Waterford River
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December 2013 to January 2014

Government of Newfoundland & Labrador

Department of Environment and Conservation

Real Time Water Quality Monthly Report
Waterford River - St. John's, NL
December 4, 2013 to January 31, 2014

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 December 4, 2013 to January 31, 2014 was a YSI 6600 series multi-probe, which continuously measured water temperature, pH, dissolved oxygen, specific conductivity and turbidity. The duration of the deployment was 34 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
December 4, 2013	January 31, 2014

- 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 December 4, 2013

Parameter	Field Sonde	QAQC Sonde	Difference / % Difference	Ranking
Temperature ('C)	7.56	7.62	0.06	Excellent
pH	7.06	7.20	0.14	Excellent
Specific Conductivity (µS/cm)	294.0	289.0	1.7	Excellent
Total Dissolved Solids (g/l)	0.1910	0.1880	0.0030	
Dissolved Oxygen (%-Sat)	98.4	100.4	2.0	
Dissolved Oxygen (mg/l)	11.77	12.00	0.23	Excellent
Turbidity (NTU)	24.2	22.4	1.8	Excellent

- **Deployment rankings** of "excellent" for water temperature, pH, specific conductivity, dissolved oxygen and turbidity indicate successful cleaning and calibration, which enable these sensors to produce reliable data during the 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 January 31, 2014

Parameter	Field Sonde	QAQC Sonde	Difference / % Difference	Ranking
Temperature ('C)	0.30	0.61	0.31	Good
pH	6.53	7.00	0.47	Good
Specific Conductivity (µS/cm)	596.0	610.0	2.3	Excellent
Total Dissolved Solids (g/l)	0.3880	0.3910	0.0030	
Dissolved Oxygen (%-Sat)	100.5	103.5	3.0	
Dissolved Oxygen (mg/l)	14.55	14.85	0.30	Excellent
Turbidity (NTU)	444.2	1.2	443.0	Poor

Removal rankings of “excellent” and “good” for water temperature, pH, specific conductivity and dissolved oxygen increase confidence that the data collected for these parameters over the duration of this deployment are reliable. A removal ranking of “poor” for turbidity indicates that the difference in turbidity measurements at the time of removal, between the field sonde and the QAQC sonde, is outside the acceptable limits of WRMD’s QAQC protocol. A closer look at turbidity measurements in the Data Interpretation section below, will determine whether some of the turbidity data collected during this deployment are reliable, or whether all turbidity data should be treated as unreliable.

