
Total Uranium	ug/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.6	<0.1		--	300
Total Vanadium	ug/L	2	<2	<2	<2	<2	<2	<2	3	<2	<2	12		--	8
Total Zinc	ug/L	5	6	6	6	<5	<5	8	19	7	22	29		--	30
Microbiological Parameters															
Total Coliforms	MPN/100 ml	1	154	659	411	>2420	>2420	>2420	641	1,980	166	1,730		--	--
E. Coli	MPN/100 ml	1	3	46	3	511	3	41	1	4	<1	5		--	400
Chlorophyll A - Acidification Method	ug/L	0.05	1.10	0.31	1.34	0.35	1.22	0.62	28.94	1.85	2.47	4.86		--	--
Chlorophyll A - Wetchemeyer Method	ug/L	0.05	1.18	0.49	1.87	0.43	1.33	0.99	37.67	2.89	2.85	6.58		--	--

RDL = Reported Detection Limit (represents most recent sampling event)

-- = no guideline available / no parameter tested

Nova Scotia Environmental Quality Standards

Health Canada Guidelines for Canadian Recreational Water Quality (Third Edition 2012)

CCME PAL-F Canadian Council of Ministers of the Environment Guidelines for the Protection of Aquatic Life - Freshwater (Updated 2015)

CCME Phosphorus Trigger Range (Applied) of 0.03 mg/L

CCME PAL-F Guidelines for Aluminum, Lead, Copper and Nickel vary based on reported pH and water hardness.

CCME PAL-F Guidelines for Ammonia-N vary based on water pH and temperature. The value is converted to mg/L total ammonia-N by multiplying by 0.8224

bold and black shaded Concentration exceeds CCME PAL-F applicable guideline.

Underlined and black shaded Concentration exceeds NSE EQS Contaminated Sites Regulations and/or Health Canada Guideline for Recreational Water Quality (Reference Guidelines)

HRM Water Quality Monitoring Program Results

TABLE 1B: Historical Data - Bedford West Water Quality Sampling Program

Fall 2017	Units	RM (2017)	NCE EQS for Surface Water (Reference)	Health Goals for Recreational Water Quality (Reference)	COWE Guideline PAL (Approved)	HRM Phosphate Trigger Range (Approved)	Highway 303																															
							WAYPOINT 1																															
Sampling Date	Sampling Time	2008/09/24	2008/10/01	2008/10/08	2008/10/15	2008/10/22	2008/10/29	2008/11/05	2008/11/12	2008/11/19	2008/11/26	2008/12/03	2008/12/10	2008/12/17	2008/12/24	2009/01/07	2009/01/14	2009/01/21	2009/01/28	2009/02/04	2009/02/11	2009/02/18	2009/02/25	2009/03/04	2009/03/11	2009/03/18	2009/03/25	2009/04/01	2009/04/08	2009/04/15	2009/04/22	2009/04/29	2009/05/06	2009/05/13				
PHYSICAL DATA																																						
Water Temp	°C	11.8	13.8	15.2	16.9	19.6	21.4	13.4	17.8	14.6	10.7	11.7	13.5	8.2	13.3	10.2	14.3	10.2	14.3	10.2	14.3	10.2	14.3	10.2	14.3	10.2	14.3	10.2	14.3	10.2	14.3	10.2	14.3	10.2	14.3	10.2	14.3	
Water Depth	m	1.1	5.8	7.5	9.2	11.1	6.1	6.2	11.1	1.1	5.7	7.1	7.6	11.1	7.1	11.1	7.1	11.1	7.1	11.1	7.1	11.1	7.1	11.1	7.1	11.1	7.1	11.1	7.1	11.1	7.1	11.1	7.1	11.1	7.1	11.1	7.1	
Flow Velocity	m/s	0.0	5.4	1.1	3.1	3.1	1.6	1.4	1.0	4.8	3.7	6.4	8.2	1.1	6.6	6.6	1.1	6.4	6.4	1.1	6.2	6.2	1.1	6.2	6.2	1.1	6.2	6.2	1.1	6.2	6.2	1.1	6.2	6.2	1.1	6.2	6.2	
Water Conductivity	µS/cm	194.0	151.0	103.8	113.0	106.0	108.4	111.1	107.6	108.4	200.0	171.2	188.0	225.0	135.5	238.0	171.2	244.0	188.0	171.2	244.0	188.0	171.2	244.0	188.0	171.2	244.0	188.0	171.2	244.0	188.0	171.2	244.0	188.0	171.2	244.0	188.0	
HEALTH GOALS																																						
Total Alkalinity (as CaCO3)	mg/L	5	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	
Ammonia Nitrogen	mg/L	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
Phosphate	mg/L	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
ADDITIONAL PARAMETERS																																						
Ammonia Nitrogen	mg/L	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
Phosphate	mg/L	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
PHYSICAL DATA																																						
Water Temp	°C	13.5	15.0	16.5	18.0	19.5	21.0	22.5	24.0	25.5	27.0	28.5	30.0	31.5	33.0	34.5	36.0	37.5	39.0	40.5	42.0	43.5	45.0	46.5	48.0	49.5	51.0	52.5	54.0	55.5	57.0	58.5	60.0	61.5	63.0	64.5	66.0	
Water Depth	m	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	
Flow Velocity	m/s	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Water Conductivity	µS/cm	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	
HEALTH GOALS																																						
Total Alkalinity (as CaCO3)	mg/L	5	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15		
Ammonia Nitrogen	mg/L	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
Phosphate	mg/L	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
ADDITIONAL PARAMETERS																																						
Ammonia Nitrogen	mg/L	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
Phosphate	mg/L	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	

N/A - Not Applicable, NC - Not Collected, NCC - Not Collected
 EQS - Environmental Quality Standards (from monitoring event)
 * - no guideline available / Not Tested
 COWE PAL - Canadian Council of Ministers of the Environment Quality Objectives for the Protection of Aquatic Life - Freshwater (updated 2011)
 COWE PAL-F Guidelines for Aluminum, Lead, Copper and Nickel vary based on reported pH and water hardness (COWE PAL-F calculation equations). The target guideline value for each respective element range was always used.
 Health Goals - Guidelines for Canadian Recreational Water Quality - Draft (December 2008)
 New Brunswick Environmental Quality Standards (EQS) for Contaminated Sites (NSI 2014) Table A2 Reference for Pathway Specific Standards for Surface Water (µg/L) - Fresh Water
 NCE EQS - New Brunswick Environmental Quality Standards (EQS) for Contaminated Sites (NSI 2014) Table A2 Reference for Pathway Specific Standards for Surface Water (µg/L) - Fresh Water
 HRM Phosphate Trigger Range - Parameter concentration exceeds COWE PAL-F Guideline
 Health Goals - Parameter concentration exceeds NCE EQS Contaminated Sites Regulations and/or Health Goals Guideline for Recreational Water Quality
 NCC - Not Collected

Appendix E

Laboratory Certificate of Analysis

**CLIENT NAME: SNC Lavalin Inc.
5657 SPRING GARDEN RD, SUITE 200
HALIFAX , NS B3J3R4
(902) 492-4544**

ATTENTION TO: Maria Gutierrez

PROJECT: 631477

AGAT WORK ORDER: 17X273114

WATER ANALYSIS REVIEWED BY: Laura Baker, Inorganics Data Reporter

DATE REPORTED: Oct 27, 2017

PAGES (INCLUDING COVER): 13

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (902) 468-8718

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories (V1)

Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)
Western Enviro-Agricultural Laboratory Association (WEALA)
Environmental Services Association of Alberta (ESAA)

AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.

Page 1 of 13

*Results relate only to the items tested and to all the items tested
All reportable information as specified by ISO 17025:2005 is available from AGAT Laboratories upon request*



Certificate of Analysis

AGAT WORK ORDER: 17X273114
PROJECT: 631477

11 Morris Drive, Unit 122
Dartmouth, Nova Scotia
CANADA B3B 1M2
TEL (902)468-8718
FAX (902)468-8924
http://www.agatlabs.com

CLIENT NAME: SNC Lavalin Inc.

ATTENTION TO: Maria Gutierrez

SAMPLING SITE:

SAMPLED BY:

