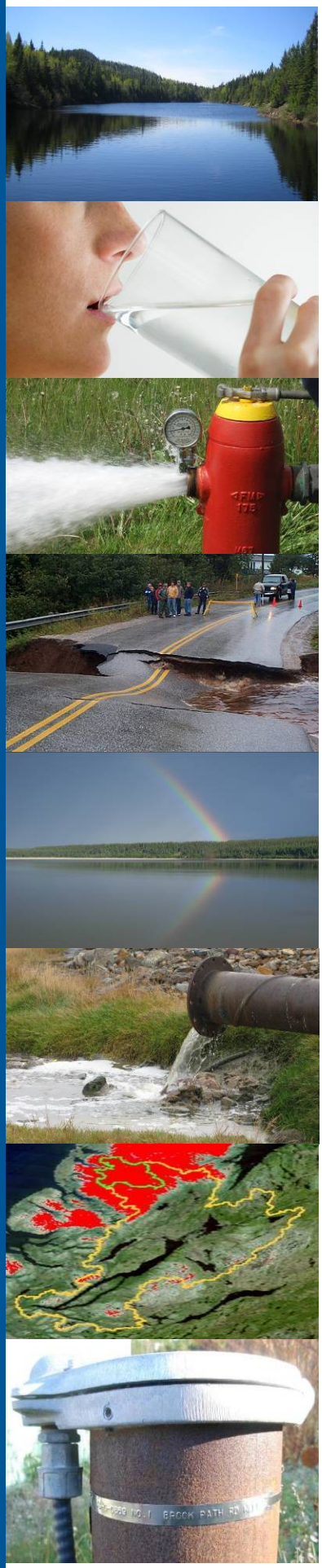

Waterford River @ Kilbride

NF02ZM0009

September 2013

Government of Newfoundland & Labrador

Department of Environment and Conservation

Real Time Water Quality Monthly Report
Waterford River - St. John's, NL
August 27 to September 30, 2013

General

- Data from the Waterford River real-time station is regularly monitored by the Water Resources Management Division (WRMD).
- The instrument used for the deployment period from August 27 to September 30, 2013 was a YSI 6600 series multi-probe, which continuously measured water temperature, dissolved oxygen, pH, specific conductivity and turbidity. The duration of the deployment was 35 days.

Maintenance and Calibration of Instruments

- **Table 1** displays the dates when routine cleaning, maintenance and calibration were performed on the water quality probe during this deployment.

Table 1: **Table of Water Quality Probe Installation and Removal**

Date Deployed	Date Removed
August 27, 2013	September 30, 2013

- Water quality readings were taken with a second freshly cleaned and calibrated water quality instrument at the time of deployment and removal, in compliance with WRMD quality assurance and quality control protocol.

Deployment

- Deployment comparison rankings between the field instrument and the QAQC instrument are summarized in **Table 2**.

Table 2: Field sonde to QAQC sonde comparison rankings for deployment of the RTWQ instrument on August 27, 2013

Parameter	Field Sonde	QAQC Sonde	Difference / % Difference	Ranking
Temperature ('C)	18.27	18.10	0.17	Excellent
pH	8.27	7.87	0.40	N/A
Specific Conductivity (µS/cm)	532.0	532.9	0.2	Excellent
Total Dissolved Solids (g/l)	0.3460	0.3412	0.0048	
Dissolved Oxygen (%-Sat)	109.4	101.1	8.3	
Dissolved Oxygen (mg/l)	10.39	9.60	0.79	Fair
Turbidity (NTU)	2.4	5.0	2.6	Good

- **Deployment rankings** of "excellent" and "good" for water temperature, specific conductivity and turbidity indicate successful cleaning and calibration, which enable these sensors to produce reliable data during the deployment period. A deployment ranking of "fair" for dissolved oxygen (DO) indicates that the difference between the DO measurements on the field sonde and the QAQC sonde at the time of deployment meets the QAQC protocol for Water Resources Management Division and DO data collected during this deployment are reliable; however, the "fair" ranking indicates that the difference between the DO measurements on the two instruments is approaching the acceptable limits of the protocol. The glass bulb is broken on the pH sensor and no pH data was available for this deployment period.

