NOVA SCOTIA
Environment

Nova Scotia Environment's
Automated Surface Water Quality Monitoring Network

Data Analysis and Interpretative Report

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Executive Summary

The Nova Scotia Automated Surface Water Quality Network was established in 1999 to monitor water quality in surface waters across the province. The results are used to help manage water resources, determine baseline water quality in lakes and streams throughout the province, evaluate the impact of human activities on surface water, and assess long term trends in water quality.

In addition to contributing to provincial water resource management activities, this program supports both the Canadian Heritage River Program and the national Canadian Environmental Sustainability Indicators (CESI) reporting initiative.

Network stations located on streams employ electronic dataloggers which record water levels and water quality data on an hourly basis. Lake stations record water quality data only. These data are transmitted to a central computer housed at Nova Scotia Environment offices in Halifax. Grab samples are taken during periodic maintenance visits and analyzed for common water quality parameters including pH, conductivity, turbidity, major ions , nutrients, and selected metals.

Although the short period of record precludes statistical trend analysis at this time, apparent water quality trends suggest decreasing pH over time at two stations (Pockwock Lake and Kelley River). The trend at Kelley River appears to have reversed in 2007. These apparent trends are likely due to atmospheric deposition since neither watershed is significantly developed. All of the river stations experienced episodes of increased water turbidity to varying degrees during and following more severe precipitation events. Two stations (North East {NE} Margaree and St Mary's River) experienced more frequent and intensive turbidity events than other stations, likely due to more development and disturbances in their watersheds. One station (NE Margaree) had considerably higher conductivity values. This was attributed to the bedrock and surficial geology of the area, rather than influences from human activities (e.g. road salt applications).

Results at most stations indicated exceedences of national water quality guidelines for certain parameters. Protection of Aquatic Life (PAL) guidelines were exceeded periodically for temperature and pH. Drinking water and Recreational water quality guidelines were exceeded frequently for both turbidity and pH. Significant pH guideline exceedences occurred at all stations but one (NE Margaree). The extent of the pH exceedences was highly variable among the stations, ranging from nearly 100 % at three stations (Kelly, Shelburne, and Pockwock) to <1 % at NE Margaree. This variation was attributed to differences in bedrock and surficial geology and relative abundance of wetlands in the watershed. Exceedences occurred most frequently for PAL guidelines, with Drinking Water, and Recreational water use guideline exceedences occurring progressively less often. This was due to the more stringent PAL guideline values recommended for this more sensitive water use.

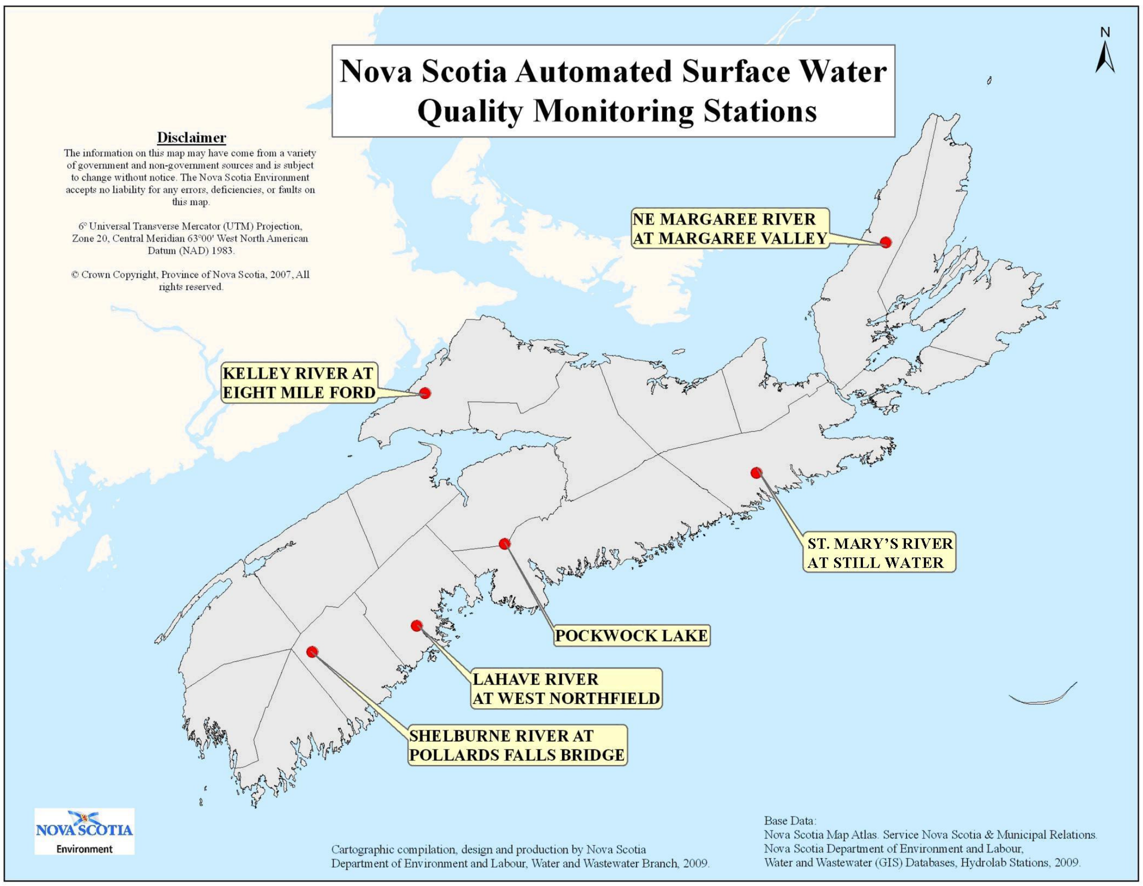
Water quality in the lake and rivers monitored in this network was primarily affected by precipitation, geology, vegetative cover and presence of wetland areas. Both regional and local influences from human activities are likely effecting water quality to some extent, and to varying degrees at each station. Sources of substances which triggered guideline exceedences were likely of both natural and human origin although natural influences dominate at this time.

Surface water resources are vulnerable to a multitude of pollutant sources and environmental influences and are sensitive to their effects. Measures need to be taken to protect these valuable assets for the beneficial use of all Nova Scotians. Long-term monitoring and reporting activities contribute to the protection of water resources and require ongoing program support. An increased frequency of maintenance is recommended for this program to ensure more complete data capture. Expansion is also desirable to provide better geographical coverage as additional resources become available.

1.0 Introduction

The Nova Scotia Automated Surface Water Quality Monitoring Network (Figure 1.0 - 1) was initiated in 1999. It consists of a series of stations located throughout the province where automated equipment monitors water quality in support of water management decisions. It is part of a long term comprehensive water resource monitoring program for the province.

Figure 1.0 - 1 Map of Automated Surface Water Quality Monitoring Locations



The network currently consists of 6 stations with the most recent station being added during the Fall of 2008. Both water quality and stream levels are monitored at all stations. The results are used to help manage water resources, determine baseline water quality in various lakes and streams throughout the province and evaluate the impact of human activities on surface water. Long term trends in water quality will be statistically evaluated in both relatively pristine watersheds as well as more impacted sites, as sufficient data becomes available.

This report presents monitoring results collected to December 2008 for the six monitoring stations currently in the network.

1.1 Historical Background

Automated water quality monitoring equipment was first introduced at Pockwock Lake in 1999 as a pilot project and then expanded to the Shelburne River (2000), North East Margaree River (2001), and Kelley River (2004. Prior to the initiation of this automated network, water quality assessments undertaken in the province employed grab sampling techniques with water quality analysis performed by certified laboratories. Both automated data collection and manual sampling techniques are now commonly used throughout Nova Scotia for water quality assessment.

Automated monitoring stations include areas of provincial significance such as Heritage River sites, Provincial Parks and Sanctuaries and Municipal Drinking Water Supplies. Monitoring stations are located in both relatively pristine watersheds as well as more impacted sites. They are typically co-located with hydrometric (stream flow) monitoring stations to allow 1) program delivery efficiencies, 2) capabilities for real-time reporting, and 3) calculations of loadings of contaminants or other water quality constituents. Stations have been chosen based on set criteria, including to be representative of geographic regions, important fish habitat (e.g. salmon), and to support development and use of a Water Quality Index.

In addition to contributing to provincial water resource management activities, this program supports both the Canadian Heritage River Program and the national Canadian Environmental Sustainability Indicators (CESI) reporting initiative.

One report has been previously published on the network, entitled “Nova Scotia Automated Water Quality Monitoring Program” (Scott et al., 2007). The 2007 report presented a summary of surface water quality data collected at the initial four stations between 2002 and 2005. It is available on the Nova Scotia Environment (NSE) web page at: www.gov.ns.ca/nse/water/surfacewater/ under “Publications”.

1.2 Description of Current Network

The automated water quality network consisted of the initial four stations until 2007. Subsequently stations were added at St Mary’s River (Fall of 2007), and Lahave River (Fall of 2008) for a total of six stations to date. The automated equipment installed at the St. Mary’s River station in 2007was decommissioned the following year due to significant recurring sediment fowling of the sensors. Automated data collected at that site is presented in this text, but will likely not be presented in future iterations of this report. However, grab sample data collection is still expected to continue at this site and will be included in subsequent reports. The current monitoring stations are listed in Table 1.2 - 1 and their locations are shown in Figure 1.0 - 1.

All stations in the network currently employ Hydrolab® datasondes equipped with temperature, pH, conductivity, dissolved oxygen, and turbidity sensors. These sensors gather information, at hourly intervals, which is stored on a datalogger shared with hydrometric (stage/flow measuring) equipment. The data are downloaded at regular intervals and verified by NSE staff. Water samples are collected from the stations periodically during site visits and tested for general chemistry involving about 30 parameters, including pH, conductivity, major ions, nutrients, and metals.

The data collected is available for download, in spreadsheet format, on the Nova Scotia Environment (NSE) web page at: http://www.gov.ns.ca/nse/water/surfacewater/ under "Databases".

Table 1.2 - 1 Nova Scotia Automated Surface Water Quality Monitoring Stations

Station Name	County	Year Monitoring Started
Pockwock Lake	Halifax	1999*
Shelburne River	Queens	2000*
North East Margaree River	Inverness	2001*
Kelley River	Cumberland	2004
St. Mary's River	Guysborough	2007
Lahave River	Lunenburg	2008

*Data collected prior to 2002 has not been reported on due to data quality and quantity issues.

2.0 Methods

Methods used for data collection, quality assurance, assessment and interpretation are outlined in the previous release of this report. A brief description is included below.

2.1 Data Collection

Network stations were equipped with a Hydrolab Water Quality Sonde located in a five inch diameter perforated PVC pipe insitu to the water via shore line deployment method. Infrastructure design, equipment deployment, and QA/QC measures followed methods established by US Geological Survey and equipment manufacturers (see previous report for details). Water quality parameters measured include temperature, pH, conductivity, turbidity, and dissolved oxygen. Stage or water level data were collected independently by Environment Canada (EC) staff as part of the Nova Scotia Hydrometric program.

The five river stations, Shelburne, North East Margaree, Kelley, St. Mary's, and Lahave River were equipped with electronic dataloggers which recorded water quality and water level data every hour. These dataloggers communicated via GOES Satellite to a central computer and relayed data at 3 hour intervals. The station at Pockwock Lake had a datalogger that recorded water quality data, but water level was not recorded. The Pockwock datalogger communicated via phone land line to a central computer.

The stations was visited by Nova Scotia Environment staff approximately every 3 months for maintenance, field verification of data, and to replace the deployed Hydrolab datasonde with a fresh unit. Readings from the deployed unit were recorded prior to removal and replacement of the datasonde. The replacement datasonde was calibrated at the NSE lab prior to the field trip. Measurements were also captured with a Quanta P hand-held water quality meter, prior to the removal of the datasonde, for subsequent comparison and possible data adjustments where necessary. The grab samples were analyzed for common water quality parameters including pH, conductivity, turbidity, major ions , nutrients, and selected metals.

Water levels were verified periodically by Environment Canada (EC) staff through field visits where staff gauge readings were manually recorded. Stream flows were subsequently determined from stage/ discharge relationship curves by EC staff.

2.2 QA /QC

After the raw water quality sensor data were collected and downloaded to central computer, data corrections were made if required. Sensor data were compared with field measurements for temperature, conductivity, pH, turbidity and dissolved oxygen taken with the freshly calibrated portable Quanta P water quality meter. If there were problems with any of the Quanta P sensors, grab sample lab results could be used for data correction. Data deletions or corrections were made to the recorded sensor data if differences from the field measurements exceeded established quality criteria and specifications of the equipment (see Appendix I). Additionally, manual field data were compared to the data recorded by the hydrolab units using the Criteria for Water Quality Data Shifts table (see Appendix I). Shifts were made to the recorded data as required.

As mentioned above, stage or water level data were collected by Environment Canada (EC) staff as part of the Nova Scotia Hydrometric program. Data quality assessment was undertaken through that program. Stage data reported in this report is raw data that has not yet been verified or corrected. EC Water Survey staff should be consulted for any confirmation of stage or water level data if required.

2.3 Data Quality Assessment

Water quality data validation was assessed through comparisons with other environmental data including water levels and precipitation. The focus of this exercise was to assess extremely high or low values to confirm data coherence with episodic weather events or possible pollutant events.

Each of the parameters measured were assessed for abrupt changes (extreme high or low values) for the entire period of record. Rainfall data were acquired from Environment Canada for the period of record from the closest station to each site. Comparison of increases and decreases of each parameter to rainfall data were carried out through visual inspection of the graphs. Grab sample data was also plotted against the recorded data.

If discrepancies or lack of coherence between sensor data and other environmental data was identified, possible reasons for the change were evaluated. If extreme values could not be justified or confirmed with other data, these data were deemed erroneous and deleted from the dataset.

2.4 Statistics and Guideline Exceedences

Statistics were computed from the final datasets of hourly data for each site. Final datasets are also expressed in a series of tables and/or plots as hourly, monthly, seasonal and annual minimum/maximum/mean/standard deviation values for each year of record for each station for each measured quantity. Results of the analyses are presented in this report with each station summary.

In addition to the above, individual exceedence tables have been generated using validated hourly datasets that are based on guidelines published by the Canadian Council of the Ministers of the Environment (CCME) for the Protection of Freshwater Aquatic Life, and through the Committee on Health and the Environment (CHE) for Drinking Water, and Recreational Use. The water temperature criteria published by Alabaster and Lloyd (1982) for salmon and trout have been adopted for this exercise instead of those published by the referenced national committees since it is more sensitive and relevant to the established water use. This is consistent with methods employed in the previous iteration of this report, where the fish guideline is used rather than the drinking water guideline. The drinking water guideline is an aesthetic objective for treated water and is considered to have little bearing on this review.

2.5 Data Interpretation

Water quality at each station was assessed for obvious or apparent changes over time, was compared to relevant national guidelines, and was cursorily assessed for influencing factors which may account for any difference or changes in water quality.

Factors considered in the interpretation of water quality results included the following which are known to commonly influence water quality in Nova Scotia surface waters;

- climate related events (e.g. air temperature, precipitation, and seasonal flows),
- watershed characteristics (e.g. forest cover, amount of wetlands, land use, bedrock geology and soil type), and
- pollutant sources (point and non-point).

These factors were also considered during the preceding data quality assessment step when validating the datasets.

Due to the relatively short length of record for this program, no statistical trend analysis was performed to assess long term temporal trends.

3.0 Results

3.1 POCKWOCK LAKE

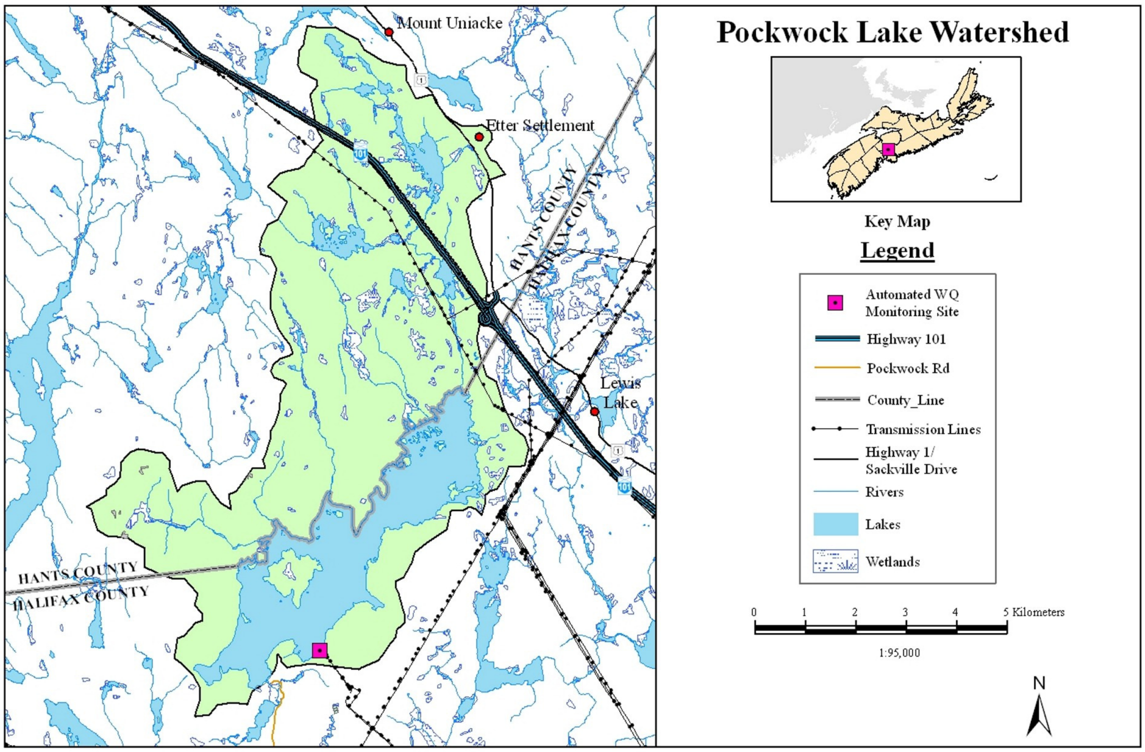


Figure 3.1 - 1 Location of Pockwock Lake watershed.

3.1.1 Background Information

Location of Station
The Pockwock Lake Automated Network Station is located at Latitude 44°46'56"N, Longitude 63°50'43" W.

Geographic Setting
Pockwock Lake is located on the border between Halifax and Hants Counties and is the drinking water supply for Halifax, Bedford, Sackville, Timberlea, Fall River and Waverley. The watershed is 56.61 km^2, is protected by provincial designation and is jointly managed by the Halifax Regional Water Commission (HRWC) and the Nova Scotia Department of Natural Resources.

Geology and Geomorphology
The bedrock geology in the Pockwock watershed is made up of two main rock types. Pockwock Lake represents the contact between the South Mountain Batholith (SMB), granitic rocks, which dominate the central and western regions of Nova Scotia and the Goldenville Formation of the Meguma Group, found in the southern mainland of the province.

The surficial geology of the area developed as a result of the numerous glaciations. The southern portion of the Pockwock watershed is characterized by the presence of several till units with varying textures, compositions, age and places of origin. In areas north of Pockwock Lake, less till was deposited by retreating glaciers and as a result, exposed granite bedrock structures are frequently visible. Tills on the west side of the lake are derived from the underlying granites and tills on the eastern side of the lake are derived from the underlying Goldenville Formation.

The dominant landform in the watershed is the undulating to moderately rolling plain with a thin mantle of stony till and peat bogs.

Forest Cover and Land Use

The watershed is under forest management by HRWC and contract to Elmsdale Lumber Ltd., with goals of water quality protection and sustainable forestry. About 61% of the land within the watershed is forested, 13% is clear-cut, and 23% of it is covered by water and/or wetlands. 2.7 % of the watershed is considered as urban land use.

Climate

Normal (1971-2000) annual precipitation in the Pockwock Lake watershed, as recorded at the Environment Canada Climate Station at Pockwock Lake is 1529 mm, comprised of 1335 mm of rainfall and 190 cm of snowfall. The mean annual temperature is 6.4 ^{o}C with a mean monthly high of 18.4 ^{o}C in July and a low of –5.9 ^{o}C in January.

Figure 3.1 - 2 Precipitation and Air Temperature data from Environment Canada Climate Station at Pockwock (Pockwock Watershed) for 2006 through 2008. Gaps in the plot indicate missing data.

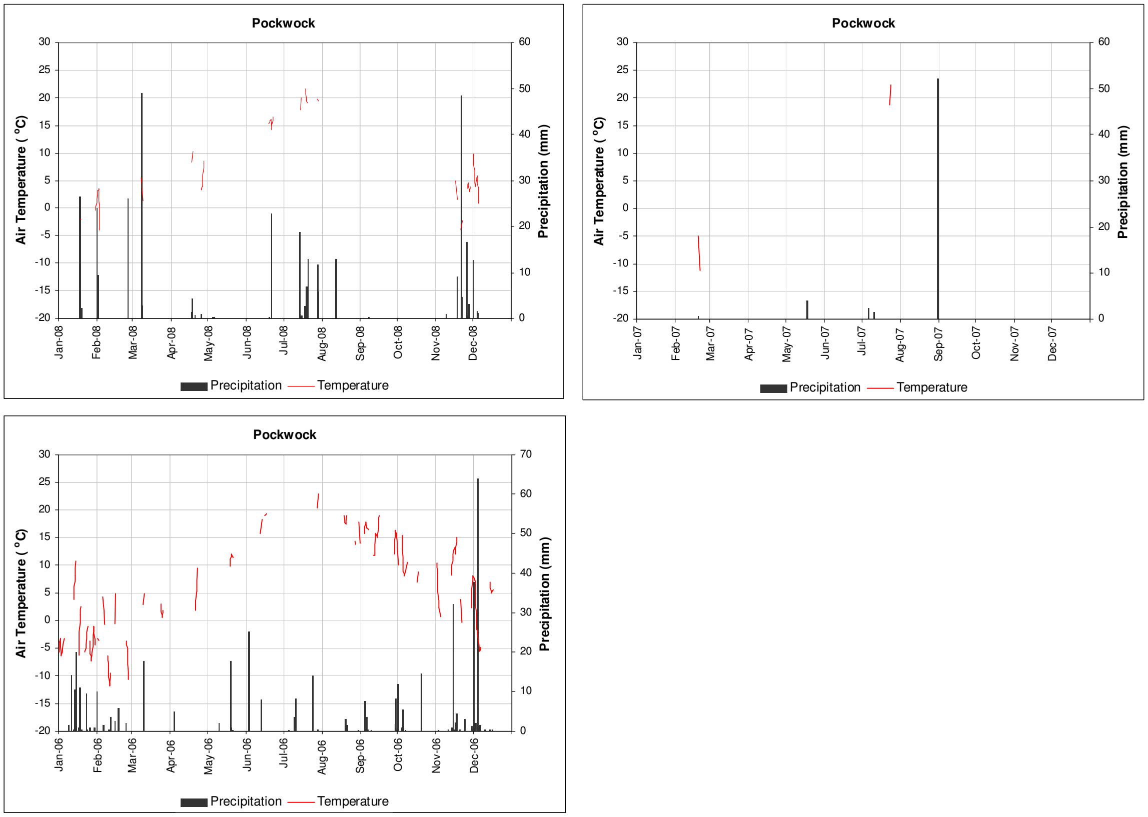


Figure 3.1 - 3 Aerial view of Pockwock Lake

Wildlife and Habitat

The Pockwock Lake watershed provides habitat for many species of plants and animals, including deer, beaver, and muskrat. Such wildlife species are important to water use in this context, due to the potential for fecal contamination and the lake water use as a drinking water supply. Treatment technologies are employed which address such issues prior to final water use.

Human Settlement and Industrial Development

The name Pockwock comes from the Mi'kmaq word Paakwaak, meaning "must stop here". Early European settlement occurred slowly in the area, with a recent increase in residential development during the late 1990s and early in the following decade. Industrial development in the watershed is restricted and includes only limited forestry overseen by the HRWC. This watershed became a protected drinking water supply area as designated under the Environment Act in 1994.

3.1.2 Land Use Summary Information

Table 3.1 - 1 Land use summary table for Pockwock Lake watershed

Land Type	km^2	% of Total Area
Agriculture	0	0
Barren	0.3	0.6
Clearcut	7.0	12.9
Forested	32.7	60.6
Urban	1.5	2.7
Wetland/Water	12.5	23.1
Total	54.0	100

3.1.3 Water Quality Summary Information

Table 3.1 - 2 Hourly statistics of minimum, maximum, mean, and standard deviation and exceedences as per established water quality guidelines for hourly real time data for Pockwock Lake for the period 2002 – 2008

Parameter	Year	Min	Max	Mean	SD	CWQ Guideline FWAL[1]	CWQ Guideline DW[1]	CWQ Guideline REC[1]	Readings[5]	# of Exceedences			Exceedences As % of Readings		
Temperature, °C	2002	9.4	24.5	18.2	3.6				2123	494			23		
	2003	0.8	23.3	10.8	7.6				7922	1072			14		
	2004	0.3	23.3	9.9	7.4				8158	867			11		
	2005	6.4	23.3	16.4	4.8	20-21[2]			4102	1022			25		
	2006	-0.1	23.7	10.8	7.5				8103	678			8		
	2007	-0.2	24.1	9.6	7.6				7907	574			7		
	2008	1.0	23.9	10.5	7.3				7918	808			10		
Turbidity, NTU										DW <1[3]	DW ≤5[4]	REC	DW <1[3]	DW ≤5[4]	REC
	2002	-	-	-	-				-	-	-	-	-	-	-
	2003	0.0	1.8	0.3	0.3				5383	38	0	0	1	0	0
	2004	0.0	7.6	1.2	0.8				4817	2468	1	0	51	<1	0
	2005	0.0	35.9	1.0	1.5		<1[3], ≤5[4]	≤50	4102	2130	41	0	52	1	0
	2006	0.0	4.7	1.1	0.8				6729	2746	0	0	41	0	0
	2007	0.0	4.0	1.0	1.0				7655	3704	0	0	48	0	0
	2008	0.0	1.8	0.1	0.2				7808	28	0	0	<1	0	0
Conductivity, uS/cm	2002	38.8	40.2	39.4	0.7										
	2003	34.7	39.8	37.7	1.4										
	2004	35.7	43.4	39.9	1.7										
	2005	35.5	42.4	37.9	1.2										
	2006	36.2	40.4	38.6	1.0										
	2007	35.6	43.2	40.2	2.1										
	2008	30.5	39.3	35.9	1.4										
Dissolved Oxygen, mg/L	2002	6.6	10.7	8.7	0.7	≥5.0			2128	0			0		
	2003	7.6	14.2	10.8	2.2				7922	0			0		
	2004	7.7	13.4	10.8	1.9				8155	0			0		

Parameter	Year	Min	Max	Mean	SD	CWQ Guideline			Readings[5]	# of Exceedences			Exceedences As % of Readings		
						FWAL[1]	DW[1]	REC[1]							
	2005	7.5	10.9	8.8	0.8				4102		0			0	
	2006	6.9	13.8	10.4	2.3				8103		0			0	
	2007	7.7	13.7	11.4	1.8				6890		0			0	
	2008	7.8	13.5	10.8	1.9				7499		0			0	
pH, Units										FWAL	DW	REC	FWAL	DW	REC
	2002	5.3	5.5	5.4	0.0				2131	2131	2131	2131	100	100	100
	2003	4.9	5.8	5.3	0.2				7921	7921	7921	7921	100	100	100
	2004	4.9	5.6	5.3	0.1				8157	8157	8157	8157	100	100	100
	2005	4.8	5.4	5.1	0.1	6.5-9.0	6.5-8.5	6.5-9.5	4100	4100	4100	4100	100	100	100
	2006	4.7	5.2	4.9	0.1				8103	8103	8103	8103	100	100	100
	2007	5.0	5.4	5.2	0.1				7249	7249	7249	7249	100	100	100
	2008	4.9	5.5	5.2	0.1				5226	5226	5226	5226	100	100	100

[1] FWAL: Freshwater Aquatic Life; DW: Drinking Water; REC: Recreational Use
[2] Upper permissible limit for salmon and trout (Alabaster and Lloyd, 1982). CCME DW guideline deemed to be inappropriate.
[3] Maximum Acceptable Concentration for water entering a distribution system.
[4] Aesthetic Objective. 5NTU may be permitted if demonstrated that the disinfection method is not compromised.
[5] The number of hourly readings possible in each of the years 2002, 2003, 2005, 2006, and 2007 is 8760. For 2004 and 2008 the number is 8784. The number recorded in the table refers to the actual number of approved measurements

3.1.3.1 Temperature

Figure 3.1 - 4 Water temperature from 2006 through 2008 for the Pockwock Lake using hourly values. Gaps in the plot indicate missing data.

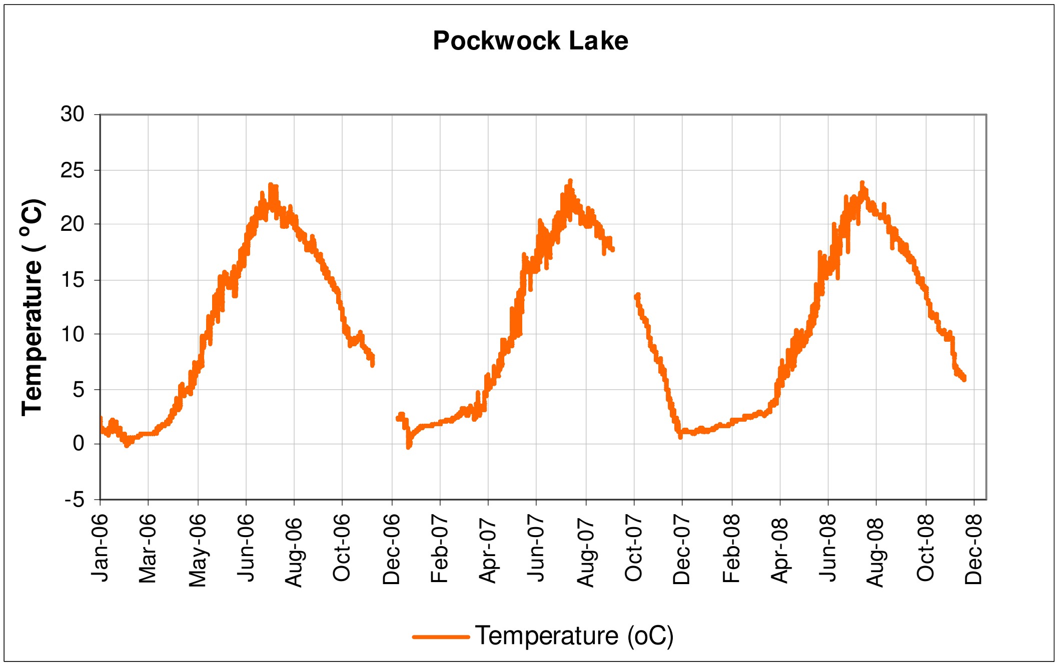


Figure 3.1 - 5 Water temperature from 2002 through 2008 for the Pockwock Lake using daily mean values. Gaps in the plot indicate missing data.

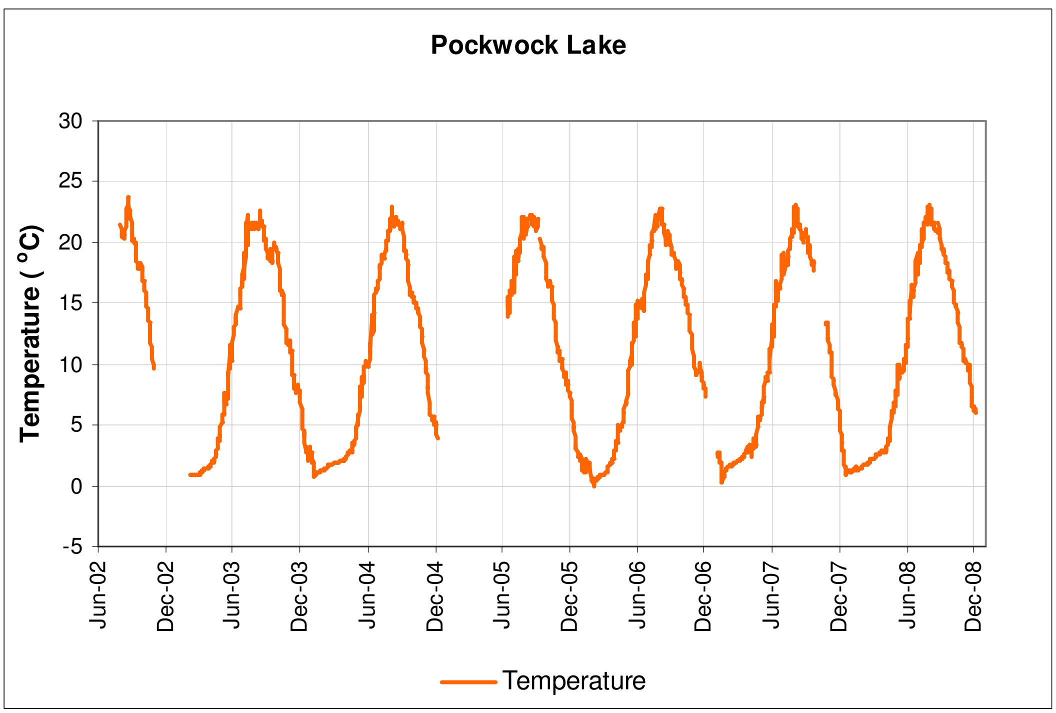


Figure 3.1 - 6 Water temperature from 2002 through 2008 for Pockwock Lake using monthly mean values. Gaps in the plot indicate missing data.

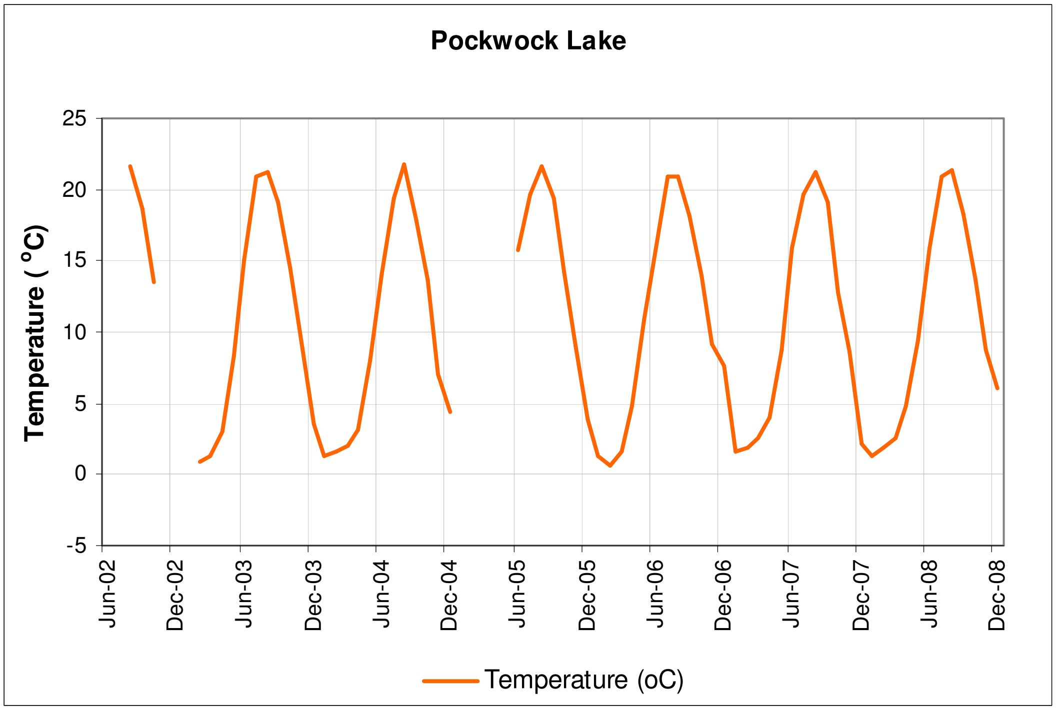


Table 3.1 - 3 Mean monthly water temperature for Pockwock Lake during 2006 – 2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----		---------- °C ----------		-----
January	2006	1.3	0.5	2.2	0.4
February	2006	0.6	0.0	1.0	0.3
March	2006	1.6	1.0	2.8	0.5
April	2006	4.7	2.9	6.8	1.1
May	2006	10.6	6.8	14.8	2.3
June	2006	15.6	14.1	18.1	1.1
July	2006	20.8	18.5	22.8	1.2
August	2006	21.0	19.8	22.8	0.9
September	2006	18.2	16.8	19.7	0.8
October	2006	14.1	10.3	16.9	1.8
November	2006	9.3	7.9	10.6	0.7
December	2006	7.7	7.3	8.2	0.4
January	2007	1.5	0.3	2.7	0.7
February	2007	1.8	1.6	2.0	0.1
March	2007	2.5	2.1	3.2	0.4
April	2007	3.9	2.4	5.7	1.0
May	2007	8.6	5.6	12.7	1.9
June	2007	15.6	11.4	18.9	1.8
July	2007	19.6	17.4	22.5	1.3
August	2007	21.3	19.9	23.1	0.9
September	2007	19.2	17.7	21.1	0.9
October	2007	12.9	12.1	13.4	0.6

Month	Year	Mean	Minimum	Maximum	SD
-----	-----		---------- °C ----------		-----
November	2007	8.9	6.2	12.0	1.9
December	2007	2.3	0.9	5.7	1.4
January	2008	1.3	1.0	1.6	0.1
February	2008	1.9	1.6	2.2	0.2
March	2008	2.6	2.3	2.9	0.2
April	2008	4.6	2.7	7.0	1.4
May	2008	9.3	7.4	11.6	1.2
June	2008	15.6	11.4	19.2	2.0
July	2008	20.8	17.9	22.9	1.4
August	2008	21.5	20.3	23.1	0.8
September	2008	18.3	16.9	19.9	1.0
October	2008	13.9	11.3	16.7	1.7
November	2008	8.8	6.3	11.1	1.6
December	2008	6.2	6.0	6.3	0.1

Table 3.1 - 4 Mean annual water temperature for Pockwock Lake during 2002 – 2008 based on mean daily data.

Year	Mean	Minimum	Maximum	SD
-----		---------- °C ----------		-----
2002	18.13	9.66	23.82	3.65
2003	10.78	0.84	22.58	7.61
2004	9.92	0.68	22.88	7.43
2005	14.73	2.01	22.22	6.26
2006	10.76	-0.04	22.84	7.51
2007	9.62	0.29	23.12	7.58
2008	10.61	1.02	23.05	7.32

3.1.3.2 Turbidity

Figure 3.1 - 7 Turbidity levels from 2006 – 2008 for the Pockwock Lake based on hourly values. Gaps in the plot indicate missing data.

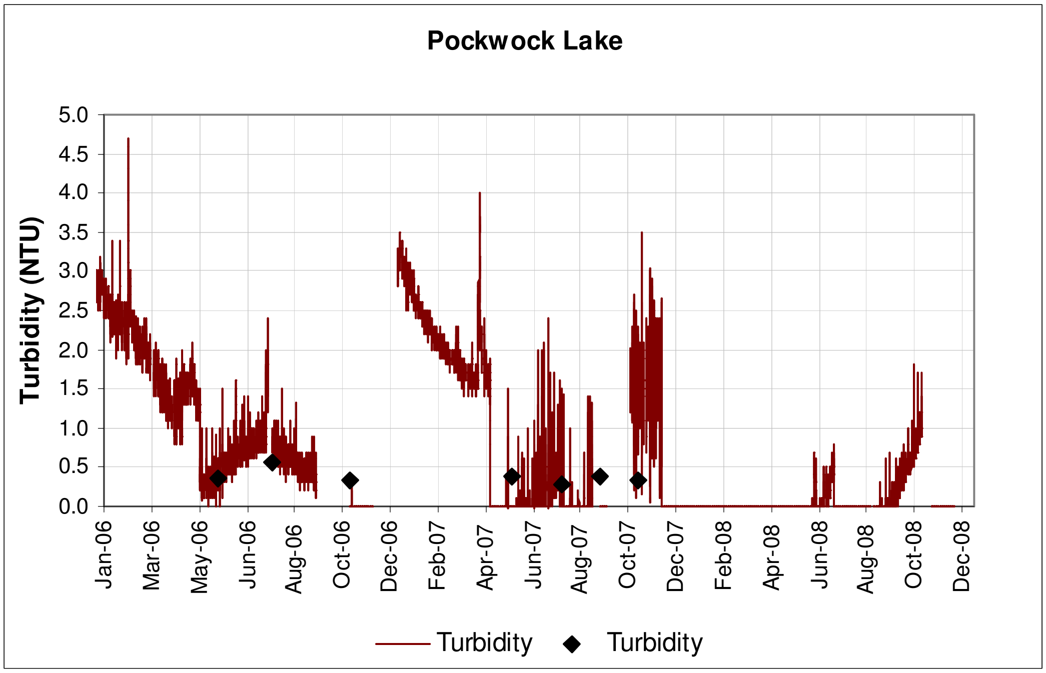


Figure 3.1 - 8 Turbidity levels from 2002 – 2008 for the Pockwock Lake based on daily mean values. Gaps in the plot indicate missing data.

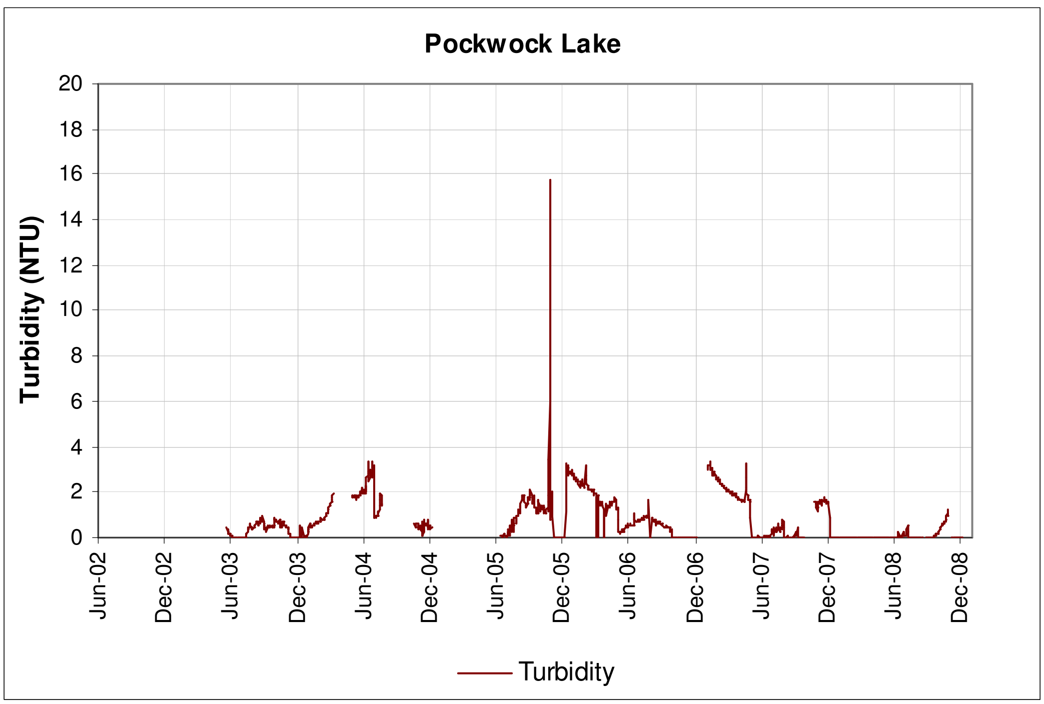


Figure 3.1 - 9 Turbidity levels from 2002 – 2008 for the Pockwock Lake based on monthly mean values. Gaps in the plot indicate missing data.

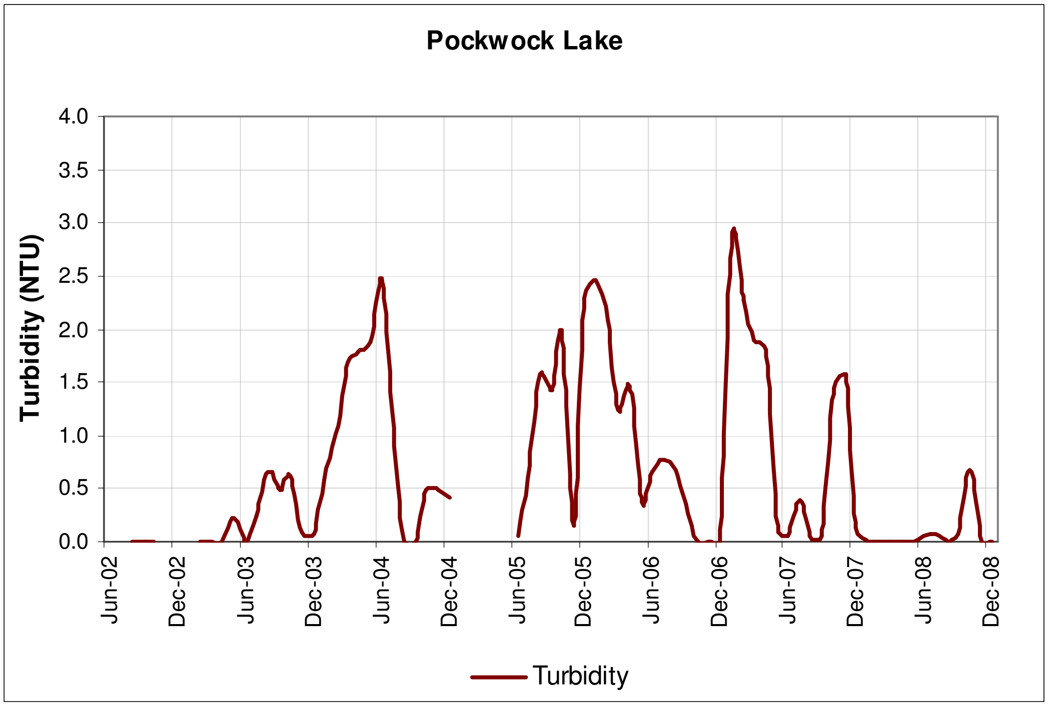


Table 3.1 - 5 Mean monthly turbidity for Pockwock Lake during 2006 – 2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----		---------- NTU ----------		-----
January	2006	2.4	2.2	2.7	0.1
February	2006	2.2	1.9	3.2	0.3
March	2006	1.2	0.0	1.9	0.6
April	2006	1.5	1.0	1.7	0.2
May	2006	0.4	0.2	1.3	0.2
June	2006	0.6	0.5	1.0	0.1
July	2006	0.8	0.0	1.7	0.4
August	2006	0.7	0.5	0.9	0.1
September	2006	0.4	0.0	0.6	0.2
October	2006	0.0	0.0	0.0	0.0
November	2006	0.0	0.0	0.0	0.0
December	2006	0.0	0.0	0.0	0.0
January	2007	2.9	2.6	3.3	0.2
February	2007	2.3	2.1	2.6	0.2
March	2007	1.9	1.7	2.1	0.1
April	2007	1.8	1.6	3.2	0.4
May	2007	0.1	0.0	1.6	0.4
June	2007	0.1	0.0	0.3	0.1
July	2007	0.4	0.1	0.8	0.2
August	2007	0.0	0.0	0.4	0.1
September	2007	0.1	0.0	0.4	0.1
October	2007	1.5	1.3	1.6	0.1

Month	Year	Mean	Minimum	Maximum	SD
-----	-----		---------- NTU ----------		-----
November	2007	1.5	1.1	1.7	0.1
December	2007	0.2	0.0	1.5	0.5
January	2008	0.0	0.0	0.0	0.0
February	2008	0.0	0.0	0.0	0.0
March	2008	0.0	0.0	0.0	0.0
April	2008	0.0	0.0	0.0	0.0
May	2008	0.0	0.0	0.0	0.0
June	2008	0.0	0.0	0.3	0.1
July	2008	0.1	0.0	0.5	0.2
August	2008	0.0	0.0	0.0	0.0
September	2008	0.1	0.0	0.3	0.1
October	2008	0.7	0.3	1.2	0.2
November	2008	0.0	0.0	0.0	0.0
December	2008	0.0	0.0	0.0	0.0

Table 3.1 - 6 Mean annual turbidity for Pockwock Lake during 2002 – 2008 based on mean daily data.

Year	Mean	Minimum	Maximum	SD
-----		---------- NTU ----------		-----
2002				
2003	0.3	0.0	1.0	0.3
2004	1.2	0.1	3.4	0.8
2005	1.2	0.0	15.7	1.4
2006	0.9	0.0	3.2	0.8
2007	1.0	0.0	3.3	1.0
2008	0.1	0.0	1.2	0.2

3.1.3.3 Conductivity

Figure 3.1 - 10 Conductivity levels from 2006 – 2008 for the Pockwock Lake based on hourly values. Gaps in the plot indicate missing data.

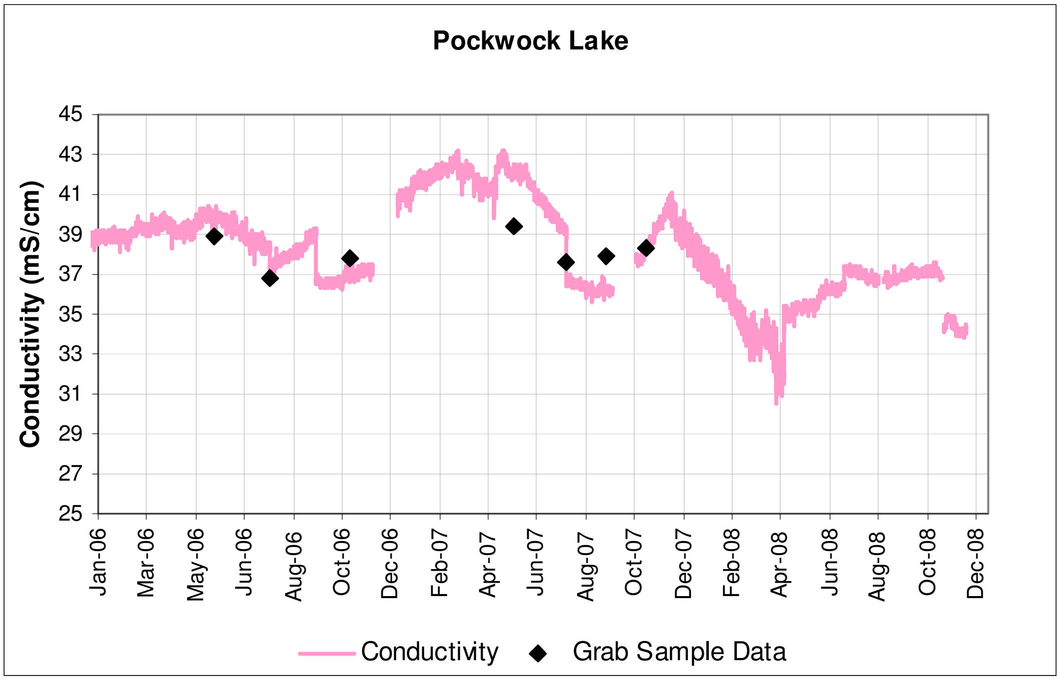


Figure 3.1 - 11 Turbidity levels from 2002 – 2008 for the Pockwock Lake based on daily mean values. Gaps in the plot indicate missing data.

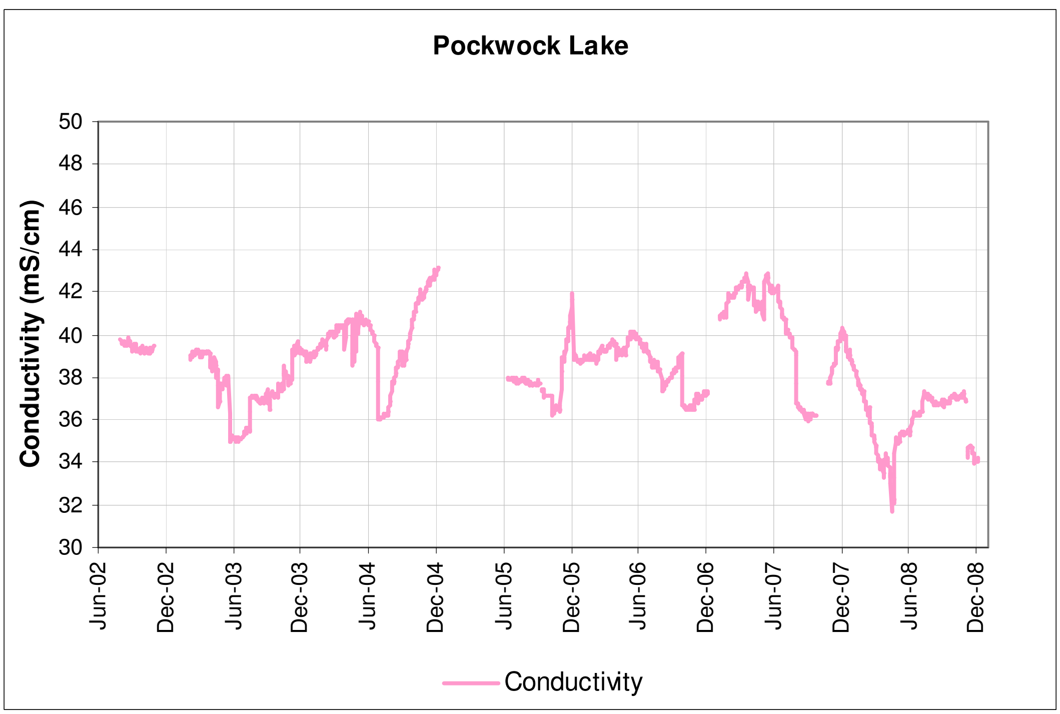


Figure 3.1 - 12 Conductivity levels from 2002 – 2008 for the Pockwock Lake based on monthly mean values. Gaps in the plot indicate missing data.

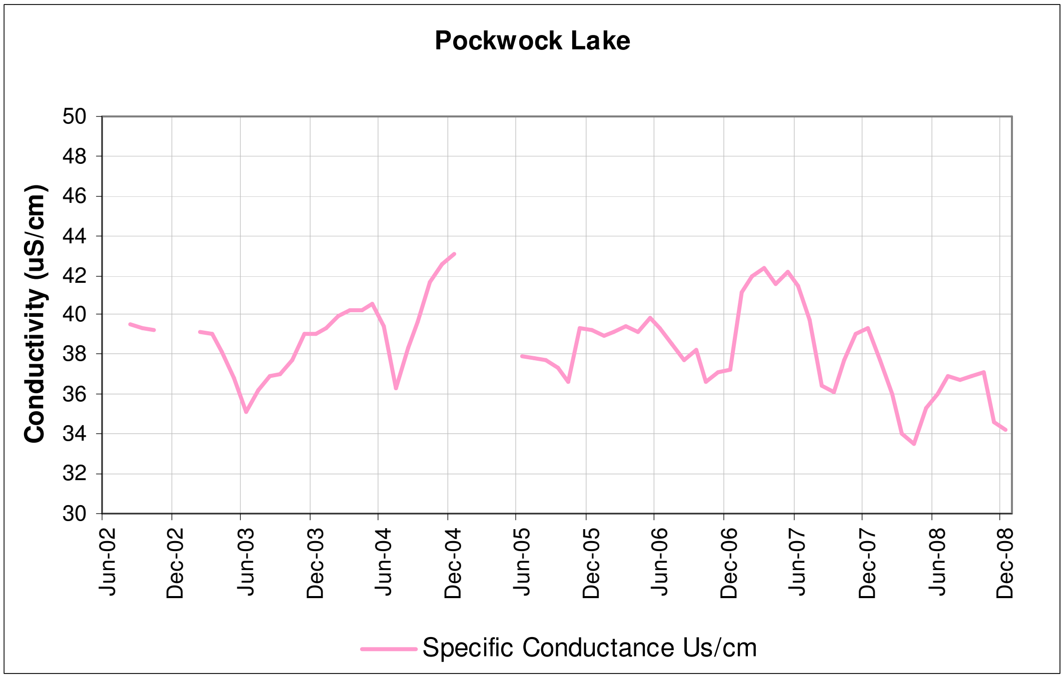


Table 3.1 - 7 Mean monthly conductivity for Pockwock Lake during 2006 – 2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----		---------- µS/cm ----------		-----
January	2006	38.9	38.8	39.1	0.1
February	2006	39.1	38.6	39.5	0.2
March	2006	39.5	39.2	39.7	0.2
April	2006	39.2	38.8	39.4	0.1
May	2006	39.9	39.5	40.2	0.1
June	2006	39.4	38.9	39.8	0.2
July	2006	38.6	38.3	38.9	0.2
August	2006	37.8	37.3	38.2	0.2
September	2006	38.3	36.6	39.1	0.7
October	2006	36.6	36.5	37.0	0.1
November	2006	37.1	36.8	37.3	0.1
December	2006	37.2	37.1	37.3	0.1
January	2007	41.1	40.7	41.9	0.4
February	2007	41.9	41.7	42.3	0.2
March	2007	42.4	41.7	42.9	0.2
April	2007	41.6	41.1	42.2	0.4
May	2007	42.2	40.7	42.9	0.6
June	2007	41.5	40.7	42.3	0.5
July	2007	39.9	39.0	40.7	0.5
August	2007	36.5	36.0	37.7	0.3
September	2007	36.2	35.9	36.3	0.1
October	2007	37.7	37.7	37.8	0.1
November	2007	39.0	37.8	40.1	0.7

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	----------	µS/cm	----------	-----
December	2007	39.4	38.7	40.3	0.5
January	2008	37.8	37.1	38.6	0.5
February	2008	36.1	35.1	37.3	0.6
March	2008	34.1	33.3	35.0	0.4
April	2008	33.5	31.7	35.2	1.1
May	2008	35.3	34.9	35.5	0.2
June	2008	36.0	35.3	36.4	0.3
July	2008	36.9	36.2	37.3	0.3
August	2008	36.8	36.6	37.0	0.1
September	2008	36.9	36.6	37.2	0.2
October	2008	37.1	37.0	37.3	0.1
November	2008	34.7	34.0	37.0	0.9
December	2008	34.1	34.0	34.3	0.1

Table 3.1 - 8 Mean annual conductivity for Pockwock Lake during 2002 – 2008 based on mean daily data.

Year	Mean	Minimum	Maximum	SD
-----	----------	uS/cm	----------	-----
2002	39.4	39.1	39.9	0.2
2003	37.7	35.0	39.7	1.4
2004	39.9	36.0	43.1	1.7
2005	38.0	36.2	41.9	1.1
2006	38.6	36.5	40.2	1.0
2007	40.1	35.9	42.9	2.1
2008	35.9	31.7	38.6	1.4

3.1.3.4 Dissolved Oxygen

Figure 3.1 - 13 Dissolved Oxygen levels from 2006 – 2008 for the Pockwock Lake based on hourly values. Gaps in the plot indicate missing data.

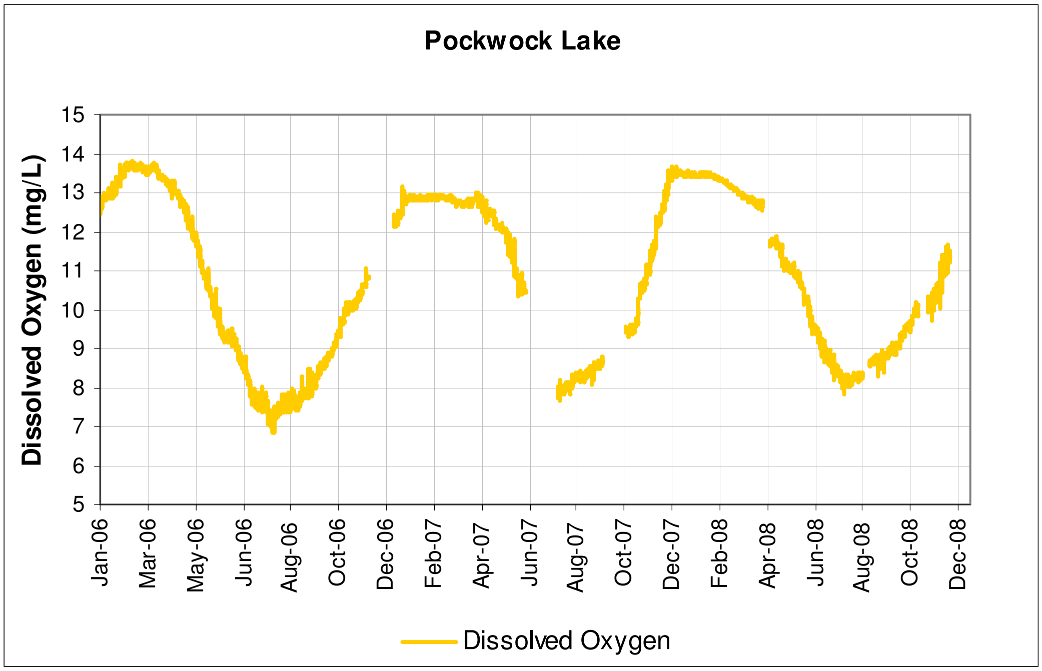


Figure 3.1 - 14 Dissolved Oxygen levels from 2002 – 2008 for the Pockwock Lake based on daily mean values. Gaps in the plot indicate missing data.

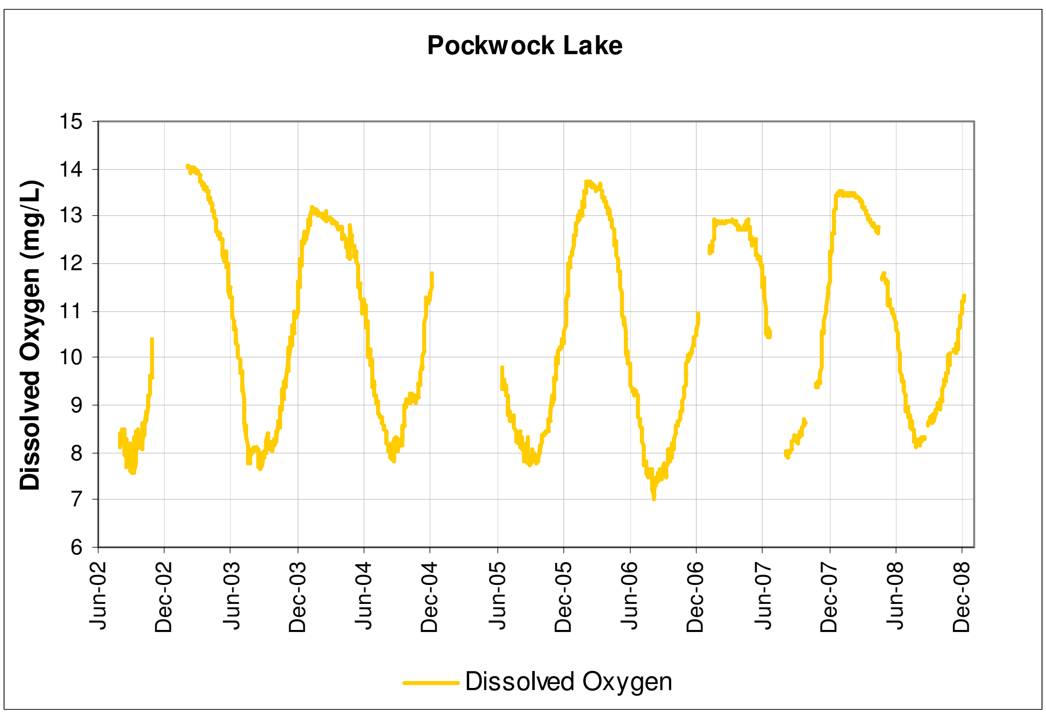


Figure 3.1 - 15 Dissolved Oxygen levels from 2002 – 2008 for the Pockwock Lake based on monthly mean values. Gaps in the plot indicate missing data.

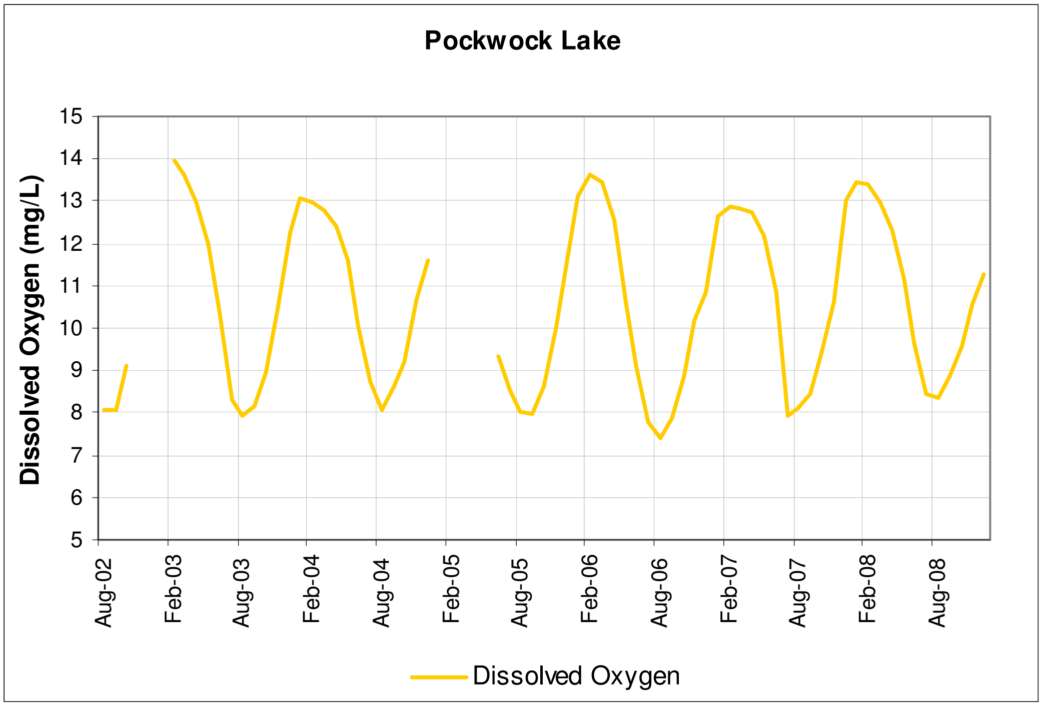


Table 3.1 - 9 Mean monthly dissolved oxygen for Pockwock Lake during 2006 – 2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----		---------- mg/L ----------		-----
January	2006	13.1	12.6	13.5	0.3
February	2006	13.7	13.6	13.7	0.0
March	2006	13.5	13.1	13.7	0.2
April	2006	12.6	11.8	13.2	0.4
May	2006	10.7	9.7	11.8	0.7
June	2006	9.1	8.6	9.7	0.3
July	2006	7.8	7.4	8.5	0.3
August	2006	7.4	7.0	7.8	0.2
September	2006	7.8	7.5	8.2	0.2
October	2006	8.8	8.3	9.7	0.4
November	2006	10.1	9.7	10.6	0.3
December	2006	10.8	10.6	10.9	0.1
January	2007	12.6	12.2	12.9	0.3
February	2007	12.9	12.8	12.9	0.0
March	2007	12.8	12.7	12.9	0.1
April	2007	12.7	12.5	12.9	0.1
May	2007	12.2	11.5	12.5	0.3
June	2007	10.9	10.4	11.7	0.4
July	2007				
August	2007	8.1	7.9	8.3	0.1
September	2007	8.5	8.2	8.7	0.1
October	2007	9.4	9.4	9.5	0.1

Month	Year	Mean	Minimum	Maximum	SD
-----	-----		---------- mg/L ----------		-----
November	2007	10.5	9.5	11.6	0.7
December	2007	13.0	11.8	13.5	0.5
January	2008	13.5	13.4	13.5	0.0
February	2008	13.4	13.2	13.5	0.1
March	2008	13.0	12.8	13.2	0.1
April	2008	12.4	11.7	12.8	0.5
May	2008	11.2	10.7	11.7	0.3
June	2008	9.7	8.9	10.6	0.5
July	2008	8.5	8.1	9.0	0.3
August	2008	8.3	8.1	8.7	0.2
September	2008	8.8	8.6	9.1	0.1
October	2008	9.6	9.1	10.1	0.3
November	2008	10.5	10.1	11.2	0.4
December	2008	11.3	11.2	11.3	0.1

Table 3.1 - 10 Mean annual dissolved oxygen for Pockwock Lake during 2002 – 2008 based on mean daily data

Year	Mean	Minimum	Maximum	SD
-----		---------- mg/L ----------		-----
2002	8.4	7.6	10.4	0.6
2003	10.8	7.6	14.1	2.2
2004	10.8	7.8	13.2	1.9
2005	9.2	7.7	12.6	1.3
2006	10.4	7.0	13.7	2.3
2007	11.4	7.9	13.5	1.8
2008	10.8	8.1	13.5	1.9

3.1.3.5 pH

Figure 3.1 - 16 pH levels from 2006 – 2008 for the Pockwock Lake based on hourly values. Gaps in the plot indicate missing data.

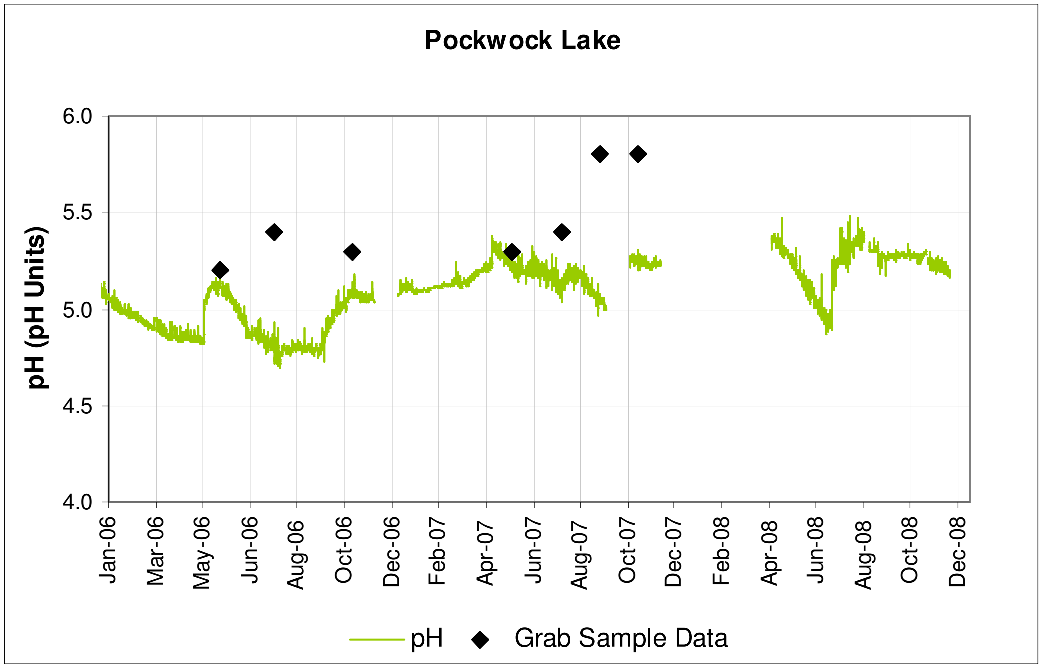


Figure 3.1 - 17 pH levels from 2002 – 2008 for the Pockwock Lake based on daily mean values. Gaps in the plot indicate missing data.