SNC-Lavalin Bedford West Custom Inorganics Package

DATE RECEIVED: 2017-10-18

DATE REPORTED: 2017-10-27

Parameter	Unit	SAMPLE DESCRIPTION:		KL-1	KL-2	KL-3	KL-4	KL-5	PML-1	
		SAMPLE TYPE:		Water	Water	Water	Water	Water	Water	
		G / S	RDL	2017-10-18 8827302	2017-10-18 8827306	2017-10-18 8827308	2017-10-18 8827309	2017-10-18 8827310	RDL	2017-10-18 8827311
Alkalinity	mg/L		5	10	9	9	10	9	5	9
Chloride	mg/L	640, 120	1	60	19	59	59	60	1	59
True Color	TCU	Narrative	5	12	57	15	16	14	5	24
Nitrate + Nitrite as N	mg/L		0.05	0.10	<0.05	0.24	0.15	0.09	0.05	0.20
Nitrate as N	mg/L	550, 13	0.05	0.10	<0.05	0.24	0.15	0.09	0.05	0.20
Nitrite as N	mg/L	0.06	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05
Ammonia as N	mg/L	Fact Sheet	0.03	0.04	0.04	0.03	0.04	0.04	0.03	0.05
Total Organic Carbon	mg/L		0.5	4.8	8.5	4.1	4.0	3.9	0.5	6.3
Ortho-Phosphate as P	mg/L		0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
pH		6.5-9.0		7.00	6.66	6.88	6.95	6.93		6.75
Total Calcium	mg/L		0.1	8.3	3.9	8.1	8.6	7.5	0.1	9.5
Total Magnesium	mg/L		0.1	1.3	0.9	1.2	1.3	1.1	0.1	1.5
Total Phosphorus	mg/L	Fact Sheet	0.002	0.005	0.010	0.007	0.006	0.005	0.004	0.099
Total Potassium	mg/L		0.1	1.2	0.7	1.0	1.1	0.9	0.1	1.3
Total Sodium	mg/L		0.1	35.7	13.0	35.9	38.9	37.2	0.1	36.0
Reactive Silica as SiO2	mg/L		0.5	1.8	4.6	1.9	2.1	1.7	0.5	1.8
Total Suspended Solids	mg/L	Narrative	5	<5	<5	<5	<5	<5	5	104
Sulphate	mg/L		2	10	3	10	10	10	2	11
Turbidity	NTU	Narrative	0.1	0.8	1.6	2.6	1.6	0.9	0.1	31.3
Electrical Conductivity	umho/cm		1	249	97	247	248	246	1	248
Anion Sum	me/L			2.11	0.78	2.07	2.08	2.09		2.09
Bicarb. Alkalinity (as CaCO3)	mg/L		5	10	9	9	10	9	5	9
Calculated TDS	mg/L		1	123	47	122	126	123	1	142
Carb. Alkalinity (as CaCO3)	mg/L		10	<10	<10	<10	<10	<10	10	<10
Cation sum	me/L			2.12	0.90	2.10	2.27	2.12		3.15
Hardness	mg/L			26.1	13.4	25.2	26.8	23.3		29.9
% Difference/ Ion Balance (NS)	%			0.2	7.5	0.8	4.3	0.7		20.3
Langelier Index (@20C)	NA			-2.68	-3.35	-2.85	-2.71	-2.84		-2.92
Langelier Index (@ 4C)	NA			-3.00	-3.67	-3.17	-3.03	-3.16		-3.24
Saturation pH (@ 20C)	NA			9.68	10.0	9.73	9.66	9.77		9.67

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Certificate of Analysis

AGAT WORK ORDER: 17X273114
PROJECT: 631477

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CLIENT NAME: SNC Lavalin Inc.

ATTENTION TO: Maria Gutierrez

SAMPLING SITE:

SAMPLED BY:

SNC-Lavalin Bedford West Custom Inorganics Package

DATE RECEIVED: 2017-10-18

DATE REPORTED: 2017-10-27

Parameter	Unit	SAMPLE DESCRIPTION:		KL-1	KL-2	KL-3	KL-4	KL-5	RDL	PML-1
		SAMPLE TYPE:	Water	Water	Water	Water	Water	Water		
		DATE SAMPLED:	2017-10-18	2017-10-18	2017-10-18	2017-10-18	2017-10-18	2017-10-18		
		G / S	RDL	8827302	8827306	8827308	8827309	8827310		8827311
Saturation pH (@ 4C)	NA			10.0	10.3	10.1	9.98	10.1		9.99
Total Aluminum	ug/L	Variable	5	46	240	43	55	44	5	4190
Total Antimony	ug/L		2	<2	<2	<2	<2	<2	2	<2
Total Arsenic	ug/L	5	2	<2	<2	<2	<2	<2	2	3
Total Barium	ug/L		5	17	14	20	20	17	5	58
Total Beryllium	ug/L		2	<2	<2	<2	<2	<2	2	<2
Total Bismuth	ug/L		2	<2	<2	<2	<2	<2	2	<2
Total Boron	ug/L	29000,	5	26	17	12	11	10	5	12
Total Cadmium	ug/L	1.0, 0.09	0.017	<0.017	<0.017	<0.017	<0.017	<0.017	0.017	0.179
Total Chromium	ug/L		1	<1	1	<1	<1	<1	1	5
Total Cobalt	ug/L		1	<1	<1	<1	<1	<1	1	6
Total Copper	ug/L	Equation	1	1	1	1	<1	1	1	8
Total Iron	ug/L	300	50	116	572	130	141	106	50	12600
Total Lead	ug/L	Equation	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	9.1
Total Manganese	ug/L		2	17	64	54	48	13	2	894
Total Molybdenum	ug/L	73	2	<2	<2	<2	<2	<2	2	<2
Total Nickel	ug/L	Equation	2	<2	<2	<2	<2	<2	2	6
Total Selenium	ug/L	1	1	<1	<1	<1	<1	<1	1	<1
Total Silver	ug/L	0.25	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
Total Strontium	ug/L		5	40	20	41	40	38	5	47
Total Thallium	ug/L	0.8	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
Total Tin	ug/L		2	<2	<2	<2	<2	<2	2	<2
Total Titanium	ug/L		2	<2	<2	<2	<2	<2	2	75
Total Uranium	ug/L	33, 15	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.6
Total Vanadium	ug/L		2	<2	<2	<2	<2	<2	2	12
Total Zinc	ug/L	30	5	6	6	6	<5	<5	5	29
Total Coliforms (MPN)	MPN/100 mL		1	154	659	411	>2420	>2420	1	166
E. Coli (MPN)	MPN/100 mL		1	3	3	46	3	517	1	<1
Chlorophyll A - Acidification Method	ug/L		0.05	Y	Y	Y	Y	Y	0.05	Y

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PROJECT: 631477

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CLIENT NAME: SNC Lavalin Inc.

ATTENTION TO: Maria Gutierrez

SAMPLING SITE:

SAMPLED BY:

SNC-Lavalin Bedford West Custom Inorganics Package

DATE RECEIVED: 2017-10-18

DATE REPORTED: 2017-10-27

Parameter	Unit	SAMPLE DESCRIPTION:		KL-1	KL-2	KL-3	KL-4	KL-5	RDL	PML-1
		SAMPLE TYPE:		Water	Water	Water	Water	Water		Water
		DATE SAMPLED:		2017-10-18	2017-10-18	2017-10-18	2017-10-18	2017-10-18		2017-10-18
		G / S	RDL	8827302	8827306	8827308	8827309	8827310		8827311
Chlorophyll A - Welschmeyer Method	ug/L		0.05	Y	Y	Y	Y	Y	0.05	Y
Total Kjeldahl Nitrogen as N	mg/L		0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.4	1.1

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SAMPLING SITE:

SAMPLED BY:

SNC-Lavalin Bedford West Custom Inorganics Package

DATE RECEIVED: 2017-10-18

DATE REPORTED: 2017-10-27

Parameter	Unit	SAMPLE DESCRIPTION:		PML-2	HWY-102-1	HWY-102-2	RDL	LU	LDS	
		SAMPLE TYPE:		Water	Water	Water		Water	Water	
		G / S	RDL	2017-10-18	2017-10-18	2017-10-18		2017-10-18	2017-10-18	
Alkalinity	mg/L		5	11	16	11	5	20	5	20
Chloride	mg/L	640, 120	1	60	51	92	2	143	1	36
True Color	TCU	Narrative	5	19	29	22	5	8	5	21
Nitrate + Nitrite as N	mg/L		0.05	0.16	0.58	0.07	0.05	1.72	0.05	0.22
Nitrate as N	mg/L	550, 13	0.05	0.16	0.58	0.07	0.05	1.72	0.05	0.22
Nitrite as N	mg/L	0.06	0.05	<0.05	<0.05	<0.05	0.05	<0.05	0.05	<0.05
Ammonia as N	mg/L	Fact Sheet	0.03	<0.03	0.07	0.14	0.03	0.04	0.03	0.04
Total Organic Carbon	mg/L		0.5	4.1	6.9	5.9	0.5	5.4	0.5	6.9
Ortho-Phosphate as P	mg/L		0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.01	<0.01
pH		6.5-9.0		6.99	6.90	6.51		7.13		7.01
Total Calcium	mg/L		0.1	8.1	14.6	14.7	0.1	22.8	0.1	6.7
Total Magnesium	mg/L		0.1	1.2	2.2	2.1	0.1	2.5	0.1	1.6
Total Phosphorus	mg/L	Fact Sheet	0.002	0.006	0.008	0.011	0.002	0.008	0.002	0.015
Total Potassium	mg/L		0.1	1.1	2.0	1.6	0.1	2.6	0.1	1.2
Total Sodium	mg/L		0.1	35.5	29.6	55.2	0.1	86.9	0.1	23.0
Reactive Silica as SiO2	mg/L		0.5	2.0	5.6	6.4	0.5	5.9	0.5	4.0
Total Suspended Solids	mg/L	Narrative	5	<5	<5	8	5	<5	5	<5
Sulphate	mg/L		2	11	19	9	2	33	2	4
Turbidity	NTU	Narrative	0.1	1.8	1.1	12.5	0.1	3.0	0.1	15.1
Electrical Conductivity	umho/cm		1	255	258	366	1	610	1	171
Anion Sum	me/L			2.15	2.20	3.01		5.24		1.51
Bicarb. Alkalinity (as CaCO3)	mg/L		5	11	16	11	5	20	5	20
Calculated TDS	mg/L		1	124	131	187	1	311	1	87
Carb. Alkalinity (as CaCO3)	mg/L		10	<10	<10	<10	10	<10	10	<10
Cation sum	me/L			2.09	2.28	3.60		5.21		1.59
Hardness	mg/L			25.2	45.5	45.4		67.2		23.3
% Difference/ Ion Balance (NS)	%			1.6	1.8	8.9		0.3		2.3
Langelier Index (@20C)	NA			-2.66	-2.33	-2.90		-1.85		-2.44
Langelier Index (@ 4C)	NA			-2.98	-2.65	-3.22		-2.17		-2.76
Saturation pH (@ 20C)	NA			9.65	9.23	9.41		8.98		9.45

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PROJECT: 631477

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CLIENT NAME: SNC Lavalin Inc.

