HALIFAX
REGIONAL MUNICIPALITY

P.O. Box 1749
Halifax, Nova Scotia
B3J 3A5 Canada

7.1.1

Item No.
Dartmouth Lakes Advisory Board
February 1, 2012

TO: Chair and Members of the Dartmouth Lakes Advisory Board

SUBMITTED BY: Jackie Barkhouse
Councillor Jackie Barkhouse, Chair, Harbour East Community Council

DATE: January 18, 2012

SUBJECT: **Russell Lake Water Quality**

ORIGIN

Harbour East Community Council January 17, 2012 meeting.

RECOMMENDATION

Harbour East Community Council recommends that the Dartmouth Lakes Advisory Board, pursuant to the December 19, 2011 staff report, prepare a written report of recommended policy alternatives for the consideration of Harbour East Community Council to enhance the preservation of water quality, particularly at Russell Lake.

BACKGROUND/DISCUSSION

The Harbour East Community Council considered the staff report dated December 19, 2012 (attached) respecting Russell Lake Water Quality during their January 17, 2012 meeting.

Further background is outlined in the attached staff report.

BUDGET IMPLICATIONS

Budget Implications are outlined in the attached staff report dated December 19, 2011.

FINANCIAL MANAGEMENT POLICIES/BUSINESS PLAN

This report complies with the Municipality's Multi-Year Financial Strategy, the approved Operating, Project and Reserve budgets, policies and procedures regarding withdrawals from the utilization of Project and Operating reserves, as well as any relevant legislation.

COMMUNITY ENGAGEMENT

Following the completion of the requested report of recommended policy alternatives from the Dartmouth Lakes Advisory Board to Harbour East Community Council, staff have been directed to hold a community consultation entitled "Options for the Protection of Russell Lake". The attached staff report outlines further details of the community consultation. Following the community consultation, Harbour East Community Council has directed staff to prepare a recommendation report to Community Council reviewing all the presented options and alternatives.

The Harbour East Community Council is comprised of six members of Regional Council, duly elected to represent Districts 4, 5, 6, 7, 8, and 9. Meetings are open to the public, unless otherwise stated, and include a Public Participation portion at the end of each meeting for members of the public to address Community Council with any comments or concerns. Agendas, minutes and reports for Community Council meetings are a part of the public record and posted online.

ALTERNATIVES

None identified.

ATTACHMENTS

Staff Report dated December 19, 2011

A copy of this report can be obtained online at http://www.halifax.ca/council/agendasc/cagenda.html then choose the appropriate meeting date, or by contacting the Office of the Municipal Clerk at 490-4210, or Fax 490-4208.

Report Prepared by: Jennifer Weagle, Legislative Assistant, Municipal Clerks Office, 490-6517

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P.O. Box 1749
Halifax, Nova Scotia
B3J 3A5 Canada

10.1.4

Harbour East Community Council
January 12, 2012

TO: Chair and Members of Harbour East Community Council

SUBMITTED BY: Phillip Townsend, Director, Planning & Infrastructure

DATE: December 19, 2011

SUBJECT: **Russell Lake Water Quality**

ORIGIN

- Dartmouth Municipal Planning Strategy
- 2011 Water Sampling Results from Stantec for Clayton Developments

RECOMMENDATION

It is recommended that Harbour East Community Council:

1. Forward a copy of this report to the Dartmouth Lakes Advisory Board and request a written report of recommended policy alternatives for the consideration of HECC to enhance the preservation of water quality, particularly at Russell Lake;

2. Following receipt of the referenced DLAB report, direct staff to hold a community consultation, entitled "Options for the Protection of Russell Lake", to review:
   a. The recommended policy alternatives presented by DLAB;
   b. Additional community or other stakeholder options or alternatives;
   c. The historical and relevant data related to water quality;

3. Direct staff to prepare a recommendation report to HECC reviewing all the presented options and alternatives.

BACKGROUND

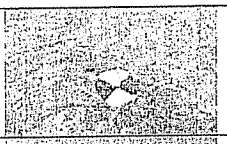
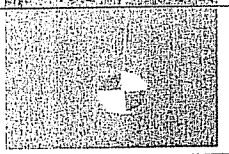
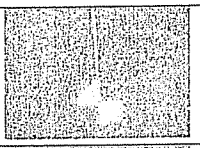
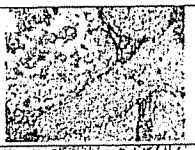
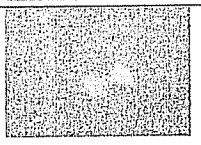
The Dartmouth Municipal Planning Strategy directs with policy ML-31:

Pursuant to policy ML-30, in the event the critical water quality threshold levels for Morris or Russell Lakes are reached, it shall be the intention of Council to immediately undertake a review of existing plan policies contained herein and determine an appropriate course of action respecting watershed management and future land use development in the area. Critical water quality thresholds shall be made available to the public.

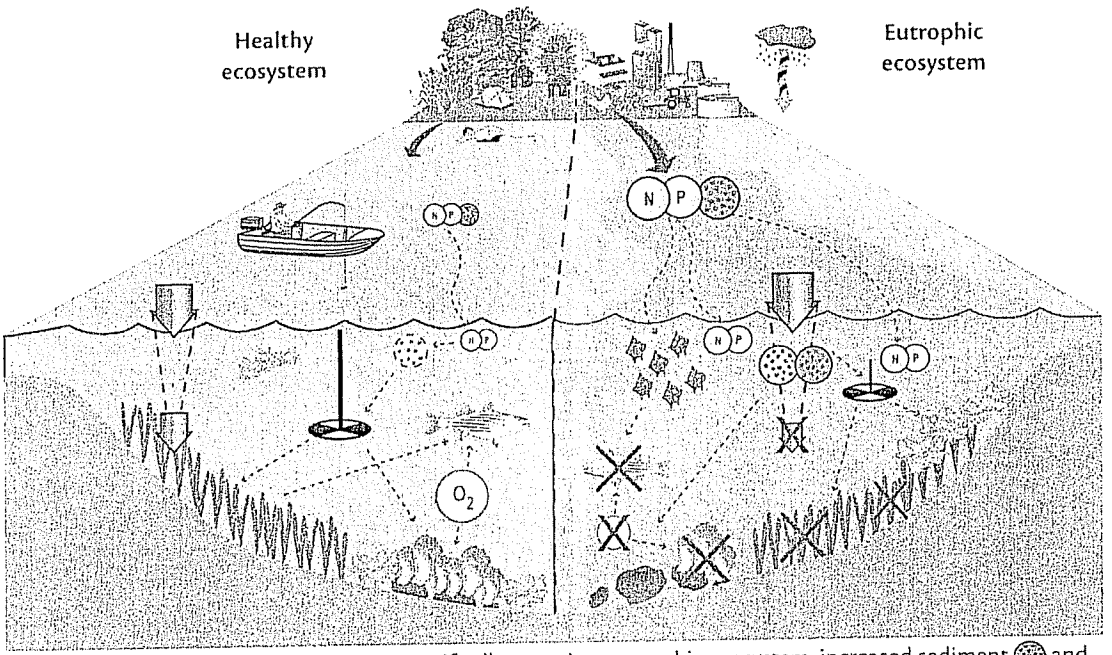
As per Attachment One, sampling during 2011 yielded results that exceeded the agreed TP threshold of 15 mg/L. Summarily, the 2011 results were: Marc (31); June (21); August (19); November (17).

DISCUSSION

Without pre-supposing the impacts of the increased phosphorus levels in Russell Lake, according to Environment Canada the levels of nutrients and their expected effects in lakes and rivers can be categorized and described as their trophic status. Below is a description of the various trophic states:

oligotrophic	0.004-0.010	Very Low nutrients and plant growth, high water clarity		
Mesotrophic	0.010-0.020	Moderate levels of nutrients and plant growth, reduced water clarity		
Mesoeutrophic	0.020-0.035	Moderate levels of nutrients and plant growth, reduced water clarity		
Eutrophic	0.035-0.100	High levels of nutrients and plant growth, low water clarity		
Hypereutrophic	>0.100	Very high levels of nutrients and plant growth, very limited water clarity		

A visual of the impacts of a eutrophic system is as follows, and the reasons that policy directs staff to review policy should the threshold level be exceeded:



In healthy ecosystems, nutrient inputs, specifically nitrogen and phosphorus, occur at a rate that stimulates a level of macroalgal and phytoplankton (chlorophyll *a*) growth in balance with grazer biota. A low level of chlorophyll *a* in the water column helps keep water clarity high, allowing light to penetrate deep enough to reach submerged aquatic vegetation. Low levels of phytoplankton and macroalgae result in dissolved oxygen (O_2) levels most suitable for healthy fish and shellfish so that humans can enjoy the benefits that a coastal environment provides.

In a eutrophic ecosystem, increased sediment and nutrient loads from farming, urban development, water treatment plants, and industry, in combination with atmospheric nitrogen, help trigger both macroalgae and phytoplankton (chlorophyll *a*) blooms, exceeding the capacity of grazer control. These blooms can result in decreased water clarity, decreased light penetration, decreased dissolved oxygen, loss of submerged aquatic vegetation, nuisance/toxic algal blooms and the contamination or die off of fish and shellfish.

The historical data for Russell Lake is as follows:

Sample Date	INLAKE STATION	NORTH INLET	SOUTH INLET	OUTLET	
2011 Annual Average	**0.022**				
09-Nov-11	0.017	0.027	0.030	0.013	
10-Aug-11	0.019	0.050	0.052	0.016	
23-Jun-11	0.021	0.027	0.070	0.017	
27-Mar-11	0.031	0.015	0.031	0.023	
2010 Annual Average	**0.006**				
03-Nov-10	0.005	0.006	0.045	0.007	
10-Aug-10	0.007	0.014	0.047	0.007	
23-Jun-10	0.008	0.008	0.046	0.014	
18-Mar-10	0.002	0.007	0.026	0.006	
2009 Annual Average	**0.012**	**0.025**	**0.060**	**0.013**	
29-Oct-09	0.003	0.007	0.027	0.006	
12-Aug-09	0.020	0.010	0.071	0.017	
03-Jun-09	0.012	0.011	0.110	0.011	
13-Apr-09	0.013	0.073	0.030	0.017	
2008 Annual Average	0.009	0.067	0.027	0.011	
01-Oct-08	--	--	--	--	
01-Aug-08	0.007	0.006	0.028	0.008	
01-Jun-08	0.012	0.015	0.036	0.015	
01-Mar-08	0.009	0.180	0.018	0.009	
2007 Annual Average	0.012	0.023	0.026	0.028	
01-Oct-07	0.014	0.012	0.044	0.012	
01-Aug-07	0.014	0.023	0.014	0.014	
01-Jun-07	0.007	0.056	0.010	0.073	
01-Apr-07	0.012	0.000	0.034	0.014	
01-Oct-06	0.011	0.010	0.053	0.010	
01/09/2006 (additional)	--	--	0.110	--	HECC established TP threshold August 3, 2006
01-Aug-06	0.020	0.180	0.080	< 0.020	
01-Jun-06	0.008	0.009	0.086	0.004	
01-Mar-06	0.015	0.008	0.031	0.010	
01-Nov-05	0.025	--	0.088	0.027	
01-Aug-05	0.012	0.022	0.043	0.016	
01-Jun-05	0.007	--	0.046	0.010	
01-Apr-05	0.000	0.029	0.042	0.007	

The 2011 results and related reports compel staff and the community to further examine the results, compare them with other trends and information, examine opportunities for water resource protection, and report back to Community Council with recommendations.

The recommended method will:

1. Ensure that subject matter expertise from DLAB is engaged;
2. The community is involved with reviewing options and alternatives; and
3. Council is provided a menu of options for water resource stewardship and a further examination of the impacts.

It should also be noted, as per the historical results, that TP levels have fluctuated up and down over time; so continued testing in 2012 may demonstrate that levels are within the threshold without any policy revisions or actions. As DLAB and the community are engaged, future results regarding Russell Lake will be of great interest.