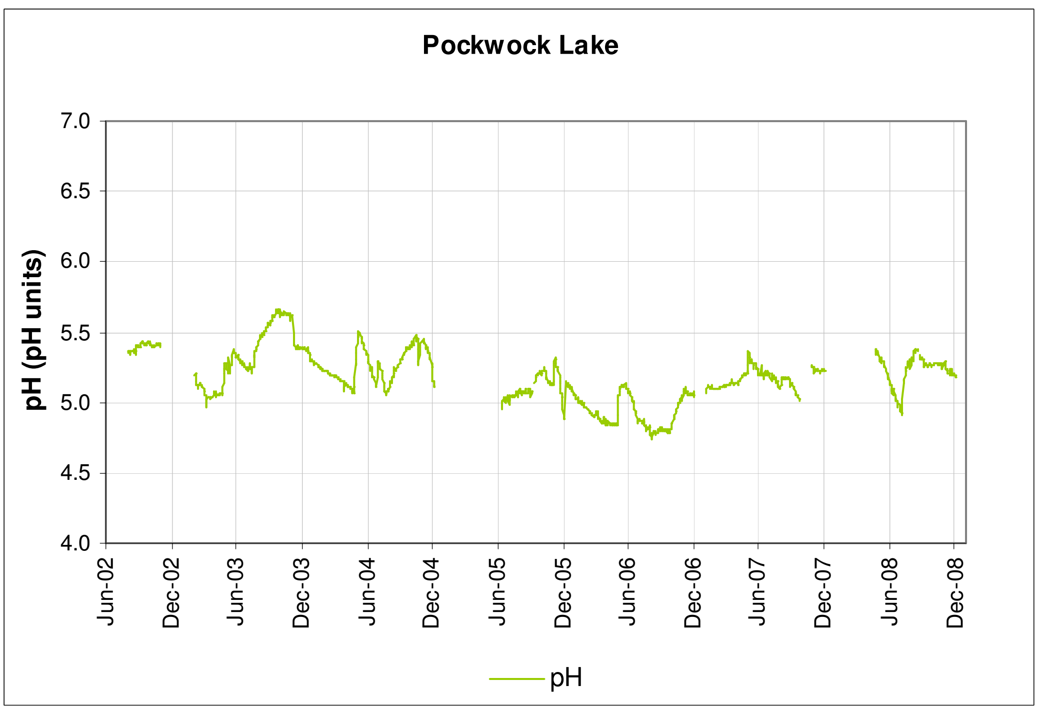


Figure 3.1 - 18 pH levels from 2002 – 2008 for the Pockwock Lake based on monthly mean values. Gaps in the plot indicate missing data.

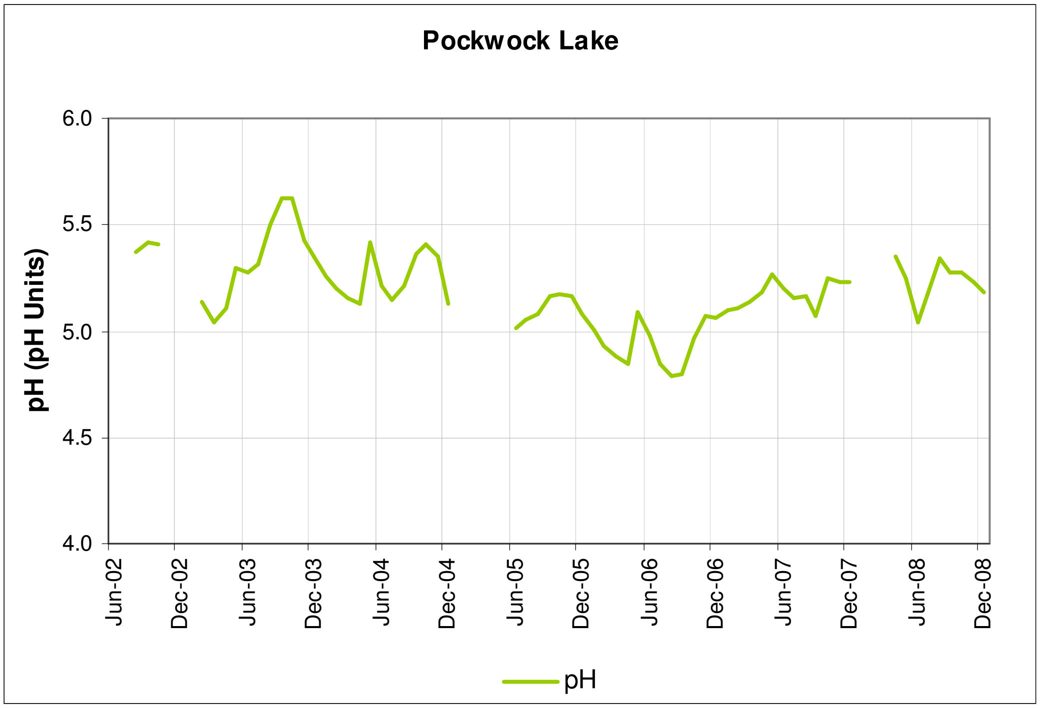


Table 3.1 - 11 Mean monthly pH for Pockwock Lake during 2006 – 2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	-----	-----	-----	-----
January	2006	5.0	5.0	5.1	0.0
February	2006	4.9	4.9	5.0	0.0
March	2006	4.9	4.8	4.9	0.0
April	2006	4.8	4.8	4.9	0.0
May	2006	5.1	4.8	5.1	0.1
June	2006	5.0	4.9	5.1	0.1
July	2006	4.8	4.8	4.9	0.0
August	2006	4.8	4.7	4.8	0.0
September	2006	4.8	4.8	4.8	0.0
October	2006	5.0	4.8	5.1	0.1
November	2006	5.1	5.0	5.1	0.0
December	2006	5.1	5.0	5.1	0.0
January	2007	5.1	5.1	5.1	0.0
February	2007	5.1	5.1	5.1	0.0
March	2007	5.1	5.1	5.2	0.0
April	2007	5.2	5.1	5.2	0.0
May	2007	5.3	5.2	5.4	0.0
June	2007	5.2	5.2	5.3	0.0
July	2007	5.2	5.1	5.2	0.0
August	2007	5.2	5.1	5.2	0.0
September	2007	5.1	5.0	5.1	0.0
October	2007	5.3	5.2	5.3	0.0
November	2007	5.2	5.2	5.2	0.0

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	-----	-----	-----	-----
December	2007	5.2	5.2	5.2	0.0
January	2008				
February	2008				
March	2008				
April	2008	5.4	5.3	5.4	0.0
May	2008	5.3	5.2	5.4	0.1
June	2008	5.0	4.9	5.1	0.1
July	2008	5.2	4.9	5.3	0.1
August	2008	5.3	5.3	5.4	0.0
September	2008	5.3	5.2	5.3	0.0
October	2008	5.3	5.2	5.3	0.0
November	2008	5.2	5.2	5.3	0.0
December	2008	5.2	5.2	5.2	0.0

Table 3.1 - 12 Mean annual pH for Pockwock Lake during 2002 – 2008 based on mean daily data

Year	Mean	Minimum	Maximum	SD
-----	-----	-----	-----	-----
2002	5.4	5.3	5.4	0.0
2003	5.3	5.0	5.7	0.2
2004	5.3	5.1	5.5	0.1
2005	5.1	4.9	5.3	0.1
2006	4.9	4.7	5.1	0.1
2007	5.2	5.0	5.4	0.1
2008	5.2	4.9	5.4	0.1

3.1.4 Overview of Pockwock Lake Water Quality

Water quality data collected at this station since 2002 are typical of a predominantly forested watershed (61% of total area) with a significant surface water component (23% of total area) of which a large portion exists as lake area. Igneous bedrock dominates the watershed geology. Small areas of metamorphic bedrock are also present.

Water quality data gathered at this monitoring station represents conditions at a depth of approximately 5m at the pumped outlet of the lake.

Data collection during 2002 and 2005 was incomplete due to equipment malfunction, where of a possible 8760 hourly readings per year only 2123 and 4102 were recorded for 2002 and 2005 respectively. Although limited data are provided for this station, summary statistics are not representative of annual conditions and should be viewed with caution. Therefore, no summary statistics, nor data interpretation for 2002 are provided in this overview.

Water temperature varied according to a seasonal pattern very similar to that of air temperature, and was typical of larger lakes. A slight lag between air and water temperature existed during the Fall cooling phase of the annual heat cycle, due to the slower rate of heat loss from the large thermal mass of the lake water as compared to the ambient air. Minimum hourly water temperatures during Winter (December to February) ranged from -0.2 ^{o}C in 2007 to 0.8^{o}C in 2003. Maximum hourly water temperatures during Summer (June to August) ranged from 23.3 ^{o}C in 2003 and 2004 to 24.1 ^{o}C in 2007. Mean hourly temperature readings ranged from 9.6 ^{o}C in 2007 to 10.8 ^{o}C in 2003 and 2006.

Based on hourly records, a range of from 7% (2007) to 14% (2003) of annual temperature measurements exceeded the recommended temperature limit of 20-21 ^{o}C for salmon and trout, all of which occurred in the months of June, July and August.

Turbidity values were relatively low for most of the period of record with an overall hourly mean of 0.7 NTU for the period of record. Minimum turbidity values were recorded as 0.0 NTU in all years of record. Maximum turbidity values ranged from 1.8 NTU in 2003 and 2008 to 35.9 NTU in 2005. Higher turbidity measurements generally occurred simultaneously with precipitation events. On occasion short- term peaks were observed in the absence of rain events which may be indicative of intermittent local land or water disturbances. High turbidity events greater than 25 NTU occurred only once between 2002 and 2008. Over a 24-hour period between October 25 and 26, 2005 turbidity readings reached upwards of 36 NTU. On October 23, 25 mm of rainfall occurred which may have played a minor role in the increase, but because other rainfall events of similar and greater amounts triggered only minor turbidity responses, it is more likely that some other factor was the main cause. During the study period no hourly turbidity measurements were greater than 50 NTU, the guideline for recreational use. Other than the event in October of 2005 no hourly turbidity measurements were greater than the drinking water aesthetic objective of 5 NTU. There appeared to be a repeating turbidity peak during the Spring and early growing season of some years that is possibly associated with algal growth, the magnitude of which is dependent on ambient conditions. Monthly mean data showed gradual increases in turbidity values starting in December, peaking in March, and declining to background levels in June or July. It should be noted that these relative ‘peak’ monthly values never exceeded 3.0 NTU, and were therefore not truly significant events overall.

Conductivity of Pockwock Lake varied only in a minor way and was characteristic of dilute waters with very few sources of impact. Minimum hourly values ranged from 30.5 uS/cm (2008) to 36.2 uS/cm (2006). Maximum hourly values ranged from 39.3 uS/cm (2008) to 40.4 uS/cm (2006), and mean values ranged from 35.9 uS/cm (2008) to 40.2 uS/cm (2007). No consistent temporal trend was observed, although monthly mean conductivity values seemed to hit seasonal lows during June in most years of record. This could be indicative of the lack of influence of groundwater seepage during the low flow Summer period.

Dissolved oxygen concentrations followed a trend that was essentially the inverse of temperature, showing seasonal Summer lows in the July-August period of each year. This is typical of shallow surface waters where the solubility of oxygen in water decreases as water temperature rises. Minimum hourly dissolved oxygen values ranged from 6.9 mg/l (2006) to 7.8 mg/l (2008) typically in July and August when water temperature peaked. Maximum values ranged from 13.4 mg/l (2004) to 14.2 mg/l (2003) during the colder months of January and February. The overall daily mean values ranged from 10.4 mg/l (2006) to 11.4 mg/l (2007). This annual trend was consistent throughout the period of record (2002 to 2008). At no time during this period did hourly concentrations dip below 6.9 mg/L, therefore never exceeding the recommended guideline for the protection of aquatic life of 5.0 mg/L.

Pockwock Lake pH data was highly variable during the study period (2002 to 2008) and indicated slightly acidic conditions. There were no apparent seasonal or annual trends consistently observed during this study period. However, there were indications of a downward pH trend occurring in the lake until 2006, with an increasing trend thereafter. Minimum hourly pH values ranged from 4.7 units (2006) to 5.0 units (2007), while maximum values ranged from a pH of 5.2 (2006) to a pH of 5.8 (2003). Mean hourly values ranged from a pH of 4.9 (2006) to a pH of 5.3 (2003 and 2004). There is some indication of pH lows occurred during late Fall to early Spring periods during the study period. The Pockwock Lake watershed contains substantial wetland areas which are known sources of organic acids that play a role in lowering pH. These acids are typically released into downstream receiving water during periods of high flow. This is also consistent with situations where snow melt and runoff cause low pH fluxes from watersheds experiencing atmospheric acid deposition – suggesting this possible source as well. Given the slightly acidic nature of the lake, recommended ranges of pH established as national guidelines for the Protection of Aquatic Life, Drinking Water, and Recreational use (6.5 to 9.0, 6.5 to 8.5 and,6.5 to 9.5 respectively) were exceeded for the entire monitoring period .

Data from grab samples or field meter readings taken during site visits generally were in good agreement with automated sensor values confirming quality of the dataset. Data for pH during the 2008 sampling season however were an exception with lesser agreement. This merits further investigation as to cause.

3.2 SHELBURNE RIVER

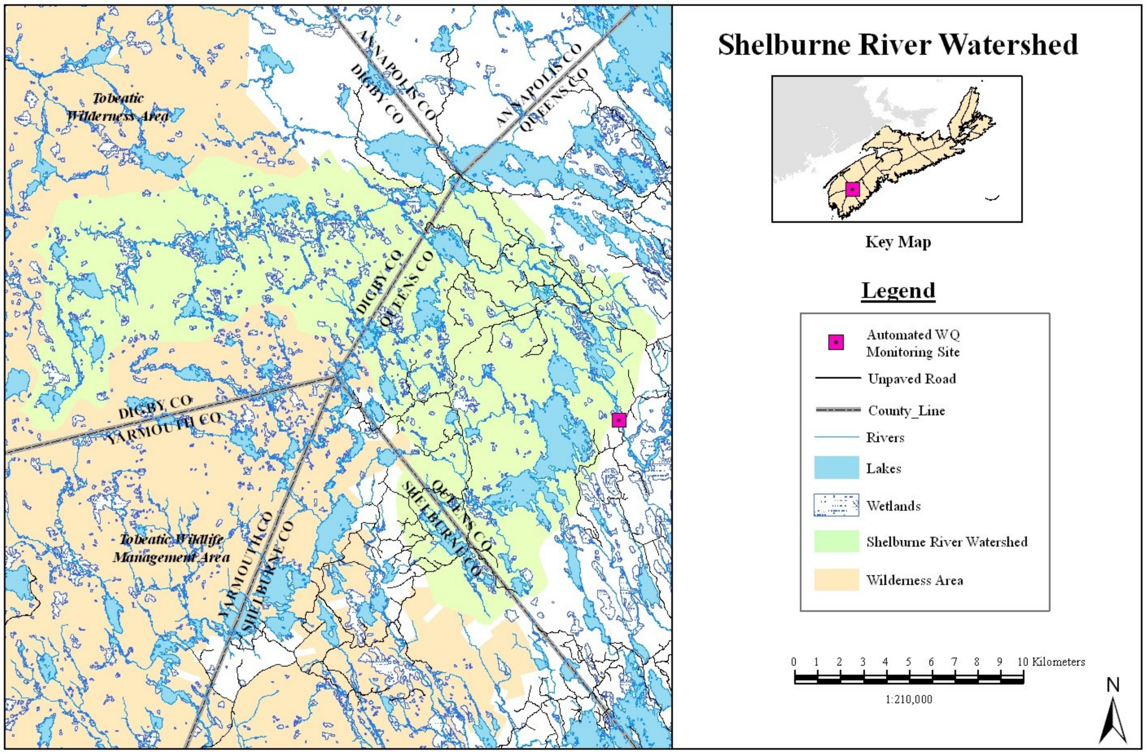


Figure 3.2 - 1 Location of Shelburne River watershed.

3.2.1 Background Information

Location of Station

The Shelburne River Automated Network Station is located at Latitude 44^{o}12’59”N, Longitude 65^{o}14’32” W.

Geographical Setting

The Shelburne River begins at Buckshot Lake in the Tobeatic Wilderness Area and empties into Lake Rossignol. It is 53 km long, its drainage area is 277.4 km^2 and it flows through many shallow, rocky lakes and rapids as well as wetlands and undisturbed forests. 5% of the watershed lies within Kejimkujik National Park.

Geology and Geomorphology

For the upper two-thirds of its length, the Shelburne flows over plutonic granites and granitoids, which lie under a large portion of southwestern Nova Scotia. It is covered by a thin layer of loose, stony, granite till. The lower portion of the river, east of Irving Lake, flows over more easily erodable quartzites and slates.

The dominant landscape features of the Shelburne have resulted from exposed underlying bedrock and glacial action. Exceptional examples of erratics, eskers, and outwash plains are characteristic of the Shelburne River. Drainage is poor, with peat bogs forming in the shallow depressions.

The dominant landform in the watershed is the undulating to moderately rolling plain with a thin mantle of stony till and peat bogs.

Forest Cover and Land Use

The river corridor is heavily forested and has some of the last old-growth stands of white pine, red spruce and hemlock in Nova Scotia, while the barren land surrounding it consists primarily of heath vegetation and bogs. About 75% of the watershed is Provincial Crown Land in wilderness condition. 75% of the land within the watershed is forested, 18% of it is covered by a combination of wetlands and water, and less than 0.5 % characterized as urban land use.

Climate

Normal (1971-2000) annual precipitation in the Shelburne River watershed, as recorded at the Environment Canada Climate Station in Kejimkujik National Park, is 1399 mm, comprised of 1155 mm of rainfall and 244 cm of snowfall. The mean annual temperature is 6.3 ^{o}C with a mean monthly high of 18.4 ^{o}C in July and a low of -6.1 ^{o}C in January.

Figure 3.2 - 2 Precipitation and Air Temperature data from Environment Canada Climate Station at Kejimkujik (Shelburne River Watershed) for 2006 through 2008. Gaps in the plot indicate missing data.

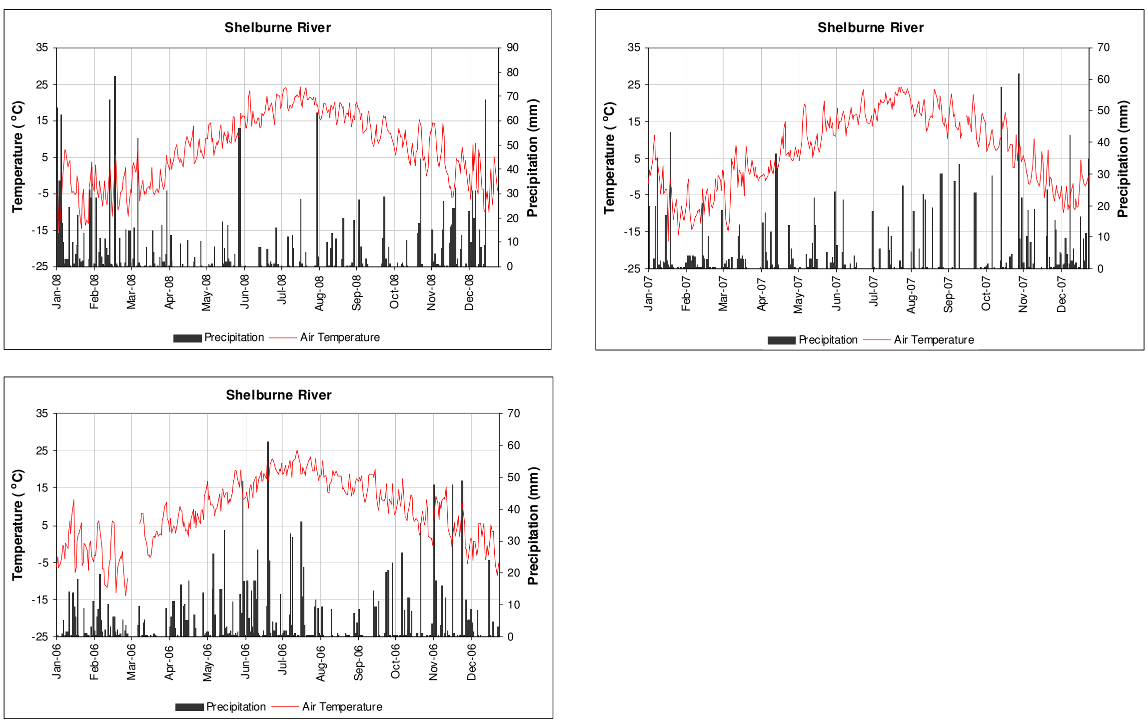


Figure 3.2 - 3 Shelburne River Automated Water Quality Monitoring Station.

Wildlife and Habitat
The area supports large black bear and moose populations and other species which prefer remote areas. There are numerous wetlands in the watershed which provide habitat for nesting ducks, beaver, otter and muskrat.

Human Settlement and Industrial Development
Centuries ago, the Shelburne River was used by the Mi'kmaq as a travel route as part of an important web of lakes and rivers. European settlers followed these Mi'kmaq canoe routes to hunt, fish, trap and explore. Industrial development in the watershed includes a limited amount of forestry, recreational fishing (e.g. salmon and brook trout), and tourism. The undisturbed riverbanks make the entire river corridor a popular wilderness canoeing destination. The undisturbed barrens and eskers also provide scenic views for hikers. The Shelburne River system was designated a Canadian Heritage River in 1997.

3.2.2 Land Use Summary Information

Table 3.2 - 1 Land use summary table for Shelburne River watershed

Land Type	km^2	% of Total Area
Agriculture	0	0
Barren	15.9	5.9
Clearcut	1.0	0.4
Forested	202.3	75.4
Urban	0.7	0.3
Wetland/Water	48.4	18.0
Total	268.3	100

3.2.3 Water Quality Summary Information

Table 3.2 - 2 Hourly statistics of minimum, maximum, mean and standard deviation and exceedences as per established water quality guidelines for hourly real time data for Shelburne River for the period 2002 – 2008.

Parameter	Year	Min	Max	Mean	SD	CWQ Guideline FWAL[1]	DW[1]	REC[1]	Readings[5]	# of Exceedences			Exceedences As % of Readings		
Temperature, °C	2002	0.0	30.3	10.8	8.3				3278	433			13		
	2003	0.0	28.7	10.4	8.8				8434	1345			16		
	2004	-0.2	27.9	9.7	8.8				8447	1351			16		
	2005	-0.1	29.6	11.6	8.8	20-21[2]			7961	1684			21		
	2006	-0.1	26.9	11.1	8.2				8540	1465			17		
	2007	-0.3	30.9	10.8	9.1				8573	1508			18		
	2008	-0.1	28.6	12.2	8.7				7621	1665			22		
Turbidity, NTU										DW <1[3]	DW ≤5[4]	REC	DW <1[3]	DW ≤5[4]	REC
	2002	0.0	74.6	1.4	2.5				2382	1372	22	2	58	<1	<1
	2003	0.0	6.4	0.4	0.6				1246	114	2	0	9	<1	0
	2004	0.0	19.6	0.8	0.8				6538	2395	23	0	37	<1	0
	2005	0.0	106.4	1.3	3.2		<1[3], ≤5[4]	≤50	7620	3171	146	5	42	2	<1
	2006	0.0	148.2	0.8	2.5				6512	1874	47	1	29	<1	<1
	2007	0.0	327.7	0.3	4.1				8439	545	22	3	6	<1	<1
	2008	0.0	148.6	0.1	2.0				6931	197	4	2	3	<1	<1
Conductivity, uS/cm	2002	24.2	44.6	34.2	4.7										
	2003	24.2	45.3	34.6	5.6										
	2004	21.3	46.9	34.2	7.0										
	2005	24.2	41.7	32.2	5.3										
	2006	25.0	45.0	32.7	4.4										
	2007	27.6	43.3	34.3	3.8										
	2008	21.5	42.4	28.6	5.7										
Dissolved Oxygen, mg/L	2002	5.4	14.2	10.0	2.5	≥5.0			3278	0			0		
	2003	5.4	14.3	10.5	2.8				8434	0			0		
	2004	5.0	13.2	10.0	2.4				8447	0			0		
	2005	5.9	13.6	9.9	2.4				7961	0			0		
	2006	6.3	13.4	9.4	2.0				7822	0			0		

Parameter	Year	Min	Max	Mean	SD	CWQ Guideline FWAL[1]	DW[1]	REC[1]	Readings[5]	# of Exceedences			Exceedences As % of Readings		
	2007	5.8	13.9	10.5	2.3				8572		0			0	
	2008	6.0	13.8	10.2	2.4				7621		0			0	
pH, Units										FWAL	DW	REC	FWAL	DW	REC
	2002	4.2	4.8	4.4	0.2				2474	2474	2474	2474	100	100	100
	2003	4.2	4.7	4.4	0.1				4186	4186	4186	4186	100	100	100
	2004	4.2	4.7	4.4	0.1				8447	8447	8447	8447	100	100	100
	2005	4.1	4.7	4.4	0.1	6.5-9.0	6.5-8.5	6.5-9.5	7961	7961	7961	7961	100	100	100
	2006	4.3	4.7	4.4	0.1				8540	8540	8540	8540	100	100	100
	2007	4.0	4.6	4.3	0.1				8573	8573	8573	8573	100	100	100
	2008	4.0	4.6	4.3	0.1				7621	7621	7621	7621	100	100	100

[1] FWAL: Freshwater Aquatic Life; DW: Drinking Water; REC: Recreational Use
[2] Upper permissible limit for salmon and trout (Alabaster and Lloyd, 1982). CCME DW guideline deemed to be inappropriate.
[3] Maximum Acceptable Concentration for water entering a distribution system.
[4] Aesthetic Objective. 5NTU may be permitted if demonstrated that the disinfection method is not compromised.
[5] The number of hourly readings possible in each of the years 2002, 2003, 2005, 2006, and 2007 is 8760. For 2004 and 2008 the number is 8784. The number recorded in the table refers to the actual number of approved measurements

3.2.3.1 Temperature

Figure 3.2 - 4 Water temperature from 2006 through 2008 for the Shelburne River using hourly values. Gaps in the plot indicate missing data

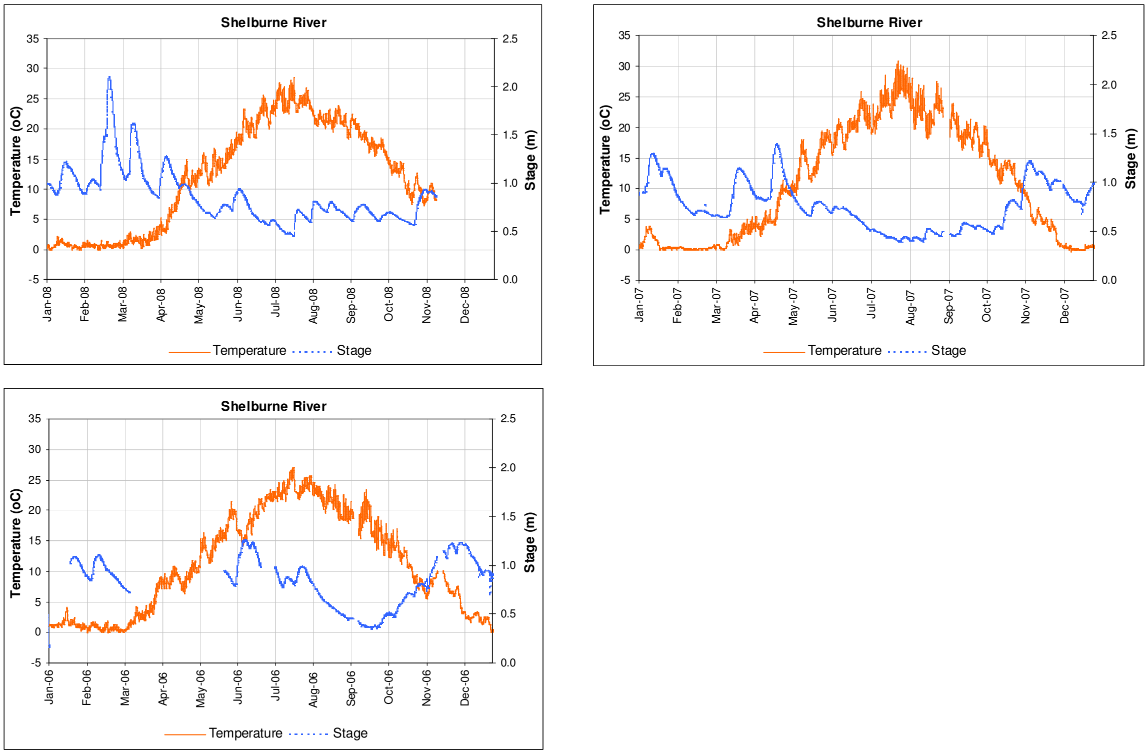


Figure 3.2 - 5 Water temperature from 2002 through 2008 for the Shelburne River using mean daily values. Gaps in the plot indicate missing data

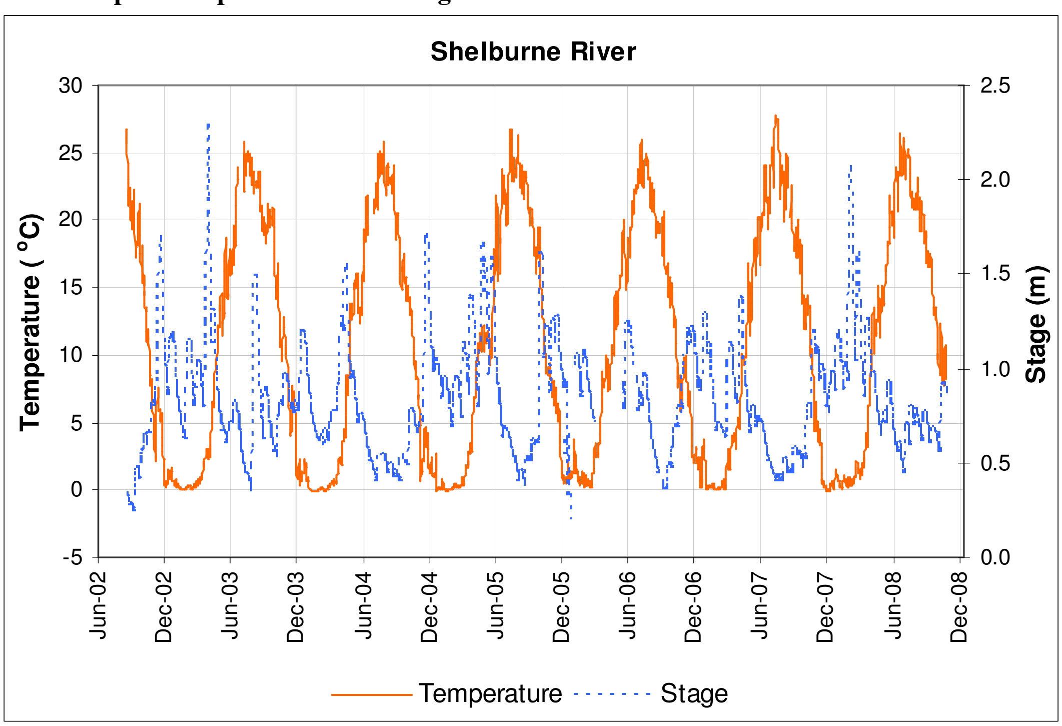


Figure 3.2 - 6 Water temperature from 2002 through 2008 for the Shelburne River using mean monthly values. Gaps in the plot indicate missing data

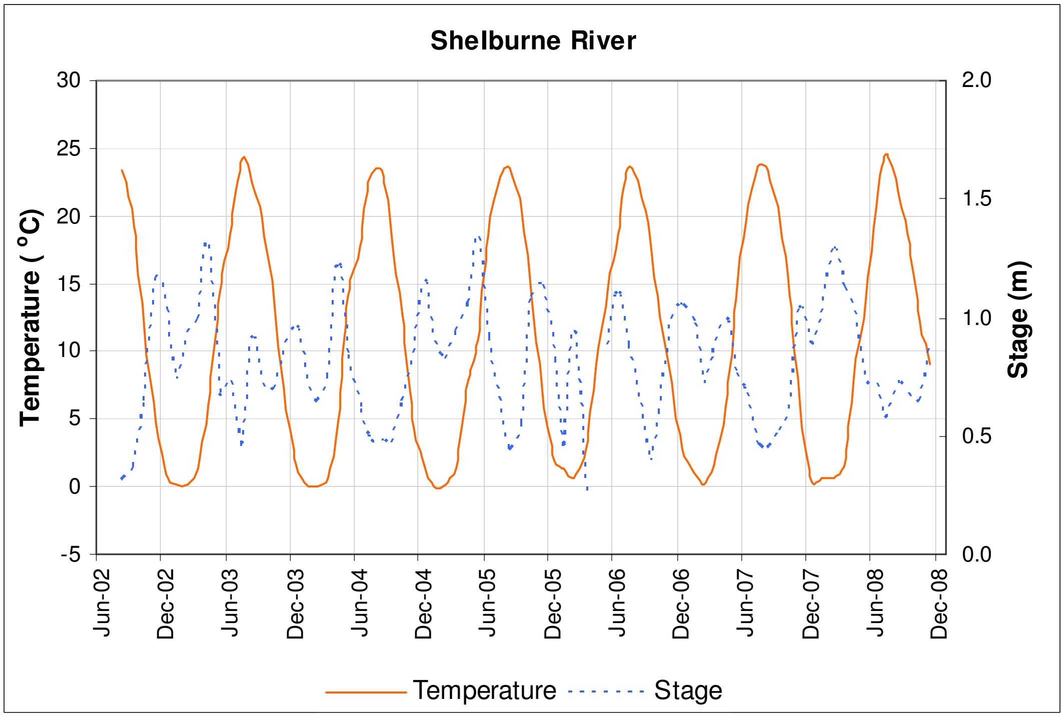


Table 3.2 - 3 Mean monthly water temperature for Shelburne River during 2006-2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----		---------- °C ----------		-----
January	2006	1.3	0.5	3.7	0.6
February	2006	0.7	0.2	1.4	0.3
March	2006	2.8	0.1	7.5	1.8
April	2006	8.8	7.3	10.8	1.0
May	2006	14.6	9.9	20.0	2.6
June	2006	18.7	14.9	22.2	2.2
July	2006	23.5	22.1	26.1	1.2
August	2006	22.0	18.7	25.0	1.6
September	2006	18.3	16.0	20.6	1.6
October	2006	12.5	7.6	15.8	2.5
November	2006	7.7	5.9	10.0	1.2
December	2006	2.8	0.2	7.4	1.7
January	2007	1.1	0.1	3.7	1.2
February	2007	0.2	0.1	0.4	0.1
March	2007	1.7	0.1	4.1	1.3
April	2007	5.9	3.1	10.2	2.4
May	2007	13.8	9.2	18.7	3.0
June	2007	19.7	15.9	24.0	2.1
July	2007	23.7	19.3	27.7	2.5
August	2007	23.4	19.8	27.0	2.0
September	2007	19.4	17.2	22.6	1.5

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	----------	---------- °C ----------	----------	-----
October	2007	14.1	10.3	18.5	2.1
November	2007	6.1	3.3	10.8	2.4
December	2007	0.4	-0.1	2.4	0.5
January	2008	0.6	0.1	1.6	0.4
February	2008	0.6	0.2	1.0	0.2
March	2008	1.5	0.5	2.8	0.5
April	2008	8.0	3.1	13.5	3.5
May	2008	13.8	11.3	16.6	1.5
June	2008	20.5	16.7	23.9	2.0
July	2008	24.6	22.2	26.4	1.1
August	2008	21.8	20.7	24.6	0.9
September	2008	18.6	16.5	21.3	1.5
October	2008	12.3	8.4	17.0	2.3
November	2008	9.0	7.7	10.7	0.9
December	2008				

Table 3.2 - 4 Mean annual water temperature for Shelburne River during 2002-2008 based on mean daily data.

Year	Mean	Minimum	Maximum	SD
-----	----------	---------- °C ----------	----------	-----
2002	11.99	0.94	23.31	9.42
2003	10.82	0.21	24.22	9.11
2004	10.06	0.01	23.30	9.09
2005	10.72	0.06	23.49	8.95
2006	11.14	0.66	23.46	8.29
2007	10.79	0.16	23.72	9.26
2008	11.95	0.56	24.57	8.78

3.2.3.2 Turbidity

Figure 3.2 - 7 Turbidity from 2006 through 2008 for the Shelburne River using hourly values. Gaps in the plot indicate missing data.

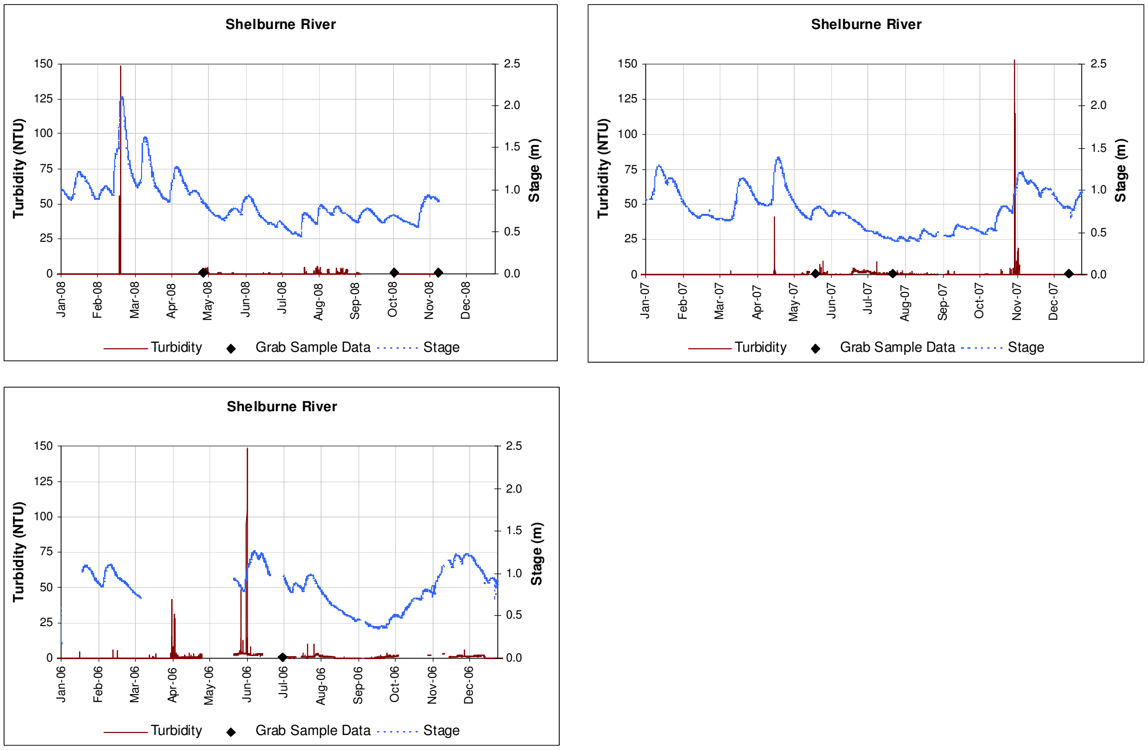


Figure 3.2 - 8 Turbidity from 2002 through 2008 for the Shelburne River using mean daily values. Gaps in the plot indicate missing data.

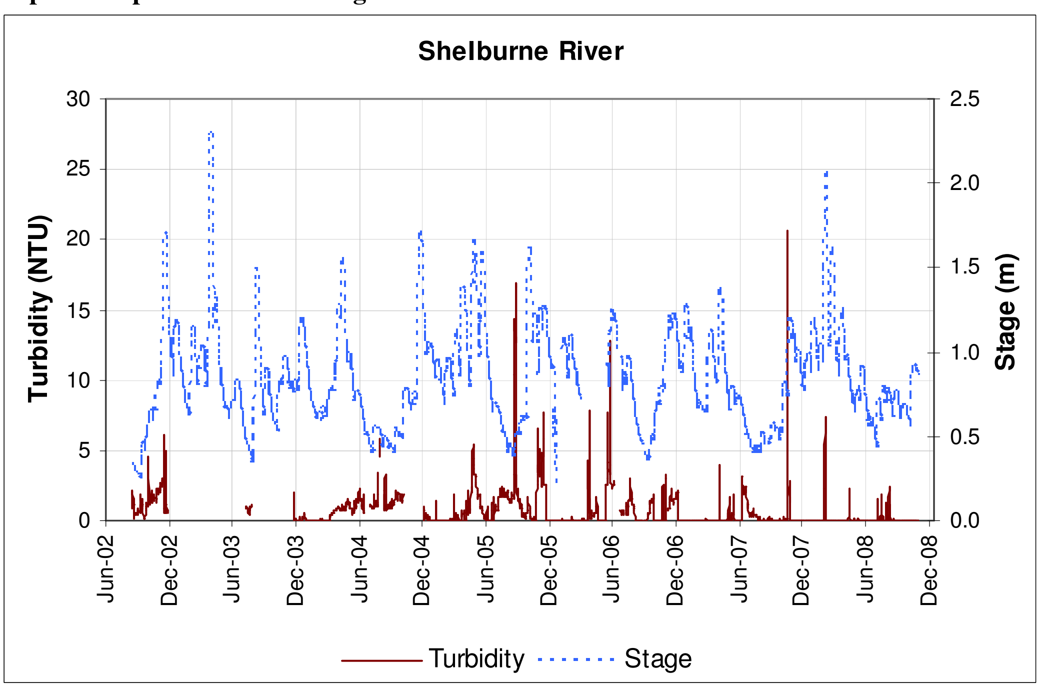


Figure 3.2 - 9 Turbidity from 2002 through 2008 for the Shelburne River using mean monthly values. Gaps in the plot indicate missing data.

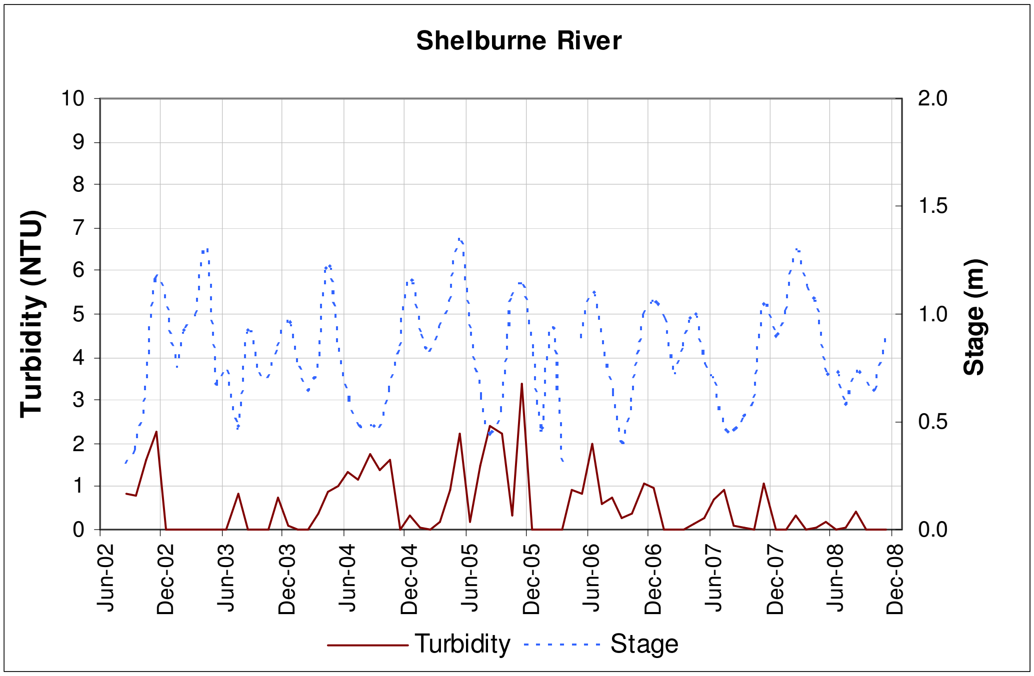


Table 3.2 - 5 Mean monthly turbidity for Shelburne River during 2006-2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	----------	NTU	----------	-----
January	2006	0.0	0.0	0.2	0.0
February	2006	0.0	0.0	0.2	0.1
March	2006	0.0	0.0	0.1	0.0
April	2006	0.9	0.0	7.8	1.5
May	2006	0.8	0.0	7.7	1.8
June	2006	2.0	0.0	12.7	2.5
July	2006	0.6	0.0	1.6	0.5
August	2006	0.7	0.0	2.9	0.9
September	2006	0.3	0.0	1.4	0.4
October	2006	0.4	0.0	1.9	0.7
November	2006	1.0	0.0	3.2	1.0
December	2006	1.0	0.0	2.1	0.8
January	2007	0.0	0.0	0.0	0.0
February	2007	0.0	0.0	0.0	0.0
March	2007	0.0	0.0	0.1	0.0
April	2007	0.1	0.0	4.0	0.7
May	2007	0.3	0.0	1.8	0.5
June	2007	0.7	0.0	3.1	1.1
July	2007	0.9	0.3	2.5	0.7
August	2007	0.1	0.0	0.4	0.1
September	2007	0.0	0.0	0.3	0.1
October	2007	0.0	0.0	0.3	0.1
November	2007	1.1	0.0	20.6	3.8

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	---------- NTU ----------			-----
December	2007	0.0	0.0	0.0	0.0
January	2008	0.0	0.0	0.0	0.0
February	2008	0.3	0.0	7.4	1.4
March	2008	0.0	0.0	0.0	0.0
April	2008	0.1	0.0	1.3	0.2
May	2008	0.2	0.0	2.3	0.5
June	2008	0.0	0.0	0.0	0.0
July	2008	0.1	0.0	1.5	0.3
August	2008	0.4	0.0	2.4	0.6
September	2008	0.0	0.0	0.2	0.0
October	2008	0.0	0.0	0.0	0.0
November	2008	0.0	0.0	0.0	0.0
December	2008				

Table 3.2 - 6 Mean annual turbidity for Shelburne River during 2002-2008 based on mean monthly data.

Year	Mean	Minimum	Maximum	SD
-----	---------- NTU ----------			-----
2002	1.37	0.77	2.25	0.71
2003	0.55	0.11	0.82	0.38
2004	0.89	0.01	1.74	0.63
2005	1.12	0.00	3.38	1.19
2006	0.65	0.01	2.01	0.58
2007	0.27	0.00	1.05	0.40
2008	0.09	0.00	0.40	0.15

3.2.3.3 Conductivity

Figure 3.2 - 10 Conductivity from 2006 through 2008 for the Shelburne River using hourly values. Gaps in the plot indicate missing data.

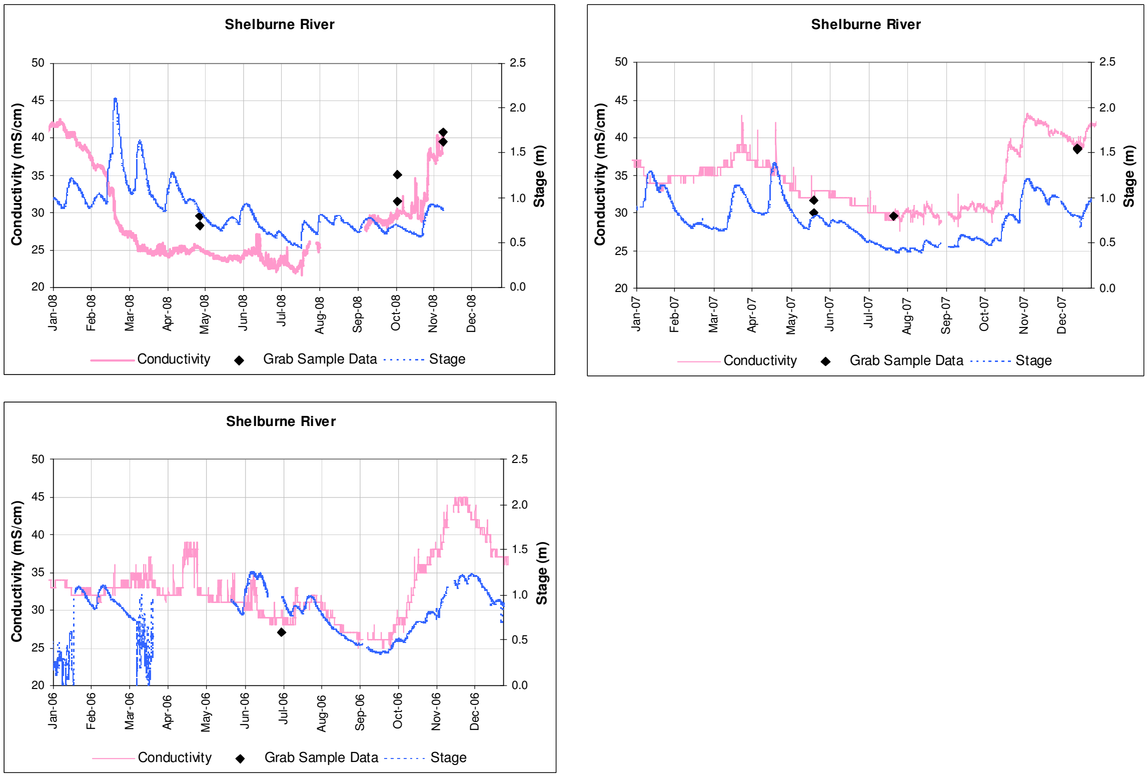


Figure 3.2 - 11 Conductivity from 2002 through 2008 for the Shelburne River using mean daily values. Gaps in the plot indicate missing data.

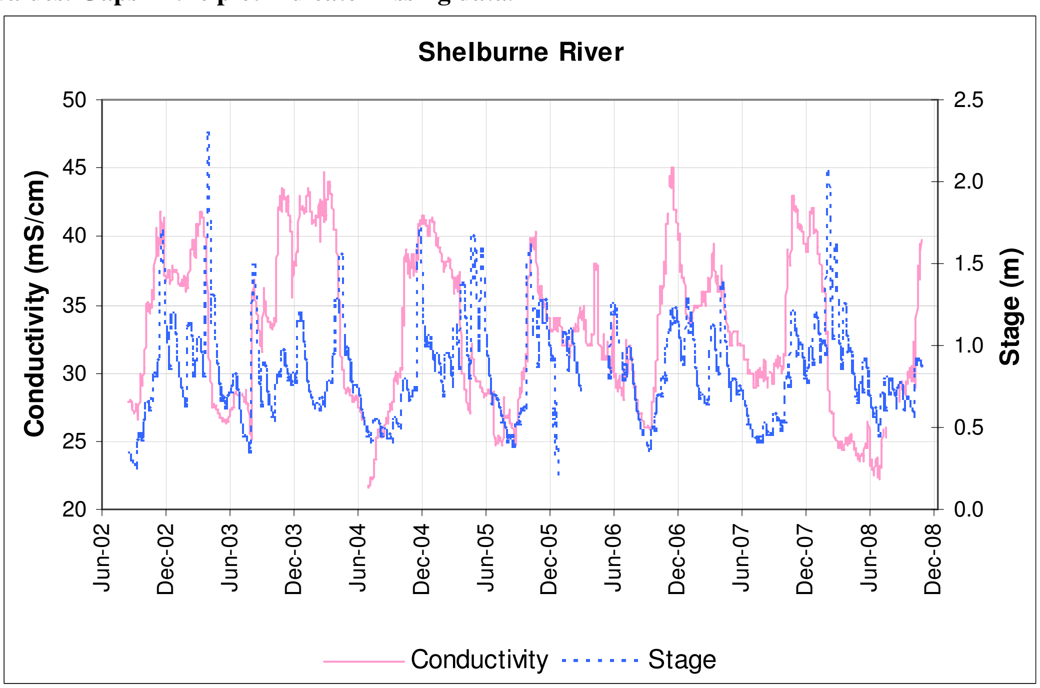


Figure 3.2 - 12 Conductivity from 2002 through 2008 for the Shelburne River using mean monthly values. Gaps in the plot indicate missing data.

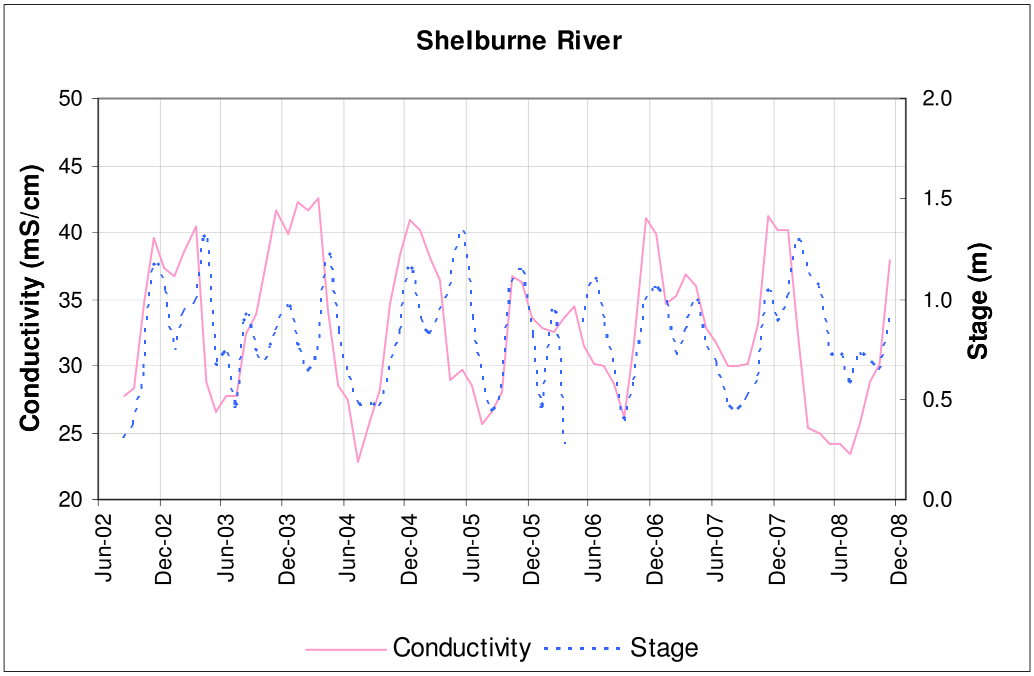


Table 3.2 - 7 Mean monthly conductivity for Shelburne River during 2006-2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	----------	µS/cm	----------	-----
January	2006	32.8	32.0	34.0	0.8
February	2006	32.6	31.2	33.5	0.7
March	2006	33.6	32.0	35.0	0.9
April	2006	34.5	32.0	38.0	2.7
May	2006	31.5	31.0	32.9	0.6
June	2006	30.1	28.6	34.3	1.4
July	2006	30.0	28.0	32.5	1.4
August	2006	28.7	27.0	31.1	1.5
September	2006	26.2	25.9	27.0	0.3
October	2006	31.7	26.6	36.4	3.3
November	2006	41.1	36.3	45.0	3.1
December	2006	39.8	36.7	44.3	2.3
January	2007	34.6	33.5	37.0	1.0
February	2007	35.2	34.8	36.0	0.4
March	2007	36.9	35.0	39.5	1.3
April	2007	36.0	34.1	37.8	0.9
May	2007	32.8	32.0	34.0	0.6
June	2007	31.8	31.0	33.0	0.6
July	2007	30.0	29.0	31.0	0.6
August	2007	30.0	29.1	31.0	0.5
September	2007	30.2	28.9	31.2	0.7
October	2007	33.1	30.0	39.0	3.4
November	2007	41.3	37.8	43.0	1.5

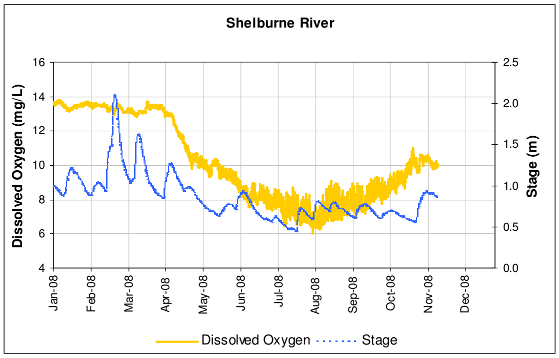
Month	Year	Mean	Minimum	Maximum	SD
-----	-----	---------- µS/cm ----------			-----
December	2007	40.1	38.9	41.8	0.8
January	2008	40.1	37.3	42.2	1.4
February	2008	32.6	27.1	37.3	3.7
March	2008	25.4	24.5	27.1	0.9
April	2008	25.0	24.3	25.5	0.3
May	2008	24.1	23.5	25.0	0.4
June	2008	24.1	22.7	26.4	1.0
July	2008	23.4	22.2	25.9	1.0
August	2008	25.6	25.3	26.0	0.4
September	2008	28.8	27.9	29.3	0.4
October	2008	30.1	28.9	32.5	0.9
November	2008	37.8	35.5	39.8	1.1
December	2008				

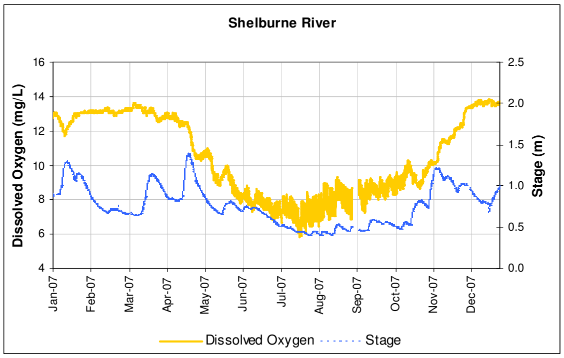
Table 3.2 - 8 Mean annual conductivity for Shelburne River during 2002-2008 based on mean monthly data.

Year	Mean	Minimum	Maximum	SD
-----	---------- uS/cm ----------			-----
2002	33.57	27.75	39.60	5.30
2003	34.34	26.64	41.69	5.54
2004	33.93	22.80	42.52	7.14
2005	32.38	25.71	40.16	5.00
2006	32.71	26.15	41.08	4.27
2007	34.33	29.96	41.26	3.77
2008	28.83	23.38	40.13	5.79

3.2.3.4 Dissolved Oxygen

Figure 3.2 - 13 Dissolved Oxygen from 2006 through 2008 for the Shelburne River using hourly values. Gaps in the plot indicate missing data.





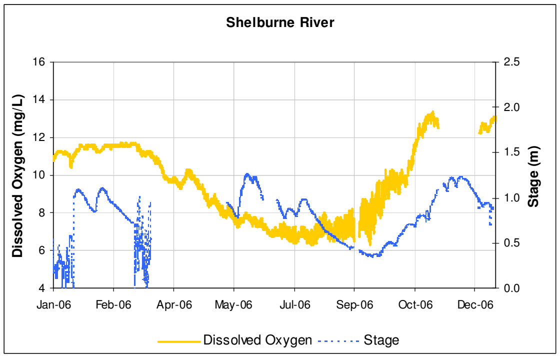


Figure 3.2 - 14 Dissolved Oxygen from 2002 through 2008 for the Shelburne River using mean daily values. Gaps in the plot indicate missing data.

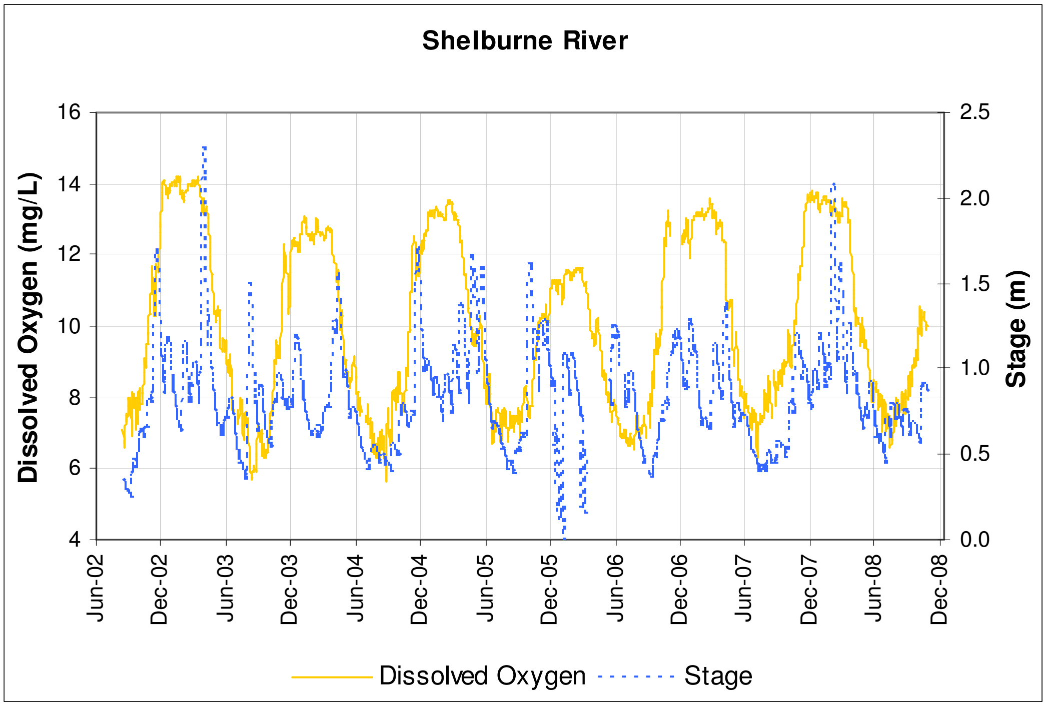


Figure 3.2 - 15 Dissolved Oxygen from 2002 through 2008 for the Shelburne River using mean monthly values. Gaps in the plot indicate missing data.

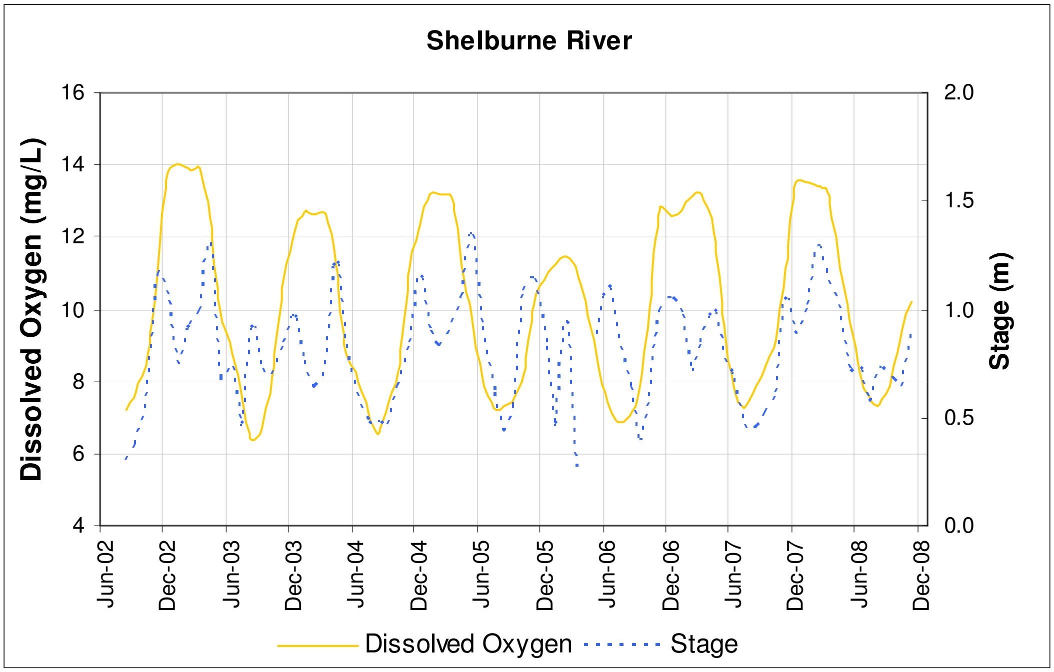


Table 3.2 - 9 Mean monthly dissolved oxygen for Shelburne River during 2006-2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	----------	mg/L	----------	-----
January	2006	11.2	10.6	11.6	0.2
February	2006	11.5	11.3	11.6	0.1
March	2006	11.2	10.4	11.6	0.4
April	2006	9.8	9.4	10.3	0.2
May	2006	8.5	7.6	9.4	0.5
June	2006	7.4	6.8	7.9	0.3
July	2006	6.9	6.6	7.1	0.1
August	2006	7.0	6.5	7.5	0.2
September	2006	7.8	6.9	8.8	0.5
October	2006	10.1	8.8	12.5	0.9
November	2006	12.8	12.2	13.2	0.3
December	2006	12.6	12.3	12.9	0.2
January	2007	12.7	11.9	13.2	0.4
February	2007	13.1	13.0	13.3	0.1
March	2007	13.2	12.6	13.6	0.3
April	2007	12.1	10.5	13.0	0.9
May	2007	9.6	8.3	10.8	0.8
June	2007	7.9	7.1	8.3	0.3
July	2007	7.3	6.3	7.7	0.3
August	2007	7.9	7.3	8.6	0.4
September	2007	8.4	7.7	8.8	0.3
October	2007	9.1	8.6	9.9	0.4
November	2007	11.2	9.7	12.4	0.8

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	---------- mg/L ----------			-----
December	2007	13.5	12.6	13.8	0.2
January	2008	13.5	13.2	13.7	0.1
February	2008	13.4	13.1	13.5	0.2
March	2008	13.2	12.9	13.6	0.2
April	2008	11.6	10.0	13.1	1.1
May	2008	9.7	9.0	10.2	0.3
June	2008	8.2	7.6	9.0	0.3
July	2008	7.6	7.0	8.1	0.3
August	2008	7.4	6.6	8.0	0.4
September	2008	8.2	7.5	8.7	0.4
October	2008	9.4	8.3	10.5	0.6
November	2008	10.2	9.9	10.4	0.2
December	2008				

Table 3.2 - 10 Mean annual dissolved oxygen for Shelburne River during 2002-2008 based on mean monthly data.

Year	Mean	Minimum	Maximum	SD
-----	---------- mg/L ----------			-----
2002	9.76	7.23	13.78	2.74
2003	10.40	6.38	14.02	2.86
2004	9.91	6.56	12.67	2.40
2005	9.99	7.27	13.20	2.33
2006	9.73	6.87	12.77	2.15
2007	10.50	7.27	13.51	2.38
2008	10.21	7.37	13.50	2.37

3.2.3.5 pH

Figure 3.2 - 16 pH from 2006 through 2008 for the Shelburne River using hourly values. Gaps in the plot indicate missing data.

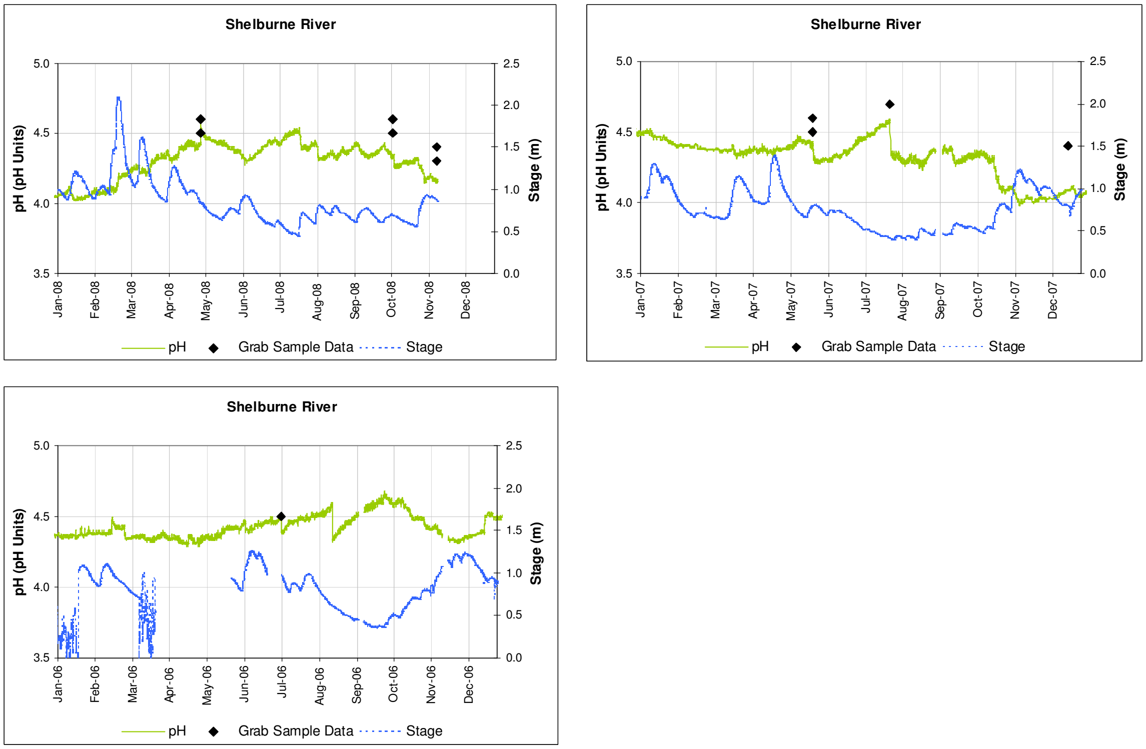


Figure 3.2 - 17 pH from 2002 through 2008 for the Shelburne River using mean daily values. Gaps in the plot indicate missing data.

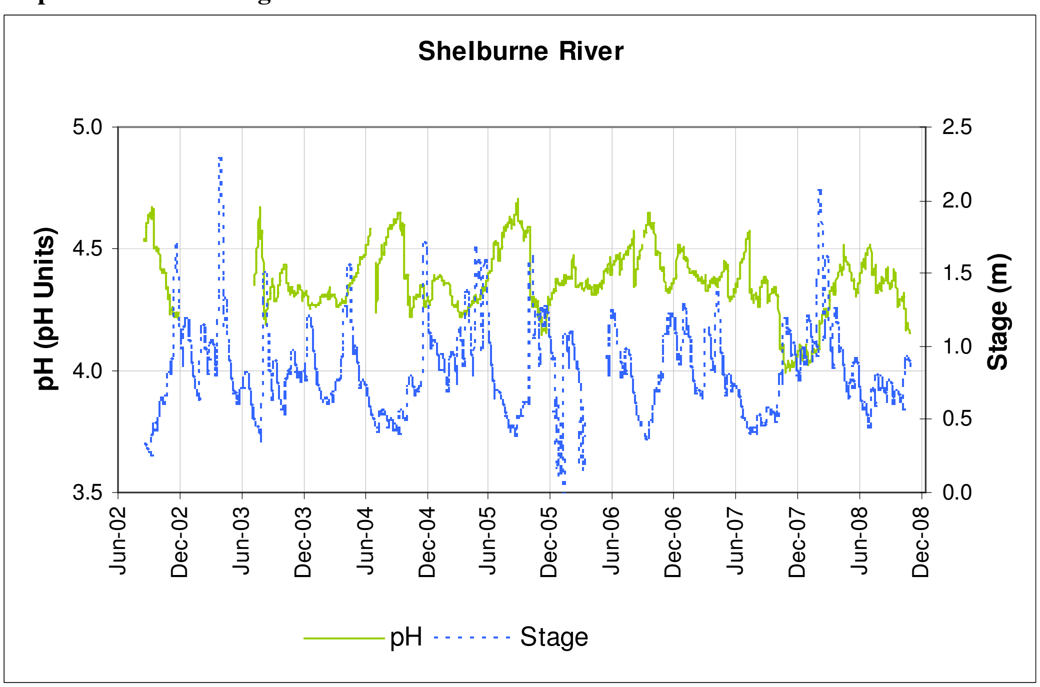


Figure 3.2 - 18 pH from 2002 through 2008 for the Shelburne River using mean monthly values. Gaps in the plot indicate missing data.