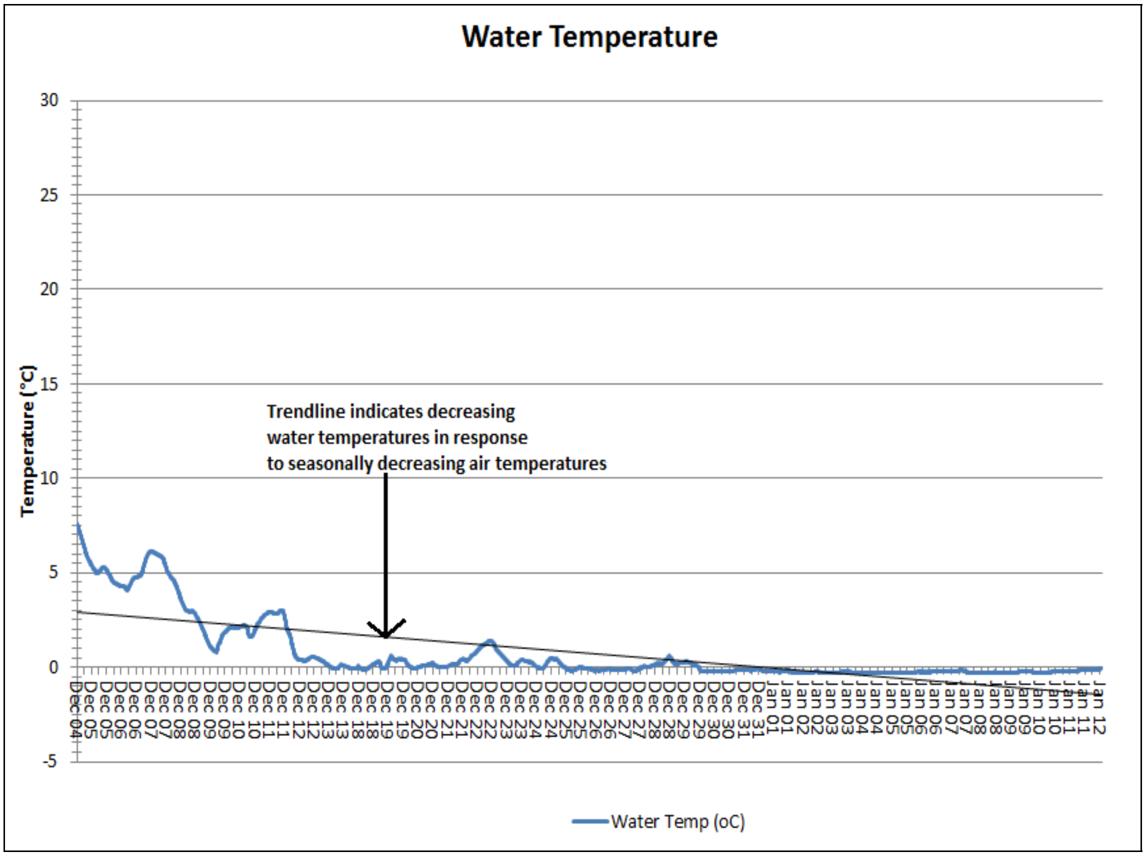
<u>Data Interpretation</u>

There were two periods during this deployment when data was unreliable: December 14 – 17, when the sonde was partially out of water due to decreasing water levels; and January 12-31 when heavy precipitation and flow on January 12 resulted in the sonde’s protective casing becoming partially filled with gravel, thereby impairing water quality measurements. **Data will be interpreted from December 4-14 and from December 17 – January 12.**

The pH sensor, which was removed from the sonde at the end of August 2013, due to a malfunction, was replaced with a new, freshly calibrated pH sensor for this deployment and pH data was collected.

