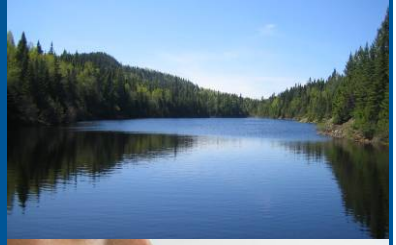







Real-Time Water Quality Report

Waterford River at Kilbride

Deployment Period
September 6, 2016 to October 18, 2016

Newfoundland Labrador

Government of Newfoundland & Labrador
Department of Environment and Climate Change
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 and Climate Change Canada (WSC-ECCC), 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 period from deployment on September 6, 2016 to October 18, 2016

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).

WRMD staff (Environment and Climate Change (ECC)) 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.

WSC staff (Environment and Climate Change Canada (ECCC)) 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. WSC-ECCC 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 along with the water 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	Sept 6	Deployment	Excellent	Good	Good	Excellent	Excellent
	Oct 18	Removal	Excellent	Good	Excellent	Excellent	Excellent

On deployment the ranking of the field data against the QAQC data was: water temperature, dissolved oxygen and turbidity data ranked as 'Excellent', with the pH and conductivity data ranked as 'Good'. All rankings for the water quality parameters were acceptable for the initial deployment of the field instrument.

At removal of the instrument, the ranking for water temperature, conductivity, dissolved oxygen and turbidity all ranked as 'Excellent'. The ranking for pH was 'Good'. These were reasonable rankings after the instrument was in the brook for approximately 43 days.

Concerns or Issues during the Deployment Period

There were no detected issues with the instrument or any problems with the data being transmitted from the station during this deployment period.

During this deployment period, there were two reported fish kill events in the Waterford River. The fish kills were reported by members of the public on the early mornings of September 10th and September 21st, 2016. The cause of the first fish kill on September 10th was determined to be a water main break on September 9th. The chloramine treated drinking water was flowing directly into one of the tributaries that feed into Waterford River. It was indicated that the treated drinking water killed off the fish as it was flushed through the brook. Under Section 64 of the Canadian Environmental Protection Act (1999), chloramines are listed as 'toxic' to fish. It was not determined what caused the second fish kill on September 21st. The fish kill events were not in the vicinity of the Real-Time Station on Waterford River in Kilbride, the evidence indicates the fish kill events were further upstream from the station.

The fish kill events were under investigation by Environmental Officers with Environment and Climate Change Canada and Environmental Protection Officers with Government Services Centre in St. John's. Water Resources Management Division provided assistance when requested.

For information purposes the dates that the fish kills were observed have been highlighted in stars on each parameter graph; however no specific time of day was allocated for the fish kills. The highlighted section is not a reflection on the time of day.

Waterford River at Kilbride

Water Temperature

Water temperature ranged from 7.70°C to 19.71°C during this deployment period (Figure 2).

The water temperature at this station displays diurnal variations although slightly elongated due to the depth of water at this station. Deeper streams are influenced more subtly by natural diurnal variations in air temperatures (Appendix I).

Over the duration of the deployment period the water temperature gradually decreases as the air temperatures decrease with the cooler temperatures approaching. During high stage events there is a slight increase in the water temperatures for a short period of time until the temperatures start to dip again. This is evident after a peak in stage on September 9th there is a subsequent peak in water temperature and then a dip to a lower temperature as the stage stabilizes again.

Please note the stage data is raw data that is published on the ECC 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.