ATTENTION TO: Maria Gutierrez

SAMPLING SITE:

SAMPLED BY:

SNC-Lavalin Bedford West Custom Inorganics Package

DATE RECEIVED: 2017-10-18

DATE REPORTED: 2017-10-27

Parameter	Unit	SAMPLE DESCRIPTION:		PML-2	HWY-102-1	HWY-102-2	RDL	LU	LDS	
		SAMPLE TYPE:		Water	Water	Water		Water	Water	
		DATE SAMPLED:		2017-10-18	2017-10-18	2017-10-18		2017-10-18	2017-10-18	
		G / S	RDL	8827312	8827313	8827314		8827315	RDL	8827316
Saturation pH (@ 4C)	NA			9.97	9.55	9.73		9.30		9.77
Total Aluminum	ug/L	Variable	5	34	100	542	5	29	5	401
Total Antimony	ug/L		2	<2	<2	<2	2	<2	2	<2
Total Arsenic	ug/L	5	2	<2	<2	<2	2	<2	2	<2
Total Barium	ug/L		5	23	77	122	5	111	5	11
Total Beryllium	ug/L		2	<2	<2	<2	2	<2	2	<2
Total Bismuth	ug/L		2	<2	<2	<2	2	<2	2	<2
Total Boron	ug/L	29000,	5	11	24	12	5	19	5	20
Total Cadmium	ug/L	1.0, 0.09	0.017	<0.017	<0.017	0.048	0.017	0.052	0.017	<0.017
Total Chromium	ug/L		1	<1	1	2	1	1	1	1
Total Cobalt	ug/L		1	<1	<1	2	1	<1	1	<1
Total Copper	ug/L	Equation	1	1	1	3	1	3	1	1
Total Iron	ug/L	300	50	145	281	4760	50	289	50	874
Total Lead	ug/L	Equation	0.5	<0.5	<0.5	3.3	0.5	<0.5	0.5	0.7
Total Manganese	ug/L		2	26	28	215	2	91	2	250
Total Molybdenum	ug/L	73	2	<2	<2	<2	2	<2	2	<2
Total Nickel	ug/L	Equation	2	<2	<2	3	2	<2	2	<2
Total Selenium	ug/L	1	1	<1	<1	<1	1	<1	1	<1
Total Silver	ug/L	0.25	0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1
Total Strontium	ug/L		5	39	76	80	5	111	5	31
Total Thallium	ug/L	0.8	0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1
Total Tin	ug/L		2	<2	<2	<2	2	<2	2	<2
Total Titanium	ug/L		2	<2	<2	15	2	<2	2	7
Total Uranium	ug/L	33, 15	0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1
Total Vanadium	ug/L		2	<2	<2	3	2	<2	2	<2
Total Zinc	ug/L	30	5	5	8	19	5	22	5	7
Total Coliforms (MPN)	MPN/100 mL		1	1730	>2420	>2420	1	1990	1	641
E. Coli (MPN)	MPN/100 mL		1	5	3	41	1	4	1	1
Chlorophyll A - Acidification Method	ug/L		0.05	Y	Y	Y	0.05	Y	0.05	Y

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CLIENT NAME: SNC Lavalin Inc.

ATTENTION TO: Maria Gutierrez

SAMPLING SITE:

SAMPLED BY:

SNC-Lavalin Bedford West Custom Inorganics Package

DATE RECEIVED: 2017-10-18

DATE REPORTED: 2017-10-27

Parameter	Unit	SAMPLE DESCRIPTION:			PML-2	HWY-102-1	HWY-102-2	RDL	LU	LDS					
		SAMPLE TYPE:									2017-10-18	2017-10-18	2017-10-18	2017-10-18	2017-10-18
		G / S	RDL												
Chlorophyll A - Welschmeyer Method	ug/L		0.05	Y	Y	Y	0.05	Y	0.05	Y					
Total Kjeldahl Nitrogen as N	mg/L		0.4	<0.4	3.8	0.6	0.4	0.6	0.4	10.0					

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard; Refers to CCME FWAL - update 2015
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

8827302-8827310 Total Phosphorus was analysed at AGAT Mississauga.
Chlorophyll A was analysed by a sub-contracted laboratory.

8827311 Total Phosphorus was analysed at AGAT Mississauga.
Chlorophyll A was analysed by a sub-contracted laboratory.
Ion Balance is biased high, contributing parameters have been confirmed.

8827312-8827316 Total Phosphorus was analysed at AGAT Mississauga.
Chlorophyll A was analysed by a sub-contracted laboratory.

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AGAT Laboratories

Guideline Violation

AGAT WORK ORDER: 17X273114

PROJECT: 631477

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CLIENT NAME: SNC Lavalin Inc.

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SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
8827306	KL-2	NS-CCME FWAL	SNC-Lavalin Bedford West Custom Inorganics Package	Total Iron	ug/L	300	572
8827311	PML-1	NS-CCME FWAL	SNC-Lavalin Bedford West Custom Inorganics Package	Total Iron	ug/L	300	12600
8827314	HWY-102-2	NS-CCME FWAL	SNC-Lavalin Bedford West Custom Inorganics Package	Total Iron	ug/L	300	4760
8827316	LDS	NS-CCME FWAL	SNC-Lavalin Bedford West Custom Inorganics Package	Total Iron	ug/L	300	874

Quality Assurance

CLIENT NAME: SNC Lavalin Inc.

AGAT WORK ORDER: 17X273114

PROJECT: 631477

ATTENTION TO: Maria Gutierrez

SAMPLING SITE:
SAMPLED BY:

Water Analysis																
RPT Date: Oct 27, 2017			DUPLICATE				Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Measured Value		Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits		
								Lower	Upper		Lower	Upper		Lower	Upper	

SNC-Lavalin Bedford West Custom Inorganics Package

Alkalinity	8825639		88	87	0.9%	< 5	92%	80%	120%	NA	80%	120%	NA	80%	120%
Chloride	8827302	8827302	60	62	3.2%	< 1	93%	80%	120%	NA	80%	120%	NA	80%	120%
True Color	8828239		<5	<5	NA	< 5	105%	80%	120%	NA			NA		
Nitrate as N	8827302	8827302	0.10	0.10	NA	< 0.05	98%	80%	120%	NA	80%	120%	91%	80%	120%
Nitrite as N	8827302	8827302	<0.05	<0.05	NA	< 0.05	92%	80%	120%	NA	80%	120%	97%	80%	120%
Ammonia as N	1	8824699	1.63	1.58	3.1%	< 0.03	109%	80%	120%		80%	120%	80%	80%	120%
Total Organic Carbon	1	8825177	5.4	6.3	15.4%	< 0.5	99%	80%	120%		80%	120%	98%	80%	120%
Ortho-Phosphate as P	1	8835716	<0.01	<0.01	NA	< 0.01	98%	80%	120%		80%	120%	96%	80%	120%
pH	8825639		7.03	7.02	0.1%	<	101%	80%	120%	NA	80%	120%	NA	80%	120%
Total Calcium	8828902		18.6	17.6	5.7%	< 0.1	103%	80%	120%	112%	80%	120%	NA	70%	130%
Total Magnesium	8828902		2.1	2.1	0.9%	< 0.1	104%	80%	120%	109%	80%	120%	NA	80%	120%
Total Phosphorus	8827302	8827302	0.005	0.006	NA	< 0.002	97%	90%	110%	101%	90%	110%	105%	80%	120%
Total Potassium	8828902		0.9	0.9	0.1%	< 0.1	105%	80%	120%	109%	80%	120%	102%	70%	130%
Total Sodium	8828902		24.6	23.3	5.5%	< 0.1	105%	80%	120%	109%	80%	120%	NA	70%	130%
Reactive Silica as SiO2	1	8825716	6.6	6.7	1.5%	< 0.5	108%	80%	120%		80%	120%	91%	80%	120%
Total Suspended Solids	8827302	8827302	<5	<5	NA	< 5	101%	80%	120%	NA			93%	80%	120%
Sulphate	8827302	8827302	10	10	NA	< 2	115%	80%	120%	NA	80%	120%	93%	80%	120%
Turbidity	8828239		0.5	0.5	12.5%	< 0.1	101%	80%	120%	NA			NA		
Electrical Conductivity	8825639		185	185	0.1%	< 1	102%	80%	120%	NA	80%	120%	NA	80%	120%
Bicarb. Alkalinity (as CaCO3)	8825639		88	87	0.9%	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Carb. Alkalinity (as CaCO3)	8825639		<10	<10	NA	< 10	NA	80%	120%	NA	80%	120%	NA	80%	120%
Total Aluminum	8828902		13	10	NA	< 5	107%	80%	120%	112%	80%	120%	103%	70%	130%
Total Antimony	8828902		<2	<2	NA	< 2	95%	80%	120%	96%	80%	120%	96%	70%	130%
Total Arsenic	8828902		<2	<2	NA	< 2	99%	80%	120%	101%	80%	120%	99%	70%	130%
Total Barium	8828902		8	8	NA	< 5	96%	80%	120%	100%	80%	120%	99%	70%	130%
Total Beryllium	8828902		<2	<2	NA	< 2	106%	80%	120%	109%	80%	120%	104%	70%	130%
Total Bismuth	8828902		<2	<2	NA	< 2	103%	80%	120%	108%	80%	120%	104%	70%	130%
Total Boron	8828902		8	8	NA	< 5	107%	80%	120%	109%	80%	120%	115%	70%	130%
Total Cadmium	8828902		<0.017	<0.017	NA	< 0.017	98%	80%	120%	97%	80%	120%	93%	70%	130%
Total Chromium	8828902		<1	<1	NA	< 1	97%	80%	120%	99%	80%	120%	109%	70%	130%
Total Cobalt	8828902		<1	<1	NA	< 1	96%	80%	120%	100%	80%	120%	110%	70%	130%
Total Copper	8828902		164	161	1.8%	< 1	100%	80%	120%	103%	80%	120%	NA	70%	130%
Total Iron	8828902		119	127	NA	< 50	100%	80%	120%	103%	80%	120%	96%	70%	130%
Total Lead	8828902		<0.5	<0.5	NA	< 0.5	107%	80%	120%	108%	80%	120%	108%	70%	130%
Total Manganese	8828902		4	3	NA	< 2	95%	80%	120%	97%	80%	120%	109%	70%	130%
Total Molybdenum	8828902		<2	<2	NA	< 2	94%	80%	120%	97%	80%	120%	115%	70%	130%
Total Nickel	8828902		<2	<2	NA	< 2	97%	80%	120%	105%	80%	120%	109%	70%	130%
Total Selenium	8828902		<1	<1	NA	< 1	99%	80%	120%	107%	80%	120%	96%	70%	130%
Total Silver	8828902		<0.1	<0.1	NA	< 0.1	101%	80%	120%	104%	80%	120%	81%	70%	130%

