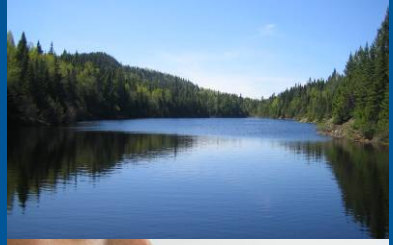







Real-Time Water Quality Report

Waterford River at Kilbride

Deployment Period
November 26, 2014 to January 21, 2015

Newfoundland Labrador

Government of Newfoundland & Labrador
Department of Environment and Conservation
Water Resources Management Division

Waterford River at Kilbride, Newfoundland and Labrador

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General

The Water Resources Management Division (WRMD), in partnership with Water Survey of Canada - Environment Canada, maintain a real-time water quality and water quantity monitoring station on Waterford River at Kilbride.

This deployment report discusses water quality related events occurring at this station.

The purpose of the real-time water quality station is to monitor process and publish real-time water quality data.

This report covers the 56-day period from deployment on November 26, 2014 until removal on January 21, 2015.

Figure 1: Waterford River at Kilbride Real-Time Water Quality and Quantity Station.

Quality Assurance and Quality Control

As part of the Quality Assurance and Quality Control protocol (QA/QC), an assessment of the reliability of data recorded by an instrument is made at the beginning and end of the deployment period. The procedure is based on the approach used by the United States Geological Survey.

At deployment and removal, a QA/QC Sonde is temporarily deployed alongside the Field Sonde. Values for temperature, pH, conductivity, dissolved oxygen and turbidity are compared between the two instruments**.** Based on the degree of difference between the parameters on the Field Sonde and QA/QC Sonde at deployment and at removal, a qualitative statement is made on the data quality (Table 1).

Water Resources Management (WRMD) staff (Environment and Conservation (ENVC)) is responsible for maintenance of the real-time water quality monitoring equipment, as well as recording and managing the water quality data. Tara Clinton, under the supervision of Renee Paterson, is ENVC's main contact for the real-time water quality monitoring operation at Waterford River station, and is responsible for maintaining and calibrating the water quality instrument, as well as grooming, analyzing and reporting on water quality data recorded at the station.

Water Survey of Canada (WSC) staff (Environment Canada (EC)) under the management of Howie Wills, play an essential role in the data logging/communication aspect of the network and the maintenance of the water quantity monitoring equipment. EC-WSC staff visit the site regularly to ensure the data logging and data transmitting equipment are working properly. WSC is responsible for handling stage and streamflow issues. The quantity data is raw data that is transmitted via satellite and published online with the quality data on the Real-Time Stations website. Quantity data has not been corrected or groomed when published online or used in the monthly reports for the stations. WSC is responsible for QA/QC of water quantity data. Corrected stage and streamflow data can be obtained upon request to WSC.

Table 1: Instrument Performance Ranking classifications for deployment and removal

	Rank				
Parameter	**Excellent**	**Good**	**Fair**	**Marginal**	**Poor**
Temperature (°C)	<=+/-0.2	>+/-0.2 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	<+/-1
pH (unit)	<=+/-0.2	>+/-0.2 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Sp. Conductance (µS/cm)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Sp. Conductance > 35 µS/cm (%)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Dissolved Oxygen (mg/L) (% Sat)	<=+/-0.3	>+/-0.3 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Turbidity <40 NTU (NTU)	<=+/-2	>+/-2 to 5	>+/-5 to 8	>+/-8 to 10	>+/-10
Turbidity > 40 NTU (%)	<=+/-5	>+/-5 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20

It should be noted that the temperature sensor on any sonde is the most important. All other parameters can be divided into subgroups of: temperature dependant, temperature compensated and temperature independent. Due to the temperature sensor's location on the sonde, the entire sonde must be at a constant temperature before the temperature sensor will stabilize. The values may take some time to climb to the appropriate reading; if a reading is taken too soon it may not accurately portray the water body.

Table 2: Instrument performance rankings for Waterford River at Kilbride

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Waterford	Nov 26 2014	Deployment	Excellent	Excellent	Excellent	Fair	Excellent
	Jan 21 2015	Removal	Excellent	Excellent	Excellent	Good	Poor

- During the Outer Cove Brook below Airport station deployment, water temperature, pH, conducitivity and turbidity parameters ranked as 'Excellent'. Dissolved oxygen ranked as 'Fair' during initial installment of the instrument. It is likely that an air bubble may have influenced the data ranking of 'Fair'. Air bubbles can inhibit the sensors ability to read accurately for a short span of time.
- At removal of the instrument, the water temperature, pH, conductivity data ranked as 'Excellent'. The dissolved oxygen data ranked as 'Good' and turbidity data ranked as 'Poor' which may have been a result of the fouling present on the sensor at the time of removal.