Removal

- Removal comparison rankings between the field instrument and the QAQC instrument are summarized in **Table 3**.

Table 3: Field sonde to QAQC sonde comparison rankings for removal of the RTWQ instrument on September 30, 2013

Parameter	Field Sonde	QAQC Sonde	Difference / % Difference	Ranking
Temperature ('C)	12.34	12.53	0.19	Excellent
pH	8.51	7.20	1.31	N/A
Specific Conductivity (µS/cm)	334.0	364.0	9.0	Good
Total Dissolved Solids (g/l)	0.2170	0.2330	0.0160	
Dissolved Oxygen (%-Sat)	102.8	98.4	4.4	
Dissolved Oxygen (mg/l)	10.98	10.28	0.70	Fair
Turbidity (NTU)	15.2	0.9	14.3	Poor

Removal rankings of “excellent” and “good” for water temperature and specific conductivity increase confidence that the data collected for these parameters over the duration of this deployment are reliable. A removal ranking of “fair” for dissolved oxygen data indicates the difference between the DO measurements on the field sonde and the QAQC sonde at the time of removal meets the QAQC protocol for Water Resources Management Division and all DO data collected during this deployment are reliable; however, the “fair” ranking indicates that the difference between the DO measurements on the two instruments is approaching the acceptable limits of the protocol. A removal ranking of “poor” for turbidity indicates that the difference between the turbidity measurements, on the field sonde compared to the QAQC sonde, is outside the acceptable range for Water Resources Management Division QAQC protocol. It is quite likely that the turbidity sensor became fouled during this deployment, and some of the data collected prior to the fouling may be reliable. The turbidity data will be scrutinized more closely in the **Data Interpretation** section, below. As indicated above, the pH sensor is broken and no pH data was collected during this deployment.

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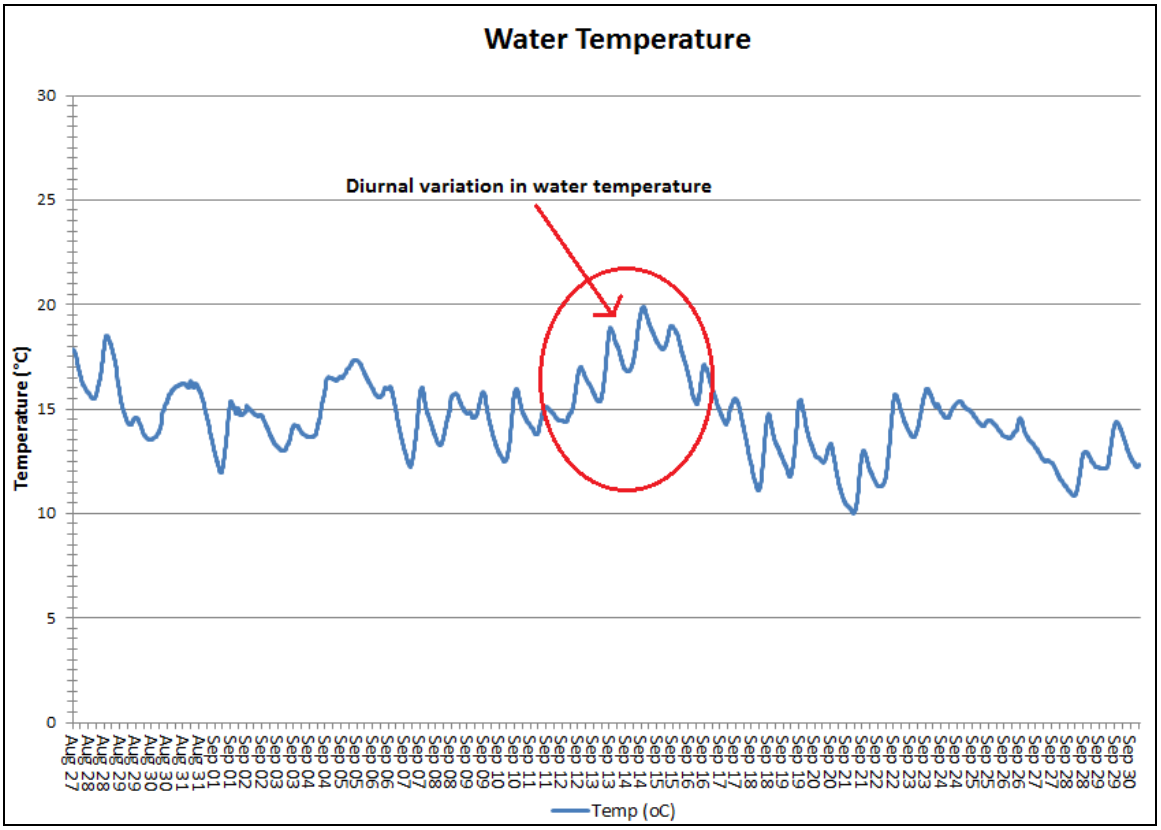
Data Interpretation