Quality Assurance

CLIENT NAME: SNC Lavalin Inc.

AGAT WORK ORDER: 17X273114

PROJECT: 631477

ATTENTION TO: Maria Gutierrez

SAMPLING SITE:
SAMPLED BY:

Water Analysis (Continued)

RPT Date: Oct 27, 2017			DUPLICATE				Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Measured Value		Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits		
								Lower	Upper		Lower	Upper		Lower	Upper	
Total Strontium	8828902		129	124	4.3%	< 5	93%	80%	120%	99%	80%	120%	NA	70%	130%	
Total Thallium	8828902		<0.1	<0.1	NA	< 0.1	101%	80%	120%	106%	80%	120%	105%	70%	130%	
Total Tin	8828902		<2	<2	NA	< 2	94%	80%	120%	96%	80%	120%	98%	70%	130%	
Total Titanium	8828902		<2	<2	NA	< 2	101%	80%	120%	107%	80%	120%	98%	70%	130%	
Total Uranium	8828902		<0.1	<0.1	NA	< 0.1	101%	80%	120%	101%	80%	120%	108%	70%	130%	
Total Vanadium	8828902		<2	<2	NA	< 2	92%	80%	120%	95%	80%	120%	112%	70%	130%	
Total Zinc	8828902		192	184	4.6%	< 5	98%	80%	120%	105%	80%	120%	NA	70%	130%	
Total Kjeldahl Nitrogen as N	1	8827310	<0.4	<0.4	NA	< 0.4	97%	80%	120%		80%	120%	101%	80%	120%	

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By: _____

Method Summary

CLIENT NAME: SNC Lavalin Inc.

AGAT WORK ORDER: 17X273114

PROJECT: 631477

ATTENTION TO: Maria Gutierrez

SAMPLING SITE:
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Alkalinity	INORG-121-6001	SM 2320 B	
Chloride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
True Color	INORG-121-6014	EPA 110.2	NEPHELOMETER
Nitrate + Nitrite as N	INORG-121-6005	SM 4110 B	CALCULATION
Nitrate as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INORG-121-6003	SM 4500-NH3 G	COLORIMETER
Total Organic Carbon	INORG-121-6026	SM 5310 B	TOC ANALYZER
Ortho-Phosphate as P	INORG-121-6005	SM 4110 B	COLORIMETER
pH	INOR-121-6001	SM 4500 H+B	PC TITRATE
Total Calcium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Magnesium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Phosphorus	INOR-93-1022	SM 4500-P B & E	SPECTROPHOTOMETER
Total Potassium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Sodium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Reactive Silica as SiO ₂	INORG-121-6028	SM 4110 B	COLORIMETER
Total Suspended Solids	INOR-121-6024, 6025	SM 2540C, D	GRAVIMETRIC
Sulphate	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Turbidity	INORG-121-6022	SM 2130 B	NEPHELOMETER
Electrical Conductivity	INOR-121-6001	SM 2510 B	PC TITRATE
Anion Sum	CALCULATION	SM 1030E	CALCULATION
Bicarb. Alkalinity (as CaCO ₃)	INORG-121-6001	SM 2320 B	PC TITRATE
Calculated TDS		SM 1030E	CALCULATION
Carb. Alkalinity (as CaCO ₃)	INORG-121-6001	SM 2320 B	PC TITRATE
Cation sum	CALCULATION	SM 1030E	CALCULATION
Hardness	CALCULATION	SM 2340B	CALCULATION
% Difference/ Ion Balance (NS)	CALCULATION	SM 1030E	CALCULATION
Langelier Index (@20C)	CALCULATION	CALCULATION	CALCULATION
Langelier Index (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 20C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Total Aluminum	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Antimony	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Arsenic	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Barium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Beryllium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Bismuth	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Boron	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Cadmium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS

Method Summary

CLIENT NAME: SNC Lavalin Inc.

AGAT WORK ORDER: 17X273114

PROJECT: 631477

ATTENTION TO: Maria Gutierrez

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Total Chromium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Cobalt	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Copper	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Iron	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Lead	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Manganese	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Molybdenum	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Nickel	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Selenium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Silver	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Strontium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Thallium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Tin	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Titanium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Uranium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Vanadium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Zinc	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Coliforms (MPN)	MIC-121-7000	Based on SM 9223B	INCUBATOR
E. Coli (MPN)	MIC-121-7000	Based on SM 9223B	INCUBATOR
Chlorophyll A - Acidification Method	Subcontracted	Subcontracted	
Chlorophyll A - Welschmeyer Method	Subcontracted	Subcontracted	ICP-MS
Total Kjeldahl Nitrogen as N	INOR-121-6020	SM 4500 NORG D	COLORIMETER



Dalhousie University

Department of Oceanography
Halifax, N.S.
B3H 4R2

23-Oct-17 AGAT Laboratories, 11 Morris Dr. Unit 122, Dartmouth, NS, B3B 1M2

Attention: Janetta Fraser

Re: Determination of chlorophyll a in algae by fluorescence

AGAT Job#: 17X273114

PO#: 107799

Acidification Technique:

Sample ID	Chl a ($\mu\text{g/L}$)
KL1	1.10
KL2	0.31
KL3	1.34
KL4	0.35
KL5	1.22
PML-1	4.86
PML-2	1.27
HWY-102-1	0.62
HWY-102-2	28.94
LU	2.47
LSD	1.85

Welschmeyer Technique:

Sample ID	Chl a ($\mu\text{g/L}$)
KL1	1.18
KL2	0.49
KL3	1.87
KL4	0.43
KL5	1.33
PML-1	6.58
PML-2	1.47
HWY-102-1	0.99
HWY-102-2	37.67
LU	2.85
LSD	2.89

- **CHI a = chlorophyll a**
- **An underestimation of chl a occurs by the fluorescence acidification technique in the presence of Chl b. Since chl b containing chlorophytes are often present in freshwater ecosystems another technique (welschmeyer) was also employed.**
- **Reference for Welschmeyer technique Limnol. Oceanogr., 39(8) 1994, 1985-1992**

Received: 19-Oct-17
Completed: 20-Oct-17

Shannah Rastin



AGAT Laboratories

Unit 122 • 11 Morris Drive
Dartmouth, NS
B3B 1M2

webearth.agatlabs.com • www.agatlabs.com

Laboratory Use Only

Arrival Condition: Good Poor (see notes)
Arrival Temperature: 15.8°C * Sample of same day
Hold Time: 17x273114
AGAT Job Number: 17x273114

Chain of Custody Record

P: 902.468.8718 • F: 902.468.8924

Report Information

Company: SNC-Lavalin INC
Contact: MARIA GUTIERREZ
Address: PARKLANE Suite 200
Halifax, NS
Phone: _____ Fax: _____
Client Project #: 631477

Report Information (Please print):

1. Name: MARIA GUTIERREZ
Email: MARIA.GUTIERREZ@SNC
2. Name: @SNC-Lavalin.com
Email: _____

Report Format

Single Sample per page
 Multiple Samples per page
 Excel Format Included
 Export

Notes: Parameters to be confirmed by SNCL.

Turnaround Time Required (TAT)

Regular TAT 5 to 7 working days
Rush TAT Same day 1 day
 2 days 3 days

AGAT Quotation:

Please Note: If quotation number is not provided client will be billed full price for analysis.