Waterford River at Kilbride

Water Temperature

Water temperature ranged from -0.10°C to 8.31°C during this deployment period (Figure 2). There were noticeable increases and decreases in the water temperature during this deployment period. This is consistent with ambient air temperatures over this time period, generally increasing during daylight hours and cooling overnight.

The peaks in water temperature corresponded with higher stage levels; this is displayed on Figure 2. The water temperatures at this station do display diurnal variations although slightly elongated due to the depth of water at this station. Deeper streams are not as influenced by natural diurnal variations in the surrounding air temperatures.

As the deployment period came to an end the water temperature decreased to just above freezing.

Please note, the stage data is raw data that is published on our web page. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

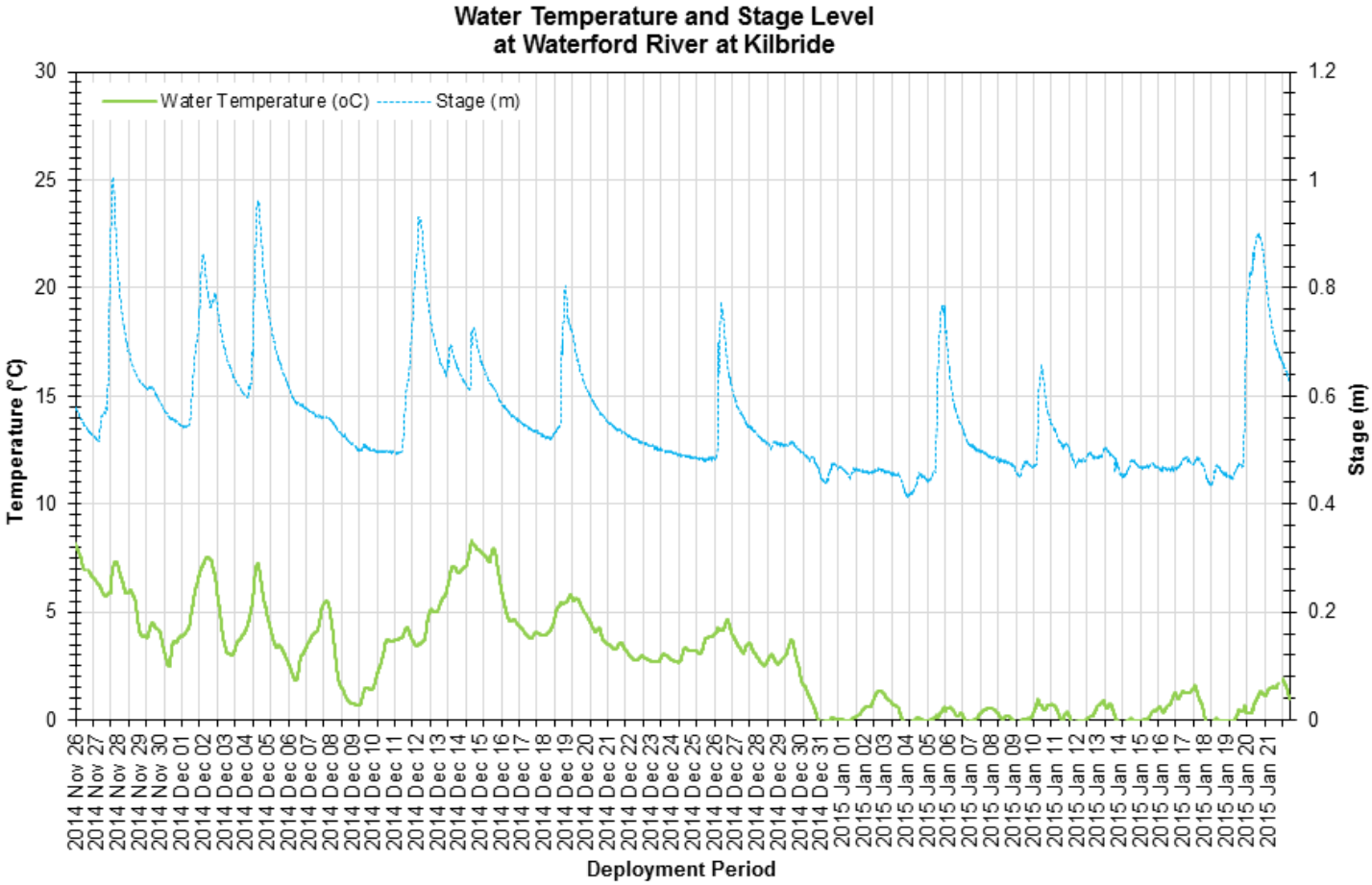


Figure 2: Water temperature (°C) and Stage (m) values at Waterford River at Kilbride

pH

Throughout the deployment period, pH values ranged between 6.98 pH units and 7.37 pH units (Figure 3).

During this deployment, the pH data was reasonably consistent. The pH values at this station were above the minimum CCME Guideline for the Protection of Aquatic Life (above 6.5 pH units).