BUDGET IMPLICATIONS

There are no impacts to the 2011/2012 Operating or Capital Budget. Costs for the referenced consultations can be captured within existing operating budgets. Costs for potential policy alternatives will be provided upon identification of those.

FINANCIAL MANAGEMENT POLICIES / BUSINESS PLAN

This report complies with the Municipality's Multi-Year Financial Strategy, the approved Operating, Project and Reserve budgets, policies and procedures regarding withdrawals from the utilization of Project and Operating reserves, as well as any relevant legislation.

COMMUNITY ENGAGEMENT

This process will result in Community Engagement related to water quality and protection of.

ALTERNATIVES

None identified.

ATTACHMENTS

Attachment One: Stantec Report

A copy of this report can be obtained online at http://www.halifax.ca/commcoun/cc.html then choose the appropriate Community Council and meeting date, or by contacting the Office of the Municipal Clerk at 490-4210, or Fax 490-4208.

Report Prepared by: Richard MacLellan, Manager, Energy and Environment, 490-6056

Stantec Consulting Ltd.
102 - 40 Highfield Park Drive
Dartmouth NS B3A 0A3
Tel: (902) 468-7777
Fax: (902) 468-9009

Stantec

December 9, 2010
File: SD19184/121510291

Clayton Developments Limited
255 Lacewood Drive, Suite 100C
Halifax, NS B3M 4G2

Attention: Mike Hanusiak, Sr. Vice President, General Manager

Dear Mr. Hanusiak:

Reference: Water Quality Monitoring Results for Russell Lake – November 2011 Sampling Event

To monitor the effects of development, water quality monitoring has been undertaken on a seasonal basis since April of 2005 at four stations in Russell Lake (Figure A1 in Attachment). Monitoring events include one spring, two summers and one fall sampling event each year. Water samples are not collected in winter. Sampling results have been provided in previous letter reports to you, with a summary of the sampling up to August 10, 2011 presented in the report dated August 30, 2011. The present report builds on the results to date while focusing on the monitoring results for the November 9, 2011 fall sampling event.

The weather was calm and cloudy with an air temperature of 4°C at the time of sampling, and cloudy for four days prior to the sampling event on November 9, 2011. Winds blew generally from the west and were below 30 km/hr for the four days leading up to the day of sample collection, and less than 10 km/hr the day of sample collection.

Sampling was conducted between 11:15 a.m. and 12:35 p.m. on November 9, 2010. At the time of sample collection, the water at the North Inlet station was observed to be opaque and brown. The grating within the culvert at this station was obstructed by garbage but no smell was noted. Water flowing from the South Inlet was clear and the flow was moderate. No algae were observed and the aquatic vegetation was limited to attached macrophytes. No sedimentation was observed in the pools. No birds were observed in the wetlands near the South Inlet. At the In-Lake station, approximately ten gulls were observed about 30 m south of the sampling location and ducks were observed along the northern shore. Algal growth was present on the dock. The water at the In-Lake station was brown and turbid. At the Outlet station of Russell Lake the water was running clear and no odour was detected. Filamentous algae covered the substrate at this station. The aquatic vegetation had died off for the year by the date of sampling.

Tables A1 - A4 (in Attachment) present the water quality data for the period from April 2005 to November 2011 at the four Russell Lake monitoring stations: In-Lake, Outlet, South Inlet and North Inlet sampling stations. The trends for some of the key parameters (total suspended solids (TSS), pH, conductivity, sodium and chloride, total phosphorus (TP), chlorophyll *a* and faecal coliforms) are presented graphically in Figures A2 to A8 (in Attachment).

Total Suspended Solids

TSS concentrations (Figure A2 in Attachment) were low with a concentration of 3 mg/L at the In-Lake station, 2 mg/L at the North Inlet and Outlet stations, and 1 mg/L at the South Inlet. These results are consistent with previous fall results. The TSS measured in the duplicate field sample for the North Inlet station was 3 mg/L, which is similar to the result for the field sample (2 mg/L).

pH

Measurements of pH collected in the field since April 2005 (Figure A3 in Attachment) indicate that the waters of Russell Lake are generally neutral. The pH readings in early November 2011 were slightly acidic at pH 5.7 for both the In-Lake and South inlet stations and which were below the CCME freshwater aquatic guideline of pH 6.5. The historic range for these two stations in the fall is slightly higher with a pH from 6.8 to 7.7 for the In-Lake station and a pH from 6.7 to 7.7 for the South Inlet station. The North Inlet station had a higher pH of 8.1 than what would normally be encountered in the fall and which would range from pH 7.5 to 7.9. The Outlet station measured pH 6.8 and within the historic range of pH 6.8 to 7.8.

Salt Concentrations

Russell Lake has higher levels of salt concentrations due to the level of development within the watershed. This is typical of any urban lake when compared to a similar lake in a less developed watershed. Conductivity increases with salt concentrations and elevated levels are typically exhibited during spring melt conditions. Concentrations tend to be higher at the North Inlet where the road network and associated drainage is concentrated and lower at the South Inlet which is less developed.

The November 2011 conductivity, chloride (Cl) ion, and sodium (Na) concentrations were generally within the range of past fall sampling results. As is typical, the concentrations at the North Inlet were higher when compared to the other three stations (Tables A1 to A4; Figures A4 and A5 in Attachment).

The fall 2005 to 2010 values for the North Inlet station ranged from 430 to 790 µS/cm for conductivity, from 49 to 110 mg/L for sodium, and from 87 to 190 mg/L for chloride. In early November 2011, the concentrations measured at the North Inlet station for conductivity, sodium and chloride were 1000 µS/cm, 132 mg/L and 250 mg/L, respectively. The 2011 results at this station were all slightly higher than the range of previous results.

The values measured in the fall of 2005 to 2010 at the South Inlet station ranged from 120 to 210 µS/cm for conductivity, with results for sodium ranging from 13 to 23 mg/L and chloride ranging from 20 to 37 mg/L. The early November 2011 values at this station were within that range with conductivity measuring at 150 µS/cm, sodium at 16 mg/L and chloride at 27 mg/L.

The fall values for the In-Lake sampling station for 2005 to 2010 ranged from 310 to 700 µS/cm for conductivity, from 45 mg/L to 110 mg/L for sodium and from 72 to 190 mg/L for chloride. In early November 2011 the values at this station were within that range with conductivity measuring at 390 µS/cm, sodium at 57 mg/L and chloride at 94 mg/L.

Similar values are typically observed between the Outlet station and the In-Lake station, as supported by the range of fall values at the Outlet station for conductivity (300 to 700 µS/cm), sodium (44 to 110 mg/L) and chloride (72 to 190 mg/L) for the fall 2005 to 2010sampling events. In early November 2011 at the Outlet

station, the results were within this range with conductivity measured at 390 µS/cm, sodium at 58 mg/L and chloride at 93 mg/L.

Nutrient Enrichment

The chlorophyll *a* (Chl *a*) concentration (based on the acidification technique) at the In-Lake station for November 2011 was 18.67 µg/L. This concentration is higher than results for the previous fall events. The fall results for the previous sampling years ranged from 1.48 µg/L in 2008 to 16.2 µg/L in 2005 (Figure A7 in Attachment). Chl *a* concentrations were measured at 6.58 µg/L, 7.11 µg/L, 1.48 µg/L, 4.78 µg/L, and 3.96 µg/L in 2006, 2007, 2008, 2009, and 2010 respectively. Total phosphorus (TP) concentrations at the In-Lake site have fluctuated over the fall sampling periods, ranging from a low of 2 µg/L in 2010 to a high of 25 µg/L in November of 2005 (Figure A6 in Attachment). The November 2011 result was 17 µg/L which is within the range of previous values but above the HRM threshold value of 15 µg/L for Russell Lake. It is noted that the threshold value is intended for comparison to sample results at the In-Lake station only.

The Chl *a* concentration at the Outlet station measured 16.61 ug/L in November 2011. The 2011 result is within the range of the 2005 to 2010 values which ranged from 1.04 µg/L in October 2008 to 17.7 µg/L in November 2005 but higher than the trend since 2006 which has been less than 5.46 µg/L for the fall results. The November 2011 TP concentration at the Outlet station measured 13 µg/L which is within the range of previous fall results (Table A2 in Attachment) and ranged from a low of 6 µg/L in 2009 to a high of 27 µg/L in 2005.

The Chl a concentration for the fall sampling event at the South Inlet station was 0.13 µg/L. This result is lower than the range observed for all previous fall values of between 0.15 µg/L in 2007 to 1.08 µg/L in 2006. The TP concentration at the South Inlet station in November 2011 measured 31 µg/L and which is in the range of all past fall results that ranged from 26 µg/L in 2010 to 88 µg/L in 2006.

At 1.61 µg/L, the Chl a concentration at the North Inlet station in November 2011 was within the range of previous fall results where the fall 2007, 2006, 2009, 2010 and 2008 values of 6.60 µg/L, 1.74 µg/L 1.44 µg/L, 1.04 µg/L, and 0.17 µg/L were obtained. Chl a concentrations were not measured in the fall of 2005. The TP concentration for the North Inlet station measured 27 µg/L which is the highest fall value obtained since 2006 (TP concentrations were not measured in the fall of 2005). The next highest TP value of 12 µg/L in the fall was measured in 2007.

Total Phosphorus Discussion

Total phosphorus (TP) concentrations at the In-Lake site have fluctuated over the fall sampling periods, ranging from a low of 2 µg/L in 2010 to a high of 25 µg/L in November of 2005 (Figure A6 in Attachment). The November 2011 result was 17 µg/L which is within the range of previous values but above the HRM threshold value of 15 µg/L for Russell Lake. It is noted that the threshold value is intended for comparison to sample results at the In-Lake station only. TP results for the fall 2008 sampling event were invalid.

In 2011, the In-Lake TP concentrations were above threshold values for each of the four sampling events. This led to further investigations to attempt to correlate the In-Lake TP concentrations to the North or South Inlet stations. Annual mean concentrations were calculated for the In-Lake and inlet stations to aid in determining any annual trends (Table 1). The 2011 mean for the In-Lake station was the highest observed since the beginning of monitoring at 22 ug/L. The mean TP concentrations for 2011 for the North and South inlet stations were observed to be within ranges previous measured and just above the 2005 to 2011 means of 48 ug/L and 33 ug/L, respectively.

Table 1 Annual mean TP concentrations for the In-Lake and Inlet stations (2005-2011)

Year	Annual In-Lake TP Mean	Annual N-Inlet TP Mean	Annual S-Inlet TP Mean
2005	12	55	26
2006	14	77	51
2007	12	27	23
2008	9	32	67
2009	12	60	25
2010	6	41	9
2011	22	46	30
2005 - 2011	**12**	**48**	**33**

The Pearson correlation coefficient statistic was used on individual values and not the mean values to determine which of the inlet stations most strongly correlated to the In-Lake TP concentrations (Table 2). The Pearson correlation coefficient ranges from −1 to 1. A value of 1 implies that a linear equation describes the relationship between *Inlet* and *In-Lake concentrations* perfectly, with all data points lying on a line for which *In-Lake concentrations* increase as *Inlet concentrations* increase. A value of −1 implies that all data points lie on a line for which *In-Lake concentrations* decrease as *Inlet concentrations* increase. A value of 0 implies that there is no linear correlation between the variables. This exercise in correlation was completed for the North and South Inlet stations for all years of monitoring and subsequently for their sum as total contribution of TP to Russel Lake. The correlation coefficients for comparison of Inlet stations with the In-Lake station TP concentrations were very low.

Table 2 Pearson correlation coefficients between the In-Lake and inlet stations for TP concentrations

Inlet	Pearson Correlation (2005-2011)
North Inlet TP Concentration	0.0159
South Inlet TP Concentration	0.0190
Sum of Inlet TP Concentrations	0.0215

A method of visual correlation of the Inlet stations and In-Lake station concentrations illustrate that high concentrations of TP in the Inlet stations are not strongly associated with elevated levels in the In-Lake station. Figures 1, 2 and 3 below illustrate the data with a trend line through the data illustrating the linear regression equation and the R-squared coefficient (R^2). The R-squared coefficient represents how the data fits the linear regression equation. A value of 1 implies that the data completely fits the linear regression equation with a value of 0 implying that the data points do not fit the equation. The R-squared coefficients are low, varying from 0.0245 to 0.0363. Based on the results of the Pearson correlation and linear regression, the elevated TP concentrations observed for the In-Lake station cannot be correlated to the TP concentrations observed coming from the North or South Inlet stations. This suggests that there are other sources of TP within Russell Lake.