Regulatory Requirements (Check):

List Guidelines on Report Do not list Guidelines on Report
 PIRI
 Tier 1 Res Pot Coarse
 Tier 2 Com N/Pot Fine
 Gas Fuel Lube

Drinking Water Sample: Yes No Salt Water Sample: Yes No
Reg. No.: _____

Invoice To

Same Yes / No

Company: Payables@snc-lavalin.com
Contact: _____
Address: _____
Phone: _____ Fax: _____
PO/Credit Card#: 631477

CCME CDWQ
 Industrial NSEQS-Cont Sites
 Commercial HRM 101
 Res/Park Storm Water
 Agricultural Waste Water
 FWAL Other
 Sediment RECREATIONAL WATER

Sample Identification	Date/Time Sampled	Sample Matrix	# Containers	Comments - Site/Sample Info. Sample Containment	Field Filtered/Preserved	Standard Water Analysis	Mercury	BOD	CEOD	pH	TSS	TDS	VSS	TKN	Total Phosphorus	Phenols	Tier 1: TPH/BTEX (PIR) <input type="checkbox"/> low level	Tier 2: TPH/BTEX Fractionation	CCME/CWS TPH/BTEX	VOC	THM	HAA	PAH	PCB	TC+EC <input type="checkbox"/> P/A <input checked="" type="checkbox"/> MPN <input type="checkbox"/> MF	HPC <input type="checkbox"/> Pseudomonas	Other: <u>CINOBAPHY A</u>	Other:	Hazardous (Y/N)
KL-1	Oct 18/17 9:35	WATER	7		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
KL-2	" 10:30	"	7		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
KL-3	" 10:15	"	7		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
KL-4	" 10:05	"	7		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
KL-5	" 9:50	"	7		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
PML-1	" 1:25 PM	"	7		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
PML-2	" 2:00 PM	"	7		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
HWY-102-1	" 11:40	"	7		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
HWY-102-2	" 12:25	"	7		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
LU	" 12:00	"	7		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
ESD	" 11:05	"	7		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	

Collected/Retrieved By (Print Name): <u>MARIA GUTIERREZ</u>	Date/Time: <u>Oct 18/17 (2:39 p.m.)</u>	Collected/Retrieved By (Print Name): <u>C. Deamel</u>	Date/Time: <u>Oct 18/17</u>	Pink Copy - Client	Page <u>1</u> of <u>1</u>
Collected/Retrieved By (Signature):	Date/Time:	Collected/Retrieved By (Signature):	Date/Time: <u>15:10</u>	Yellow Copy - AGAT	
				White Copy - AGAT	No: <u>59636</u>

Revised 02, ENR 133-1501 004

Appendix F

Graphs (Seasonal and Historical)