During the higher stage periods the pH values only dipped very slightly. Please note the stage data is raw data that is published on our web page. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

The CCME guideline provides a basis by which to judge the overall health of the brook. Naturally, all streams and brooks are different. During the deployment period the median pH level was 7.14 pH units.

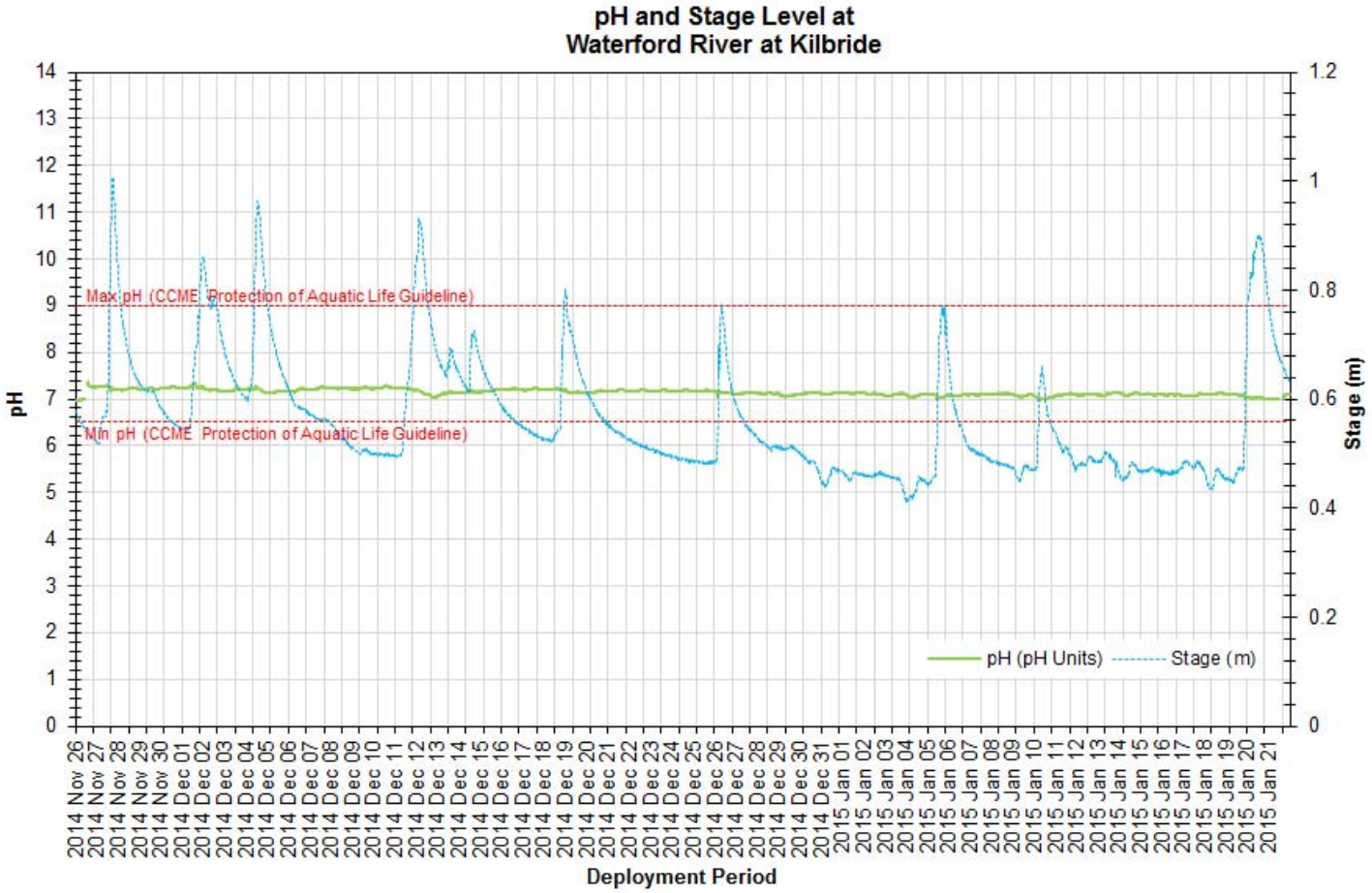


Figure 3: pH (pH units) and stage level (m) values at Waterford River at Kilbride

Specific Conductivity & TDS

The conductivity levels were within 236 µS/cm and 3024 µS/cm during this deployment period. TDS (a calculated value) ranged from 0.1530 g/L to 1.9650 g/L.

Commonly the relationship between conductivity and stage level is inversed. When stage levels rise, the specific conductance levels drop in response as the increased amount of water in the river system dilutes the solids that are present. During this deployment period at several times the conductivity levels also increased with high stage levels. Due to the station being located in a highly urbanize area and influenced greatly from road runoff it is likely during road salting times the increased conductivity was due to the runoff of the road salt.