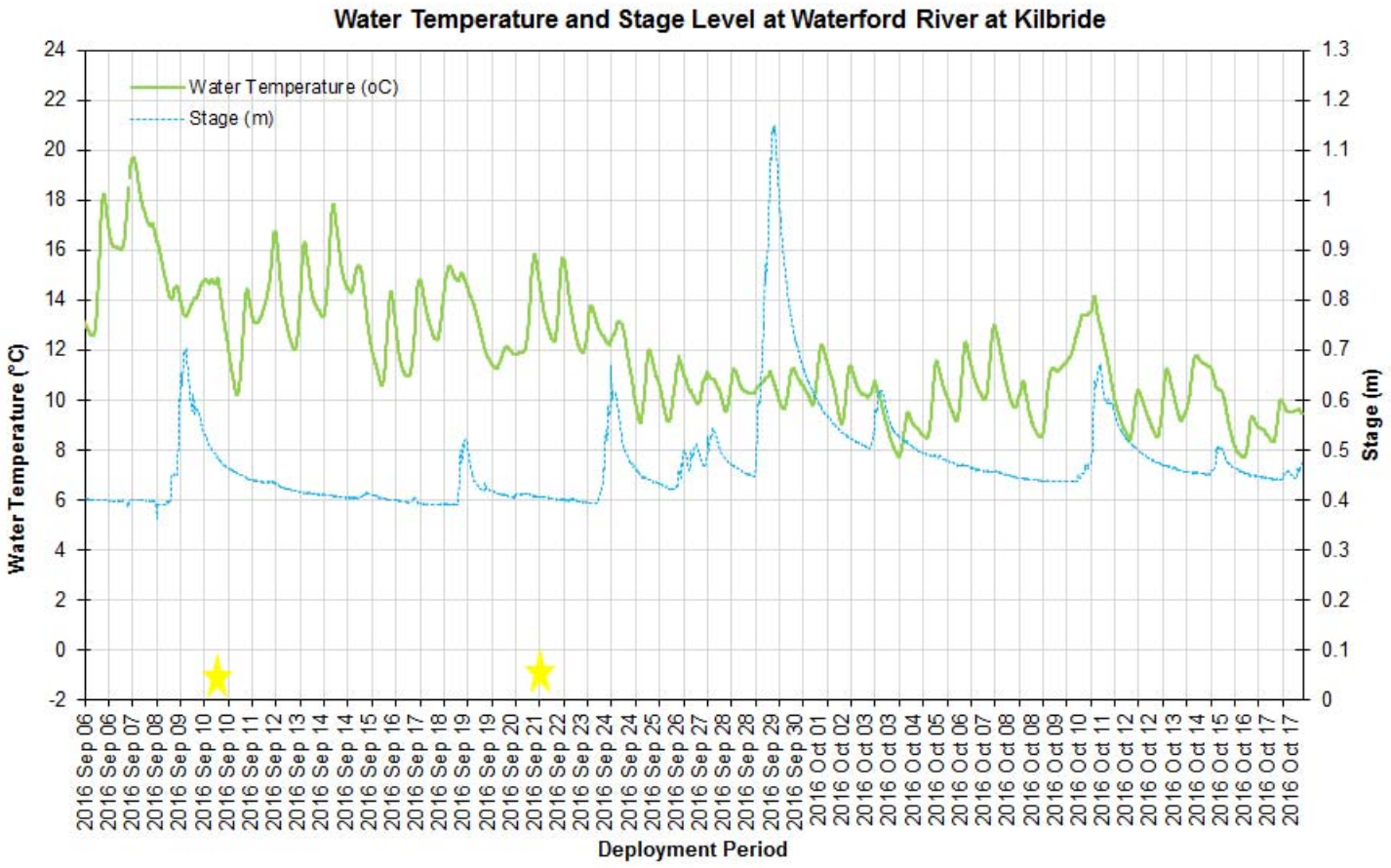

Figure 2: Water temperature (°C) and Stage (m) values at Waterford River at Kilbride

pH

Throughout the deployment period, pH values ranged between 6.81 pH units and 8.18 pH units (Figure 3).

On September 9th there is an evident dip in pH, this dip continues into the early hours of September 10th. The morning of September 10th was the first sighting of dead fish in the river. September 21st was the second fish kill while there is no substantial change in pH that day, there is a dip in pH on September 19th and 20th. It is not clear if these changes in pH are related to the cause of the fish kills.

The pH levels are reasonably consistent and remained within the guidelines indicated on the graph; however during and after high stage levels the pH data decreases slightly for short period of times and is a natural occurrence. In this stream the CCME guideline provides a basis by which to judge the overall health of the brook. pH levels did not indicate that there were any immediate issues with water quality in Waterford River during this deployment. The median pH level was 7.23 pH units.