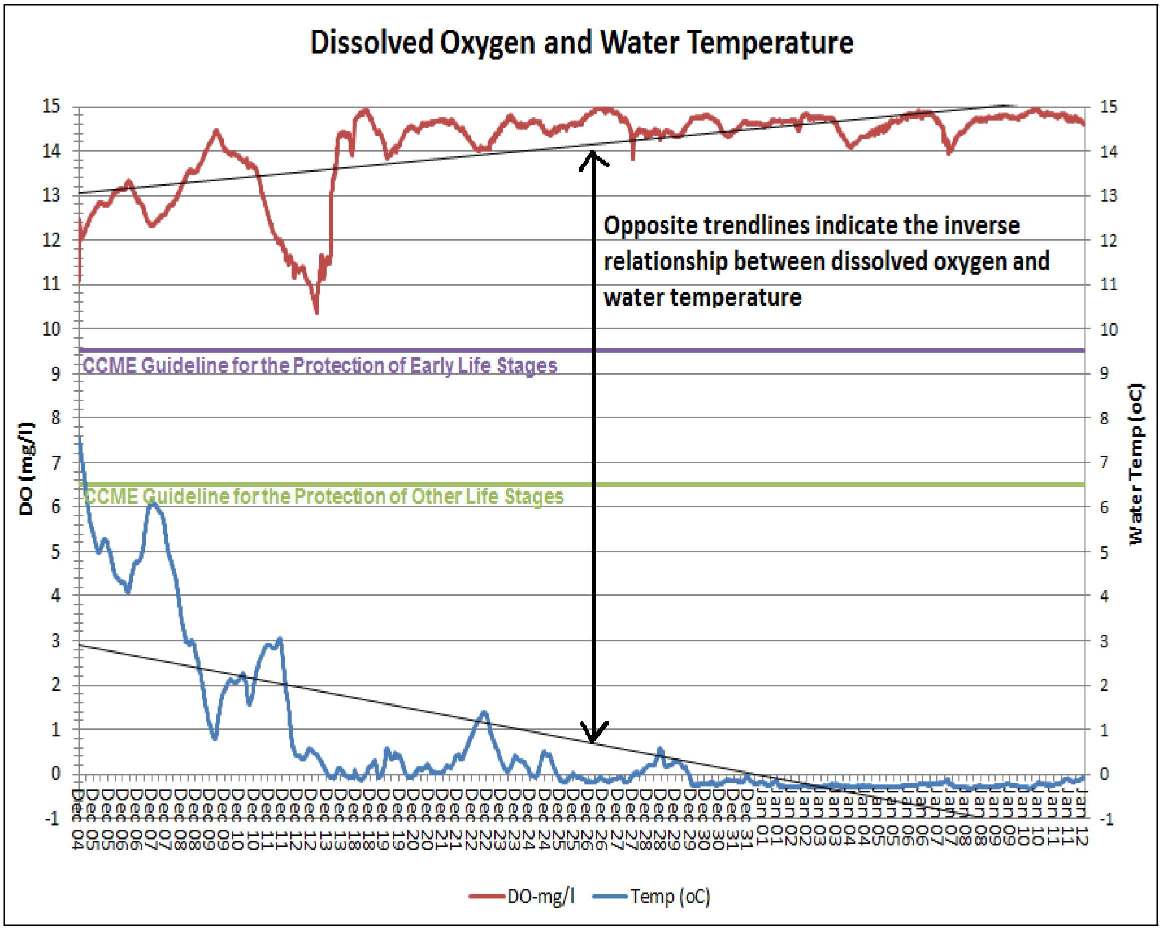
- **Water temperature,** which fluctuated between -0.86 and 7.56°C during this deployment period, is shown in blue in the graph in **Figure 1**. The graph indicates a decreasing trend in water temperature, which corresponds with seasonally decreasing air temperatures. Fluctuations in water temperature correspond with rainfall and sporadic increases in air temperature, as shown in Environment Canada's Daily Climate Data in **Appendix 1** at the end of this report.