Air temperatures around 0°C or below 0°C create frosty and icy road conditions, the roadways are salted and the conductivity levels increase as the residual salt is flushed into the brook through rainfall/runoff.

On November 30th, 2014 and January 13th & 17th, 2015 conductivity increases did not correspond with significant stage increases (peaks highlighted in black circles). It is not clear what caused the conductivity increases at these times.

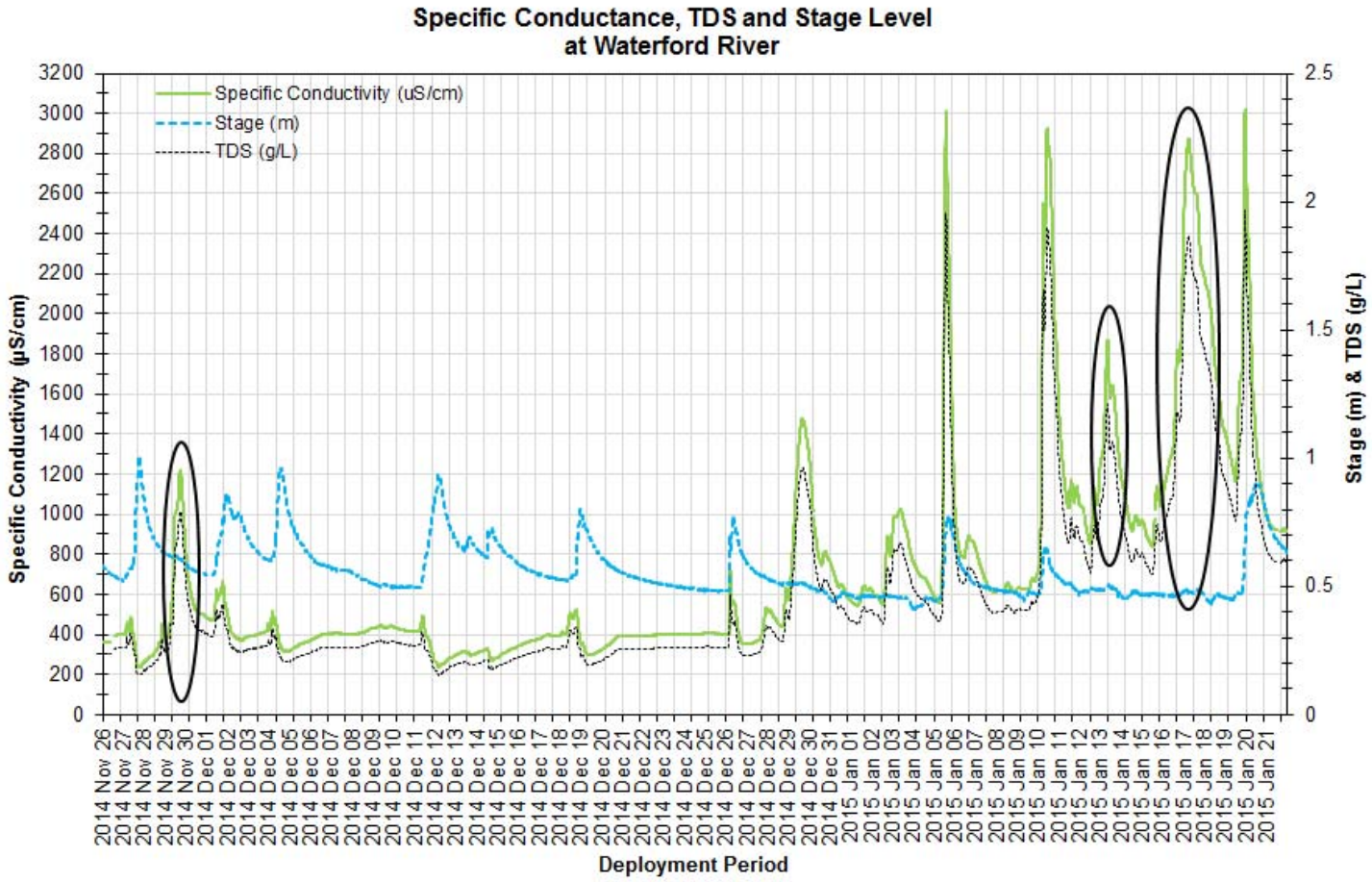


Figure 4: Specific conductivity (µS/cm), TDS (g/L) and stage (m) values at Waterford River at Kilbride.

Dissolved Oxygen

The water quality instrument measures dissolved oxygen (mg/L) with the dissolved oxygen probe and then the instrument calculates percent saturation (% Sat) with water temperature.

The Dissolved Oxygen % Sat levels within this deployment period were within 99.6 %Sat to 106.8 %Sat. Dissolved Oxygen (mg/L) measured 11.82 mg/L to 15.44 mg/L.