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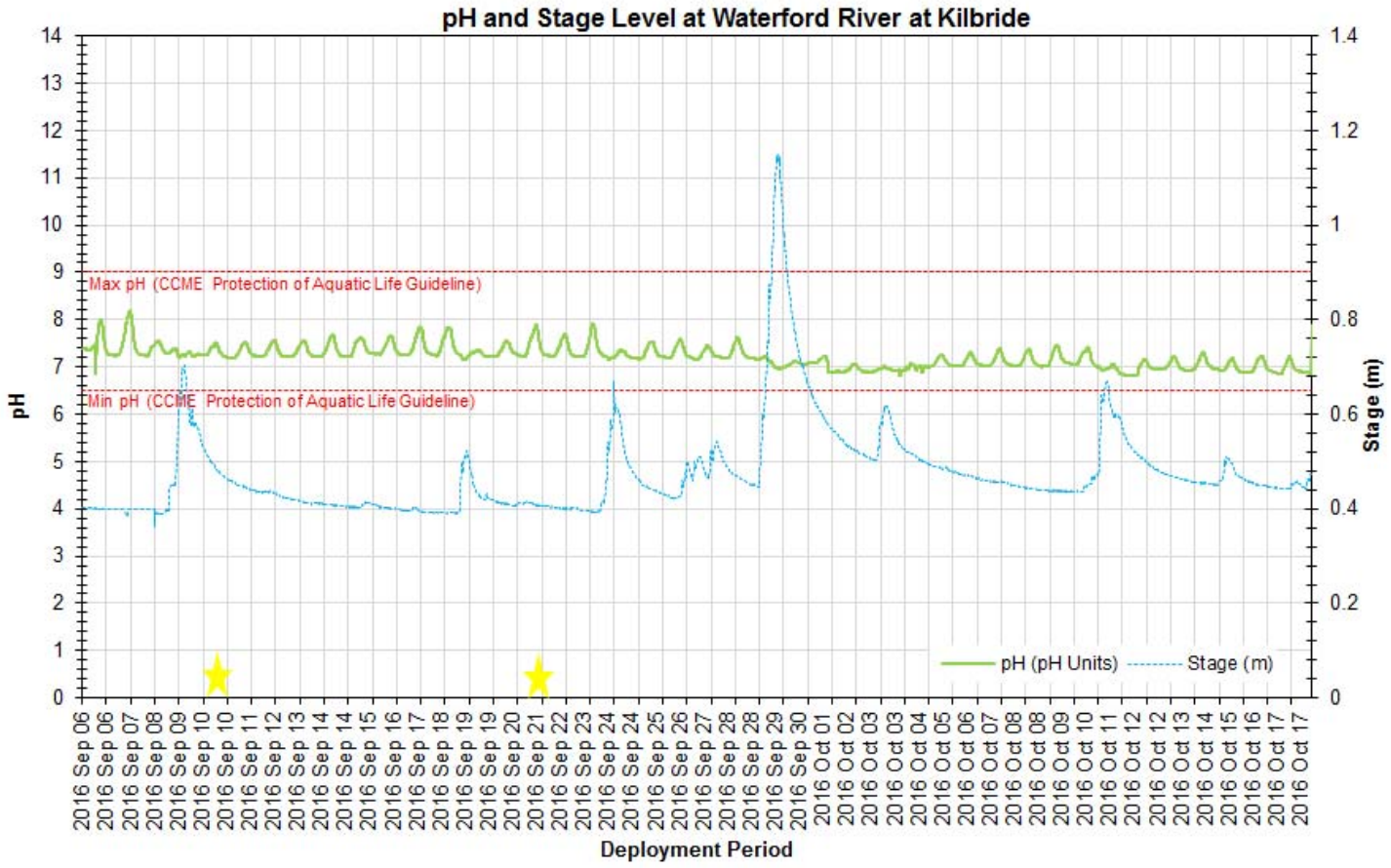

Figure 3: pH (pH units) and stage level (m) values at Waterford River at Kilbride

Specific Conductivity & Total Dissolved Solids

The conductivity levels were within 197.0 µS/cm and 679.0 µS/cm during this deployment period. TDS (a calculated value) ranged from 0.1280 g/L to 0.4410 g/L (Figure 4).

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 (as noted on Figure 4).

On September 9th there is a dip in specific conductivity indicating an increase in water passing through the brook during and around this timeframe. It was later determined after the first fish kill that there had been a water main break in a tributary that leads into Waterford River. It is possible that the water main break contributed to the stage level on this day, however there was also substantial precipitation on September 9th as well.