Reference: Water Quality Monitoring Results for Russell Lake – November 2011 Sampling Event

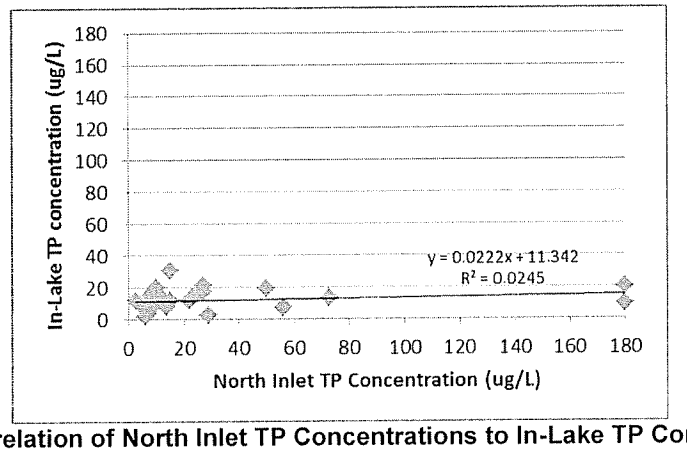


Figure 1 Correlation of North Inlet TP Concentrations to In-Lake TP Concentrations

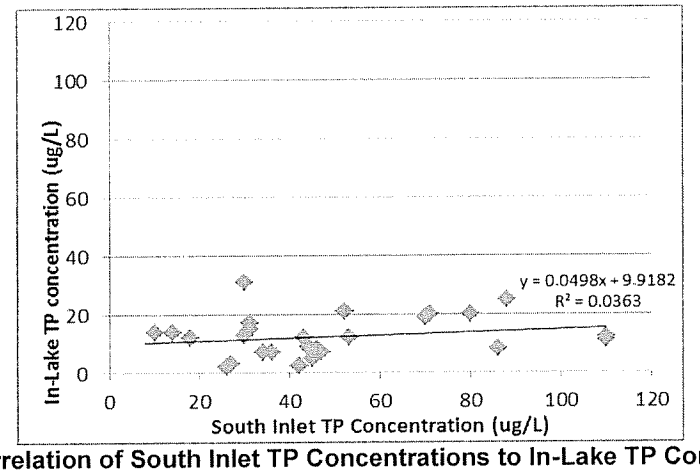


Figure 2 Correlation of South Inlet TP Concentrations to In-Lake TP Concentrations

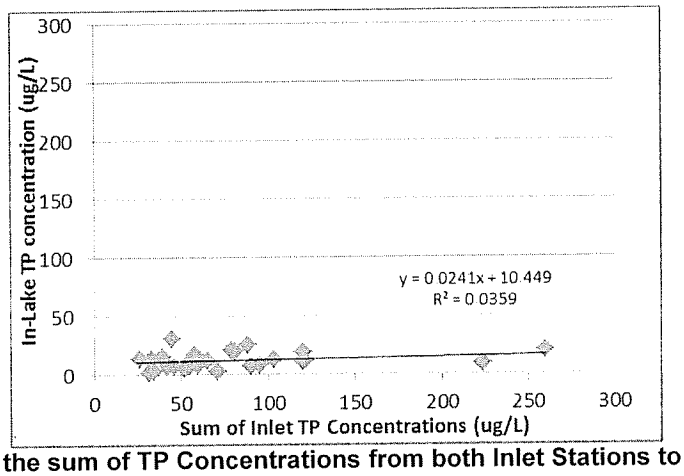


Figure 3 Correlation of the sum of TP Concentrations from both Inlet Stations to the In-Lake TP Concentrations

Bacterial Contamination

Bacterial contamination in Russell Lake is measured by sampling and testing for the presence of faecal coliforms in the water. In addition to faecal coliform analysis conducted by the lab, analysis of *Escherichia coli* (*E. coli*) has been added. *E coli* are a type of faecal coliform but may be considered a more specific indicator of bacteria found in the intestines of warm blooded animals and humans and a strong indication of recent sewage or animal waste contamination, whereas some faecal bacteria may originate from non-faecal sources. *E coli* counts measured 4 Colony Forming Unit (CFU)/100 mL for the In-Lake and Outlet stations, and 5 CFU/100mL for the South Inlet station (Figure A8 in Attachment). At the North Inlet station and in the duplicate field sample, *E coli* counts were 14 CFU/100 mL and 11 CFU/100 mL, respectively.

Samples analyzed for faecal coliforms at the four stations during early November 2011 measured below the detection limit (<1 Most Probable Number (MPN)/100 mL) at the In-Lake station and Outlet station, 11 MPN/100 mL at the South Inlet, 15 MPN/100 mL at the North Inlet and 25 MPN/100 mL in the duplicate sample. The geometric mean of the results for faecal coliform analysis of 4 MPN/100 mL indicates that faecal coliform levels were below the CCME Recreational Guideline (200 MPN/100 mL) for freshwater at the time of sample collection. The geometric mean for the *E. coli* results is 7 CFU/100 mL, which is also below the recreational guideline value of 200 *E. coli* per 100 mL.

Sample results at all stations for faecal coliform were within the range of previous fall results. Historical fall results at the South Inlet station range from <1 MPN/100 ML (2005 and 2006) to 280 MPN/100 mL in 2010. Results for 2007 and 2009 were 6 MPN/100 mL and 2 MPN/100 mL, respectively. At the Outlet station, previous fall results range from <1 MPN/100 mL (2005 and 2006) to 640 MPN/100 mL (2007). The In-Lake station faecal coliform value was <1 MPN/100 mL, within the range of past results from <1 MPN/100 mL (2005 and 2006) to 140 MPN/100 mL (2007). Faecal coliform results at the North Inlet station are typically higher than the other stations. The faecal coliform value for the 2011 fall sample (15 MPN/100 mL) was within the range of the fall sampling events for this station, which ranged in the past from <1 MPN/100 mL (2005) to 710 MPN/100 mL (2007).

Reference: Water Quality Monitoring Results for Russell Lake – November 2011 Sampling Event

Conclusions

The results of the November 2011 sampling event indicate that total phosphorus level at the In-Lake station was 17 µg/L, which is higher than previous fall sampling results with the exception of 2005 when the total phosphorus result was 25 µg/L, and is slightly above the HRM threshold value of 15 µg/L. Based on the results of the Pearson correlation and linear regression, the elevated TP concentrations observed in the In-Lake Stations are not correlated to TP concentrations observed in the North or South Inlet stations. Chl *a* concentrations were also lower or within the range for the 2011 fall event and compared to previous years, with the exception of the In-Lake station where the concentration was slightly higher than the range at 18.67 µg/L. It is possible that the higher TP concentration observed for the In-Lake station is attributable to the higher Chl a concentration and *in-situ* algal biomass in Russell Lake.

The November 2011 conductivity, sodium (Na) and chloride (Cl) concentrations were within the range of previous sampling events for all sites. The values at the North Inlet station have tended toward higher concentrations since 2007. Higher levels of salts would be anticipated as development progresses in and around the Lake. TSS measurements were low and pH measurements indicate that the lake water is generally neutral, but which had a basic pH of 8.1 for the North Inlet station and an acidic pH of 5.7 for both the In-Lake and South Inlet stations for the fall sampling event. The latter two stations are below the CCME freshwater aquatic pH guideline of 6.5. The geometric means of all *E. coli* and faecal coliform results were below the CCME recreational guideline of 200 MPN/100mL. The overall results for the various water quality parameters measured suggest generally consistent water quality in Russell Lake for the fall 2011 sampling event compared to previous years, except for possibly pH, total phosphorous, and Chl *a*.

Sincerely,

STANTEC CONSULTING LTD

ORIGINAL SIGNED BY

Kelley Fraser, MES, EPt
Project Manager
Tel: (902) 468-7777
kelley.fraser@stantec.com