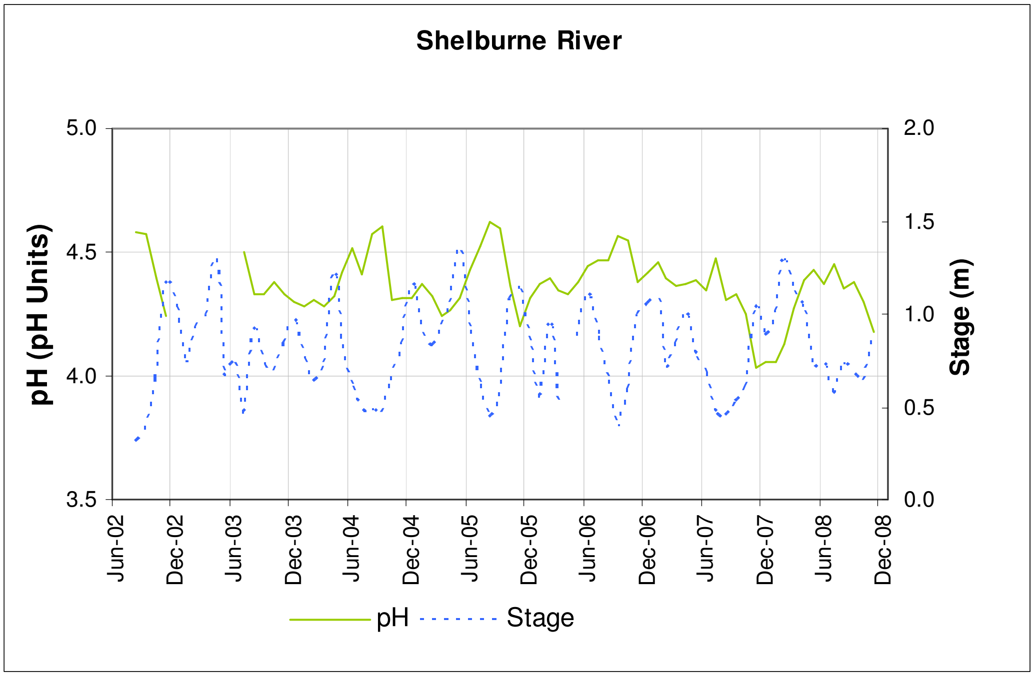


Table 3.2 - 11 Mean monthly pH for Shelburne River during 2006-2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	-----	-----	-----	-----
January	2006	4.4	4.4	4.4	0.0
February	2006	4.4	4.3	4.5	0.0
March	2006	4.4	4.3	4.4	0.0
April	2006	4.3	4.3	4.4	0.0
May	2006	4.4	4.3	4.4	0.0
June	2006	4.4	4.4	4.5	0.0
July	2006	4.5	4.4	4.5	0.0
August	2006	4.5	4.3	4.6	0.1
September	2006	4.6	4.5	4.7	0.1
October	2006	4.5	4.5	4.6	0.1
November	2006	4.4	4.3	4.4	0.0
December	2006	4.4	4.3	4.5	0.1
January	2007	4.5	4.4	4.5	0.0
February	2007	4.4	4.4	4.4	0.0
March	2007	4.4	4.3	4.4	0.0
April	2007	4.4	4.3	4.4	0.0
May	2007	4.4	4.3	4.4	0.1
June	2007	4.3	4.3	4.4	0.0
July	2007	4.5	4.3	4.6	0.1
August	2007	4.3	4.3	4.4	0.0
September	2007	4.3	4.3	4.4	0.0
October	2007	4.3	4.1	4.3	0.1
November	2007	4.0	4.0	4.1	0.0
December	2007	4.1	4.0	4.1	0.0

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	-----	-----	-----	-----
January	2008	4.1	4.0	4.1	0.0
February	2008	4.1	4.1	4.2	0.1
March	2008	4.3	4.2	4.3	0.0
April	2008	4.4	4.3	4.5	0.0
May	2008	4.4	4.4	4.5	0.0
June	2008	4.4	4.3	4.5	0.0
July	2008	4.5	4.4	4.5	0.0
August	2008	4.4	4.3	4.4	0.0
September	2008	4.4	4.3	4.4	0.0
October	2008	4.3	4.2	4.4	0.0
November	2008	4.2	4.2	4.2	0.0
December	2008				

Table 3.2 - 12 Mean annual pH for Shelburne River during 2002-2008 based on mean monthly data.

Year	Mean	Minimum	Maximum	SD
-----	-----	-----	-----	-----
2002	4.45	4.24	4.58	0.16
2003	4.36	4.29	4.50	0.07
2004	4.39	4.28	4.60	0.12
2005	4.38	4.20	4.62	0.14
2006	4.43	4.33	4.56	0.07
2007	4.31	4.04	4.48	0.14
2008	4.30	4.06	4.45	0.13

3.2.4 Overview of Shelburne River Water Quality

Water quality data for the period of record are typical of a predominantly forested watershed (75% of total area) with a significant surface water component (18% of total area) of which a portion exists as peat bog. Bedrock geology is a combination of areas of igneous and metamorphic bedrock.

Water temperature varied according to a seasonal pattern very similar to that of air temperature, which is typical of a shallow flowing river. Minimum hourly water temperatures in Winter (December to February) ranged from -0.3 ^oC (2007) to 0.0^oC (2002 and 2003). Maximum hourly water temperatures in Summer (June to August) ranged from 26.9^oC (2006) to 30.9 ^oC (2007). Mean hourly temperature readings ranged from 9.7 ^oC (2004) to 12.2 ^oC (2008). Based on hourly records, a range of from 13% (2002) to 22% (2008) of annual temperature measurements exceeded the recommended temperature limit of 20-21 ^oC for salmon and trout, almost all of which occurred in June, July, and August. Due to low stream flows and higher air temperature, water temperature also exceeded these fish habitat guidelines frequently during early September as well.

Turbidity values were relatively low for most of the period of record although there are periods when values were relatively higher for short periods of time. Sporadic events occurred each year during periods of increased flows, primarily in the Fall but also during the Spring. Most turbidity values were not above the overall hourly mean of 0.7 NTU. Minimum turbidity values were recorded as 0.0 NTU in all years of record. Maximum turbidity values ranged from 6.4 NTU (2003) to 327.7 NTU (2007). The relatively low maximum value recorded in 2003 was due to the low capture rate (14%) of turbidity values due to equipment failure. High turbidity events greater than 25 NTU occurred on a frequency of 4 times per year in 2002, and 6, 6, 6, 3 times per year in 2005, 2006, 2007, and 2008 respectively. Overall, less than 1 percent of hourly turbidity measurements were greater than 50 NTU, the guideline for recreational use. Similarly, less than 1% of turbidity measurements were greater than the drinking water aesthetic objective of 5 NTU during the period of record.

Water conductivity of the Shelburne River was characteristic of relatively dilute waters where minimum hourly values ranged from 21.3 uS/cm (2004) to 27.6 uS/cm (2007). Maximum values ranged from 41.7.0 uS/cm (2005) to 46.9 uS/cm (2004), and mean values ranged from 28.6 uS/cm (2008) to 34.6 uS/cm (2003). Only minor fluctuations in conductivity levels were observed to occur on an annual basis. The variation in conductivity appears to generally follow a pattern similar to stage, where peak periods occur during the Winter season and lows during Summer months. This pattern is the opposite of that observed in the Kelley River and North East Margaree River, where conductivity increased as stage decreased, being suggestive of groundwater influences during low flows. Conductivity patterns in the Shelburne River is suggestive of a greater influence from dissolved substances associated with runoff from the watershed during high flows and a lesser influence from groundwater seepage during low flows.

Dissolved oxygen concentrations followed a trend that was consistent with stage and the inverse of temperature, showing seasonal Summer lows in the July-August period of each year. This is typical of shallow surface waters where the solubility of oxygen in water decreases as water temperature rises. Minimum hourly dissolved oxygen values ranged from 5.0 mg/l (2004) to 6.3 mg/l (2006). Maximum values ranged from 13.2 mg/l (2004) to 14.3 mg/l (2003), and mean values ranged from 9.4 mg/l (2006) to 10.5 mg/l (2003). At no time during the period of record (2002 to 2008) did hourly dissolved oxygen concentrations dip below 5.7 mg/L, remaining well above a suggested threshold for the protection of aquatic life of 5.0 mg/L.

Values for pH were quite variable during the study period (2002 to 2008) with periods of higher hourly values generally during the Summer low flow period and low pH values during the periods of higher flows (Spring and Fall). Therefore, pH seems to have a weak inverse relationship to stage and stream flow. Minimum hourly pH values for the Shelburne River ranged from 4.0 units (2007 and 2008) to 4.3 units (2006), while maximum values ranged from a pH of 4.6 (2007 and 2008) to a pH of 4.8 (2002). Mean hourly values ranged from a pH of 4.3 (2007 and 2008) to a pH of 4.4 (2002 -2006), suggesting a possible increasing trend. This data suggests that the Shelburne River is a relatively poorly buffered system. Values for pH are relatively low compared to most surface waters in the province, although typical of areas with poorly buffered soils. The poorly drained and bog littered Shelburne River watershed produces runoff that is acidic and highly stained (colour 104-226 TCU, see Appendix III) which is typical of many areas in the Province. This is directly related to the bedrock and soils in the watershed, as well as the high percentage of wetlands in the watershed.

The Shelburne River watershed contains substantial wetland areas which are known sources of organic acids that play a role in lowering pH. These acids are typically released into downstream receiving water during periods of high flow. This is also consistent with situations where snow melt and runoff cause low pH fluxes from watersheds experiencing atmospheric acid deposition – suggesting this possible source as well. Given the acidic nature of this stream, recommended ranges of pH established as national guidelines for the Protection of Aquatic Life, Drinking Water, and Recreational use (6.5 to 9.0, 6.5 to 8.5 and,6.5 to 9.5 respectively) were exceeded for the entire monitoring period .

Data from grab samples or field meter readings taken during site visits generally were in good agreement with automated sensor values confirming quality of the dataset. Data for pH during the 2008 sampling season however were an exception with lesser agreement. This merits further investigation as to cause.

3.3 NORTH EAST MARGAREE RIVER

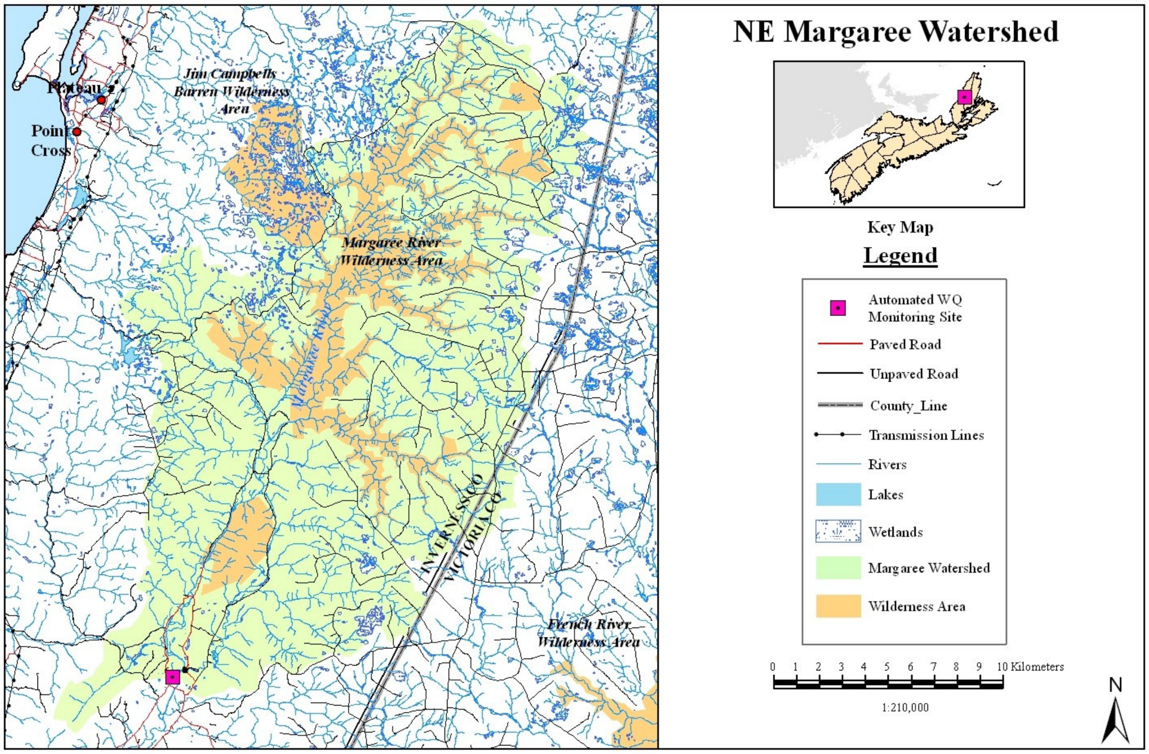


Figure 3.3 - 1 Location of North East Margaree watershed

3.3.1 Background Information

Location of Station

The North East Margaree Automated Network Station is located at Latitude 46°22'10"N, Longitude 60°58'36"W.

Geographical Setting

The North East Margaree River is located on Cape Breton Island in the Margaree River watershed. Its drainage area is 368 km^2 and it flows through the Aspy Fault as a steep valley stream and then widens to join the South East Margaree River, which traces its headwaters to Lake Ainslie, at Margaree Forks and then flows north through a wide tidal estuary to empty into the Gulf of Saint Lawrence at Margaree Harbour.

Geology and Geomorphology

The complex geology of Cape Breton is well displayed in the Margaree-Lake Ainslie system. As the North East Margaree flows along the Aspy Fault, it cuts through Precambrian, Cambrian, Ordovician and Silurian sedimentary and metamorphic rocks, visible as rhyolites and crystalline branded schists and gneisses in the upper reaches of the North East Margaree.

Classic examples of river erosion, ice erosion and deposition from the Wisconsin glaciation, including V-shaped valleys in the upper reaches and U-shaped valleys in the lower reaches dominate the landscape of the North East Margaree. The geomorphology of the system is made up of: braided channels of coarse sand and gravels; river terraces; point bars; cut banks; meanders; pools and riffles; natural levees; and finally river deltas in the broad tidal estuary where the Margaree enters the Gulf of St. Lawrence. The dominant landform in the watershed is a gently to strongly rolling plateau, with boggy depressions.

Forest Cover and Land Use

The Margaree valley has the greatest proportion of forested floodplain of any river in Nova Scotia, including spruce-fir forests, mixed hardwoods and remnant stands of maple-elm climax forest. 88% of the land within the watershed is forested, 8% covered by wetlands, and less than 0.5 % characterized as urban land use.

Climate

Normal (1971-2000) annual precipitation in the North East Margaree River watershed, as recorded at the Environment Canada Climate Station at Cheticamp is 1391 mm, comprised of 1055 mm of rainfall and 338 cm of snowfall. The mean annual temperature is 6.2 ^{o}C with a mean monthly high of 18.3 ^{o}C in July and a low of -6.7 ^{o}C in February.

Figure 3.3 - 2 Precipitation and Air Temperature data from Environment Canada Climate Station at Cheticamp (North East Margaree River Watershed) for 2006 through 2008. Gaps in the plot indicate missing data.

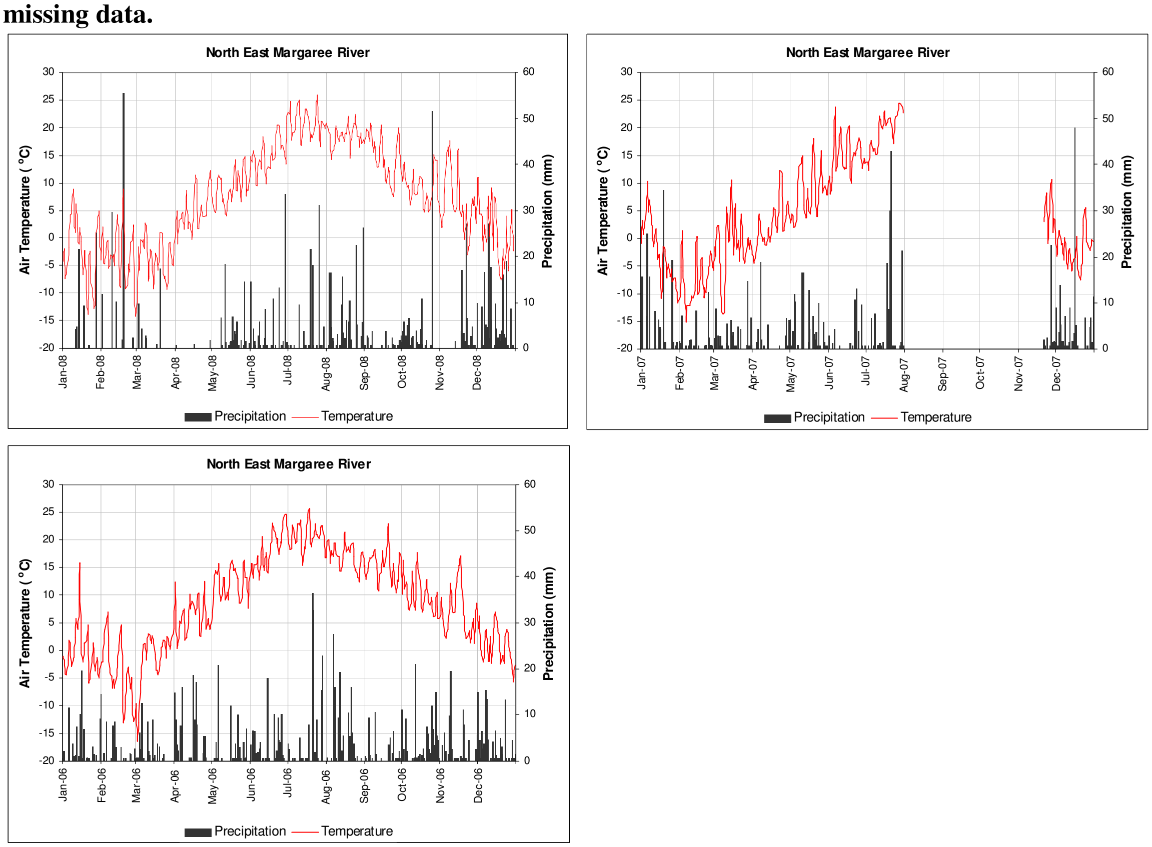


Figure 3.3 - 3 North East Margaree River monitoring station

Wildlife and Habitat

Gravel bars in the upper reaches provide safe haven for spawning salmon, which return to spawn. Young salmon, gaspereau and sea (speckled) trout run heavy in the Spring. The watershed also provides habitat to striped bass, bald eagles, osprey, ringnecked ducks, the rare Gaspé shrew, rock voles, pine martens, lynx, and moose.

Human Settlement and Industrial Development

The Mi'kmaq called the river "Weekuch". Early French settlers gave the river the name St. Marguerite in the 18th century. The 19th century saw many Scottish, English and Irish immigrants settle in the Margaree river valley to farm, fish and log. Industrial development in the watershed includes forestry, commercial and recreational fishing (e.g. salmon and gaspereau), and tourism. The river system is popular with outdoor enthusiasts for such activities as fishing, hiking and canoeing. The Margaree River system was nominated to the Canadian Heritage River System in 1991 and was designated a Canadian Heritage River in 1998.

3.3.2 Land Use Summary Information

Table 3.3 - 1 Land use summary table for North East Margaree watershed

Land Type	km^2	% of Total Area
Agriculture	2.8	0.8
Barren	9.6	2.6
Clearcut	0.8	0.2
Forested	323	88.1
Urban	1.2	0.3
Wetland/Water	29.3	8.0
Total	366.7	100

3.3.3 Water Quality Summary Information

Table 3.3 - 2 Hourly statistics of minimum, maximum, mean, and standard deviation and exceedences as per established water quality guidelines for hourly real time data for North East Margaree River for the period 2002 – 2008.

Parameter	Year	Min	Max	Mean	SD	CWQ Guideline			Readings[5]	# of Exceedences			Exceedences As % of Readings		
						FWAL[1]	DW[1]	REC[1]							
Temperature, °C	2002	-0.3	23.3	9.8	6.3				4841	87			2		
	2003	-0.2	21.7	8.8	6.3				6889	29			<1		
	2004	-0.3	21.8	6.3	6.1				8401	23			<1		
	2005	-0.1	22.0	8.1	6.4	20-21[2]			8031	25			<1		
	2006	-0.3	23.6	7.9	6.1				8727	36			<1		
	2007	-0.5	23.3	6.3	6.0				8230	24			<1		
	2008	-0.1	23.5	7.6	6.2				8104	102			1		
Turbidity, NTU										DW <1[3]	DW ≤5[4]	REC	DW <1[3]	DW ≤5[4]	REC
	2002	0.0	10.6	1.0	1.4				654	239	2	0	37	0	0
	2003	0.0	96.4	1.8	5.6				3986	1540	228	14	39	6	<1
	2004	0.0	80.5	1.5	3.9				7616	3240	365	0	42	5	0
	2005	0.0	57.4	0.8	3.9		<1[3], ≤5[4]	≤50	4841	590	163	5	12	3	<1
	2006	0.0	35.0	1.8	2.1				4586	1151	140	0	25	3	<1
	2007	0.0	98.1	1.5	4.7				7746	1469	361	15	19	5	<1
	2008	0.0	157.5	1.3	7.7				4253	182	149	24	4	4	<1
Conductivity, uS/cm	2002	48.6	329.0	158.8	71.5										
	2003	28.9	366.0	165.4	68.6										
	2004	42.6	380.0	172.6	74.8										
	2005	36.0	344.7	161.2	78.8										
	2006	25.0	300.0	155.5	56.2										
	2007	20.0	345.0	155.3	54.6										
	2008	43.5	289.0	137.2	47.7										

Parameter	Year	Min	Max	Mean	SD	CWQ Guideline FWAL[1]	DW[1]	REC[1]	Readings[5]	# of Exceedences			Exceedences As % of Readings		
Dissolved Oxygen, mg/L	2002	7.7	14.7	11.0	1.9				4841	0			0		
	2003	7.4	15.8	11.3	2.4				6001	0			0		
	2004	7.0	15.5	12.3	2.2				8361	0			0		
	2005	6.7	15.1	11.3	2.3	≥5.0			8028	0			0		
	2006	7.3	14.4	11.4	1.8				8722	0			0		
	2007	7.0	19.0	12.1	2.4				8121	0			0		
	2008	7.9	16.1	11.8	2.0				7085	0			0		
pH, Units										FWAL	DW	REC	FWAL	DW	REC
	2002	6.3	7.7	7.2	0.2				4841	40	40	40	<1	<1	<1
	2003	6.2	8.2	7.1	0.2				6885	32	32	32	<1	<1	<1
	2004	6.4	8.0	7.2	0.2				8401	11	11	11	<1	<1	<1
	2005	6.2	8.0	7.2	0.3	6.5-9.0	6.5-8.5	6.5-9.5	8031	94	94	94	3	3	3
	2006	6.2	7.8	7.2	0.2				8727	53	53	53	<1	<1	<1
	2007	6.3	7.9	7.2	0.2				8230	42	42	42	<1	<1	<1
	2008	6.3	7.8	7.1	0.3				7432	51	51	51	<1	<1	<1

[1] FWAL: Freshwater Aquatic Life; DW: Drinking Water; REC: Recreational Use
[2] Upper permissible limit for salmon and trout (Alabaster and Lloyd, 1982). CCME DW guideline deemed to be inappropriate.
[3] Maximum Acceptable Concentration for water entering a distribution system.
[4] Aesthetic Objective. 5NTU may be permitted if demonstrated that the disinfection method is not compromised.
[5] The number of hourly readings possible in each of the years 2002, 2003, 2005, 2006, and 2007 is 8760. For 2004 and 2008 the number is 8784. The number recorded in the table refers to the actual number of approved measurements.

3.3.3.1 Temperature

Figure 3.3 - 4 Water temperature from 2006 through 2008 for the North East Margaree River using hourly values. Gaps in the plot indicate missing data.

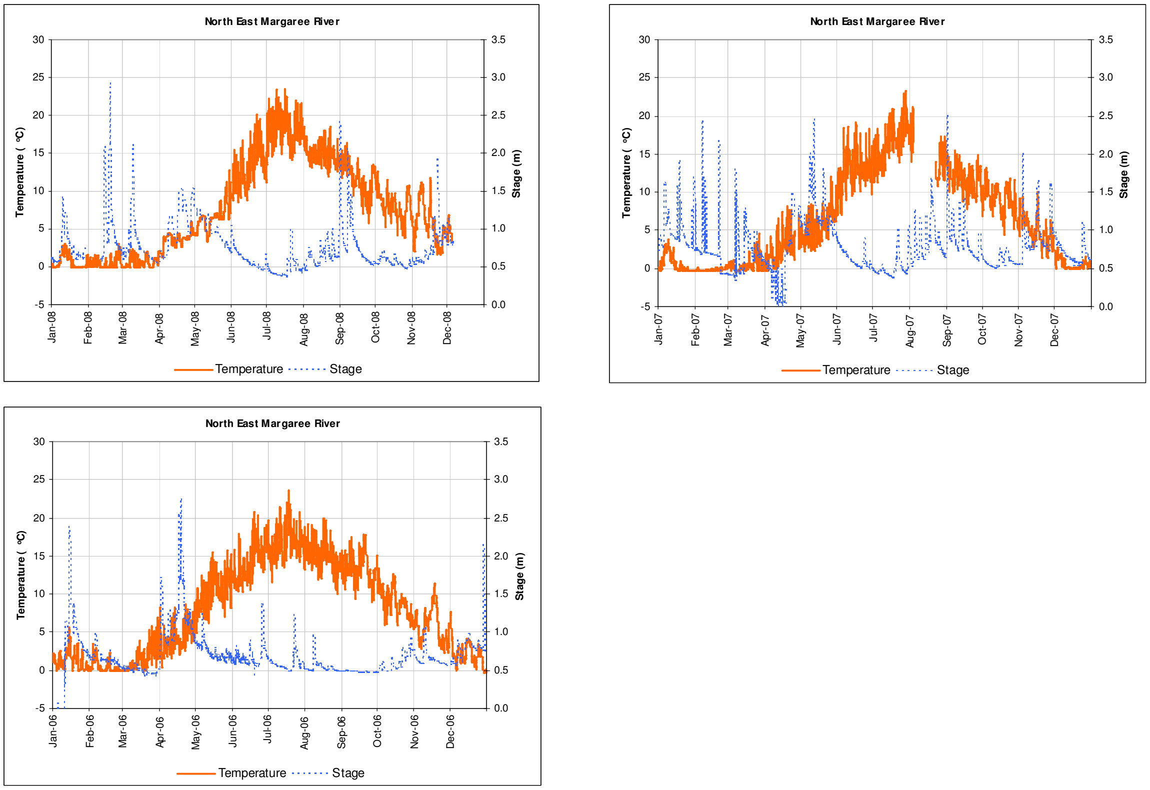


Figure 3.3 - 5 Water temperature from 2002 through 2008 for the North East Margaree River using daily values. Gaps in the plot indicate missing data.

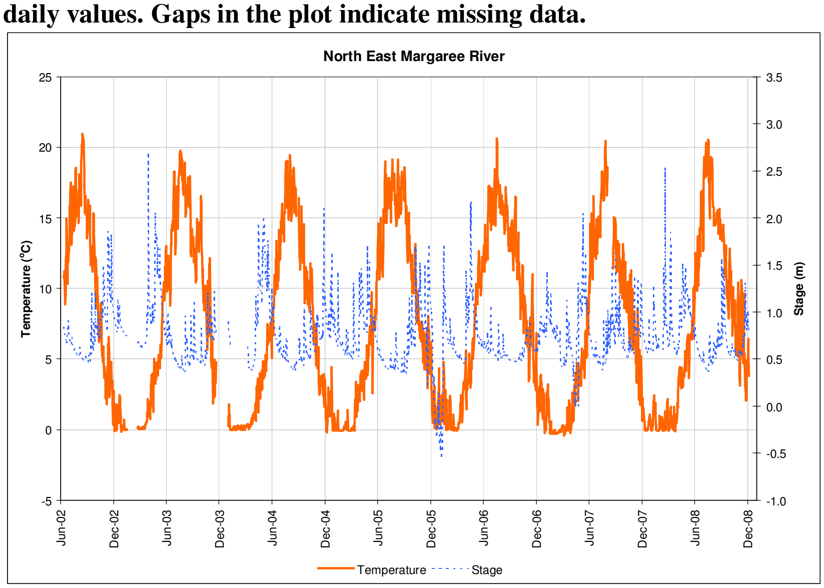


Figure 3.3 - 6 Water temperature from 2002 through 2008 for the North East Margaree River using monthly values. Gaps in the plot indicate missing data.

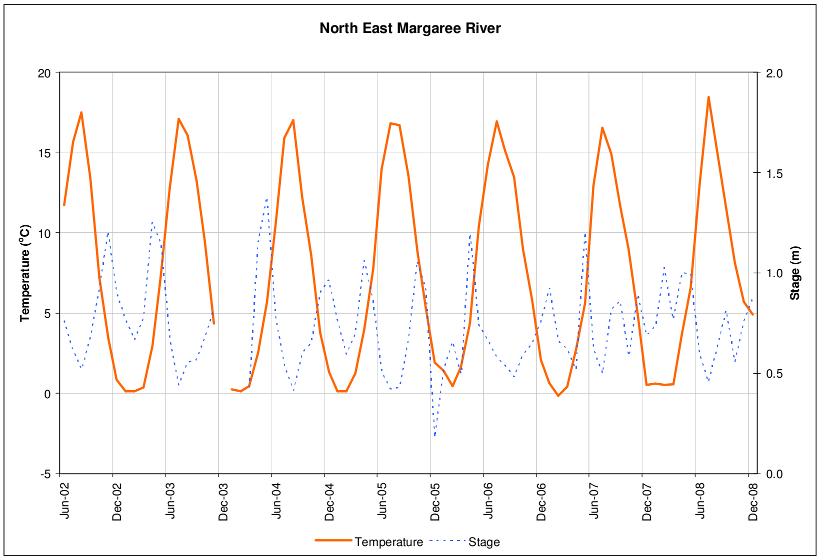


Table 3.3 - 3 Mean monthly water temperature for North East Margaree River during 2006 – 2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	----------	°C	----------	-----
January	2006	1.4	0.0	4.8	1.1
February	2006	0.5	0.0	2.4	0.7
March	2006	1.6	0.0	4.2	1.4
April	2006	4.3	1.4	6.5	1.3
May	2006	10.4	7.1	12.6	1.4
June	2006	14.2	11.2	17.3	2.0
July	2006	16.9	14.5	20.6	1.5
August	2006	15.1	12.7	17.2	1.2
September	2006	13.5	10.6	16.5	1.5
October	2006	8.9	5.9	11.8	1.7
November	2006	5.8	2.8	11.0	2.2
December	2006	2.1	-0.2	6.8	1.5
January	2007	0.6	-0.3	3.2	1.1
February	2007	-0.2	-0.3	0.2	0.1
March	2007	0.4	-0.4	2.1	0.7
April	2007	2.8	0.5	4.8	1.4
May	2007	5.6	3.1	9.2	1.6
June	2007	12.9	9.7	16.6	1.7
July	2007	16.5	13.6	20.4	2.0
August	2007	14.9	11.4	18.6	2.2
September	2007	11.6	9.3	14.4	1.2
October	2007	8.9	5.7	11.9	1.7
November	2007	5.0	1.7	8.6	1.8
December	2007	0.5	-0.1	2.2	0.6
January	2008	0.6	-0.1	2.5	0.8
February	2008	0.5	-0.1	2.1	0.6
March	2008	0.5	-0.1	1.6	0.5

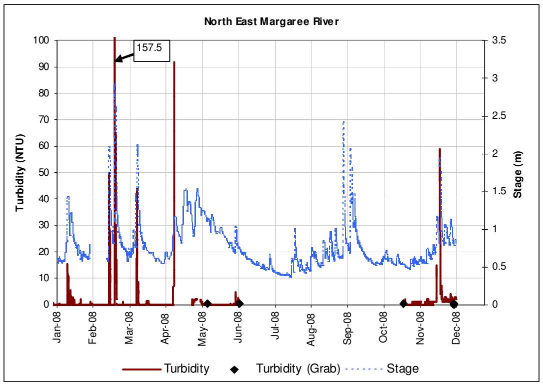
Month	Year	Mean	Minimum	Maximum	SD
-----	-----	----------	°C	----------	-----
April	2008	3.6	1.5	5.6	0.9
May	2008	6.6	3.6	10.1	1.6
June	2008	13.0	9.4	16.9	2.1
July	2008	18.4	14.9	20.5	1.4
August	2008	14.9	13.5	17.2	0.8
September	2008	11.6	7.9	14.5	2.0
October	2008	8.1	5.2	11.3	1.7
November	2008	5.7	2.1	10.6	2.5
December	2008	4.9	3.8	6.4	1.1

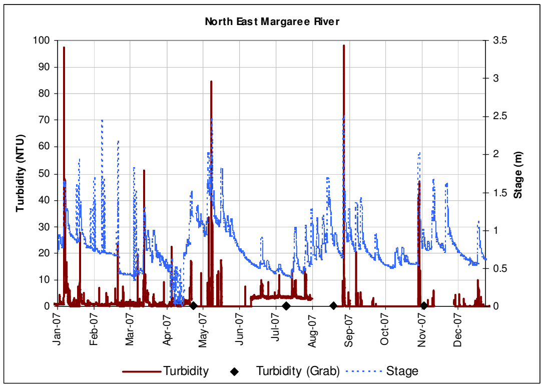
Table 3.3 - 4 Mean annual water temperature fro North East Margaree River during 2002 – 2008 based on mean daily data.

Year	Mean	Minimum	Maximum	SD
-----	----------	°C	----------	-----
2002	9.86	-0.15	20.93	6.21
2003	8.73	-0.03	19.76	6.24
2004	6.36	-0.21	19.42	5.96
2005	7.57	-0.07	19.13	6.29
2006	7.94	-0.23	20.63	5.96
2007	6.28	-0.42	20.44	5.90
2008	7.61	-0.08	20.53	6.10

3.3.3.2 Turbidity

Figure 3.3 - 7 Turbidity from 2006 through 2008 for the North East Margaree River using hourly values. Gaps in the plot indicate missing data.





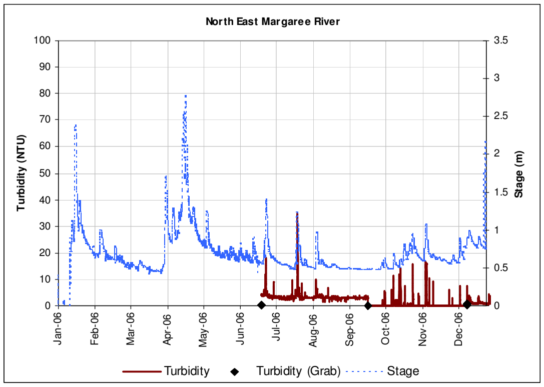


Figure 3.3 - 8 Turbidity from 2002 through 2008 for the North East Margaree River using daily values. Gaps in the plot indicate missing data.

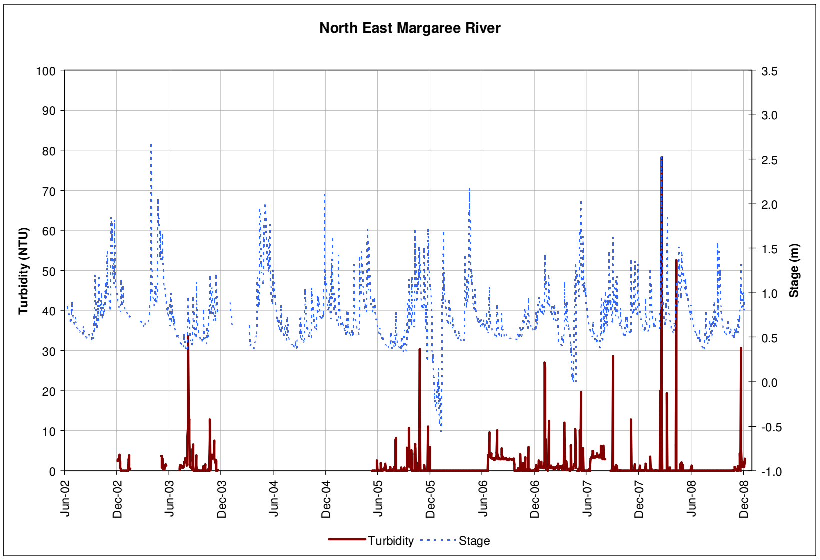


Figure 3.3 - 9 Turbidity from 2002 through 2008 for the North East Margaree River using monthly values. Gaps in the plot indicate missing data.

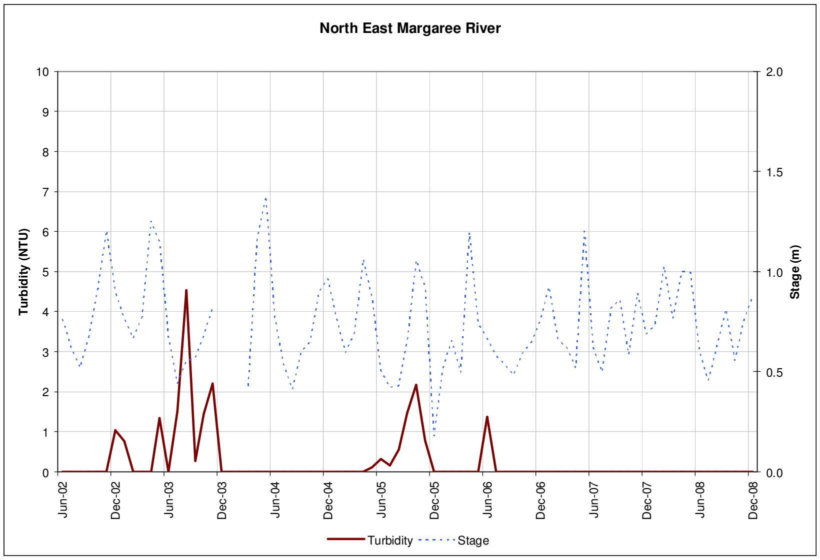


Table 3.3 - 5Mean monthly turbidity for the North East Margaree River during 2006 – 2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	----------	NTU	----------	-----
January	2006	0.0	0.0	0.0	0.0
February	2006	0.0	0.0	0.0	0.0
March	2006	0.0	0.0	0.0	0.0
April	2006	0.0	0.0	0.0	0.0
May	2006	0.0	0.0	0.0	0.0
June	2006	1.4	0.0	9.5	2.4
July	2006	3.5	2.7	10.1	1.3
August	2006	3.1	2.8	5.7	0.5
September	2006	2.0	0.0	3.0	1.3
October	2006	0.5	0.0	4.2	1.0
November	2006	0.4	0.0	5.9	1.2
December	2006	0.7	0.0	2.6	0.7
January	2007	3.5	0.0	27.0	6.7
February	2007	0.8	0.4	1.8	0.3
March	2007	1.6	0.1	12.0	2.8
April	2007	1.4	0.0	10.4	2.3
May	2007	1.4	0.0	19.6	4.0
June	2007	2.0	0.0	4.9	1.8
July	2007	3.8	2.9	6.2	0.8
August	2007	0.9	0.0	3.3	1.4
September	2007	1.2	0.0	28.6	5.2
October	2007	0.0	0.0	0.0	0.0
November	2007	0.5	0.0	12.8	2.3
December	2007	0.2	0.0	1.7	0.4
January	2008	0.2	0.0	3.6	0.7
February	2008	3.9	0.0	78.3	14.9
March	2008	0.8	0.0	19.4	3.5

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	---------- NTU ----------			-----
April	2008	2.2	0.0	52.6	9.6
May	2008	0.1	0.0	1.5	0.3
June	2008	0.1	0.0	1.3	0.4
July	2008	0.0	0.0	0.0	0.0
August	2008	0.0	0.0	0.0	0.0
September	2008	0.0	0.0	0.0	0.0
October	2008	0.0	0.0	0.3	0.1
November	2008	1.9	0.0	30.6	5.6
December	2008	1.9	1.0	3.0	0.7

Table 3.3 - 6 Mean annual turbidity for North East Margaree River during 2002 – 2008 based on mean daily data.

Year	Mean	Minimum	Maximum	SD
-----	---------- NTU ----------			-----
2002	1.0	0.0	4.0	1.4
2003	1.8	0.0	33.6	3.6
2004				
2005	0.7	0.0	30.4	2.7
2006	1.0	0.0	10.1	1.6
2007	1.5	0.0	28.6	3.3
2008	0.9	0.0	78.3	5.6

3.3.3.3 Conductivity

Figure 3.3 - 10 Conductivity from 2006 through 2008 for the North East Margaree River using hourly values. Gaps in the plot indicate missing data.

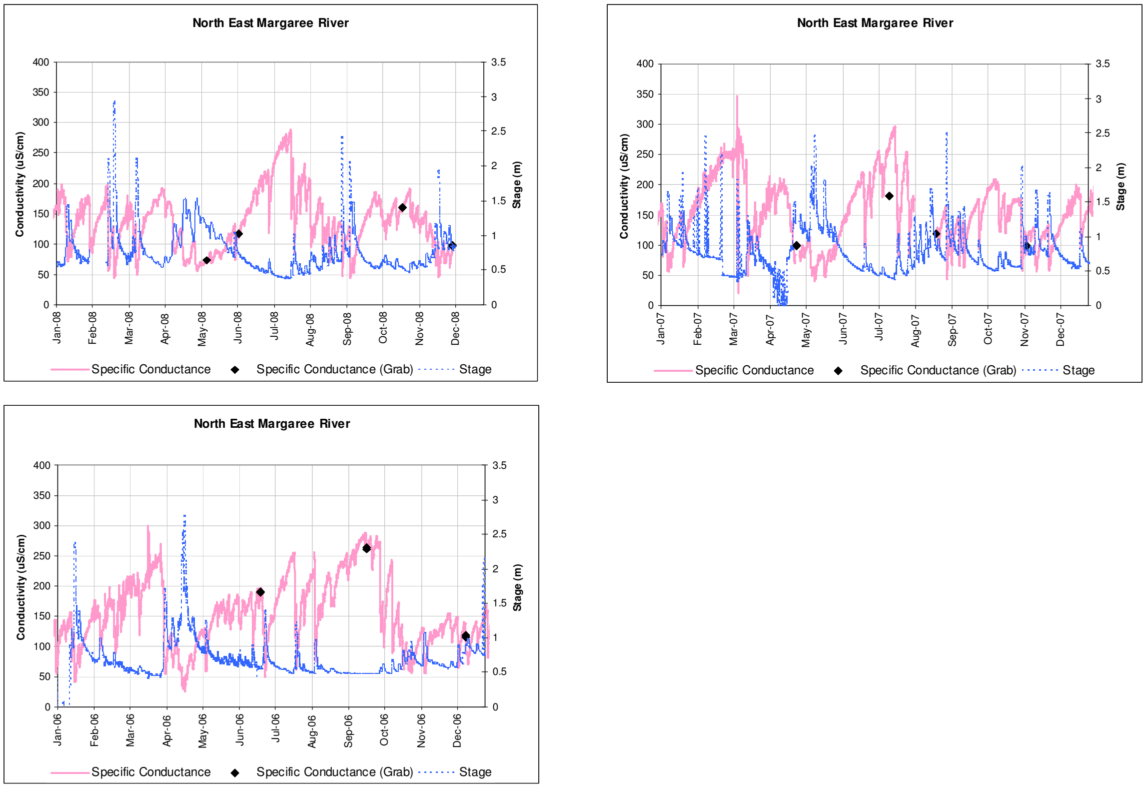


Figure 3.3 - 11 Conductivity from 2002 through 2008 for the North East Margaree River using daily values. Gaps in the plot indicate missing data.

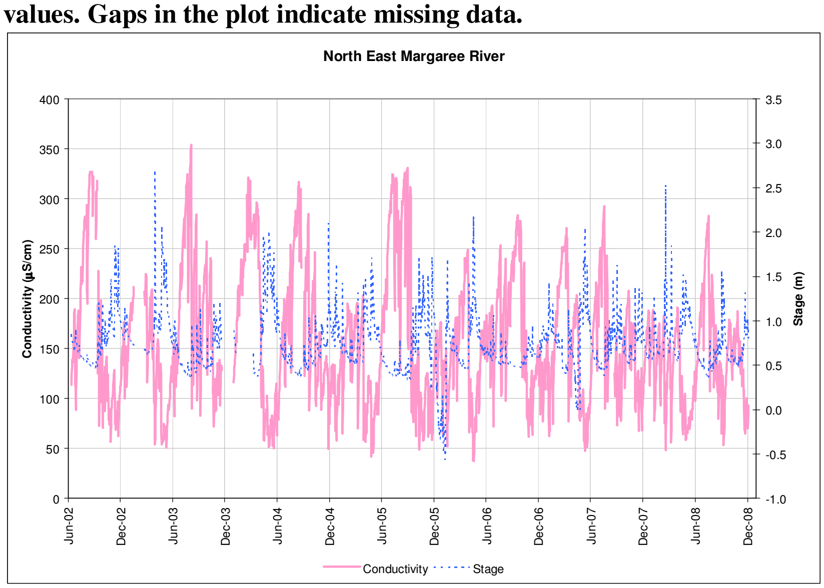


Figure 3.3 - 12 Conductivity from 2002 through 2008 for the North East Margaree River using monthly values. Gaps in the plot indicate missing data.

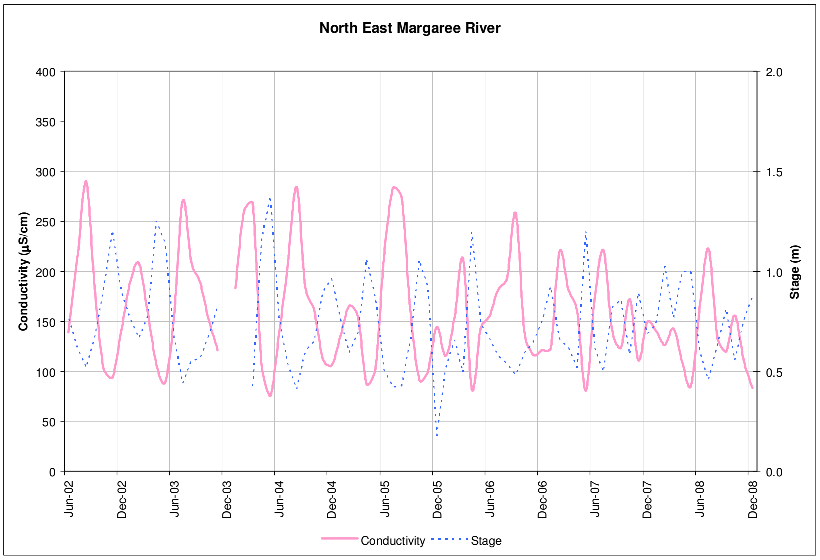


Table 3.3 - 7 Mean monthly conductivity for North East Margaree River during 2006 – 2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	----------	µS/cm	----------	-----
January	2006	115.6	52.3	156.3	27.1
February	2006	153.0	97.3	187.8	23.5
March	2006	212.4	160.6	248.7	23.0
April	2006	82.4	37.3	176.8	28.5
May	2006	143.0	85.3	177.0	22.9
June	2006	155.0	72.2	192.9	31.9
July	2006	182.2	102.5	253.0	41.8
August	2006	193.0	97.5	239.7	32.9
September	2006	258.3	217.4	283.0	17.9
October	2006	138.3	61.7	267.5	56.4
November	2006	116.6	63.6	153.5	21.4
December	2006	121.1	77.2	153.3	21.8
January	2007	123.2	62.2	174.3	30.9
February	2007	220.0	171.8	252.3	25.0
March	2007	181.8	77.1	270.5	62.8
April	2007	160.7	77.6	203.5	41.2
May	2007	80.7	47.8	109.2	16.7
June	2007	171.9	113.9	216.1	29.9
July	2007	221.2	90.0	292.1	50.4
August	2007	141.0	102.2	176.9	22.9
September	2007	123.8	73.4	171.3	28.5
October	2007	172.1	128.5	207.5	22.1
November	2007	111.1	67.6	174.7	27.0
December	2007	149.0	97.8	187.9	25.4
January	2008	140.6	78.0	188.7	33.1
February	2008	126.3	48.3	183.1	33.3
March	2008	143.0	56.2	191.0	33.1

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	----------	µS/cm	----------	-----
April	2008	109.4	58.5	189.9	39.0
May	2008	85.9	63.5	127.0	17.3
June	2008	163.3	97.8	215.5	35.4
July	2008	222.4	107.2	282.6	43.3
August	2008	134.1	79.7	198.7	27.8
September	2008	120.2	53.2	179.2	36.9
October	2008	156.0	118.7	187.6	16.5
November	2008	111.7	65.3	157.3	28.4
December	2008	83.4	70.1	93.1	9.6

Table 3.3 - 8 Mean annual conductivity for North East Margaree River during 2002 – 2008 based on mean daily data.

Year	Mean	Minimum	Maximum	SD
-----	----------	uS/cm	----------	-----
2002	161.6	56.4	326.9	73.1
2003	165.5	50.8	353.6	67.7
2004	171.9	49.8	321.4	74.0
2005	159.8	42.0	330.7	75.2
2006	156.0	37.3	283.0	55.7
2007	155.0	47.8	292.1	53.7
2008	137.1	48.3	282.6	46.9

3.3.3.4 *Dissolved Oxygen*

Figure 3.3 - 13 Dissolve Oxygen from 2006 through 2008 for the North East Margaree River using hourly values. Gaps in the plot indicate missing data.

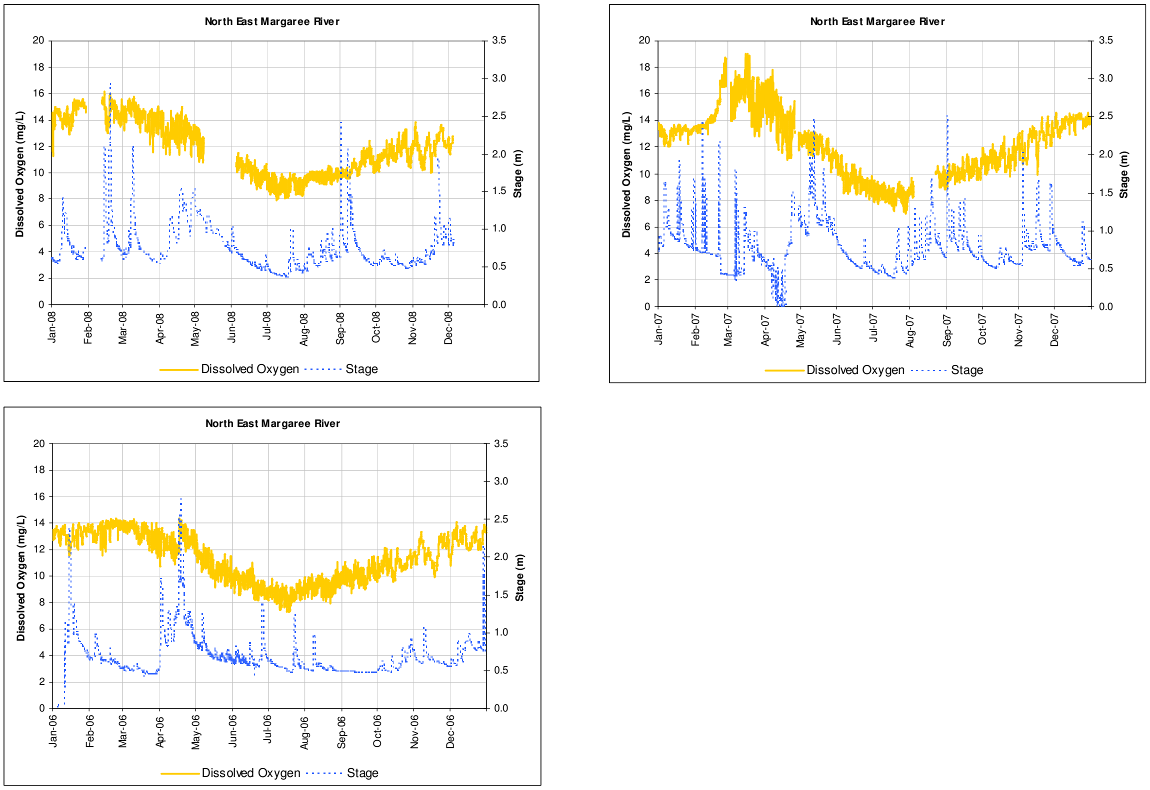


Figure 3.3 - 14 Dissolve Oxygen from 2002 through 2008 for the North East Margaree River using daily values. Gaps in the plot indicate missing data.

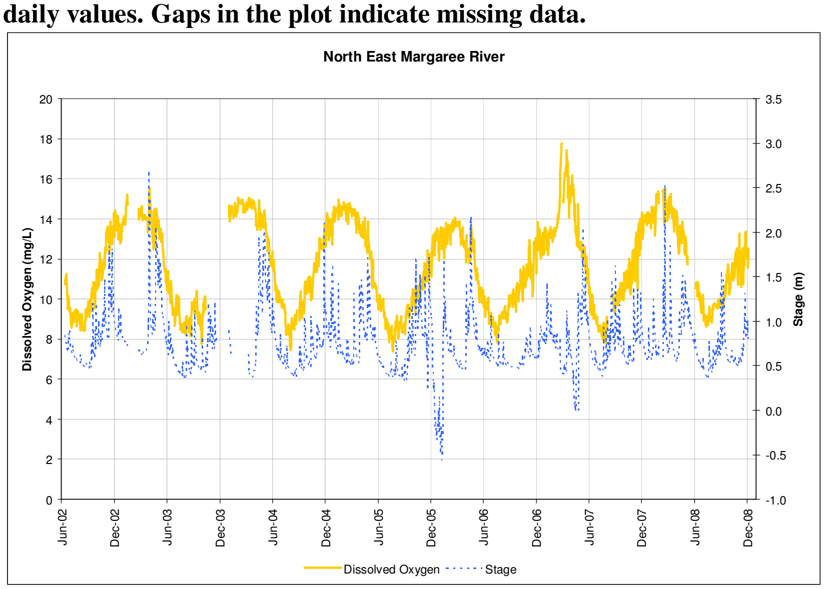


Figure 3.3 - 15 Dissolve Oxygen from 2002 through 2008 for the North East Margaree River using monthly values. Gaps in the plot indicate missing data.

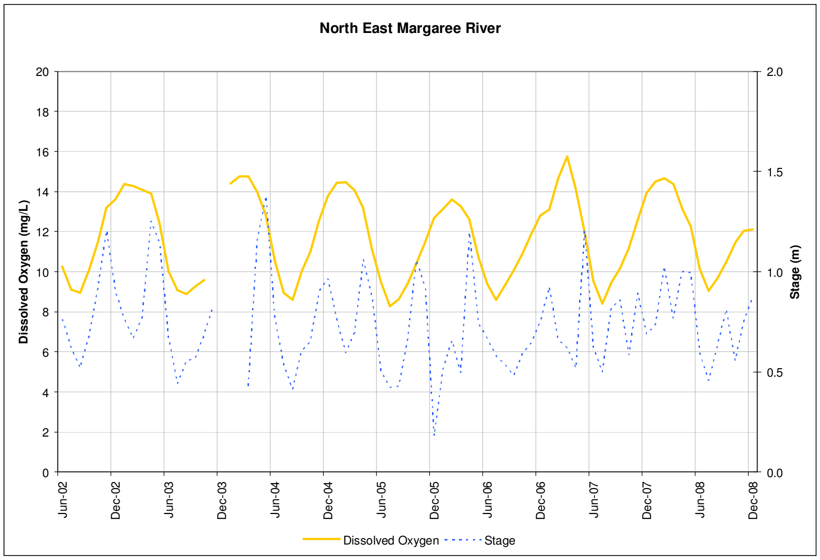


Table 3.3 - 9 Mean monthly dissolved oxygen for North East Margaree River during 2006-2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	----------	mg/L	----------	-----
January	2006	13.1	12.0	13.8	0.5
February	2006	13.6	12.7	14.1	0.3
March	2006	13.3	12.4	13.9	0.5
April	2006	12.6	11.8	13.7	0.5
May	2006	10.8	9.8	12.3	0.6
June	2006	9.4	8.6	10.1	0.5
July	2006	8.6	7.8	9.2	0.3
August	2006	9.3	8.8	10.2	0.3
September	2006	10.1	9.4	10.8	0.4
October	2006	10.9	9.9	11.7	0.5
November	2006	11.9	10.1	13.0	0.8
December	2006	12.8	11.3	13.8	0.6
January	2007	13.1	12.2	13.6	0.4
February	2007	14.7	13.1	17.8	1.5
March	2007	15.7	14.1	17.4	0.8
April	2007	14.2	12.5	16.2	1.2
May	2007	12.0	10.8	12.8	0.6
June	2007	9.5	8.7	10.6	0.5
July	2007	8.4	7.8	8.8	0.3
August	2007	9.5	8.7	10.3	0.5
September	2007	10.2	9.5	10.8	0.3
October	2007	11.2	10.2	12.4	0.5
November	2007	12.6	10.5	14.0	0.9
December	2007	13.9	13.0	14.3	0.3
January	2008	14.5	13.2	15.4	0.6
February	2008	14.7	13.7	15.5	0.6
March	2008	14.4	13.4	15.2	0.4

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	----------	mg/L	----------	-----
April	2008	13.1	12.2	14.1	0.5
May	2008	12.3	11.7	12.9	0.4
June	2008	10.2	9.3	10.8	0.5
July	2008	9.0	8.6	9.6	0.3
August	2008	9.7	9.2	10.0	0.2
September	2008	10.5	9.6	11.7	0.6
October	2008	11.5	10.6	12.5	0.6
November	2008	12.0	10.6	13.4	0.8
December	2008	12.1	11.6	12.5	0.4

Table 3.3 - 10 Mean annual dissolved oxygen for North East Margaree River during 2002 – 2008 based on mean daily data.

Year	Mean	Minimum	Maximum	SD
-----	----------	mg/L	----------	-----
2002	11.0	8.4	14.4	1.8
2003	11.3	7.8	15.5	2.3
2004	12.2	7.4	15.1	2.2
2005	11.4	7.4	15.0	2.2
2006	11.3	7.8	14.1	1.7
2007	12.2	7.8	17.8	2.3
2008	11.9	8.6	15.5	2.0

3.3.3.5 pH

Figure 3.3 - 16 pH from 2006 through 2008 for the North East Margaree River using hourly values. Gaps in the plot indicate missing data.

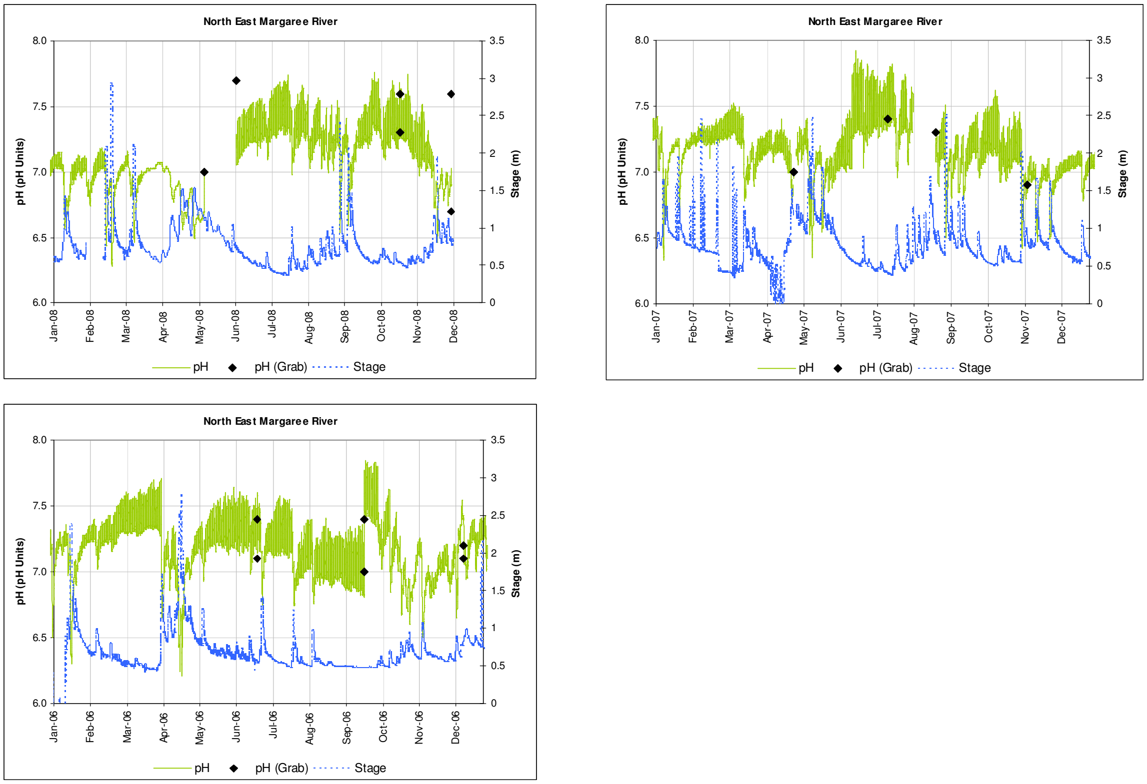


Figure 3.3 - 17 pH from 2002 through 2008 for the North East Margaree River using daily values. Gaps in the plot indicate missing data.

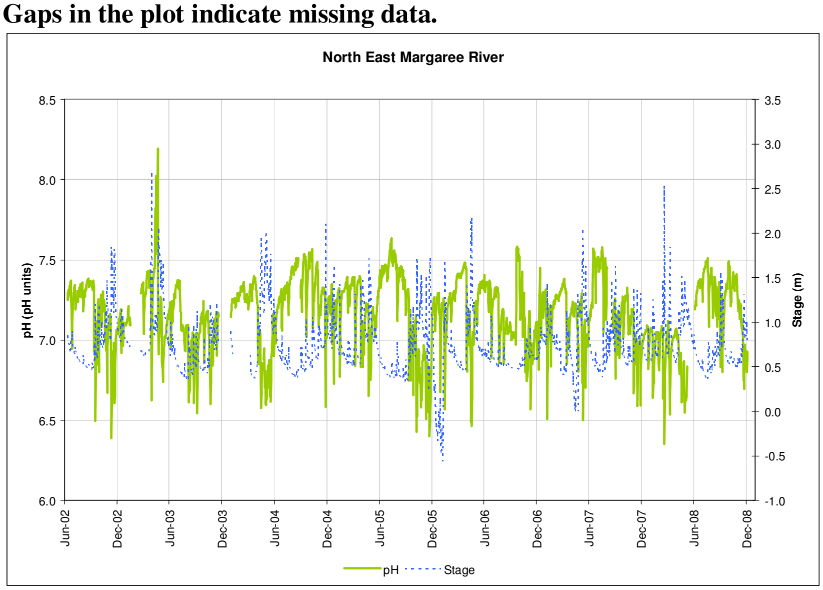


Figure 3.3 - 18 pH from 2002 through 2008 for the North East Margaree River using monthly values. Gaps in the plot indicate missing data.

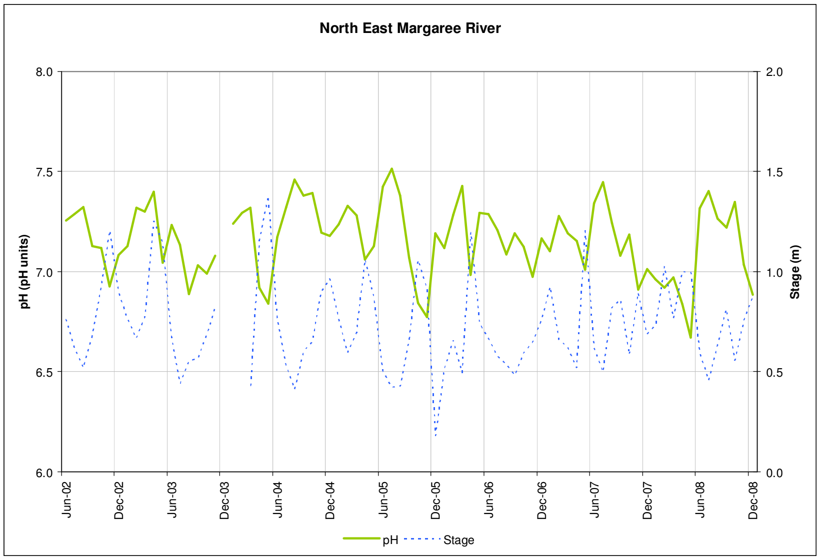


Table 3.3 - 11 Mean monthly pH for North East Margaree River during 2006 – 2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	-----	-----	-----	-----
January	2006	7.1	6.6	7.3	0.2
February	2006	7.3	7.1	7.4	0.1
March	2006	7.4	7.4	7.5	0.0
April	2006	7.0	6.5	7.4	0.2
May	2006	7.3	7.1	7.4	0.1
June	2006	7.3	6.9	7.4	0.1
July	2006	7.2	6.9	7.3	0.1
August	2006	7.1	6.9	7.2	0.1
September	2006	7.2	7.0	7.6	0.2
October	2006	7.1	6.7	7.5	0.2
November	2006	7.0	6.6	7.2	0.1
December	2006	7.2	6.8	7.5	0.2
January	2007	7.1	6.5	7.3	0.2
February	2007	7.3	7.2	7.3	0.0
March	2007	7.2	6.9	7.4	0.2
April	2007	7.2	6.8	7.2	0.1
May	2007	7.0	6.5	7.3	0.2
June	2007	7.3	7.1	7.6	0.2
July	2007	7.4	7.1	7.6	0.1
August	2007	7.2	7.1	7.5	0.1
September	2007	7.1	6.8	7.3	0.1
October	2007	7.2	7.0	7.3	0.1
November	2007	6.9	6.6	7.2	0.2
December	2007	7.0	6.8	7.1	0.1
January	2008	7.0	6.6	7.1	0.1
February	2008	6.9	6.4	7.1	0.2
March	2008	7.0	6.5	7.1	0.1

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	-----	-----	-----	-----
April	2008	6.8	6.5	7.1	0.2
May	2008	6.7	6.6	6.8	0.1
June	2008	7.3	7.2	7.4	0.1
July	2008	7.4	7.1	7.5	0.1
August	2008	7.3	7.1	7.4	0.1
September	2008	7.2	6.8	7.5	0.2
October	2008	7.3	7.2	7.5	0.1
November	2008	7.0	6.7	7.2	0.2
December	2008	6.9	6.8	6.9	0.1

Table 3.3 - 12 Mean annual pH for North East Margaree during 2002 – 2008 based on mean daily data.

Year	Mean	Minimum	Maximum	SD
-----	-----	-----	-----	-----
2002	7.2	6.4	7.4	0.2
2003	7.1	6.5	8.2	0.2
2004	7.2	6.6	7.6	0.2
2005	7.2	6.4	7.6	0.3
2006	7.2	6.5	7.6	0.2
2007	7.2	6.5	7.6	0.2
2008	7.1	6.4	7.5	0.2

3.3.4 Overview of North East Margaree River Water Quality

Water quality data collected at this station since 2002 are fairly typical of a predominantly forested watershed (88% of total area) located on a combination of areas of sedimentary and metamorphic bedrock.

Water temperature varied according to a seasonal pattern very similar to that of air temperature, which is typical of a shallow flowing river. Minimum hourly water temperatures for Winter (December to February) ranged from -0.1 ^{o}C (2005 and 2008) to -0.5^{o}C (2007). Maximum hourly water temperatures for Summer (June to August) ranged from 21.7^{o}C (2003) to 23.6 ^{o}C (2006). Mean hourly temperature readings ranged from 6.3 ^{o}C (2004 and2007) to 9.8 ^{o}C (2002). Based on hourly records, a range of from <1% (2003 to 2007) to 2% (2002) of annual temperature measurements exceeded the recommended temperature limit of 20-21 ^{o}C for salmon and trout, almost all of which occurred in July.

Turbidity values were relatively low for most of the period of record although there are periods when values were relatively higher for short periods of time. Sporadic events occurred each year during periods of increased flows, primarily in the Fall but also during the Spring. Most turbidity values were not above the overall hourly mean of 1.4 NTU. Minimum turbidity values were recorded as 0.0 NTU in all years of record. Maximum turbidity values ranged from 106 NTU in 2002 to 157.5 NTU in 2008. High turbidity events greater than 25 NTU occurred on a frequency of 1 time per year in 2003, and 0, 1, 0, 2 and 3 times per year in 2004, 2005, 2006, 2007, and 2008 respectively. Overall, less than 1 percent of hourly turbidity measurements were greater than 50 NTU, the guideline for recreational use. Between 4% (2008) and 42% (2004) of turbidity measurements were greater than the drinking water aesthetic objective of 5 NTU. Peak turbidity measurements generally occurred simultaneously with peak flows and precipitation events and generally during the Fall. Environmental conditions (soil moisture, evapotranspiration rates, etc.) are such that more of the rainfall landing on the terrestrial ecosystem at this time of year is available as runoff, therefore increasing runoff velocities and erosion potential.

Water conductivity of the North East Margaree was characteristic of relatively dilute waters where minimum hourly values ranged from 20.0 uS/cm (2007) to 48.6 uS/cm (2002). Maximum values ranged from 289.0 uS/cm (2008) to 380.0 uS/cm (2004), and mean values ranged from 137.2 uS/cm (2008) to 172.6 uS/cm (2004). Conductivity appears to follow a pattern that is inverse to stage. This is reasonable assuming that increased stage is the result of precipitation events and/or snowmelt that are diluting the concentration of ions in the river and lowering conductivity. Conductivity levels were observed to peak during the low flow months of July and August and show seasonal lows during the typically higher flow months of October/November and April/May The potential effect on water conductivity due to increased chloride content from road-de-icing activities appears negligible. Peak conductivity measurements occurring during the low flow Summer period may be indicative of a dominant influence of groundwater seepage during this period.