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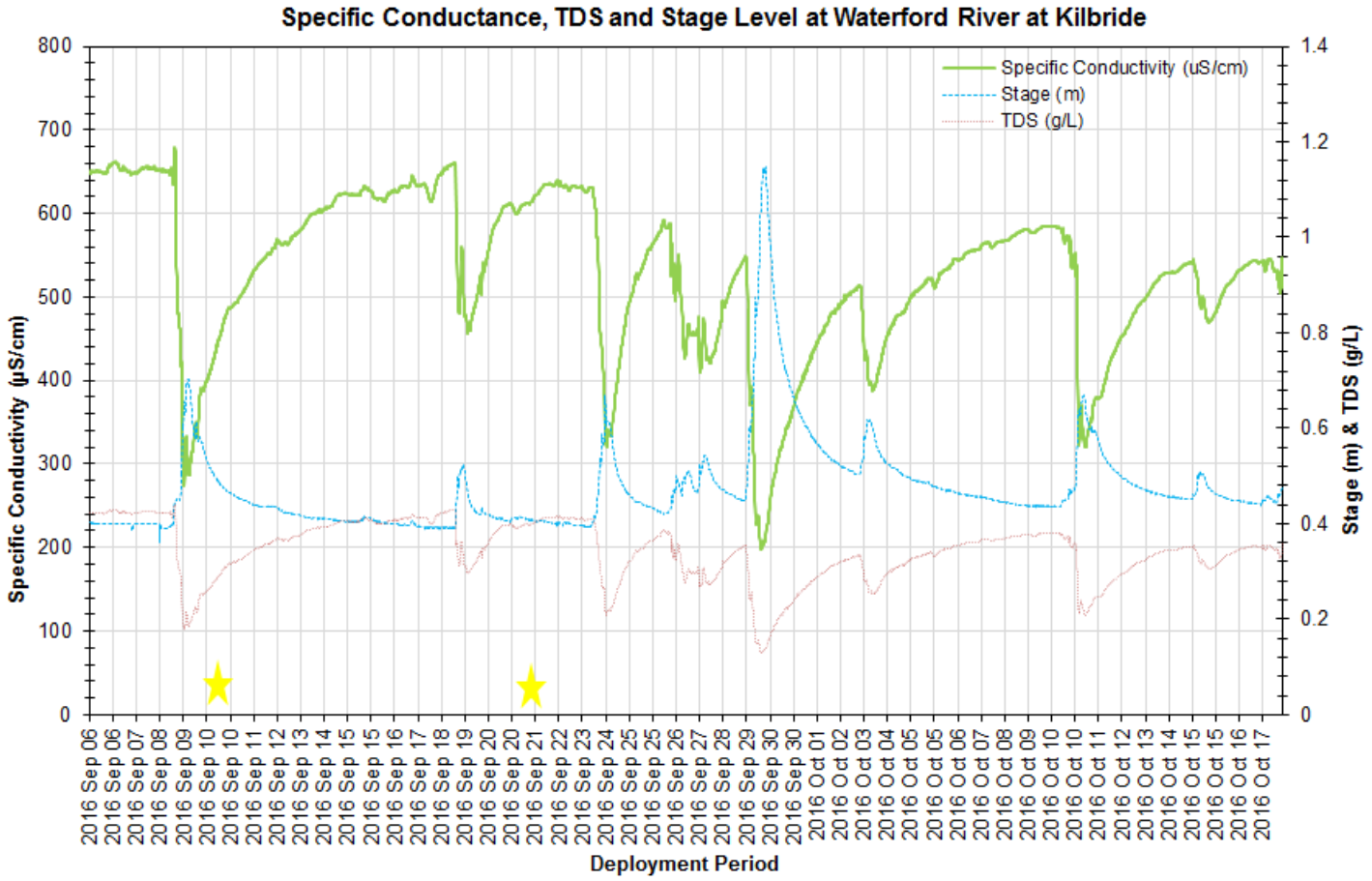


Figure 4: Specific conductivity (µS/cm), TDS (g/L) and stage (m) values at Waterford River at Kilbride.

Dissolved Oxygen

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

During the deployment the dissolved oxygen concentration levels ranged within a minimum of 8.86 mg/L to a maximum of 12.55 mg/L. The percent saturation levels for dissolved oxygen ranged within 92.3% Saturation to 109.3% Saturation (Figure 5).

On September 9th there was a slight change in dissolved oxygen concentration where it dipped to a lower amount before returning to the natural diurnal pattern. On September 21st there was no significant change in the DO. The dissolved oxygen data did not indicate any problems with the water quality which may have resulted in a fish kill.

Dissolved oxygen concentration remained above the Guideline for the Protection of Early Life Stages (9.5mg/L) for the majority of the deployment period. It is not unusual to see the dissolved oxygen concentration in the brook dip during warmer water temperatures. As the fall season continues with the decrease in water temperature, there will be a gradual increase of the dissolved oxygen present in the brook. The reduction in aquatic flora and fauna growth will increase the amount of dissolved oxygen present in the brook as the dissolved oxygen is not being used. This is a natural occurrence.