During the deployment the dissolved oxygen levels were reasonably consistent. There was an evident relationship between water temperature and dissolved oxygen. As water temperatures leveled out toward the end of deployment so did the dissolved oxygen readings. Generally there is more dissolved oxygen present in a waterbody during the cooler temperatures.

The CCME guideline provides a basis by which to judge the overall health of the brook. Naturally, all streams and brooks are different and can have their own dissolved oxygen levels of 'normal'. During the deployment period the median dissolved oxygen level was 14.01mg/L.

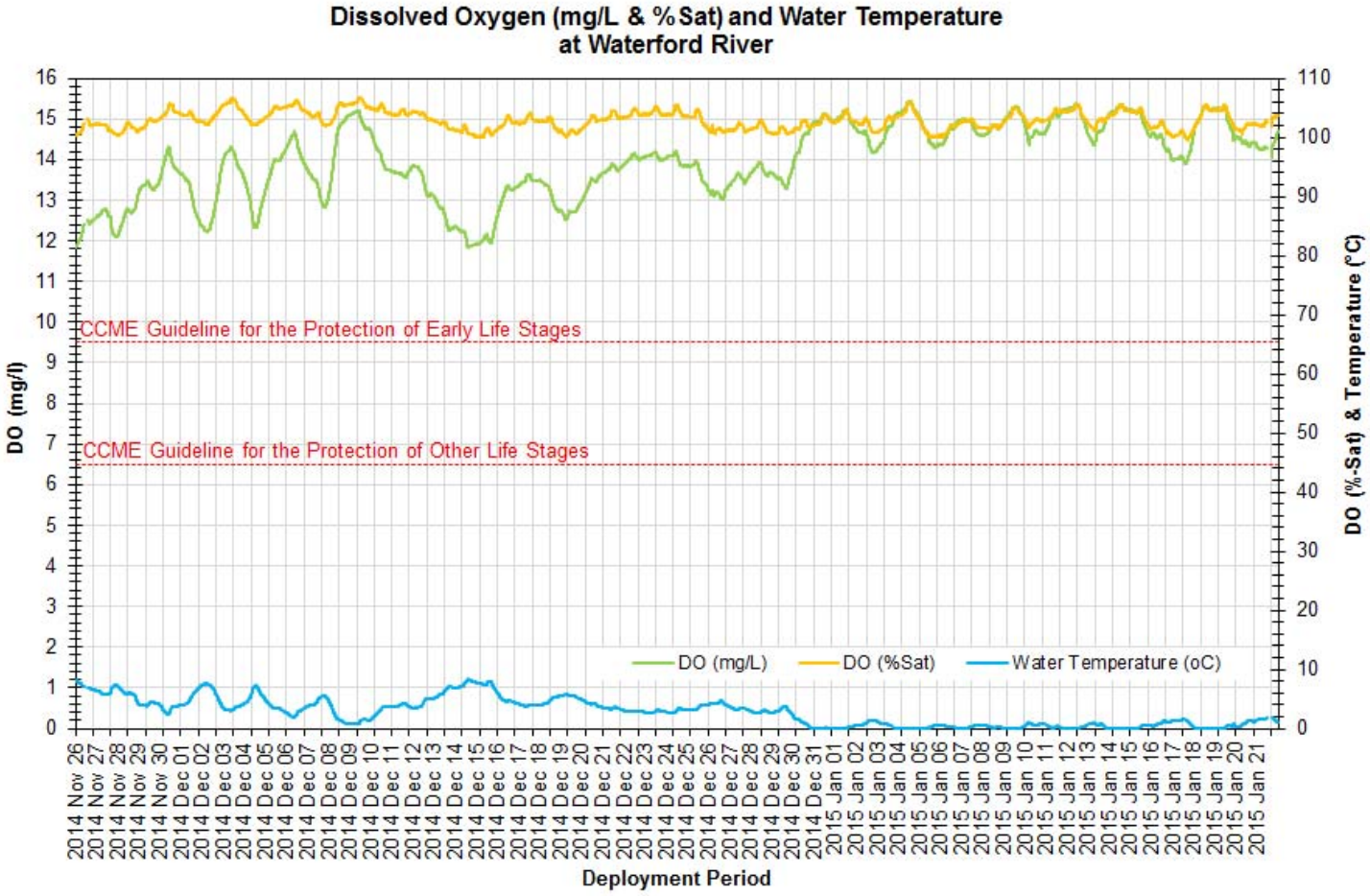


Figure 5: Dissolved oxygen (mg/L & % sat) and water temperature (°C) values at Waterford River at Kilbride.

Turbidity

Turbidity levels during the deployment ranged within 2.2 NTU and 490.5 NTU (Figure 6). The deployment data had a median of 5.3 NTU.

The turbidity sensor on this instrument can read turbidity values between 0 NTU and 3000 NTU. However a turbidity reading of 3000 NTU is always identified as an error reading and should not be used as a valid reading or included in any statistical analysis.