Dissolved oxygen concentrations followed a trend that was the inverse of temperature, showing seasonal Summer lows in the July-August period of each year. This is typical of shallow surface waters where the solubility of oxygen in water decreases as water temperature rises. Minimum hourly dissolved oxygen values ranged from 6.7 mg/l (2005) to 7.9 mg/l (2008). Maximum values ranged from 14.4 mg/l (2006) to 19.0 mg/l (2007), and mean values ranged from 11.0 mg/l (2002) to 12.3 mg/l (2004).
At no time during the period of record (2002 to 2008) did hourly concentrations dip below 6.7 mg/L, remaining well above a suggested threshold for the protection of aquatic life of 5.0 mg/L.

pH was highly variable during the study period (2002 to 2008) with high hourly values somewhat predominant during the Summer low flow period and low pH values somewhat dominating the periods of higher flows (Spring and Fall). Therefore, pH seems to have a weak inverse relationship to flow. Minimum hourly pH values ranged from 6.2 units (2003, 2005 & 2006) to 6.4 units (2004), while maximum values ranged from a pH of 7.7 (2002) to a pH of 8.2 (2003). Mean hourly values ranged from a pH of 7.1 (2003 & 2008) to a pH of 7.2 (2002, 2004, 2005, 2006, & 2007). This data suggests that the North East Margaree River is a relatively well buffered system since pH values are relatively high compared to most surface waters in the province. This is directly related to the bedrock and soils in the watershed.

Overall less than 1 percent of all pH measurements taken during the study period exceeded the recommended ranges of pH established as national guidelines for the

Protection of Aquatic Life, Drinking Water, and Recreational use of 6.5 to 9.0, 6.5 to 8.5 and, 6.5 to 9.5 respectively.

Data from grab samples or field meter readings taken during site visits generally were in good agreement with automated sensor values confirming quality of the dataset. Data for pH during the 2008 sampling season however were an exception with lesser agreement. This merits further investigation as to cause.

3.4 KELLEY RIVER

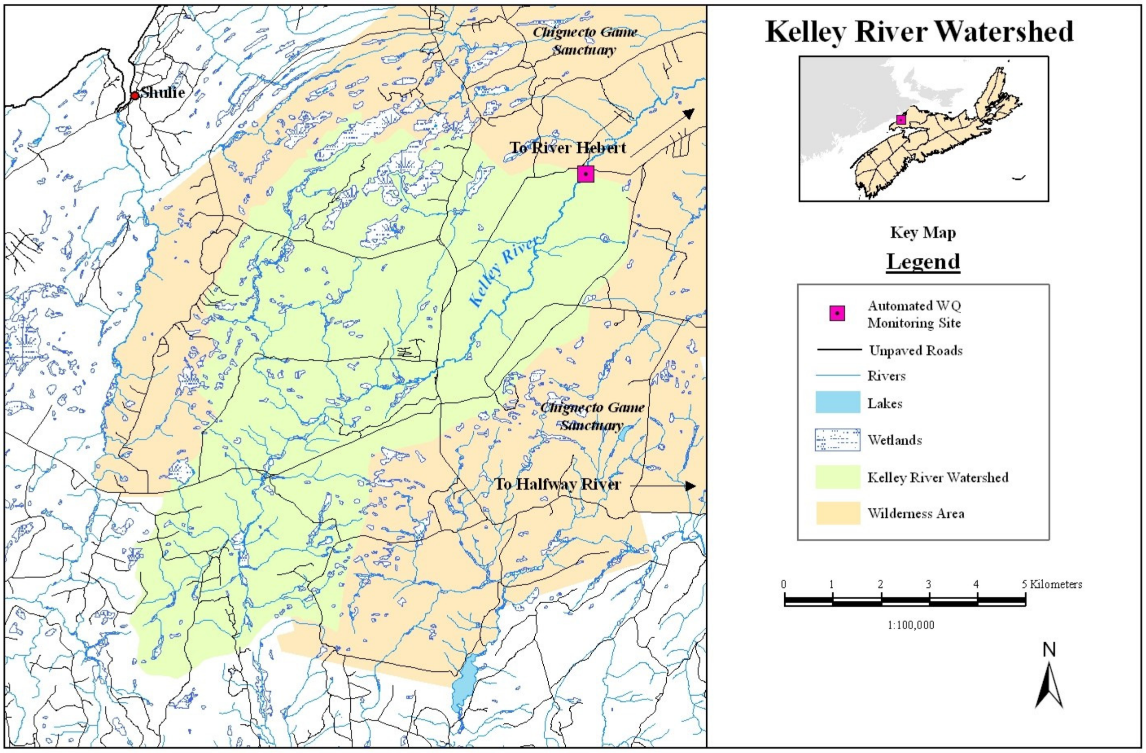


Figure 3.4 - 1 Location of Kelley River watershed

3.4.1 Background Information

Location of Station

The Kelley River Automated Network Station is located at Latitude 45°35'10"N, Longitude 64°27'05" W and is denoted in Figure 3.4 - 1.

Geographical Setting

The Kelley River is located in Cumberland County, within the Chignecto Game Sanctuary. It flows northeast where it meets the River Hebert, which has its outlet in Cumberland Basin. The drainage area of the Kelley River is 64.5 km^2.

Geology and Geomorphology

The bedrock geology of the Kelley River watershed is dominated by sandstones, conglomerates and shales of varying grain size. The surficial geology is made up of a thin mantle of sandy till. The main river channel is characterized by glaciofluvial sands and gravels.

The dominant landform in the watershed is the undulating to moderately rolling plain with a thin mantle of stony till and peat bogs.

Forest Cover and Land Use

The vegetation in the Kelley River watershed includes barrens, wetlands, bogs, and conifer-dominated forests. The upper reaches of the Kelley River watershed contain salmon spawning areas, sensitive wetlands and patches of old growth forest. 80% of the land within the watershed is forested, 12% is covered by wetlands and or water, and about 1 % characterized as under urban land use.

Figure 3.4 - 2 Kelley River looking upstream (left) and downstream (right) from the monitoring station.

Climate

Normal (1971-2000) annual precipitation in the Kelley River watershed, as recorded at the Environment Canada Climate Station at Nappan is 1181 mm, comprised of 916 mm of rainfall and 265 cm of snowfall. The mean annual temperature is 5.8 ^{o}C with a mean monthly high of 18.4 ^{o}C in July and a low of –7.3 ^{o}C in January.

Figure 3.4 - 3 Kelley River monitoring station.

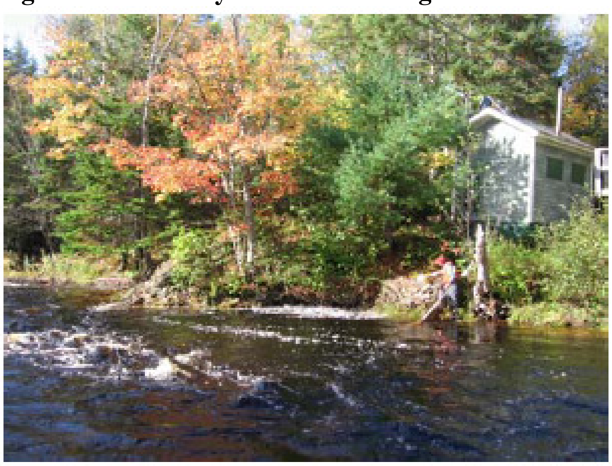
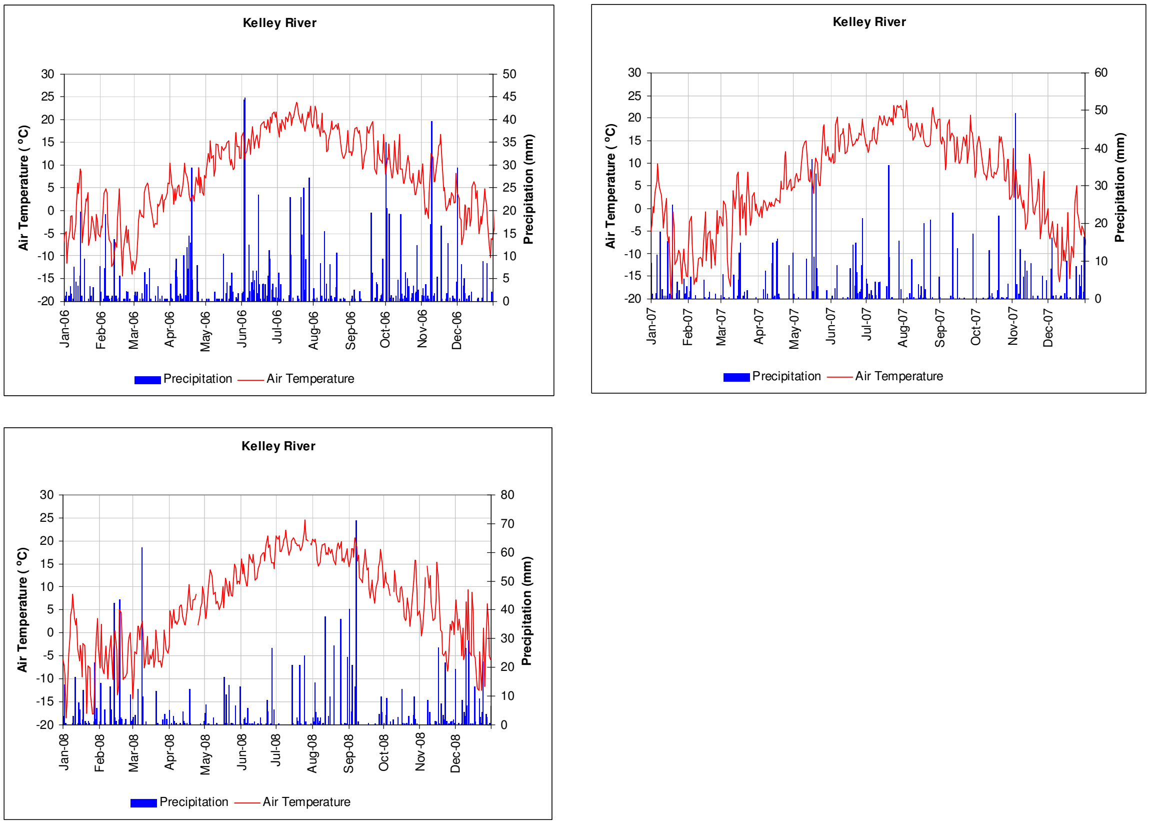


Figure 3.4 - 4 Precipitation and Air Temperature data from Environment Canada Climate Station at Nappan (Kelley River Watershed) for 2006 through 2008. Gaps in the plot indicate missing data.



Wildlife and Habitat

The Kelley River watershed provides habitat for many species of plants and animals, including moose (which was recently declared endangered on mainland Nova Scotia by the provincial government) and black bear.

Human Settlement and Industrial Development

Centuries before the arrival of Europeans, the First Nations People travelled through and encamped in the area, which is now Cumberland County, following the annual migration of great herds of caribou into the province. The Cobequid Mountain Pass was used by native people and early European explorers. Industrial activities n the watershed include forestry, tourism and coal-mining. There are many kilometres of undeveloped riverbanks and coastlines which are popular with birders and hikers. The Chignecto Game Sanctuary, which the Kelley River flows through, was created in 1937, in part to protect native moose populations.

3.4.2 Land Use Summary Information

Table 3.4 - 1 Land use summary table for Kelley River

Land Type	km^2	% of Total Area
Agriculture	0.04	0.1
Barren	0.1	0.2
Clearcut	4.3	6.7
Forested	51.8	80.3
Urban	0.8	1.2
Wetland/Water	7.4	11.5
Total	64.5	100

3.4.3 Water Quality Summary Information

Table 3.4 - 2 Hourly statistics of minimum, maximum, mean, and standard deviation and exceedences as per established water quality guidelines for hourly real time data for Kelley River for 2005 – 2008.

Parameter	Year	Min	Max	Mean	SD	CWQ Guideline			Readings[5]	# of Exceedences			Exceedences As % of Readings		
						FWAL[1]	DW[1]	REC[1]							
Temperature, °C	2005	-0.3	28.1	9.6	7.8	20-21[2]			6910		441			6	
	2006	-0.3	26.5	8.5	7.2				8760		201			2	
	2007*	-0.2	13.1	1.9	3.5				3974		0			0	
	2008	-0.2	27.8	8.3	7.8				8697		488			6	
Turbidity, NTU										DW <1[3]	DW ≤5[4]	REC	DW <1[3]	DW ≤5[4]	REC
	2005	0.0	161.3	1.9	5.3		<1[3], ≤5[4]	≤50	5293	3091	256	5	58	5	<1
	2006	0.0	92.7	1.8	6.0				6956	1158	717	24	17	10	<1
	2007*	0.0	40.8	0.3	1.8				3973	110	74	0	3	2	0
	2008	0.0	324.7	1.3	11.4				6600	339	197	25	5	3	<1
Conductivity, uS/cm	2005	16.4	43.7	25.6	5.6										
	2006	15.7	37.4	23.4	3.8										
	2007*	12.6	36.9	26.1	3.4										
	2008	8.8	44.2	20.6	4.3										
Dissolved Oxygen, mg/L	2005	5.8	15.2	10.8	2.5	≥5.0			7026		0			0	
	2006	6.1	14.4	10.9	2.1				8539		0			0	
	2007*	9.5	14.5	12.5	1.0				3973		0			0	
	2008	6.7	14.8	11.6	2.3				7423		0			0	
pH, Units										FWAL	DW	REC	FWAL	DW	REC
	2005	4.4	6.9	5.5	0.6	6.5-9.0	6.5-8.5	6.5-9.5	6910	6568	6568	6568	95	95	95
	2006	4.5	6.7	5.6	0.5				8760	8518	8518	8518	97	97	97
	2007*	4.6	6.6	5.5	0.5				3973	3953	3953	3953	99	99	99
	2008	4.2	6.8	5.4	0.6				8697	8486	8486	8486	98	98	98

[1] FWAL: Freshwater Aquatic Life; DW: Drinking Water; REC: Recreational Use

[2] Upper permissible limit for salmon and trout (Alabaster and Lloyd, 1982). CCME DW guideline deemed to be inappropriate.

[3] Maximum Acceptable Concentration for water entering a distribution system.

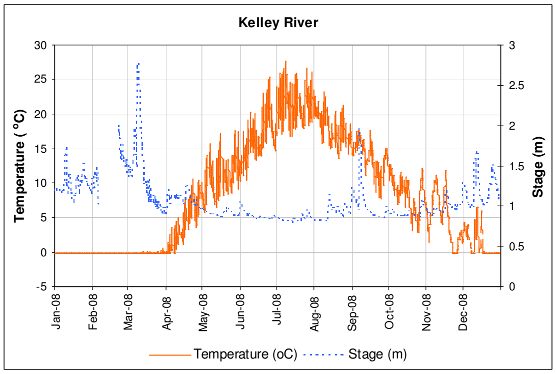
[4] Aesthetic Objective. 5NTU may be permitted if demonstrated that the disinfection method is not compromised.

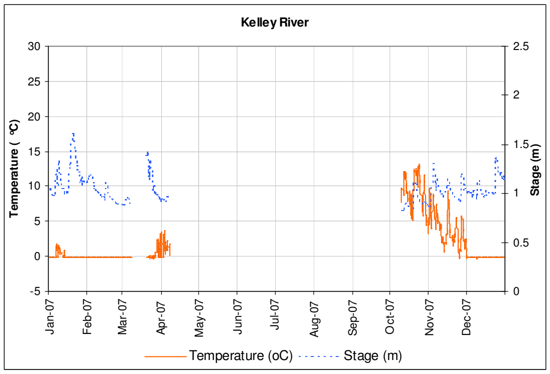
[5] The number of hourly readings possible in each of the years 2002, 2003, 2005, 2006, and 2007 is 8760. For 2004 and 2008 the number is 8784. The number recorded in the table refers to the actual number of approved measurements.

*Equipment failure due to vandalism, resulting in limited data collection. Therefore, interpret with caution.

3.4.3.1 Temperature

Figure 3.4 - 5 Water temperature from 2006 through 2008 for the Kelley River using hourly values. Gaps in the plot indicate missing data.





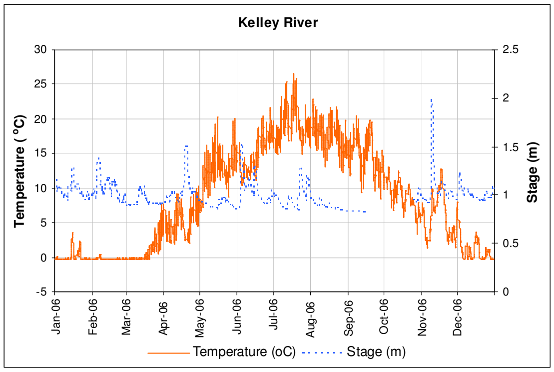


Figure 3.4 - 6 Water temperature from 2004 through 2008 for the Kelley River using <u>daily mean values</u>. Gaps in the plot indicate missing data.

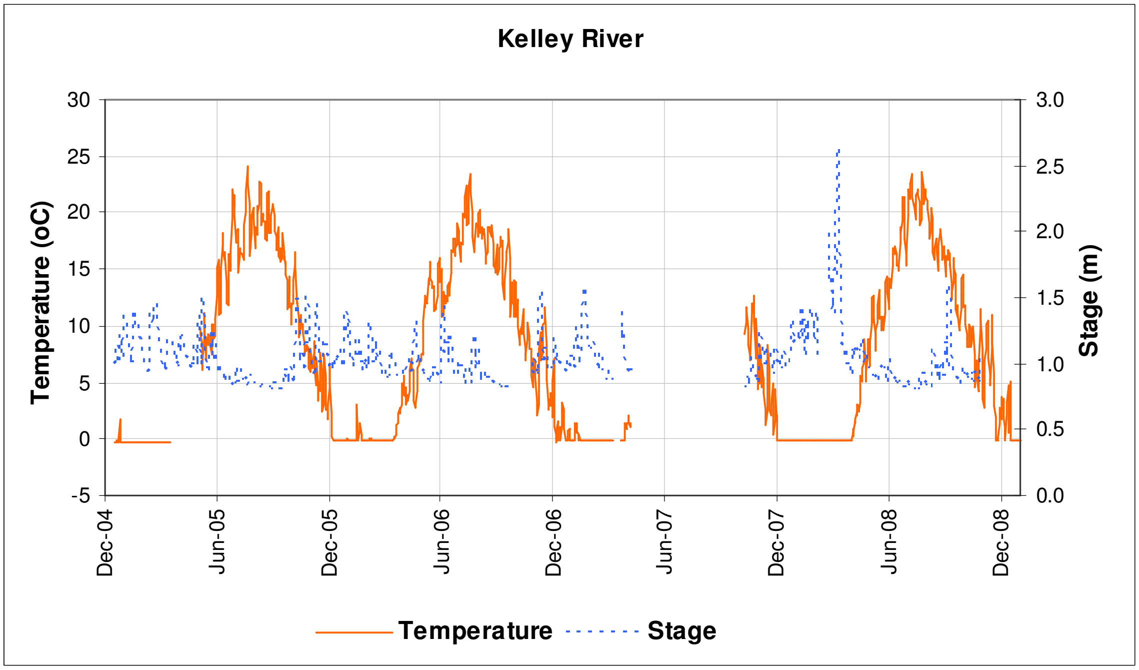


Figure 3.4 - 7 Water temperature from 2004 through 2008 for the Kelley River using monthly mean values. Gaps in the plot indicate missing data.

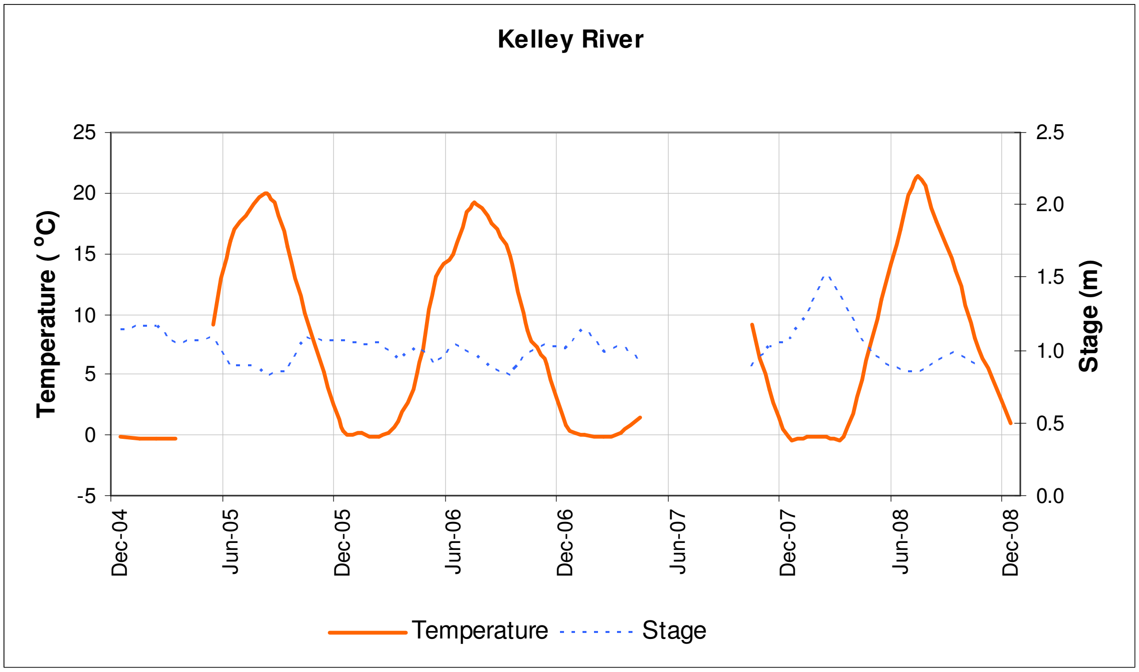


Table 3.4 - 3 Mean monthly water temperature for Kelley River during 2006 – 2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	---------- °C	----------		-----
January	2006	0.1	-0.2	3.1	0.7
February	2006	-0.1	-0.2	0.1	0.1
March	2006	1.0	-0.2	5.0	1.6
April	2006	5.1	2.7	7.4	1.5
May	2006	12.8	7.5	16.0	2.1
June	2006	14.8	10.9	19.1	2.4
July	2006	19.1	15.7	23.5	2.0
August	2006	17.5	14.7	20.3	1.5
September	2006	14.9	10.8	18.5	2.2
October	2006	8.9	4.5	12.4	2.0
November	2006	5.9	2.0	11.7	2.9
December	2006	1.1	-0.3	7.1	1.7
January	2007	0.0	-0.2	1.5	0.4
February	2007	-0.2	-0.2	-0.2	0.0
March	2007	0.1	-0.2	1.4	0.5
April	2007	1.4	1.1	2.1	0.3
May	2007				
June	2007				
July	2007				
August	2007				
September	2007				
October	2007	9.2	4.4	12.7	2.3
November	2007	4.1	0.3	8.3	2.2

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	---------- °C ----------			-----
December	2007	-0.2	-0.2	0.1	0.1
January	2008	-0.2	-0.2	-0.1	0.0
February	2008	-0.2	-0.2	-0.2	0.0
March	2008	-0.2	-0.2	-0.1	0.0
April	2008	4.4	0.3	8.8	2.8
May	2008	11.0	6.4	14.4	1.7
June	2008	16.7	12.6	21.4	2.3
July	2008	21.4	18.8	23.6	1.1
August	2008	17.7	14.4	20.5	1.7
September	2008	13.6	9.6	16.8	2.2
October	2008	8.3	4.2	11.8	2.2
November	2008	4.7	-0.2	11.0	3.5
December	2008	1.1	-0.2	5.1	1.7

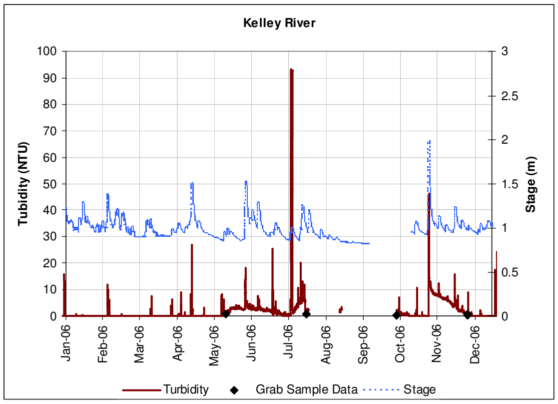
Table 3.4 - 4 Mean annual water temperature for Kelley River during 2004 – 2008 based on mean daily data.

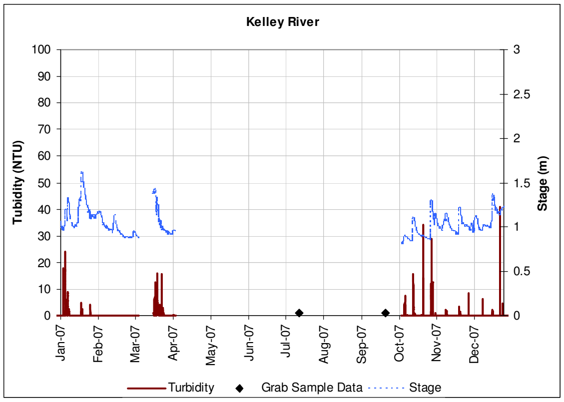
Year	Mean	Minimum	Maximum	SD
-----	---------- °C ----------			-----
2004	-	-	-	-
2005	9.03	-0.25	24.09	7.89
2006	8.48	-0.26	23.50	7.13
2007*	1.94	-0.20	12.66	3.45
2008	8.23	-0.20	23.61	7.68

Missing values implies insufficient data to compute the statistic.
* Mean and max statistics are not representative of annual values due to lack of seasonal data. Equipment failure due to vandalism, resulting in limited data collection. Therefore, interpret with caution.

3.4.3.2 Turbidity

Figure 3.4 - 8 Turbidity levels from 2006 through 2008 for the Kelley River using <u>hourly values</u>. Gaps in the plot indicate missing data.





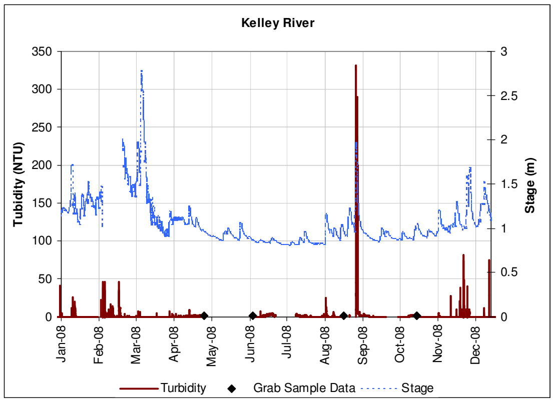


Figure 3.4 - 9 Turbidity levels from 2004 through 2008 for the Kelley River using <u>daily mean values</u>. Gaps in the plot indicate missing data.

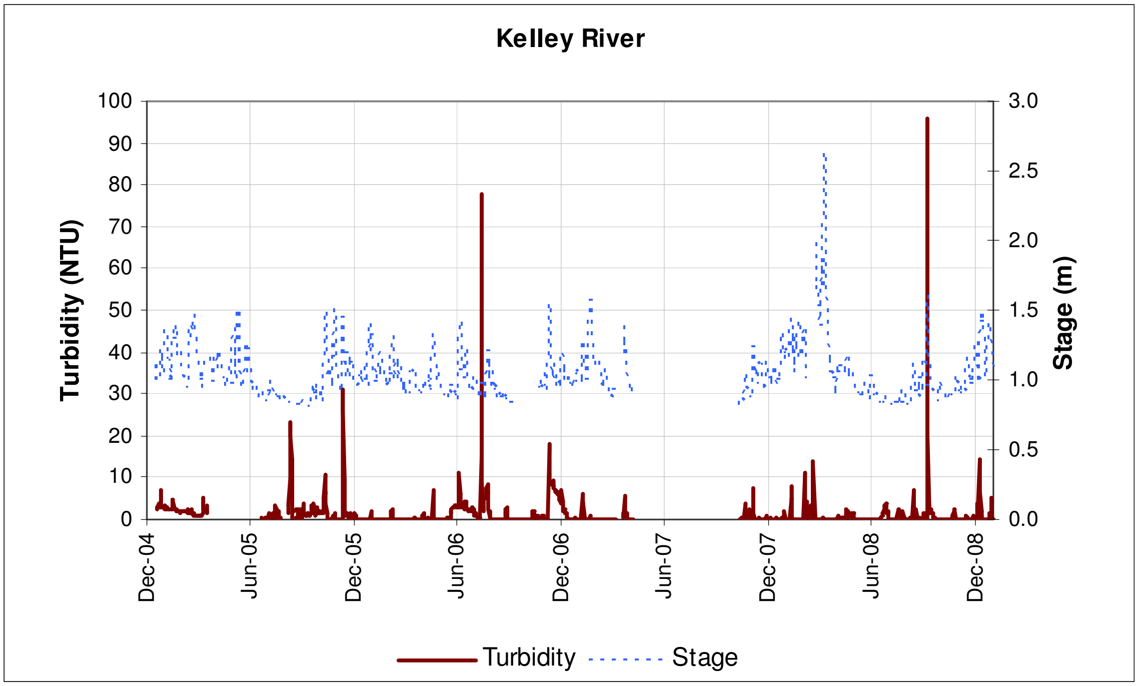


Figure 3.4 - 10 Turbidity levels from 2004 through 2008 for the Kelley River using <u>Monthly mean values</u>. Gaps in the plot indicate missing data.

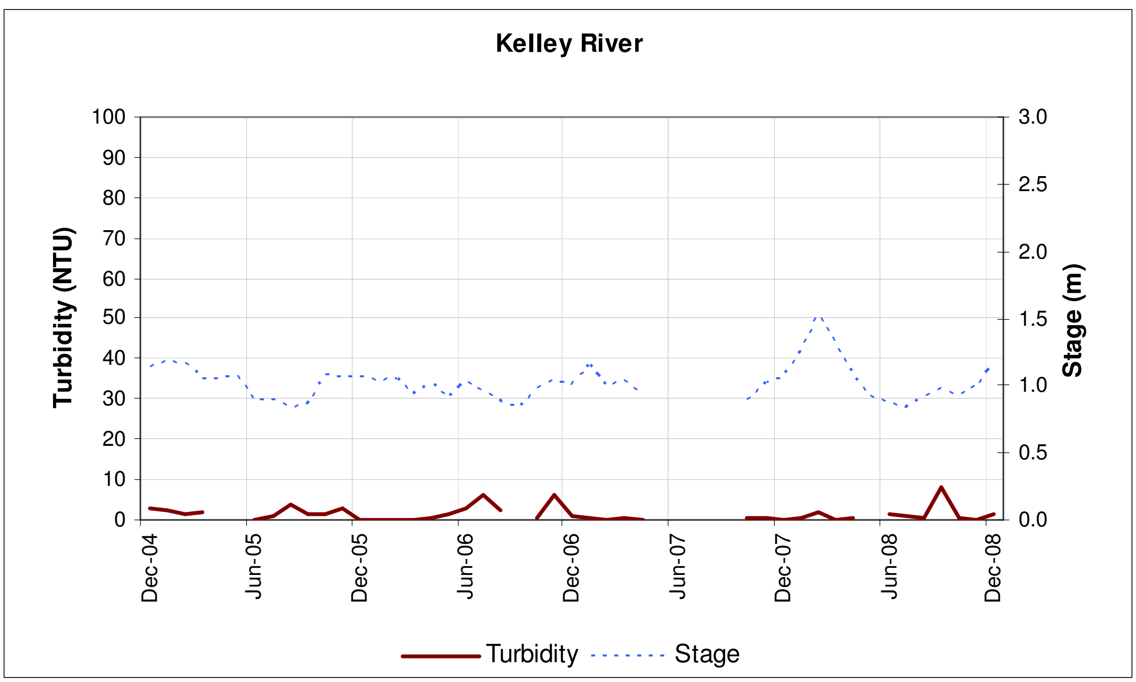


Table 3.4 - 5 Mean monthly turbidity for Kelley River during 2006 – 2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	----------	NTU	----------	-----
January	2006	0.0	0.0	0.2	0.0
February	2006	0.2	0.0	2.3	0.5
March	2006	0.0	0.0	0.3	0.1
April	2006	0.4	0.0	7.0	1.3
May	2006	1.1	0.0	3.4	1.3
June	2006	3.1	1.6	11.1	1.7
July	2006	6.0	0.1	77.9	14.6
August	2006	2.2	1.6	2.8	0.6
September	2006				
October	2006	0.7	0.0	1.7	0.6
November	2006	5.9	0.0	18.0	4.6
December	2006	1.0	0.0	7.2	1.7
January	2007	0.5	0.0	6.0	1.4
February	2007	0.0	0.0	0.0	0.0
March	2007	0.7	0.0	5.7	1.3
April	2007	0.0	0.0	0.0	0.0
May	2007				
June	2007				
July	2007				
August	2007				
September	2007				
October	2007	0.3	0.0	3.6	0.9
November	2007	0.4	0.0	7.6	1.4
December	2007	0.1	0.0	1.7	0.3
January	2008	0.5	0.0	8.0	1.7
February	2008	1.8	0.0	13.9	3.4
March	2008	0.0	0.0	0.3	0.1
April	2008	0.7	0.0	2.1	0.6
May	2008				
June	2008	1.3	0.0	3.8	1.3
July	2008	0.9	0.0	2.5	0.9
August	2008	0.4	0.0	6.8	1.3
September	2008	8.4	0.0	95.6	25.0
October	2008	0.4	0.0	2.2	0.8
November	2008	0.1	0.0	1.2	0.3
December	2008	1.2	0.0	14.5	2.9

Table 3.4 - 6 Mean annual turbidity for Kelley River during 2004 – 2008 based on mean daily data

Year	Mean	Minimum	Maximum	SD
-----	---------- NTU ----------			-----
2004	-	-	-	-
2005	1.73	0.00	31.03	3.43
2006	1.84	0.00	77.87	5.25
2007*	0.30	0.00	7.58	1.03
2008	1.42	0.00	95.63	8.01

Missing values implies insufficient data to compute the statistic.
* Mean and max statistics are not representative of annual values due to lack of seasonal data. Equipment failure due to vandalism, resulting in limited data collection. Therefore, interpret with caution.

3.4.3.3 Conductivity

Figure 3.4 - 11 Conductivity levels from 2006 through 2008 for the Kelley River using hourly values. Points on graphs indicate grab samples. Gaps in the plot indicate missing data.

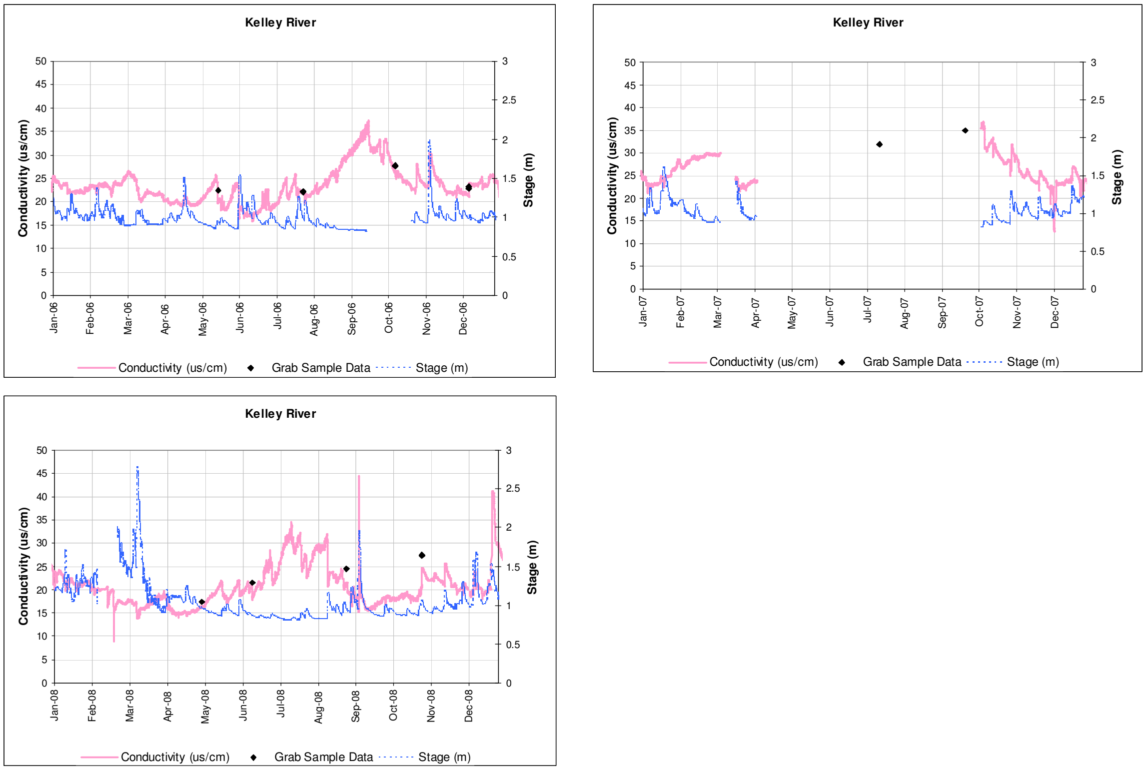


Figure 3.4 - 12 Conductivity levels from 2004 through 2008 for the Kelley River using daily mean values. Gaps in the plot indicate missing data.

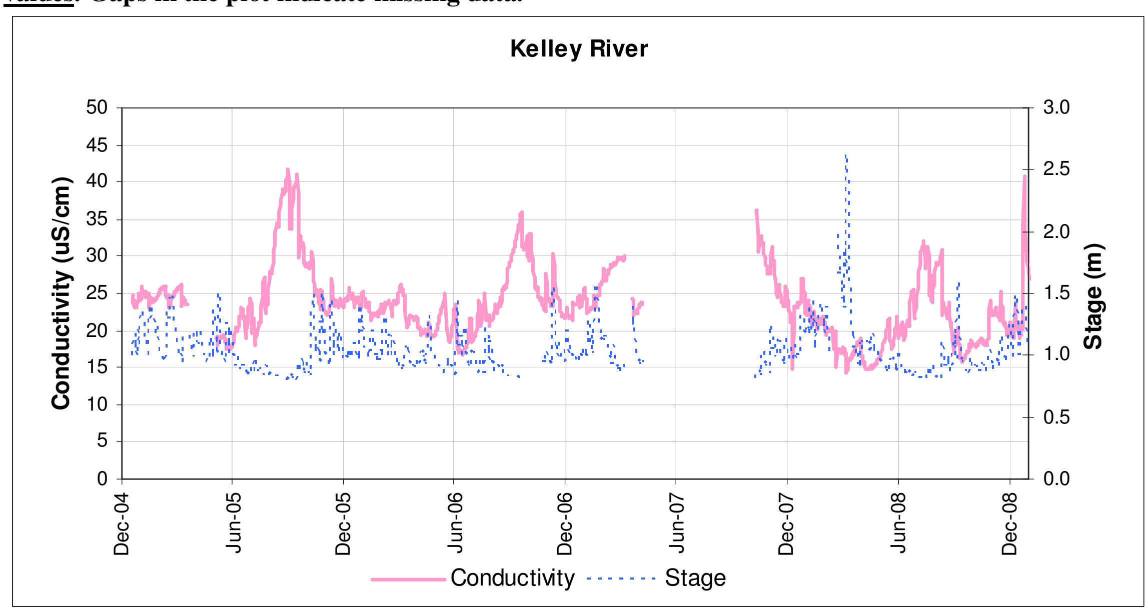


Figure 3.4 - 13 Conductivity levels from 2004 through 2008 for the Kelley River using Monthly mean values. Gaps in the plot indicate missing data.

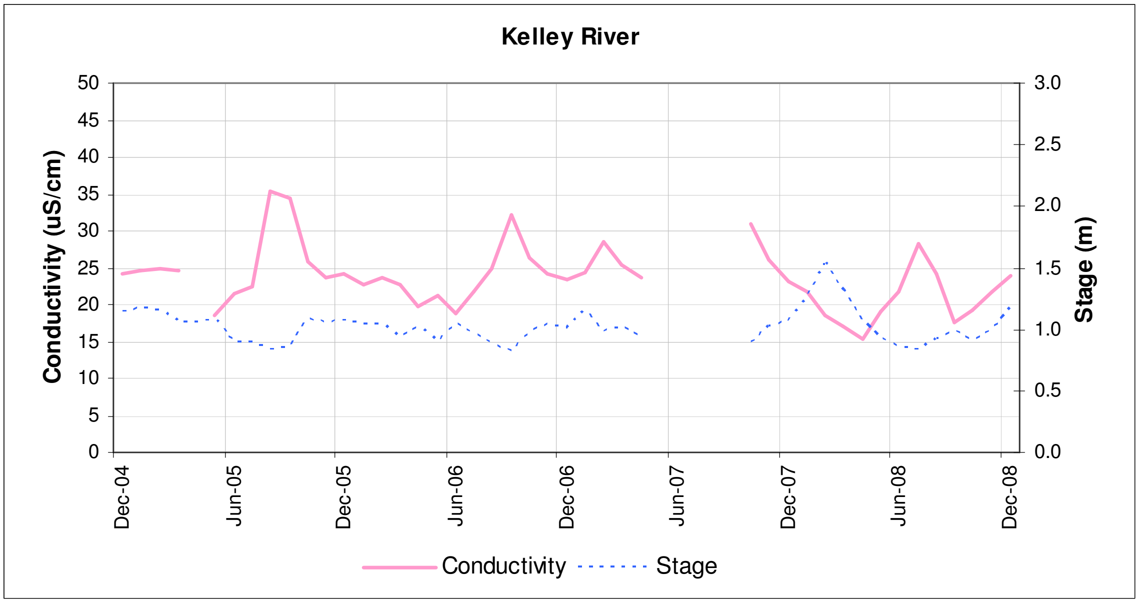


Table 3.4 - 7 Mean monthly conductivity for Kelley River during 2006 – 2008 based on mean daily data

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	----------	µS/cm	----------	-----
January	2006	22.9	21.4	25.4	1.0
February	2006	23.5	21.9	24.9	0.6
March	2006	22.8	20.3	26.3	1.9
April	2006	19.8	19.1	21.4	0.6
May	2006	21.1	18.4	25.1	1.9
June	2006	18.8	16.6	23.5	2.1
July	2006	21.7	18.8	25.1	1.7
August	2006	24.6	21.3	29.2	2.4
September	2006	32.2	29.4	36.0	1.8
October	2006	26.4	22.5	33.1	3.0
November	2006	24.2	21.6	30.3	2.1
December	2006	23.2	21.5	25.5	1.1
January	2007	24.3	22.3	27.6	1.4
February	2007	28.6	26.7	29.9	0.9
March	2007	25.6	22.1	30.0	3.4
April	2007	23.6	23.3	23.9	0.2
May	2007				
June	2007				
July	2007				
August	2007				
September	2007				
October	2007	31.1	27.7	36.3	2.6
November	2007	26.1	23.4	31.3	2.3
December	2007	23.2	14.8	26.9	2.3
January	2008	21.8	20.0	24.0	1.0

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	---------- µS/cm ----------			-----
February	2008	18.7	15.0	20.4	1.5
March	2008	17.0	14.2	18.8	1.1
April	2008	15.4	14.8	16.6	0.6
May	2008	19.0	16.4	21.9	1.4
June	2008	21.5	18.6	25.5	2.1
July	2008	28.0	23.6	32.1	2.7
August	2008	24.4	17.0	30.8	4.1
September	2008	17.5	15.8	20.3	1.2
October	2008	19.0	17.8	24.1	1.8
November	2008	21.8	19.4	25.1	1.4
December	2008	23.6	18.8	40.8	6.2

Table 3.4 - 8 Mean annual conductivity for Kelley River during 2004 – 2008 based on mean daily data

Year	Mean	Minimum	Maximum	SD
-----	---------- uS/cm ----------			-----
2004	-	-	-	-
2005	25.53	17.46	41.76	5.44
2006	23.43	16.64	36.01	3.74
2007*	26.13	14.80	36.25	3.36
2008	20.68	14.21	40.82	4.28

Min, Mean and max statistics are not representative of annual values due to lack of seasonal data. Equipment failure due to vandalism, resulting in limited data collection. Therefore, interpret with caution.
Missing values implies insufficient data to compute the statistic.

3.4.3.4 Dissolved Oxygen

Figure 3.4 - 14 Dissolved Oxygen levels from 2006 through 2008 for the Kelley River using <u>hourly values</u>. Gaps in the plot indicate missing data.

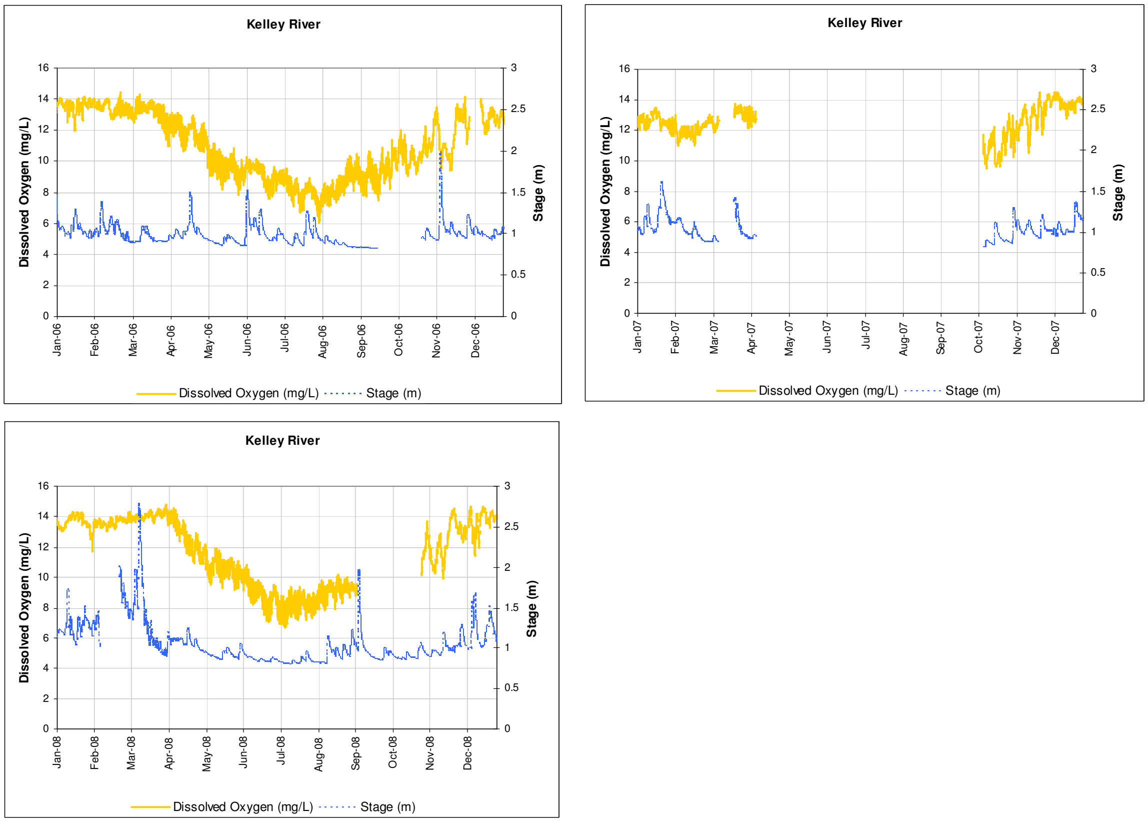


Figure 3.4 - 15 Dissolved oxygen levels from 2004 through 2008 for the Kelley River using <u>daily mean values</u>. Gaps in the plot indicate missing data.

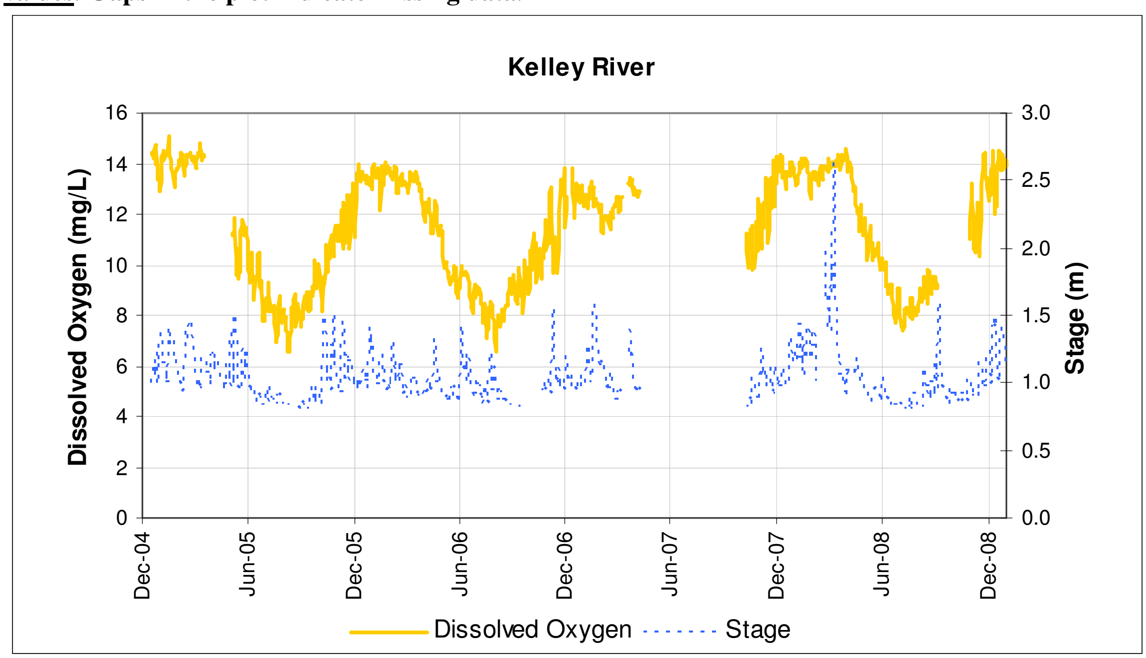


Figure 3.4 - 16 Dissolved Oxygen levels from 2004 through 2008 for the Kelley River using Monthly mean values. Gaps in the plot indicate missing data.

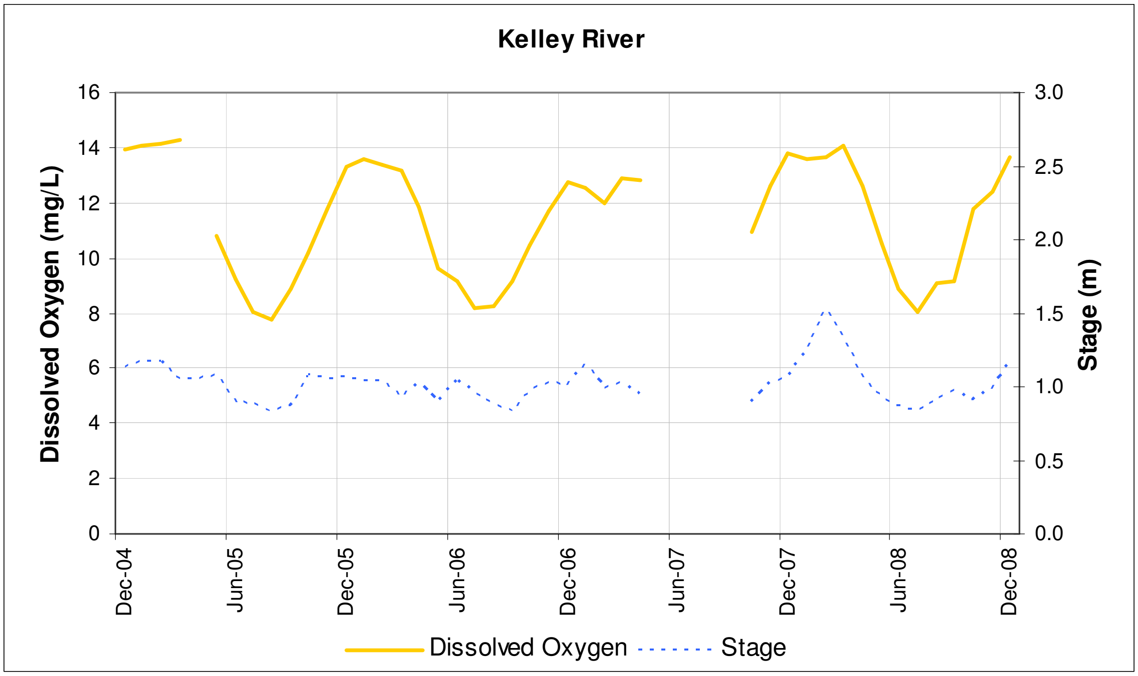


Table 3.4 - 9 Mean monthly dissolved oxygen for Kelley River during 2006 – 2008 based on mean daily data

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	----------	mg/L	----------	-----
January	2006	13.6	12.1	14.0	0.4
February	2006	13.4	12.8	13.9	0.3
March	2006	13.2	12.2	13.7	0.4
April	2006	11.9	11.2	12.6	0.5
May	2006	9.7	8.7	11.4	0.6
June	2006	9.2	8.1	10.0	0.5
July	2006	8.2	7.1	9.1	0.6
August	2006	8.2	6.6	9.5	0.7
September	2006	9.1	8.1	10.2	0.5
October	2006	10.4	9.3	11.7	0.6
November	2006	11.7	9.7	13.8	1.2
December	2006	12.7	11.5	13.8	0.5
January	2007	12.6	12.1	13.2	0.3
February	2007	11.9	11.2	12.7	0.4
March	2007	12.9	12.0	13.4	0.4
April	2007	12.8	12.7	12.9	0.1
May	2007				
June	2007				
July	2007				
August	2007				
September	2007				
October	2007	10.9	9.8	12.6	0.8

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	---------- mg/L ----------			-----
November	2007	12.5	10.6	14.1	0.9
December	2007	13.8	13.0	14.4	0.3
January	2008	13.6	12.6	14.2	0.4
February	2008	13.6	13.2	14.2	0.2
March	2008	14.1	13.7	14.6	0.2
April	2008	12.7	11.2	14.1	0.9
May	2008	10.6	9.8	11.9	0.5
June	2008	8.9	7.7	10.1	0.7
July	2008	8.0	7.4	8.7	0.3
August	2008	9.0	8.2	9.8	0.4
September	2008	9.2	9.0	9.3	0.1
October	2008	11.5	11.0	11.8	0.4
November	2008	12.4	10.3	14.4	1.2
December	2008	13.6	12.0	14.5	0.7

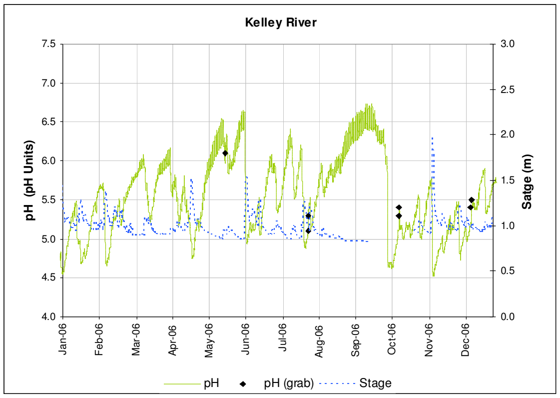
Table 3.4 - 10 Mean annual dissolved oxygen for Kelley River during 2004 – 2008 based on mean daily data

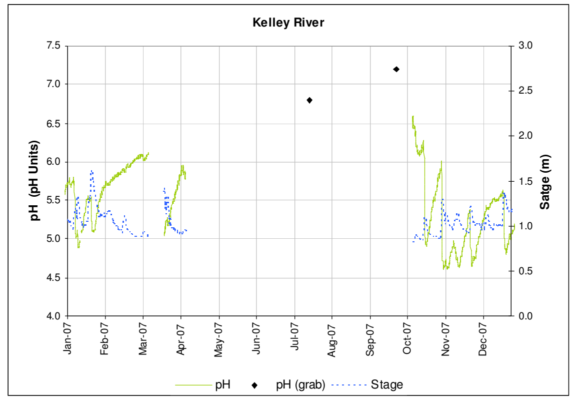
Year	Mean	Minimum	Maximum	SD
-----	---------- mg/L ----------			-----
2004	-	-	-	-
2005	10.97	6.58	15.07	2.44
2006	10.88	6.56	14.01	2.06
2007*	12.52	9.83	14.36	1.00
2008	11.61	7.39	14.56	2.27

Missing values implies insufficient data to compute the statistic.
* Mean and max statistics are not representative of annual values due to lack of seasonal data. Equipment failure due to vandalism, resulting in limited data collection. Therefore, interpret with caution.

3.4.3.5 pH

Figure 3.4 - 17 pH levels from 2006 through 2008 for the Kelley River using hourly values. Points on graphs indicate grab samples. Gaps in the plot indicate missing data.





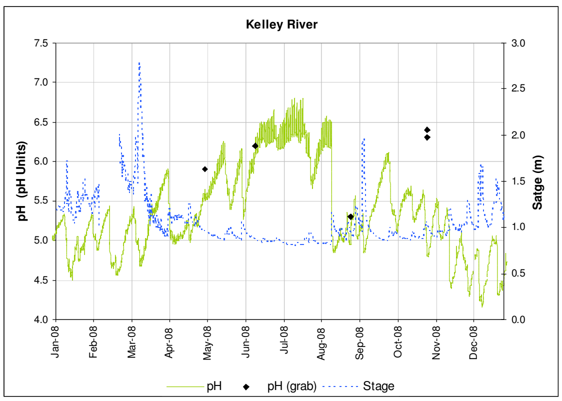


Figure 3.4 - 18 pH levels from 2004 through 2008 for the Kelley River using daily mean values. Gaps in the plot indicate missing data.

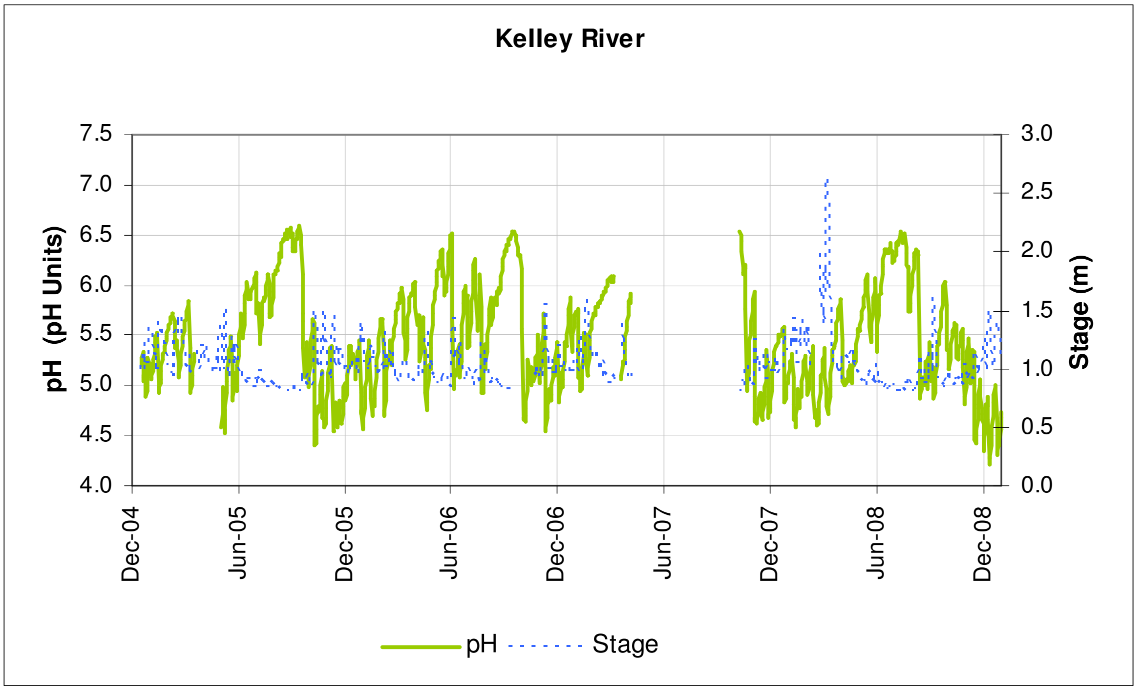


Figure 3.4 - 19 pH levels from 2004 through 2008 for the Kelley River using Monthly mean values. Gaps in the plot indicate missing data.

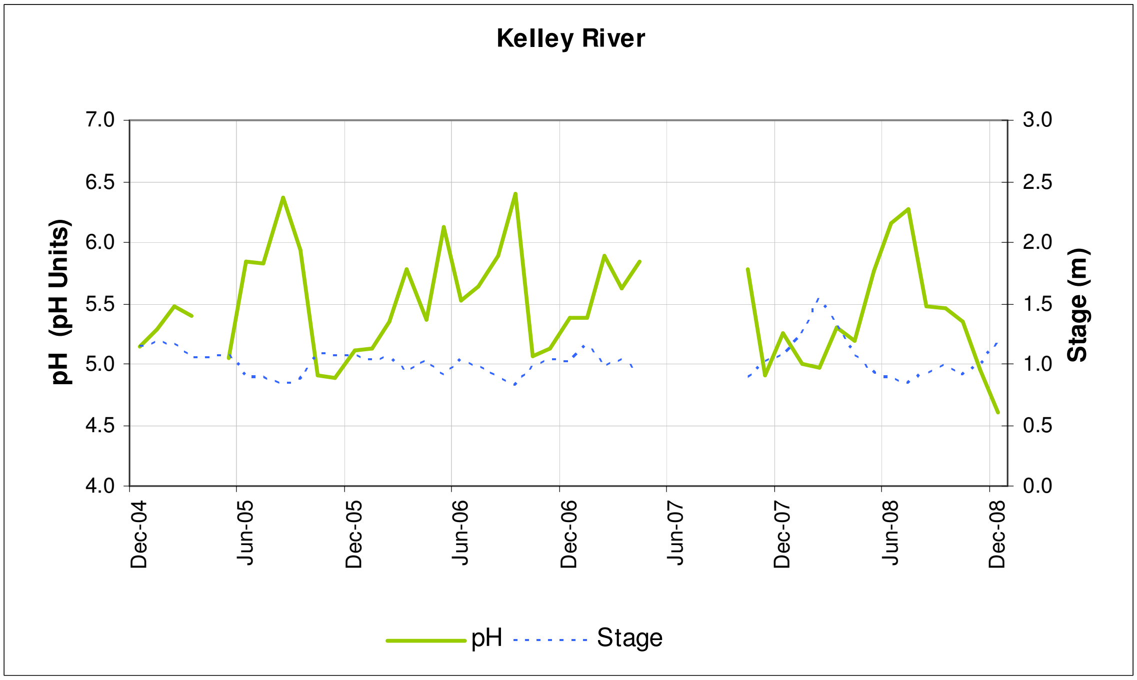


Table 3.4 - 11 Mean monthly pH for Kelley River during 2006 – 2008 based on mean daily data

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	-----	-----	-----	-----
January	2006	5.1	4.6	5.6	0.3
February	2006	5.3	4.7	5.7	0.3
March	2006	5.8	5.3	6.0	0.2
April	2006	5.4	4.8	6.0	0.3
May	2006	6.1	5.7	6.4	0.2
June	2006	5.6	5.0	6.5	0.5
July	2006	5.6	4.9	6.3	0.4
August	2006	5.9	5.3	6.3	0.2
September	2006	6.4	6.2	6.5	0.1
October	2006	5.1	4.6	6.0	0.3
November	2006	5.1	4.5	5.7	0.3
December	2006	5.4	4.8	5.9	0.3
January	2007	5.4	4.9	5.8	0.3
February	2007	5.9	5.7	6.1	0.1
March	2007	5.6	5.1	6.1	0.4
April	2007	5.8	5.7	5.9	0.1
May	2007				
June	2007				
July	2007				
August	2007				
September	2007				
October	2007	5.8	4.9	6.5	0.5
November	2007	4.9	4.6	5.9	0.4
December	2007	5.2	4.8	5.6	0.3
January	2008	5.0	4.6	5.3	0.2
February	2008	5.0	4.6	5.4	0.2
March	2008	5.3	4.7	5.9	0.3
April	2008	5.2	5.0	5.6	0.2
May	2008	5.8	5.4	6.1	0.2
June	2008	6.1	5.3	6.4	0.3
July	2008	6.3	5.7	6.5	0.2
August	2008	5.5	4.9	6.4	0.6
September	2008	5.5	4.9	6.0	0.4
October	2008	5.4	4.8	5.6	0.2
November	2008	5.0	4.4	5.5	0.3
December	2008	4.6	4.2	5.0	0.2

Table 3.4 - 12 Mean annual pH for Kelley River during 2004 – 2008 based on mean daily data

Year	Mean	Minimum	Maximum	SD
-----	-----	-----	-----	-----
2004	-	-	-	-
2005	5.47	4.41	6.59	0.56
2006	5.56	4.55	6.54	0.49
2007*	5.46	4.62	6.54	0.46
2008	5.38	4.20	6.53	0.56

Missing values implies insufficient data to compute the statistic.

* Mean and max statistics are not representative of annual values due to lack of seasonal data. Equipment failure due to vandalism, resulting in limited data collection. Therefore, interpret with caution.

3.4.4 Overview of Kelley River Water Quality

Water quality data collected at this station since 2005 are fairly typical of a predominantly forested watershed (80% of total area) located on sedimentary bedrock.

Data collection during 2007 was interrupted at this station between April and October due to vandalism, although limited data are provided for this station, summary statistics are not representative of annual conditions and should be viewed with caution.

Water temperature varied according to a seasonal pattern very similar to that of air temperature, which is typical of a shallow flowing river. Minimum hourly water temperatures for Winter (December to February) ranged from -0.2 ^{o}C in 2007 and 2008 to -0.3^{o}C in 2005 and 2006. Maximum hourly water temperatures for Summer (June to August) ranged from 26.5^{o}C in 2006 to 28.1^{o}C in 2005. Mean hourly temperature readings ranged from 8.3 ^{o}C in 2008 to 9.6 ^{o}C in 2005. Based on hourly records, a range of from 2% (in 2006) to 6% (in 2005 and 2008) of annual temperature measurements exceeded the recommended temperature limit of 20-21 ^{o}C for salmon and trout, all of which occurred in the months of June, July and August.

Turbidity values were relatively low for most of the period of record with only a few sporadic events each year having values significantly above the overall hourly mean of 1.7 NTU. Minimum turbidity values were recorded as 0.0 NTU in all years of record. Maximum turbidity values ranged from 92.7 NTU in 2006 to 324.7 NTU in 2008. High turbidity events greater than 25 NTU occurred on a frequency of 5 times per year in 2005, and 5, >4, and 10 times in 2006, 2007, and 2008 respectively. Overall, less than 1 percent of hourly turbidity measurements were greater than 50 NTU, the guideline for recreational use. Between 3% (2008) and 10% (2006) of turbidity measurements were greater than the drinking water aesthetic objective of 5 NTU. Peak turbidity measurements generally occurred simultaneously with peak flows and precipitation events. On occasion short- term peaks were observed in the absence of rain events which may be indicative of intermittent local land or water disturbances.

Conductivity of Kelley River was characteristic of dilute waters where minimum hourly values ranged from 8.8 uS/cm (2008) to 16.4 uS/cm (2005). Maximum values ranged from 37.4 uS/cm (2006) to 44.2 uS/cm (2008), and mean values ranged from 20.6 uS/cm (2008) to 25.6 uS/cm (2005. Peak measurements occurred during the low flow Summer period which is indicative of the dominant influence of groundwater seepage.

Dissolved oxygen concentrations followed a trend that was essentially the inverse of temperature, showing seasonal Summer lows in the July-August period of each year. This is typical of shallow surface waters where the solubility of oxygen in water decreases as

water temperature rises. Minimum hourly dissolved oxygen values ranged from 5.8 mg/l (2005) to 6.7 mg/l (2008). Maximum values ranged from 14.4 mg/l (2006) to 15.2 mg/l (2005), and mean values ranged from 10.8 mg/l (2005) to 11.6 mg/l (2008).
At no time during the period of record (2005 to 2008) did hourly concentrations dip below 5.8 mg/L, remaining well above a suggested threshold for the protection of aquatic life of 5.0 mg/L.

pH was highly variable during the study period (2005 to 2008) with high hourly values predominant during the Summer low flow period and low pH values dominating the periods of higher flows (Oct to March). Minimum hourly pH values ranged from 4.2 units (2008) to 4.5 units (2006), while maximum values ranged from a pH of 6.7 (2006) to a pH of 6.9 (2005). Mean hourly values ranged from a pH of 5.4 (2008) to a pH of 5.6 (2006). The Kelley River watershed contains very substantial wetland areas (11.5 % of total area) which are known sources of organic acids that play a role in lowering pH. These acids are typically released into downstream receiving water during periods of high flow. The lowest seasonal pH values occurred during late Fall to early Spring periods. This is consistent with situations where snow melt and runoff cause low pH fluxes in streams in areas experiencing atmospheric acid deposition – suggesting this possible source as well. The more acidic conditions of Kelley River showed an overall annual mean pH of 5.5 during the 2005-2008 study period. Over 95% (95 to 98 %) of the hourly readings taken during the study period exceeded the recommended ranges of pH established as national guidelines for the Protection of Aquatic Life, Drinking Water, and Recreational use of 6.5 to 9.0, 6.5 to 8.5 and,6.5 to 9.5 respectively.

Data from grab samples or field meter readings taken during site visits generally were in good agreement with automated sensor values confirming quality of the dataset. Data for pH during the 2008 sampling season however were an exception with lesser agreement. This merits further investigation as to cause.

3.5 ST. MARY'S RIVER

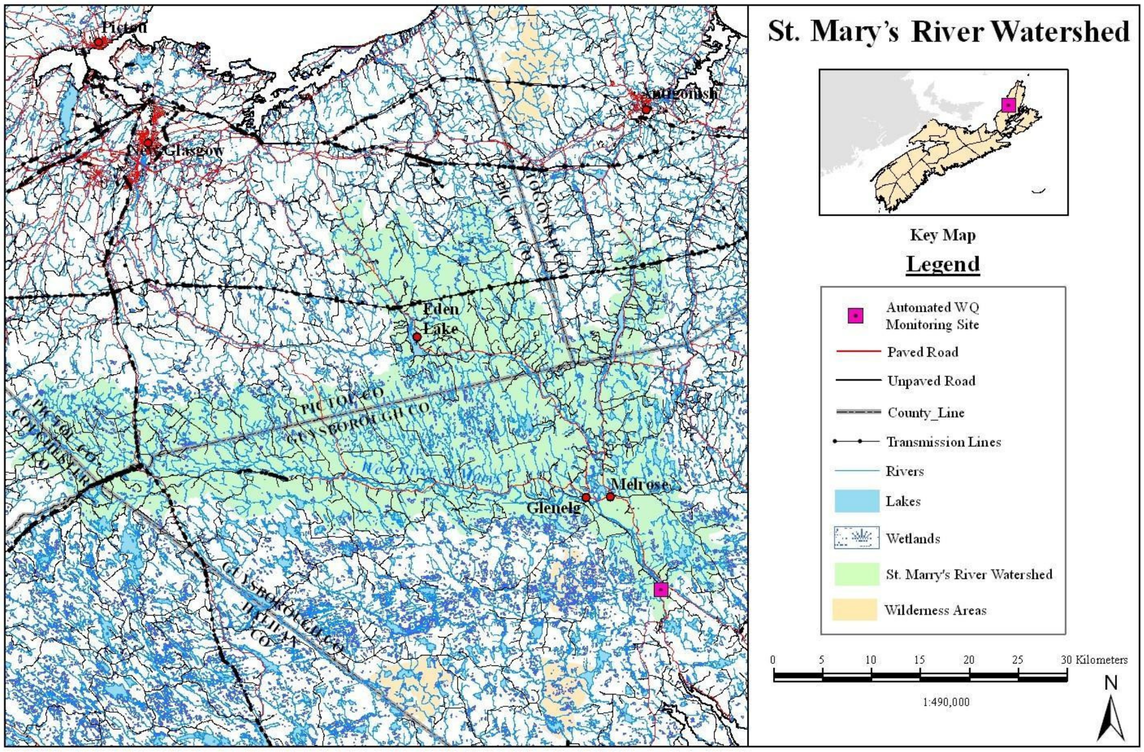


Figure 3.5 - 1 Location of St. Mary's River watershed

3.5.1 Background Information

Location of Station

The St. Mary's River Automated Network Station is located at Latitude 45^{o} 10' 24" N, Longitude 61^{o} 58' 54" W.