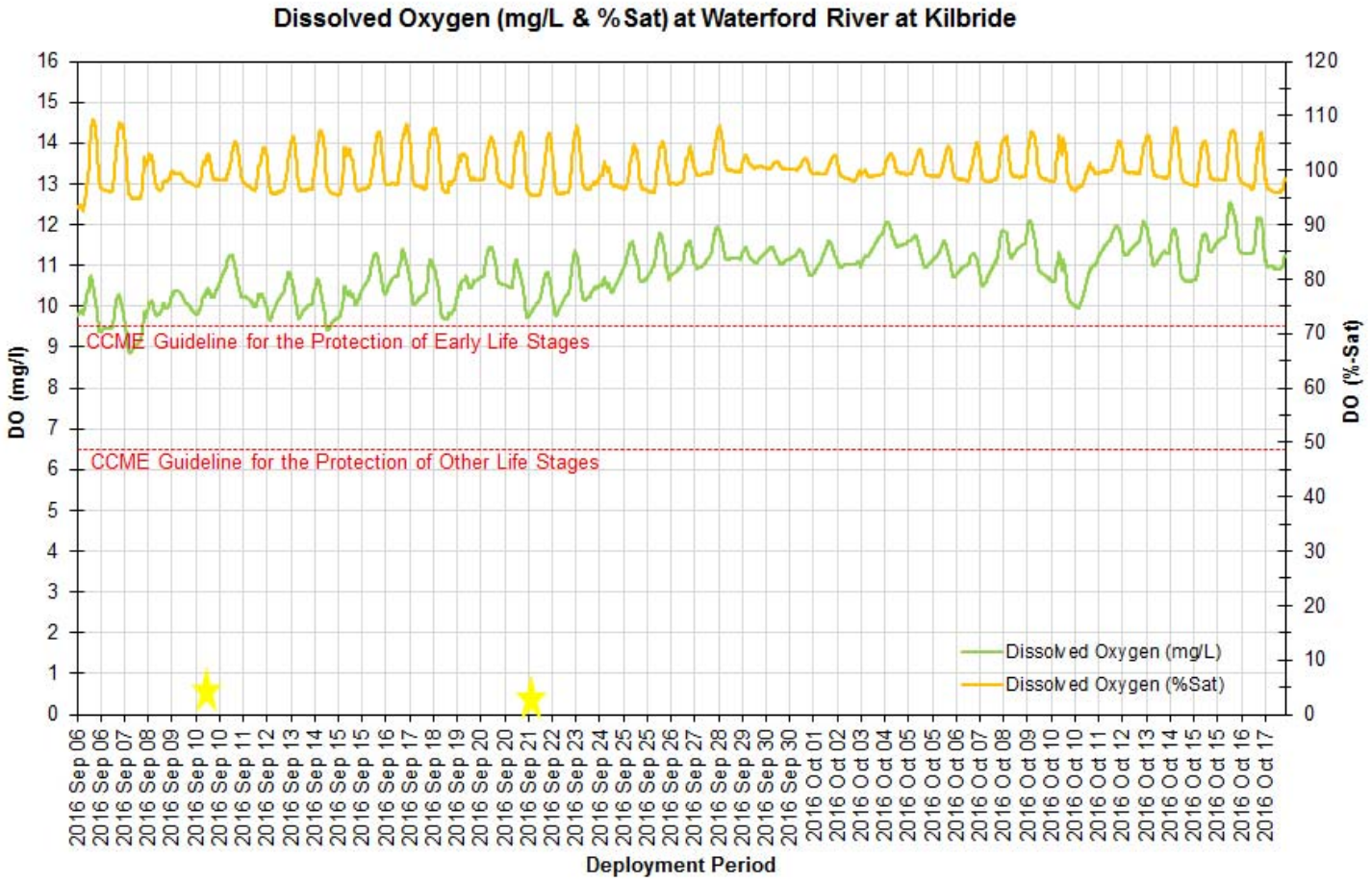


Figure 5: Dissolved Oxygen (mg/L & Percent Saturation) values at Waterford River at Kilbride.

Turbidity

Turbidity levels during the deployment ranged within 0.6 NTU and 1050.0 NTU (Figure 6). The deployment data had a median of 2.8 NTU.

The higher turbidity events throughout the deployment period correlate with increases in stage potentially from precipitation. Precipitation can increase the presence of suspended material in water. The turbidity data does return to lower levels after the high peaks. The highest turbidity value of 1050.0 NTU was recorded during a high stage event. The turbidity data did return to a lower value as the stage level decreased. Turbidity levels can change quickly at Waterford River. This site has a significant streamflow rate which can flush the turbid water or sediments from the brook. As this brook is in the heart of the City of St. John's the turbidity values can be heavily influenced by its surroundings.

The next highest turbidity event was captured on October 17th, 2016. There is no corresponding stage increase or precipitation during the time frame therefore it is unclear what may have caused the turbidity to increase to that level. There was some debris around the protective casing when the instrument was removed for cleaning and calibration. Turbidity is slightly elevated during the first observed fish kill on September 10th, 2016, however there was no significant turbidity changes on the second fish kill. With turbidity at those lower levels it is not likely that turbidity could have played a part in the first fish kill.

Please note the stage data is raw data that is published on the ECC 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.