cc: Cameron Deacoff, Halifax Regional Municipality

Attachments: Figures A1- A8 and Tables A1- A4

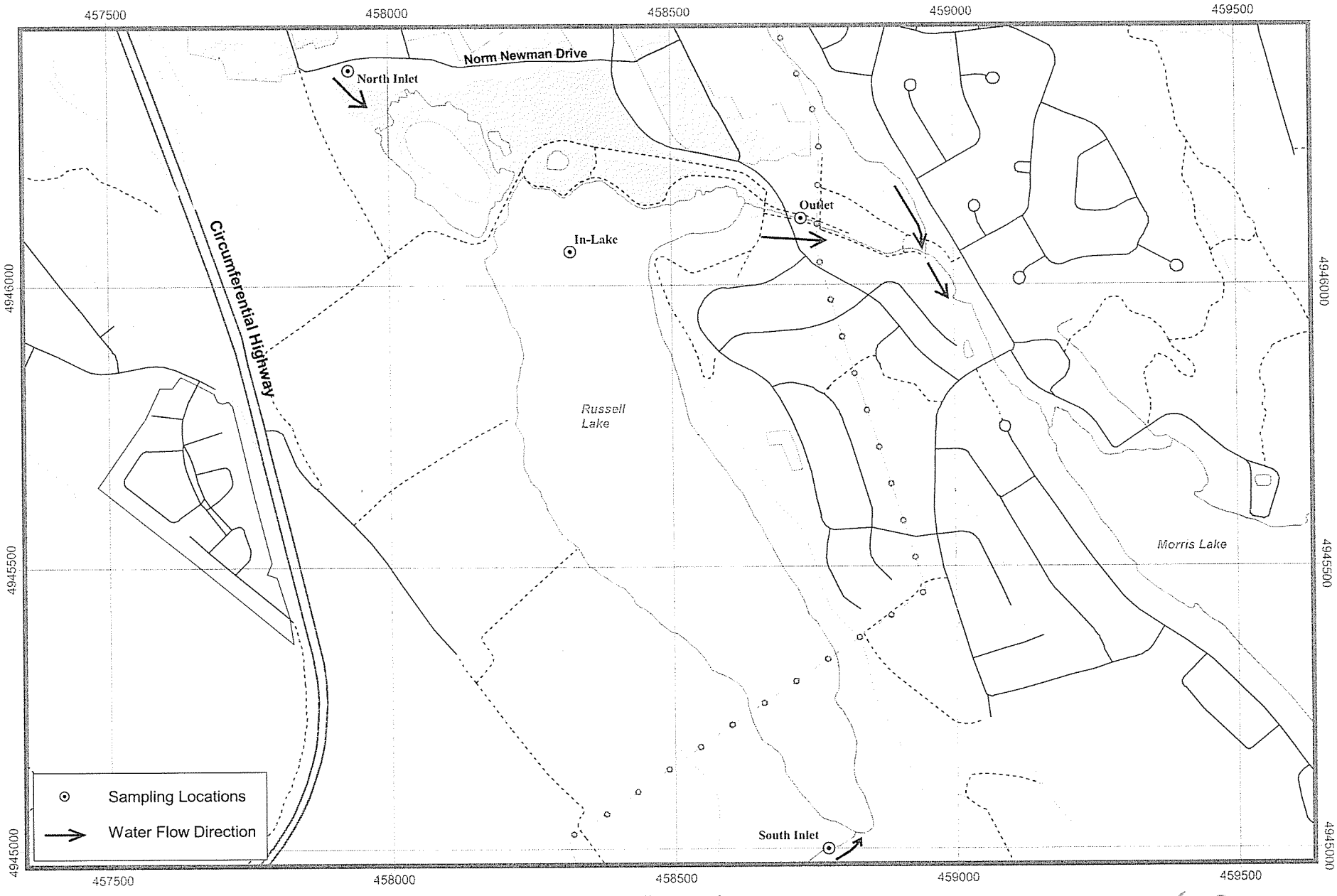


Figure 1

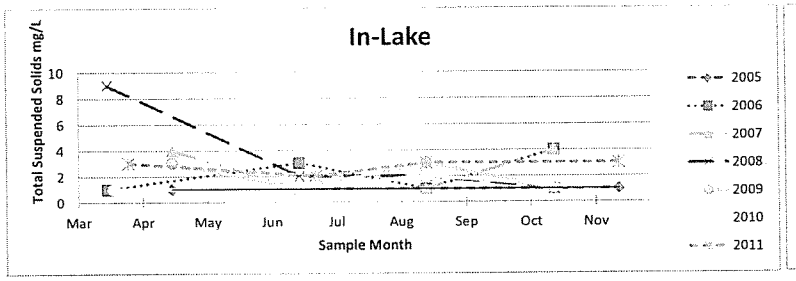
Russell Lake Sampling Locations

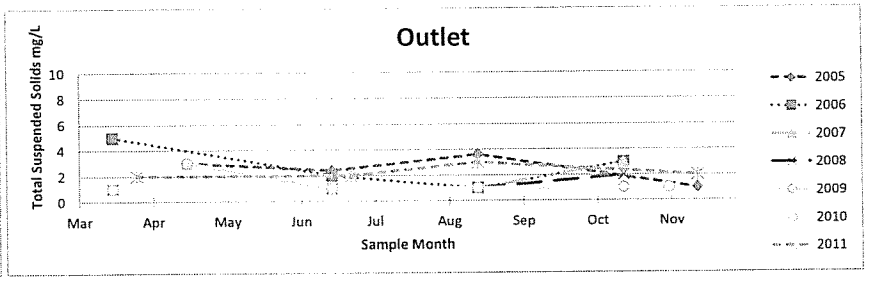
0 250 500

Metres

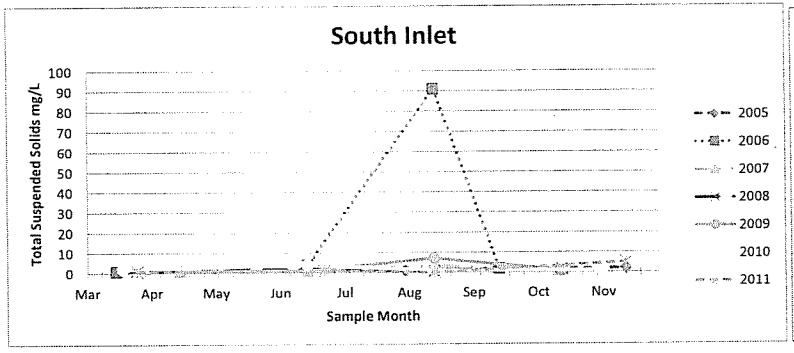
Map Parameters
Projection: UTM-NAD83-Z20
Scale 1:9,000
Date: May 11, 2007
Project No.. NSD19184

Stantec





*gaps are shown where data is unavailable



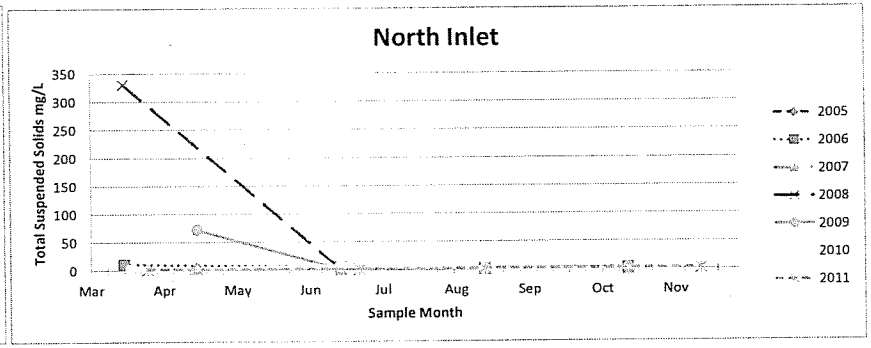
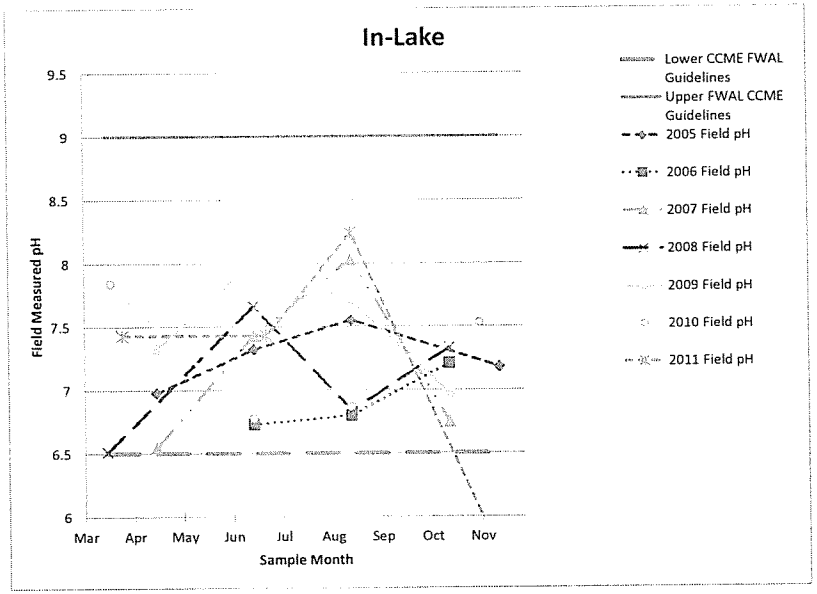
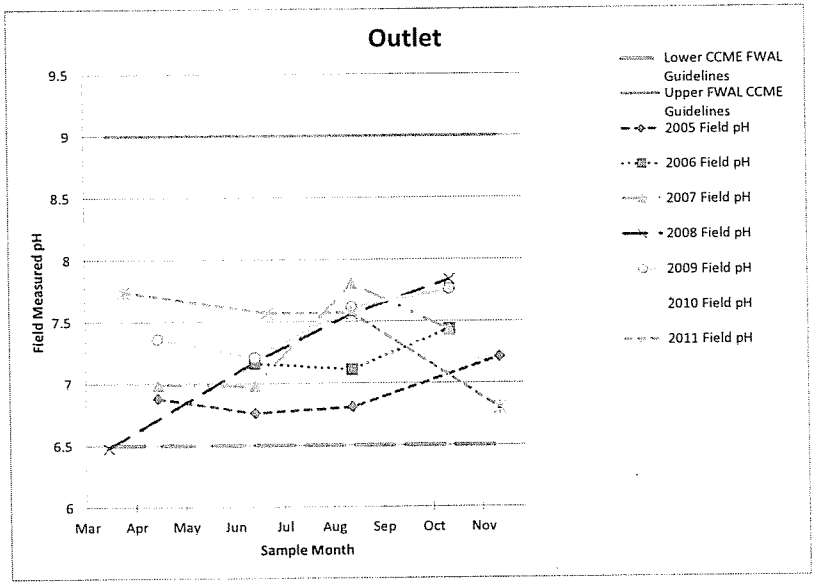
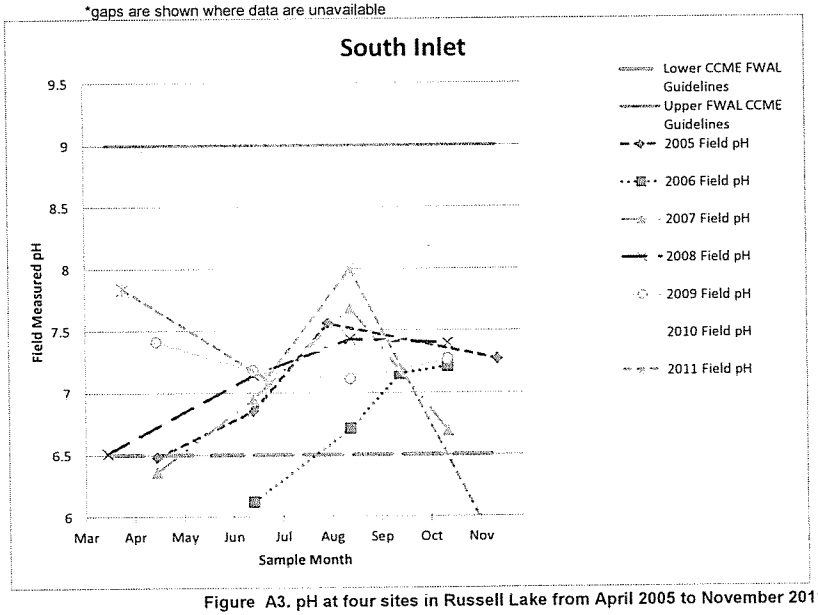


Figure A2. Total Suspended Solids at four sites in Russell Lake from April 2005 to November 2011