The majority of the turbidity events in the deployment period correlate with increases in stage potentially from precipitation (Figure 6). Precipitation can increase the presence of suspended material in water. The large turbidity event on January 6th does correspond with a stage increase however the display of data after the event is evident of debris blocking the sensor and inhibiting its ability to correctly record data.

The highlighted cluster of turbidity data from January 6th the end of deployment is likely a result of the buildup of sediment or debris around the turbidity probe. This data will not be included in any statistical analysis.

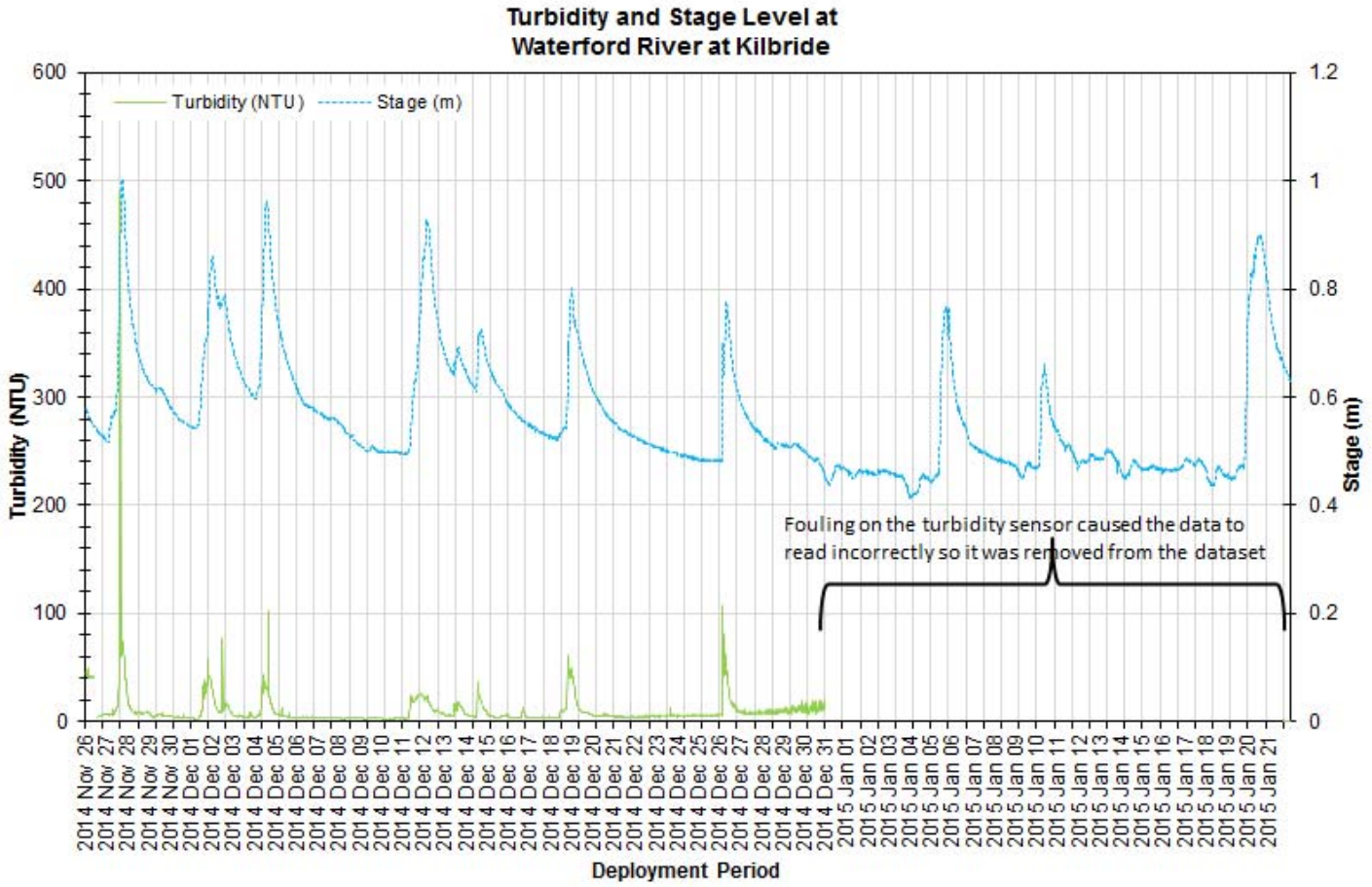


Figure 6: Turbidity (NTU) and stage level (m) values at Waterford River at Kilbride.

Stage & Stream Flow

Stage can be defined as the height or elevation of the stream's water surface above a reference elevation (sea level, gage level)**.** Stage is important to display as it provides an estimation of water level at the station and can explain some of the events that are occurring with other parameters (i.e. Specific Conductivity, DO, turbidity). Stream flow can be defined as the volume of water in a river at a specific location and time. It is measured in cubic meters per second. Stage and Stream flow will increase during rainfall events (Figure 7) and during any surrounding snow or ice melt as runoff will collect in the brooks. However, direct snowfall will not cause them to rise significantly.