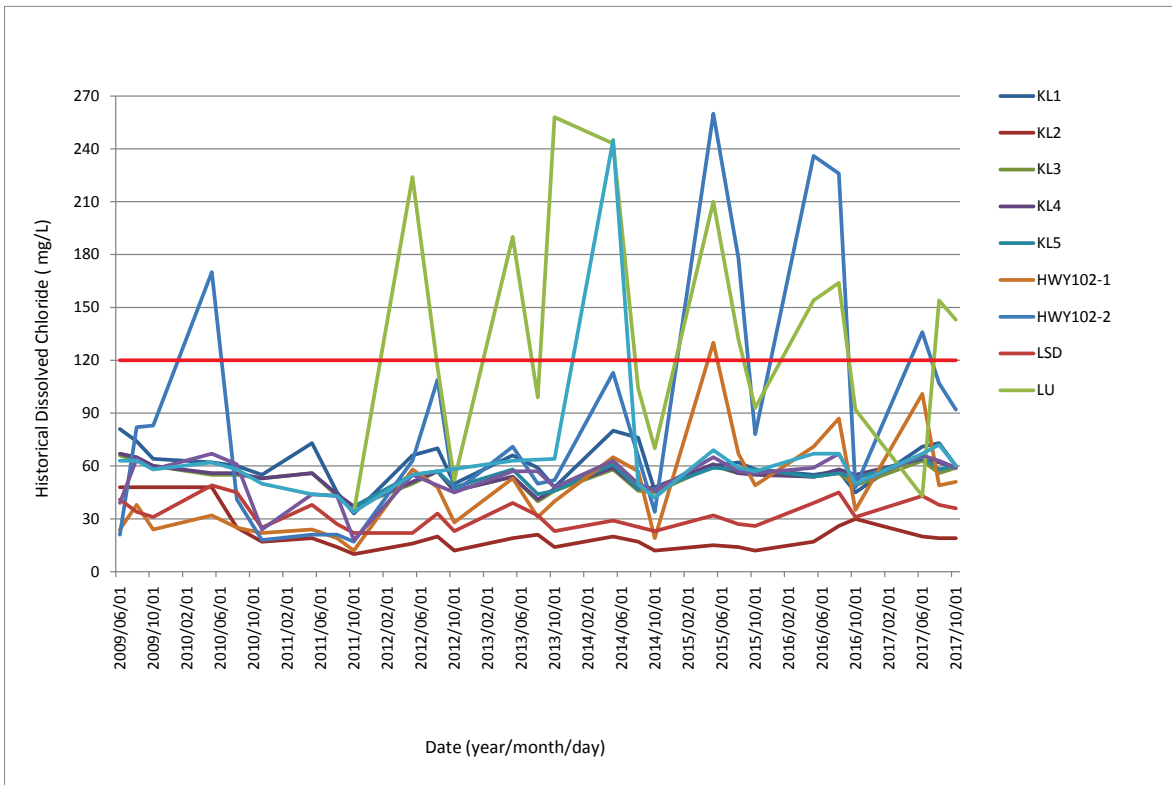


Figure 1 - Dissolved Chloride Concentrations

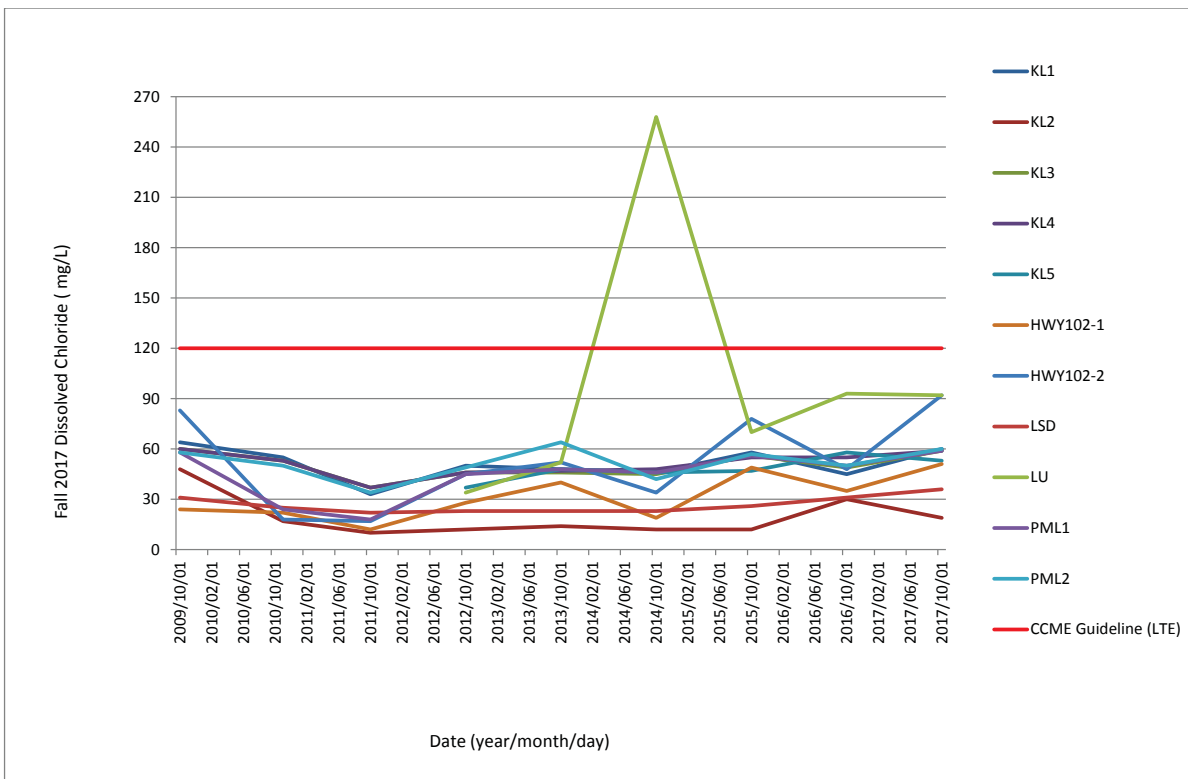


Figure 2 – Fall Dissolved Chloride Concentrations

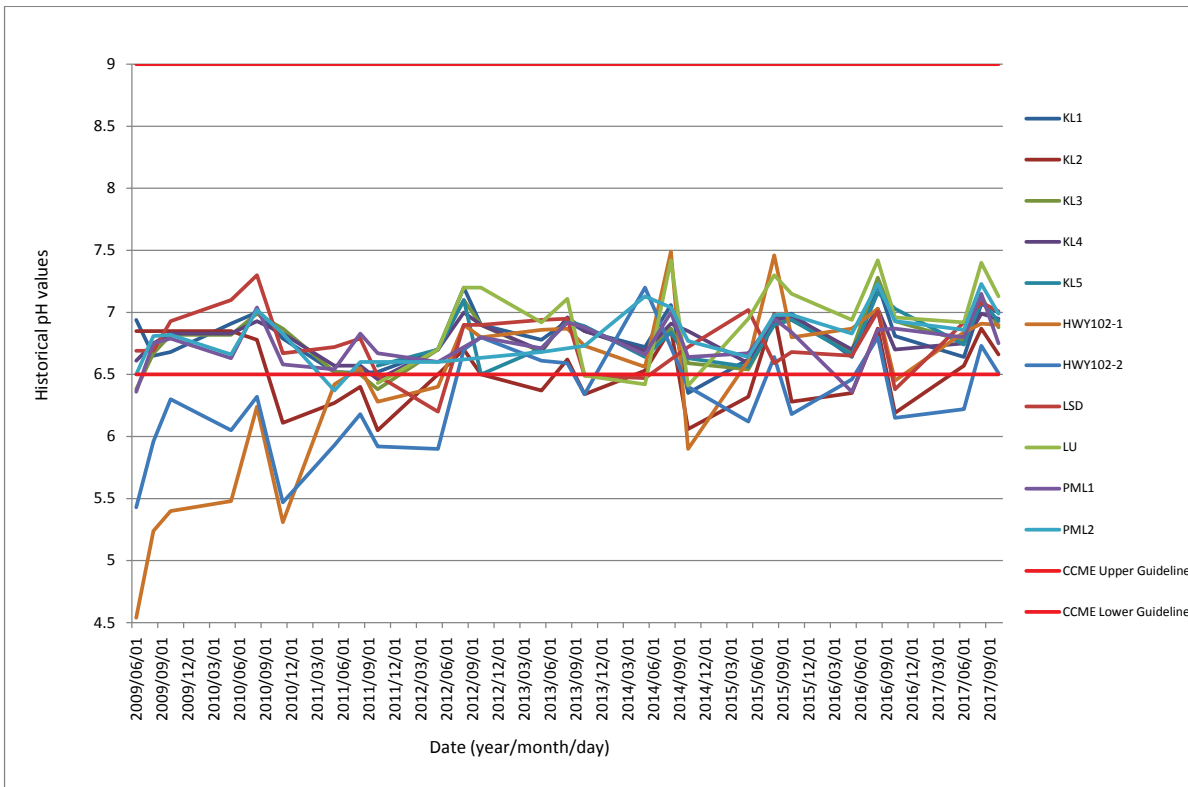


Figure 3 – pH values

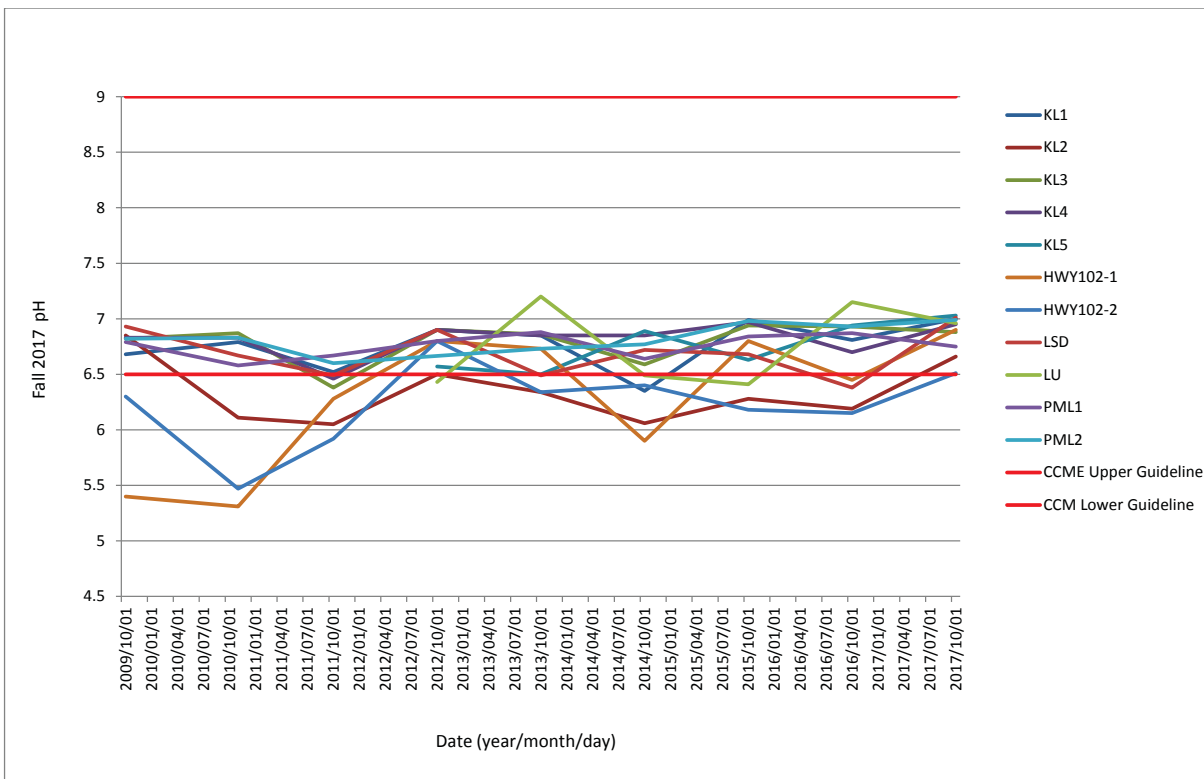


Figure 4 – Fall pH values