Geographic Setting

The St. Mary's River monitoring station is located in Guysborough County. Although the river flows mostly through Guysborough and Pictou counties, the St. Mary's River headwaters actually span five of Nova Scotia's Counties - Guysborough, Halifax, Colchester, Pictou, and Antigonish. The river flows predominately southeast and discharges directly to the Atlantic Coast. The total area of the watershed is approximately 1350 km^2.

Geology and Geomorphology

The St. Mary's River is located in an area called the Meguma Terrane which differs geologically from the rest of the Nova Scotia mainland. This area is dominated by sandstones and shales. Faults control many of the drainage patterns within the St. Mary's River watershed.

The dominant landforms in the watershed vary from rolling hills to relatively steep terrains.

Forest Cover and Land Use
Historically, as part of the Acadian Forest, the St. Mary's River watershed was made up of red pine, eastern white pine, red spruce, america beech, eastern hemlock, balsam fir and sugar maple. Due to human settlement, the watershed has become dominated by softwoods and agricultural lands. Wetlands are present throughout the watershed. 82.5% of the land within the watershed is forested, 5.9% is covered by a combination of wetlands and water, and 0.4 % characterized as urban land use.

Climate
Normal (1971-2000) annual precipitation in the St, Mary's watershed, as recorded at the Environment Canada Climate Station at Stillwater-Sherbrooke is 1517 mm - comprised of 1345 mm of rainfall and 172 cm of snowfall. The mean annual temperature is 6.3 °C with a mean monthly high of 18.4 °C in August and a low of –6 °C in January.

Figure 3.5 - 2 Precipitation and Air Temperature data from Environment Canada Climate Station at Malay Falls (St. Mary's River Watershed) for 2007 and 2008. Gaps in the plot indicate missing data.

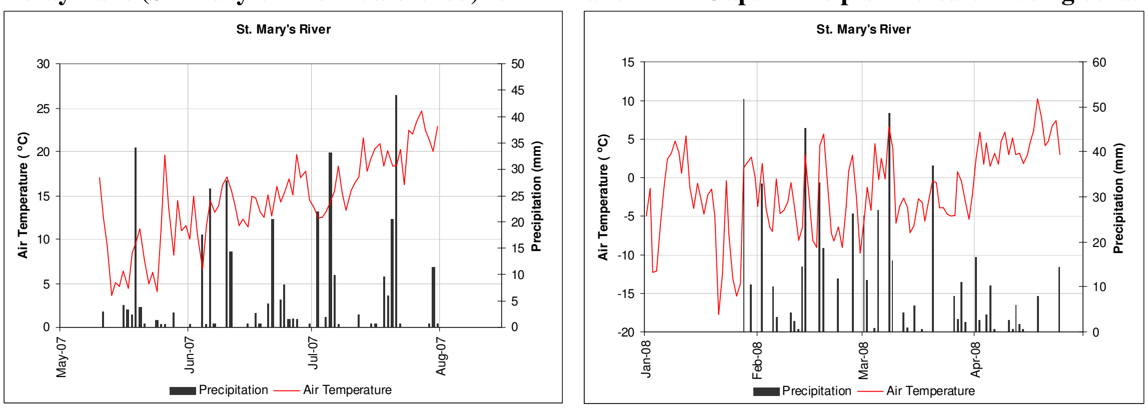


Figure 3.5 - 3 St. Mary's river monitoring station

Wildlife and Habitat

The St. Mary's watershed supports populations of black bear, moose, whitetail deer and coyote. The river is home to many fish species, including atlantic salmon, brook trout, rainbow smelt and yellow perch. The watershed is also home to the endangered wood turtle.

Human Settlement and Industrial Development

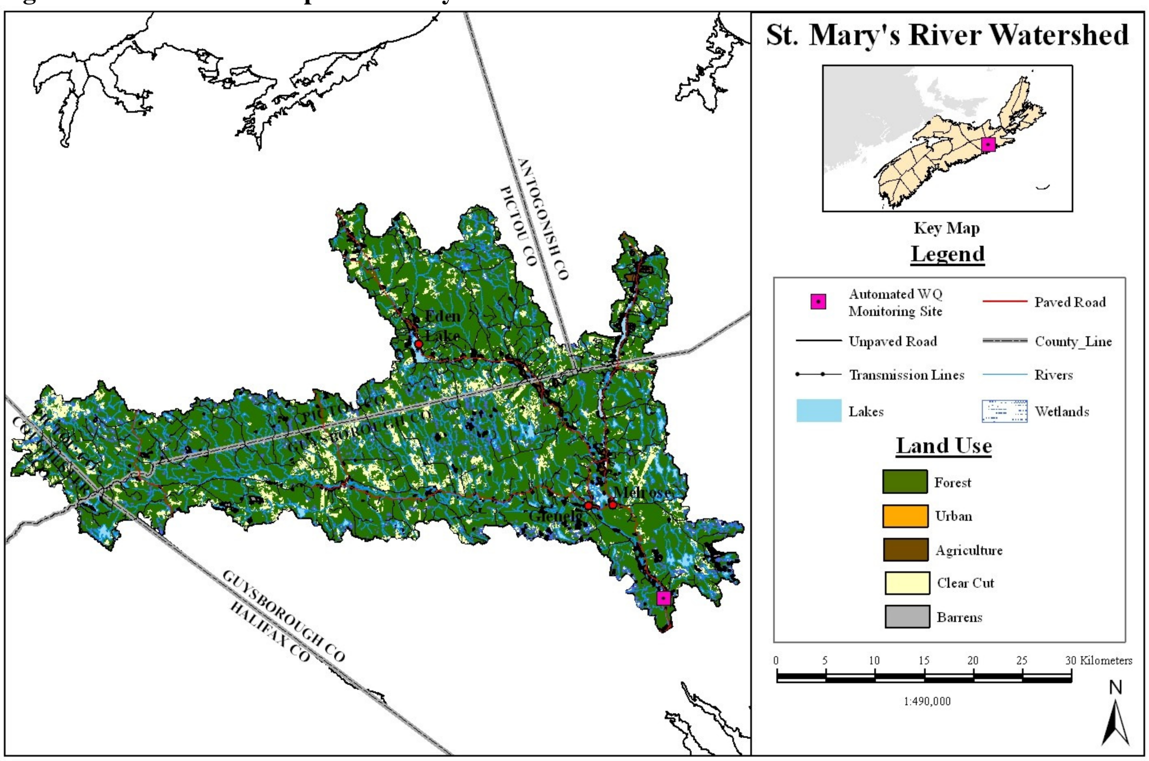
Prior to European contact, the St. Mary's River was used by the Mi'kmaq First Nation for inland travel and for fishing. The first European settlement on the river was by the French in 1654. During the early 19th century the St. Mary's River had a thriving commercial salmon fishery and also a long history of log drives for exporting lumber. By the mid 19th century the number of salmon in the river had declined to almost nothing due to over-fishing. Currently the primary industries are tourism, forestry and agriculture.

3.5.2 Land Use Summary Information

Table 3.5 - 1 Land use summary for St. Mary's River watershed

Land Type	km^2	% of Total Area
Agriculture	14.0	1.0
Barren	6.8	0.5
Clearcut	127.9	9.6
Forested	1102.8	82.5
Urban	5.5	0.4
Wetland/Water	79.5	5.9
Total	1336.8	100.0

Figure 3.5 - 4 Land use map of St. Mary's River watershed.



3.5.3 Water Quality Summary Information

Table 3.5 - 2 Hourly statistics of minimum, maximum, mean and standard deviation and exceedences as per established water quality guidelines for hourly real time data for St. Mary's River for the period 2007 – 2008.

Parameter	Year	Min	Max	Mean	SD	CWQ Guideline			Readings[5]	# of Exceedences			Exceedences As % of Readings		
						FWAL[1]	DW[1]	REC[1]							
Temperature, °C	2007	-0.3	25.5	12.2	7.1	20-21[2]			5037	474			9		
	2008	-0.3	11.0	1.4	2.8				2656	0			0		
Turbidity, NTU										DW <1[3]	DW ≤5[4]	REC	DW <1[3]	DW ≤5[4]	REC
	2007	0.0	37.6	1.1	1.9		<1[3], ≤5[4]	≤50	2711	1064	60	0	39	2	0
	2008	0.8	2991.0	12.1	100.8				1944	1943	486	35	99.9	25	2
Conductivity, uS/cm	2007	11.4	41.8	32.9	3.5				5033						
	2008	20.9	38.0	29.5	3.7				2656						
Dissolved Oxygen, mg/L	2007	6.9	14.6	10.6	2.4	≥5.0			3208	0			0		
	2008	10.2	14.7	13.6	1.0				2566	0			0		
pH, Units										FWAL	DW	REC	FWAL	DW	REC
	2007	5.7	7.1	6.5	0.3	6.5-9.0	6.5-8.5	6.5-9.5	3199	1434	1434	1434	45	45	45
	2008	5.1	6.3	5.9	0.2				2656	2656	2656	2656	100	100	100

1 FWAL: Freshwater Aquatic Life; DW: Drinking Water; REC: Recreational Use
2 Upper permissible limit for salmon and trout (Alabaster and Lloyd, 1982). CCME DW guideline deemed to be inappropriate.
3 Maximum Acceptable Concentration for water entering a distribution system.
4 Aesthetic Objective. 5NTU may be permitted if demonstrated that the disinfection method is not compromised.
5 The number of hourly readings possible in each of the years 2002, 2003, 2005, 2006, and 2007 is 8760. For 2004 and 2008 the number is 8784. The number recorded in the table refers to the actual number of approved measurements

3.5.3.1 Temperature

Figure 3.5 - 5 Water temperature from May 2007 through April 2008 for the St. Mary's River using hourly values. Gaps in the plot indicate missing data.

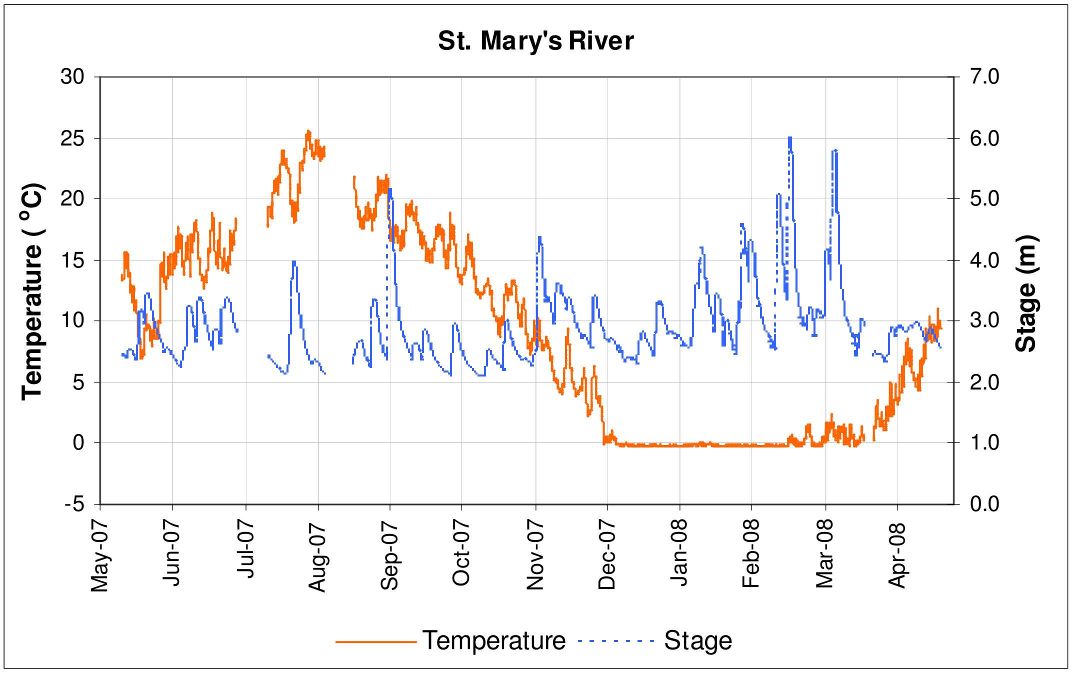


Figure 3.5 - 6 Water temperature from May 2007 through April 2008 for the St. Mary's River using mean daily values. Gaps in the plot indicate missing data.

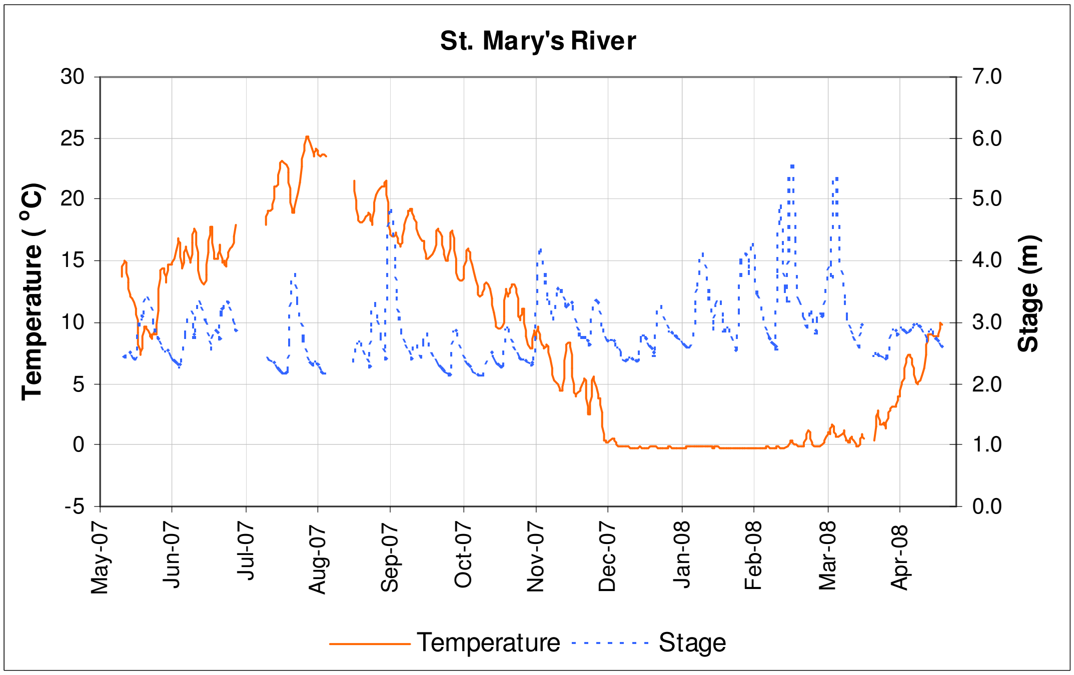


Figure 3.5 - 7 Water temperature from May 2007 through April 2008 for the St. Mary's River using mean monthly values. Gaps in the plot indicate missing data.

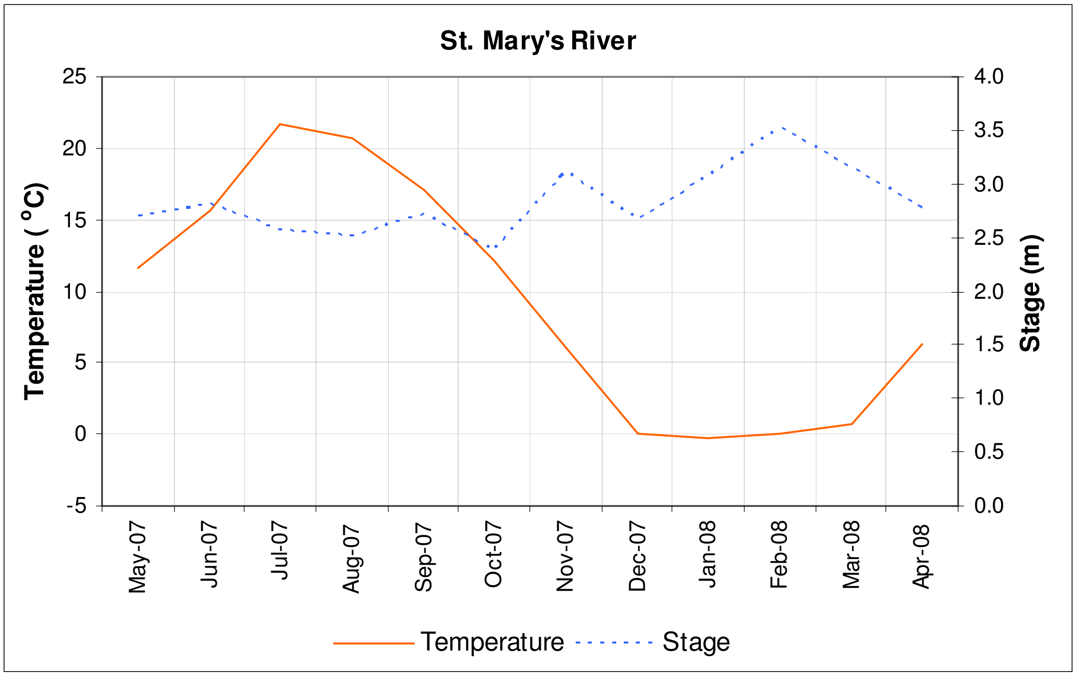


Table 3.5 - 3 Mean monthly water temperature for St. Mary's River during 2007-2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	----------	°C	----------	-----
May	2007	11.5	7.3	15.0	2.6
June	2007	15.7	13.1	17.9	1.3
July	2007	21.6	17.9	25.1	2.1
August	2007	20.7	18.0	24.1	2.2
September	2007	17.0	14.7	19.3	1.3
October	2007	12.1	7.9	16.1	2.0
November	2007	6.0	2.5	9.6	2.0
December	2007	0.0	-0.2	2.6	0.5
January	2008	-0.2	-0.3	0.0	0.1
February	2008	0.0	-0.2	1.1	0.4
March	2008	0.7	-0.2	2.8	0.7
April	2008	6.3	2.3	10.0	2.4

Table 3.5 - 4 Mean annual water temperature for St. Mary's River during 2007-2008 based on mean monthly data.

Year	Mean	Minimum	Maximum	SD
-----	----------	°C	----------	-----
2007	13.09	0.00	21.65	7.34
2008	1.70	-0.19	6.26	3.07

3.5.3.2 Turbidity

Figure 3.5 - 8 Turbidity from May 2007 through April 2008 for the St. Mary's River using hourly values. Gaps in the plot indicate missing data.

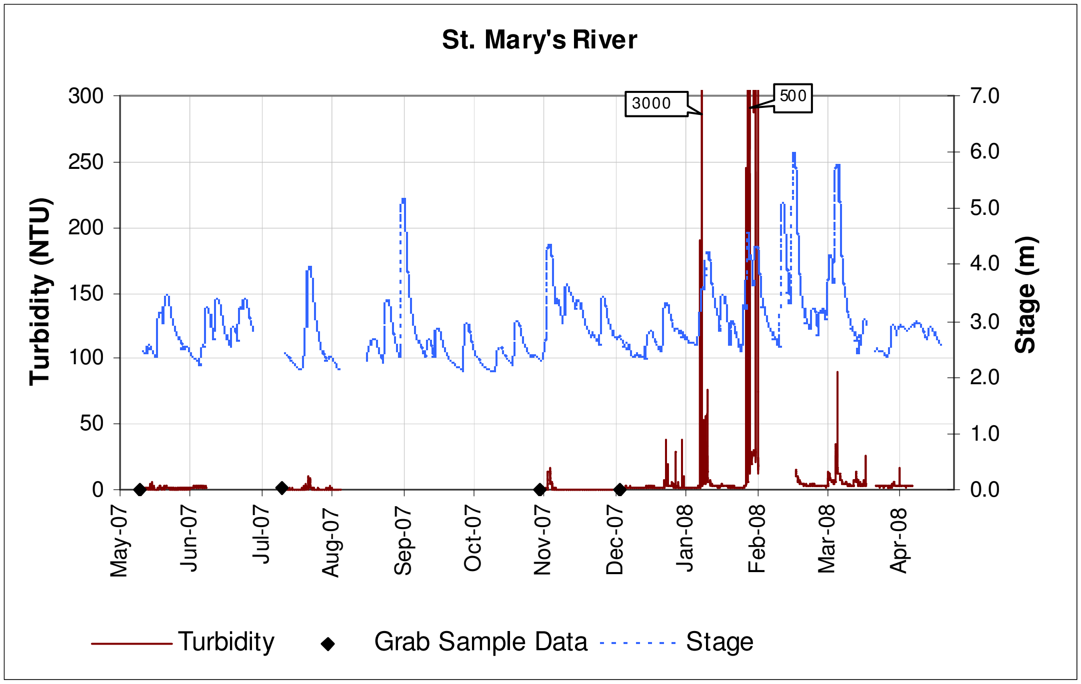


Figure 3.5 - 9 Turbidity from May 2007 through April 2008 for the St. Mary's River using mean daily values. Gaps in the plot indicate missing data.

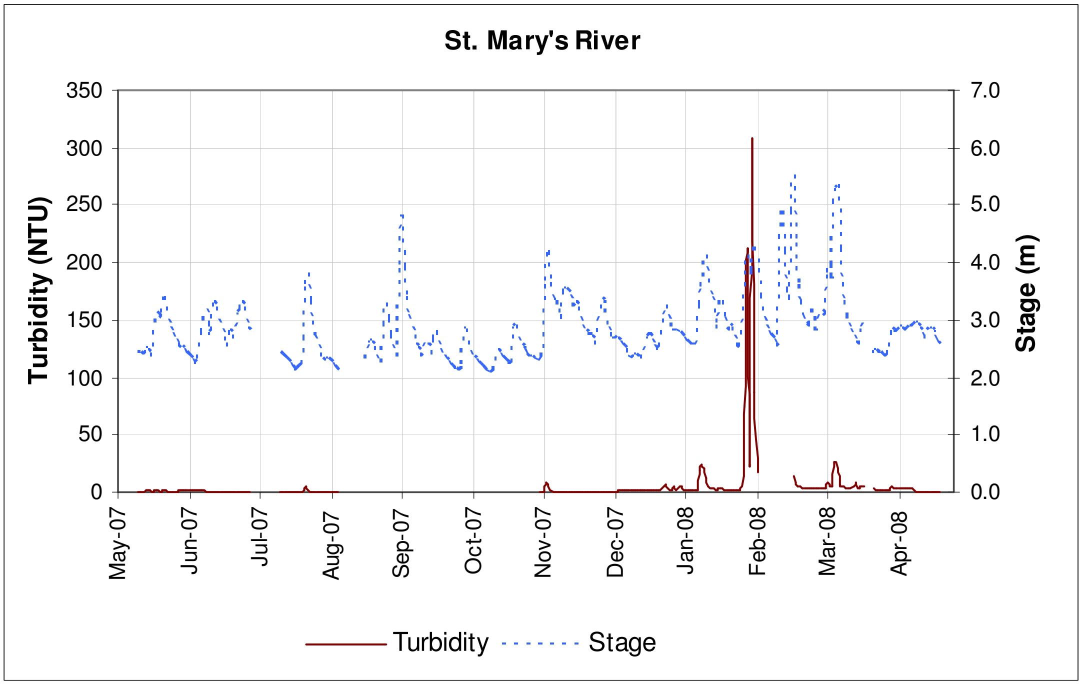


Figure 3.5 - 10 Turbidity from May 2007 through April 2008 for the St. Mary's River using mean monthly values. Gaps in the plot indicate missing data.

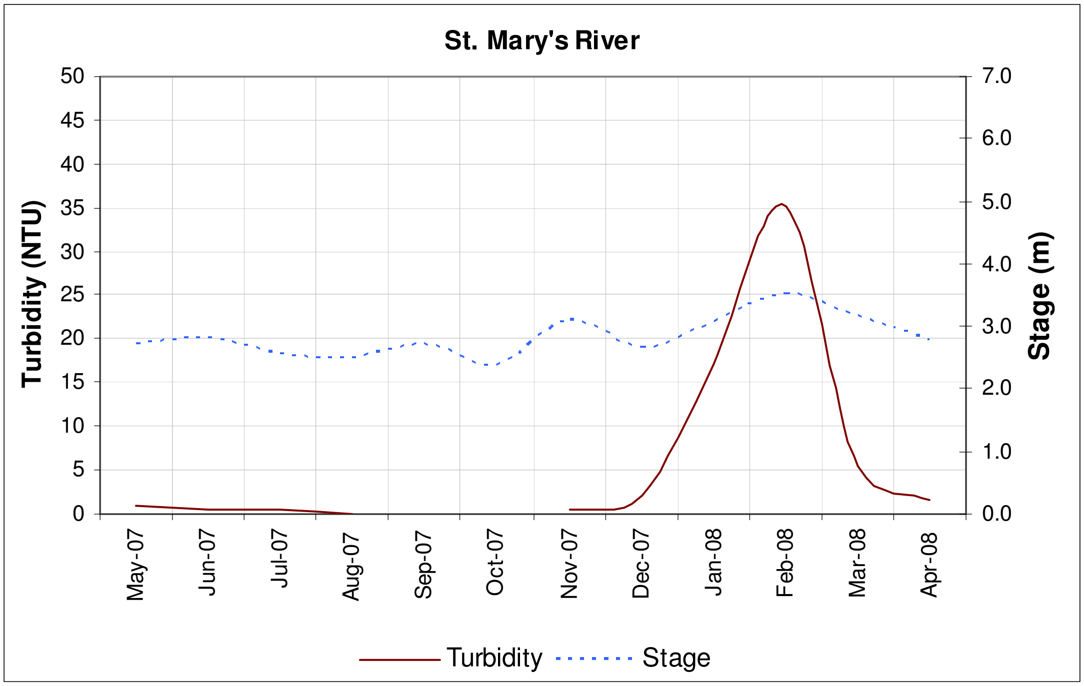


Table 3.5 - 5 Mean monthly turbidity for St. Mary's River during 2007-2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	----------	°C	----------	-----
May	2007	11.5	7.3	15.0	2.6
June	2007	15.7	13.1	17.9	1.3
July	2007	21.6	17.9	25.1	2.1
August	2007	20.7	18.0	24.1	2.2
September	2007	17.0	14.7	19.3	1.3
October	2007	12.1	7.9	16.1	2.0
November	2007	6.0	2.5	9.6	2.0
December	2007	0.0	-0.2	2.6	0.5
January	2008	-0.2	-0.3	0.0	0.1
February	2008	0.0	-0.2	1.1	0.4
March	2008	0.7	-0.2	2.8	0.7
April	2008	6.3	2.3	10.0	2.4

Table 3.5 - 6 Mean annual turbidity for St. Mary's River during 2007-2008 based on mean monthly data.

Year	Mean	Minimum	Maximum	SD
-----	----------	°C	----------	-----
2007	0.76	0.01	2.06	0.70
2008	14.87	1.60	35.12	15.04

3.5.3.3 Conductivity

Figure 3.5 - 11 Conductivity from May 2007 through April 2008 for the St. Mary's River using hourly values. Gaps in the plot indicate missing data.

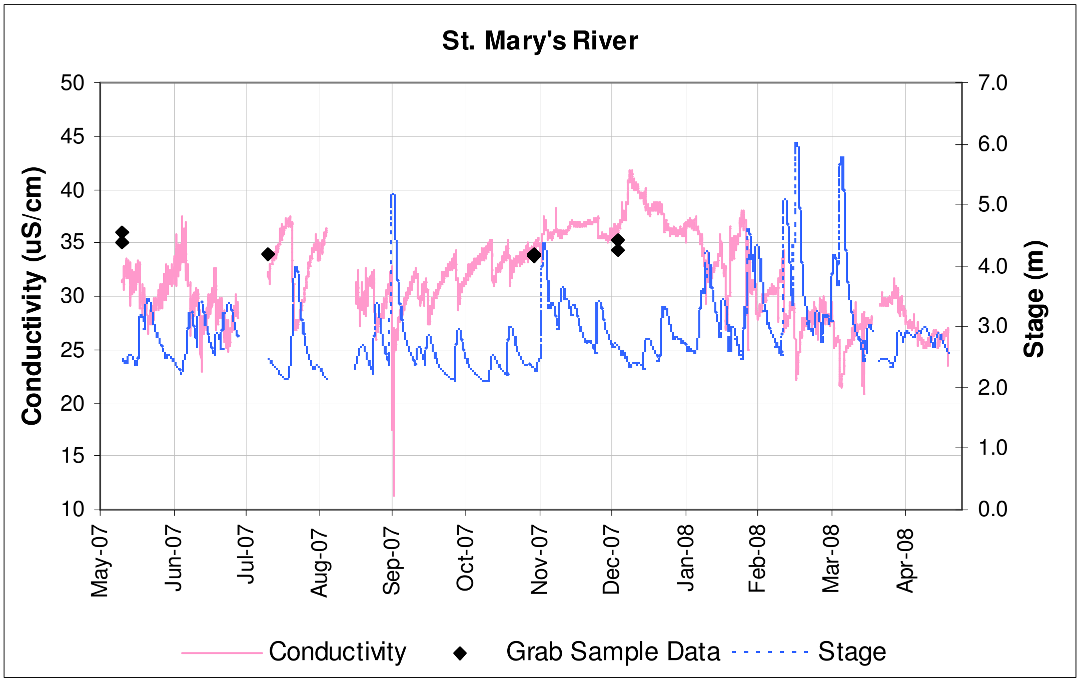


Figure 3.5 - 12 Conductivity from May 2007 through April 2008 for the St. Mary's River using mean daily values. Gaps in the plot indicate missing data.

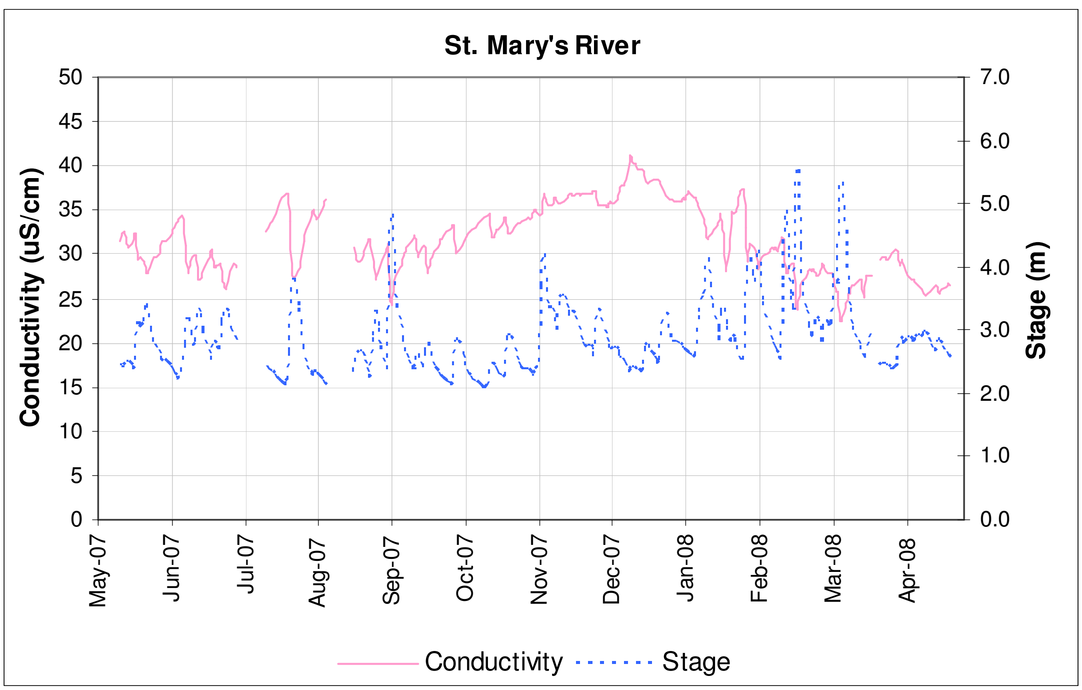


Figure 3.5 - 13 Conductivity from May 2007 through April 2008 for the St. Mary's River using mean monthly values. Gaps in the plot indicate missing data.

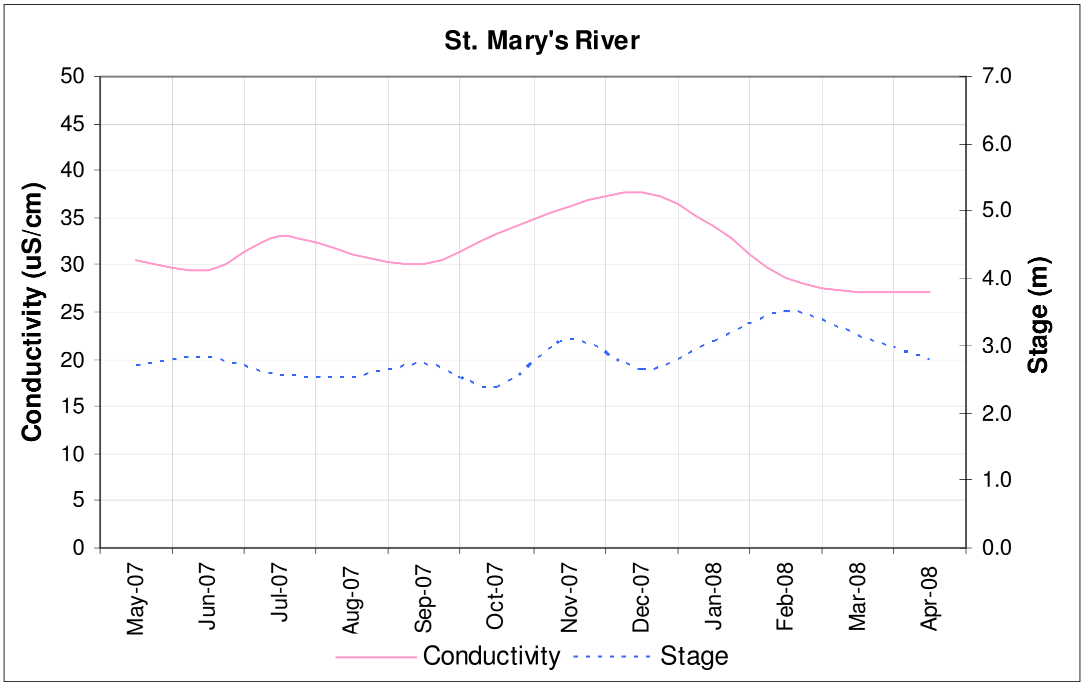


Table 3.5 - 7 Mean monthly conductivity for St. Mary's River during 2007-2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----		---------- NTU ----------		-----
May	2007	0.9	0.3	2.1	0.5
June	2007	0.5	0.0	2.2	0.8
July	2007	0.5	0.0	5.4	1.2
August	2007	0.0	0.0	0.0	0.0
September	2007		0.0	0.0	
October	2007		0.0	0.0	
November	2007	0.6	0.0	8.2	1.9
December	2007	2.1	0.0	6.3	1.4
January	2008	17.2	1.9	209.1	46.9
February	2008	35.1	3.2	308.6	81.7
March	2008	5.6	2.4	25.3	5.2
April	2008	1.6	0.0	4.4	1.7

Table 3.5 - 8 Mean annual conductivity for St. Mary's River during 2007-2008 based on mean monthly data.

Year	Mean	Minimum	Maximum	SD
-----		---------- °C ----------		-----
2007	32.68	29.50	37.76	2.98
2008	29.26	27.05	34.15	3.35

3.5.3.4 Dissolved Oxygen

Figure 3.5 - 14 Dissolved Oxygen from May 2007 through April 2008 for the St. Mary's River using hourly values. Gaps in the plot indicate missing data.

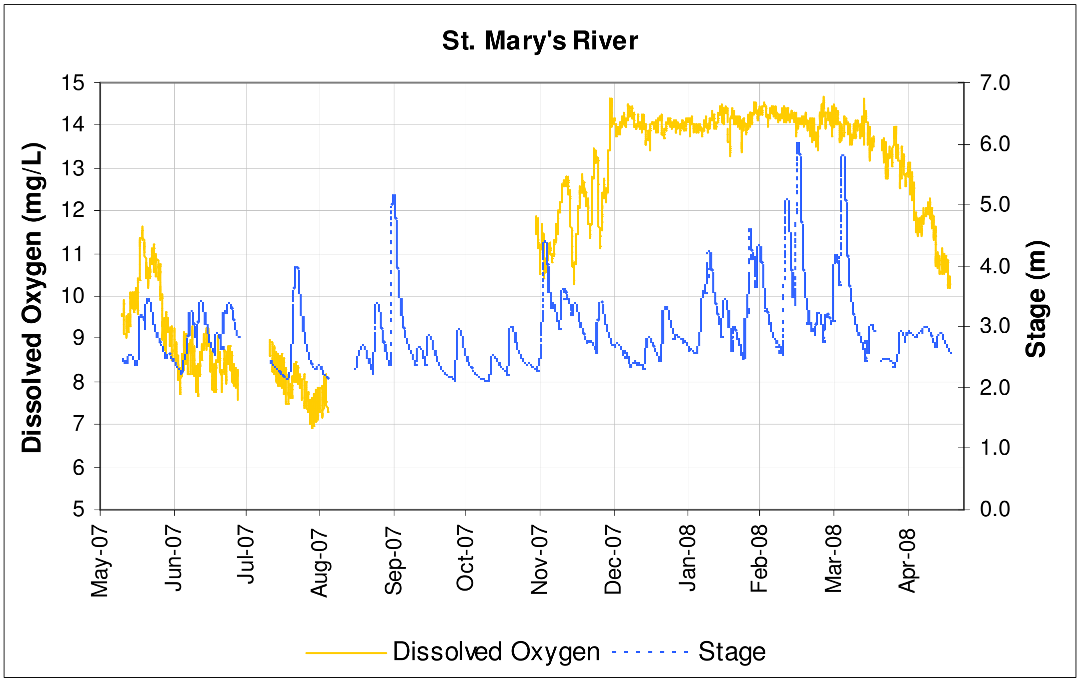


Figure 3.5 - 15 Dissolved Oxygen from May 2007 through April 2008 for the St. Mary's River using mean daily values. Gaps in the plot indicate missing data.

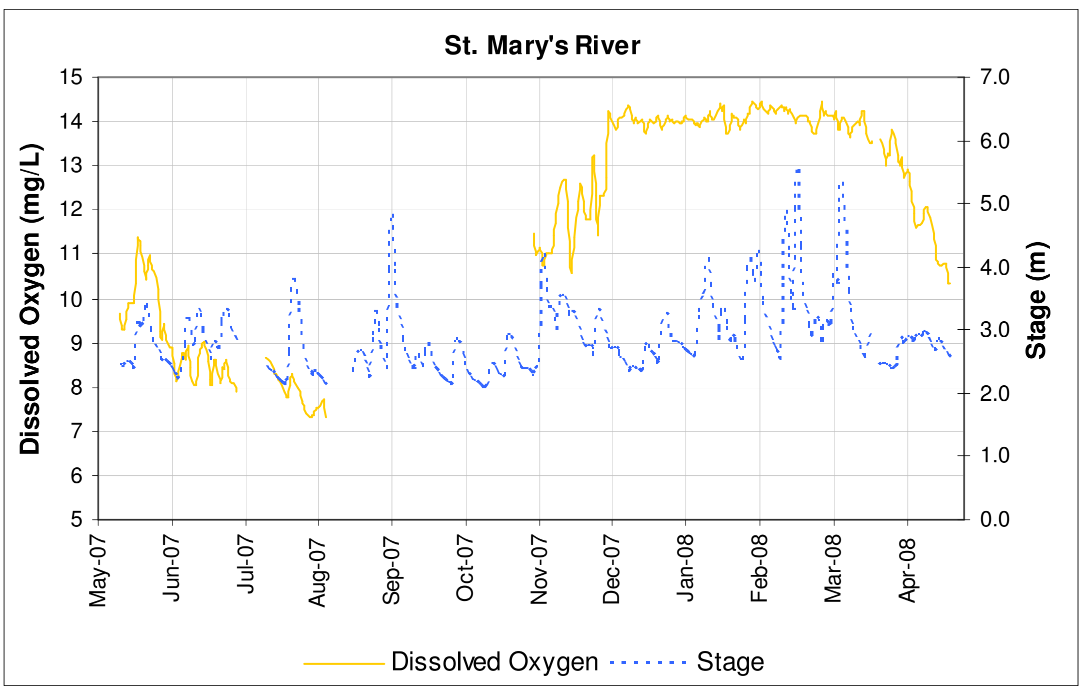


Figure 3.5 - 16 Dissolved Oxygen from May 2007 through April 2008 for the St. Mary's River using mean monthly values. Gaps in the plot indicate missing data.

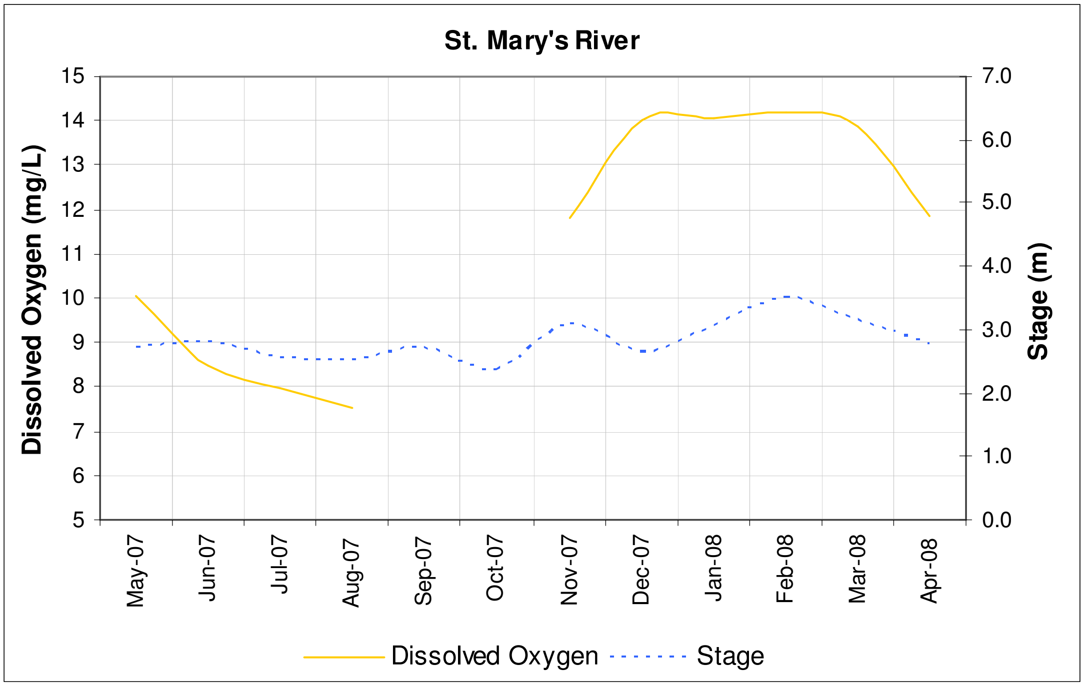


Table 3.5 - 9 Mean monthly dissolved oxygen for St. Mary's River during 2007-2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	----------	mg/L	----------	-----
May	2007	10.0	8.9	11.4	0.7
June	2007	8.5	7.9	9.0	0.3
July	2007	8.0	7.3	8.7	0.4
August	2007	7.5	7.3	7.7	0.2
September	2007				
October	2007				
November	2007	11.8	10.6	13.2	0.7
December	2007	14.0	12.8	14.4	0.3
January	2008	14.1	13.7	14.4	0.2
February	2008	14.2	13.7	14.5	0.2
March	2008	13.9	13.0	14.4	0.3
April	2008	11.9	10.3	13.5	1.0

Table 3.5 - 10 Mean annual dissolved oxygen for St. Mary's River during 2007-2008 based on mean monthly data.

Year	Mean	Minimum	Maximum	SD
-----	----------	°C	----------	-----
2007	9.96	7.54	13.99	2.52
2008	13.49	11.86	14.18	1.09

3.5.3.5 pH

Figure 3.5 - 17 pH from May 2007 through April 2008 for the St. Mary's River using hourly values. Gaps in the plot indicate missing data.

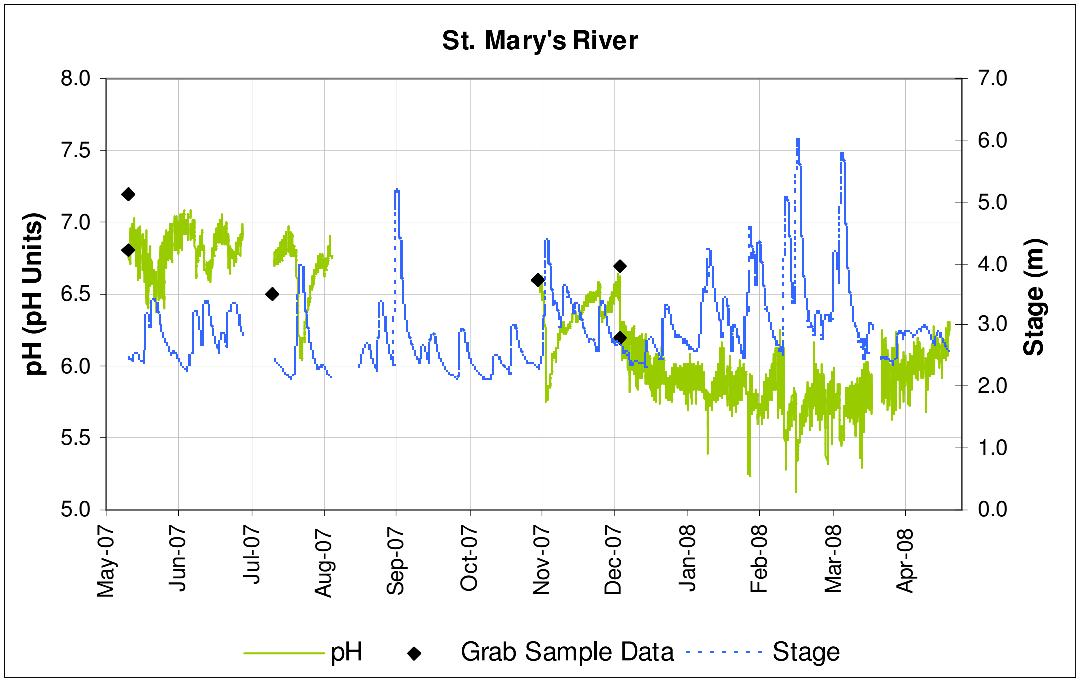


Figure 3.5 - 18 pH from May 2007 through April 2008 for the St. Mary's River using mean daily values. Gaps in the plot indicate missing data.

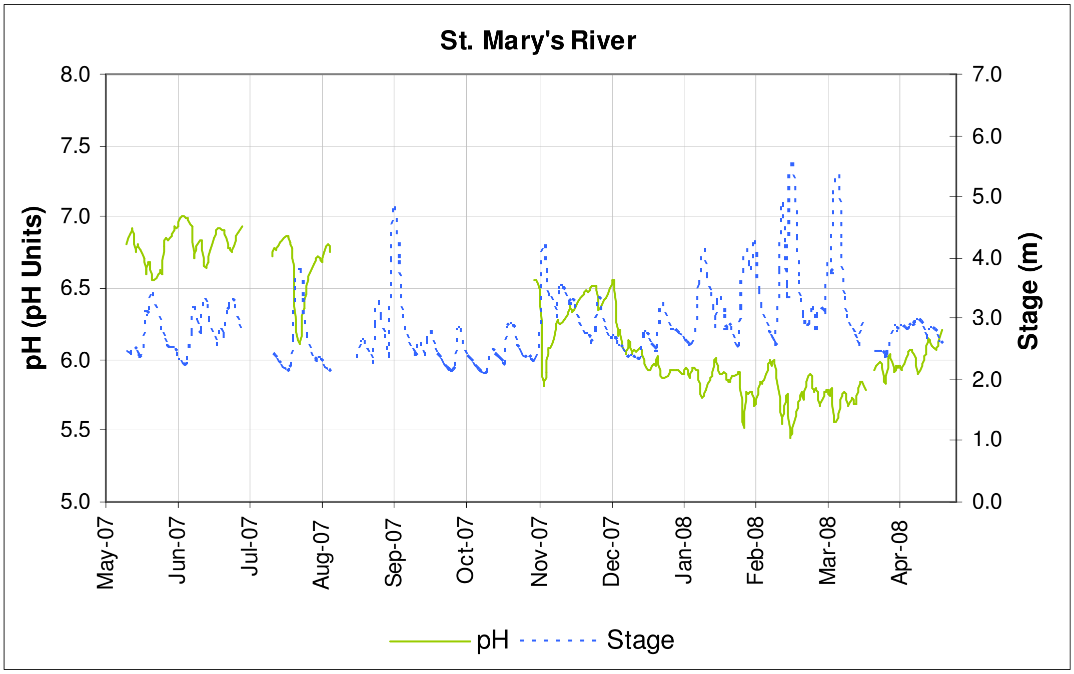


Figure 3.5 - 19 pH from May 2007 through April 2008 for the St. Mary's River using mean monthly values. Gaps in the plot indicate missing data.

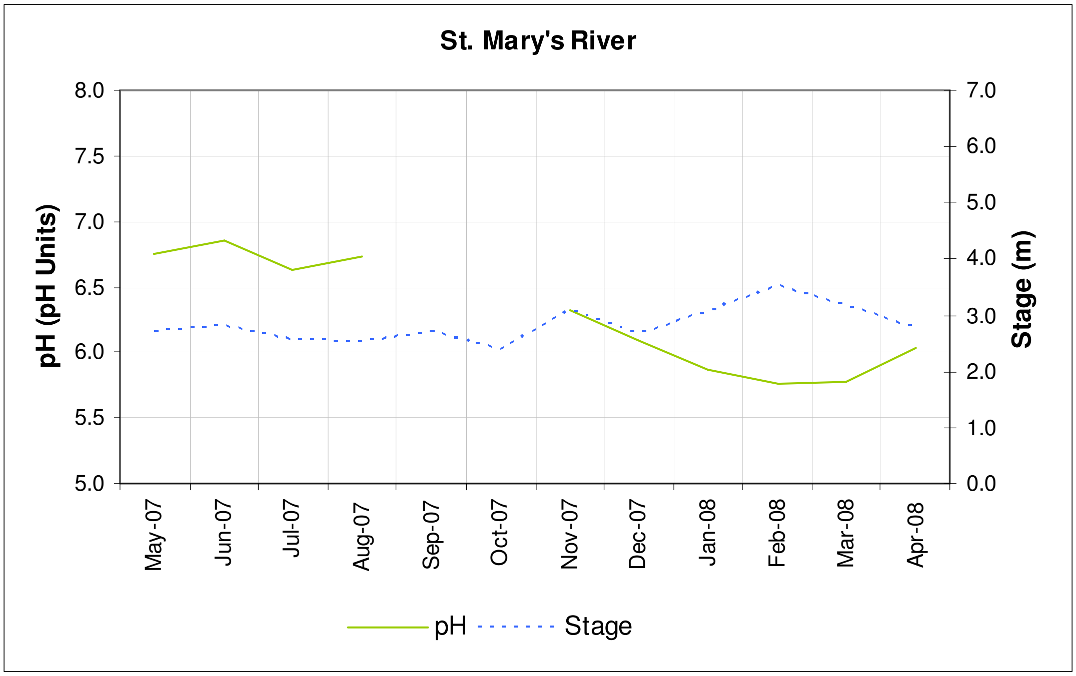


Table 3.5 - 11 Mean monthly pH for St. Mary's River during 2007-2008 based on mean daily data.

Month	Year	Mean	Minimum	Maximum	SD
-----	-----	-----	-----	-----	-----
May	2007	6.8	6.6	6.9	0.1
June	2007	6.9	6.6	7.0	0.1
July	2007	6.6	6.1	6.9	0.2
August	2007	6.7	6.7	6.8	0.0
September	2007		0.0	0.0	
October	2007		0.0	0.0	
November	2007	6.3	5.8	6.6	0.2
December	2007	6.1	5.9	6.6	0.2
January	2008	5.9	5.5	6.0	0.1
February	2008	5.8	5.4	6.0	0.1
March	2008	5.8	5.6	6.0	0.1
April	2008	6.0	5.9	6.2	0.1

Table 3.5 - 12 Mean annual pH for St. Mary's River during 2007-2008 based on mean monthly data.

Year	Mean	Minimum	Maximum	SD
-----		---------- °C ----------		-----
2007	6.57	6.09	6.85	0.30
2008	5.86	5.76	6.03	0.12

3.5.4 Overview of St. Mary's River Water Quality

Water quality data collected at this station during 2007-2008 are fairly typical of a predominantly forested watershed (82.5% of total area) with a significant surface water/ wetland component (5.9% of total area). Influences from the meguma bedrock geology as well as the significant clearcut land use type (9.6%) are evident.

Data collection at the St Mary's River station was problematic due to recurring fowling of the automated sensors by sedimentation during high flows. Equipment maintenance schedules precluded more frequent visits to keep these sensors functioning optimally. Data was collected from May 2007 to May 2008, at which point the automated data collection was suspended. Although limited data are provided for this station, summary statistics are not representative of annual conditions and should be viewed with caution.

Water temperature varied according to a seasonal pattern very similar to that of air temperature, which is typical of a relatively shallow flowing river. Minimum hourly water temperatures for Winter (December to February) were -0.3 ^{o}C for both 2007 and 2008. Maximum hourly water temperatures for Summer (June to August) were 25.5^{o}C for 2007. Mean hourly temperature readings ranged from 12.2 ^{o}C (2007) to 1.4 ^{o}C (2008), neither of which captured full seasonal data for the year. Based on hourly records, a range of from 0 % (2008) to 9% (2007) of annual temperature measurements exceeded the recommended temperature limit of 20-21 ^{o}C for salmon and trout, almost all of which occurred in July and August.

Recorded turbidity values were low for most of the period of record with only a few sporadic events observed having values significantly above the hourly mean of 6.6 NTU. However, there was one period (Jan 30, 2007-Feb 2,2008) when values were very high for a short period of time. Hourly turbidity peaked at 2991 NTU on January 30th and 2795 NTU the following day, with readings of between 200 and 300 NTU for six hours following the second peak. These turbidity readings occurred after a > 50 mm precipitation event (highest recorded in2007-2008) was recorded for that area. Similar peaks in precipitation and stage did not result in similar peaks in turbidity being recorded however. Other sporadic turbidity events may have occurred during periods of increased flow in the Fall or Spring, but equipment failure precluded capturing any such events. Sensors captured only about 53% of the possible hourly turbidity readings for the period of record due to equipment failure. Minimum turbidity values ranged from 0.0 NTU (2007) to 0.8 NTU (2008). Maximum turbidity values ranged from 38 NTU in 2007 to 2991 NTU in 2008. Somewhat elevated turbidity events greater than 25 NTU occurred > 50 times during the year long monitoring period between May 2007 and May 2008. Overall, 1 percent of hourly turbidity measurements were greater than 50 NTU, the guideline for recreational use. Between 2% (2007) and 25% (2008) of turbidity measurements were greater than the drinking water aesthetic objective of 5 NTU. Peak turbidity measurements generally occurred simultaneously with peak flows and precipitation events and most notably during the Winter of 2007-2008. The increased frequency and intensity of turbidity values observed at this station, relative to other monitoring stations, may be the result of both prevailing geology and soil conditions as well as land use practices such as forestry clear cutting, road construction and drainage, and agricultural practices.

Water conductivity of the St Mary's River was characteristic of dilute waters where minimum hourly values ranged from 11.4 uS/cm (2007) to 20.9 uS/cm (2008). Maximum values ranged from 38.0 uS/cm (2008) to 41.8 uS/cm (2007), and mean values ranged from 29.5 uS/cm (2008) to 32.9 uS/cm (2007). Fairly significant fluctuations in conductivity levels were observed to occur as a result of precipitation events and higher flows. Conductivity appears to follow two patterns, although difficult to determine due to the short period of record. There appeared to be a pattern that was inverse to stage, with respect to individual precipitation events and associated peak flows. In fact, the lowest conductivity values by far occurred during the three highest stage events (in September, February, and March). The second pattern appeared to be one where conductivity generally increased with increasing stage from September to December. This pattern would be consistent with stage (not inverse) and opposing to the former trend observed. A longer period of record would be needed to confirm either pattern. The short-term stream response to major precipitation events, with sharp declines in conductivity, could be the result of precipitation events and/or snowmelt that are diluting the concentration of ions in the river and lowering conductivity.

The potential effect on water conductivity due to increased chloride content from road-de-icing activities appears negligible. Peak conductivity measurements occurring during low flow periods may be indicative of a dominant influence of groundwater seepage during this period.

Dissolved oxygen concentrations followed a trend that was the inverse of temperature, showing seasonal Summer lows in the July-August period of the year. This is typical of shallow surface waters where the solubility of oxygen in water decreases as water temperature rises. Minimum hourly dissolved oxygen values ranged from 6.9 mg/l (2007) to 10.2 mg/l (2008). Maximum values ranged from 14.6 mg/l (2007) to 14.7 mg/l (2008), and mean values ranged from 10.6 mg/l (2007) to 13.6 mg/l (2008).At no time during the period of record (2007 to 2008) did hourly concentrations dip below 6.9 mg/L, remaining well above a suggested threshold for the protection of aquatic life of 5.0 mg/L.

pH was highly variable during the study period with high hourly values predominant during the Summer low flow period and low pH values dominating the periods of higher flows (Spring and Fall). Therefore, pH seems to have a fairly strong inverse relationship to flow. Minimum hourly pH values ranged from 5.1 units (2008) to 5.7 units (2007), while maximum values ranged from a pH of 6.3 (2008 to a pH of 7.1 (2007). Mean hourly values ranged from a pH of 5.9 (2008) to a pH of 6.5 (2007). This data suggests that the St Mary's River is a poorly buffered system since pH values are relatively low compared to most surface waters in the province. This is directly related to the bedrock and soils in the watershed including the presence of slates. The presence of wetlands and organic acids from coloured waters may also be influencing pH in this river system. Given the relatively acidic nature of this stream, recommended ranges of pH established as national guidelines for the Protection of Aquatic Life, Drinking Water, and

Recreational use (6.5 to 9.0, 6.5 to 8.5 and,6.5 to 9.5 respectively) were exceeded for 100 % of the monitoring period in 2008 and 45% of the time in 2007.

Data from grab samples or field meter readings taken during site visits generally were in good agreement with automated sensor values confirming quality of the dataset. Data for pH during the 2008 sampling season however were an exception with lesser agreement. This merits further investigation as to cause.

The St Mary's River station was discontinued as an automated network site in 2008 due to significant recurring sediment fowling of the sensors. This fowling resulted from a stream flow eddying effect at the location where the equipment was deployed. No other more suitable deployment site has been located because of the strong seasonal currents in this river. Manual data collection is expected to continue at this station, with reporting in subsequent reports.

3.6 LAHAVE RIVER

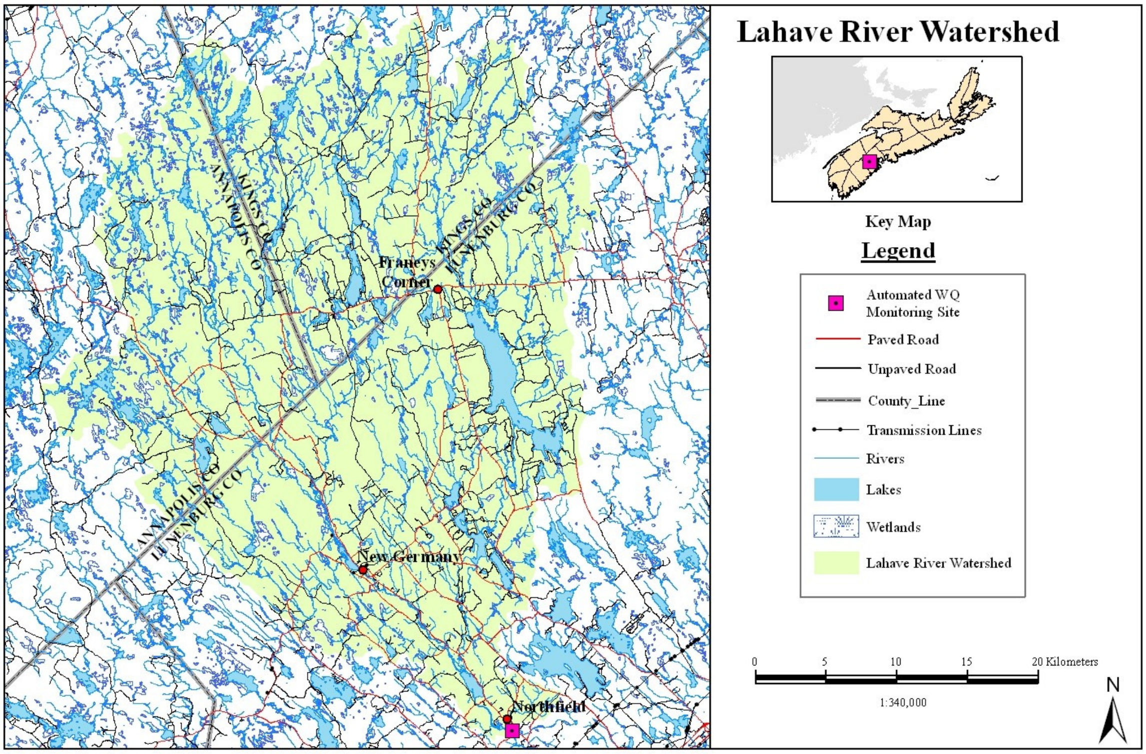


Figure 3.6 - 1 Location of Lahave River watershed

3.6.1 Background Information

Location of Station

The Lahave River Automated Network Station is located at Latitude 44° 26' 50" N, Longitude 65° 35' 29" W.

Geographic Setting

The Lahave River primarily flows through Lunenburg County with its headwaters originating in Annapolis and Kings Counties. The discharge point of the Lahave River is to the Atlantic Ocean. The approximate size of the watershed is 1260 km^2.

Figure 3.6 - 2 Lahave River looking downstream (left) and upstream (right) from the monitoring station.

Geology and Geomorphology

The Lahave watershed area may be best described as an undulating plain which rises from the Atlantic coast northwards. The origin of the topography in the area is glacial. The bedrock in the area is mainly of the Meguma Group (Halifax and Goldenville formation). The surficial geology features include exposed bedrock, Drumlins, till plains and glaciofluvial deposits.

The Lahave River watershed flows southward through a narrow valley in a nearly straight line to the coast. It descends approximately 150 m along its course. The principal tributaries to the Lahave River are the North Branch and North River on the east side and the West Branch and Ohio River on the West Side.

Forest Cover and Land Use

Much of the Lahave watershed is in forested land use. The majority of tree species found in the watershed are red maple, sugar maple, red oak, yellow birch, wire birch, white pine, red spruce, black spruce, balsam fir, hemlock, and juniper. In areas which are dominated by barrens topography, blueberry bushes, ferns, bracken, and stunted pine and fir species are found. Wetlands and marsh lands are found throughout the watershed. 86.3% of the land within the watershed is forested, 10.1% of it is covered by a combination of wetlands and water, and 1.4% characterized as urban land use.

Climate

Normal (1971 – 2000) climate data is collected for the town of Bridgewater (located southeast of the monitoring station) and indicates that annual precipitation in the Lahave watershed is 1523 mm, which is comprise of 1322 mm of rainfall and 199 mm of snowfall. The mean annual temperature is 6.8 ^{o}C, with a mean monthly high of 18.9 ^{o}C in July and a low of –5.1 ^{o}C in January.

Figure 3.6 - 3 Air Temperature data from Environment Canada Climate Station at Lunenburg (Lahave River Watershed) for 2006 through 2008. Gaps in the plot indicate missing data. No precipitation monitoring data is available.

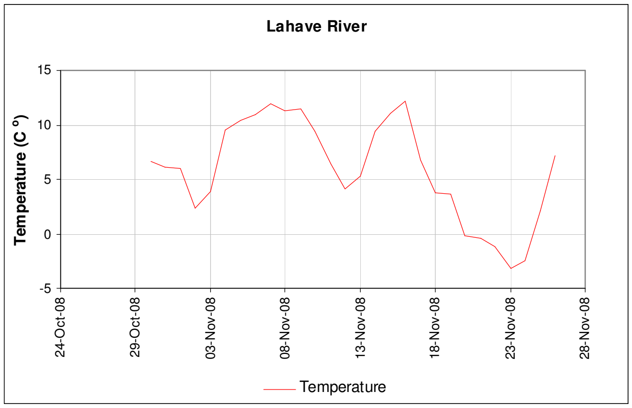


Figure 3.6 - 4 Lahave River monitoring station

Wildlife and Habitat

The Lahave River watershed provides habitat for many species of plants and animals, including deer, beaver, and muskrat. The river itself provides suitable habitat for a number of fish species, most notably salmon and brook trout.

Human Settlement and Industrial Development

For centuries the Lahave river basin was used by the Mi'kmaq people for fishing and travelling, many settlements have been located along the banks of the "Pitjinoiskog" River. French settlers were the first Europeans to colonize the area and this began in the early 1600's with the arrival of explorers Samuel de Champlain and Pierre Du Gua de

Monts. The French settlement became one of the first permanent settlements in the province, even becoming the capital of New France (1632 – 1636). The area was known as Cap de la Heve, after Le Havre, France.

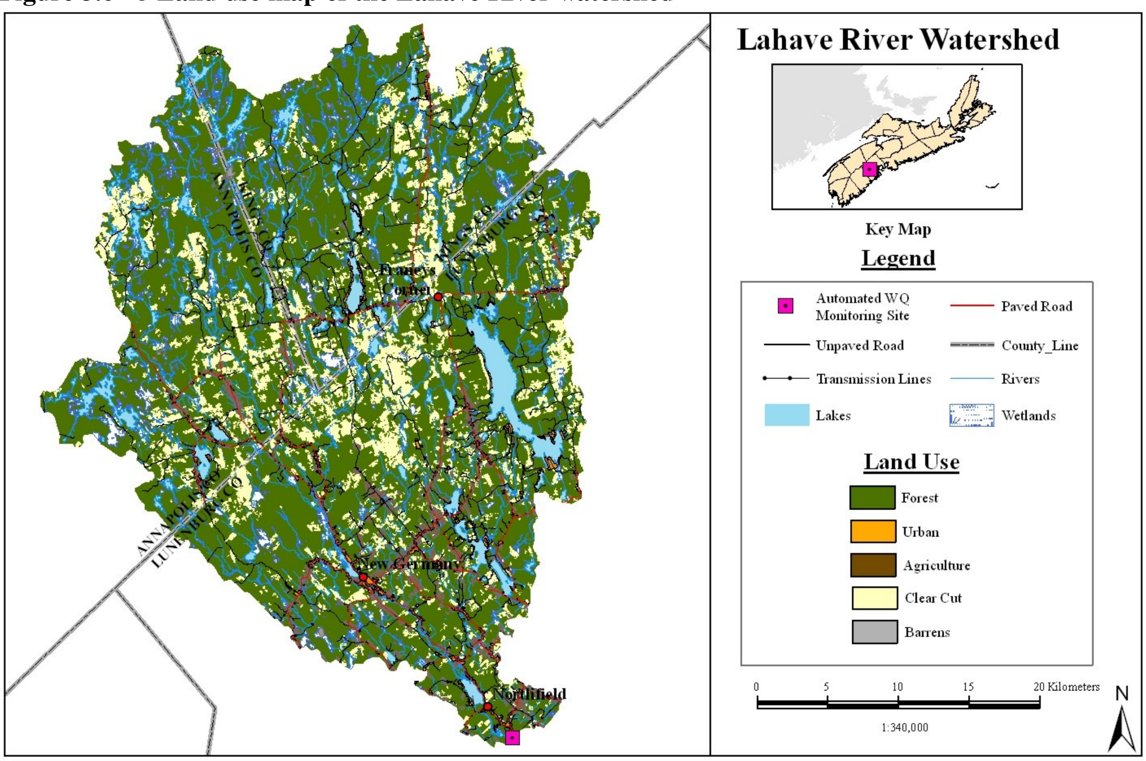
The waterway of the Lahave River was popular for ship building, fishing, farming and industrial mills for harvesting the hemlocks and pines in the area. In the 1800's the area was popular with pirates who preyed on merchant ships from New England. Today the area is popular for tourism, recreational fishing and sailing.

3.6.2 Land Use Summary Information

Table 3.6 - 1 Land use summary table for Lahave River watershed

Land Type	km^2	% of Total Area
Agriculture	26.7	2.1
Barren	1.8	0.1
Clearcut	0.0	0.0
Forested	1086.1	86.3
Urban	17.1	1.4
Wetland/Water	126.9	10.1
Total	1258.7	100.0

Figure 3.6 - 5 Land use map of the Lahave River watershed



3.6.3 Water Quality Summary Information

Table 3.6 - 2 Hourly statistics of minimum, maximum, mean and standard deviation and exceedences as per established water quality guidelines for hourly real time data for Lahave River for the period October 2008 and November 2008.