During the deployment period, the stage values ranged from 0.44m to 0.85m. The stream flow values ranges from 0.8m^3/s to 6.67m^3/s. The larger peaks in stage and stream flow do correspond with substantial rainfall events as noted on Figure 7.

Precipitation data was obtained from Environment Canada's St. John's Airport weather station. Precipitation ranges for the deployment period were a minimum of 0.0 mm and a maximum of 26.4 mm on December 11th which increased both stage and streamflow at that time.

Please note the stage and streamflow data graphed below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

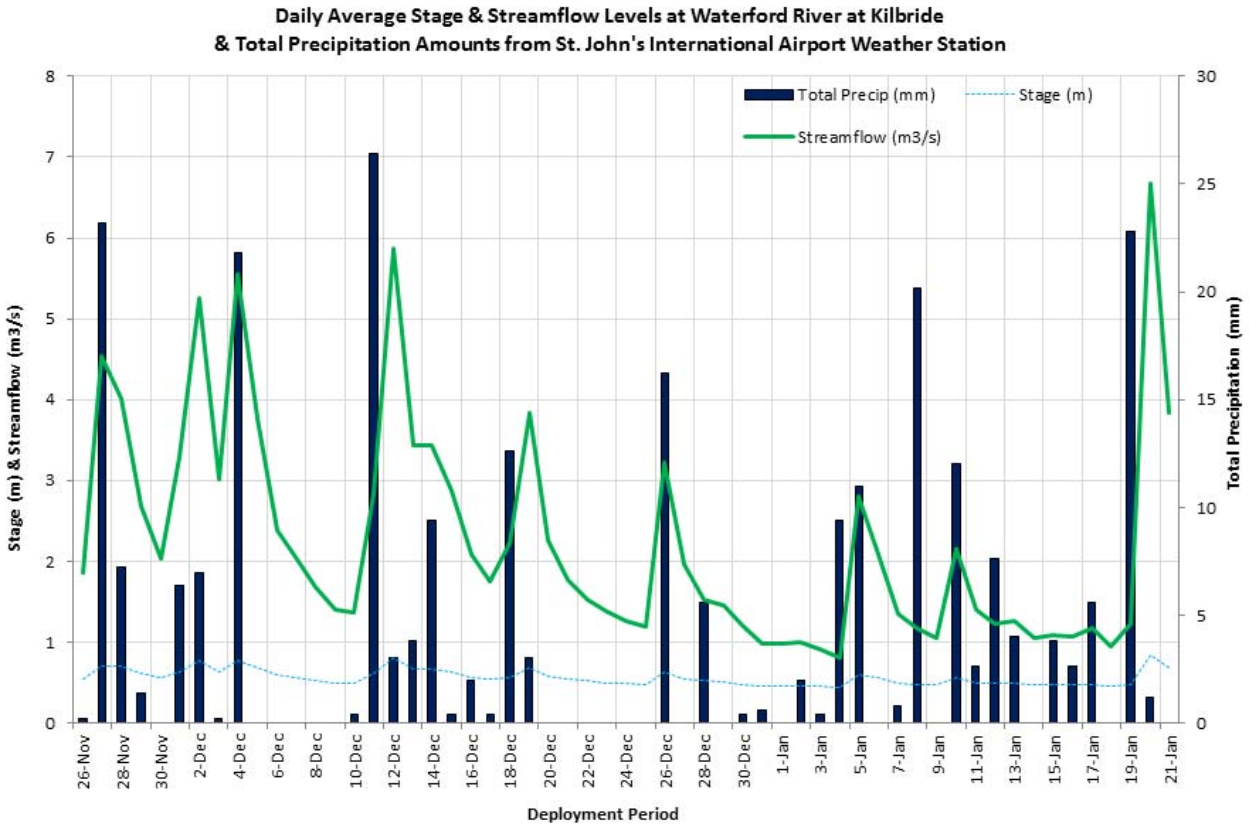


Figure 7: Daily average stage & stream flow values at Waterford River at Kilbride and daily total precipitation from Environment Canada's St. John's Airport Station.

Conclusion

- As with many urban brooks and streams, precipitation and runoff events play a role in influencing the water quality within the water body. This Waterford River flows through significant developed areas, including residential and industrial zones, the brook can also be found along the boundaries of heavily used road ways, all these factors can influence the parameters that are recorded by the water quality instrument.