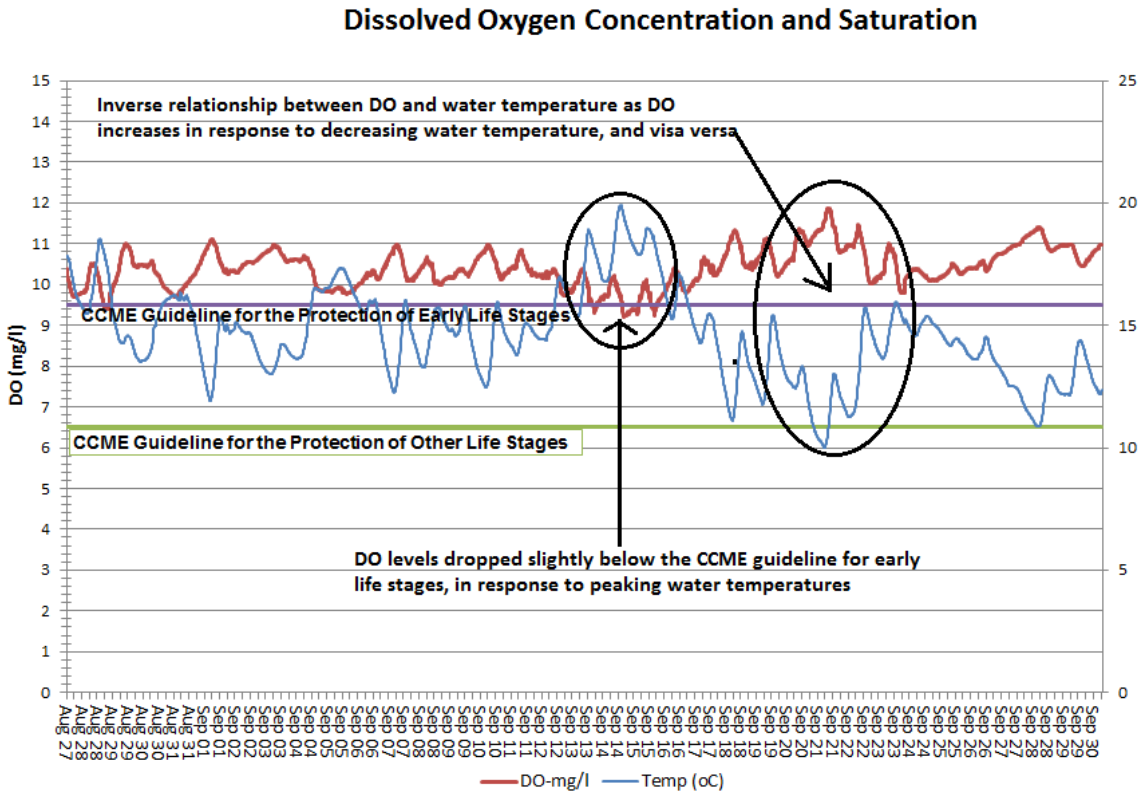
- A graph of **water temperature,** which fluctuated between 10.02 and 19.91^{o}C during this deployment period, is shown in blue ink in **Figure 1**, below. Diurnal variation in water temperature is clearly seen with colder temperatures occurring at night and warmer temperatures occurring during the day, corresponding with cooler nightly air and warmer daily air temperatures. Water temperature during this deployment is showing an overall decreasing trend in response to seasonally decreasing air temperature. Daily air temperatures for this deployment period are shown in Environment Canada's Daily Climate Data, in **Appendix 1** at the end of this report.