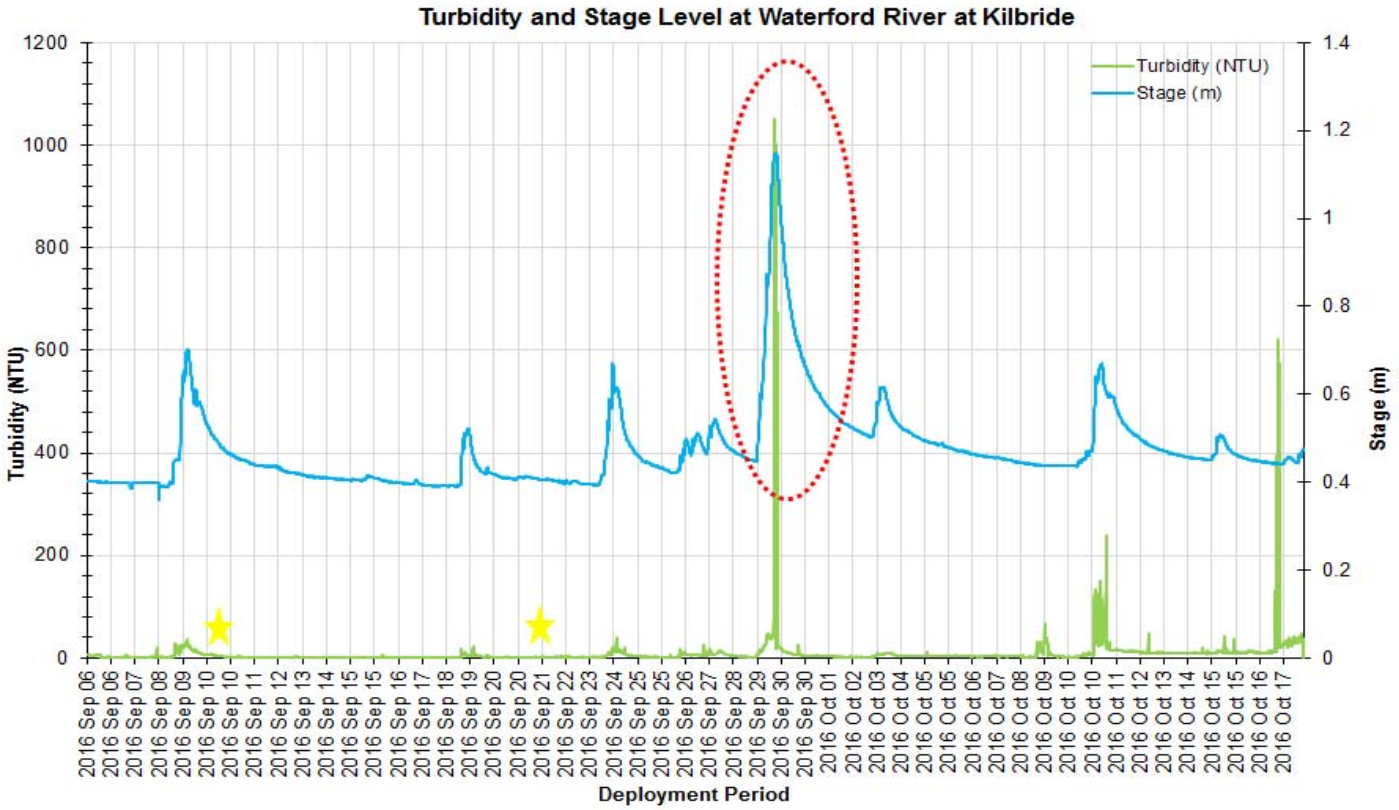


Figure 6: Turbidity (NTU) and stage level (m) values at Waterford River at Kilbride.

Stage and Precipitation

Please note the stage 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.

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). Stage 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 0.361m to 1.149m. The larger peaks in stage 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 46.4 mm on September 29th, 2016.

The stars indicate the observed fish kills that occurred during this deployment. Both fish kills occurred after a day or two of rainfall and subsequent high stage levels. It was determined that the first fish kill was a result of a water main break in the brook.