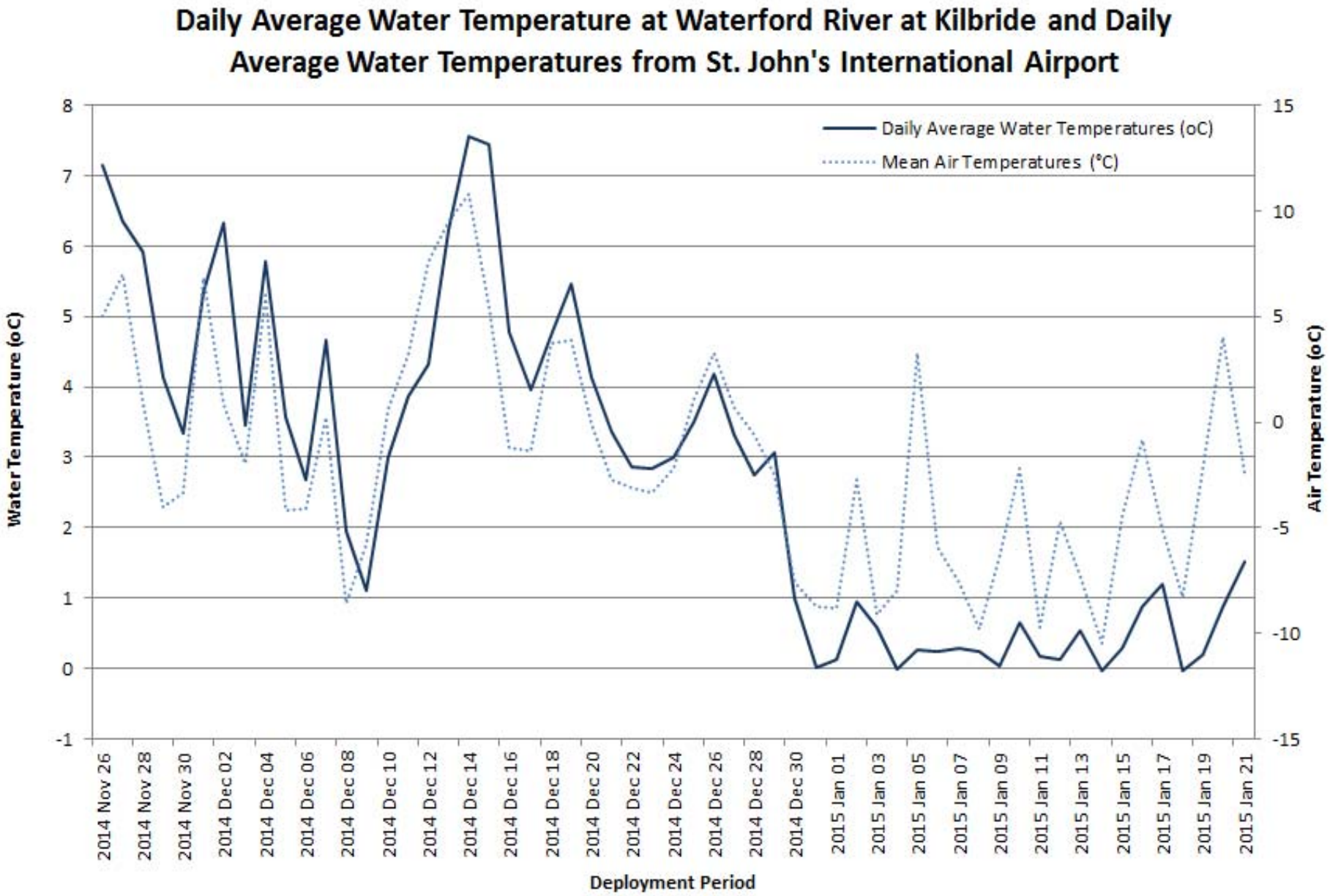
- It is evident by the recorded data that precipitation events have influenced fluctuations in stage and streamflow. When reviewing the graphs as a whole it is evident that the larger precipitation events did create varying effects with the water quality parameters.

- Road salting and precipitation events were likely the cause of the higher conductivity levels throughout the deployment period. However this does not explain some of the independent high conductivity values highlighted on the conductivity graph. Rainfall was likely the contributor to the increases in turbidity in the brook for short periods of time.

- The cooler ambient air temperatures toward the end of the deployment (Appendix I) influenced the water temperature at Waterford River station. This in turn directly influences the concentration of dissolved oxygen in the brook. As the season changed from fall climate conditions into winter the water quality parameters are going to adjust accordingly.

- Overall the water quality parameters recorded at Waterford River at Kilbride displayed natural events expected of a brook in an urbanized environment.

APPENDIX I


Daily Average Water Temperature at Waterford River at Kilbride and Daily Average Water Temperatures from St. John's International Airport
Daily Average Water Temperatures (oC)
Mean Air Temperatures (°C)
Water Temperature (oC)
Air Temperature (oC)
Deployment Period
8
7
6
5
4
3
2
1
0
-1
15
10
5
0
-5
-10
-15
2014 Nov 26
2014 Nov 28
2014 Nov 30
2014 Dec 02
2014 Dec 04
2014 Dec 06
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2014 Dec 10
2014 Dec 12
2014 Dec 14
2014 Dec 16
2014 Dec 18
2014 Dec 20
2014 Dec 22
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