Parameter	Month	Min	Max	Mean	SD	CWQ Guideline FWAL[1]	CWQ Guideline DW[1]	CWQ Guideline REC[1]	Readings[5]	# of Exceedences			Exceedences As % of Readings		
Temperature, °C	Oct. 2008	9.8	11.0	10.4	0.4	20-21[2]			37		0.0			0	
	Nov. 2008	1.6	11.2	7.4	2.5				613		0.0			0	
Turbidity, NTU										DW <1[3]	DW ≤5[4]	REC	DW <1[3]	DW ≤5[4]	REC
	Oct. 2008	0.0	0.0	0.0	0.0		<1[3], ≤5[4]	≤50	37	0	0	0	0	0	0
	Nov. 2008	0.0	0.0	0.0	0.0				612	0	0	0	0	0	0
Conductivity, uS/cm	Oct. 2008	33.2	35.1	34.0	0.6				37						
	Nov. 2008	29.6	64.3	33.0	4.8				612						
Dissolved Oxygen, mg/L	Oct. 2008	-	-	-	-	≥5.0			-		-			-	
	Nov. 2008	-	-	-	-				-		-			-	
pH, Units										FWAL	DW	REC	FWAL	DW	REC
	Oct. 2008	5.3	6.0	5.5	0.1	6.5-9.0	6.5-8.5	6.5-9.5	37	37	37	37	100	45	45
	Nov. 2008	5.2	6.1	5.5	0.2				612	612	612	612	100	100	100

[1] FWAL: Freshwater Aquatic Life; DW: Drinking Water; REC: Recreational Use

[2] Upper permissible limit for salmon and trout (Alabaster and Lloyd, 1982). CCME DW guideline deemed to be inappropriate.

[3] Maximum Acceptable Concentration for water entering a distribution system.

[4] Aesthetic Objective. 5NTU may be permitted if demonstrated that the disinfection method is not compromised.

[5] The number of hourly readings possible in each of the years 2002, 2003, 2005, 2006, and 2007 is 8760. For 2004 and 2008 the number is 8784. The number recorded in the table refers to the actual number of approved measurements

3.6.3.1 Temperature

Figure 3.6 - 6 Water temperature from October 2008 through November 2008 for the Lahave River using hourly values. Gaps in the plot indicate missing data.

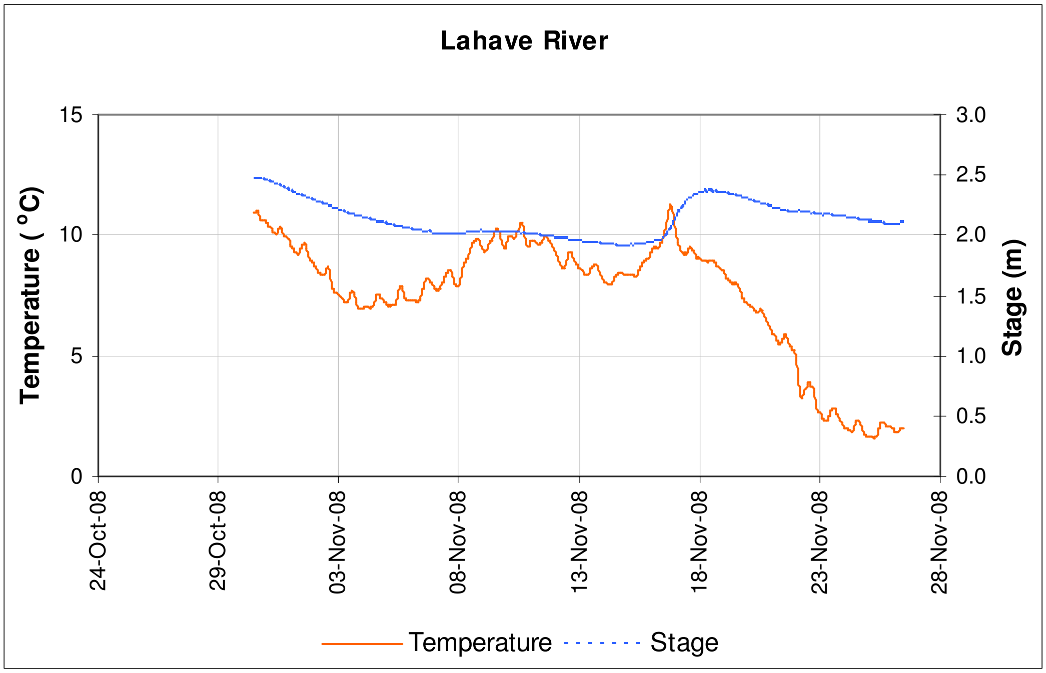
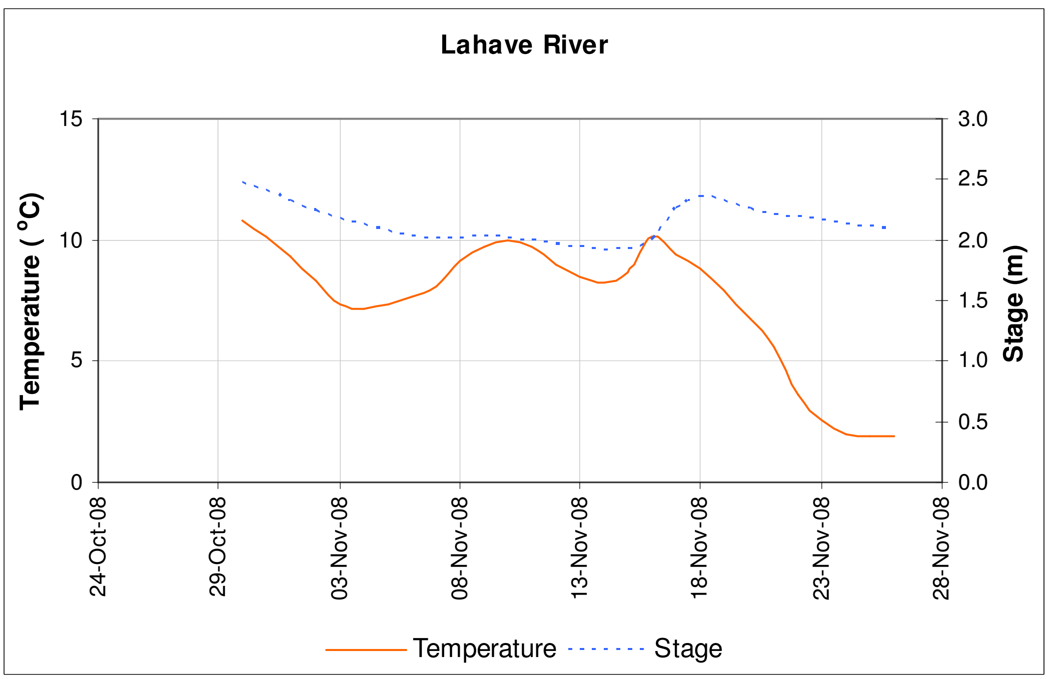


Figure 3.6 - 7 Water temperature from October 2008 through November 2008 for the Lahave River using mean daily values. Gaps in the plot indicate missing data.



3.6.3.2 Turbidity

Figure 3.6 - 8 Turbidity from October 2008 through November 2008 for the Lahave River using hourly values. Gaps in the plot indicate missing data.

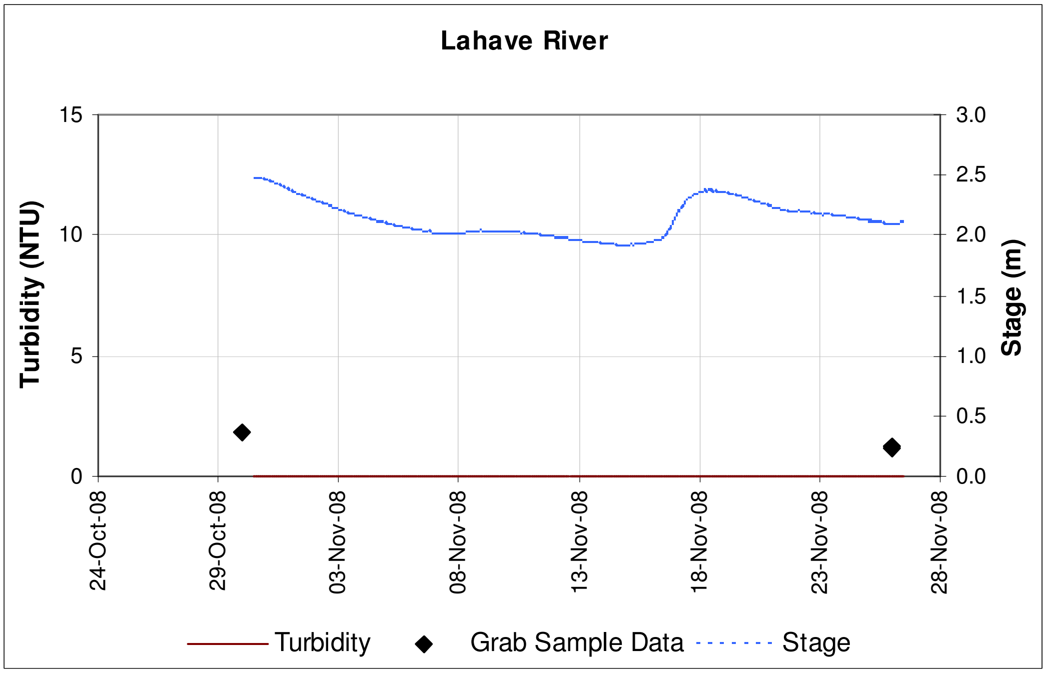
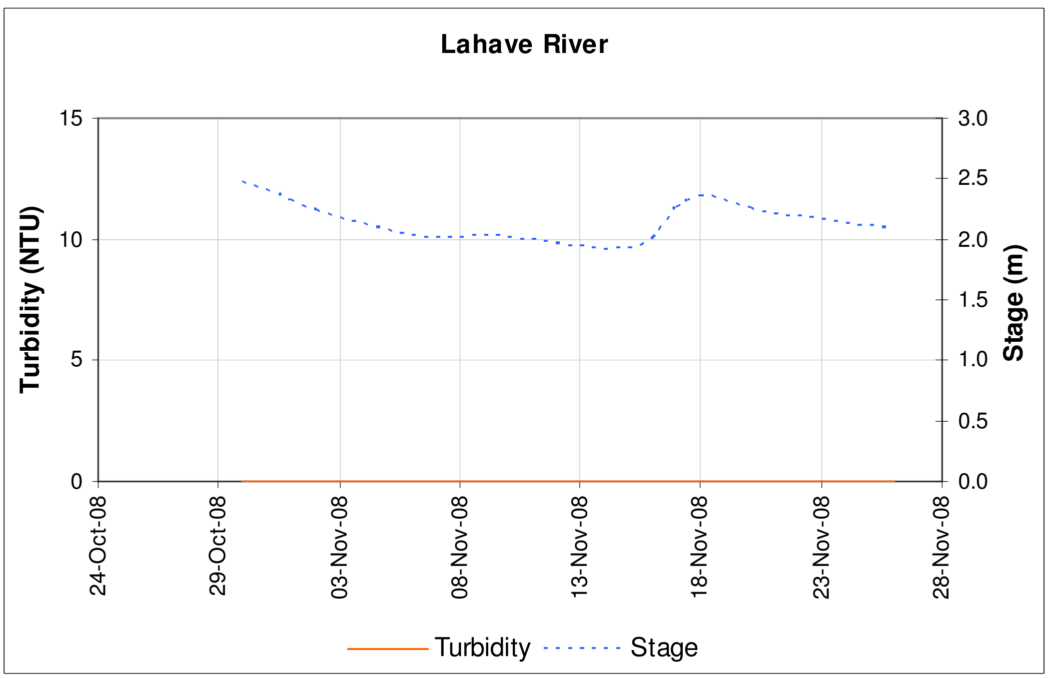


Figure 3.6 - 9 Turbidity from October 2008 through November 2008 for the Lahave River using mean daily values. Gaps in the plot indicate missing data.



3.6.3.3 Conductivity

Figure 3.6 - 10 Conductivity from October 2008 through November 2008 for the Lahave River using hourly values. Gaps in the plot indicate missing data.

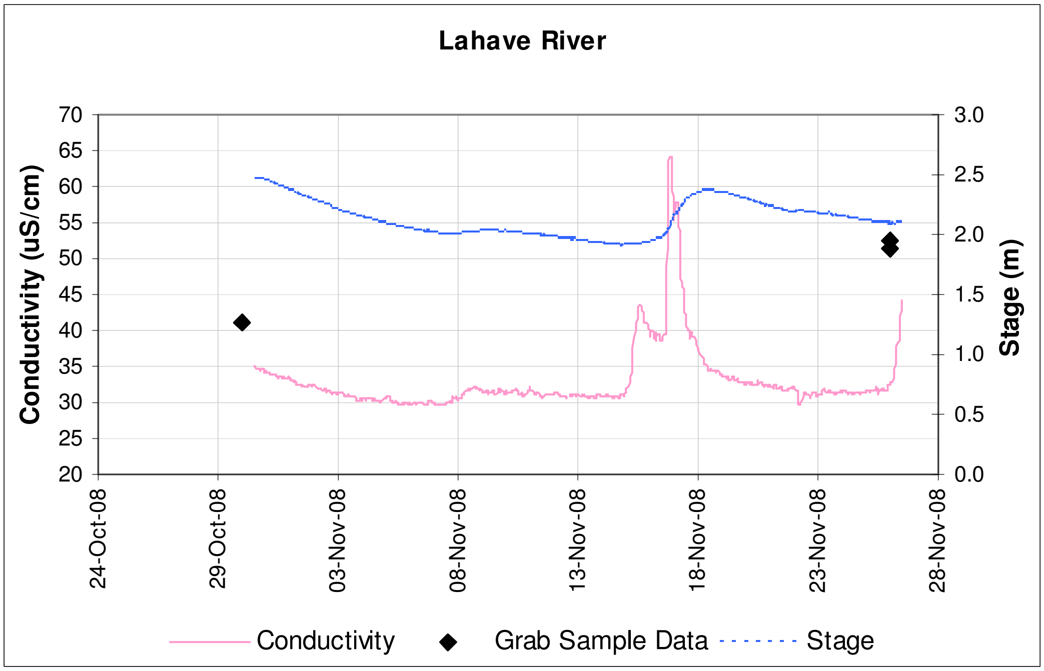
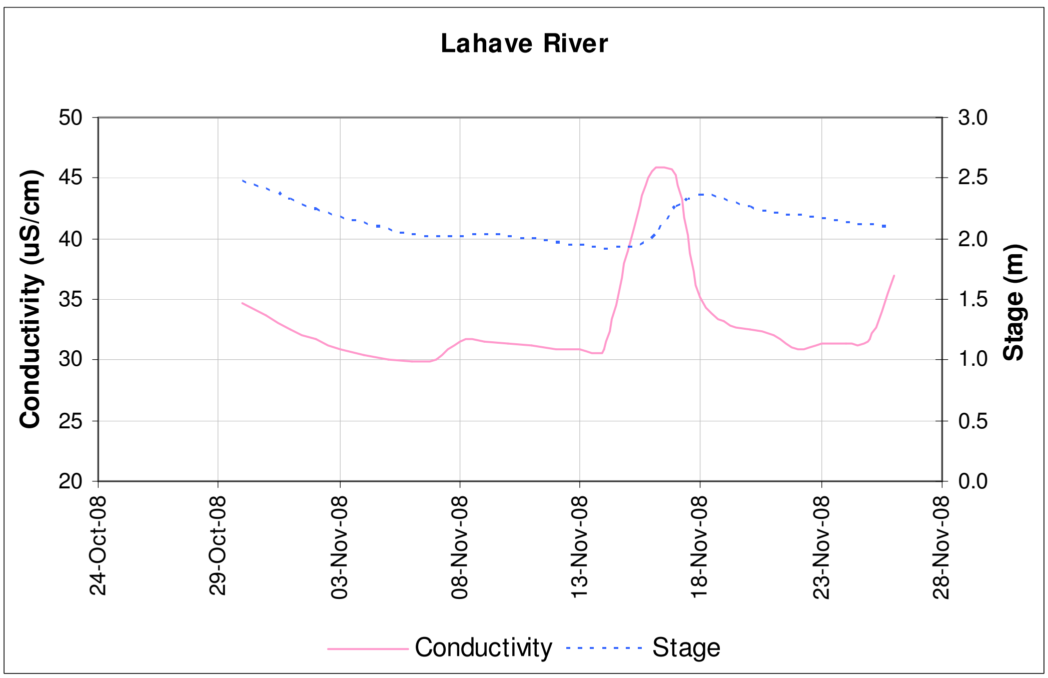


Figure 3.6 - 11 Conductivity from October 2008 through November 2008 for the Lahave River using mean daily values. Gaps in the plot indicate missing data.



3.6.3.4 Dissolved Oxygen

Due to sensor malfunction no data was collected for dissolved oxygen.

3.6.3.5 pH

Figure 3.6 - 12 pH from October 2008 through November 2008 for the Lahave River using hourly values. Gaps in the plot indicate missing data.

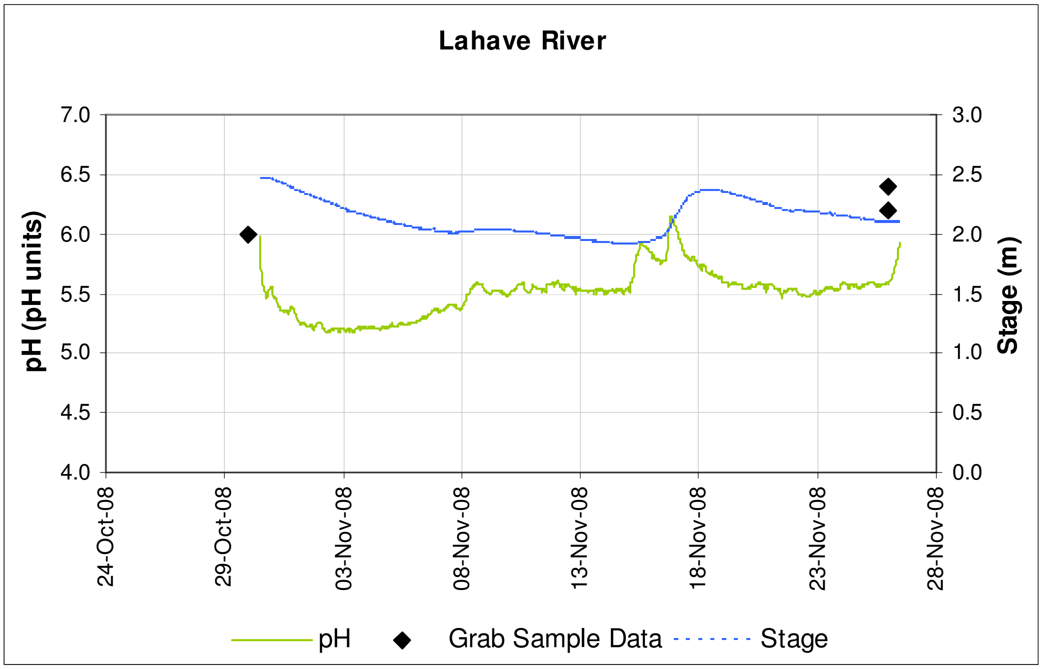
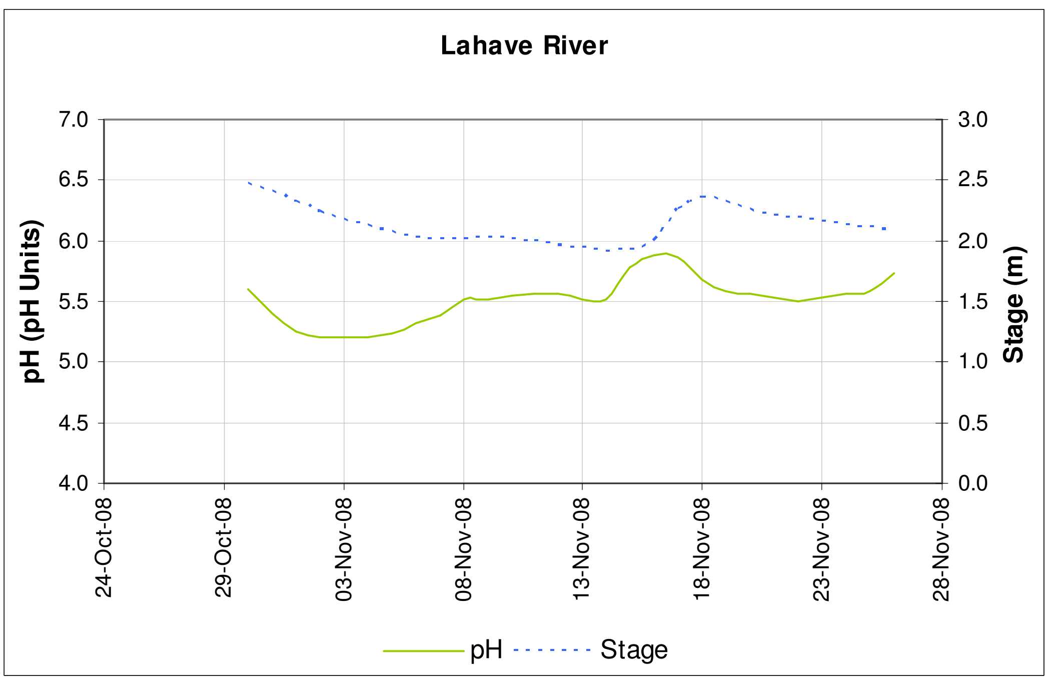


Figure 3.6 - 13 pH from October 2008 through November 2008 for the Lahave River using mean daily values. Gaps in the plot indicate missing data.



3.6.4 Overview of Lahave River Water Quality

Water quality data for the period of record are typical of a predominantly forested watershed (86.3% of total area) with a significant surface water / wetland component (10.1% of total area) with bedrock geology mainly of the Meguma Group.

Limited data for the Lahave River station was available at the time of publishing this report. Data included automated temperature, conductivity, and pH values collected during the period of October and November 2008. Dissolved oxygen and turbidity values were not collected and therefore not reported here in. Due to the limited time series of this data, no seasonal patterns or trends are possible to determine. Moreover, summary statistics for minimum, maximum, and mean values do not represent annual values. These statistics as well as any guideline exceedences should be interpreted with caution.

Water temperature followed a pattern very similar to that of air temperature, which is typical of a shallow flowing river. Minimum hourly water temperatures was 1.6 ^{o}C in November, and maximum hourly water temperatures was 11.2 ^{o}C also in November. Mean hourly temperature readings ranged from 10.4 ^{o}C in October 7.4 ^{o}C in November. No hourly temperature measurements exceeded the recommended temperature limit of 20-21 ^{o}C for salmon and trout during the monitoring period.

The automated sampling of turbidity was not collected at this site, however grab samples were collected. The turbidity values reported from the grab samples indicated values < 5 NTU during the limited sampling period.

Water conductivity of the Lahave River was characteristic of relatively dilute waters with conductivity ranging from a minimum hourly value of 29.6 uS/cm to a maximum value of 64.3 uS/cm. The overall mean hourly conductivity value for the limited period of observation was 33.5 uS/cm . Only minor fluctuations in conductivity levels were observed with the exception of a peak in conductivity on November 16th which coincided with an increase in stage – assembly due to a precipitation event.

No dissolved oxygen (DO) concentrations were reported for this station during this short monitoring period since the DO sensor had not yet become operational.

Values for pH were quite variable during the short study period (Oct –Nov 2008. No pattern or trend was observed. pH ranged from a minimum hourly value of 5.2 units to a maximum of 6.1 units. The overall mean hourly pH was 5.5 .This data suggests that the Lahave River is a relatively poorly buffered system. Values for pH are relatively low compared to most surface waters in the province, although typical of areas with poorly buffered soils. This is directly related to the bedrock and soils in the watershed, as well as the high percentage of wetlands in the watershed. Given the relatively acidic nature of this river, recommended ranges of pH established as national guidelines for the Protection of Aquatic Life, Drinking Water, and Recreational use (6.5 to 9.0, 6.5 to 8.5 and,6.5 to 9.5 respectively) were exceeded for 100 % of the monitoring period in November 2008 and 45% of the time in October 2008.

Data from grab samples or field meter readings taken during site visits generally were in good agreement with automated sensor values confirming quality of the dataset. Data for pH during the 2008 sampling season however were an exception with lesser agreement. This merits further investigation as to cause.

4.0 RESULTS - (Grab Samples)

The following tables provide summary statistics for selected water quality parameters. These are data as determined from manually collected samples taken during periodic site visits. Exceedences of national guideline values are also presented as both number of occurrences and percentage of samples collected. No further analysis or interpretation is provided at this time.

Table 4.0 - 1 Summary table for selected water quality parameters at Kelley's River monitoring station between 2005 and 2008

Parameter	# of Samples	Min	Max	Mean	SD	CWQ Guideline			# of Exceedences			Exceedences as %		
						FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]
Alkalinity as CaCO3 mg/L	16	0.5	6.2	2.4	2.0									
Aluminium ug/L	16	106.0	345.0	193.1	73.1	5-100 ug/L	100-200 ug/L		16	5		100	31	
Ammonia mg/L	16	0.0	0.0	0.0	0.0									
Antimony ug/L	16	1.0	1.0	1.0	0.0		6 ug/L			0				
Barium ug/L	16	4.0	23.0	10.4	5.2		1000 ug/L			0				
Beryllium ug/L	16	1.0	1.0	1.0	0.0									
Bicarbonate as CaCo3 mg/L	10	1.2	6.2	3.1	2.1									
Boron ug/L	16	2.5	12.0	4.4	2.9		5000 ug/L			0				
Cadmium ug/L	16	0.5	3.0	0.9	0.6	0.017 ug/L	5 ug/L		16	0		100		
Calcium mg/L	16	0.5	1.3	0.9	0.2									
Carbonate as CaCO3 mg/L	10	0.0	0.0	0.0	0.0									
Chloride mg/l	16	2.3	4.8	3.5	0.7		≤250 mg/L			0				
Chlorophyll A mg/m3	16	0.2	3.8	1.2	1.1									
Chromium ug/L	16	1.0	1.0	1.0	0.0	1.0 ug/L	50 ug/L		0	0				
Cobalt ug/L	16	1.0	1.0	1.0	0.0									
Colour TCU	16	54.0	173.0	96.7	34.1		≤15 TCU			16			100	
Conductivity umho/cm	22	17.4	34.9	24.7	4.7		≤1000 ug/L			0				
Copper ug/L	16	1.0	204.0	13.7	50.8	2-4 ug/L			1			6		
Hardness as CaCo3 mg/L	6	4.6	6.1	5.2	0.5									
Iron ug/L	16	1.0	885.0	488.1	224.6	300 ug/L	≤300 ug/L		13	13		81	81	
Lead ug/L	16	1.0	1.0	1.0	0.0	1-7 ug/L	10 ug/L		0	0				
Magnesium mg/L	16	0.3	0.7	0.4	0.2									

Parameter	# of Samples	Min	Max	Mean	SD	CWQ Guideline			# of Exceedences			Exceedences as %		
						FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]
Manganese ug/L	16	17.0	263.0	88.1	73.6		≤50 ug/L			9			56	
Nickel ug/L	16	1.0	1.0	1.0	0.0	25-150 ug/L			0					
Nitrate+Nitrite mg/L	16	0.0	0.0	0.0	0.0									
Ortho Phosphorus mg/L	16	0.0	0.0	0.0	0.0									
pH	22	4.7	7.2	5.8	0.7	6.5 - 9.0	6.5 - 8.5	5.0 - 9.0	19	19	2	86	86	9
Potassium mg/L	16	0.3	0.5	0.3	0.1									
Selenium ug/L	16	1.0	1.0	1.0	0.0	1.0 ug/L	10 ug/L		0	0				
Silica mg/L	16	1.8	4.1	2.9	0.7									
Sodium mg/L	16	1.7	4.9	2.8	0.9		≤200 mg/L			0				
Sulphate mg/L	16	0.5	2.5	2.1	0.8		≤500 mg/L			0				
Suspended Solids mg/L	16	0.3	5.0	1.0	1.1									
Tin ug/L	16	1.0	1.0	1.0	0.0									
Total Nitrogen mg/L	16	0.2	0.4	0.3	0.1									
Total Organic Carbon mg/L	16	6.8	21.2	12.4	4.7									
Total Phosphorus mg/L	16	0.0	0.0	0.0	0.0									
Turbidity NTU	22	0.4	1.1	0.7	0.2		1.0 NTU	50 NTU		3	0		14	
Vanadium ug/L	16	1.0	2.5	1.1	0.4									
Zinc ug/L	16	1.0	78.0	8.9	19.1	30 ug/L	≤5000 ug/L		1	0		6		

Table 4.0 - 2 Summary table for selected water quality parameters at NE Margaree River monitoring station between 2002 and 2008

Parameter	# of Samples	Min	Max	Mean	SD	CWQ Guideline			# of Exceedences			Exceedences as %		
						FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]
Alkalinity as CaCO3 mg/L	24	5.3	18.0	12.0	3.8									
Aluminium ug/L	24	17.0	153.0	65.9	41.8	5-100 ug/L	100-200 ug/L		6	0		25		
Ammonia mg/L	24	0.0	0.0	0.0	0.0									
Antimony ug/L	24	1.0	1.0	1.0	0.0		6 ug/L			0				
Barium ug/L	24	16.0	30.0	22.5	4.2		1000 ug/L			0				
Beryllium ug/L	24	1.0	2.5	1.1	0.3									
Bicarbonate as CaCo3 mg/L	23	5.3	18.0	12.3	3.6									

Parameter	# of Samples	Min	Max	Mean	SD	CWQ Guideline FWAL[1]	CWQ Guideline DW[1]	CWQ Guideline REC[1]	# of Exceedences FWAL[1]	# of Exceedences DW[1]	# of Exceedences REC[1]	Exceedences as % FWAL[1]	Exceedences as % DW[1]	Exceedences as % REC[1]
Boron ug/L	24	2.5	7.0	3.7	1.7		5000 ug/L			0				
Cadmium ug/L	24	0.2	1.0	0.8	0.3	0.017 ug/L	5 ug/L		24	0		100		
Calcium mg/L	24	5.2	21.1	11.4	4.5									
Carbonate as CaCO3 mg/L	23	0.0	0.1	0.0	0.0									
Chloride mg/l	24	0.4	44.0	18.8	12.2		≤250 mg/L			0				
Chlorophyll A mg/m3	24	0.1	2.1	0.8	0.6									
Chromium ug/L	24	1.0	1.0	1.0	0.0	1.0 ug/L	50 ug/L		0	0				
Cobalt ug/L	24	0.5	1.0	1.0	0.1									
Colour TCU	24	5.3	56.0	19.4	13.3		≤15 TCU			15			63	
Conductivity umho/cm	43	56.7	281.0	149.6	60.8		≤1000 ug/L			0				
Copper ug/L	24	1.0	3.0	1.1	0.4	2-4 ug/L			0					
Hardness as CaCo3 mg/L	23	16.6	60.1	34.5	12.1									
Iron ug/L	24	10.0	126.0	37.4	31.8	300 ug/L	≤300 ug/L		0	0				
Lead ug/L	24	0.3	1.0	0.9	0.2	1-7 ug/L	10 ug/L		0	0				
Magnesium mg/L	24	0.7	1.8	1.3	0.3									
Manganese ug/L	24	1.0	4.0	2.6	1.0		≤50 ug/L			0				
Nickel ug/L	24	1.0	3.0	1.1	0.4	25-150 ug/L			0					
Nitrate+Nitrite mg/L	24	0.0	0.1	0.1	0.0									
Ortho Phosphorus mg/L	24	0.0	0.0	0.0	0.0									
pH	43	6.7	7.8	7.3	0.3	6.5 - 9.0	6.5 - 8.5	5.0 - 9.0	0	0	0			
Potassium mg/L	24	0.3	0.6	0.3	0.1									
Selenium ug/L	24	1.0	1.0	1.0	0.0	1.0 ug/L	10 ug/L		0	0				
Silica mg/L	24	4.3	7.6	6.4	0.9									
Sodium mg/L	24	4.5	28.2	13.5	6.5		≤200 mg/L			0				
Sulphate mg/L	24	8.3	39.0	21.1	8.6		≤500 mg/L			0				
Suspended Solids mg/L	24	0.3	3.0	1.2	0.6									
Tin ug/L	23	1.0	1.0	1.0	0.0									
Total Nitrogen mg/L	24	0.1	0.3	0.1	0.1									
Total Organic Carbon mg/L	24	1.2	7.7	3.1	1.7									
Total Phosphorus mg/L	24	0.0	0.1	0.0	0.0									

Parameter	# of Samples	Min	Max	Mean	SD	CWQ Guideline			# of Exceedences			Exceedences as %		
						FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]
Turbidity NTU	43	0.1	0.8	0.3	0.1		1.0 NTU	50 NTU		0	0			
Vanadium ug/L	24	1.0	1.0	1.0	0.0									
Zinc ug/L	24	1.0	25.0	4.3	6.0	30 ug/L	≤5000 ug/L		0	0				

Table 4.0 - 3 Summary table for selected water quality parameters at Pockwock Lake monitoring station between 2002 and 2008

Parameter	# of Samples	Min	Max	Mean	SD	CWQ Guideline			# of Exceedences			Exceedences as %		
						FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]
Alkalinity as CaCO3 mg/L	24	0.5	2.7	0.6	0.5									
Aluminium ug/L	19	80.0	156.0	118.5	21.5	5-100 ug/L	100-200 ug/L		15	0		79		
Ammonia mg/L	19	0.0	0.0	0.0	0.0									
Antimony ug/L	7	1.0	1.0	1.0	0.0		6 ug/L			0				
Barium ug/L	6	5.0	6.0	5.5	0.5		1000 ug/L			0				
Beryllium ug/L	7	1.0	2.5	1.2	0.6									
Bicarbonate as CaCo3 mg/L	2	1.0	2.7	1.9	1.2									
Boron ug/L	7	2.5	6.0	3.4	1.5		5000 ug/L			0				
Cadmium ug/L	7	1.0	1.0	1.0	0.0	0.017 ug/L	5 ug/L		7	0		100		
Calcium mg/L	18	0.9	1.4	1.2	0.1									
Carbonate as CaCO3 mg/L	2	0.0	0.0	0.0	0.0									
Chloride mg/l	18	6.0	7.6	6.8	0.4		≤250 mg/L			0				
Chlorophyll A mg/m3	25	0.1	0.9	0.6	0.2									
Chromium ug/L	7	1.0	1.0	1.0	0.0	1.0 ug/L	50 ug/L		0	0				
Cobalt ug/L	7	0.5	1.0	0.9	0.2									
Colour TCU	18	4.2	15.0	9.3	2.5		≤15 TCU			0				
Conductivity umho/cm	36	35.9	42.8	39.1	1.3		≤1000 ug/L			0				
Copper ug/L	18	1.0	13.0	1.9	2.9	2-4 ug/L			2			11		
Hardness as CaCo3 mg/L	14	4.4	6.0	5.0	0.4									
Iron ug/L	18	0.0	100.0	41.4	24.0	300 ug/L	≤300 ug/L		0	0				
Lead ug/L	7	1.0	1.0	1.0	0.0	1-7 ug/L	10 ug/L		0	0				
Magnesium mg/L	18	0.3	0.6	0.4	0.1									

Parameter	# of Samples	Min	Max	Mean	SD	CWQ Guideline			# of Exceedences			Exceedences as %		
						FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]
Manganese ug/L	18	46.0	65.0	56.7	5.1		≤50 ug/L			16			89	
Nickel ug/L	7	1.0	1.0	1.0	0.0	25-150 ug/L			0					
Nitrate+Nitrite mg/L	19	0.0	0.1	0.0	0.0									
Ortho Phosphorus mg/L	19	0.0	0.0	0.0	0.0									
pH	42	5.1	5.6	5.3	0.1	6.5 - 9.0	6.5 - 8.5	5.0 - 9.0	42	42	0	100	100	
Potassium mg/L	18	0.2	0.3	0.3	0.0									
Selenium ug/L	7	1.0	1.0	1.0	0.0	1.0 ug/L	10 ug/L		0	0				
Silica mg/L	18	0.5	1.7	1.3	0.3									
Sodium mg/L	18	3.4	4.8	4.2	0.3		≤200 mg/L			0				
Sulphate mg/L	18	3.3	5.5	4.3	0.6		≤500 mg/L			0				
Suspended Solids mg/L	16	0.3	2.4	0.9	0.6									
Tin ug/L	7	1.0	1.0	1.0	0.0									
Total Nitrogen mg/L	19	0.1	0.2	0.1	0.0									
Total Organic Carbon mg/L	18	1.9	5.1	3.1	0.8									
Total Phosphorus mg/L	25	0.0	0.1	0.0	0.0									
Turbidity NTU	34	0.2	1.7	0.4	0.3		1.0 NTU	50 NTU		3	0		9	
Vanadium ug/L	7	1.0	1.0	1.0	0.0									
Zinc ug/L	18	1.0	15.0	6.6	3.5	30 ug/L	≤5000 ug/L		0	0				

Table 4.0 - 4 Summary table for selected water quality parameters at Shelburne River monitoring station between 2002 and 2008

Parameter	# of Samples	Min	Max	Mean	SD	CWQ Guideline			# of Exceedences			Exceedences as %		
						FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]
Alkalinity as CaCO3 mg/L	20	0.5	1.5	0.8	0.4									
Aluminium ug/L	20	183.0	473.0	296.0	77.8	5-100 ug/L	100-200 ug/L		20	19		100	95	
Ammonia mg/L	20	0.0	0.0	0.0	0.0									
Antimony ug/L	20	1.0	1.0	1.0	0.0		6 ug/L			0				
Barium ug/L	20	2.0	4.0	3.1	0.4		1000 ug/L			0				
Beryllium ug/L	20	1.0	1.0	1.0	0.0									

Parameter	# of Samples	Min	Max	Mean	SD	CWQ Guideline			# of Exceedences			Exceedences as %		
						FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]
Bicarbonate as CaCo3 mg/L	0	0.0	0.0	-	-									
Boron ug/L	20	2.5	4.0	2.7	0.5		5000 ug/L			0				
Cadmium ug/L	20	0.5	1.0	0.9	0.2	0.017 ug/L	5 ug/L		20	0		100		
Calcium mg/L	20	0.3	0.5	0.3	0.1									
Carbonate as CaCO3 mg/L	0	0.0	0.0	-	-									
Chloride mg/l	20	3.4	5.0	4.3	0.4		≤250 mg/L			0				
Chlorophyll A mg/m3	20	0.5	4.8	1.8	1.3									
Chromium ug/L	20	1.0	1.0	1.0	0.0	1.0 ug/L	50 ug/L		0	0				
Cobalt ug/L	20	1.0	1.0	1.0	0.0									
Colour TCU	20	84.0	226.0	151.2	43.3		≤15 TCU			20			100	
Conductivity umho/cm	37	24.3	40.7	32.4	4.7		≤1000 ug/L			0				
Copper ug/L	20	1.0	1.0	1.0	0.0	2-4 ug/L			0					
Hardness as CaCo3 mg/L	0	0.0	0.0	-	-									
Iron ug/L	20	126.0	328.0	211.3	61.2	300 ug/L	≤300 ug/L		2	2		10	10	
Lead ug/L	20	1.0	1.0	1.0	0.0	1-7 ug/L	10 ug/L		0	0				
Magnesium mg/L	20	0.3	0.3	0.3	0.0									
Manganese ug/L	20	8.0	16.0	11.9	2.1		≤50 ug/L			0				
Nickel ug/L	20	1.0	3.0	1.1	0.4	25-150 ug/L			0					
Nitrate+Nitrite mg/L	20	0.0	0.0	0.0	0.0									
Ortho Phosphorus mg/L	20	0.0	0.0	0.0	0.0									
pH	37	4.3	4.7	4.5	0.1	6.5 - 9.0	6.5 - 8.5	5.0 - 9.0	37	37	37	100	100	100
Potassium mg/L	20	0.3	0.3	0.3	0.0									
Selenium ug/L	20	1.0	1.0	1.0	0.0	1.0 ug/L	10 ug/L		0	0				
Silica mg/L	20	0.8	5.1	2.9	1.3									
Sodium mg/L	20	2.2	3.0	2.5	0.2		≤200 mg/L			0				
Sulphate mg/L	20	0.5	2.5	1.7	0.9		≤500 mg/L			0				
Suspended Solids mg/L	20	0.3	10.0	1.7	2.1									
Tin ug/L	20	1.0	1.0	1.0	0.0									
Total Nitrogen mg/L	20	0.2	0.4	0.3	0.1									
Total Organic Carbon mg/L	20	10.1	22.1	15.4	4.2									

Parameter	# of Samples	Min	Max	Mean	SD	CWQ Guideline			# of Exceedences			Exceedences as %		
						FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]
Total Phosphorus mg/L	20	0.0	0.1	0.0	0.0									
Turbidity NTU	37	0.4	1.1	0.7	0.2		1.0 NTU	50 NTU		2	0		5	
Vanadium ug/L	20	1.0	1.0	1.0	0.0									
Zinc ug/L	20	1.0	25.0	6.3	8.9	30 ug/L	≤5000 ug/L		0	0				

Table 4.0 - 5 Summary table for selected water quality parameters at St. Mary's River monitoring station in 2007

Parameter	# of Samples	Min	Max	Mean	SD	CWQ Guideline			# of Exceedences			Exceedences as %		
						FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]
Alkalinity as CaCO3 mg/L	6	1.5	4.4	3.4	1.1									
Aluminium ug/L	6	66.0	100.0	87.2	12.1	5-100 ug/L	100-200 ug/L		0	0				
Ammonia mg/L	6	0.0	0.0	0.0	0.0									
Antimony ug/L	6	1.0	1.0	1.0	0.0		6 ug/L			0				
Barium ug/L	6	6.0	8.0	7.2	1.0		1000 ug/L			0				
Beryllium ug/L	6	1.0	1.0	1.0	0.0									
Bicarbonate as CaCo3 mg/L	5	3.0	4.4	3.8	0.7									
Boron ug/L	6	2.5	7.0	4.8	1.9		5000 ug/L			0				
Cadmium ug/L	6	0.5	1.0	0.7	0.3	0.017 ug/L	5 ug/L		6	0		100		
Calcium mg/L	6	1.2	1.6	1.5	0.2									
Carbonate as CaCO3 mg/L	5	0.0	0.0	0.0	0.0									
Chloride mg/l	6	0.1	6.4	3.9	3.0		≤250 mg/L			0				
Chlorophyll A mg/m3	6	0.4	1.5	1.0	0.4									
Chromium ug/L	6	1.0	1.0	1.0	0.0	1.0 ug/L	50 ug/L		0	0				
Cobalt ug/L	6	1.0	1.0	1.0	0.0									
Colour TCU	6	27.4	51.8	37.7	9.6		≤15 TCU			6			100	
Conductivity umho/cm	9	30.8	35.9	34.0	1.5		≤1000 ug/L			0				
Copper ug/L	6	1.0	1.0	1.0	0.0	2-4 ug/L			0					
Hardness as CaCo3 mg/L	6	5.5	6.9	6.3	0.5									
Iron ug/L	6	103.0	391.0	229.5	99.1	300 ug/L	≤300 ug/L		1	1		17	17	

Parameter	# of Samples	Min	Max	Mean	SD	CWQ Guideline			# of Exceedences			Exceedences as %		
						FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]
Lead ug/L	6	1.0	1.0	1.0	0.0	1-7 ug/L	10 ug/L		0	0				
Magnesium mg/L	6	0.6	0.7	0.6	0.1									
Manganese ug/L	6	23.0	67.0	42.7	16.7		≤50 ug/L			2			33	
Nickel ug/L	6	1.0	1.0	1.0	0.0	25-150 ug/L			0					
Nitrate+Nitrite mg/L	6	0.0	0.1	0.0	0.0									
Ortho Phosphorus mg/L	6	0.0	0.0	0.0	0.0									
pH	9	6.2	7.2	6.7	0.3	6.5 - 9.0	6.5 - 8.5	5.0 - 9.0	1	1	0	11	11	
Potassium mg/L	6	0.3	0.3	0.3	0.0									
Selenium ug/L	6	1.0	1.0	1.0	0.0	1.0 ug/L	10 ug/L		0	0				
Silica mg/L	6	0.5	3.3	1.8	1.1									
Sodium mg/L	6	3.5	4.3	3.8	0.3		≤200 mg/L			0				
Sulphate mg/L	6	2.5	2.5	2.5	0.0		≤500 mg/L			0				
Suspended Solids mg/L	6	0.8	1.5	1.3	0.4									
Tin ug/L	6	1.0	1.0	1.0	0.0									
Total Nitrogen mg/L	6	0.2	0.3	0.2	0.0									
Total Organic Carbon mg/L	6	3.8	6.7	5.4	1.2									
Total Phosphorus mg/L	6	0.0	0.0	0.0	0.0									
Turbidity NTU	9	0.6	1.5	0.7	0.3		1.0 NTU	50 NTU		1	0		11	
Vanadium ug/L	6	1.0	1.0	1.0	0.0									
Zinc ug/L	6	2.5	6.0	3.1	1.4	30 ug/L	≤5000 ug/L		0	0				

Table 4.0 - 6 Summary table for selected water quality parameters at Lahave River monitoring station during 2008

Parameter	# of Samples	Min	Max	Mean	SD	CWQ Guideline			# of Exceedences			Exceedences as %		
						FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]
Alkalinity as CaCO3 mg/L	7	1.5	3.9	2.4	1.1									
Aluminium ug/L	7	146.0	329.0	200.7	63.7	5-100 ug/L	100-200 ug/L		7	3		100	43	
Ammonia mg/L	7	0.0	0.0	0.0	0.0									
Antimony ug/L	7	1.0	1.0	1.0	0.0		6 ug/L			0				

Parameter	# of Samples	Min	Max	Mean	SD	CWQ Guideline			# of Exceedences			Exceedences as %		
						FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]
Barium ug/L	7	3.0	5.0	3.6	0.8		1000 ug/L			0				
Beryllium ug/L	7	1.0	1.0	1.0	0.0									
Bicarbonate as CaCo3 mg/L	1	2.8	2.8	2.8	-									
Boron ug/L	7	2.5	2.5	2.5	0.0		5000 ug/L			0				
Cadmium ug/L	7	0.5	0.5	0.5	0.0	0.017 ug/L	5 ug/L		7	0		100		
Calcium mg/L	7	1.3	2.3	1.7	0.5									
Carbonate as CaCO3 mg/L	1	0.0	0.0	0.0	-									
Chloride mg/l	7	5.4	9.8	6.6	1.5		≤250 mg/L			0				
Chlorophyll A mg/m3	7	0.8	3.1	2.1	0.9									
Chromium ug/L	7	1.0	1.0	1.0	0.0	1.0 ug/L	50 ug/L		0	0				
Cobalt ug/L	7	1.0	1.0	1.0	0.0									
Colour TCU	7	51.0	94.0	69.0	17.7		≤15 TCU			7			100	
Conductivity umho/cm	9	31.6	110.0	46.3	25.3		≤1000 ug/L			0				
Copper ug/L	7	1.0	1.0	1.0	0.0	2-4 ug/L			0					
Hardness as CaCo3 mg/L	4	5.3	9.4	7.1	2.1									
Iron ug/L	7	178.0	500.0	304.9	127.1	300 ug/L	≤300 ug/L		3	3		43	43	
Lead ug/L	7	1.0	1.0	1.0	0.0	1-7 ug/L	10 ug/L		0	0				
Magnesium mg/L	7	0.3	0.9	0.6	0.2									
Manganese ug/L	7	29.0	92.0	47.9	22.0		≤50 ug/L			2			29	
Nickel ug/L	7	1.0	1.0	1.0	0.0	25-150 ug/L			0					
Nitrate+Nitrite mg/L	7	0.0	0.1	0.0	0.0									
Ortho Phosphorus mg/L	7	0.0	0.0	0.0	0.0									
pH	9	6.0	7.6	6.7	0.6	6.5 - 9.0	6.5 - 8.5	5.0 - 9.0	5	5	0	56	56	
Potassium mg/L	7	0.3	0.7	0.4	0.2									
Selenium ug/L	7	1.0	1.0	1.0	0.0	1.0 ug/L	10 ug/L		0	0				
Silica mg/L	7	1.5	5.0	2.8	1.4									
Sodium mg/L	7	3.4	5.0	4.0	0.5		≤200 mg/L			0				
Sulphate mg/L	7	2.5	5.0	2.9	0.9		≤500 mg/L			0				
Suspended Solids mg/L	7	0.8	4.0	1.7	1.1									
Tin ug/L	7	1.0	1.0	1.0	0.0									

Parameter	# of Samples	Min	Max	Mean	SD	CWQ Guideline			# of Exceedences			Exceedences as %		
						FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]	FWAL[1]	DW[1]	REC[1]
Total Nitrogen mg/L	7	0.2	0.4	0.3	0.1									
Total Organic Carbon mg/L	7	6.9	14.1	9.6	2.7									
Total Phosphorus mg/L	7	0.0	0.0	0.0	0.0									
Turbidity NTU	9	0.2	1.8	1.0	0.5		1.0 NTU	50 NTU		5	0		56	
Vanadium ug/L	7	1.0	1.0	1.0	0.0									
Zinc ug/L	7	2.5	6.0	3.0	1.3	30 ug/L	≤5000 ug/L		0	0				

5.0 Summary and Conclusions

Water quality in the lake and rivers monitored in this network was primarily affected by precipitation, geology, vegetative cover and presence of wetland areas. Anthropogenic or human influences on water quality were considered generally to have relatively minor roles at this point in time in influencing water quality at the stations currently selected. Nevertheless, both regional and local influences from human activities are likely effecting water quality to some extent, and to varying degrees at each station. Regional influences include acid rain and climate change related factors (such as changes in air temperature, precipitation, and stream hydrological patterns). Local influences include land use changes through activities such as forestry, agriculture, and urbanization.

Although general and apparent trends in water quality are suggested at some stations and in some parameters, no long-term statistical trends have been assessed due to the relatively short period of record. A Mann- Kendall statistical test, commonly used to assess trends in environmental data, requires ten years of data.

Table 5.0-1 presents a summary of water quality results for each of the monitoring network stations. Annual mean values for each of the five parameters recorded by the automated equipment is provided to aid in the comparison of water quality between waterbodies, and over time at each station. Detailed water chemistry results are shown in tables and graphs in Section 3. Additional detailed results for periodic grab samples are available in Section 4.

Table 5.0 - 1 A summary of water quality annual mean values for the six monitoring stations for the parameters measured between 2002 and 2008.

Station (year)	Temperature °C	Turbidity NTU	Conductivity uS/cm	Dissolved Oxygen mg/L	pH
Pockwock Lake					
2002	18.2	-	39.4	8.4	5.4
2003	10.8	0.3	37.7	10.8	5.3
2004	9.9	1.2	39.9	10.8	5.3
2005	16.4	1.0	37.9	8.8	5.1
2006	10.8	1.1	38.6	10.4	4.9
2007	9.6	1.0	40.2	11.4	5.2
2008	10.5	0.1	35.9	10.8	5.2
NE Margaree River					
2002	9	1.0	161.6	11.0	7.2
2003	8.7	1.8	165.4	11.3	7.1
2004	6.4	1.6	171.9	12.2	7.2
2005	8.1	0.9	161.2	11.3	7.2
2006	7.9	1.8	155.5	11.4	7.2
2007	6.3	1.5	155.3	12.1	7.2
2008	7.6	1.3	137.2	11.8	7.1
Shelburne River					
2002	10.8	1.4	34.2	10.0	4.4

Station (year)	Temperature °C	Turbidity NTU	Conductivity uS/cm	Dissolved Oxygen mg/L	pH
2003	10.5	0.4	34.6	10.5	4.4
2004	9.7	0.8	34.2	10.0	4.4
2005	11.6	1.2	32.2	9.9	4.4
2006	11.1	0.8	32.7	9.4	4.4
2007	10.8	0.3	34.3	10.5	4.3
2008	12.2	0.1	28.6	10.2	4.3
Kelley River					
2005	9.7	1.9	25.6	10.8	5.5
2006	8.5	1.8	23.4	10.9	5.6
*2007	1.9	0.3	26.1	12.5	5.5
2008	8.3	1.3	20.6	11.6	5.4
St Mary's River					
**2007	12.2	1.1	32.9	10.6	6.5
**2008	1.4	12.1	29.5	13.6	5.9
Lahave River					
**2008	8.9	-	33.5	-	5.5

*Equipment failure due to vandalism, resulting in limited data collection. Interpret with caution.
**New station and equipment deployment, resulting in limited data collection. Interpret with caution.

An overall summary of each parameter measured in the automated network is provided below.

As observed in the previous network report all stations experienced trends in water temperature which for the most part followed daily and seasonal air temperature patterns. Although minimum and maximum water temperatures did not match air temperature extremes, river waters responded to changes in air temperature more quickly than the lake system (Pockwock Lake). The response time lag observed in the lake was due to the time required to heat the lake water to the depth of the temperature sensor (5 meters). There appeared to be a stepwise decreasing trend in water temperature at three stations (Pockwock, Margaree, and Shelburne) during the period 2002-2004, and again from 2005-2007. The latter trend was observed at the Kelley River station as well. No cause for this apparent trend is offered.

All of the river stations experienced episodes of increased water turbidity to varying degrees during and following more severe precipitation events. The lake system showed fewer and less intensive turbidity peak values, due to a dampening effect from dilution. Soil erosion and stream bed disturbance were considered to be the main contributors of turbidity events at the river stations. Although turbidity measurements seldom exceeded 5 NTU in Pockwock Lake, a reduction in water transparency during the Summer was attributed to algal production in the lake. All stations generally showed very low turbidity values with occasional peaks coinciding with significant precipitation events. NE Margaree and St Mary's River stations experienced more frequent and intensive turbidity events than other stations, likely due to more development and disturbances in their watersheds. No other apparent trends in turbidity at or between stations were observed.

Water conductivity at nearly all stations was reflective of dilute waters with mean annual ranges of between 20 and 41 uS/cm. Conductivity levels were observed to remain fairly constant on a daily basis throughout the period of record with only minor shifts outside annual mean ranges. The North East Margaree River mean annual conductivity was much higher however, ranging from 137 – 172 uS/cm which indicates a much greater dissolved solids content. This was attributed to the bedrock and surficial geology of the area, rather than influences from human activities such as the application of road salt. At all river stations conductivity had an inverse relationship to flow. That is, conductivity levels were lower during higher flow periods compared to low flow periods. This was thought to be due to the effects of groundwater seepage (with higher concentrations of dissolved solids) during low flows, as well as the dilution effect of precipitation and snowmelt runoff (with low dissolved solids) during high flows. No other apparent trends in conductivity at or between stations were observed.

All stations remained well-oxygenated throughout the monitoring period with daily mean dissolved oxygen concentrations ranging from 5.7 – 15.5 mg/L. Patterns in dissolved oxygen were the inverse of water temperature, explainable by the fact that the solubility of oxygen in water decreases with the rise in temperature. The levels of dissolved oxygen were also characteristic of low biological productivity. No other apparent trends in dissolved oxygen at or between stations were observed.

Acidity of surface waters in the watersheds being monitored is a reflection of the surficial geology, vegetative landscape and likely the quality of precipitation. The lower pH of Shelburne River (pH 4.3 to 4.4) is characteristic of poorly buffered and organic acids associated with highly coloured water. A major source of these acids and colour is sphagnum bogs, which are assumed to constitute a significant portion of the 48 km^2 of wetland/water area identified for this watershed. Pockwock Lake and Kelley River watersheds produced a slightly less acidic runoff with annual mean pH ranging from 4.9 to 5.4 and 5.4 to 5.6, respectively. Water colour is less prominent in both watersheds indicating a reduced influence of wetland areas as compared to runoff in the Shelburne River watershed. A reduced soil buffering capacity and the effects of acid precipitation are in evidence for these two watersheds. These two stations may be showing decreasing trends in pH over time. The trend at Pockwock Lake appears to have reversed in 2007. The North East Margaree River, on the other hand, appears to be well-buffered with an annual mean pH ranging from 7.1 to 7.2. Only 8 percent of this watershed is made up of water/wetland areas suggesting little influence from acidic wetlands. No other apparent trends in pH at or between stations were observed.

Exceedences of national guideline values were observed at most stations for temperature, pH, and turbidity. Dissolved oxygen guidelines were never exceeded at any station. Temperature guidelines for cold water fish were exceeded at all stations except one (Lahave R) which only recorded data during Oct and Nov 2008. These temperature exceedences were generally short lived and occurred almost exclusively during the months of July and August. Two stations (Pockwock Lake and Shelburne River) had significantly more frequent temperature exceedences with up to 25% and 22% of the annual readings exceeding the guideline. This was attributed to the relatively shallow waters where sensors were deployed at these stations, as well as to lake versus stream dynamics related to warming patterns. Guidelines for pH were exceeded for all water uses at all stations, at some point during the monitoring period. However, there was much variability among stations. Two stations (Pockwock and Shelburne) exceeded the pH guidelines 100% of the time. Two stations (St Mary's and Lahave) exceeded the pH guidelines 72% of the time. One station (NE Margaree) exceeded the guidelines <1 % of the time on average. This variation was attributed to differences in bedrock and surficial geology, relative abundance of wetlands in the watershed, and known patterns of atmospheric acid deposition (e.g. acid raid). Exceedences occurred most frequently for Protection of Aquatic Life guidelines, with Drinking Water, and Recreational water use guideline exceedences occurring progressively less often. This situation would be due to the more stringent guideline values recommended for this more sensitive water use.

Data quality and completeness of record is critical to the effectiveness of the network and accuracy of interpretation of results. Both have improved consistently and progressively since inception of this network, resulting in credible water quality information being reported. Over 90% of the possible hourly readings have been captured by the automated equipment at most stations in recent years, as opposed to as little as 24% of possible readings when the network was first commissioned. Newer stations (with shorter periods of record) have yet to achieve the level of success of long–term stations. Although there has been a general increase in the percent of hours for which reliable data were collected since 2002, there is still room for improvement. The inability of the current program to detect and address equipment malfunctions in a timely manner has resulted in data record voids. To overcome this inadequacy it is recommended to increase the frequency of field visits where resources allow and to employ software alarms or flags to alert network administrators that maintenance is required.

The quality of the dataset has been confirmed through good agreement between automated sensor values and quality assurance samples collected periodically during site visits. Data for pH during the 2008 sampling season however were an exception with lesser agreement. The cause of this situation merits further investigation.

One station (St Mary's River) was discontinued in 2008 due to ongoing fowling of equipment which could not be resolved by relocating automated equipment.

It is recommended to include additional stations in the network as resources become available to broaden coverage throughout the province and increase protection of valuable surface water resources.

6.0 References

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APPENDIX I – DATA QUALITY ASSURANCE/QUALITY CONTROL

I.1 DATA COLLECTION AND DATA HANDLING

The Network employs Hydrolab™ models DS4, DS4a, DS5, and DS5x datasondes equipped with temperature, pH, conductivity, dissolved oxygen, and turbidity sensors (Appendix IV). Readings are taken at hourly intervals beginning at 0000 hours and ending at 2300 hours for the day of record then stored on a datalogger.

The Kelley River, Lahave River, North East Margaree sites employ Sutron dataloggers and St. Mary's River site employ Vedas datalogger that log hydrolab parameters through an SDI port. Every three hours, the data is transmitted via GOES satellite to Wallops Command and Data Acquisition (CDA) in Wallops Island, Virginia. From here the data becomes part of the National Environmental Satellite, Data, and Information Service (NESDIS) maintained by the National Oceanic and Atmospheric Administration (NOAA). NESDIS is queried by CMC in Dorval (Water Survey of Canada) and the data is pushed to the all regional New Leaf server as telemetry data.

Every 4 to 8 weeks depending on site access and other factors, the Sutron and Vedas dataloggers are manually downloaded by the Water Survey of Canada onto field computers or PCMCIA ramcard in Sutron logger format (.LG1). Raw data logger files are transferred from field laptops or PCMCIA ramcard to a secure database in Fredericton, Nova Scotia or Newfoundland. This raw data contained in the .LG1 files are used for data correction and archiving as they form the most complete record.

The Pockwock Lake station employs a Campbell Scientific CR510 datalogger with a landline connection to a dedicated terminal in the NSE Central Region office. Automated downloads occur on a daily basis.

I.2 NORMALIZATION OF DATA RECORDS

The first step in the normalization procedure is one which rates the accuracy of each segment of continuous field data based on one of four accuracy classifications (Table I - 1) ranging from poor to excellent. A specific rating is assigned to each data segment according to the magnitude of the difference between Hydrolab sensor readings taken at the beginning and end of the data segment and the respective reading at the time of sensor field calibration. A calibrated (using commercially available liquid standards, see Appendix II) portable Quanta P hand held water quality meter is used for field calibration. If the magnitude of the difference exceeds a maximum allowable limit (Table I - 2), the entire data segment for that parameter, or portion thereof, is rejected and deleted from the permanent data record. A degree of professional judgement is applied in timing of field visits. At the present time, a strict scheduling routine does not exist for the purpose of downloading stored data from the Sutron data logger and equipment maintenance. Since the start-up of the program, time between site visits ranged from 2 to 7 months. Winter conditions play a major role in determining the frequency of visits possible between late-November and early-May.

The next step in the normalization procedure is the examination of the individual data series for anomalous sensor readings due to occurrences such as sensor failure, data logger malfunction and sensor fouling by submerged debris. If any suspect readings are detected, the series of readings leading up to and immediately following those in question, as well as readings for other network parameters are considered when deciding if the suspect data points should be omitted from the data set. A record of all data omissions is kept.

Other gaps in a data series are the direct result of routine servicing in which the datasondes are inactive for up to a day.

Table I - 1 Water Quality Data Rating System (adopted from USGS Report Wagner, 2006).

Parameter	Rating			
	Excellent	Good	Fair	Poor
Water Temperature	≤ +/- 0.20 oC	> +/- 0.2 to 0.5 oC	> +/- 0.5 to 0.8 oC	> +/- 0.8 oC
Specific Conductance	The greater of ≤+/- 3% or ≤ +/- 5 uS/cm	The greater of >+/- 3 to 10 % or > +/- 5 to 15 uS/cm	The greater of > +/- 10 to 15 % or > +/- 15 to 25 uS/cm	The greater of > +/- 15 % or 25 uS/cm
Dissolved Oxygen	≤ +/- 0.3 mg/L	> +/- 0.3 to 0.5 mg/L	> +/- 0.5 to 0.8 mg/L	> +/- 0.8 mg/L
pH	≤ +/- 0.2 units	> +/- 0.2 to 0.5 units	> +/- 0.5 to 0.8 units	> +/- 0.8 units
Turbidity	The greater of ≤ +/- 5% or ≤ +/- 2 NTUs	The greater of > +/- 5 to 10% or > +/- 2 to 5 NTUs	The greater of > +/- 10 to 15% or > +/- 5 to 8 NTUs	The greater of > +/- 15% or > +/- 8 NTUs

Explanation of symbols: ≤, less than or equal to; +/-, plus or minus value shown; oC, degree Celsius; >, greater than; %, percent; mg/L, milligrams per litre; pH unit, standard pH unit.

Table I - 2 Data Rejection Criteria (adapted from USGS 2000). Maximum allowable limits for continuous water-quality monitoring sensors (+/-, plus or minus value shown; oC, degree Celsius; mg/L, milligrams per litre; pH unit, standard pH unit)

Measured physical property	Maximum allowable limits for water-quality sensor values
Temperature	+/- 2.0 oC
Specific conductance	+/- 30 percent
Dissolved oxygen	The greater of +/- 2.0 mg/L or 20 percent
pH	+/- 2 pH units
Turbidity	The greater of 15 NTUs or 30 percent

The final step in the normalization procedure is a linear adjustment of the data segment. Microsoft Excel software is used for this function. Annual Data Quality Analysis reports are generated by NSE for each monitoring site that provides a detailed listing of these data verification procedures. These reports can be found in Section I.4 of this Appendix.

I.3 DATA OMISSION

As earlier pointed out in this section, data are rejected due to probe and/or logger malfunction, probe interference due to submerged debris, and exceedence of established maximum allowable limits. For this report, individual data sets have undergone further scrutiny by NSE staff prior to carrying out statistical analysis and based on professional judgement, some additional data were deleted.

Data listed in Table I - 3 were deleted from their respective data sets because they could not be explained by either environmental influences (precipitation event occurring within a 48-hour period leading up to the measurement) or supported by complimentary changes for any other recorded parameter (within a 12-hour window of the measurement). For turbidity, readings before and after the measurement in question were typically <2 NTU and more often 0 NTU. For conductivity, recorded before and after measurements were steady at 50-80 uS/cm above those omitted.

Table I - 3 List of data deleted from dataset based on professional judgement

	Date	Time	Parameter	Reading	Comment
NE Margaree River					
2002	30-Dec	1000	Turbidity	4.5	0 NTU 6 hr before/after
		1700	Turbidity	7.0	0 NTU 6 hr before/after
		1800	Conductivity	75.6	165 uS/cm 6 hr before
		1900	Conductivity	77.1	172 uS/cm @ 2100
		2000	Conductivity	88.0	125 uS/cm @ 6 hr before
2005	19-Feb	0100	Conductivity	72.0	135 uS/cm @ 0200
Shelburne River					
2002	21-Aug	0300	Turbidity	18.7	Mean for Aug 21 = 1.0 NTU
		0500	Turbidity	18.7	No precipitation
		2200	Turbidity	43.7	All other parameters steady
		2300	Turbidity	32.7	
2004	10-May	1300	Turbidity	10.9	<1 NTU 6 hr before/after
2005	26-Jul	0600	Turbidity	21.2	No precipitation
		0700	Turbidity	17.6	All other parameters steady
		0800	Turbidity	84.4	
	31-Jul	0600	Turbidity	65.9	No precipitation
		0700	Turbidity	13.8	All other parameters steady
	04-Aug	1100	Turbidity	32.9	<2 NTU 6 hr before/after
	26-Aug	1300	Turbidity	9.9	No precipitation
		1400	Turbidity	23.6	All other parameters steady
	28-Aug	0900	Turbidity	16.2	<2.5 NTU 6 hr before/after
		1100	Turbidity	46.1	
		1600	Turbidity	17.2	
	04-Sep	0100	Turbidity	60.3	<1.0 NTU 6 hr before/after
		0700	Turbidity	148	All other parameters steady
		0800	Turbidity	14.1	
	09-Sep	1500	Turbidity	12.7	<1.5 NTU 6 hr before/after All other parameters steady
	10-Sep	0100	Turbidity	11.6	<3 NTU 6 hr before/after
		1000	Turbidity	29.8	No precipitation
		1200	Turbidity	16.9	All other parameters steady
		2200	Turbidity	32.7	
	11-Sep	0200	Turbidity	9.4	<1.5 NTU 6 hr before/after
		1000	Turbidity	13.6	before/during/after
		1500	Turbidity	20.2	All other parameters steady
		2000	Turbidity	28.3	
	12-Sep	1200	Turbidity	62.7	<2.0 NTU 6 hr before/after All other parameters steady
	14-Nov	1800	Turbidity	50.3	<3.0 NTU 6 hr before/after
		2100	Turbidity	11.9	All other parameters steady
Kelley River					
2005	24-Oct	0100	Turbidity	85.5	<5.0 NTU 6 hr before / 0 NTU after All other parameters steady

I.4 ANNUAL REPORTING

Operational reports are prepared on an annual basis for each monitoring station, which provide detailed summaries of station descriptions and data quality analyses. Station description reports include such information as geographical location, watershed area, period of hydrometric and water quality records and water quality parameters measured. Data quality analysis reporting contains information on equipment, watercourse characteristics, instrument calibration, and data management.

Station description and data quality analysis reports contained in this section cover the complete period of operation, specifically:

Pockwock Lake 2002 – 2008
Shelburne River 2002 – 2008
North East Margaree River 2002 – 2008
Kelley River 2005 – 2008
St. Mary’s River 2007 – 2008
Lahave River 2008

Nova Scotia Environment
Automated Water Quality Monitoring Network

MONITORING STATION DESCRIPTION

Pockwock Lake

Record Period: December 4, 2007 to December 5, 2008

LOCATION: Latitude 44^0 46’ 56” N Longitude 63^0 50’ 43” W

GROSS DRAINAGE AREA: 54.0 km^2

WATER QUALITY RECORD LENGTH: 7 years

WATER QUALITY PEROID OF RECORD: 2002 - 2008

Water Quality measurement

Period of record	Water Quality Parameters	Operation schedule	Gauge type
2002 – 2008	Temperature, Turbidity, pH, Dissolved Oxygen and Specific Conductance	Continuous	Recorder

WATER QUALITY REAL-TIME DATA AVAILABLE: YES

Water Quality monitoring equipment is located in a five inch perforated PVC pipe insitu to lake via shore deployment method. The location has not changed since installation in 2002 Water Quality data is recorded hourly and stored in Campbell’s Scientific CR510 datalogger. The data is downloaded daily via landline connect to logger.

NOTE: All data management decisions were based on Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Site Selection, Field Operation, Calibration, Record Computation, and Reporting. U.S Geological Survey. Water-Resources Investigations Report 00-4252.

Excluding:
-cross-section measurement and adjustments p. 17 and 22.

Also, modification to following two tables:

-Table 8. Data Rejection Criteria. Maximum allowable limits for continuous water-quality monitoring sensors. [+/-, plus or minus value shown; °C, degree Celsius; mg/L, milligram per litre; pH unit, standard pH unit]

Measured physical property	Maximum allowable limits for water-quality Sensor values
Temperature	+/- 2.0 °C
Specific conductance	+/- 30 percent
Dissolved oxygen	The greater of +/- 2.0 mg/L or 20 percent
pH	+/- 2 pH units
Turbidity	The greater of 15 NTUs or 30 percent

Table 9. Data Quality Rating. Rating continuous water-quality records

[≤ , less than or equal to; +/-, plus or minus value shown; °C, degree Celsius; >, greater than; %, percent; mg/L, milligram per litre; pH unit, standard pH unit]

Measured physical property	Excellent	Good	Fair	Poor
Water temperature	≤ +/- 0.20 °C	> +/- 0.2 to 0.5 °C	> +/- 0.5 to 0.8 °C	> +/- 0.8 °C
Specific conductance	The greater of ≤ +/- 3% or ≤ +/- 5 uS/cm	The greater of > +/- 3 to 10 % or > +/- 5 to 15 uS/cm	The greater of > +/- 10 to 15 % or > +/- 15 to 25 uS/cm	The greater of > +/- 15 % or 25 uS/cm
Dissolved oxygen	≤ +/- 0.3 mg/L	> +/- 0.3 to 0.5 mg/L	> +/- 0.5 to 0.8 mg/L	> +/- 0.8 mg/L
pH	≤ +/- 0.2 units	> +/- 0.2 to 0.5 units	> +/- 0.5 to 0.8 units	> +/- 0.8 units
Turbidity	The greater of ≤ +/- 5% or ≤ +/- 2 NTUs	The greater of > +/- 5 to 10% or > +/- 2 to 5 NTUs	The greater of > +/- 10 to 15% or > +/- 5 to 8 NTUs	The greater of > +/- 15% or > +/- 8 NTUs

Nova Scotia Environment
Automated Water Quality Monitoring Network

DATA QUALITY ANALYSIS

WATER QUALITY PARAMETERS

Temperature, pH, Conductivity, Dissolved Oxygen and Turbidity

Record Period: December 6, 2005 to December 4, 2007

POCKWOCK LAKE, HALIFAX COUNTY, NOVA SCOTIA

Equipment: Campbell's Scientific CR510 Data logger and Hydrolab Water Quality Sonde located in a five inch diameter perforated PVC pipe insitu to the lake via shore line deployment method.