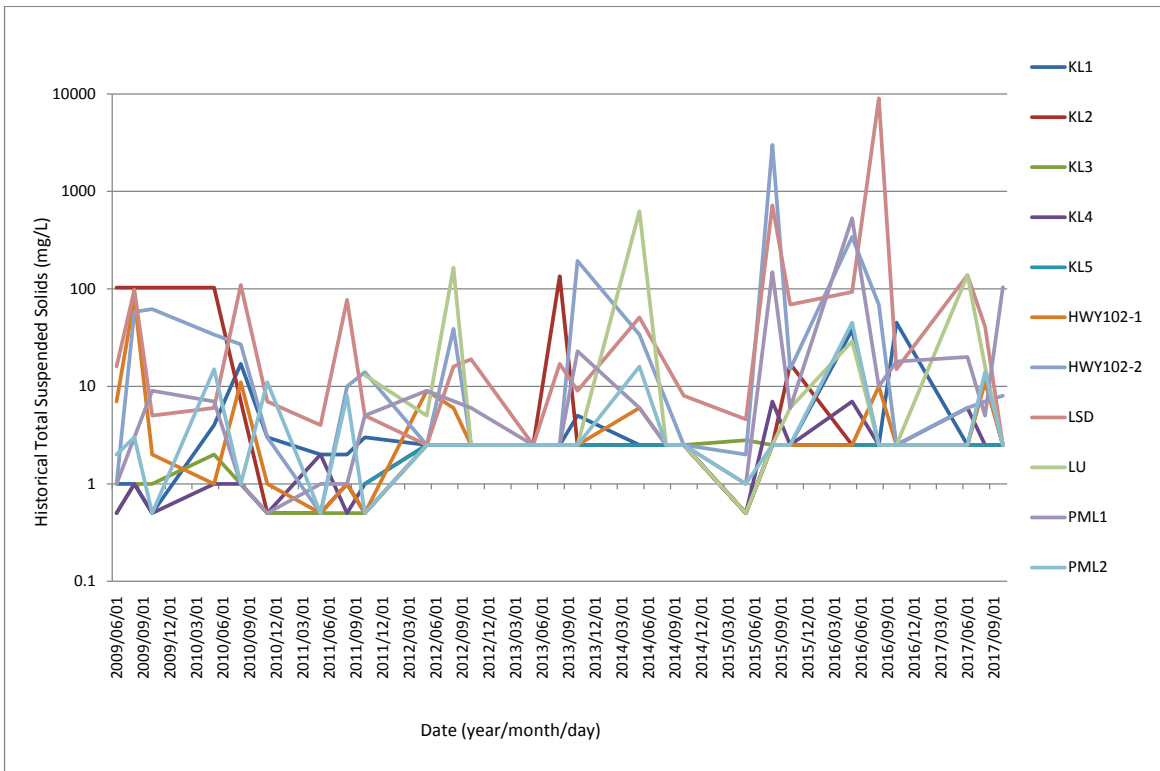


Figure 5 – Total Suspended Solids Concentrations

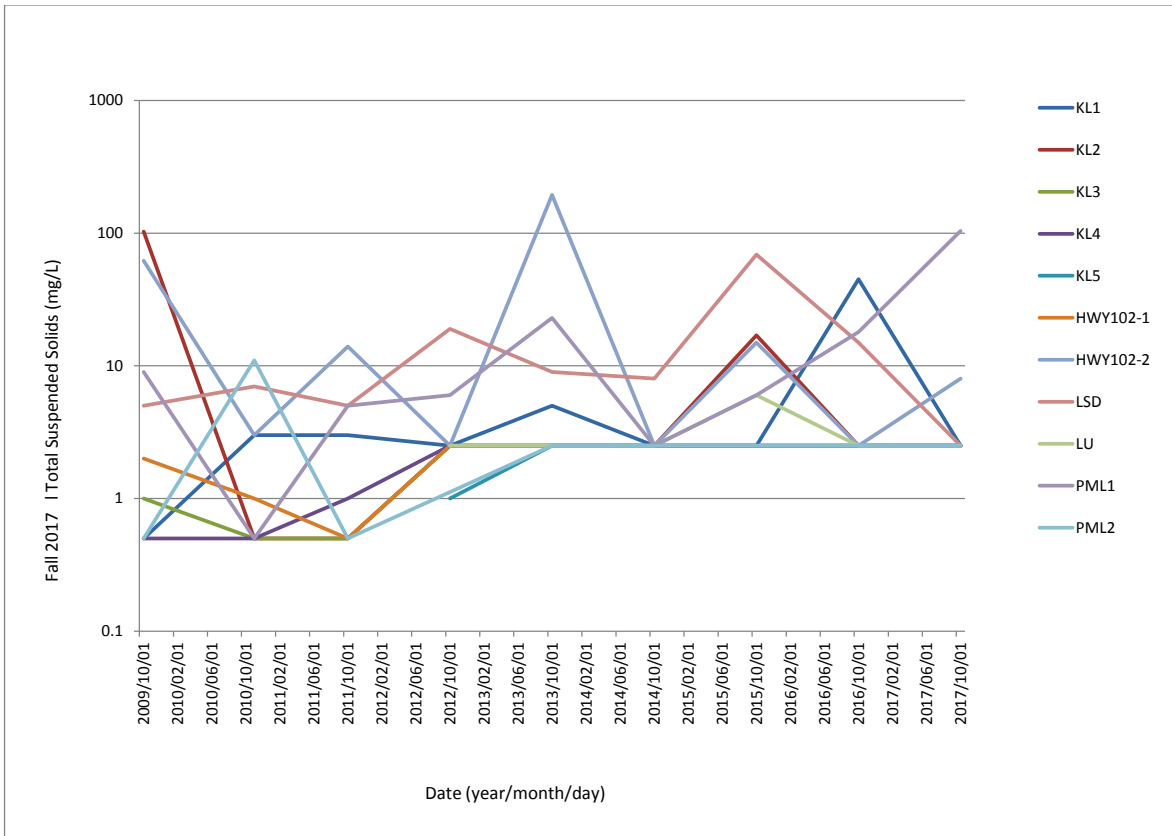


Figure 6 – Fall Total Suspended Solids Concentrations

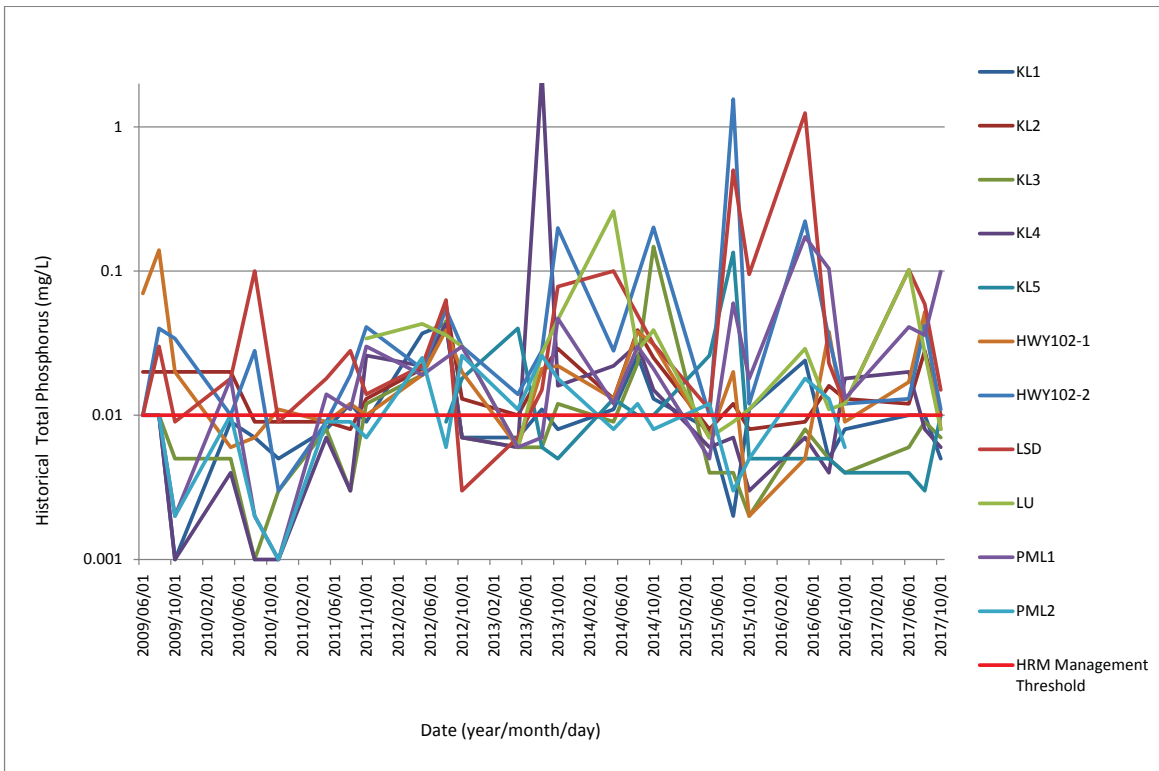


Figure 7 – Total Phosphorus Concentrations

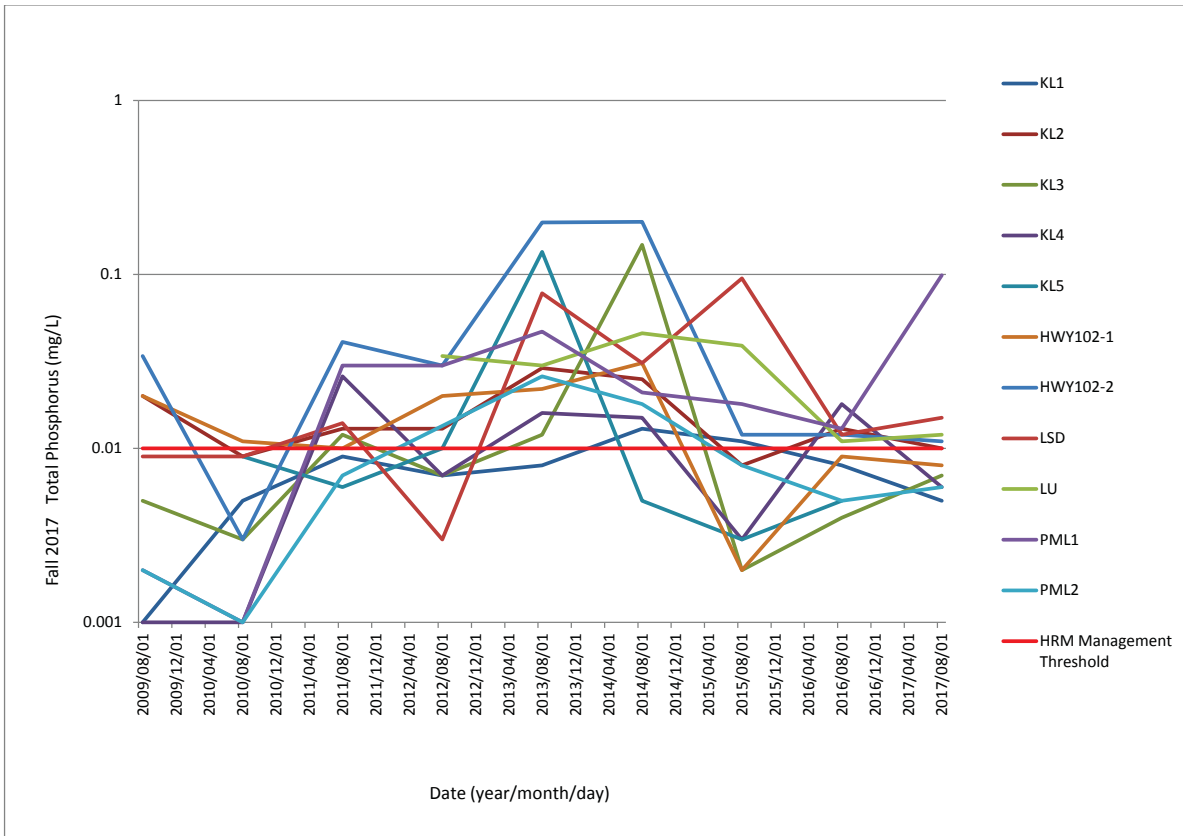


Figure 8 – Fall Total Phosphorus Concentrations