Figure 1: Water Temperature



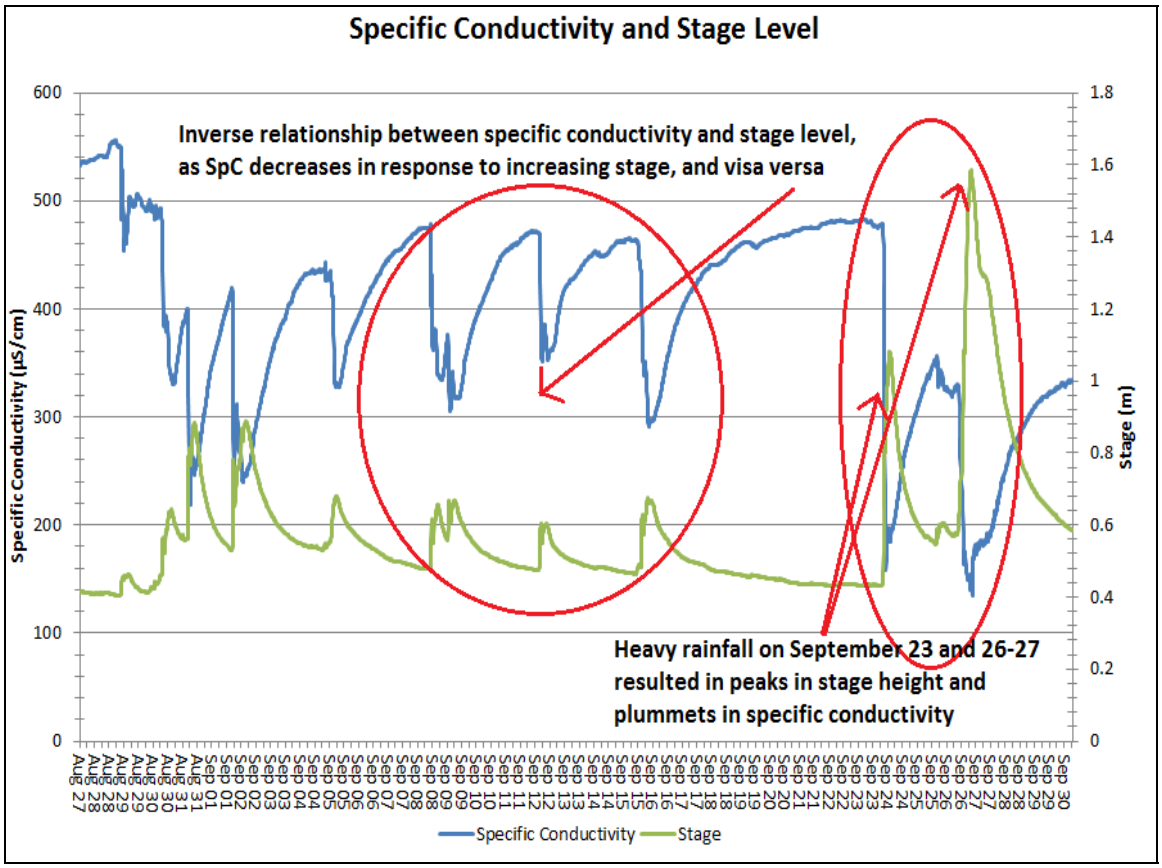
- **Dissolved Oxygen** (DO) measurements during this deployment ranged between 9.21 and 11.87 mg/l. DO concentrations are shown in red in the graph in **Figure 2**, along with water temperatures which are shown in blue. The inverse relationship between dissolved oxygen concentration and water temperature is apparent in the graph, as DO levels decrease in response to increasing water temperatures, and DO levels increase in response to decreasing water temperatures. This relationship is based on the fact that the solubility of oxygen is greater in colder water than in warmer water. Most DO measurements were above the minimum guidelines recommended by the CCME for the protection of freshwater aquatic life, of 9.5 mg/L for early life stages and 6.5 mg/L for other life stages in cold water systems. However, some DO values fell below 9.5 mg/L corresponding with the highest water temperatures of the deployment period.