*gaps are shown where data are unavailable



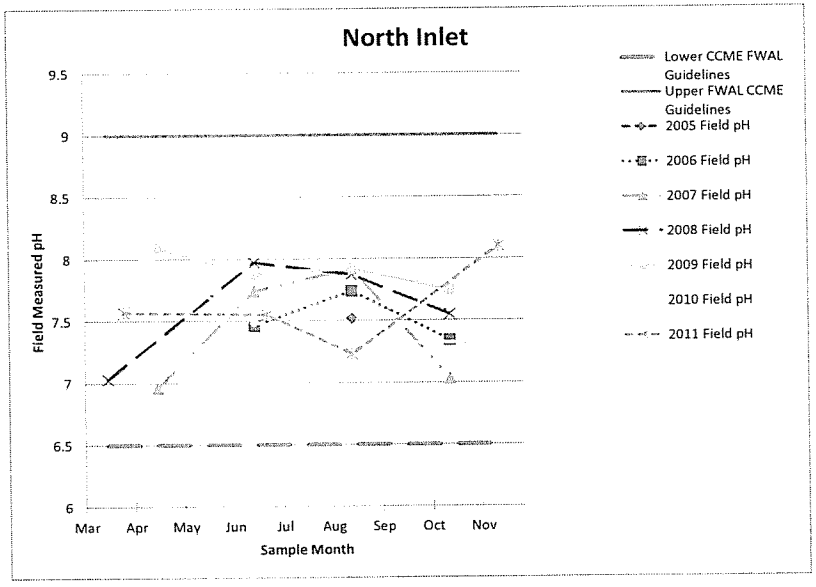
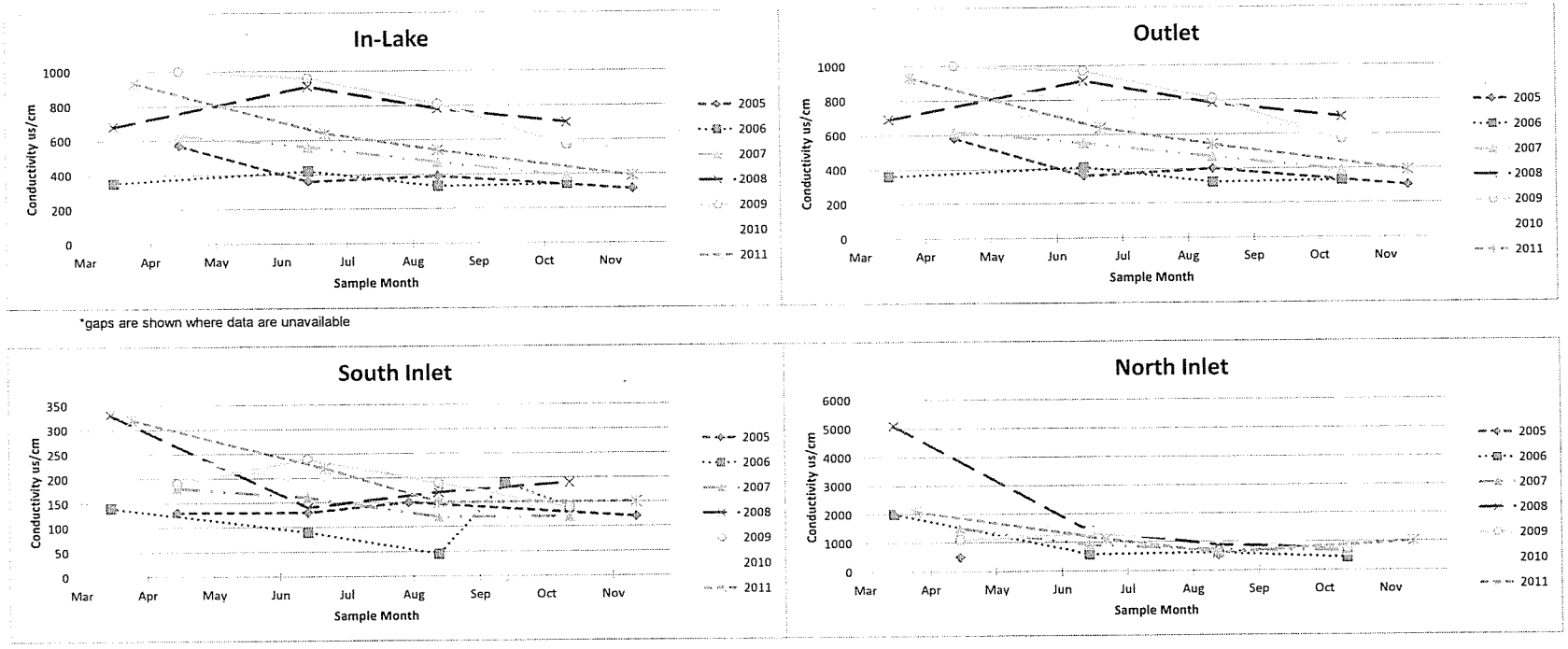
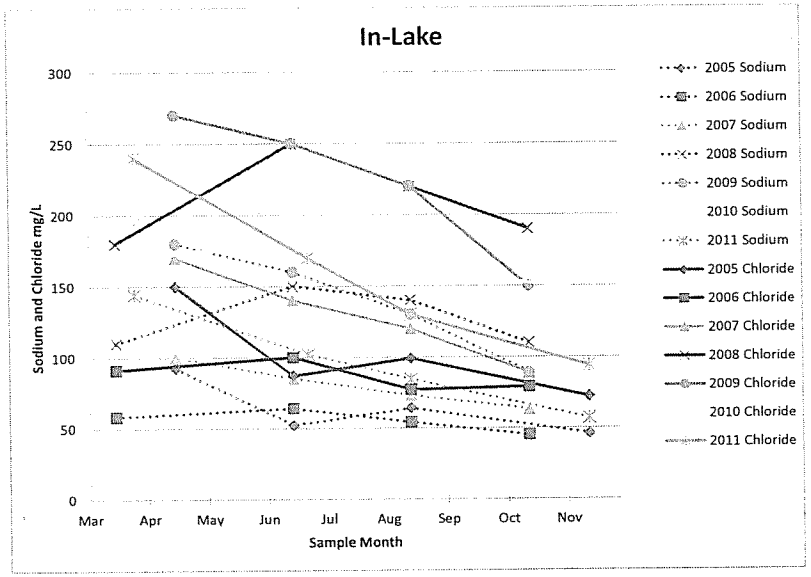


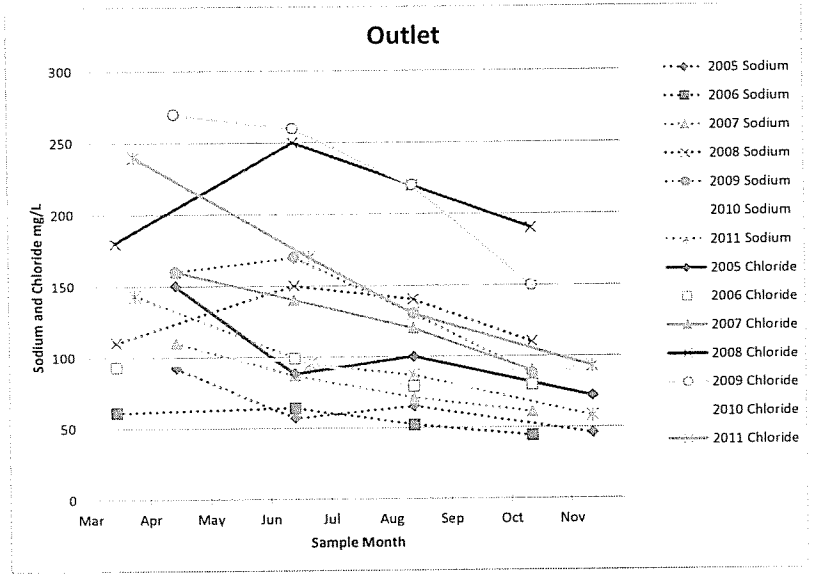
Figure A3. pH at four sites in Russell Lake from April 2005 to November 2011



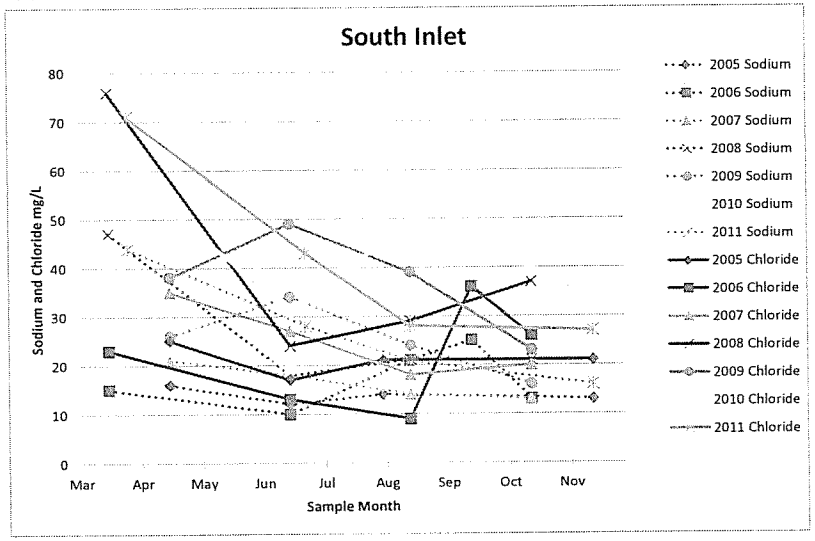
*gaps are shown where data are unavailable

Figure A4. Conductivity at four sites in Russell Lake from April 2005 to November 2011





*gaps are shown where data are unavailable



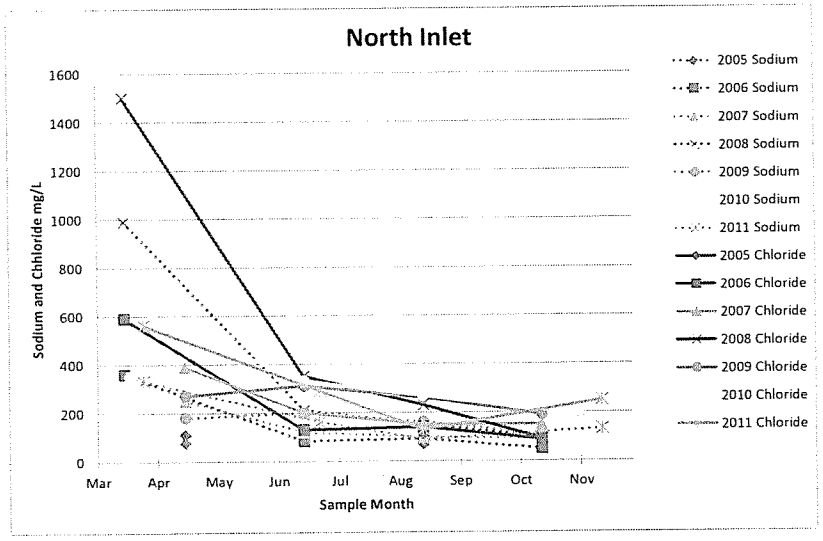
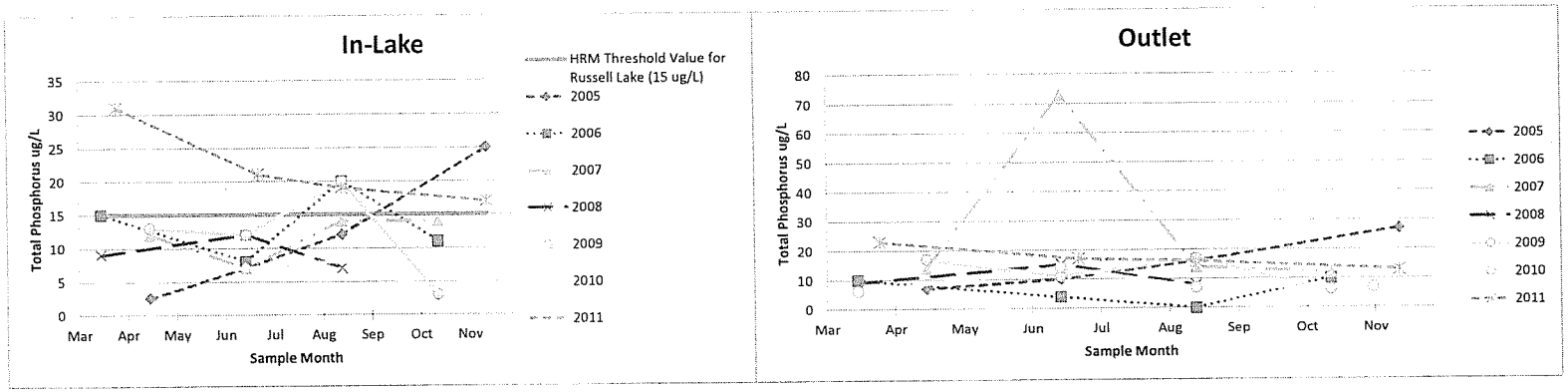


Figure A5. Sodium and chloride concentrations at four sites in Russell Lake from April 2005 to November 2011