Published records: Hourly water quality measurements.

Primary Records: Covering the period December 6, 2005 to December 4, 2007.

Lake Characteristics:

Station located at the outlet of lake in front of pumping station for water treatment plant. Water quality monitoring equipment located 5 meters below the water surface. Average water depth at station is 10 meters.

Calibration:

During the ice-free season data from the seasoned Hydrolab unit is verified by a freshly calibrated portable Quanta P hand held water quality meter prior to unit being removed. The calibration of the replacement Hydrolab unit was preformed at NSEL office prior to field trip using calibration standards. The dates of removal of seasoned Hydrolab and installation of freshly calibrated Hydrolab were:

December 6, 2005
May 2, 2006
August 1, 2006
September 26, 2006
November 7, 2006
May 3, 2007
August 1, 2007
September 25, 2007 Removal only
October 26, 2007 Installation only
December 4, 2007

Field Verifications:

Data from the Hydrolab were verified in the field during the 2005, 2006 and 2007 season using a freshly calibrated portable Quanta P hand held water quality meter. Data verification was performed on the seasoned Hydrolab on removal and the freshly calibrated Hydrolab that was installed.

Data Rating:

Period from	Period to	Temperature	pH	Conductivity	DO	Turbidity
12/06/2005	05/02/2006	Excellent	Fair	Excellent	Fair	Good
05/02/2006	08/01/2006	Good	Poor	Good	Poor	Excellent
08/01/2006	09/26/2006	Excellent	Poor	Good	Poor	Excellent
09/26/2006	11/07/2006	Excellent	Good	Excellent	Poor	Rejected
11/07/2006	05/03/2007	Excellent	Good	Excellent	Poor	Good
05/03/2007	08/01/2007	Good	Good	Good	Poor	Excellent
08/01/2007	09/25/2007	Excellent	Good	Excellent	Good	Excellent
10/26/2007	12/04/2007	Excellent	Excellent	Good	Poor	Excellent

Data Correction:

Data correction was made to collected data by comparing the freshly calibrated portable Quanta P water quality meter measurements for Temperature, Conductivity, pH and DO. The field verification and Hydrolab recorded values were compared using the Criteria for Water Quality Data Shifts table. Shifts were made to the recorded data as required.

Data Rejected:

Periods of turbidity data rejected because the data were outside the Maximum allowable limits for Turbidity (The greater of 15 NTUs or 30 percent):

September 26, 2006 to November 7, 2006.
July 26, 2006 to August 1, 2006

Missing Data:

Periods of missing data for all parameters due to sonde malfunctions:

December 4, 2006 to January 5, 2007
September 25, 2007 to October 26, 2007

Periods of missing data for Turbidity data due to sensor malfunction:

February 28, 2006 to March 4, 2006
March 5, 2006 to March 7, 2006

March 24, 2006 to March 27, 2006
March 28, 2006 to March 29, 2006
September 7, 2007 to September 18, 2007

Some Turbidity values removed because of debris in front of sensor.

Period of missing Dissolved Oxygen data due to sensor malfunction:

June 20, 2007 to August 1, 2007

Nova Scotia Environment
Automated Water Quality Monitoring Network

DATA QUALITY ANALYSIS

WATER QUALITY PARAMETERS

Temperature, pH, Conductivity, Dissolved Oxygen and Turbidity

Record Period: December 4, 2007 to December 5, 2008

POCKWOCK LAKE, HALIFAX COUNTY, NOVA SCOTIA

Equipment: Campbell's Scientific CR510 Data logger and Hydrolab Water Quality Sonde located in a five inch diameter perforated PVC pipe insitu to the lake via shore line deployment method.

Published records: Hourly water quality measurements.

Primary Records: Covering the period December 4, 2007 to December 5, 2008.

Lake Characteristics:

Station located at the outlet of lake in front of pumping station for water treatment plant. Water quality monitoring equipment located 5 meters below the water surface. Average water depth at station is 10 meters.

Calibration:

During the ice-free season data from the seasoned Hydrolab unit is verified by a freshly calibrated portable Hydrolab MS5 hand held water quality meter prior to unit being removed. The calibration of the replacement Hydrolab unit was preformed at NSE office prior to field trip using calibration standards. The dates of removal of seasoned Hydrolab and installation of freshly calibrated Hydrolab were:

December 4, 2007
April 23, 2008
July 8, 2008
August 26, 2008
November 6, 2008 Removal only
November 7, 2008 Installation only
December 5, 2008

Field Verifications:

Data from the Hydrolab were verified in the field during the 2007 and 2008 season using a freshly calibrated portable Hydrolab MS5 hand held water quality meter. Data verification was performed on the seasoned Hydrolab on removal and the freshly calibrated Hydrolab that was installed.

Data Rating:

Period from (mm/dd/yyyy)	Period to (mm/dd/yyyy)	Temperature	pH	Conductivity	DO	Turbidity
12/04/2007	04/23/2008	Good	Data Rejected	Good	Excellent	Excellent
04/23/2008	07/08/2008	Good	Good	Excellent	Good	Excellent
07/08/2008	08/26/2008	Excellent	Good	Excellent	Excellent	Excellent
08/26/2008	11/06/2008	Good	Excellent	Excellent	Excellent	Excellent
11/07/2008	12/05/2008	Excellent	Excellent	Excellent	Good	Excellent

Data Correction:

Data correction was made to collected data by comparing the freshly calibrated portable Hydrolab MS5 water quality meter measurements for Temperature, Conductivity, pH and DO. The field verification and Hydrolab recorded values were compared using the Criteria for Water Quality Data Shifts table. Shifts were made to the recorded data as required.

Missing Data:

Interruptions in record are due to malfunction of the recording instrument or sensors.

Nova Scotia Environment and Labour
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MONITORING STATION DESCRIPTION

Shelburne River

Record Period: July 26, 2007 to November 13, 2008

LOCATION COORDINATES: Latitude 44^0 12’ 59” N Longitude 65^0 14’ 32” W

GROSS DRAINAGE AREA: 268 km^2

HYDROMETRIC RECORD LENGTH: 10 years

HYDROMETRIC PEROID OF RECORD: 1999 – 2008

Hydrometric measurement

Period of record	Type	Operation schedule	Gauge type
1999 - 2008	Flow	Continuous	Recorder

HYDROMETRIC REAL-TIME DATA AVAILABLE: YES

WATER QUALITY RECORD LENGTH: 7 YEARS

WATER QUALITY PEROID OF RECORD: 2002 to present

Water Quality measurement

Period of record	Water Quality Parameters	Operation schedule	Gauge type
2002 to 2008	Temperature, Turbidity, pH, Dissolved Oxygen and Specific Conductance	Continuous	Recorder

WATER QUALITY REAL-TIME DATA AVAILABLE: NO

Water Quality monitoring equipment is located in a five inch perforated white PVC pipe insitu to river via shore deployment method. The location has not changed since installation in 2002. Water Quality data is recorded hourly and stored by Environment Canada Sutron Logger. The data is downloaded manually on maintenance visit.

NOTE: All data management decisions were based on Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Site Selection, Field Operation, Calibration, Record Computation, and Reporting. U.S Geological Survey. Water-Resources Investigations Report 00-4252.

Excluding:
-cross-section measurement and adjustments p. 17 and 22.

Also, modification to following two tables:

-Table 8. Data Rejection Criteria. Maximum allowable limits for continuous water-quality monitoring sensors. [+/-, plus or minus value shown; ^{o}C, degree Celsius; mg/L, milligram per litre; pH unit, standard pH unit]

Measured physical property	Maximum allowable limits for water-quality Sensor values
Temperature	+/- 2.0 ^{o}C
Specific conductance	+/- 30 percent
Dissolved oxygen	The greater of +/- 2.0 mg/L or 20 percent
pH	+/- 2 pH units
Turbidity	The greater of +/-15 NTUs or 30 percent

Table 9. Data Quality Rating. Rating continuous water-quality records

[≤ , less than or equal to; +/-, plus or minus value shown; ^{o}C, degree Celsius; >, greater than; %, percent; mg/L, milligram per litre; pH unit, standard pH unit]

Measured physical property	Excellent	Good	Fair	Poor
Water temperature	≤ +/- 0.20 ^{o}C	> +/- 0.2 to 0.5 ^{o}C	> +/- 0.5 to 0.8 ^{o}C	> +/- 0.8 ^{o}C
Specific conductance	The greater of ≤ +/- 3% or ≤ +/- 5 uS/cm	The greater of > +/- 3 to 10 % or > +/- 5 to 15 uS/cm	The greater of > +/- 10 to 15 % or > +/- 15 to 25 uS/cm	The greater of > +/- 15 % or 25 uS/cm
Dissolved oxygen	≤ +/- 0.3 mg/L	> +/- 0.3 to 0.5 mg/L	> +/- 0.5 to 0.8 mg/L	> +/- 0.8 mg/L
pH	≤ +/- 0.2 units	> +/- 0.2 to 0.5 units	> +/- 0.5 to 0.8 units	> +/- 0.8 units
Turbidity	The greater of ≤ +/- 5% or ≤ +/- 2 NTUs	The greater of > +/- 5 to 10% or > +/- 2 to 5 NTUs	The greater of > +/- 10 to 15% or > +/- 5 to 8 NTUs	The greater of > +/- 15% or > +/- 8 NTUs

Nova Scotia Environment and Labour
Automated Water Quality Monitoring Network

DATA QUALITY ANALYSIS

WATER QUALITY PARAMETERS

Temperature, pH, Conductivity, Dissolved Oxygen and Turbidity

Record Period: November 29, 2005 to July 26, 2007

SHELBURNE RIVER, QUEENS COUNTY, NOVA SCOTIA

Equipment: Sutron Data logger and Hydrolab Water Quality Sonde located in a five inch diameter perforated PVC pipe insitu to the river via shore line deployment method.

Published records: Hourly water quality measurements.

Primary Records: Covering the period November 29, 2005 to July 26, 2007.

Channel Characteristics:

Channel above station is straight for 60 metres and channel below station is straight for 300 metres. Both banks are rocky, wooded and liable to flooding. Streambed is rock, gravel and ledge rock.

Calibration:

During the ice-free season data from the seasoned Hydrolab unit is verified by a freshly calibrated portable Quanta P hand held water quality meter prior to unit being removed. Also a grab sample is taken for backup QAQC purposes. The calibration of the replacement Hydrolab unit was preformed at NSEL office prior to field trip using calibration standards. The dates of removal of seasoned Hydrolab and installation of freshly calibrated Hydrolab were:

November 29, 2005
July 5, 2006
August 16, 2006
December 20, 2006
May 23, 2007
July 26, 2007

Field Verifications:

Data from the Hydrolab were verified in the field during the 2005, 2006 and 2007 season using a freshly calibrated portable Quanta P hand held water quality meter. The backup QAQC grab samples were analysed for pH, Conductivity and Turbidity. Data verification was performed on the seasoned Hydrolab on removal and the freshly calibrated Hydrolab that was installed.

Data Rating:

Period from	Period to	Temperature	pH	Specific Conductance	DO	Turbidity
11/29/2005	07/05/2006	Excellent	Excellent	Excellent	Good	Excellent
07/05/2006	08/16/2006	Excellent	Excellent	Excellent	Fair	Good
08/16/2006	12/20/2006	Excellent	Excellent	Excellent	Fair	Good
12/20/2006	05/23/2007	Excellent	Good	Excellent	Excellent	Excellent
05/23/2007	07/26/2007	Excellent	Excellent	Excellent	Fair	Excellent

Data Correction:

Data correction was made to collected data by comparing the freshly calibrated portable Quanta P water quality meter measurements for Temperature, Conductivity, pH and DO. The backup QAQC grab sample lab results for Turbidity were used periodically for data correction due to Quanta P Turbidity sensor issues. The field verification and Hydrolab recorded values were compared using the Criteria for Water Quality Data Shifts table. Shifts were made to the recorded data as required.

Missing Data:

Periods of missing data for all parameters due to sonde and/or data logger malfunctions:

September 7, 2006 to September 12, 2006
November 16, 2006 to November 20, 2006

Data Rejected:

pH:

From	To	Comment
2005-12-25 9:00	2005-12-26 8:00	Data Rejected: anomalous data
2006-01-11 11:00	2006-01-11 17:00	Data Rejected: anomalous data

Dissolved Oxygen:

From	To	Comment
2006-11-20 17:00	2006-12-20 11:00	Data Rejected: outside Maximum Allowable Limits for Dissolved Oxygen (the greater +/- 2.0 mg/l or 20 percent of readings)

Turbidity:

From	To	Comment
2006-06-18 2:00	2006-07-05 10:00	Data Rejected: outside Maximum Allowable Limits for Turbidity (the greater of +/-15 NTU's or 30 percent of readings)
2006-04-28 3:00	2006-05-24 23:00	Data Rejected: debris in front of sensor
2006-07-15 13:00	2006-07-20 7:00	Data Rejected: debris in front of sensor
2006-10-08 19:00	2006-10-24 15:00	Data Rejected: debris in front of sensor
2006-10-31 7:00	2006-11-02 18:00	Data Rejected: debris in front of sensor
2006-11-05 1:00	2006-11-15 11:00	Data Rejected: debris in front of sensor
2007-05-17 9:00	2007-05-22 3:00	Data Rejected: debris in front of sensor

Nova Scotia Environment
Automated Water Quality Monitoring Network

DATA QUALITY ANALYSIS

WATER QUALITY PARAMETERS

Temperature, pH, Conductivity, Dissolved Oxygen and Turbidity

Record Period: July 26, 2007 to November 13, 2008

SHELBURNE RIVER, QUEENS COUNTY, NOVA SCOTIA

Equipment: Sutron Data logger and Hydrolab Water Quality Sonde located in a five inch diameter perforated PVC pipe insitu to the river via shore line deployment method.

Published records: Hourly water quality measurements.

Primary Records: Covering the period July 26, 2007 to November 13, 2008.

Channel Characteristics:

Channel above station is straight for 60 metres and channel below station is straight for 300 metres. Both banks are rocky, wooded and liable to flooding. Streambed is rock, gravel and ledge rock.

Calibration:

During the ice-free season data from the seasoned Hydrolab unit is verified by a freshly calibrated portable Hydrolab MS5 hand held water quality meter prior to unit being removed. Also a grab sample is taken for backup QAQC purposes. The calibration of the replacement Hydrolab unit was preformed at NSE office prior to field trip using calibration standards. The dates of removal of seasoned Hydrolab and installation of freshly calibrated Hydrolab were:

July 26, 2007
April 4, 2008
October 7, 2008
November 13, 2008

Field Verifications:

Data from the Hydrolab were verified in the field during the 2007 and 2008 season using a freshly calibrated portable Hydrolab MS5 hand held water quality meter. The backup QAQC grab samples were analysed for pH, Conductivity and Turbidity. Data verification was performed on the seasoned Hydrolab on removal and the freshly calibrated Hydrolab that was installed.

Data Rating:

Period from (mm/dd/yyyy)	Period to (mm/dd/yyyy)	Temperature	pH	Specific Conductance	DO	Turbidity
07/26/2007	04/29/2008	Excellent	Excellent	Good	Excellent	Excellent
04/29/2008	10/07/2008	Excellent	Good	Good	Excellent	Excellent
10/07/2008	11/13/2008	Excellent	Excellent	Excellent	Poor	Excellent

Data Correction:

Data correction was made to collected data by comparing the freshly calibrated portable Hydrolab MS5 water quality meter measurements for Temperature, Conductivity, pH and DO. The field verification and Hydrolab recorded values were compared using the Criteria for Water Quality Data Shifts table. Shifts were made to the recorded data as required.

Missing Data:

Interruptions in record are due to malfunction of the recording instrument or sensors.

Nova Scotia Environment
Automated Water Quality Monitoring Network

MONITORING STATION DESCRIPTION

North East Margaree

Record Period: November 11, 2007 to December 4, 2008

LOCATION: Latitude 46^0 22’ 10” N Longitude 60^0 58’ 36” W

GROSS DRAINAGE AREA: 368 km^2

HYDROMETRIC RECORD LENGTH: 92 years

HYDROMETRIC PEROID OF RECORD: 1916 – PRESENT

Hydrometric measurement

Period of record	Type	Operation schedule	Gauge type
1916 - 1920	Flow	Continuous	Manual
1921 - 1921	Flow	Seasonal	Manual
1922 - 1927	Flow	Continuous	Manual
1928 - 1928	Flow	Seasonal	Manual
1929 - 1941	Flow	Continuous	Manual
1942 - 2008	Flow	Continuous	Recorder

HYDROMETRIC REAL-TIME DATA AVAILABLE: YES

WATER QUALITY RECORD LENGTH: 7 YEARS

WATER QUALITY PEROID OF RECORD: 2002 – 2008

Water Quality measurement

Period of record	Water Quality Parameters	Operation schedule	Gauge type
2002 – 2008	Temperature, Turbidity, pH, Dissolved Oxygen and Specific Conductance	Continuous	Recorder

WATER QUALITY REAL-TIME DATA AVAILABLE: NO

Water Quality monitoring equipment is located in a five inch perforated white PVC pipe insitu to river via shore deployment method. The location has not changed since installation in 2002. Water Quality data is recorded hourly and stored by Environment Canada Sutron Logger. The data is downloaded manually on maintenance visit.

NOTE: All data management decisions were based on Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Site Selection, Field Operation, Calibration, Record Computation, and Reporting. U.S Geological Survey. Water-Resources Investigations Report 00-4252.

Excluding:
-cross-section measurement and adjustments p. 17 and 22.

Also, modification to following two tables:

-Table 8. Data Rejection Criteria. Maximum allowable limits for continuous water-quality monitoring sensors. [+/-, plus or minus value shown; °C, degree Celsius; mg/L, milligram per litre; pH unit, standard pH unit]

Measured physical property	Maximum allowable limits for water-quality Sensor values
Temperature	+/- 2.0 °C
Specific conductance	+/- 30 percent
Dissolved oxygen	The greater of +/- 2.0 mg/L or 20 percent
pH	+/- 2 pH units
Turbidity	The greater of +/-15 NTUs or 30 percent

Table 9. Data Quality Rating. Rating continuous water-quality records

[≤ , less than or equal to; +/-, plus or minus value shown; °C, degree Celsius; >, greater than; %, percent; mg/L, milligram per litre; pH unit, standard pH unit]

Measured physical property	Excellent	Good	Fair	Poor
Water temperature	≤ +/- 0.20 °C	> +/- 0.2 to 0.5 °C	> +/- 0.5 to 0.8 °C	> +/- 0.8 °C
Specific conductance	The greater of ≤ +/- 3% or ≤ +/- 5 uS/cm	The greater of > +/- 3 to 10 % or > +/- 5 to 15 uS/cm	The greater of > +/- 10 to 15 % or > +/- 15 to 25 uS/cm	The greater of > +/- 15 % or 25 uS/cm
Dissolved oxygen	≤ +/- 0.3 mg/L	> +/- 0.3 to 0.5 mg/L	> +/- 0.5 to 0.8 mg/L	> +/- 0.8 mg/L
pH	≤ +/- 0.2 units	> +/- 0.2 to 0.5 units	> +/- 0.5 to 0.8 units	> +/- 0.8 units
Turbidity	The greater of ≤ +/- 5% or ≤ +/- 2 NTUs	The greater of > +/- 5 to 10% or > +/- 2 to 5 NTUs	The greater of > +/- 10 to 15% or > +/- 5 to 8 NTUs	The greater of > +/- 15% or > +/- 8 NTUs

Nova Scotia Environment and Labour
Automated Water Quality Monitoring Network

DATA QUALITY ANALYSIS

WATER QUALITY PARAMETERS

Temperature, pH, Conductivity, Dissolved Oxygen and Turbidity

Record Period: December 1, 2005 to November 8, 2007

NORTH EAST MARGAREE, INVERNESS COUNTY, NOVA SCOTIA

Equipment: Sutron Data logger and Hydrolab Water Quality Sonde located in a five inch diameter perforated PVC pipe insitu to the river via shore line deployment method.

Published records: Hourly water quality measurements.

Primary Records: Covering the period December 1, 2005 to December 4, 2007.
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Channel Characteristics:

Channel above station is not straight. It comes in from two widely separated streams at sharp angles. Channel below station is straight for about 60m. Flow to the station and away from it is very swift and deep. Right bank is high, rocky, and wooded and not liable to flooding. Left bank is low, wooded and liable to flooding in many places. Stream bed is gravel and ledge rock.

Calibration:

During the ice-free season data from the seasoned Hydrolab unit is verified by a freshly calibrated portable Quanta P hand held water quality meter prior to unit being removed. Also a grab sample is taken for backup QAQC purposes. The calibration of the replacement Hydrolab unit was preformed at NSEL office prior to field trip using calibration standards. The dates of removal of seasoned Hydrolab and installation of freshly calibrated Hydrolab were:

December 1, 2005
June 22, 2006
September 21, 2006
December 14, 2006
April 26, 2007
June 14, 2007
August 23, 2007
November 8, 2007

Field Verifications:

Data from the Hydrolab were verified in the field during the 2005, 2006 and 2007 season using a freshly calibrated portable Quanta P hand held water quality meter. The backup QAQC grab samples were analysed for pH, Conductivity and Turbidity. Data verification was performed on the seasoned Hydrolab on removal and the freshly calibrated Hydrolab that was installed.

Data Rating:

Period from	Period to	Temperature	pH	Conductivity	DO	Turbidity
12/01/2005	06/22/2006	Excellent	Excellent	Good	Poor	Rejected
06/22/2006	09/21/2006	Excellent	Fair	Excellent	Poor	Excellent
09/21/2006	12/14/2006	Excellent	Fair	Good	Good	Excellent
12/14/2006	04/26/2007	Excellent	Good	Good	Poor	Good
04/26/2007	06/14/2007	Excellent	Good	Good	Good	Excellent
06/14/2007	08/23/2007	Excellent	Good	Good	Good	Excellent
08/23/2007	2007/11/08	Excellent	Good	Good	Good	Excellent

Data Correction:

Data correction was made to collected data by comparing the freshly calibrated portable Quanta P water quality meter measurements for Temperature, Conductivity, pH and DO. The backup QAQC grab sample lab results for Turbidity were used periodically for data correction due to Quanta P Turbidity sensor issues. The field verification and Hydrolab recorded values were compared using the Criteria for Water Quality Data Shifts table. Shifts were made to the recorded data as required.

Missing Data:

Periods of missing data for all parameters due to sonde and/or data logger malfunctions:

From	To
08-31-2006 00:00	08-31-2006 06:00
09-23-2006 22:00	09-24-2006 03:00
09-27-2006 04:00	09-27-2006 09:00
09-27-2006 13:00	09-27-2006 18:00
09-27-2006 22:00	09-28-2006 06:00
2007-04-25 15:00	2007-04-26 11:00
2007-04-26 14:00	2007-04-28 23:00
08-04-2007 20:00	08-23-2007 15:00

Data Rejected:

Dissolved Oxygen:

From	To	Comment
2007-02-27 7:00	2007-03-03 1:00	Data Rejected: anomalous data
2007-03-17 8:00	2007-03-17 13:00	Data Rejected: anomalous data
2007-03-20 4:00	2007-03-20 6:00	Data Rejected: anomalous data

Turbidity:

From	To	Comment
12-01-2005 14:00	06-22-2006 12:00	Data Rejected: outside Maximum Allowable Limits for Turbidity (the greater of +/-15 NTU's or 30 percent of readings)

Nova Scotia Environment
Automated Water Quality Monitoring Network

DATA QUALITY ANALYSIS

WATER QUALITY PARAMETERS

Temperature, pH, Conductivity, Dissolved Oxygen and Turbidity

Record Period: November 8, 2007 to December 4, 2008

NORTH EAST MARGAREE, INVERNESS COUNTY, NOVA SCOTIA

Equipment: Sutron Data logger and Hydrolab Water Quality Sonde located in a five inch diameter perforated PVC pipe insitu to the river via shore line deployment method.

Published records: Hourly water quality measurements.

Primary Records: Covering the period November 8, 2007 to December 4, 2008.
.

Channel Characteristics:

Channel above station is not straight. It comes in from two widely separated streams at sharp angles. Channel below station is straight for about 60m. Flow to the station and away from it is very swift and deep. Right bank is high, rocky, and wooded and not liable to flooding. Left bank is low, wooded and liable to flooding in many places. Stream bed is gravel and ledge rock.

Calibration:

During the ice-free season data from the seasoned Hydrolab unit is verified by a freshly calibrated portable Hydrolab MS5 hand held water quality meter prior to unit being removed. Also a grab sample is taken for backup QAQC purposes. The calibration of the replacement Hydrolab unit was preformed at NSE office prior to field trip using calibration standards. The dates of removal of seasoned Hydrolab and installation of freshly calibrated Hydrolab were:

November 8, 2007
May 8, 2008
June 4, 2008
October 22, 2008
December 4, 2008

Field Verifications:

Data from the Hydrolab were verified in the field during the 2007 and 2008 season using a freshly calibrated portable Hydrolab MS5 hand held water quality meter. The backup QAQC grab samples were analysed for pH, Conductivity and Turbidity. Data verification was performed on the seasoned Hydrolab on removal and the freshly calibrated Hydrolab that was installed.

Data Rating:

Period from (mm/dd/yyyy)	Period to (mm/dd/yyyy)	Temperature	pH	Conductivity	DO	Turbidity
11/08/2007	05/08/2008	Excellent	Good	Good	Poor	Excellent
05/08/2008	06/04/2008	Excellent	Fair	Good	Fair	Excellent
06/04/2008	10/22/2008	Excellent	Excellent	Excellent	Excellent	Rejected
10/22/2008	12/04/2008	Excellent	Good	Excellent	Good	Excellent

Data Correction:

Data correction was made to collected data by comparing the freshly calibrated portable Hydrolab MS5 water quality meter measurements for Temperature, Conductivity, pH and DO. The field verification and Hydrolab recorded values were compared using the Criteria for Water Quality Data Shifts table. Shifts were made to the recorded data as required.

Missing Data:

Interruptions in record are due to malfunction of the recording instrument or sensors.

Nova Scotia Environment
Automated Water Quality Monitoring Network

MONITORING STATION DESCRIPTION

Kelley River

Record Period: October 10, 2007 to October 29, 2008

LOCATION: Latitude 45^0 35' 10" N Longitude 64^0 27' 05" W

GROSS DRAINAGE AREA: 63.2 km^2

HYDROMETRIC RECORD LENGTH: 40 years

HYDROMETRIC PEROID OF RECORD: 1969 – PRESENT

Hydrometric measurement

Period of record	Type	Operation schedule	Gauge type
1969 - present	Flow	Continuous	Recorder

HYDROMETRIC REAL-TIME DATA AVAILABLE: YES

WATER QUALITY RECORD LENGTH: 4 YEAR

WATER QUALITY PEROID OF RECORD: 2005 - PRESENT

Water Quality measurement

Period of record	Water Quality Parameters	Operation schedule	Gauge type
2005 - present	Temperature, Turbidity, pH, Dissolved Oxygen and Specific Conductance	Continuous	Recorder

WATER QUALITY REAL-TIME DATA AVAILABLE: NO

Water Quality monitoring equipment is located in a four inch slotted stainless steel pipe insitu to river via shore deployment method. The location has not changed since installation in 2004. Water Quality data is recorded hourly and stored by Environment Canada Sutron Logger. The data is downloaded manually on maintenance visit.

NOTE: All data management decisions were based on Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Site Selection, Field Operation, Calibration, Record Computation, and Reporting. U.S Geological Survey. Water-Resources Investigations Report 00-4252.

Excluding:
-cross-section measurement and adjustments p. 17 and 22.

Also, modification to following two tables:

-Table 8. Data Rejection Criteria. Maximum allowable limits for continuous water-quality monitoring sensors. [+/-, plus or minus value shown; °C, degree Celsius; mg/L, milligram per litre; pH unit, standard pH unit]

Measured physical property	Maximum allowable limits for water-quality Sensor values
Temperature	+/- 2.0 °C
Specific conductance	+/- 30 percent
Dissolved oxygen	The greater of +/- 2.0 mg/L or 20 percent
pH	+/- 2 pH units
Turbidity	The greater of +/-15 NTUs or 30 percent

Table 9. Data Quality Rating. Rating continuous water-quality records

[≤ , less than or equal to; +/-, plus or minus value shown; °C, degree Celsius; >, greater than; %, percent; mg/L, milligram per litre; pH unit, standard pH unit]

Measured physical property	Excellent	Good	Fair	Poor
Water temperature	≤ +/- 0.20 °C	> +/- 0.2 to 0.5 °C	> +/- 0.5 to 0.8 °C	> +/- 0.8 °C
Specific conductance	The greater of ≤ +/- 3% or ≤ +/- 5 uS/cm	The greater of > +/- 3 to 10 % or > +/- 5 to 15 uS/cm	The greater of > +/- 10 to 15 % or > +/- 15 to 25 uS/cm	The greater of > +/- 15 % or 25 uS/cm
Dissolved oxygen	≤ +/- 0.3 mg/L	> +/- 0.3 to 0.5 mg/L	> +/- 0.5 to 0.8 mg/L	> +/- 0.8 mg/L
pH	≤ +/- 0.2 units	> +/- 0.2 to 0.5 units	> +/- 0.5 to 0.8 units	> +/- 0.8 units
Turbidity	The greater of ≤ +/- 5% or ≤ +/- 2 NTUs	The greater of > +/- 5 to 10% or > +/- 2 to 5 NTUs	The greater of > +/- 10 to 15% or > +/- 5 to 8 NTUs	The greater of > +/- 15% or > +/- 8 NTUs

Nova Scotia Environment and Labour
Automated Water Quality Monitoring Network

DATA QUALITY ANALYSIS

WATER QUALITY PARAMETERS

Temperature, pH, Conductivity, Dissolved Oxygen and Turbidity

Record Period: December 8, 2005 to September 27, 2007

KELLEY RIVER, CUMBERLAND COUNTY, NOVA SCOTIA

Equipment: Sutron Data logger and Hydrolab Water Quality Sonde located in a five inch diameter perforated PVC pipe insitu to the river via shore line deployment method.

Published records: Hourly water quality measurements

Primary Records: Covering the period December 8, 2005 to September 27, 2007.

Channel Characteristics:

Both banks are low, rocky with vegetation and grasses right to water's edge. The stream bottom is composed of gravels and boulders and some ledge rock. The approach and departure of flows is general straight and fast except for gauge pool. Flow is natural.

Calibration:

During the ice-free season data from the seasoned Hydrolab unit is verified by a freshly calibrated portable Quanta P hand held water quality meter prior to unit being removed. Also a grab sample is taken for backup QAQC purposes. The calibration of the replacement Hydrolab unit was preformed at NSEL office prior to field trip using calibration standards. The dates of removal of seasoned Hydrolab and installation of freshly calibrated Hydrolab were:

December 8, 2005
May 18, 2006
July 27, 2006
August 24, 2006
October 12, 2006
December 12, 2006
September 27, 2007

Field Verifications:

Data from the Hydrolab were verified in the field during the 2005, 2006 and 2007 season using a freshly calibrated portable Quanta P hand held water quality meter. The backup QAQC grab samples were analysed for pH, Conductivity and Turbidity. Data verification was performed on the seasoned Hydrolab on removal and the freshly calibrated Hydrolab that was installed.

Data Rating:

Period from	Period to	Temperature	pH	Conductivity	DO	Turbidity
12/08/2005	05/18/2006	Excellent	Good	Good	Fair	Excellent
05/18/2006	07/27/2006	Excellent	Good	Excellent	Poor	Poor
07/27/2006	08/24/2007	Excellent	Fair	Excellent	Fair	Excellent
08/24/2006	10/12/2006	Excellent	Excellent	Excellent	Excellent	Good
10/12/2006	12/12/2006	Excellent	Excellent	Excellent	Excellent	Fair
12/12/2006	04/07/2007	Excellent	Excellent	Good	Fair	Excellent

Data Correction:

Data correction was made to collected data by comparing the freshly calibrated portable Quanta P water quality meter measurements for Temperature, Conductivity, pH and DO. The backup QAQC grab sample lab results for Turbidity were used periodically for data correction due to Quanta P Turbidity sensor issues. The field verification and Hydrolab recorded values were compared using the Criteria for Water Quality Data Shifts table. Shifts were made to the recorded data as required.

Note: Data from December 12, 2006 to April 7, 2007 was adjusted and rated based on one point verification on December 12, 2006.

Missing Data:

Periods of missing data for all parameters due to sonde and/or data logger malfunctions:

From	To
2007-01-11 03:00	2007-01-11 23:00
2007-02-17 00:00	2007-02-17 08:00
2007-03-08 03:00	2007-03-20 13:00
2007-04-07 19:00	2007-09-13 13:00

Data Rejected:

Dissolved Oxygen:

From	To	Comment
2006-12-03 06:00	2006-12-12 10:00	Data Rejected: outside Maximum Allowable Limits for Dissolved Oxygen (the greater of +/-2.0 mg/L or 20 percent of readings)
2007-02-17 00:00	2007-02-17 08:00	Data Rejected: anomalous data

Turbidity:

From	To	Comment
2006-05-17 14:00	2006-05-18 12:00	Data Rejected: outside Maximum Allowable Limits for Turbidity (the greater of +/-15 NTU's or 30 percent of readings)
2006-07-28 21:00	2006-08-24 11:00	Data Rejected: outside Maximum Allowable Limits for Turbidity (the greater of +/-15 NTU's or 30 percent of readings)
2006-08-26 04:00	2006-10-12 08:00	Data Rejected: outside Maximum Allowable Limits for Turbidity (the greater of +/-15 NTU's or 30 percent of readings)
2006-07-20 05:00	2006-07-20 12:00	Data Rejected: anomalous data

Nova Scotia Environment
Automated Water Quality Monitoring Network

DATA QUALITY ANALYSIS

WATER QUALITY PARAMETERS

Temperature, pH, Conductivity, Dissolved Oxygen and Turbidity

Record Period: October 10, 2007 to October 29, 2008

KELLEY RIVER, CUMBERLAND COUNTY, NOVA SCOTIA

Equipment: Sutron Data logger and Hydrolab Water Quality Sonde located in a four inch diameter slotted stainless steel pipe insitu to the river via shore line deployment method.

Published records: Hourly water quality measurements.

Primary Records: Covering the period October 10, 2007 to October 29, 2008.

Channel Characteristics:

Both banks are low, rocky with vegetation and grasses right to water's edge. The stream bottom is composed of gravels and boulders and some ledge rock. The approach and departure of flows is general straight and fast except for gauge pool. Flow is natural.

Calibration:

During the ice-free season data from the seasoned Hydrolab unit is verified by a freshly calibrated portable Hydrolab MS5 hand held water quality meter prior to unit being removed. Also a grab sample is taken for backup QAQC purposes. The calibration of the replacement Hydrolab unit was preformed at NSE office prior to field trip using calibration standards. The dates of removal of seasoned Hydrolab and installation of freshly calibrated Hydrolab were:

October 10, 2007
May 1, 2008
June 11, 2008
August 28, 2008
October 29, 2008

Field Verifications:

Data from the Hydrolab were verified in the field during the 2007 and 2008 season using a freshly calibrated portable Hydrolab MS5 hand held water quality meter. The backup QAQC grab samples were analysed for pH, Conductivity and Turbidity. Data verification was performed on the seasoned Hydrolab on removal and the freshly calibrated Hydrolab that was installed.

Data Rating:

Period from (mm/dd/yyyy)	Period to (mm/dd/yyyy)	Temperature	pH	Conductivity	DO	Turbidity
10/10/2007	05/01/2008	Excellent	Good	Excellent	Excellent	Excellent
05/01/2008	06/11/2008	Excellent	Good	Excellent	Excellent	Rejected
06/11/2008	08/28/2008	Excellent	Good	Excellent	Poor	Excellent
08/28/2008	10/29/2008	Excellent	Good	Excellent	Good	Excellent

Data Correction:

Data correction was made to collected data by comparing the freshly calibrated portable Hydrolab MS5 water quality meter measurements for Temperature, Conductivity, pH and DO. The field verification and Hydrolab recorded values were compared using the Criteria for Water Quality Data Shifts table. Shifts were made to the recorded data as required.

Missing Data:

Interruptions in record are due to malfunction of the recording instrument or sensors.

Nova Scotia Environment
Automated Water Quality Monitoring Network

MONITORING STATION DESCRIPTION

St. Mary's River

Record Period: December 6, 2007 to April 24, 2008

LOCATION: Latitude 45^0 10' 24" N Longitude 61^0 58' 54" W

GROSS DRAINAGE AREA: 1350 km^2

HYDROMETRIC RECORD LENGTH: 93 years

HYDROMETRIC PEROID OF RECORD: 1915 – PRESENT

Hydrometric measurement

Period of record	Type	Operation schedule	Gauge type
1915 - 1955 1956 - 2008	Flow Flow	Continuous Continuous	Manual Recorder

HYDROMETRIC REAL-TIME DATA AVAILABLE: YES

WATER QUALITY RECORD LENGTH: 2 YEARS

WATER QUALITY PEROID OF RECORD: 2007 to present

Water Quality measurement

Period of record	Water Quality Parameters	Operation schedule	Gauge type
2007 to present	Temperature, Turbidity, pH, Dissolved Oxygen and Specific Conductance	Continuous	Recorder

WATER QUALITY REAL-TIME DATA AVAILABLE: NO

Water Quality monitoring equipment is located in a five inch perforated white PVC pipe insitu to river via shore deployment method. The location has not changed since installation in 2007. Water Quality data is recorded hourly and stored by Environment Canada Sutron Logger. The data is downloaded manually on maintenance visit.

NOTE: All data management decisions were based on Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Site Selection, Field Operation, Calibration, Record Computation, and Reporting. U.S Geological Survey. Water-Resources Investigations Report 00-4252.

Excluding:
-cross-section measurement and adjustments p. 17 and 22.

Also, modification to following two tables:

-Table 8. Data Rejection Criteria. Maximum allowable limits for continuous water-quality monitoring sensors. [+/-, plus or minus value shown; °C, degree Celsius; mg/L, milligram per litre; pH unit, standard pH unit]

Measured physical property	Maximum allowable limits for water-quality Sensor values
Temperature	+/- 2.0 °C
Specific conductance	+/- 30 percent
Dissolved oxygen	The greater of +/- 2.0 mg/L or 20 percent
pH	+/- 2 pH units
Turbidity	The greater of +/-15 NTUs or 30 percent

Table 9. Data Quality Rating. Rating continuous water-quality records

[≤ , less than or equal to; +/-, plus or minus value shown; °C, degree Celsius; >, greater than; %, percent; mg/L, milligram per litre; pH unit, standard pH unit]

Measured physical property	Excellent	Good	Fair	Poor
Water temperature	≤ +/- 0.20 °C	> +/- 0.2 to 0.5 °C	> +/- 0.5 to 0.8 °C	> +/- 0.8 °C
Specific conductance	The greater of ≤ +/- 3% or ≤ +/- 5 uS/cm	The greater of > +/- 3 to 10 % or > +/- 5 to 15 uS/cm	The greater of > +/- 10 to 15 % or > +/- 15 to 25 uS/cm	The greater of > +/- 15 % or 25 uS/cm
Dissolved oxygen	≤ +/- 0.3 mg/L	> +/- 0.3 to 0.5 mg/L	> +/- 0.5 to 0.8 mg/L	> +/- 0.8 mg/L
pH	≤ +/- 0.2 units	> +/- 0.2 to 0.5 units	> +/- 0.5 to 0.8 units	> +/- 0.8 units
Turbidity	The greater of ≤ +/- 5% or ≤ +/- 2 NTUs	The greater of > +/- 5 to 10% or > +/- 2 to 5 NTUs	The greater of > +/- 10 to 15% or > +/- 5 to 8 NTUs	The greater of > +/- 15% or > +/- 8 NTUs

Nova Scotia Environment
Automated Water Quality Monitoring Network

MONITORING STATION DESCRIPTION

St. Mary's River

Record Period: May 5, 2007 to December 6, 2007

LOCATION: Latitude 45^0 10' 24" N Longitude 61^0 58' 54" W

GROSS DRAINAGE AREA: 1350 km^2

HYDROMETRIC RECORD LENGTH: 92 years

HYDROMETRIC PEROID OF RECORD: 1915 – PRESENT

Hydrometric measurement

Period of record	Type	Operation schedule	Gauge type
1915 - 1955 1956 - 2007	Flow Flow	Continuous Continuous	Manual Recorder

HYDROMETRIC REAL-TIME DATA AVAILABLE: YES

WATER QUALITY RECORD LENGTH: 1 YEARS

WATER QUALITY PEROID OF RECORD: 2007

Water Quality measurement

Period of record	Water Quality Parameters	Operation schedule	Gauge type
2007	Temperature, Turbidity, pH, Dissolved Oxygen and Specific Conductance	Continuous	Recorder

WATER QUALITY REAL-TIME DATA AVAILABLE: NO

Water Quality monitoring equipment is located in a five inch perforated white PVC pipe insitu to river via shore deployment method. The location has not changed since installation in 2007. Water Quality data is recorded hourly and stored by Environment Canada Sutron Logger. The data is downloaded manually on maintenance visit.

NOTE: All data management decisions were based on Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Site Selection, Field Operation, Calibration, Record Computation, and Reporting. U.S Geological Survey. Water-Resources Investigations Report 00-4252.

Excluding:
-cross-section measurement and adjustments p. 17 and 22.

Also, modification to following two tables:

-Table 8. Data Rejection Criteria. Maximum allowable limits for continuous water-quality monitoring sensors. [+/-, plus or minus value shown; °C, degree Celsius; mg/L, milligram per litre; pH unit, standard pH unit]

Measured physical property	Maximum allowable limits for water-quality Sensor values
Temperature	+/- 2.0 °C
Specific conductance	+/- 30 percent
Dissolved oxygen	The greater of +/- 2.0 mg/L or 20 percent
pH	+/- 2 pH units
Turbidity	The greater of +/-15 NTUs or 30 percent

Table 9. Data Quality Rating. Rating continuous water-quality records

[≤ , less than or equal to; +/-, plus or minus value shown; °C, degree Celsius; >, greater than; %, percent; mg/L, milligram per litre; pH unit, standard pH unit]

Measured physical property	Excellent	Good	Fair	Poor
Water temperature	≤ +/- 0.20 °C	> +/- 0.2 to 0.5 °C	> +/- 0.5 to 0.8 °C	> +/- 0.8 °C
Specific conductance	The greater of ≤ +/- 3% or ≤ +/- 5 uS/cm	The greater of > +/- 3 to 10 % or > +/- 5 to 15 uS/cm	The greater of > +/- 10 to 15 % or > +/- 15 to 25 uS/cm	The greater of > +/- 15 % or 25 uS/cm
Dissolved oxygen	≤ +/- 0.3 mg/L	> +/- 0.3 to 0.5 mg/L	> +/- 0.5 to 0.8 mg/L	> +/- 0.8 mg/L
pH	≤ +/- 0.2 units	> +/- 0.2 to 0.5 units	> +/- 0.5 to 0.8 units	> +/- 0.8 units
Turbidity	The greater of ≤ +/- 5% or ≤ +/- 2 NTUs	The greater of > +/- 5 to 10% or > +/- 2 to 5 NTUs	The greater of > +/- 10 to 15% or > +/- 5 to 8 NTUs	The greater of > +/- 15% or > +/- 8 NTUs

Nova Scotia Environment
Automated Water Quality Monitoring Network

DATA QUALITY ANALYSIS

WATER QUALITY PARAMETERS

Temperature, pH, Conductivity, Dissolved Oxygen and Turbidity

Record Period: May 10, 2007 to December 6, 2007

ST. MARY'S RIVER, GUYSBOROUGH COUNTY, NOVA SCOTIA

Equipment: VEDAS Data logger and Hydrolab Water Quality Sonde located in a five inch diameter perforated PVC pipe insitu to the river via shore line deployment method.

Published records: Hourly water quality measurements.

Primary Records: Covering the period May 10, 2007 to December 6, 2007.
.

Channel Characteristics:

Channel above station is not straight. It has a stream entering the main river 300 meters up stream of the station. The channel below station is straight for 400m. Flow to the station and away from it is slow and shallow. River banks are steep and rocky. Stream bed is mud, gravel and boulders.

Calibration:

During the ice-free season data from the seasoned Hydrolab unit is verified by a freshly calibrated portable Quanta P hand held water quality meter prior to unit being removed. Also a grab sample is taken for backup QAQC purposes. The calibration of the replacement Hydrolab unit was preformed at NSEL office prior to field trip using calibration standards. The dates of removal of seasoned Hydrolab and installation of freshly calibrated Hydrolab were:

May 10, 2007
July 11, 2007
November 1, 2007
December 6, 2007

Field Verifications:

Data from the Hydrolab were verified in the field during the 2007 season using a freshly calibrated portable Quanta P hand held water quality meter. The backup QAQC grab samples were analysed for pH, Conductivity and Turbidity. Data verification was performed on the seasoned Hydrolab on removal and the freshly calibrated Hydrolab that was installed.

Data Rating:

Period from	Period to	Temperature	pH	Conductivity	DO	Turbidity
05/10/2007	07/11/2007	Excellent	Fair	Excellent	Excellent	Excellent
07/11/2007	11/01/2007	Excellent	Fair	Good	Poor	Excellent
11/01/2007	12/06/2007	Excellent	Good	Good	Poor	Excellent

Data Correction:

Data correction was made to collected data by comparing the freshly calibrated portable Quanta P water quality meter measurements for Temperature, Conductivity, pH and DO. The backup QAQC grab sample lab results for Turbidity were used periodically for data correction due to Quanta P Turbidity sensor issues. The field verification and Hydrolab recorded values were compared using the Criteria for Water Quality Data Shifts table. Shifts were made to the recorded data as required.

Missing Data:

Periods of missing data for all parameters due to sonde and/or data logger malfunctions:

From	To
2007-06-28 09:05	2007-07-11 12:05
2007-08-05 02:05	2007-08-17 07:05

Data Rejected:

Dissolved Oxygen:

From	To	Comment
2007-08-17 08:05	2007-11-01 12:05	Data Rejected: Outside Maximum Allowable Limits for DO (+/- 2 mg/L)

Turbidity:

From	To	Comment
2007-06-07 17:05	2007-06-28 08:05	Data Rejected: anomalous data
2007-08-17 08:05	2007-11-01 12:05	Data Rejected: outside Maximum Allowable Limits for Turbidity (the greater of +/-15 NTU's or 30 percent of readings)

pH:

From	To	Comment
2007-08-19 15:05	2007-11-01 12:05	Data Rejected: outside Maximum Allowable Limits for pH (2 units).

Nova Scotia Environment
Automated Water Quality Monitoring Network

DATA QUALITY ANALYSIS

WATER QUALITY PARAMETERS

Temperature, pH, Conductivity, Dissolved Oxygen and Turbidity

Record Period: December 6, 2007 to April 24, 2008

ST. MARY'S RIVER, GUYSBOROUGH COUNTY, NOVA SCOTIA

Equipment: VEDAS Data logger and Hydrolab Water Quality Sonde located in a five inch diameter perforated PVC pipe insitu to the river via shore line deployment method.

Published records: Hourly water quality measurements.

Primary Records: Covering the period December 6, 2007 to April 24, 2008.
.

Channel Characteristics:

Channel above station is not straight. It has a stream entering the main river 300 meters up stream of the station. The channel below station is straight for 400m. Flow to the station and away from it is slow and shallow. River banks are steep and rocky. Stream bed is mud, gravel and boulders.

Calibration:

During the ice-free season data from the seasoned Hydrolab unit is verified by a freshly calibrated portable Hydrolab MS5 hand held water quality meter prior to unit being removed. Also a grab sample is taken for backup QAQC purposes. The calibration of the replacement Hydrolab unit was preformed at NSEL office prior to field trip using calibration standards. The dates of removal of seasoned Hydrolab and installation of freshly calibrated Hydrolab were:

December 6, 2007
April 24, 2008

Field Verifications:

Data from the Hydrolab were verified in the field during the 2007/2008 season using a freshly calibrated portable Hydrolab MS5 hand held water quality meter. The backup QAQC grab samples were analysed for pH, Conductivity and Turbidity. Data verification was performed on the seasoned Hydrolab on removal and the freshly calibrated Hydrolab that was installed.

Data Rating:

Period from (mm/dd/yyyy)	Period to (mm/dd/yyyy)	Temperature	pH	Conductivity	DO	Turbidity
12/06/2007	04/24/2008	Excellent	Excellent	Good	Good	Excellent

Data Correction:

Data correction was made to collected data by comparing the freshly calibrated portable Hydrolab MS5 water quality meter measurements for Temperature, Conductivity, pH and DO. The field verification and Hydrolab recorded values were compared using the Criteria for Water Quality Data Shifts table. Shifts were made to the recorded data as required.

Missing Data:

Interruptions in record are due to malfunction of the recording instrument or sensors.

Nova Scotia Environment
Automated Water Quality Monitoring Network

MONITORING STATION DESCRIPTION

Lahave River

Record Period: October 30, 2008 to November 26, 2008

LOCATION: Latitude 44^0 26' 5010" N Longitude 64^0 35' 28" W

GROSS DRAINAGE AREA: 1250 km^2

HYDROMETRIC RECORD LENGTH: 93 years

HYDROMETRIC PEROID OF RECORD: 1915 – 2008

Hydrometric measurement

Period of record	Type	Operation schedule	Gauge type
1915 - present	Flow	Continuous	Recorder

HYDROMETRIC REAL-TIME DATA AVAILABLE: YES

WATER QUALITY RECORD LENGTH: 1 YEAR

WATER QUALITY PEROID OF RECORD: 2008

Water Quality measurement

Period of record	Water Quality Parameters	Operation schedule	Gauge type
2008	Temperature, Turbidity, pH, Dissolved Oxygen and Specific Conductance	Continuous	Recorder

WATER QUALITY REAL-TIME DATA AVAILABLE: NO

Water Quality monitoring equipment is located in a four five inch perforated white PVC pipe insitu to river via shore deployment method. The location has not changed since installation in 2008. Water Quality data is recorded hourly and stored by Environment Canada Sutron Logger. The data is downloaded manually on maintenance visit.

NOTE: All data management decisions were based on Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Site Selection, Field Operation, Calibration, Record Computation, and Reporting. U.S Geological Survey. Water-Resources Investigations Report 00-4252.

Excluding:
-cross-section measurement and adjustments p. 17 and 22.

Also, modification to following two tables:

-Table 8. Data Rejection Criteria. Maximum allowable limits for continuous water-quality monitoring sensors. [+/-, plus or minus value shown; ^{o}C, degree Celsius; mg/L, milligram per litre; pH unit, standard pH unit]

Measured physical property	Maximum allowable limits for water-quality Sensor values
Temperature	+/- 2.0 ^{o}C
Specific conductance	+/- 30 percent
Dissolved oxygen	The greater of +/- 2.0 mg/L or 20 percent
pH	+/- 2 pH units
Turbidity	The greater of +/-15 NTUs or 30 percent

Table 9. Data Quality Rating. Rating continuous water-quality records

[≤ , less than or equal to; +/-, plus or minus value shown; °C, degree Celsius; >, greater than; %, percent; mg/L, milligram per litre; pH unit, standard pH unit]

Measured physical property	Excellent	Good	Fair	Poor
Water temperature	≤ +/- 0.20 °C	> +/- 0.2 to 0.5 °C	> +/- 0.5 to 0.8 °C	> +/- 0.8 °C
Specific conductance	The greater of ≤ +/- 3% or ≤ +/- 5 uS/cm	The greater of > +/- 3 to 10 % or > +/- 5 to 15 uS/cm	The greater of > +/- 10 to 15 % or > +/- 15 to 25 uS/cm	The greater of > +/- 15 % or 25 uS/cm
Dissolved oxygen	≤ +/- 0.3 mg/L	> +/- 0.3 to 0.5 mg/L	> +/- 0.5 to 0.8 mg/L	> +/- 0.8 mg/L
pH	≤ +/- 0.2 units	> +/- 0.2 to 0.5 units	> +/- 0.5 to 0.8 units	> +/- 0.8 units
Turbidity	The greater of ≤ +/- 5% or ≤ +/- 2 NTUs	The greater of > +/- 5 to 10% or > +/- 2 to 5 NTUs	The greater of > +/- 10 to 15% or > +/- 5 to 8 NTUs	The greater of > +/- 15% or > +/- 8 NTUs

Nova Scotia Environment
Automated Water Quality Monitoring Network

DATA QUALITY ANALYSIS

WATER QUALITY PARAMETERS

Temperature, pH, Conductivity, Dissolved Oxygen and Turbidity

Record Period: October 30, 2008 to November 26, 2008

LAHAVE RIVER, LUNENBURG COUNTY, NOVA SCOTIA

Equipment: Sutron Data logger and Hydrolab Water Quality Sonde located in a four inch diameter perforated PVC pipe insitu to the river via shore line deployment method.

Published records: Hourly water quality measurements.

Primary Records: Covering the period October 30, 2008 to November 26, 2008.

Channel Characteristics:

Both banks are low, with vegetation and grasses right to water's edge. The stream bottom is composed of gravels and boulders and some ledge rock. The approach and departure of flows is general straight and smooth. Flow is natural.

Calibration:

During the ice-free season data from the seasoned Hydrolab unit is verified by a freshly calibrated portable Hydrolab MS5 hand held water quality meter prior to unit being removed. Also a grab sample is taken for backup QAQC purposes. The calibration of the replacement Hydrolab unit was preformed at NSE office prior to field trip using calibration standards. The dates of removal of seasoned Hydrolab and installation of freshly calibrated Hydrolab were:

October 30, 2008
November 26, 2008

Field Verifications:

Data from the Hydrolab were verified in the field during the 2008 season using a freshly calibrated portable Hydrolab MS5 hand held water quality meter. The backup QAQC grab samples were analysed for pH, Conductivity and Turbidity. Data verification was performed on the seasoned Hydrolab on removal and the freshly calibrated Hydrolab that was installed.

Data Rating:

Period from (mm/dd/yyyy)	Period to (mm/dd/yyyy)	Temperature	pH	Conductivity	DO	Turbidity
10/30/2008	11/26/2008	Good	Excellent	Excellent	Rejected	Excellent

Data Correction:

Data correction was made to collected data by comparing the freshly calibrated portable Hydrolab MS5 water quality meter measurements for Temperature, Conductivity, pH and DO. The field verification and Hydrolab recorded values were compared using the Criteria for Water Quality Data Shifts table. Shifts were made to the recorded data as required.

Missing Data:

Interruptions in record are due to malfunction of the recording instrument or sensors.

APPENDIX II – EQUIPMENT, DEPLOYMENT, MAINTENANCE, AND CHEMICAL STANDARD SOLUTIONS

EQUIPMENT

Data sondes used in the water quality monitoring network were manufactured by Hydrolab® and purchased through Campbell Scientific Ltd. from which instrument specifications are available. The following contact information is provided:

Campbell Scientific Canada Corp.
11564 - 149 Street NW
Edmonton, AB
Canada T5M 1W7
Phone 780-454-2505
Fax 780-454-2655

General E-Mail dataloggers@campbellsci.ca
Web Site http://www.campbellsci.ca

DEPLOYMENT AND MAINTENANCE

Deployment and maintenance documentation was provided by Mr. Dave Allan, Water Quality Specialist, Campbell Scientific Ltd.

II.1 REMOTE AND REAL-TIME DEPLOYMENT

Shore Deployments

Figures 1 and 2 illustrate the structure and configuration presently used to deploy either real time or remote water quality instruments from shore. Many sites in southern Alberta and British Columbia use this type of deployment due to limited access and variable water level. The Datasonde or Minisonde is placed in the downstream end of a 3 to 6 meter length of 10 cm PVC pipe that has 1.5-meter of one end slotted. This pipe is oriented downstream such that water is able to pass through the slotted end and past the

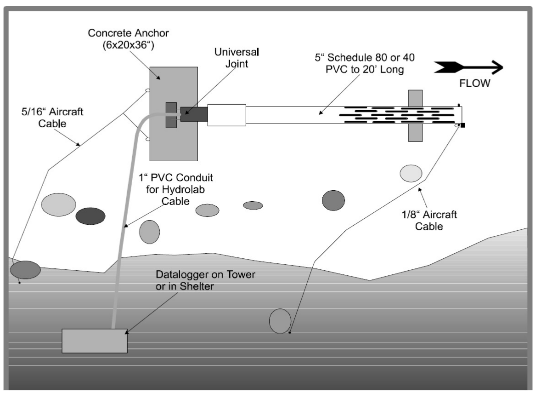

Figure 1

sensors. The pipe is connected by a heavy duty coupling to a universal joint that allows the pipe to swivel in any direction. This allows the field crew to easily raise and turn the pipe towards shore for inspection and to change instruments.

The pipe and universal joint are bolted directly to a large concrete anchor weighing approximately 70 kg. If high flows are expected any number of additional anchors can be attached along with a heavy aircraft cable to shore. This cable will also facilitate the removal of the structure at the end of the season. A length of light aircraft cable is attached at the downstream end of the pipe and runs to shore to aid the field crew in the pipe retrieval. This cable is locked to a large pin that passes through the end of the pipe and prevents the unauthorized removal of the instrument. A concrete curb or rock is placed on the bottom under the slotted end

Figure 2

of the pipe to hold the pipe above the river bottom substrate and prevent it from becoming clogged with silt. The greatest advantage with this structure is its entirely submerged and any floating material passes over it without incident.

A second method used on small streams, shown in Figures 3 and 4, is to attach the slotted pipe to a 2x12 pressure treated board, which is then bolted to stakes driven into the bank. The pipe and 2x12 are angled down into the water at about 45° and the Datasonde or Minisonde is loaded in from the top and slides down the pipe into place at the slotted end. The cables run up the pipe and into conduit at the top and then to the shelter housing the datalogger. The end cap is removable so that sand, silt and any build up of debris can be cleaned out.

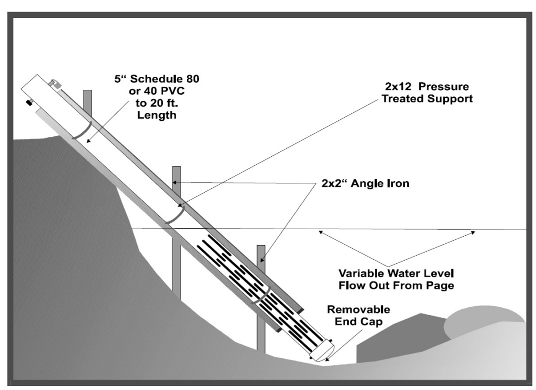

Figure 3

Figure 4

Bridge Deployment

The following figures (5 & 6) illustrate the deployment of a Hydrolab Datasonde or Minisonde from a bridge. The instrument is placed inside a PVC pipe 3 to 6 meters in length that has been slotted at one end. The slots allow water to freely pass through the pipe and past the sensors. The pipe is attached to the bridge pier with two heavy timbers (2x12 or larger) usually near the center of the river. The slotted end with removable cap is placed slightly above the river bottom but can be raised or lowered depending on the water level at the time.

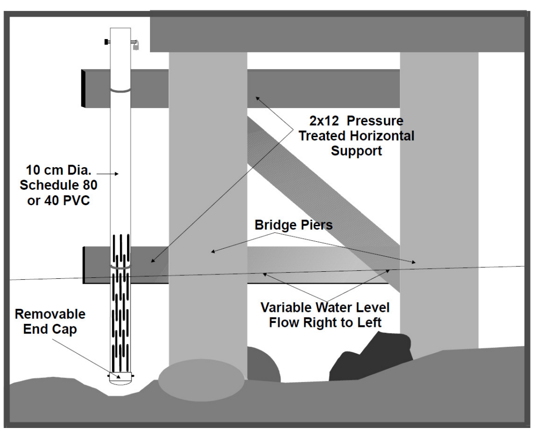

Figure 5

The pipe should be suspended behind the pier for protection as in Figure 6 or it may become snagged on floating debris. The advantage is mainly the ease of access. The following is a photo from the Salmon River in BC where this type of deployment is presently being used.

Methods of deployment can be complex but the theme is the same for all. The instrument must be protected, the information must represent the true conditions in the river and the field crews must be able to recover the instrument at any time with a minimum of effort. It is vital that field crews are skilled, trained and safety oriented. This is potentially dangerous work, with many hazards.

Figure 6

II.2 GENERAL MAINTENANCE

Background

Although individual Datasonde 4a's (DS4a) or Minisondes4a (MS4a) can be configured in a multitude of ways, the sonde itself will need to be cleaned and serviced on occasion. Great care needs to taken here, in that any damage to the sonde, housing or O-ring seals will have a catastrophic effect on the entire unit. It is preferable, and in some cases you will be required, to maintain a log of all the repairs, maintenance and calibration that is done on each unit. This log can take any form that is convenient to you but should include the unit serial number, date, who serviced the equipment and what was done.

Figure 7

Equipment

- DS or MS4a calibration cup.
- Distilled water, methanol, cotton swabs and silicone grease.
- Table clamp or lab chain clamp to hold the sonde inverted and vertical.
- Hydrolab's Basic Maintenance Kit for DS or MS4a including small Allen wrenches and Philips screwdriver.
- Duct tape (the wider the better).
- Scrub pads and cleanser (lab grade Sparkleen works great).
- Soft bristle scrub brush or old toothbrush.

Maintenance

The sonde, circulator and individual probes should be maintained on a regular basis (at least monthly during daily use) or prior to and after any long-term deployment.

1. If the sonde is covered with sediment, algae and other biological growth when it is recovered, try to clean as much off right away so it doesn't bake on while it is in the back of your truck.

2. After returning to your lab remove the duct tape (if you have used it to help keep the sonde clean) and with the scrub pads and Sparkleen get all the caked on sediment algae and other material off as best you can. You may need to let the whole thing soak in a sink of warm water and Sparkleen overnight to soften the gunk up and try scrubbing again the next day.

3. Use the toothbrush or other small nylon brush to gently remove sediment, algae, bugs, and any other debris around the sensors. It is important not to use soaps or solvents if any of the ion sensors are installed (NH4 , Chloride & Nitrate).

4. On DS & MS4a's, remove the circulator's impeller and clean and remove any debris that may be wrapped around it. In some areas pyrite or other iron based materials can accumulate around the magnet of the circulator and in time can interfere with it's function and even cause premature wearing of the surfaces.

5. On H20's & DS3's, remove the circulator's impeller and clean and remove any debris that may be wrapped around it. Put a very small amount of silicone grease on the impeller post.

6. Every other year or so the O-rings and internal memory battery in the sonde need to be checked. Great care is needed to open the sonde and if you are unsure check with Campbell Scientific (Canada) Corp. for assistance.

7. Check the pair of O-rings for any wear spots, tears or deterioration and replace as required. Thoroughly clean both the bulkhead and the inside of the tube and lightly grease the O rings with silicone.

8. Check the internal lithium battery in the DS or MS4a to ensure it is still at or above 3 volts DC. If not, replace the battery. With DS3's the lithium battery is soldered to the CPU board and may need to be returned to CSCC for replacement. H20's and DS3's could have a pair of 3-volt lithium batteries installed to power the Dissolved Oxygen probe. Check to ensure they are still above 2.75 volts and replace if required. Replace the desiccant packets and carefully put the sonde back together.

9. With the sonde back together and the set screws in place tape the outside of the sonde at the O rings with the wide duct tape to help to keep sediment and debris out of there. If the sonde is to be out for long periods (especially in warm productive water) you can duct tape the whole thing to make cleaning easier next time (don't tape the storage cup).

Cautions & Problems

Maintenance of the sonde and probes should become second nature. In other words too much maintenance is better than not enough. The amount or frequency of maintenance is directly related to the overall quality of data you will collect. On long term deployments if you are only able to get to the site to service the unit every
6 weeks, you may have to be satisfied with broader data acceptance criteria, especially towards the end of the deployment period. If you visit the site every other week you can expect to have the best data possible.

If the sample site has been chosen well, maintenance problems could be minimized but will not likely be eliminated. When choosing a site, especially for long term deployment look for sufficient flow without turbulence, depth without direct sunlight.

Under certain conditions it may be advisable to make a mesh screen to protect the sensors from debris, slush, macrophytes, algae, bubbles and even sunlight. Screens as in the figure below can be easily made from Nitex mesh, window screening, shade cloth or any available mesh material that will let water pass through but help to keep the other junk out.

Figure 8

II.3 CHEMICAL STANDARD SOLUTIONS

As mentioned in an earlier section, Hydrolab and Quanta P sensors are routinely calibrated to guarantee the best possible the accuracy of data being gathered. pH, conductivity and turbidity sensors are calibrated using commercially manufactured liquid calibration standards as specified below.

pH – HACH buffer solutions pH 7.00 (Cat.# 22835-56) and 4.01 (Cat.# 22834-56) available from Atlantic Purification Systems Ltd., Dartmouth, Nova Scotia.

Conductivity – Ricca Chemical Company Conductivity/TDS standards - 100 umhos/cm (Cat.# 2237-1) and 500 umhos/cm (Cat.# 2241-1).

Turbidity – AMCO Clear Turbidity standards 50NTU (HACH Cat.# 013710HY) and 100
NTU (HACH Cat.# 013720HY) available from Campbell Scientific Limited.

Dissolved Oxygen – calibrated using air saturation method.

APPENDIX III – WATER QUALITY DATASET (FINAL VALIDATED)

III.1 REALTIME WATER QUALITY DATA

These data are available upon request by contacting the Water and Wastewater Branch, NSE. Phone (902) 424-2553

III.2 GRAB SAMPLE WATER QUALITY DATA

As part of its routine program, NSE collects grab samples for chemical analyses. These data represent that work.