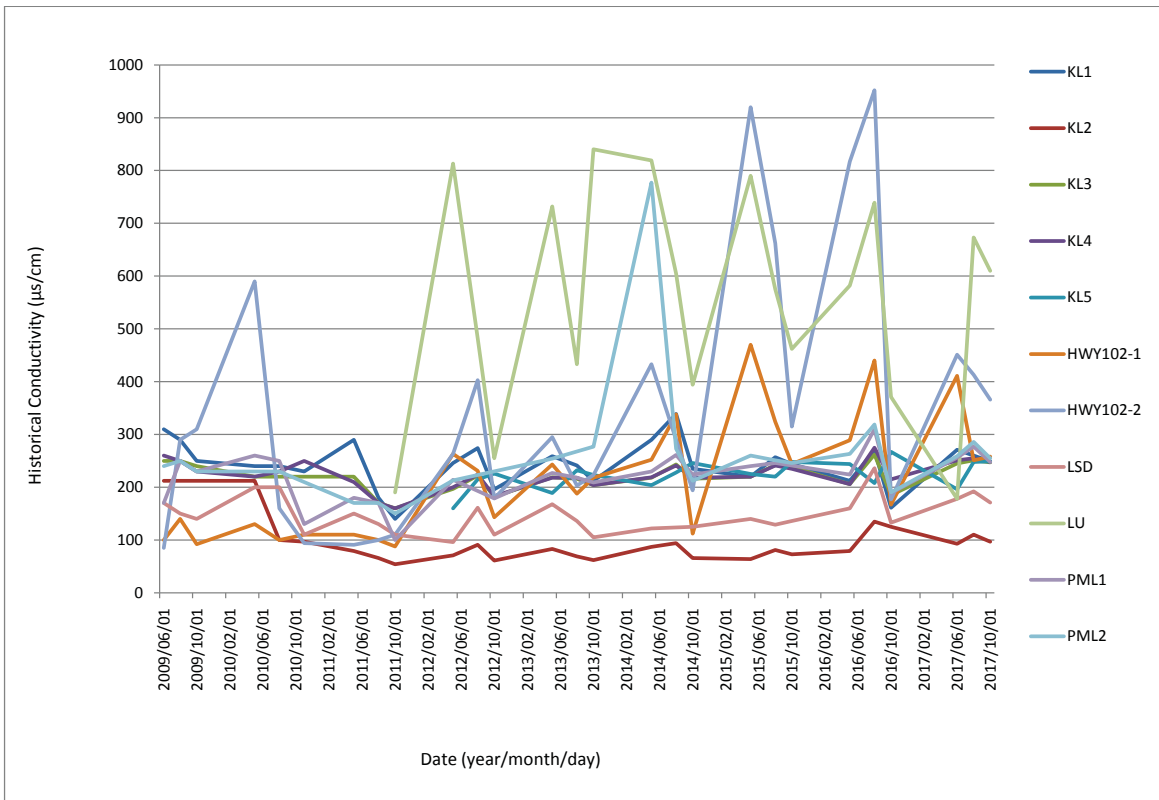


Figure 9 – Conductivity values

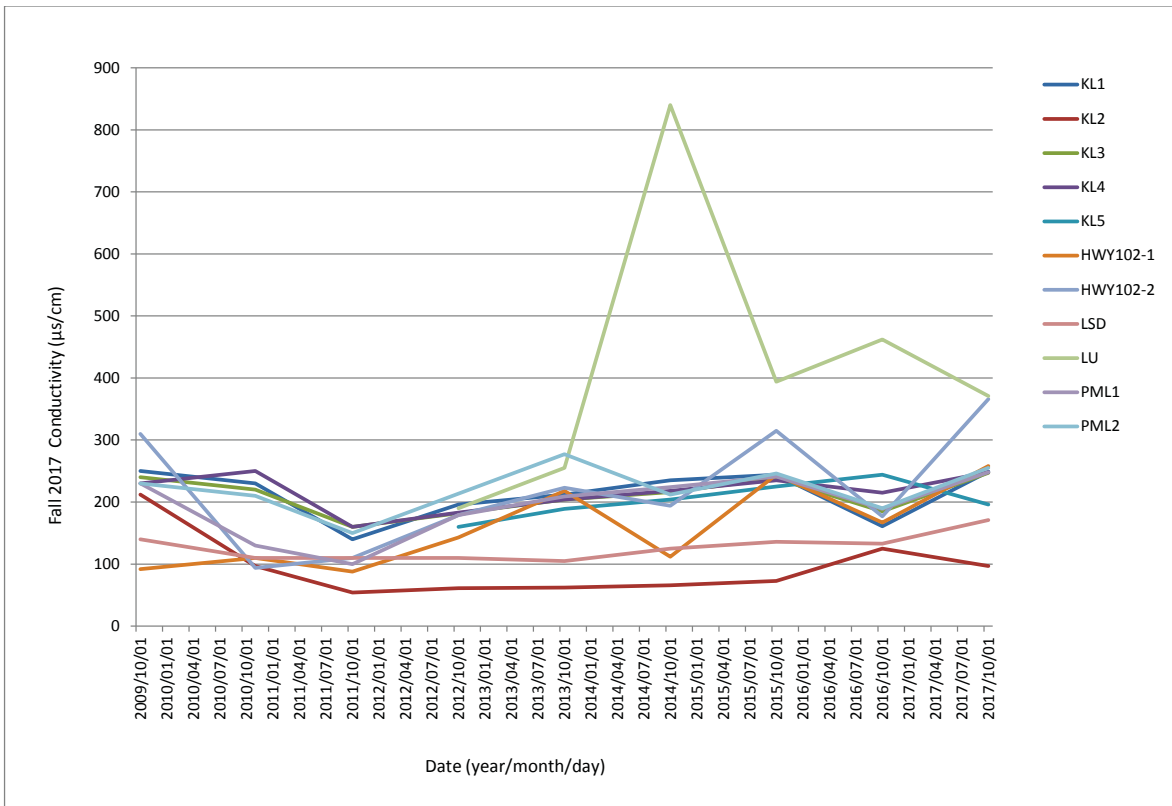


Figure 10 – Fall Conductivity values

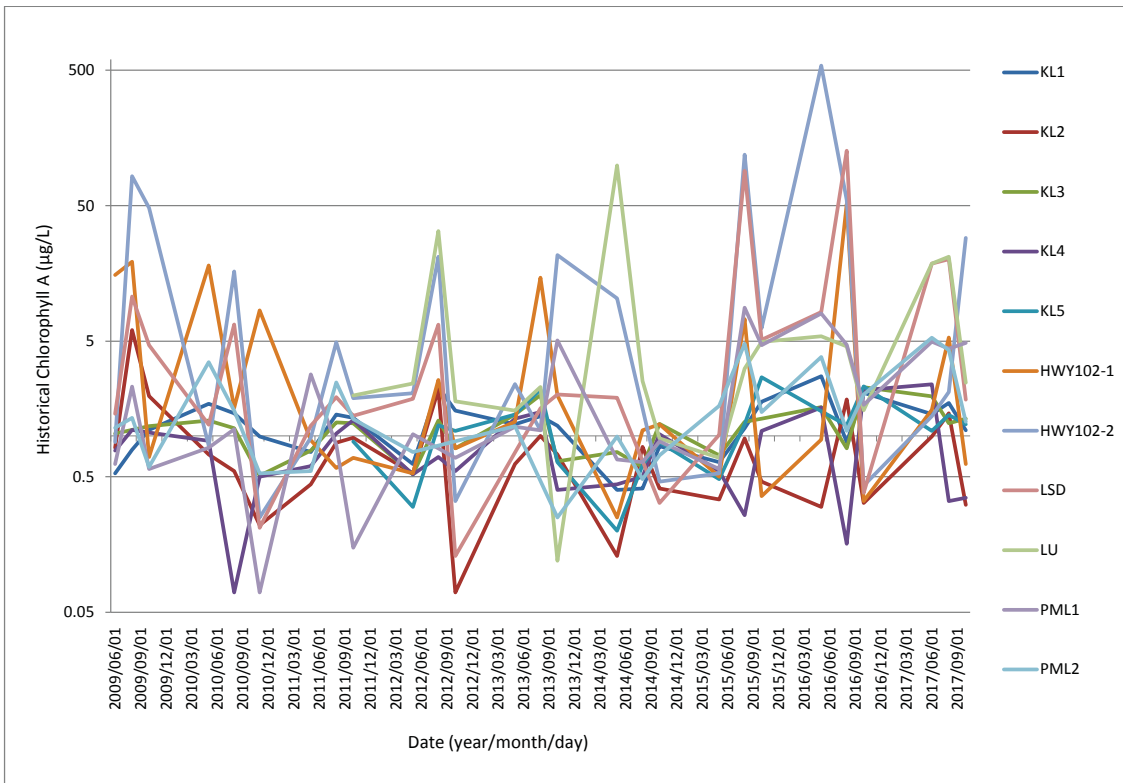


Figure 11 – Chlorophyll A concentrations

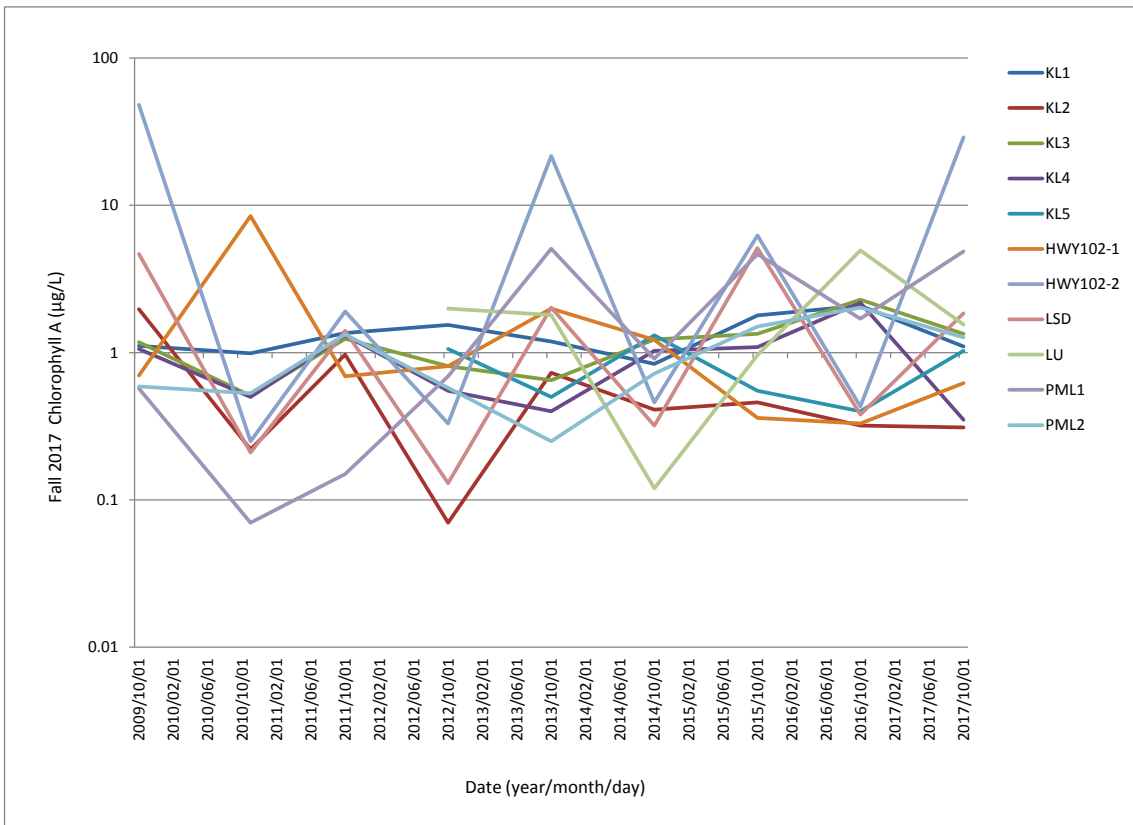


Figure 12 – Fall Chlorophyll A concentrations