*gaps are shown where data are unavailable

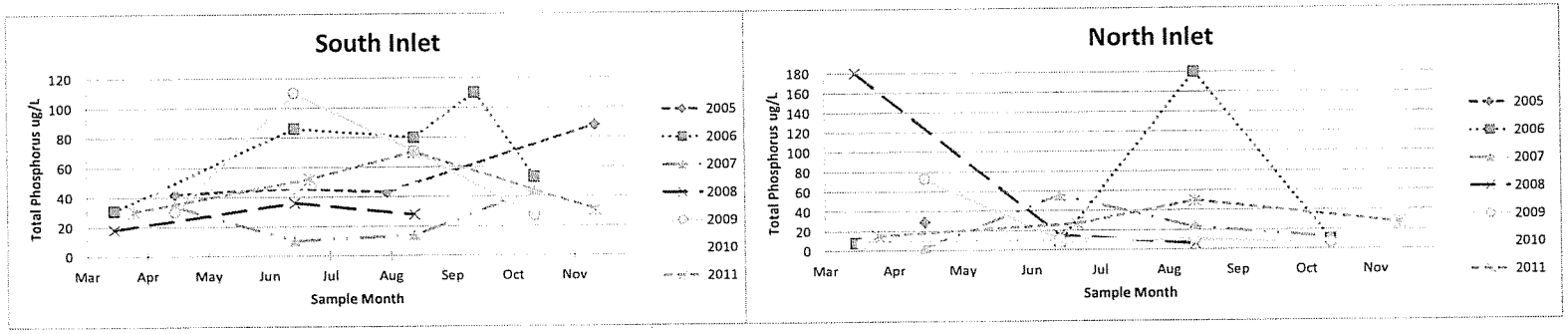
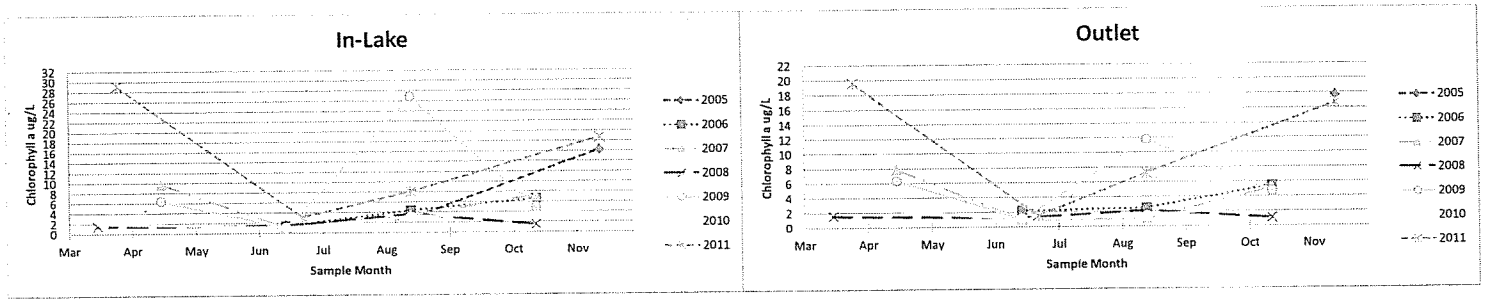
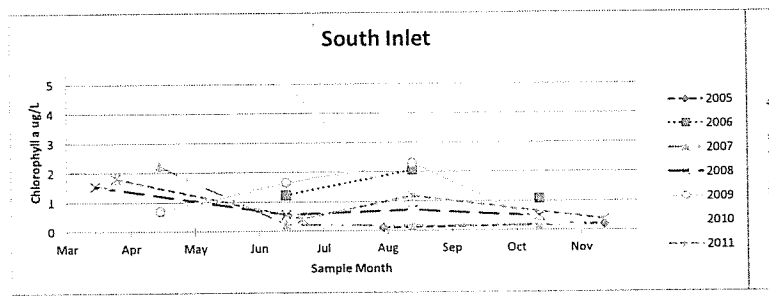


Figure A6.Total phosphorus concentrations at four sites in Russell Lake from April 2005 to November 2011



*gaps are shown where data are unavailable



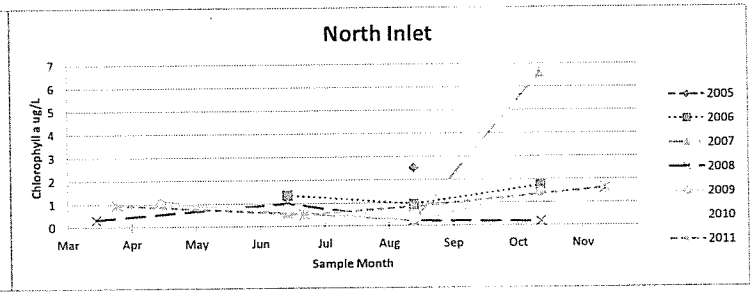
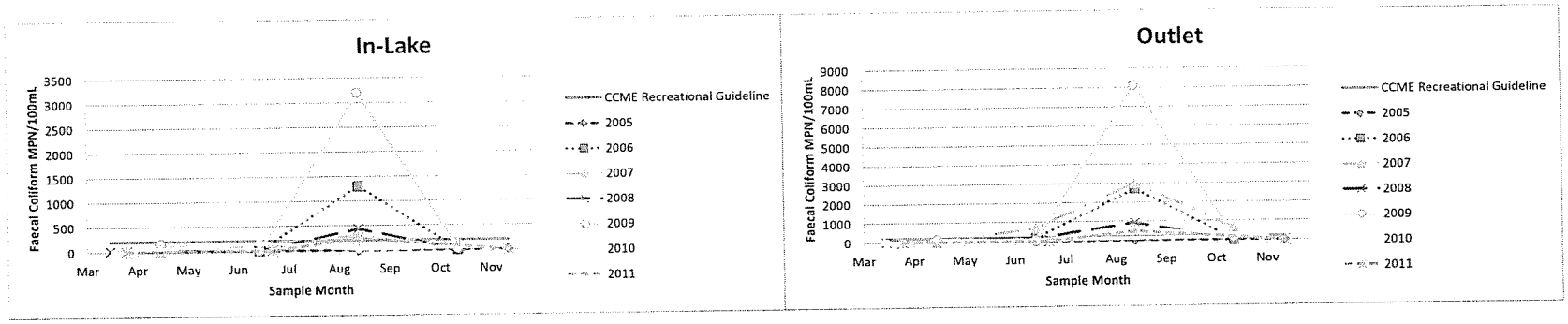


Figure A7. Chlorophyll *a* at four sites in Russell Lake from April 2005 to November 2011



*gaps are shown where data are unavailable

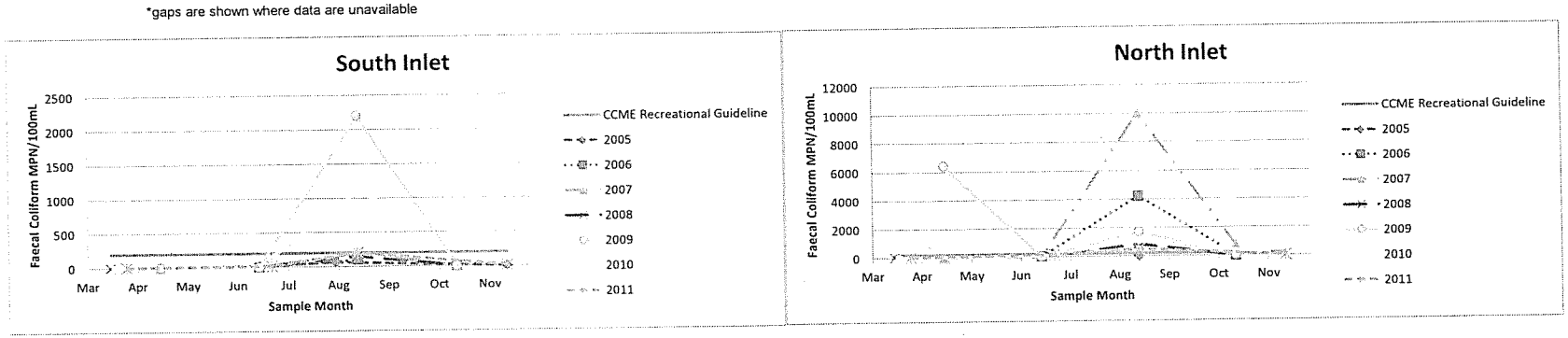


Figure A8. Faecal coliforms at four sites in Russell Lake from April 2005 to November 2011

TABLE A1 Surface Water Quality Data for Russell Lake, In-Lake (2005-2011)

Analyte	Units	CCME FWAL	In-Lake																									
			2005				2006				2007				2008				2009				2010				2011			
			Apr	Jun	Aug	Nov	Mar	Jun	Aug	Oct	Apr	Jun	Aug	Oct	Mar	Jun	Aug	Oct	Apr	Jun	Aug	Oct	Mar	Jun	Aug	Nov	Mar	Jun	Aug	Nov
General Chemistry																														
Total Alkalinity (as $CaCO_3$)	mg/L		20	17	21	17	15	20	25	26	22	29	27	30	19	22	28	34	27	30	36	35	30	35	36	36	32	31	33	35
Chloride	mg/L		150	87	99	72	91	100	77	79	170	140	120	69	180	250	220	190	270	250	220	150	170	160	160	150	240	170	130	94
Colour	TCU		12	12	8	18	12	14	13	11	9	9	8	12	10	11	15	9	16	9	14	20	14	8	10	15	14	19	22	21
Hardness (as $CaCO_3$)	mg/L		48	34	40	37		43	39	42	59	53	52	46	52	62	64	56	70	65	66	52	54	69	65	58	69	60	53	47
Nitrate + 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	<0.05	0.15	<0.05	<0.05	<0.05	0.2	<0.05	<0.05	<0.05	0.11	<0.05	<0.05	<0.05	0.08	<0.05	<0.05	<0.05
Nitrate (as N)	mg/L	13000	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05											<0.05			<0.05	<0.05				
Nitrite (as N)	mg/L	60	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01											<0.01			<0.01	<0.01				
Ammonia (as N)	mg/L	19	<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	0.12	<0.05
Total Kejldahl Nitrogen	mg/L				0.4	0.4	0.3	0.3																						
Total Organic Carbon	mg/L		1.9	3.6	3	4.4	<0.5	3.7	4.6	3.6	2.7	4	2.4	4.3	2	2.2	2.4	4.3	3.3	3.1	5	4.5	2.9	2.4	4.1	3.3	2.7	3.5	4.2	<5
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	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Phosphorus	ug/L		2.5	7	12	25	15	8	20	11	12	7	14	14	9	12	7		13	12	20	3	5	7	8	2	31	21	19	17
Dissolved Phosphorus	mg/L		<0.005		<0.1		0.006				<0.1																			
pH	Units	6.5-9	7.0	7.0	7.1	7.3	7.0	6.8	7.4	7.5	7.4	7.5	7.6	7.5	7.5	7.6	7.4	7.4	7.1	7.4	7.5	7.5	7.3	7.5	7.5	7.5	7.4	7.5	6.8	7.6
Reactive Silica (as SiO_2)	mg/L		1.8	0.7	2.1	3.5	2.5	1.3	2.5	<0.5	0.9	0.7	2.3	0.6	1.8	0.8	2.6	3.6	2.2	0.6	2.2	3.4	2.6	1.2	2.4	2.4	1.9	0.8	2.0	2.5
Sulphate	mg/L		16	12	13	13	15	15	11	12	17	16	16	13	20	24	23	20	25	26	20	17	18	16	16	16	23	17	16	13
Turbidity	NTU		0.7	0.6	0.8	2	1.3	1.1	1	3.6	2.9	0.9	0.8	3.2	3.1	1	1.7	0.7	1.4	0.6	1	0.8	1.1	0.5	1	1.2	2.8	1.0	2.2	1.2
Conductivity	µS/cm		570	360	390	310	350	420	330	340	630	560	470	390	680	910	780	700	1000	960	810	570	620	720	630	580	930	640	540	390
TDS (calculated)	mg/L		269	176	206	159	192	212	176	170	326	285	245	204	345	462	434	368	516	485	418	300	327	358	139	309	456	332	279	207
Bicarbonate (as $CaCO_3$)	mg/L		20	17.1	21.3	17	15	20	25	26	22	29	27	30	19	22	27	34	27	30	36	35	30	35	36	36	31	31	33	35
Carbonate (as $CaCO_3$)	mg/L		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Calcium	mg/L		16	12	14	12	13	14	13	14	20	16	17	15	16	21	22	19	24	22	23	16	16	23	22	20	24	20	18	16
Magnesium	mg/L		1.8	1.4	1.7	1.6	1.7	1.8	1.8	1.8	2.5	2.1	2.1	1.8	1.8	2.2	2.2	2.1	2.4	2.2	2.3	2	1.9	2.6	2.4	2.2	2.3	2.2	2.0	1.9
Potassium	mg/L		1.5	1.2	1.5	1.5	1.5	1.4	1.6	1.7	2.2	2.3	2.1	2.3	2.1	2.3	2.4	2.4	2.6	2.5	2.5	2.3	2.0	2.2	2.1	2.3	2	1.9	1.8	1.9
Sodium	mg/L		92	52	64	46	58	64	54	45	100	85	73	63	110	150	140	110	160	160	130	89	95	107	89	94	144	102	85	57
*Total Suspended Solids	mg/L		1	1	1	1	1	3	1	4	4	1	1	4	9	2	2	1	3	1	3	1	1	1	2	1	3	2	3	3
Chlorophyll a	µg/L			1.60	2.80	16.20		1.42	4.35	6.56	9.69	1.07	3.45	7.11	1.44	1.47	3.64	1.48	6.43	1.17	26.80	4.78	1.99	0.96	2.99	3.96	29.01	3.04	8.11	18.67
Field Measurements																														
Secchi disc depth	m			3.4	2.8	3.0		2.8		1.5		4.6	2.5	1.5			1.75	4	1.3	6	1.4	3.75	3.5	4	2.3	2.6	1.7	1.6	1.5	1.4
Dissolved Oxygen	mg/L		10.5	8.9	7.3	13.2		10.6	5.6	12.3	14.5	9.6	11.0	10.2	16.9	9.5	8.0	10.8	9.7	11.3	8.6	10.9	13.4	8.1	7.6	13.1	13.1	7.4	5.9	10.5
pH	units		7.0	7.3	7.6	7.2		6.7	6.8	7.2	6.6	7.4	8.0	6.8	6.5	7.7	6.8	7.3	7.3	8.0	7.7	7.0	7.8	6.8	6.9	7.5	7.4	7.4	6.2	5.7
Conductivity	µS/cm		602	334	186	129		393	310	330	612	527	474	276	444	1701	1514	600	1031	278	631		601	696	635	570	917	631	526	387
Temperature (field)	°C		10.4	19.6	23.4	7.2		19.8	21.1	8.4	7.8	20.4	23.3	11.1	5.6	18.3	21.9	9.5	5.3	16.9	22.2	8.3	5.2	20.6	22.6	8.7	3.4	18.3	20.7	8.0
Bacteriological																														
**E.Coli	CFU/100ml																						1	1	3	3	<1	3	67	4
**Faecal Coliform	MPN/100 ml		1	1	1	1		5	1300	1	3	120	300	140	11	8	440	2	150	1	3200	32	1	160	20	57	2	3	240	1

FWAL - Freshwater Aquatic Life

*Results below detection limits (DL) shown as 1

Cells left intentionally blank for graphs to indicate no sample collected

Cells with dash indicate no sample collected

April 2005 result for TP is italized because result was below detection limit (DL) and shown as 2.5 (1/2 DL). The DL is now 2 ug/L.