Figure 1: Water Temperature



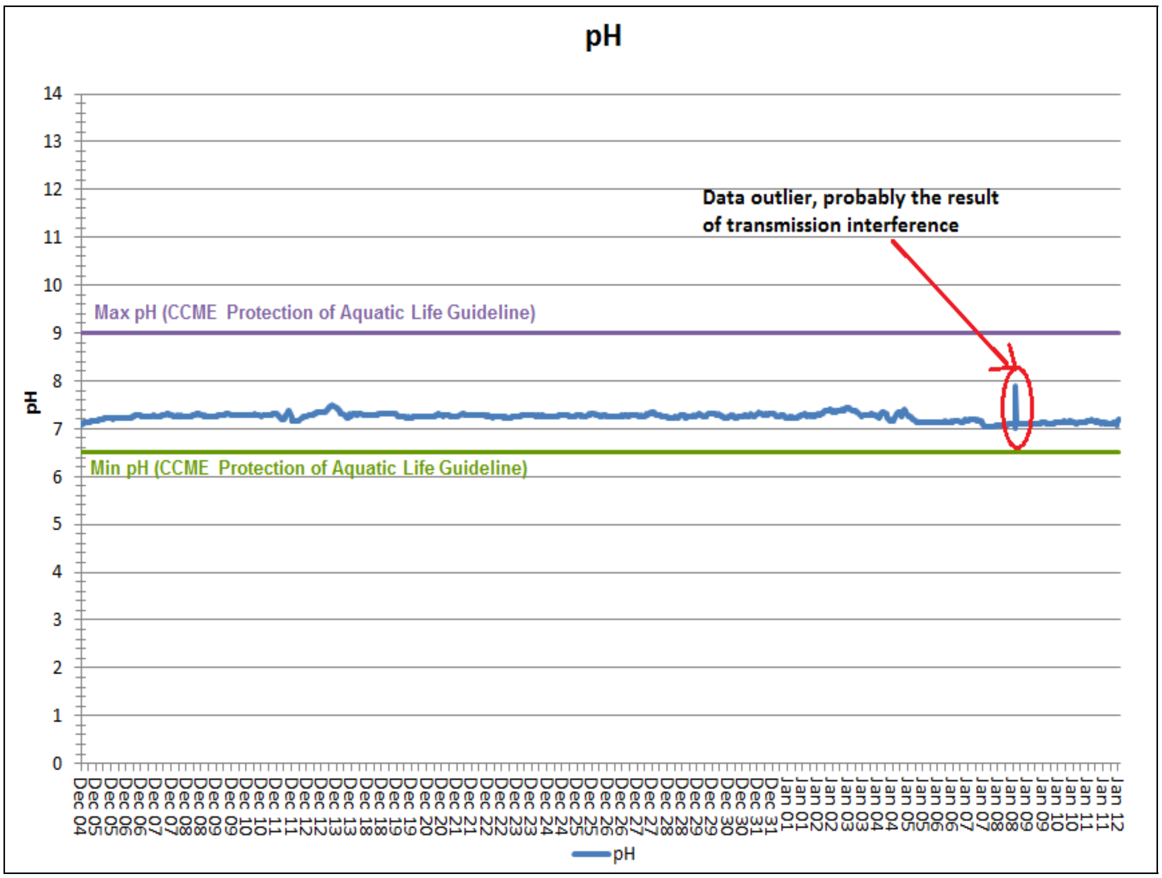
- **Dissolved Oxygen** (DO) measurements during this deployment ranged between 10.43 and 14.34 mg/l. DO concentrations are shown in red in the graph in **Figure 2**, along with water temperatures which are shown in blue. The inverse relationship between dissolved oxygen concentration and water temperature is apparent in the graph, as DO levels increase in response to decreasing water temperatures, and visa versa. This relationship is based on the fact that the solubility of oxygen is greater in colder water than in warmer water. All 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