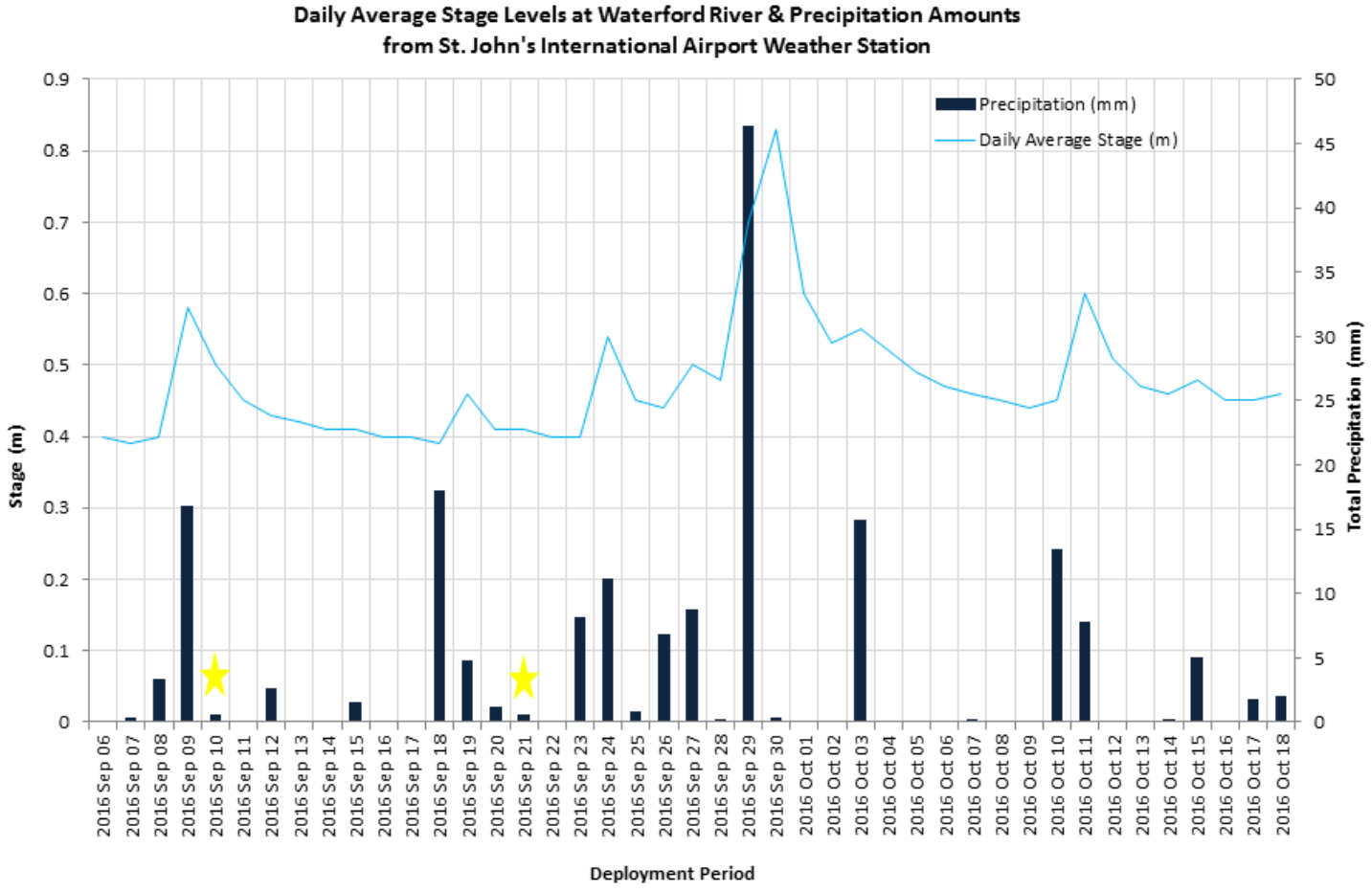


Figure 7: Daily average stage values at Waterford River at Kilbride and daily total precipitation from St. John's Airport Weather Station.

Conclusion

As with many urban brooks and streams, precipitation and runoff events play a role in influencing the water quality within the water body. Waterford River at Kilbride 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.