TABLE A2 Surface Water Quality Data for Russell Lake, Outlet (2005-2011)

Analyte	Units	CCME FWAL	Outlet																									
			2005				2006				2007				2008				2009				2010				2011			
			Apr	Jun	Aug	Nov	Mar	Jun	Aug	Oct	Apr	Jun	Aug	Oct	Mar	Jun	Aug	Oct	Apr	Jun	Aug	Oct	Mar	Jun	Aug	Nov	Mar	Jun	Aug	Nov
General Chemistry																														
Total Alkalinity (as $CaCO_3$)	mg/L		19	17	23	17	16	21	25	26	22	26	27	30	19	23	27	33	27	29	36	34	30	34	37	37	29	33	34	34
Chloride	mg/L		150	88	100	72	93	99	79	80	160	140	120	90	180	250	220	190	270	260	220	150	170	180	170	150	240	170	130	93
Colour	TCU		11	12	12	18	12	14	14	11	9	9	9	12	11	10	16	9	16	10	16	18	16	14	14	18	13	21	21	22
Hardness (as $CaCO_3$)	mg/L		49	6.94	42	37	-	43	41	41	59	54	50	44	53	63	65	59	65	68	66	51	56	73	62	58	68	55	54	48
Nitrate + 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	<0.05	0.14	<0.05	<0.05	<0.05	0.21	<0.05	<0.05	<0.05	0.07	<0.05	<0.05	<0.05	0.07	<0.05	<0.05	<0.05
Nitrate (as N)	mg/L	13000	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	<0.05	-	-	<0.05	<0.05	-	-	-	-
Nitrite (as N)	mg/L	60	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	<0.01	<0.01	-	-	-	-
Ammonia (as N)	mg/L	19	<0.05	<0.05	0.06	<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	0.09	<0.05
Total Kejdahl Nitrogen	mg/L		-	0.5	0.4	0.3	0.1	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	mg/L		2.1		3.6	4.3	3.6	3.3	5.4	2.9	2.9	3.7	3.2	4.3	2.3	3.3	3.2	3.8	2.7	3.1	3.7	3.5	2.8	3	3.7	3.6	2.5	3.7	4.2	<0.01
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	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Phosphorus	ug/L		7	10	16	27	10	4	<20	10	14	73	14	12	9	15	8	-	17	11	17	6	6	14	7	7	23	17	16	13
Dissolved Phosphorus	mg/L		0.005	-	<0.1	-	0.007	-	-	-	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.5	7.7	6.6	7.6
pH	Units	6.5-9.0	6.7	6.9	7.1	7.3	6.9	6.7	7.4	7.5	7.2	7.4	7.6	7.5	7.5	7.4	7.3	7.3	7.1	7.5	7.3	7.8	7.3	7.3	7.7	7.5	1.7	0.8	2.1	2.4
Reactive Silica (as SiO_2)	mg/L		1.4	1	2.5	3.5	2	1.3	2.4	1.4	0.9	4.4	2.3	0.8	1.8	1.6	2.6	3.4	2.1	0.5	2.4	3.3	2.3	0.9	2.4	2.4	23	17	15.0	13
Sulphate	mg/L		16	12	12	16	14	14	11	12	17	18	16	13	19	24	23	20	25	24	20	17	17	18	17	16	2.4	0.6	1.3	1.1
Turbidity	NTU		1.4	2.4	0.2	1.8	1.2	1	0.3	2.8	2.9	0.7	0.6	2.5	2.8	0.8	1.2	0.3	1.4	0.6	0.5	0.7	1.2	1	0.6	0.8	930	640	540	390
Conductivity	µS/cm		580	360	400	300	360	410	320	330	620	550	470	390	690	910	780	700	1000	970	810	570	630	750	630	580	450	324	279	207
TDS (calculated)	mg/L		292	<1	214	162	197	209	178	171	323	286	243	201	342	469	435	372	506	499	417	298	328	365	319	308	29	33	33	34
Bicarbonate (as $CaCO_3$)	mg/L		19.5	36	23	17	16	21	25	26	22	26	27	30	19	23	27	33	27	29	36	34	30	34	37	36	<1	<1	<1	<1
Carbonate (as $CaCO_3$)	mg/L		<1	16.8	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Calcium	mg/L		17	12	14	12	14	14	14	14	20	18	17	15	18	22	22	19	22	23	23	17	19	25	21	20	23	19	18	16
Magnesium	mg/L		1.8	1.5	1.7	1.6	1.7	1.7	1.7	1.8	2.3	2.2	2.1	1.8	1.8	2.2	2.2	2.1	2.2	2.3	2.3	1.9	2.0	2.7	2.3	2.1	2.3	2.0	2	1.9
Potassium	mg/L		1.6	1.3	1.2	1.5	1.5	1.4	1.5	1.7	2.4	2.1	2	2.3	2.1	2.3	2.4	2.4	2.4	2.6	2.5	2.1	2.0	2.2	2.0	2.2	2.0	1.8	1.8	1.9
Sodium	mg/L		92	57	65	46	61	64	52	44	110	87	71	61	110	150	140	110	160	170	130	88	98	112	85	93	143	95.1	87	58
**Total Suspended Solids	mg/L		3	2.4	3.6	1	5	2	1	3	3	1	1	3	1	1	1	2	1	1	1	1	1	1	1	1	2	2	3	2
Chlorophyll a	µg/L					17.70		2.19	2.46	5.46	7.85	0.95	1.08	5.16	1.54	1.20	2.16	1.04	6.35	1.07	11.60	4.72	2.92	1.00	1.35	3.18	19.56	1.49	7.22	16.61
Field Measurements																														
Secchi disc depth	m		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Oxygen	mg/L		10.2	7.4	5.5	10.8	-	11.3	8.9	11.9	14.8	8.4	11.3	10.1	19.3	8.4	7.4	10.9	9.6	6.9	8.1	10.6	11.1	5.0	5.6	13.4	12.6	7.3	5.5	11.2
pH	units		6.9	6.8	6.8	7.2		7.2	7.1	7.4	7.0	7.0	7.8	7.4	6.5	7.2	7.6	7.8	7.4	7.2	7.6	7.8	7.5	7.7	7.4	7.2	7.7	7.6	7.6	6.8
Conductivity	µS/cm		635	345	201	136		389	399	344	613	532	473	272	448	1703	1505	602	1023	278	834	-	592	702	633	571	914	634	529	389
Temperature (field)	°C		12.2	22.5	25.5	7.6	-	21.3	23.1	9.1	9.6	22.9	24.5	9.9	5.5	18.6	23.2	7.8	6.2	19.6	23.5	8.8	5.1	20.5	22.8	7.9	5.0	21.0	21	9.3
Bacteriological																														
**E.Coli	CFU/100ml																						3	1	29	10	1	28	54	4
**Faecal Coliform	MPN/100 ml		1	8	10	1		170	2700	1	1	700	3000	640	9	160	930	4	140	24	8100	160	1	35	600	200	4	23	490	1

FWAL - Freshwater Aquatic Life

*Results below detection limits (DL) shown as 2.5 (1/2 DL)

*Results below detection limits shown as 1

Cells left intentionally blank for graphs to indicate no sample collected

Cells with dash indicate no sample collected

TABLE A3 Surface Water Quality Data for Russell Lake, South Inlet (2005-2011)