Figure 2: Dissolved Oxygen



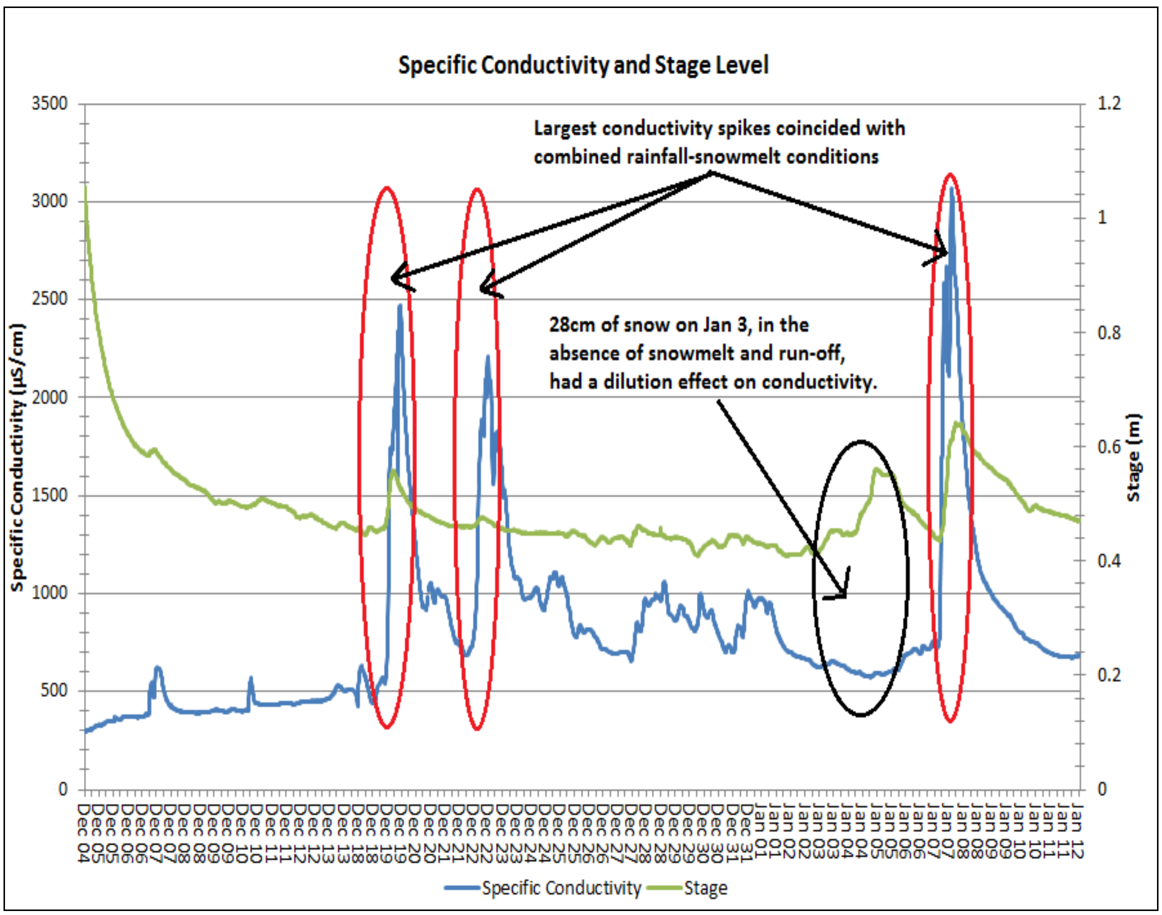
- The **pH** of water is a measure of the concentration of hydrogen ions, with pH decreasing as the concentration of hydrogen ions increases. The pH of water determines the solubility and biological availability of chemical constituents such as nutrients and heavy metals. The pH of pure water is 7.0 pH units, but both natural (geology, precipitation) and human (forest harvesting, urban run-off) processes can alter the pH of water. Metals tend to be more toxic at lower pH because they are more soluble. Photosynthesis uses up hydrogen molecules, which causes the concentration of hydrogen ions to decrease and therefore the pH to increase. For this reason, pH may be higher during daylight hours and during the growing season, when photosynthesis is at a maximum. pH values during this deployment period were quite stable, hovering near neutral pH values and ranging from 7.01 to 7.90 pH units. There was one outlying pH value recorded on January 8, which occurred over a maximum duration of 15 minutes, and is thus likely to be the result of a transmission error rather than a true pH measurement. All pH measurements were within the CCME recommended guideline range for the protection of aquatic life, of 6.5 - 9.0 pH units. pH values for this deployment are shown in blue in the graph in **Figure 3.**