Figure 2: Dissolved Oxygen



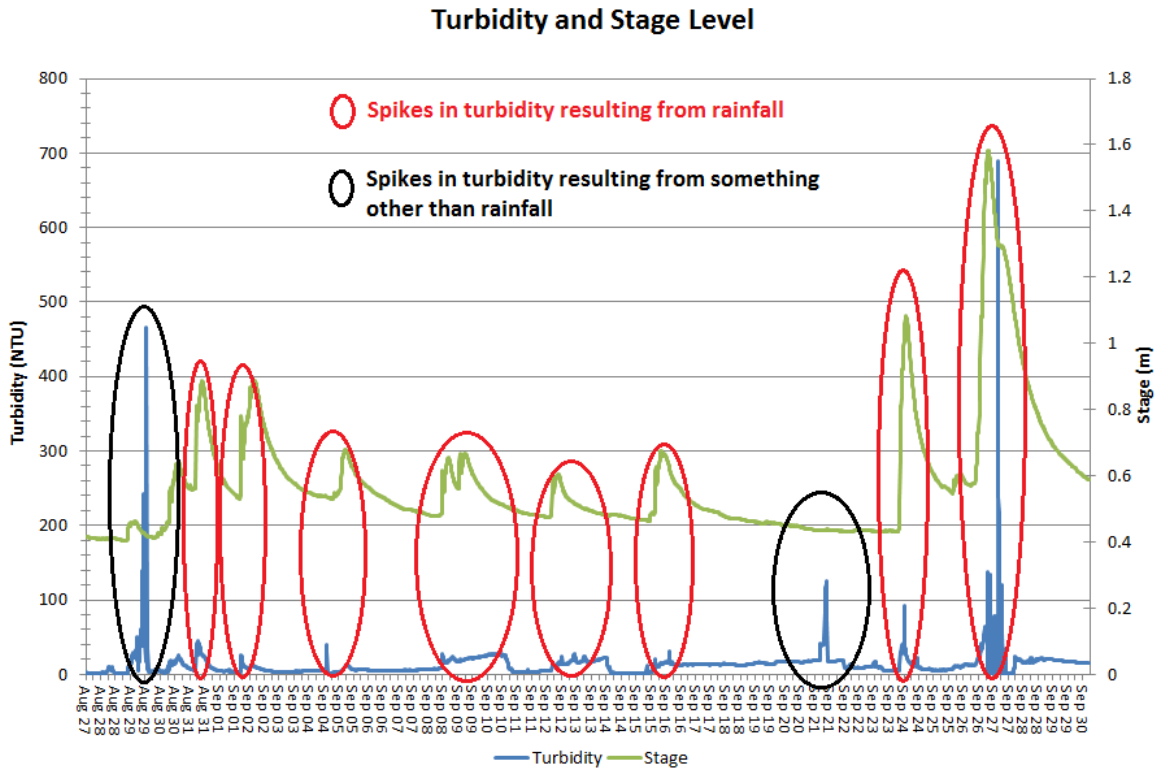
- **Specific conductivity (SpC)** measures the ability of water to pass an electrical current. Conductivity in streams and rivers is affected by the geology of the area through which the water flows. Streams that run through granite bedrock tend to have lower conductivity than those that flow through limestone and clay soils. High specific conductance readings are often influenced by urban run-off. The effects of urban run-off are dependent upon the season. During warmer temperatures, when road salt is not being used for ice control, rainfall and urban run-off can have a dilution effect, causing specific conductivity levels to decrease as stage height increases. However, during the winter months when road salting operations are in effect, urban run-off can result in spikes in specific conductivity. In **Figure 4,** below, specific conductivity (shown in blue) tends to increase during dry spells marked by decreases in stage level (shown in green); and conversely, specific conductivity decreases as stage level increases. This observation is supported by Environment Canada Daily Climate Data, presented in **Appendix 1,** at the end of this report. The climate data indicate significant rainfall occurred on September 23 and 26-27, which coincide with concurrent spikes in stage level and dips in conductivity. Specific conductance values in Waterford River during this deployment period were within the expected range for the river at this time of year, ranging between 135 and 556µS/cm.