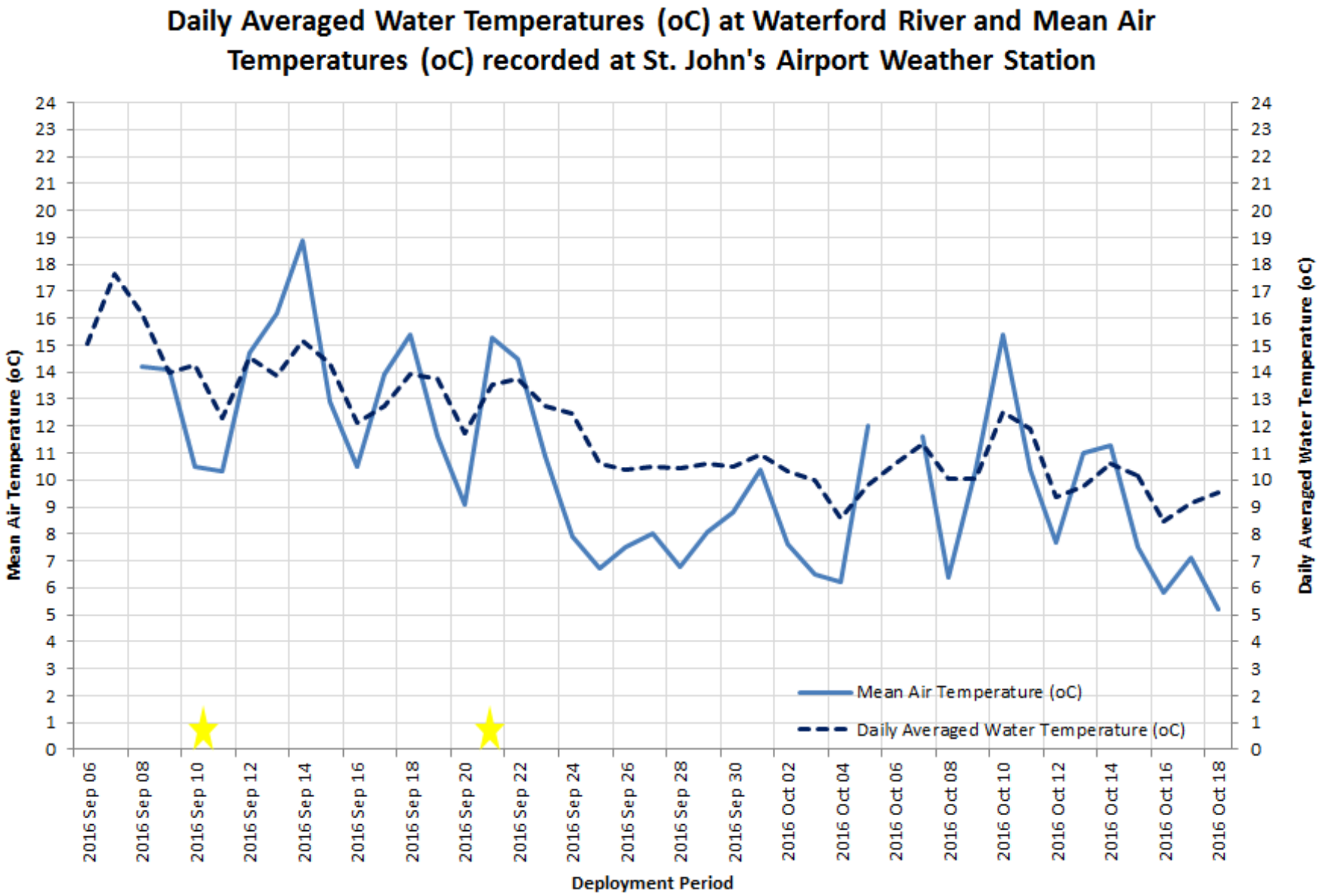
When reviewing the graphs as a whole it is evident that the larger precipitation events did create varying effects with the water quality parameters pH, conductivity, dissolved oxygen and turbidity. The movement in the water temperature data indicates that air temperatures decreased the water temperature which in turn influenced the dissolved oxygen concentration in the brook.

Due to the nature of fish kills and the time frame it takes from the moment of awareness of the kill to investigation it is very hard to pin point an exact cause for such a tragedy. As soon as the water main break was uncovered by the City of St. John's it was identified – through consultation with the Federal Department of Natural Resources - that the break was the likely cause of the first fish kill. Chlorine or Chloramines used to disinfect drinking water – while safe for human consumption – even at low levels are toxic to fish (CCME Guideline 1999). The cause of the second fish kill was not identified. Despite investigation by several different bodies it could not be determined.

There were visible changes in the pH, whereby at several periods during deployment the pH levels dip during high stage events, however for most of the deployment the pH values were reasonably consistent. Conductivity dips were a result of high stage levels and likely rainfall events. There was movement in the turbidity data over the deployment, whereby several events were related to high stage levels and rainfall periods. The potential cause of the turbidity event on October 17th could not be determined. However during removal of the instrument it was noted that the protective casing was covered in debris and silt which may have been a factor in the higher turbidity levels for October 17th.

Despite the two fish kills that occurred during this deployment, the water quality data was as expected of an urban brook. After each significant change in the data, the parameters returned to the previous levels. 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 Averaged Water Temperatures (oC) at Waterford River and Mean Air Temperatures (oC) recorded at St. John's Airport Weather Station
Mean Air Temperature (oC)
Daily Averaged Water Temperature (oC)
Deployment Period
Mean Air Temperature (oC)
Daily Averaged Water Temperature (oC)
2016 Sep 06
2016 Sep 08
2016 Sep 10
2016 Sep 12
2016 Sep 14
2016 Sep 16
2016 Sep 18
2016 Sep 20
2016 Sep 22
2016 Sep 24
2016 Sep 26
2016 Sep 28
2016 Sep 30
2016 Oct 02
2016 Oct 04
2016 Oct 06
2016 Oct 08
2016 Oct 10
2016 Oct 12
2016 Oct 14
2016 Oct 16
2016 Oct 18

APPENDIX II

References

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VOCM Local News Now, (2016, September 12) 'Chlorinated Water Break Cause of Waterford River Fish Kill: City'. Retrieved from URL: http://vocm.com/news/video-officials-investigating-cause-of-massive-fish-kill-in-waterford-river/