Figure 3: pH



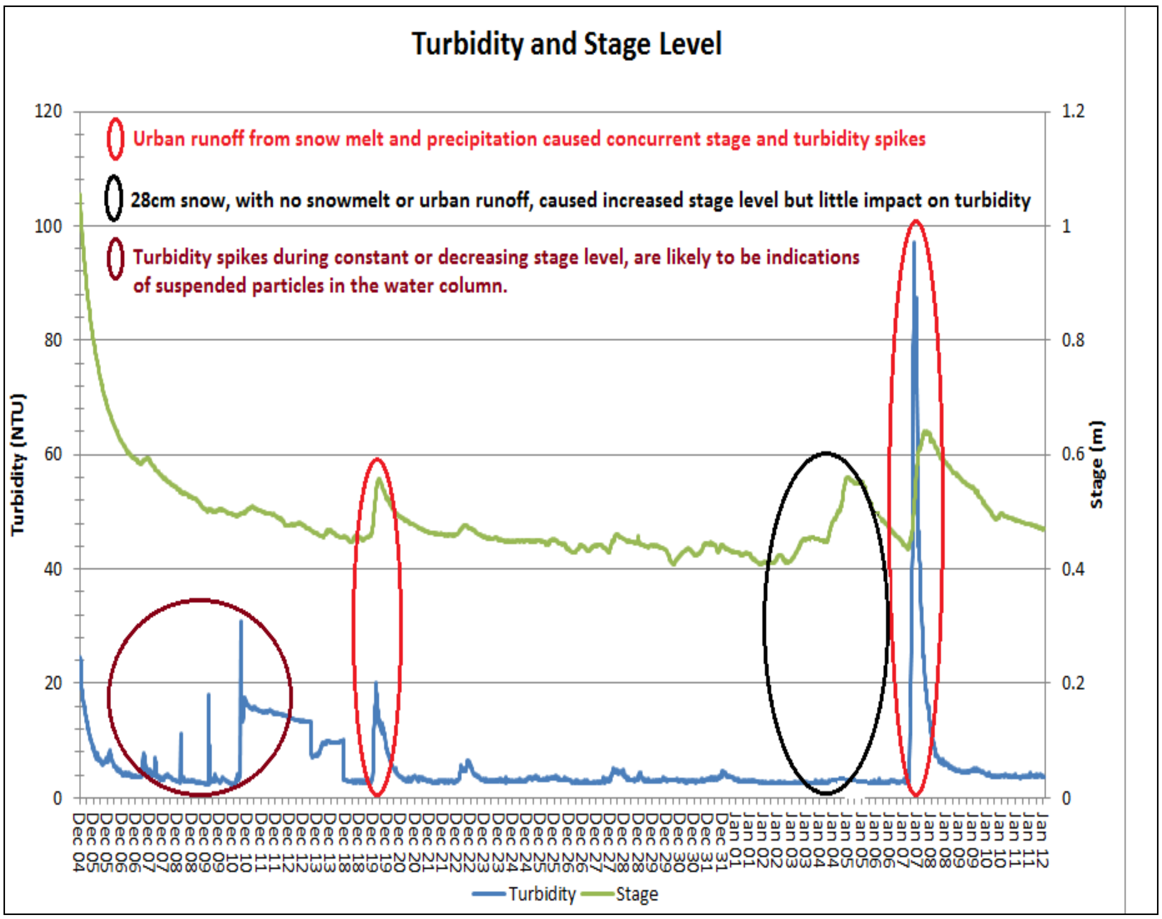
▪ **Specific conductivity (SpC)** measures the ability of water to pass an electrical current. Conductivity in streams and rivers is affected by the geology of the area through which the water flows. Streams that run through granite bedrock tend to have lower conductivity than those that flow through 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 level increases. However, during the winter months when road salting operations are in effect, urban run-off can result in spikes in specific conductivity. The graph in **Figure 4** shows three large specific conductivity spikes (in blue), occurring on December 19, 22 and January 7. The following three combined weather events occurred during each large conductivity spike: (i) the maximum air temperature rose above 0 ^{o}C; (ii) there were >25cm of snow on the ground; and (iii) there was either rainfall, snowfall, or both, on that day. Thus, the large conductivity spikes were the result of salt bearing urban run-off, caused by precipitation and snowmelt. Smaller conductivity spikes occurred on December 6, 10, 18 and 24-31, in response to precipitation in the form of rain and snow, and air temperatures hovering above and below freezing, resulting in run-off. On January 3, 28cm of snow fell while air temperatures remained well below 0^{o}C, so there was no urban run-off and the snowfall had a dilution effect on specific conductivity. Environment Canada's Daily Climate Data for December 2013 and January 2014 are presented in **Appendix 1.** Given the weather conditions during this deployment period, conductivity levels in Waterford River were within the expected range at this time of year, fluctuating between 294 and 3069 µS/cm, with a mean of 797.8µS/cm and a median of 705µS/cm.

Figure 4: Specific Conductance and Stage Level



▪ **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, snow, ice and other substances. Turbidity measurements were near background levels for much of this deployment, as shown in the graph in **Figure 5**. Turbidity measurements are shown in blue ink, while stage level is shown in green. There were two obvious turbidity spikes coinciding with increased stage height, on December 18 and January 7. There was mixed precipitation and air temperatures were above freezing on both of these dates, resulting in urban run-off. Although 28cm of snow fell on January 3, air temperatures remained below 0^o, so stage level at Waterford River increased but there was no significant change in turbidity, with the absence of urban run-off. Daily precipitation and air temperatures during this deployment period are given in Environment Canada's Climate Data, in **Appendix 1**.