Figure 4: Specific Conductance and Stage



- **Turbidity** is a measure of water clarity, and the degree to which material suspended in water decreases the passage of light through the water. Suspended materials include soil particles (clay, silt, and sand), algae, plankton, microbes, and other substances. There were several turbidity spikes during this deployment in response to significant rainfall, which occurred on August 30 and September 1-2, 4-5, 8-9, 12, 15, 23-24 and 26-27. There were two other turbidity spikes that occurred on August 29 and September 21 that cannot be attributed to precipitation, and may be the result of land based activity upstream in the watershed. Turbidity measurements ranged from 0 to 689.5 NTU during this deployment, and are shown in blue in the graph in **Figure 5.** Rainfall is represented as increased stage level in green. It is important to note that the turbidity QAQC removal ranking at the end of the deployment was "poor," suggesting that at least some of the turbidity data may be questionable. Close scrutiny of the data indicates that it reflects weather patterns and returns to background levels after precipitation events, which may suggest that the data are ok but should be used with caution in any applications. It is possible that there was a problem with the turbidity sensor on the QAQC instrument which resulted in a "poor" comparability ranking at the time the field instrument was removed from deployment.

Figure 5: Turbidity



Appendix 1:

Environment Canada Daily Climate Data (August 27-31, 2013)
St. John's International Airport

August 2013	Max Temp °C	Min Temp °C	Mean Temp °C	Total Rain mm	Max WindGust km/h
DAY					
27 -	22.6	13	17.8	0.6	41
28 -	22.4	9.8	16.1	4	48
29 -	12.4	9.4	10.9	3.6	46
30 -	18.9	12.4	15.7	**18.6**	65
31					

*Blank cells indicate no data available

See September 2013 daily climate data, next page.

Environment Canada Daily Climate Data (September, 2013)
St. John's International Airport

Sept 2013	Max Temp °C	Min Temp °C	Mean Temp °C	Total Rain mm	Max Gust km/h
DAY					
01 -	18	5.1	11.6	**15.2**	57
02 -	17.5	9.7	13.6	**2.4**	50
03 -	13.8	10	11.9	0.6	43
04 -	23	12.9	18	**9.4**	61
05 -	21.2	15	18.1	**2.2**	46
6					
07 -	19.5	6.8	13.2	0	54
08 -	18.9	12.3	15.6	**11.8**	56
09 -	17	9.6	13.3	**6.2**	72
10 -	19.7	10.9	15.3	0	59
11 -	16.9	11.2	14.1	1	52
12 -	20.2	15.1	17.7	**11.8**	59
13 -	25	16.2	20.6	0.6	59
14 -	26.1	17.9E	22.0E	M	M
15 -	23.3	13.3	18.3	**14.4**	54
16 -	20	11.3	15.7	0	52
17 -	17.6	3.6	10.6	2.8	41
18 -	17.1	4.3	10.7	0	63
19 -	18.8	7.8	13.3	0	32
20 -	11.9	3.3	7.6	0.2	52
21 -	13.1	3.1	8.1	0	44
22 -	21.7	11.1	16.4	0	57
23 -	19.2	13.5	16.4	**30.6**	57
24 -	18.8	13.5	16.2	**5.2**	56
25 -	14.8	11.1	13	**6.4**	33
26 -	13	9.7	11.4	**69.6**	52
27 -	9.8	5.9	7.9	**20.4**	70
28 -	17	5.5	11.3	T	50
29 -	20.8	11.2	16	0	43
30 -	24.7	11.5	18.1	0	<31

*Blank cells = no data available
** M = missing
***E = estimated
**** T = trace

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