Analyte	Units	CCME FWAL	South Inlet																									
			2005				2006					2007				2008				2009				2010				2011			
			Apr	Jun	Aug	Nov	Mar	Jun	Aug	Sep	Oct	Apr	Jun	Aug	Oct	Mar	Jun	Aug	Oct	Apr	Jun	Aug	Oct	Mar	Jun	Aug	Nov	Mar	Jun	Aug	Nov
General Chemistry										additional																				
Total Alkalinity (as $CaCO_3$)	mg/L		11	31	33	7	21	13	<5	35	13	11	25	24	25	18	23	37	32	16	34	54	24	25	41	56	27	25	35	24	28
Chloride	mg/L		25	17	21	21	23	13	9	36	26	35	27	18	20	76	24	29	37	38	49	39	23	62	31	49	37	71	43	28	27
Colour	TCU		24	27	21	45	14	68	380	44	38	23	47	52	41	17	52	150	51	51	50	150	57	26	47	87	59	22	83	200	42
Hardness (as $CaCO_3$)	mg/L		24	40	45	23	-	21	46	48	29	30	33	33	28	43	29	41	37	27	40	53	32	42	47	54	43	42	40	31	38
Nitrate + Nitrite (as N)	mg/L		<0.05	<0.05	0.09	0.08	0.13	<0.05	<0.05	0.12	0.08	0.09	<0.05	0.07	0.05	0.1	<0.05	0.1	<0.05	0.15	<0.05	0.14	<0.05	0.11	0.06	0.1	<0.05	<0.05	<0.05	<0.05	42
Nitrate (as N)	mg/L	13000	<0.05	<0.05	0.09	0.08	0.13	<0.05	<0.05	-	0.07	0.09	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	0.1	<0.05	-	-	-	-
Nitrite (as N)	mg/L	60	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	<0.01	0.01	-	-	-	-
Ammonia (as N)	mg/L	19	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	0.07	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	0.08	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	0.06	<0.05
Total Kelidahl Nitrogen	mg/L		-	0.3	0.4	0.3	0.3	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	mg/L		6.6	7.1	6.1	9	4.6	<0.5	45	11	7.2	5.6	11	11	9.2	3.3	8.5	17	11	6.3	6.9	13	7.8	5.5	8.1	12	8.4	4.2	9.1	17	5
Ortho Phosphate (as P)	mg/L		0.04	0.03	0.04	0.06	0.02	0.08	0.01	0.11	0.05	<0.01	0.05	0.07	0.03	<0.01	0.03	0.03	0.02	0.01	0.01	0.03	<0.01	0.01	0.03	0.02	0.03	0.01	0.02	0.03	0.01
Total Phosphorus	ug/L		42	46	43	88	31	86	80	110	53	34	10	14	44	18	36	28		30	110	71	27	45	47	46	26	30	52	70	31
Dissolved Phosphorus	mg/L		0.037	-	<0.1	-	0.021	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	Units	6.5-9.0	6.8	7.0	7.2	6.5	7.0	6.6	4.7	7.5	6.9	7.0	7.3	7.2	7.2	7.4	7.3	7.2	7.4	6.9	7.4	7.4	7.4	7.3	7.6	7.6	7.4	7.4	7.5	7.0	7.4
Reactive Silica (as SiO_2)	mg/L		4.1	7.2	9.9	5.7	7.4	3.8	5.9	10	5.8	3.5	0.7	6.1	6.5	3.8	4.8	6.5	6.8	3.2	3.5	7.1	5.5	5.6	6.8	7.2	6.4	4.8	4.1	4.8	6.8
Sulphate	mg/L		12	5.1	7.9	16	11	<2	<10	<2	13	12	<2	<2	<2	15	3	<2	<2	15	3	<2	12	12	3	<2	18	14	<2	<2	11
Turbidity	NTU		0.3	0.2	<0.1	0.7	1.2	0.4	3.2	1.3	2.8	0.8	0.5	1.6	1.2	0.5	0.5	2.4	1.6	2.4	1.1	6.4	1.5	1.1	1.7	4.1	1.5	0.9	1.0	2.5	4.5
Conductivity	µS/cm		130	130	150	120	140	89	45	190	140	180	160	120	120	330	140	170	190	190	240	190	140	270	190	260	210	320	220	150	150
TDS (calculated)	mg/L		73	74.6	89.3	70	83	43	60	113	76	91	78	66	67	170	75	98	102	104	125	128	84	147	101	139	119	165	112	83	93
Bicarbonate (as $CaCO_3$)	mg/L		10.7	31.3	32.8	7	21	13	<1	35	13	11	25	24	25	18	23	37	32	16	34	54	24	25	40	56	27	25	35	24	28
Carbonate (as $CaCO_3$)	mg/L		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Calcium	mg/L		6.6	10	11	6.7	9.1	5.8	14	14	8.4	8.3	9.4	9.3	7.9	13	8.1	13	10	8.3	12	16	9.4	12	13	16.1	13	13	12	9.7	11
Magnesium	mg/L		1.9	3.4	4.1	1.6	3.2	1.5	3	3.4	2	2.1	0.01	2.3	2	2.3	2.2	2.4	2.7	1.5	2.3	3.3	2	2.8	3.6	3.3	2.6	2.7	2.5	1.75	2.5
Potassium	mg/L		1	0.9	0.9	1	1	0.5	2	2	2.1	1.4	0.9	1	1.5	1.6	1.1	1.9	2.4	1.4	1.3	1.4	1.1	1.3	0.9	1.4	1.6	1.1	0.8	1.1	1.4
Sodium	mg/L		16	12	14	13	15	10	21	25	13	21	18	14	13	47	18	21	21	26	34	24	16	35	19	26	24	44	28	21	16
**Total Suspended Solids	mg/L		1	1	1	2	1	4	91	2	1	1	1	3	1	1	2	1	2	1	1	7	1	2	4	1	1	1	1	<2	5
Chlorophyll a	µg/L				0.10	0.20		1.23	2.07		1.08	2.22	0.22	0.16	0.15	1.54	0.56	0.70	0.48	0.69	1.67	2.32	0.29	1.37	5.05	0.64	0.13	1.80	0.42	1.18	0.36
Field Measurements																															
Secchi disc depth	m		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Oxygen	mg/L		10.4	9.3	7.4	13.0	-	10.3	8.8	-	12.3	14.8	9.9	11.7	12.5	21.4	10.5	6.9	11.4	10.0	10.9	9.1	10.7	15.6	9.3	9.5	15.1	13.7	7.9	6.3	11.0
pH	units		6.5	6.9	7.6	7.3		6.1	6.7	7.2	7.2	6.4	7.0	7.7	6.7	6.5	7.1	7.4	7.4	7.4	7.2	7.1	7.3	7.8	7.4	7.3	7.6	7.8	7.1	8.0	5.7
Conductivity	µS/cm		124	105	185	78		94	161		142	174	145	121	74	187	260	331	164	191	69	232	-	268	187	270	205	316	214	145.0	157.0
Temperature (field)	°C		9.0	15.3	23.5	5.7	-	14.7	16.9	-	6.6	4.8	14.7	16.3	5.1	0.5	12.0	17.2	5.6	4.3	13.3	16.0	5.7	3.7	13.0	16.6	5.4	2.1	13.3	17	7.0
Bacteriological																															
**E. Coli	CFU/100ml																							2	1	500	7	1	4	>250	5
**Faecal Coliform	MPN/100 ml		1	14	66	1		1	100		1	1	2	200	6	2	2	150	3	3	1	2200	2	1	1	1100	280	5	12	200	11

FWAL - Freshwater Aquatic Life

*Results below detection limits (DL) shown as 2.5 (1/2 DL)

*Results below detection limits shown as 1

Cells left intentionally blank for graphs to indicate no sample collected

Cells with dash indicate no sample collected

TABLE A4 Surface Water Quality Data for Russell Lake, North Inlet (2005-2011)

Analyte	Units	CCME FWAL	North Inlet																									
			2005				2006				2007				2008				2009				2010				2011			
			Apr	Jun	Aug	Nov	Mar	Jun	Aug	Oct	Apr	Jun	Aug	Oct	Mar	Jun	Aug	Oct	Apr	Jun	Aug	Oct	Mar	Jun	Aug	Nov	Mar	Jun	Aug	Nov
General Chemistry																												
Total Alkalinity (as $CaCO_3$)	mg/L		28		56		71	63	70	41	56	81	88	63	40	<1	87	71	47	80	92	72	70	110	99	77	83	92	77	98
Chloride	mg/L		110		110		590	130	140	87	390	200	150	150	1500	350	230	91	270	310	260	190	640	330	270	190	560	290	130	250
Colour	TCU		28		17		7	21	13	20	12	13	15	12	7	16	49	13	30	24	25	27	11	22	38	33	13	36	63	18
Hardness (as $CaCO_3$)	mg/L		62		93			66	110	81	160	150	120	120	230	150	130	120	100	140	140	110	200	170	160	120	220	150	90	170
Nitrate + Nitrite (as N)	mg/L		0.65		0.22		0.4	<0.05	0.07	1.3	0.32	0.24	0.25	0.23	0.62	0.2	0.26	0.15	0.56	0.27	0.21	0.23	0.33	0.26	0.24	0.36	0.47	0.27	0.38	0.35
Nitrate (as N)	mg/L	13000					0.4	<0.05	0.07	1.27	0.32	-	-	-	-	-	-	-	-	-	-	0.23	-	-	0.23	0.36	-	-	-	-
Nitrite (as N)	mg/L	60	<0.01				<0.01	<0.01	<0.01	0.03	<0.01											<0.01			0.01	<0.01				
Ammonia (as N)	mg/L	19	<0.05		<0.05		0.14	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.12	<0.05	<0.05	<0.05	0.06	<0.05	0.06	<0.05	<0.05	<0.05	0.15	0.07	<0.05	0.06	0.1	0.12
Total Kejdahl Nitrogen	mg/L				0.3		0.6	0.4			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
Total Organic Carbon	mg/L		6.5		3.3		2	4.6	5.6	4.9	4.2	3.9	3.7	4.3	5	3.8	6.2	3.3	5	4.7	4.8	5	3.4	5	7	4.5	3.1	5.1	6.6	6
Ortho Phosphate (as P)	mg/L		0.02		<0.01		<0.01	<0.01	0.11	<0.01	5.2	0.03	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01
*Total Phosphorus	ug/L		29		22		8	9	180	10	2.5	56	23	12	180	15	6		73	11	10	7	7	8	14	6	15	27	50	27
Dissolved Phosphorus	mg/L		-		-		0.007	-	-	-	5.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	Units	6.5-9.0	7.3		7.6		7.7	7.3	7.8	7.6	7.3	7.9	7.9	7.9	7.6	8.0	7.8	7.7	7.4	7.7	7.9	7.9	7.8	7.9	8.0	7.8	7.9	7.9	7.9	8.0
Reactive Silica (as SiO_2)	mg/L		3.3		4		3.4	2.2	3.3	5.5	3.3	3.3	4.9	4.2	2.6	2.2	5.7	4.5	3.2	2.9	4.9	5.4	4.5	5.5	5.9	6.1	5.3	4.1	5.6	5.6
Sulphate	mg/L		26		21		40	17	12	26	46	50	30	23	97	22	32	20	38	26	14	23	<0.01	17	19	29	46	23	22.0	22
Turbidity	NTU		25		3.3		14	2.1	0.7	10	4.2	1.5	1.2	1.5	170	0.8	1.5	0.6	8.5	1	0.9	1.3	1.8	0.9	2.7	1.3	1.3	1.8	4.3	1.9
Conductivity	µS/cm		490		520		2000	580	620	430	1500	900	720	670	5100	1400	890	780	1100	1300	1100	760	2200	1400	1100	790	2100	1100	610	1000
TDS (calculated)	mg/L		262		274		1110	310	339	234	804	468	392	364	2740	693	521	413	563	652	560	407	1170	-	574	426	1080	593	335	544
Bicarbonate (as $CaCO_3$)	mg/L		28		56		71	63	70	41	56	80	66	63	40	63	87	70	47	80	91	71	70	104	98	76	82	92	76	97
Carbonate (as $CaCO_3$)	mg/L		<1		<1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Calcium	mg/L		21		31		62	29	39	26	55	50	42	40	78	52	43	40	35	47	48	37	69	57	54	40	75	51	31	57
Magnesium	mg/L		2.3		3.7		6.3	3.2	4	3.7	5	5.2	4.4	4.3	8.4	5.6	4.4	4.6	3.6	5.1	5.6	4.3	7.7	7	5.8	4.2	8.6	6.1	3.3	7.3
Potassium	mg/L		2.3		2.4		3.4	2.1	2.5	5.2	5.9	4.4	4.1	4.8	6.8	2.6	3.4	3.3	3.4	2.9	3.0	2.6	4.0	3.4	3.7	3.1	3.8	2.8	2.9	3.1
Sodium	mg/L		75		68		360	83	91	49	250	120	98	90	980	210	150	100	180	200	160	110	350	174	148	109	330	162	89	132
**Total Suspended Solids	mg/L		4		3		11	5	1	3	3	3	1	1	330	1	1	1	72	1	2	3	1	7	1	1	2	1	2	2
Chlorophyll a	µg/L				2.50			1.35	0.94	1.74	1.08	0.59	0.23	6.60	0.31	1.00	0.21	0.17	1.03	0.67	0.27	1.44	0.83	0.75	0.35	1.04	0.94	0.51	0.84	1.61
Field Measurements																														
Secchi disc depth	m				-																									
Dissolved Oxygen	mg/L				12.0			11.6	9.8	12.1	13.9	10.0	11.3	13.9	20.3	10.3	9.4	11.6	10.3	9.5	9.6	11.0	12.4	8.8	7.9	14.2	13.9	5.4	7.0	11.0
pH	units				7.5			7.5	7.7	7.3	7.0	7.7	7.9	7.0	7.0	6.0	7.9	7.6	8.1	7.9	7.9	7.8	8.1	7.5	7.3	7.3	7.6	7.6	7.2	8.1
Conductivity	µS/cm				170			542	754	437	1523	908	728	444	3036	2540	1750	681	1075	366	1069	-	2093	1293	1119	760	2142	1142	598	999
Temperature (field)	°C				7.2			18.9	21.6	6.2	8.9	19.0	18.7	9.0	1.9	14.4	18.3	8.7	6.4	14.8	18.3	7.5	4.1	15.8	19.0	7.2	2.5	16.1	18	8.2
Bacteriological																														
E.Coli	CFU/100ml																						45	1	21	7	1	6	>250	14
**Faecal Coliform	MPN/100 ml				1			35	4200	1	6	34	10000	710	22	22	630	5	6400	20	1700	51	1	65	1100	180	13	150	490	15

FWAL - Freshwater Aquatic Life

*Results below detection limits (DL = 5) shown as 2.5 ug/L (1/2 DL)

**Results below detection limits (DL) shown as 1

Cells left intentionally blank for graphs to indicate no sample collected

Cells with dash indicate no sample collected