Figure 5: Turbidity



Appendix 1:

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

December 2013	Max Temp °C	Min Temp °C	Mean Temp °C	Total Rain mm	Total Snow cm	Total Precip mm	Snow on Grnd cm	Max Wind Gust km/h
DAY								
01	-2	-10.7	-6.4	0	0	0	1	37
02	**3.4**	-5.7	-1.2	0.4	T	0.4	1	57
03	**9.2**	3.4	6.3	**19.2**	0	**19.2**		78
04	**11.8**	2	6.9	**19.2**	0	**19.2**		102
05	**2.7**	-0.6	1.1	0.2	0.4	0.6		83
06	**9.1**	-2.3	3.4	1.6	0	1.6		74
07	**6.3**	-1.9	2.2	T	0	T		63
08	-0.4	-7.4	-3.9	0	T	T	T	72
09	-3.4	-7.8	-5.6	0	T	T		72
10	0.4	-5.1	-2.4	**0.8**	**13.8**	**12.4**	0	57
11	-1.1	-9	-5.1	0	0.2	0.2	9	80
12	-6	-11.3	-8.7	0	0	0	8	57
13	-7.4	-12.9	-10.2	0	T	T	8	54
14	-8	-11.2	-9.6	0	0	0	7	76
15	-4.4E	-9.5E	-7.0E	M	M	2.0E	9	M
16	**3.1**	-3.2	-0.1	1.2	0.6	1.8	20	74
17	-2.9	-10.7	-6.8	0	0.8	0.2	20	63
18	**3.8**	-12.5	-4.4	**3.4**	**6.4**	**9.4**	20	83
19	**5.3**	-7.1E	-0.9E	M	M	1.2E	19	M
20	-3.7	-7.7	-5.7	0.2	1.2	1.2	20	74
21	-0.2	-7.8	-4	0.6	**7.6**	**7.8**	20	35
22	**0.6**	-10.8	-5.1	1.2	2.2	2.8	25	46
23	-8.6	-11.4	-10	0	3.6	2.6	27	<31
24	-4.4	-8.5	-6.5	0	18.4	**15.8**	34	44
25	-5.2	-11.6	-8.4	1.4	7.2	7.6	53	57
26	-5.2	-12.3	-8.8	0	T	T	51	39
27	**1.9E**	-11.8E	-5.0E	M	M	**11.4E**	55	M
28	-0.6	-6.8	-3.7	0	2.4	1.2	50	61
29	-0.7	-14.2	-7.5	0	4.4	2.2	54	74
30	-1.5	-13.4	-7.5	0.8	14.4	**14.6**	55	85
31	-2.3	-10.4	-6.4	0	T	T	66	83

*Blank cells = no data available; T = Trace; E = Estimated; M = Missing

Environment Canada Daily Climate Data (January, 2014)
St. John's International Airport

January 2014	Max Temp °C	Min Temp °C	Mean Temp °C	Total Rain mm	Total Snow cm	Total Precip mm	Snow on Grnd cm	Max Wind Gust km/h
DAY								
1	-10.4	-15.1	-12.8	0	T	T	66	69
2	-13.4	-18.4	-15.9	0	0	0	66	82
3	-6.6	-18.3	-12.5	0	28.4	**26.6**	66	89
4	-7.7	-14.9	-11.3	0	10.4	6.2	103	111
5	-3.2	-11.2	-7.2	0	T	T	103	74
6	-2.3	-11	-6.7	0	0	0	103	80
7	**9.6**	-5.6	2	12.6	0.2	**12.8**	102	100
8	-5.6	-9.3	-7.5	0	2	1.4	88	<31
9	-4.2	-11.2	-7.7	0	1.4	1	90	70
10	-4.8	-12.8	-8.8	0	0	0	90	74
11	**2**	-4.9	-1.5	T	0	T	88	76
12	**10.8**	1.8	6.3	15.6	0	**15.6**	84	117

T=Trace

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