Sample Station	Date Sampled	Alkalinity as CaCO3 mg/L	Aluminium ug/L	Ammonia mg/L	Antimony ug/L	Barium ug/L	Beryllium ug/L	Bicarbonate as CaCo3 mg/L	Boron ug/L	Cadmium ug/L	Calcium mg/L	Carbonate as CaCO3 mg/L	Chloride mg/l
Pockwock Lake	14-Jan-02	<1.0	146	0.01							1.1		6.8
Pockwock Lake	14-Jan-02	<1.0											
Pockwock Lake	13-Mar-02	<1.0	120	0.02	<2	5	<5		<5	<2	1.1		6.5
Pockwock Lake	06-May-02	<1.0	117	0.01							1.2		6.5
Pockwock Lake	18-Jun-02	<1.0											
Pockwock Lake	22-Jul-02	<1.0	100	<0.01							1.1		6.3
Pockwock Lake	30-Jul-02												
Pockwock Lake	01-Aug-02												
Pockwock Lake	09-Sep-02	<1.0	80	0.01							1.2		7
Pockwock Lake	29-Oct-02												
Pockwock Lake	30-Oct-02		90	0.01									
Pockwock Lake	30-Oct-02	<1.0											
Pockwock Lake	08-Nov-02												
Pockwock Lake	10-Dec-02	<1.0	120	<0.01							1.1		7
Pockwock Lake	10-Dec-02	<1.0											
Pockwock Lake	28-Jan-03	<1.0	120	<0.01							1.1		7
Pockwock Lake	26-Feb-03	<1.0	150	<0.01							1.2		7.5
Pockwock Lake	23-Apr-03	<1.0	140	<0.01							0.9		6
Pockwock Lake	21-May-03												
Pockwock Lake	21-May-03												
Pockwock Lake	03-Jun-03	1	156	<0.01	<2	6	<2	1	<5	<2	1.1	0	6.3
Pockwock Lake	15-Jul-03	<1.0	133	0.01							1.3		6.5
Pockwock Lake	17-Jul-03												
Pockwock Lake	17-Jul-03												
Pockwock Lake	12-Aug-03	<1.0	111	<0.01	<2		<2		6	<2	1.1		6.7
Pockwock Lake	08-Sep-03	<1.0	101	0.01							1.2		6.8
Pockwock Lake	20-Oct-03	<1.0	107	0.02	<2	5	<2		5	<2	1.2		6.9
Pockwock Lake	06-Nov-03												
Pockwock Lake	06-Nov-03												
Pockwock Lake	17-Nov-03	<1.0	121	0.01							1.2		7
Pockwock Lake	27-Apr-04												
Pockwock Lake	27-Apr-04												
Pockwock Lake	28-Jun-04												
Pockwock Lake	28-Jun-04												
Pockwock Lake	21-Jul-04	2.7	109	<0.01	<2	6	<2	2.7	<5	<2	1.3	0	6.8
Pockwock Lake	05-Oct-04	<1.0	90	0.02	<2	5	<2		<5	<2	1.2		7.5
Pockwock Lake	20-Oct-04												
Pockwock Lake	20-Oct-04												
Pockwock Lake	06-Dec-04												
Pockwock Lake	06-Dec-04												

Sample Station	Date Sampled	Chlorophyll A mg/m3	Chromium ug/L	Cobalt ug/L	Colour TCU	Conductivity umho/cm	Copper ug/L	Hardness as CaCo3 mg/L	Iron ug/L	Lead ug/L	Magnesium mg/L	Manganese ug/L	Nickel ug/L
Pockwock Lake	14-Jan-02	0.6			7.9	39	<2	4.8	70		0.5	55	
Pockwock Lake	14-Jan-02	0.6											
Pockwock Lake	13-Mar-02	0.4	<2	<1	8.2	38.1	<2	4.8	30	<2	0.5	57	<2
Pockwock Lake	06-May-02	0.5			10.5	39.6	<2	5.05	40		0.5	56	
Pockwock Lake	18-Jun-02	0.5											
Pockwock Lake	22-Jul-02	0.5			7.3	39.6	2	4.8	40		0.5	61	
Pockwock Lake	30-Jul-02					40.1							
Pockwock Lake	01-Aug-02					40.2							
Pockwock Lake	09-Sep-02	0.3			4.2	40	<2	5.05	<0.02		0.5	62	
Pockwock Lake	29-Oct-02					39.4							
Pockwock Lake	30-Oct-02	0.7											
Pockwock Lake	30-Oct-02	0.7											
Pockwock Lake	08-Nov-02					38.3							
Pockwock Lake	10-Dec-02	0.6			11.7	39.6	5	4.8	80		0.5	52	
Pockwock Lake	10-Dec-02	0.6											
Pockwock Lake	28-Jan-03	0.3			12	38.8	<2	4.39	30		0.4	47	
Pockwock Lake	26-Feb-03	0.6			12	39.5	13	5.05	100		0.5	57	
Pockwock Lake	23-Apr-03	0.5			11	35.9	<2		49		<0.5	46	
Pockwock Lake	21-May-03					37.7							
Pockwock Lake	21-May-03					38.2							
Pockwock Lake	03-Jun-03	0.7	<2	<2	15	38.2	<2		61	<2	<0.5	56	<2
Pockwock Lake	15-Jul-03	0.4			7.7	38.5	<2	5.3	29		0.5	64	
Pockwock Lake	17-Jul-03					37.7							
Pockwock Lake	17-Jul-03					38							
Pockwock Lake	12-Aug-03	0.7	<2	<2	8.7	36.6	<2		36	<2	<0.5	65	<2
Pockwock Lake	08-Sep-03	0.6			9.1	37	<2		25		<0.5	61	
Pockwock Lake	20-Oct-03	0.9	<2	<2	6.8	37.5	<2	5.1	33	<2	0.5	56	<2
Pockwock Lake	06-Nov-03					39.3							
Pockwock Lake	06-Nov-03					39.2							
Pockwock Lake	17-Nov-03	0.8			8.7	39.4	<2	5.1	38		0.5	53	
Pockwock Lake	27-Apr-04					39.1							
Pockwock Lake	27-Apr-04					39.1							
Pockwock Lake	28-Jun-04					40							
Pockwock Lake	28-Jun-04					40							
Pockwock Lake	21-Jul-04	0.7	<2	<2	9	41.6	<2	5.3	<20	<2	0.5	57	<2
Pockwock Lake	05-Oct-04	0.5	<2	<2	7.3	40.3	<2	5.1	30	<2	0.5	56	<2
Pockwock Lake	20-Oct-04					39.8							
Pockwock Lake	20-Oct-04					39.6							
Pockwock Lake	06-Dec-04					39.1							
Pockwock Lake	06-Dec-04					39.3							

Sample Station	Date Sampled	Nitrate+Nitrite mg/L	Ortho Phosphorus mg/L	pH	Potassium mg/L	Selenium ug/L	Silica mg/L	Sodium mg/L	Sulfate mg/L	Suspended Solids mg/L	Tin ug/L	Total Nitrogen mg/L
Pockwock Lake	14-Jan-02	0.04	<0.001	5.3	0.2		0.5	4.6	3.9	2		0.18
Pockwock Lake	14-Jan-02			5.3								
Pockwock Lake	13-Mar-02	0.04	<0.001	5.2	0.3	<2	1.6	4.5	4.2	<1.2	<2	0.14
Pockwock Lake	06-May-02	0.06	<0.001	5.2	0.2		1.2	4.2	4.4	<1.2		0.16
Pockwock Lake	18-Jun-02			5.2								
Pockwock Lake	22-Jul-02	0.04	<0.001	5.3	0.2		1.2	4.2	4			0.16
Pockwock Lake	30-Jul-02			5.4								
Pockwock Lake	01-Aug-02			5.4								
Pockwock Lake	09-Sep-02	0.02	<0.001	5.4	0.3		1.1	4.2	3.9	<1.5		0.13
Pockwock Lake	29-Oct-02			5.4								
Pockwock Lake	30-Oct-02	0.04	<0.001									0.12
Pockwock Lake	30-Oct-02			5.2								
Pockwock Lake	08-Nov-02			5.4								
Pockwock Lake	10-Dec-02	0.04	<0.001	5.3	0.3		1.4	4.1	5.5	<1.2		0.16
Pockwock Lake	10-Dec-02			5.1								
Pockwock Lake	28-Jan-03	<0.01	<0.001	5.4	0.3		1.7	4.1	4.1	<1.2		0.14
Pockwock Lake	26-Feb-03	<0.01	<0.001	5.5	0.2		1.6	3.9	5			0.14
Pockwock Lake	23-Apr-03	0.04	<0.001	5.3	<0.5		1.5	3.4	4.6	<1.0		0.19
Pockwock Lake	21-May-03			5.1								
Pockwock Lake	21-May-03			5.3								
Pockwock Lake	03-Jun-03	0.04	<0.001	5.5	<0.5	<2	1.5	3.9	4.7	<1.0	<2	0.16
Pockwock Lake	15-Jul-03	0.03	<0.001	5.4	<0.5		1.3	4.4	3.7	1.3		0.13
Pockwock Lake	17-Jul-03			5.3								
Pockwock Lake	17-Jul-03			5.3								
Pockwock Lake	12-Aug-03	0.02	<0.001	5.4	<0.5	<2	0.9	4.1	4.1	1.2	<2	0.18
Pockwock Lake	08-Sep-03	0.01	<0.001	5.4	<0.5		1.3	4.2	3.3	2.4		0.13
Pockwock Lake	20-Oct-03	0.02	<0.001	5.3	<0.5	<2	1.2	4.1	4.8	1.4	<2	0.13
Pockwock Lake	06-Nov-03			5.3								
Pockwock Lake	06-Nov-03			5.5								
Pockwock Lake	17-Nov-03	0.03	0.001	5.3	<0.5		1.5	4.2	4.8	<1.0		0.17
Pockwock Lake	27-Apr-04			5.1								
Pockwock Lake	27-Apr-04			5.1								
Pockwock Lake	28-Jun-04			5.3								
Pockwock Lake	28-Jun-04			5.3								
Pockwock Lake	21-Jul-04	0.03	<0.001	5.4	<0.5	<2	1.1	4.4	4	<0.6	<2	0.11
Pockwock Lake	05-Oct-04	0.02	<0.001	5.4	<0.5	<2	0.8	4.3	3.6	<0.6	<2	0.1
Pockwock Lake	20-Oct-04			5.4								
Pockwock Lake	20-Oct-04			5.4								
Pockwock Lake	06-Dec-04			5.2								
Pockwock Lake	06-Dec-04			5.3								

Sample Station	Date Sampled	Total Organic Carbon mg/L	Total Phosphorus mg/L	Turbidity NTU	Vanadium ug/L	Zinc ug/L
Pockwock Lake	14-Jan-02	1.9	0.006	1.7		4
Pockwock Lake	14-Jan-02		0.008			
Pockwock Lake	13-Mar-02	5.1	0.006	0.34	<2	4
Pockwock Lake	06-May-02	2.9	0.005	0.32		6
Pockwock Lake	18-Jun-02		0.01			
Pockwock Lake	22-Jul-02	2.4	0.003	0.84		9
Pockwock Lake	30-Jul-02			0.28		
Pockwock Lake	01-Aug-02					
Pockwock Lake	09-Sep-02	2.5	<0.001	0.24		7
Pockwock Lake	29-Oct-02			0.34		
Pockwock Lake	30-Oct-02		0.005			
Pockwock Lake	30-Oct-02		0.015			
Pockwock Lake	08-Nov-02					
Pockwock Lake	10-Dec-02	3	0.007	1.15		12
Pockwock Lake	10-Dec-02		0.012			
Pockwock Lake	28-Jan-03	2.7	0.003	0.42		6
Pockwock Lake	26-Feb-03	4.5	0.006	1.46		15
Pockwock Lake	23-Apr-03	3.7	0.002	0.32		1
Pockwock Lake	21-May-03			0.3		
Pockwock Lake	21-May-03			0.35		
Pockwock Lake	03-Jun-03	3.1	0.006	0.39	<2	6
Pockwock Lake	15-Jul-03	3.5	0.011	0.34		5
Pockwock Lake	17-Jul-03			0.34		
Pockwock Lake	17-Jul-03			0.34		
Pockwock Lake	12-Aug-03	3.3	0.01	0.35	<2	11
Pockwock Lake	08-Sep-03	2.8	0.017	0.31		9
Pockwock Lake	20-Oct-03	2.5	0.005	0.35	<2	5
Pockwock Lake	06-Nov-03			0.32		
Pockwock Lake	06-Nov-03			0.36		
Pockwock Lake	17-Nov-03	3.3	0.005	0.33		5
Pockwock Lake	27-Apr-04			0.41		
Pockwock Lake	27-Apr-04			0.33		
Pockwock Lake	28-Jun-04			0.27		
Pockwock Lake	28-Jun-04			0.29		
Pockwock Lake	21-Jul-04	3.3	0.019	0.29	<2	5
Pockwock Lake	05-Oct-04	2.5	0.012	0.35	<2	3
Pockwock Lake	20-Oct-04			0.24		
Pockwock Lake	20-Oct-04			0.25		
Pockwock Lake	06-Dec-04			0.32		
Pockwock Lake	06-Dec-04			0.3		

Sample Station	Date Sampled	Alkalinity as CaCO3 mg/L	Aluminium ug/L	Ammonia mg/L	Antimony ug/L	Barium ug/L	Beryllium ug/L	Bicarbonate as CaCo3 mg/L	Boron ug/L	Cadmium ug/L	Calcium mg/L	Carbonate as CaCO3 mg/L	Chloride mg/l
Pockwock Lake	05-Jan-05	<1.0	140	<0.01	<2	6	<2		<5	<2	1.4		7.6
Pockwock Lake	05-Jan-05	<1.0											
Pockwock Lake	05-Jan-05	<1.0											
Pockwock Lake	17-May-05	<1.0	167	0.02	<2	6	<2		<5	<2	1.4		6.9
Pockwock Lake	02-Aug-05	<1.0	138	0.01	<2	5	<2		<5	<2	1.1		6.8
Pockwock Lake	28-Sep-05	<1.0	103	0.02	<2	5	<2		<5	<2	1.1		6.4
Pockwock Lake	15-Nov-05	2.5	141	0.02	<2	5	<2	2.5	4	<2	1.2	0	6
Pockwock Lake	24-May-06	<1.0	155	0.01	<2	6	<2		<5	<2	1.2		6.2
Pockwock Lake	01-Aug-06	<1.0	167	0.01	<2	6	<2		<5	<2	1.3		6
Pockwock Lake	07-Nov-06	<1.0	115	0.01	<2	6	<2		<5	<2	1.2		6.2
Pockwock Lake	29-May-07	<3.0	158	<0.01	<2	6	<2		<5	<2	1.2		6.2
Pockwock Lake	01-Aug-07	<3.0	121	0.01	<2	5	<2		<5	<2	1.2		6.2
Pockwock Lake	18-Sep-07	<3.0	118	0.01	<2	5	<2		6	<2	1.2		6.2
Pockwock Lake	05-Nov-07	<3.0	116	0.01	<2	5	<2		<5	<1	1.1		6.6
Pockwock Lake	20-May-09	<1.0	150	0.01	<2	<5	<2		6	<1	1.1		7.1
Pockwock Lake	20-May-09	<1.0	150	0.01	<2	<5	<2		<5	<1	1.1		7.2
Pockwock Lake	20-May-09	<1.0											
Pockwock Lake	20-May-09	<1.0											
Pockwock Lake	15-Jul-09	<1.0	128	0.02							1.1		7.6
Shelburne River	12-Aug-02												
Shelburne River	27-Nov-02												
Shelburne River	28-Nov-02												
Shelburne River	10-Jul-03	<1	251	<0.01	<2	3	<2		<5	<2	<0.5		4.2
Shelburne River	10-Jul-03												
Shelburne River	29-Jul-03	<1	254	<0.01	<2	3	<2		<5	<2	<0.5		4
Shelburne River	29-Jul-03												
Shelburne River	28-Nov-03	<1	438	0.02	<2	4	<2		<5	<2	<0.5		5
Shelburne River	28-Nov-03												
Shelburne River	22-Jun-04	<1	256	0.01	<2	3	<2		<5	<2	<0.5		4.2
Shelburne River	06-Jul-04												
Shelburne River	29-Sep-04	<1	253	0.02	<2	3	<2		4	<2	<0.5		5
Shelburne River	29-Sep-04												
Shelburne River	09-Dec-04	<1	289	0.02	<2	3	<2		<5	<2	<0.5		4.6
Shelburne River	09-Dec-04	<1	293	0.02	<2	3	<2		<5	<2	<0.5		4.5
Shelburne River	27-Apr-05	<1	245	0.02	<2	3	<2		<5	<2	<0.5		3.9
Shelburne River	27-Apr-05												
Shelburne River	05-Jul-05	<1	277	0.03	<2	3	<2		<5	<2	<0.5		3.4
Shelburne River	05-Jul-05												
Shelburne River	03-Nov-05	<1	387	0.02	<2	4	<2		4	<2	<0.5		3.8

Sample Station	Date Sampled	Chlorophyll A mg/m3	Chromium ug/L	Cobalt ug/L	Colour TCU	Conductivity umho/cm	Copper ug/L	Hardness as CaCo3 mg/L	Iron ug/L	Lead ug/L	Magnesium mg/L	Manganese ug/L	Nickel ug/L
Pockwock Lake	05-Jan-05	0.6	<2	<2	9.6	42.8	<2	6	44	<2	0.6	60	<2
Pockwock Lake	05-Jan-05	<0.1											
Pockwock Lake	05-Jan-05	0.6											
Pockwock Lake	17-May-05	0.6	<2	<2	14.3	40	<2	6	44	<2	0.6	58	<2
Pockwock Lake	02-Aug-05	0.9	<2	<2	12.3	36	<2	4.8	40	<2	0.5	71	<2
Pockwock Lake	28-Sep-05	0.4	<2	<2	8.2	38.4	<2	4.8	30	<2	0.5	64	<2
Pockwock Lake	15-Nov-05	0.5	<2	<2	11.9	38.6	<2	5.1	42	<2	0.5	60	<2
Pockwock Lake	24-May-06	1.9	<2	<2	10.8	38.9	<2	5.1	38	<2	0.5	53	<2
Pockwock Lake	01-Aug-06	1.4	<2	<2	14.7	36.8	<2	5.3	63	<2	0.5	69	<2
Pockwock Lake	07-Nov-06	1.4	<2	<2	9.4	37.8	<2	5.1	26	<2	0.5	52	<2
Pockwock Lake	29-May-07	1.2	<2	<2	18.3	39.4	<2	5.1	40	<2	0.5	52	10
Pockwock Lake	01-Aug-07	0.8	<2	<2	12.3	37.6	<2	5.1	26	<2	0.5	55	<2
Pockwock Lake	18-Sep-07	1.4	<2	<2	8.6	37.9	<2		36	<2	<0.5	54	<2
Pockwock Lake	05-Nov-07	1.1	<2	<2	9.2	38.3	<2	4.8	34	<2	0.5	46	<2
Pockwock Lake	20-May-09	0.6	<2	<2	12	40.1	<2		80	<2	<0.5	52	<2
Pockwock Lake	20-May-09	0.6	<2	<2	10	40	<2		80	<2	<0.5	51	<2
Pockwock Lake	20-May-09	<0.1											
Pockwock Lake	20-May-09	0.6											
Pockwock Lake	15-Jul-09				7.9	39.2	<2		<50		0.5	59	
Shelburne River	12-Aug-02					29.4							
Shelburne River	27-Nov-02					38.4							
Shelburne River	28-Nov-02					39.3							
Shelburne River	10-Jul-03	1.9	<2	<2	127	29.5	<2		198	<2	<0.5	12	<2
Shelburne River	10-Jul-03					30.1							
Shelburne River	29-Jul-03	1.5	<2	<2	104	27.2	<2		173	<2	<0.5	16	<2
Shelburne River	29-Jul-03					27.5							
Shelburne River	28-Nov-03	0.8	<2	<2	173	38	<2		328	<2	<0.5	14	<2
Shelburne River	28-Nov-03					38.5							
Shelburne River	22-Jun-04	1.7	<2	<2	118	30.7	<2		202	<2	<0.5	14	3
Shelburne River	06-Jul-04					29.2							
Shelburne River	29-Sep-04	0.8	<2	<2	108	28.2	<2		268	<2	<0.5	12	<2
Shelburne River	29-Sep-04					29.6							
Shelburne River	09-Dec-04	0.6	<2	<2	206	38	<2		143	<2	<0.5	13	<2
Shelburne River	09-Dec-04	0.5	<2	<2	184	36.1	<2		151	<2	<0.5	14	<2
Shelburne River	27-Apr-05	0.9	<2	<2	110	28.4	<2		139	<2	<0.5	13	<2
Shelburne River	27-Apr-05					30							
Shelburne River	05-Jul-05	2.5	<2	<2	168	25.4	<2		239	<2	<0.5	11	<2
Shelburne River	05-Jul-05					24.3							
Shelburne River	03-Nov-05	0.5	<2	<2	214	35.9	<2		249	<2	<0.5	13	<2

Sample Station	Date Sampled	Nitrate+Nitrite mg/L	Ortho Phosphorus mg/L	pH	Potassium mg/L	Selenium ug/L	Silica mg/L	Sodium mg/L	Sulfate mg/L	Suspended Solids mg/L	Tin ug/L	Total Nitrogen mg/L
Pockwock Lake	05-Jan-05	0.04	<0.001	5.2	<0.5	<2	1.2	4.8	4.1	<0.6	<2	0.21
Pockwock Lake	05-Jan-05			5.6								
Pockwock Lake	05-Jan-05			5.2								
Pockwock Lake	17-May-05	0.04	<0.005	5.2	<0.5	<2	1.4	4.1	3.3	1	<2	0.14
Pockwock Lake	02-Aug-05	0.03	<0.005	5.3	<0.5	<2	1	4	3.6	<0.6	<2	0.16
Pockwock Lake	28-Sep-05	0.03	<0.005	5.4	<0.5	<2	1	3.9	3.3	<0.6	<2	0.12
Pockwock Lake	15-Nov-05	0.04	<0.005	5.2	<0.5	<2	1.5	3.9	<5.00	<0.9	<2	0.14
Pockwock Lake	24-May-06	0.04	<0.005	5.2	<0.5	<2	1.7	4.2	<5.00	<1.2	<2	0.14
Pockwock Lake	01-Aug-06	0.03	<0.005	5.4	<0.5	<2	1.2	3.5	<5.00	<0.7	<2	0.15
Pockwock Lake	07-Nov-06	0.04	<0.005	5.3	<0.5	<2	1.4	4.4	<5.00	<1.5	<2	0.17
Pockwock Lake	29-May-07	0.04	<0.005	5.3	<0.5	<2	1.7	4	<5.00	1.3	<2	0.13
Pockwock Lake	01-Aug-07	0.03	<0.005	5.4	<0.5	<2	1.2	3.9	<5.00	2	<2	0.12
Pockwock Lake	18-Sep-07	0.02	<0.005	5.8	<0.5	<2	1.2	3.9	<5.00	<1.5	<2	0.14
Pockwock Lake	05-Nov-07	0.04	<0.005	5.8	<0.5	<2	1.4	3.9	<5.00	<3.0	<2	0.12
Pockwock Lake	20-May-09	0.04	<0.005	5.1	<0.5	<2	1.7	4	<0.5	<3.0	<2	0.14
Pockwock Lake	20-May-09	0.04	<0.005	5.2	<0.5	<2	1.8	3.9	<5.00	<3.0	<2	0.14
Pockwock Lake	20-May-09			5.5								
Pockwock Lake	20-May-09			5.2								
Pockwock Lake	15-Jul-09	0.03	<0.005	5.2	<0.5		1.5	4.3	<5.00			0.12
Shelburne River	12-Aug-02			4.7								
Shelburne River	27-Nov-02			4.3								
Shelburne River	28-Nov-02			4.3								
Shelburne River	10-Jul-03	0.01	<0.001	4.6	<0.5	<2	1.6	2.2	<2	<1	<2	0.25
Shelburne River	10-Jul-03			4.5								
Shelburne River	29-Jul-03	<0.01	<0.001	4.7	<0.5	<2	0.8	2.5	<2	1.6	<2	0.25
Shelburne River	29-Jul-03			4.6								
Shelburne River	28-Nov-03	0.01	<0.001	4.3	<0.5	<2	5.1	2.8	<2	<1.5	<2	0.37
Shelburne River	28-Nov-03			4.3								
Shelburne River	22-Jun-04	<0.01	<0.001	4.5	<0.5	<2	1.7	2.7	<1	2.4	<2	0.26
Shelburne River	06-Jul-04			4.6								
Shelburne River	29-Sep-04	<0.01	<0.001	4.6	<0.5	<2	1.7	2.9	<1	1.2	<2	0.32
Shelburne River	29-Sep-04			4.6								
Shelburne River	09-Dec-04	<0.01	0.019	4.4	<0.5	<2	3.7	2.7	<1	<1.2	<2	0.26
Shelburne River	09-Dec-04	<0.01	0.019	4.4	<0.5	<2	3.7	2.7	<1	1.6	<2	0.27
Shelburne River	27-Apr-05	0.01	<0.005	4.5	<0.5	<2	3	2.5	<2	<0.6	<2	0.2
Shelburne River	27-Apr-05			4.5								
Shelburne River	05-Jul-05	<0.01	<0.005	4.5	<0.5	<2	2	2.2	<2	1.4	<2	0.29
Shelburne River	05-Jul-05			4.6								
Shelburne River	03-Nov-05	<0.01	<0.005	4.3	<0.5	<2	4.2	2.4	<2	1	<2	0.39

Sample Station	Date Sampled	Total Organic Carbon mg/L	Total Phosphorus mg/L	Turbidity NTU	Vanadium ug/L	Zinc ug/L
Pockwock Lake	05-Jan-05	3.5	0.052	0.41	<2	5
Pockwock Lake	05-Jan-05		0.091			
Pockwock Lake	05-Jan-05		0.044			
Pockwock Lake	17-May-05	3.5	0.012	0.55	<2	5
Pockwock Lake	02-Aug-05	3.9	0.013	0.42	<2	2.5
Pockwock Lake	28-Sep-05	2.5	<0.005	0.59	<2	8
Pockwock Lake	15-Nov-05	3.4	<0.005	0.44	<2	4
Pockwock Lake	24-May-06	3.5	<0.005	0.36	<2	8
Pockwock Lake	01-Aug-06	3.9	<0.005	0.56	<2	10
Pockwock Lake	07-Nov-06	2.8	<0.005	0.34	<2	6
Pockwock Lake	29-May-07	3.1	<0.005	0.38	<2	9
Pockwock Lake	01-Aug-07	2.8	<0.005	0.29	<2	17
Pockwock Lake	18-Sep-07	3	<0.005	0.38	<2	8
Pockwock Lake	05-Nov-07	2.8	<0.005	0.32	<2	<5
Pockwock Lake	20-May-09	3.2	<0.005	0.5	<2	<5
Pockwock Lake	20-May-09	3.1	<0.005	0.5	<2	8
Pockwock Lake	20-May-09		<0.005			
Pockwock Lake	20-May-09		<0.005			
Pockwock Lake	15-Jul-09	2.7	<0.005	0.32		5
Shelburne River	12-Aug-02			0.69		
Shelburne River	27-Nov-02			0.62		
Shelburne River	28-Nov-02			0.73		
Shelburne River	10-Jul-03	12.6	0.011	0.93	<2	<5
Shelburne River	10-Jul-03			0.72		
Shelburne River	29-Jul-03	10.1	0.024	1.1	<2	<2
Shelburne River	29-Jul-03			0.97		
Shelburne River	28-Nov-03	19	0.03	0.85	<2	18
Shelburne River	28-Nov-03			0.44		
Shelburne River	22-Jun-04	11.1	0.025	0.55	<2	<2
Shelburne River	06-Jul-04			0.68		
Shelburne River	29-Sep-04	11.8	0.023	0.83	<2	<2
Shelburne River	29-Sep-04			0.57		
Shelburne River	09-Dec-04	18	0.011	0.78	<2	<2
Shelburne River	09-Dec-04	18.2	0.017	0.84	<2	<2
Shelburne River	27-Apr-05	11.2	0.019	0.84	<2	<2
Shelburne River	27-Apr-05			0.64		
Shelburne River	05-Jul-05	15	0.036	0.67	<2	<5
Shelburne River	05-Jul-05			0.62		
Shelburne River	03-Nov-05	22.1	0.01	0.55	<2	3

Sample Station	Date Sampled	Alkalinity as CaCO3 mg/L	Aluminium ug/L	Ammonia mg/L	Antimony ug/L	Barium ug/L	Beryllium ug/L	Bicarbonate as CaCo3 mg/L	Boron ug/L	Cadmium ug/L	Calcium mg/L	Carbonate as CaCO3 mg/L	Chloride mg/l
Shelburne River	03-Nov-05												
Shelburne River	29-Nov-05	<1	314	0.02	<2	3	<2		<5	<2	<0.5		3.8
Shelburne River	29-Nov-05												
Shelburne River	05-Jul-06	<1	372	0.03	<2	3	<2		<5	<2	<0.5		3.9
Shelburne River	23-May-07	<3.0	210	0.02	<2	3	<2		<5	<2	<0.5		4.7
Shelburne River	23-May-07												
Shelburne River	26-Jul-07	<3.0	229	0.02	<2	3	<2		<5	<2	<0.5		4.3
Shelburne River	20-Dec-07	<1.0	302	0.02	<2	3	<2		<5	<2	<0.5		4.6
Shelburne River	20-Dec-07												
Shelburne River	29-Apr-08	<3.0	183	0.01	<2	2	<2		<5	<1	<0.5		3.9
Shelburne River	29-Apr-08												
Shelburne River	07-Oct-08												
Shelburne River	07-Oct-08	<3.0	386	0.01	<2	3	<2		<5	<1	<0.5		4.2
Shelburne River	13-Nov-08												
Shelburne River	13-Nov-08	<3.0	473	0.02	<2	3	<2		<5	<1	<0.5		4.8
Shelburne River	14-May-09	<1	219	0.02	<2	3	<2		<5	<1	<0.5		4
Shelburne River	08-Jul-09	<1	289	0.02	<2	3	<2		<5	<1	0.5		4.7
North East Margaree	25-Sep-02												
North East Margaree	26-Sep-02												
North East Margaree	09-Jan-03	12	20	<0.01	<2	24	<5	12	5	<0.3	14	0.03	26
North East Margaree	06-May-03	5.3	117	<0.01	<2	16	<2	5.27	<5	<2	6.2	0.01	11
North East Margaree	06-May-03												
North East Margaree	08-Jul-03	18	20	<0.01	<2	26	<2	17.94	6	<2	19	0.04	42
North East Margaree	08-Jul-03												
North East Margaree	20-Nov-03	11	48	<0.01	<2	23	<2	10.98	7	<2	10.2	0.01	18
North East Margaree	20-Nov-03												
North East Margaree	08-Jul-04	18	25	0.02	<2	26	<2	17.89	<5	<2	16.4	0.08	30
North East Margaree	08-Jul-04												
North East Margaree	26-Oct-04	14	30	<0.01	<2	25	<2	13.97	<5	<0.3	12	0.02	22
North East Margaree	26-Oct-04												
North East Margaree	15-Dec-04	9.6	48	<0.01	<2	20	<2	9.51	5	<2	9.6	0.06	17
North East Margaree	15-Dec-04												
North East Margaree	11-May-05	9.9	75	0.01	<2	21	<2	9.88	<5	<2	8.5	0.01	15
North East Margaree	11-May-05												
North East Margaree	29-Jun-05	18	17	0.04	<2	30	<2	17.96	<5	<2	21.1	0.03	44
North East Margaree	29-Jun-05												
North East Margaree	14-Sep-05	13	139	<0.01	<2	23	<2	12.98	6	<2	10.1	0.01	18
North East Margaree	14-Sep-05												
North East Margaree	01-Dec-05	10	49	<0.01	<2	20	<2	9.97	<5	<2	10.5	0.02	17

Sample Station	Date Sampled	Chlorophyll A mg/m3	Chromium ug/L	Cobalt ug/L	Colour TCU	Conductivity umho/cm	Copper ug/L	Hardness as CaCo3 mg/L	Iron ug/L	Lead ug/L	Magnesium mg/L	Manganese ug/L	Nickel ug/L
Shelburne River	03-Nov-05					37.8							
Shelburne River	29-Nov-05	0.7	<2	<2	182	32.1	<2		193	<2	<0.5	11	<2
Shelburne River	29-Nov-05					34.8							
Shelburne River	05-Jul-06	3.9	<2	<2	226	27.1	<2		301	<2	<0.5	10	<2
Shelburne River	23-May-07	2.6	<2	<2	124.8	30	<2		164	<2	<0.5	10	<2
Shelburne River	23-May-07					31.7							
Shelburne River	26-Jul-07	0.6	<2	<2	121.6	29.6	<2		187	<2	<0.5	15	<2
Shelburne River	20-Dec-07	1.8	<2	<2	189	38.6	<2		200	<2	<0.5	11	<2
Shelburne River	20-Dec-07					38.5							
Shelburne River	29-Apr-08	2.4	<2	<2	84	28.2	<2		126	<2	<0.5	8	<2
Shelburne River	29-Apr-08					29.5							
Shelburne River	07-Oct-08					35.1							
Shelburne River	07-Oct-08	4.8	<2	<2	160	31.56	<2		292	<2	<0.5	10	<2
Shelburne River	13-Nov-08					40.7							
Shelburne River	13-Nov-08	2.2	<2	<2	198	39.5	<2		295	<2	<0.5	12	<2
Shelburne River	14-May-09	4.2	<2	<2	102	29.4	<2		145	<2	<0.5	9	<2
Shelburne River	08-Jul-09	1.6	<2	<2	125	29.1	<2		233	<2	<0.5	10	<2
North East Margaree	25-Sep-02					96.2							
North East Margaree	26-Sep-02					127							
North East Margaree	09-Jan-03	0.3	<2	<1	5.3	180	<2	41.1	<20	<0.5	1.5	2	<2
North East Margaree	06-May-03	0.4	<2	<2	19	77.4	<2	18.8	36	<2	0.8	3	<2
North East Margaree	06-May-03					78							
North East Margaree	08-Jul-03	0.3	<2	<2	6.5	265	<2	54.4	<20	<2	1.7	3	<2
North East Margaree	08-Jul-03					267							
North East Margaree	20-Nov-03	0.4	<2	<2	9	123	<2	31.2	47	<2	1.4	3	<2
North East Margaree	20-Nov-03					116							
North East Margaree	08-Jul-04	0.6	<2	<2	12.3	206	<2	47.5	<20	<2	1.6	2	<2
North East Margaree	08-Jul-04					206							
North East Margaree	26-Oct-04	0.2	<2	<1	17	158	<2	35.7	<50	<0.5	1.4	2	<2
North East Margaree	26-Oct-04					157							
North East Margaree	15-Dec-04	0.1	<2	<2	18	118	<2	28.9	<20	<2	1.2	3	<2
North East Margaree	15-Dec-04					120							
North East Margaree	11-May-05	0.3	<2	<2	16.3	105	<2	25.7	25	<2	1.1	<2	<2
North East Margaree	11-May-05					104							
North East Margaree	29-Jun-05	0.4	<2	<2	5.7	279	<2	60.1	<20	<2	1.8	<2	<2
North East Margaree	29-Jun-05					281							
North East Margaree	14-Sep-05	0.4	<2	<2	54.3	130	<2	30.1	126	<2	1.2	4	<2
North East Margaree	14-Sep-05					131							
North East Margaree	01-Dec-05	1.1	<2	<2	9.8	129	<2	31.1	23	<2	1.2	2	<2

Sample Station	Date Sampled	Nitrate+Nitrite mg/L	Ortho Phosphorus mg/L	pH	Potassium mg/L	Selenium ug/L	Silica mg/L	Sodium mg/L	Sulfate mg/L	Suspended Solids mg/L	Tin ug/L	Total Nitrogen mg/L
Shelburne River	03-Nov-05			4.3								
Shelburne River	29-Nov-05	0.01	<0.005	4.3	<0.5	<2	4.1	2.2	<5	1	<2	0.31
Shelburne River	29-Nov-05			4.3								
Shelburne River	05-Jul-06	<0.01	<0.005	4.5	<0.5	<2	3.1	2.4	<5	2	<2	0.34
Shelburne River	23-May-07	<0.01	<0.005	4.6	<0.5	<2	5	2.4	<5.00	<1.0	<2	0.18
Shelburne River	23-May-07			4.5								
Shelburne River	26-Jul-07	<0.01	<0.005	4.7	<0.5	<2	1	2.7	<5.00	2	<2	0.25
Shelburne River	20-Dec-07	<0.01	<0.005	4.4	<0.5	<2	4.4	2.5	<5.00	<1.5	<2	0.3
Shelburne River	20-Dec-07			4.4								
Shelburne River	29-Apr-08	<0.01	<0.005	4.6	<0.5	<2	2.6	2.2	<5.00	2	<2	0.19
Shelburne River	29-Apr-08			4.5								
Shelburne River	07-Oct-08			4.6								
Shelburne River	07-Oct-08	<0.01	<0.005	4.5	<0.5	<2	2.4	2.6	<5.00	10	<2	0.38
Shelburne River	13-Nov-08			4.3								
Shelburne River	13-Nov-08	<0.01	<0.005	4.4	<0.5	<2	4.4	3	<5.00	<3.0	<2	0.36
Shelburne River	14-May-09	<0.01	<0.005	4.5	<0.5	<2	2.3	2.6	<5.00	<3.0	<2	0.21
Shelburne River	08-Jul-09	<0.01	<0.005	4.5	<0.5	<2	1.4	2.7	<5.00	<1.2	<2	0.29
North East Margaree	25-Sep-02			7								
North East Margaree	26-Sep-02			7.2								
North East Margaree	09-Jan-03	0.11	<0.001	7.4	0.4	<2	5	15.4	25	<1.5		0.28
North East Margaree	06-May-03	0.03	<0.001	7.4	<0.5	<2	4.7	6.4	13	1.4	<2	0.08
North East Margaree	06-May-03			6.8								
North East Margaree	08-Jul-03	0.04	<0.001	7.4	0.5	<2	7.3	24.7	39	1.7	<2	0.11
North East Margaree	08-Jul-03			7.3								
North East Margaree	20-Nov-03	0.06	<0.001	7.1	<0.5	<2	7.6	10.4	16	1.5	<2	0.11
North East Margaree	20-Nov-03			7.3								
North East Margaree	08-Jul-04	0.03	<0.001	7.7	0.5	<2	6.6	21.1	33	<3.0	<2	0.09
North East Margaree	08-Jul-04			7.5								
North East Margaree	26-Oct-04	<0.01	<0.001	7.2	0.4	<2	7	14.2	22	<1.5	<2	0.14
North East Margaree	26-Oct-04			7.2								
North East Margaree	15-Dec-04	0.11	0.002	7.8	<0.5	<2	6.8	10.4	19	<0.6	<2	0.25
North East Margaree	15-Dec-04			7.8								
North East Margaree	11-May-05	0.03	<0.005	7.1	<0.5	<2	6	9.9	15	<0.6	<2	0.08
North East Margaree	11-May-05			7.1								
North East Margaree	29-Jun-05	0.05	<0.005	7.3	0.6	<2	6.3	28.2	39	1.2	<2	0.18
North East Margaree	29-Jun-05			7.2								
North East Margaree	14-Sep-05	0.03	<0.005	7	<0.5	<2	6.3	10.9	20	1	<2	0.17
North East Margaree	14-Sep-05			7								
North East Margaree	01-Dec-05	0.08	<0.005	7.3	<0.5	<2	7.3	11	21	<0.6	<2	0.17

Sample Station	Date Sampled	Total Organic Carbon mg/L	Total Phosphorus mg/L	Turbidity NTU	Vanadium ug/L	Zinc ug/L
Shelburne River	03-Nov-05			0.53		
Shelburne River	29-Nov-05	19.3	0.01	0.82	<2	<2
Shelburne River	29-Nov-05			1.13		
Shelburne River	05-Jul-06	20	0.007	0.55	<2	2
Shelburne River	23-May-07	12.5	0.13	0.6	<2	<5
Shelburne River	23-May-07			0.66		
Shelburne River	26-Jul-07	10.4	0.007	1	<2	<50
Shelburne River	20-Dec-07	17.2	0.01	0.96	<2	<50
Shelburne River	20-Dec-07			0.56		
Shelburne River	29-Apr-08	10.3	0.009	0.87	<2	<50
Shelburne River	29-Apr-08			0.58		
Shelburne River	07-Oct-08			0.63		
Shelburne River	07-Oct-08	19.4	0.009	0.64	<2	<5
Shelburne River	13-Nov-08			0.52		
Shelburne River	13-Nov-08	22.1	0.007	0.55	<2	<5
Shelburne River	14-May-09	12.1	<0.005	0.57	<2	5
Shelburne River	08-Jul-09	14.6	0.006	0.73	<2	<5
North East Margaree	25-Sep-02			0.26		
North East Margaree	26-Sep-02			0.19		
North East Margaree	09-Jan-03	1.4	0.013	0.12	<2	<2
North East Margaree	06-May-03	3.2	0.009	0.51	<2	<5
North East Margaree	06-May-03			0.37		
North East Margaree	08-Jul-03	1.6	0.012	0.13	<2	<2
North East Margaree	08-Jul-03			0.13		
North East Margaree	20-Nov-03	3.8	0.037	0.43	<2	3
North East Margaree	20-Nov-03			0.18		
North East Margaree	08-Jul-04	2.9	0.05	0.27	<2	<2
North East Margaree	08-Jul-04			0.13		
North East Margaree	26-Oct-04	2.5	0.033	0.18	<2	10
North East Margaree	26-Oct-04			0.11		
North East Margaree	15-Dec-04	2.1	0.043	0.31	<2	<2
North East Margaree	15-Dec-04			0.17		
North East Margaree	11-May-05	1.9	0.007	0.37	<2	<2
North East Margaree	11-May-05			0.25		
North East Margaree	29-Jun-05	1.7	0.028	0.26	<2	6
North East Margaree	29-Jun-05			0.18		
North East Margaree	14-Sep-05	7.3	0.011	0.36	<2	<5
North East Margaree	14-Sep-05			0.17		
North East Margaree	01-Dec-05	1.7	0.008	0.42	<2	<2

Sample Station	Date Sampled	Alkalinity as CaCO3 mg/L	Aluminium ug/L	Ammonia mg/L	Antimony ug/L	Barium ug/L	Beryllium ug/L	Bicarbonate as CaCo3 mg/L	Boron ug/L	Cadmium ug/L	Calcium mg/L	Carbonate as CaCO3 mg/L	Chloride mg/l
North East Margaree	01-Dec-05												
North East Margaree	22-Jun-06	14	55	0.02	<2	30	<2	13.98	6	<2	16.3	0.02	28
North East Margaree	22-Jun-06												
North East Margaree	21-Sep-06	18	20	0.01	<2	30	<2	17.98	5	<2	19.7	0.02	41
North East Margaree	21-Sep-06												
North East Margaree	14-Dec-06	11	48	<0.01	<2	20	<2	10.98	<5	<2	9.3	0.02	16
North East Margaree	14-Dec-06												
North East Margaree	26-Apr-07	7.3	80	<0.01	<2	20	<2	7.29	<5	<2	7.7	0.01	14
North East Margaree	26-Apr-07												
North East Margaree	14-Jul-07	14	29	<0.01	<2	24	<2	13.95	<5	<2	13.7	0.03	28
North East Margaree	14-Jul-07												
North East Margaree	23-Aug-07	13	80	<0.01	<2	18	<2	12.96	6	<2	9.4	0.02	16
North East Margaree	08-Nov-07	9.7	110	<0.01	<2	20	<2	9.69	<5	<1	7.4	0.01	14
North East Margaree	08-May-08	7	110	<0.01	<2	18	<2	6.99	<5	<1	5.5	0.01	9.8
North East Margaree	04-Jun-08	11	59	0.01	<2	20	<2	10.92	<5	<1	8.9	0.05	16
North East Margaree	22-Oct-08												
North East Margaree	22-Oct-08	15	47	<0.01	<2	23	<2	14.96	<5	<1	12.2	0.03	0.649
North East Margaree	04-Dec-08	10	62	<0.01	<2	20	<2	9.94	<5	<1	8.3	0.04	0.367
North East Margaree	04-Dec-08												
North East Margaree	07-May-09	5.5	153	<0.01	<2	16	<2		<5	<1	5.2		6.3
North East Margaree	26-Aug-09	14.1	140	<0.01	<2	28	<2	14.04	6	<1	13.5	0.04	0.705
Kelley River	26-Aug-04	5.9	147	0.03	<2	6	<2	5.9	8	<2	1.3	0	4.8
Kelley River	17-Dec-04	1.2	135	0.01	<2	11	<2	1.2	3	<2	0.7	0	3.2
Kelley River	21-Jun-05	3.6	171	0.02	<2	7	<2	3.6	<5	3	0.6	0	3.1
Kelley River	21-Jun-05												
Kelley River	13-Oct-05	<1	345	0.02	<2	23	<2		6	<2	1.1		3.4
Kelley River	13-Oct-05												
Kelley River	18-May-06	2.3	162	<0.01	<2	7	<2	2.3	<5	<2	0.7	0	2.9
Kelley River	27-Jul-06	1.7	254	0.02	<2	13	<2	1.7	<5	<2	0.8	0	3
Kelley River	27-Jul-06												
Kelley River	12-Oct-06	1.7	196	0.01	<2	13	<2	1.7	5	<2	1.2	0	4.2
Kelley River	12-Oct-06												
Kelley River	12-Dec-06	1.3	128	<0.01	<2	10	<2	1.3	<5	<2	0.6	0	3.3
Kelley River	12-Dec-06												
Kelley River	18-Jul-07	6.2	106	0.03	<2	4	<2	6.19	12	<2	1	0	3.9
Kelley River	27-Sep-07	6.1	115	0.01	<2	6	<2	6.08	8	<2	1	0.01	4.5
Kelley River	01-May-08	<3.0	140	0.01	<2	8	<2		<5	<1	0.5		2.3
Kelley River	11-Jun-08	<3.0	181	<0.01	<2	6	<2		<5	<1	0.7		3
Kelley River	28-Aug-08	<3.0	337	<0.01	<2	17	<2		<5	<1	1		3.6

Sample Station	Date Sampled	Chlorophyll A mg/m3	Chromium ug/L	Cobalt ug/L	Colour TCU	Conductivity umho/cm	Copper ug/L	Hardness as CaCo3 mg/L	Iron ug/L	Lead ug/L	Magnesium mg/L	Manganese ug/L	Nickel ug/L
North East Margaree	01-Dec-05					128							
North East Margaree	22-Jun-06	1.7	<2	<2	20.5	189	<2	47.2	40	<2	1.6	3	<2
North East Margaree	22-Jun-06					190							
North East Margaree	21-Sep-06	1.2	<2	<2	7.6	264	<2	56.1	<20	<2	1.7	2	<2
North East Margaree	21-Sep-06					261							
North East Margaree	14-Dec-06	1.8	<2	<2	12	118	<2	27.7	27	<2	1.1	2	3
North East Margaree	14-Dec-06					115							
North East Margaree	26-Apr-07	2.1	<2	<2	23.8	99.6	<2	23.3	35	<2	1	4	<2
North East Margaree	26-Apr-07					99							
North East Margaree	14-Jul-07	<0.5	<2	<2	11.2	182	<2	39.9	<20	<2	1.4	<2	<2
North East Margaree	14-Jul-07					182							
North East Margaree	23-Aug-07	<0.5	<2	<2	21	118	<2	28.4	35	<2	1.2	3	<2
North East Margaree	08-Nov-07	1.1	<2	<2	36	99	<2	23	82	<2	1.1	4	<2
North East Margaree	08-May-08	1.7	<2	<2	21	72.4	<2	16.6	<50	<2	0.7	3	<2
North East Margaree	04-Jun-08	2	<2	<2	17	117	<2	26.3	68	<2	1	2	<2
North East Margaree	22-Oct-08					160							
North East Margaree	22-Oct-08	1.3	<2	<2	19	160	<2	36.2	<50	<2	1.4	2	<2
North East Margaree	04-Dec-08	1.1	<2	<2	17	95.9	<2	23.6	<50	<2	0.7	2	<2
North East Margaree	04-Dec-08					98.4							
North East Margaree	07-May-09	0.3	<2	<2	30	56.7	3		100	<2	0.7	4	<2
North East Margaree	26-Aug-09	0.5	<2	<2	56	175	<2	40.3	83	<2	1.6	4	<2
Kelley River	26-Aug-04	0.4	<2	<2	86.3	34	<2	6.1	457	<2	0.7	17	<2
Kelley River	17-Dec-04	0.5	<2	<2	82	22.9	<2		257	<2	<0.5	103	<2
Kelley River	21-Jun-05	0.6	<2	<2	92.1	21	<2		404	<2	<0.5	28	<2
Kelley River	21-Jun-05					21.1							
Kelley River	13-Oct-05	0.2	<2	<2	133.5	26.2	<2	5.2	728	<2	0.6	263	<2
Kelley River	13-Oct-05					25.9							
Kelley River	18-May-06	1.8	<2	<2	84.9	22.5	<2		333	<2	<0.5	46	<2
Kelley River	27-Jul-06	1.1	<2	<2	173	22.1	<2		787	<2	<0.5	170	<2
Kelley River	27-Jul-06					22.2							
Kelley River	12-Oct-06	0.8	<2	<2	115.2	27.5	<2	5.1	630	<2	0.5	121	<2
Kelley River	12-Oct-06					27.8							
Kelley River	12-Dec-06	<0.5	<2	<2	65	22.8	<2		280	<2	<0.5	77	<2
Kelley River	12-Dec-06					23.2							
Kelley River	18-Jul-07	3.8	<2	<2	71.6	31.9	<2	5	493	<2	0.6	26	<2
Kelley River	27-Sep-07	3.4	<2	<2	57	34.9	<2	5	448	<2	0.6	22	<2
Kelley River	01-May-08	1.1	<2	<2	54	17.4	204		<2	<2	<0.5	46	<2
Kelley River	11-Jun-08	2	<2	<2	84	21.58	<2		483	<2	<0.5	30	<2
Kelley River	28-Aug-08	1.2	<2	<2	157	24.6	<2	4.6	885	<2	0.5	206	<2

Sample Station	Date Sampled	Nitrate+Nitrite mg/L	Ortho Phosphorus mg/L	pH	Potassium mg/L	Selenium ug/L	Silica mg/L	Sodium mg/L	Sulfate mg/L	Suspended Solids mg/L	Tin ug/L	Total Nitrogen mg/L
North East Margaree	01-Dec-05			7.1								
North East Margaree	22-Jun-06	0.05	<0.005	7.1	0.6	<2	6.6	21.7	25	1.2	<2	0.14
North East Margaree	22-Jun-06			7.4								
North East Margaree	21-Sep-06	0.02	<0.005	7	0.6	<2	7	25.7	36	1	<2	0.08
North East Margaree	21-Sep-06			7.4								
North East Margaree	14-Dec-06	0.12	<0.005	7.2	<0.5	<2	7.5	10	16	<1.0	<2	0.17
North East Margaree	14-Dec-06			7.1								
North East Margaree	26-Apr-07	0.1	<0.005	7	<0.5	<2	5	8	14	<1.5	<2	0.15
North East Margaree	26-Apr-07			7								
North East Margaree	14-Jul-07	0.03	<0.005	7.4	<0.5	<2	6.7	17.2	25	1.3	<2	0.08
North East Margaree	14-Jul-07			7.4								
North East Margaree	23-Aug-07	0.06	<0.005	7.3	<0.5	<2	7.1	10.1	17	2	<2	0.15
North East Margaree	08-Nov-07	0.11	<0.005	6.9	<0.5	<2	6.4	8.4	13	<3.0	<2	0.21
North East Margaree	08-May-08	0.04	<0.005	7	<0.5	<2	4.9	6.3	10	2	<2	0.12
North East Margaree	04-Jun-08	0.05	<0.005	7.7	<0.5	<2	6	9.6	17	<1.5	<2	0.16
North East Margaree	22-Oct-08			7.6								
North East Margaree	22-Oct-08	<0.01	<0.005	7.3	0.5	<2	6.6	14.6	23	<3.0	<2	0.07
North East Margaree	04-Dec-08	0.13	<0.005	7.6	<0.5	<2	7	9.3	15	<1.5	<2	0.18
North East Margaree	04-Dec-08			6.7								
North East Margaree	07-May-09	0.08	<0.005	7.1	<0.5	<2	4.3	4.5	8.3	3	<2	0.16
North East Margaree	26-Aug-09	0.07	<0.005	7.5	<0.5	<2	6.4	16.6	26	1.2	<2	0.23
Kelley River	26-Aug-04	<0.01	<0.001	6.5	<0.5	<2	3.1	3.9	<1	<1.5	<2	0.39
Kelley River	17-Dec-04	0.04	0.007	5.2	<0.5	<2	3.3	2.3	<1	0.8	<2	0.17
Kelley River	21-Jun-05	<0.01	<0.005	5.9	<0.5	<2	2.7	2.4	<2	<0.6	<2	0.23
Kelley River	21-Jun-05			6.2								
Kelley River	13-Oct-05	<0.01	<0.005	4.7	<0.5	<2	2.7	2.5	<2	<0.6	<2	0.3
Kelley River	13-Oct-05			4.7								
Kelley River	18-May-06	<0.01	<0.005	6.1	<0.5	<2	2.2	2.4	<5	0.8	<2	0.24
Kelley River	27-Jul-06	<0.01	<0.005	5.1	<0.5	<2	3.4	2.3	<5	1.2	<2	0.28
Kelley River	27-Jul-06			5.3								
Kelley River	12-Oct-06	<0.01	<0.005	5.3	<0.5	<2	3.8	2.8	<5.00	<1.5	<2	0.25
Kelley River	12-Oct-06			5.4								
Kelley River	12-Dec-06	0.04	<0.005	5.4	<0.5	<2	3.9	2.2	<5.00	<1.0	<2	0.21
Kelley River	12-Dec-06			5.5								
Kelley River	18-Jul-07	<0.01	<0.005	6.8	<0.5	<2	1.9	4.9	<5.00	<1.5	<2	0.22
Kelley River	27-Sep-07	<0.01	<0.005	7.2	<0.5	<2	3.2	4.8	<5.00	<1.0	<2	0.25
Kelley River	01-May-08	<0.01	<0.005	5.9	<0.5	<2	2.2	2.2	<5.00	<1.5	<2	0.15
Kelley River	11-Jun-08	<0.01	<0.005	6.2	<0.5	<2	2.6	2.5	<5.00	<1.5	<2	0.26
Kelley River	28-Aug-08	<0.01	<0.005	5.3	<0.5	<2	3.2	2.6	<5.00	5	<2	0.43

Sample Station	Date Sampled	Total Organic Carbon mg/L	Total Phosphorus mg/L	Turbidity NTU	Vanadium ug/L	Zinc ug/L
North East Margaree	01-Dec-05			0.32		
North East Margaree	22-Jun-06	3.1	<0.005	0.33	<2	<2
North East Margaree	22-Jun-06			0.26		
North East Margaree	21-Sep-06	1.2	0.011	0.14	<2	<2
North East Margaree	21-Sep-06			0.16		
North East Margaree	14-Dec-06	1.9	0.007	0.77	<2	4
North East Margaree	14-Dec-06			0.3		
North East Margaree	26-Apr-07	2.7	<0.005	0.4	<2	<50
North East Margaree	26-Apr-07			0.31		
North East Margaree	14-Jul-07	1.2	0.009	0.18	<2	<5
North East Margaree	14-Jul-07			0.17		
North East Margaree	23-Aug-07	3.1	0.007	0.31	<2	<5
North East Margaree	08-Nov-07	5.1	0.006	0.39	<2	<5
North East Margaree	08-May-08	3.3	0.007	0.26	<2	<5
North East Margaree	04-Jun-08	2.6	0.007	0.32	<2	<5
North East Margaree	22-Oct-08			0.25		
North East Margaree	22-Oct-08	2.6	0.009	0.21	<2	5
North East Margaree	04-Dec-08	4.6	0.005	0.24	<2	<5
North East Margaree	04-Dec-08			0.17		
North East Margaree	07-May-09	4.4	<0.005	0.64	<2	20
North East Margaree	26-Aug-09	7.7	0.012	0.37	<2	<5
Kelley River	26-Aug-04	13.7	0.036	0.63	<2	<2
Kelley River	17-Dec-04	8.5	0.032	0.62	<2	3
Kelley River	21-Jun-05	12.5	0.02	0.62	<2	7
Kelley River	21-Jun-05			0.64		
Kelley River	13-Oct-05	17.9	0.012	0.98	<2	<5
Kelley River	13-Oct-05			0.96		
Kelley River	18-May-06	10.1	0.006	0.7	<2	78
Kelley River	27-Jul-06	20.6	0.01	0.55	<2	3
Kelley River	27-Jul-06			0.68		
Kelley River	12-Oct-06	15.5	0.009	0.43	<2	2
Kelley River	12-Oct-06			0.48		
Kelley River	12-Dec-06	7.3	0.006	0.47	<2	3
Kelley River	12-Dec-06			0.68		
Kelley River	18-Jul-07	7	0.01	1.14	<2	<5
Kelley River	27-Sep-07	8.1	0.007	1.03	<2	22
Kelley River	01-May-08	6.8	0.007	0.65	<2	<5
Kelley River	11-Jun-08	10.4	0.01	0.78	<2	<5
Kelley River	28-Aug-08	21.2	0.011	0.65	<2	<5

Sample Station	Date Sampled	Alkalinity as CaCO3 mg/L	Aluminium ug/L	Ammonia mg/L	Antimony ug/L	Barium ug/L	Beryllium ug/L	Bicarbonate as CaCo3 mg/L	Boron ug/L	Cadmium ug/L	Calcium mg/L	Carbonate as CaCO3 mg/L	Chloride mg/l
Kelley River	29-Oct-08												
Kelley River	29-Oct-08	<3.0	245	<0.01	<2	17	<2		<5	<1	1		4.5
Kelley River	21-May-09	<1.0	190	0.01	<2	7	<2		6	<1	0.6		2.5
Kelley River	07-Jul-09	1.2	238	0.02	<2	11	<2	1.2	<5	<1	0.8	0	3.5
Lahave River	07-May-08	<3.0	146	0.02	<2	3	<2		<5	<1	1.3		6.1
Lahave River	07-May-08	<3.0	146	0.02	<2	3	<2		<5	<1	1.3		6.1
Lahave River	12-Jun-08	<3.0	174	0.01	<2	3	<2		<5	<1	1.4		5.6
Lahave River	30-Oct-08	3.8	329	<0.01	<2	5	<2		<5	<1	2.1		7.4
Lahave River	26-Nov-08												
Lahave River	26-Nov-08	3.9	209	0.02	<2	4	<2		<5	<1	2.3		9.8
Lahave River	14-May-09	1.8	177	0.02	>2	3	<2		<5	<1	1.3		5.4
Lahave River	08-Jul-09	2.8	224	0.02	<2	4	<2	2.8	<5	<1	2.1	0	5.9
St. Mary's River	10-May-07	3	66	<0.01	<2	7	<2	2.99	<5	<2	1.4	0	5.9
St. Mary's River	10-May-07												
St. Mary's River	11-Jul-07	4.4	94	<0.01	<2	8	<2	4.4	7	<2	1.6	0	5.4
St. Mary's River	01-Nov-07	4.1	100	0.02	<2	8	<2	4.1	6	<1	1.6	0	5.6
St. Mary's River	01-Nov-07												
St. Mary's River	06-Dec-07	<3.0	89	<0.01	<2	8	<2		<5	<1	1.5		6.4
St. Mary's River	06-Dec-07												
St. Mary's River	16-Jun-09	3.2	81	0.02	<2	6	<2	3.19	6	<1	1.2	0	0.141
St. Mary's River	11-Aug-09	4.4	93	0.02	<2	6	<2	4.39	5	<1	1.4	0	0.152

Sample Station	Date Sampled	Chlorophyll A mg/m3	Chromium ug/L	Cobalt ug/L	Colour TCU	Conductivity umho/cm	Copper ug/L	Hardness as CaCo3 mg/L	Iron ug/L	Lead ug/L	Magnesium mg/L	Manganese ug/L	Nickel ug/L
Kelley River	29-Oct-08					27.5							
Kelley River	29-Oct-08	1.4	<2	<2	95	27.3	<2		573	<2	0.6	142	<2
Kelley River	21-May-09	0.3	<2	<2	80	17.6	<2		360	<2	<0.5	57	<2
Kelley River	07-Jul-09	0.3	<2	<2	116	21.6	<2		690	<2	0.5	56	<2
Lahave River	07-May-08	3.1	<2	<2	51	32.6	<2	5.3	178	<2	0.5	29	<2
Lahave River	07-May-08	3.1	<2	<2	51	32.6	<2	5.3	178	<2	0.5	29	<2
Lahave River	12-Jun-08	2.5	<2	<2	63	31.89	<2		268	<2	<0.5	47	<2
Lahave River	30-Oct-08	2.4	<2	<2	94	41	<2	8.5	500	<2	0.8	92	<2
Lahave River	26-Nov-08					52.6							
Lahave River	26-Nov-08	1.6	<2	<2	78	51.4	<2	9.4	337	<2	0.9	57	<2
Lahave River	14-May-09	0.8	<2	<2	58	31.6	<2		231	<2	0.6	36	<2
Lahave River	08-Jul-09	1.2	<2	<2	88	33.3	<2		442	<2	0.6	45	<2
St. Mary's River	10-May-07	1.5	<2	<2	27.4	35.9	<2	6	103	<2	0.6	32	<2
St. Mary's River	10-May-07					35							
St. Mary's River	11-Jul-07	0.8	<2	<2	51.8	34	<2	6.5	256	<2	0.6	49	<2
St. Mary's River	01-Nov-07	1.2	<2	<2	40	33.7	<2	6.9	259	<2	0.7	23	<2
St. Mary's River	01-Nov-07					33.9							
St. Mary's River	06-Dec-07	1.4	<2	<2	29	35.2	<2	6.6	158	<2	0.7	31	<2
St. Mary's River	06-Dec-07					34.3							
St. Mary's River	16-Jun-09	0.7	<2	<2	33	30.8	<2	5.5	210	<2	0.6	54	<2
St. Mary's River	11-Aug-09	0.4	<2	<2	45	33.3	<2	6	391	<2	0.6	67	<2

Sample Station	Date Sampled	Nitrate+Nitrite mg/L	Ortho Phosphorus mg/L	pH	Potassium mg/L	Selenium ug/L	Silica mg/L	Sodium mg/L	Sulfate mg/L	Suspended Solids mg/L	Tin ug/L	Total Nitrogen mg/L
Kelley River	29-Oct-08			6.4								
Kelley River	29-Oct-08	<0.01	<0.005	6.3	0.5	<2	4.1	2.5	<5.00	<3.0	<2	0.27
Kelley River	21-May-09	<0.01	<0.005	5.7	<0.5	<2	1.8	1.7	<5.00	<1.2	<2	0.22
Kelley River	07-Jul-09	<0.01	<0.005	5.8	<0.5	<2	3	2.7	<5.00	1.2	<2	0.31
Lahave River	07-May-08	<0.01	<0.005	7.6	<0.5	<2	1.5	3.6	<5.00	<1.5	<2	0.22
Lahave River	07-May-08	<0.01	<0.005	7.6	<0.5	<2	1.5	3.6	<5.00	<1.5	<2	0.22
Lahave River	12-Jun-08	<0.01	<0.005	6.2	<0.5	<2	1.7	3.4	<5.00	4	<2	0.26
Lahave River	30-Oct-08	<0.01	<0.005	6	0.7	<2	4.4	4.2	<5.00	<3.0	<2	0.34
Lahave River	26-Nov-08			6.4								
Lahave River	26-Nov-08	0.07	<0.005	6.2	0.6	<2	5	5	5	2	<2	0.33
Lahave River	14-May-09	<0.01	<0.005	6.4	0.5	<2	2.1	4.2	<5.00	<3.0	<2	0.19
Lahave River	08-Jul-09	0.02	<0.005	6.6	<0.5	<2	3.1	3.9	<5	1.6	<2	0.36
St. Mary's River	10-May-07	0.06	<0.005	7.2	<0.5	<2	1.2	3.7	<5.00	<3.0	<2	0.17
St. Mary's River	10-May-07			6.8								
St. Mary's River	11-Jul-07	0.04	<0.005	6.5	<0.5	<2	1.5	3.6	<5.00	<1.5	<2	0.2
St. Mary's River	01-Nov-07	0.05	<0.005	6.6	<0.5	<2	3	3.8	<5.00	<3.0	<2	0.2
St. Mary's River	01-Nov-07			6.6								
St. Mary's River	06-Dec-07	0.09	<0.005	6.7	<0.5	<2	3.3	3.5	<5.00	<3.0	<2	0.22
St. Mary's River	06-Dec-07			6.2								
St. Mary's River	16-Jun-09	0.02	<0.005	6.8	<0.5	<2	<1.0	3.6	<5.00	<3.0	<2	0.18
St. Mary's River	11-Aug-09	0.03	<0.005	6.9	<0.5	<2	1.3	4.3	<5.00	<1.5	<2	0.28

Sample Station	Date Sampled	Total Organic Carbon mg/L	Total Phosphorus mg/L	Turbidity NTU	Vanadium ug/L	Zinc ug/L
Kelley River	29-Oct-08			0.96		
Kelley River	29-Oct-08	13.3	0.006	1.02	<2	<5
Kelley River	21-May-09	10.4	0.007	0.56	<2	6
Kelley River	07-Jul-09	15.4	0.011	0.68	<5	<5
Lahave River	07-May-08	6.9	0.009	0.64	<2	<5
Lahave River	07-May-08	6.9	0.009	0.64	<2	<5
Lahave River	12-Jun-08	8.9	0.008	1.14	<2	<5
Lahave River	30-Oct-08	14.1	0.013	1.8	<2	<5
Lahave River	26-Nov-08			1.26		
Lahave River	26-Nov-08	11.1	0.015	1.2	<2	<5
Lahave River	14-May-09	7.8	<0.005	0.77	<2	<5
Lahave River	08-Jul-09	11.7	0.012	1.03	<2	6
St. Mary's River	10-May-07	3.8	0.005	0.55	<2	<5
St. Mary's River	10-May-07			0.56		
St. Mary's River	11-Jul-07	5.9	0.006	0.83	<2	<5
St. Mary's River	01-Nov-07	6.5	0.007	0.68	<2	<5
St. Mary's River	01-Nov-07			0.64		
St. Mary's River	06-Dec-07	4.8	<0.005	0.68	<2	6
St. Mary's River	06-Dec-07			0.6		
St. Mary's River	16-Jun-09	4.4	0.006	1.54	<2	<5
St. Mary's River	11-Aug-09	6.7	0.009	0.66	<2	<5

APPENDIX IV – LAND USE

DETAILED BREAKDOWN OF LAND USE CATEGORIES

Table IV - 1 Pockwock Lake Watershed land classification conditions

POCKWOCK WATERSHED LAND CLASSIFICATION CONDITIONS					
For/Non Description	Grouping	Area (km)	% of Group	% of Watershed	Group % of Watershed
Agriculture	Agriculture	0.00	100.00	0.01	0.0
Rock barren-<49%exposed rock>25%live tree cvr	Barren	0.16	49.70	0.29	0.6
Barren-<25%live tree cvr >50%rock/woody plants	Barren	0.04	11.84	0.07	
Gravel pit-activer/non used extract gravel	Barren	0.12	38.47	0.22	
Clear Cut-<25%residuals in crn closure	Clearcut	6.89	98.83	12.77	12.9
Partial depletion not verified	Clearcut	0.08	1.17	0.15	
Natural Forest Stand (not treated silviculturally)	Forest	32.53	99.44	60.28	60.6
Treated Forest Stand (treatment not classified)	Forest	0.09	0.27	0.16	
Dead-stand w<25%crn close live material	Forest	0.09	0.27	0.17	
Treated stand-silvicult treat identif	Forest	0.00	0.01	0.01	
Urban	Urban	0.68	46.00	1.25	2.7
Misc-nonforested misc (eg. old mill, rifle range)	Urban	0.04	2.62	0.07	
Powerline corridor	Urban	0.22	14.98	0.41	
Road Corridor	Urban	0.54	36.41	0.99	
Wetlands general-wet not lake/river/stream/bog	Wetland/Water	0.73	5.85	1.35	23.1
Open bogs-mostly ericaceous plnts<25%live tree	Wetland/Water	0.48	3.82	0.88	
Treed bogs-mostly ericaceous>25%stunt tree	Wetland/Water	0.54	4.34	1.00	
Lake wetland-wetland in freshwater	Wetland/Water	0.09	0.70	0.16	
Inland water-lks, rivers, reservoirs, canal, pond	Wetland/Water	10.65	85.29	19.74	
Totals:		53.97		100.00	100.0

Table IV - 2 Shelburne River Watershed land classification conditions

SHELBURNE RIVER WATERSHED LAND CLASSIFICATION CONDITIONS					
For/Non Description	Grouping	Area (km)	% of Group	% of Watershed	Group % of Watershed
Rock barren-<49%exposed rock>25%live tree cvr	Barren	1.13	7.09	0.42	5.92
Barren-<25%live tree cvr >50%rock/woody plants	Barren	14.70	92.58	5.48	5.92
Gravel pit-activer/non used extract gravel	Barren	0.05	0.33	0.02	5.92
Clear Cut-<25%residuals in crn closure	Clearcut	0.80	76.48	0.30	0.39
Partial depletion verified-cut hrdwd resid>24%crn	Clearcut	0.25	23.52	0.09	0.39
Natural Forest Stand (not treated silviculturally)	Forest	200.78	99.25	74.83	75.40
Treated Forest Stand (treatment not classified)	Forest	0.28	0.14	0.11	75.40
Dead-1-stand w 25-50% crn close live material	Forest	0.05	0.03	0.02	75.40
Brush-<25%merch.tree cov>24%woody plants	Forest	1.19	0.59	0.44	75.40
Brush-<25%merch.tree cov>24%woody plants	Forest	0.00	0.00	0.00	75.40
Misc-nonforested misc (eg. old mill, rifle range)	Urban	0.66	100.00	0.25	0.25
Wetlands general-wet not lake/river/stream/bog	Wetland/Water	13.59	28.08	5.07	18.04
Beaver flowage	Wetland/Water	0.39	0.81	0.15	18.04
Open bogs-mostly ericaceous plnts<25%live tree	Wetland/Water	3.90	8.06	1.45	18.04
Treed bogs-mostly ericaceous>25%stunt tree	Wetland/Water	3.94	8.14	1.47	18.04
Lake wetland-wetland in freshwater	Wetland/Water	0.11	0.24	0.04	18.04
Inland water-lks, rivers, reservoirs, canal, pond	Wetland/Water	26.47	54.67	9.87	18.04
Totals:		268.30		100.00	100.00

Table IV - 3 Northeast Margaree River Watershed land classification conditions

NORTH EAST MARGAREE RIVER WATERSHED LAND CLASSIFICATION CONDITIONS					
For/Non Description	Grouping	Area (km)	% of Group	% of Watershed	Group % of Watershed
Agriculture	Agriculture	2.8	100.0	0.8	0.8
Rock barren-<49%exposed rock>25%live tree cvr	Barren	0.0	0.4	0.0	2.6
Barren-<25%live tree cvr >50%rock/woody plants	Barren	9.4	98.0	2.6	
Gravel pit-activer/non used extract gravel	Barren	0.2	1.6	0.0	
Clear Cut-<25%residuals in crn closure	Clearcut	0.8	99.8	0.2	0.2
Partial depletion not verified	Clearcut	0.0	0.2	0.0	
Natural Forest Stand (not treated silviculturally)	Forested	239.3	74.1	65.3	88.1
Treated Forest Stand (treatment not classified)	Forested	29.5	9.1	8.0	
Old field-<25% crn close and <1m height tree	Forested	0.5	0.2	0.1	
Dead-stand w<25%crn close live material	Forested	1.2	0.4	0.3	
Dead-1-stand w 25-50% crn close live material	Forested	1.7	0.5	0.5	
Dead-2-stand w51-100% crn close live mat.	Forested	0.5	0.1	0.1	
Treated stand-silvicult treat identif	Forested	25.3	7.8	6.9	
Dead-3-26-50%crn close/equiv dead mat	Forested	0.9	0.3	0.2	
Dead-4-51-75% crn close/equiv dead mat	Forested	0.2	0.1	0.1	
Plantation	Forested	18.9	5.9	5.2	
Brush-<25%merch.tree cov>24%woody plants	Forested	2.4	0.7	0.7	
Alders <75% cover	Forested	1.5	0.5	0.4	
Alders >75% cover	Forested	1.0	0.3	0.3	
Urban	Urban	0.9	81.3	0.3	0.3
Misc-nonforested misc (eg. old mill, rifle range)	Urban	0.0	3.1	0.0	
Road Corridor	Urban	0.2	15.5	0.0	
Wetlands general-wet not lake/river/stream/bog	Wetland/Water	5.3	18.1	1.4	8.0
Beaver flowage	Wetland/Water	1.1	3.9	0.3	
Open bogs-mostly ericaceous plants<25%live tree	Wetland/Water	10.3	35.0	2.8	
Treed bogs-mostly ericaceous>25%stunt tree	Wetland/Water	11.2	38.0	3.0	
Lake wetland-wetland in freshwater	Wetland/Water	0.0	0.2	0.0	
Inland water-lks, rivers, reservoirs, canal, pond	Wetland/Water	1.4	4.8	0.4	
Totals:		366.7	100.0	100.0	100.0

Table IV - 4 Kelley River Watershed land classification conditions

KELLEY RIVER WATERSHED LAND CLASSIFICATION CONDITIONS					
For/Non Description	Grouping	Area (km)	% of Group	% of Watershed	Group % of Watershed
Blueberries	Agriculture	0.04	100	0.1	0.1
Barren-<25%live tree cvr >50%rock/woody plants	Barren	0.11	86.3	0.2	0.2
Gravel pit-activer/non used extract gravel	Barren	0.02	13.7	0.0	
Clear Cut-<25%residuals in crn closure	Clearcut	4.32	100.0	6.7	6.7
Natural Forest Stand (not treated silviculturally)	Forest	32.49	62.7	50.3	80.3
Treated Forest Stand (treatment not classified)	Forest	1.13	2.2	1.8	
Dead-stand w<25%crn close live material	Forest	5.05	9.7	7.8	
Dead-1-stand w 25-50% crn close live material	Forest	6.34	12.2	9.8	
Dead-2-stand w51-100% crn close live mat.	Forest	3.56	6.9	5.5	
Plantation	Forest	2.79	5.4	4.3	
Brush-<25%merch.tree cov>24%woody plants	Forest	0.33	0.6	0.5	
Alders<75%cover	Forest	0.13	0.3	0.2	
Misc-nonforested misc (eg. old mill, rifle range)	Urban	0.03	3.9	0.0	1.3
Road Corridor	Urban	0.78	96.1	1.2	
Wetlands general-wet not lake/river/stream/bog	Wetland/Water	2.93	39.5	4.5	11.5
Beaver flowage	Wetland/Water	0.10	1.4	0.2	
Open bogs-mostly ericaceous plnts<25%live tree	Wetland/Water	3.03	40.9	4.7	
Treed bogs-mostly ericaceous>25%stunt tree	Wetland/Water	1.22	16.5	1.9	
Inland water-lks, rivers, reservoirs, canal, pond	Wetland/Water	0.13	1.7	0.2	
	Totals:	64.54		100.0	100.0

Table IV - 5 St. Mary's River Watershed land classification summary

Land Type	km^2	% of Total Area
Agriculture	14.0	1.0
Barren	6.8	0.5
Clearcut	127.9	9.6
Forested	1102.8	82.5
Urban	5.5	0.4
Wetland/Water	79.5	5.9
Total	1336.8	100.0

Table IV - 6 Lahave River Watershed land classification summary

Land Type	km^2	% of Total Area
Agriculture	26.7	2.1
Barren	1.8	0.1
Clearcut	0.0	0.0
Forested	1086.1	86.3
Urban	17.1	1.4
Wetland/Water	126.9	10.1
Total	1258.7	100.0