Real-Time Water Quality Report

Outer Cove Brook Network

Deployment Period
April 8, 2014 to May 14, 2014

Newfoundland Labrador

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

Outer Cove Brook, Newfoundland and Labrador

Prepared by:

Tara Clinton
Environmental Scientist
Water Resources Management Division
Department of Environment & Conservation
4th Floor, Confederation Building, West Block
PO Box 8700, St. John's NL A1B 4J6
Ph. No.: (709) 729 - 5925
Fax No.: (709) 729 - 0320
taraclinton@gov.nl.ca

Outer Cove Brook, Newfoundland and Labrador

General

The Water Resources Management Division (WRMD), in partnership with the City of St. John's and Environment Canada, maintain two real-time water quality and water quantity monitoring stations along Outer Cove Brook.

This deployment report discusses water quality related events occurring at the stations: Outer Cove Brook below Airport and Outer Cove Brook at Clovelly Golf Course in St. John's.

WRMD staff monitors the real-time web pages regularly. The City of St. John's will be notified of any water quality issues that arise so mitigative measures can be taken.

The purpose of these real-time stations is to monitor, process and publish hydrometric (water quantity) and real-time water quality data at the real-time stations. Outer Cove Brook is in the vicinity of the Torbay Road North Commercial Development Area and the real-time stations allow for assessment and management of the water body.

This report covers the 37-day period from deployment on April 8, 2014 until removal on May 14, 2014.

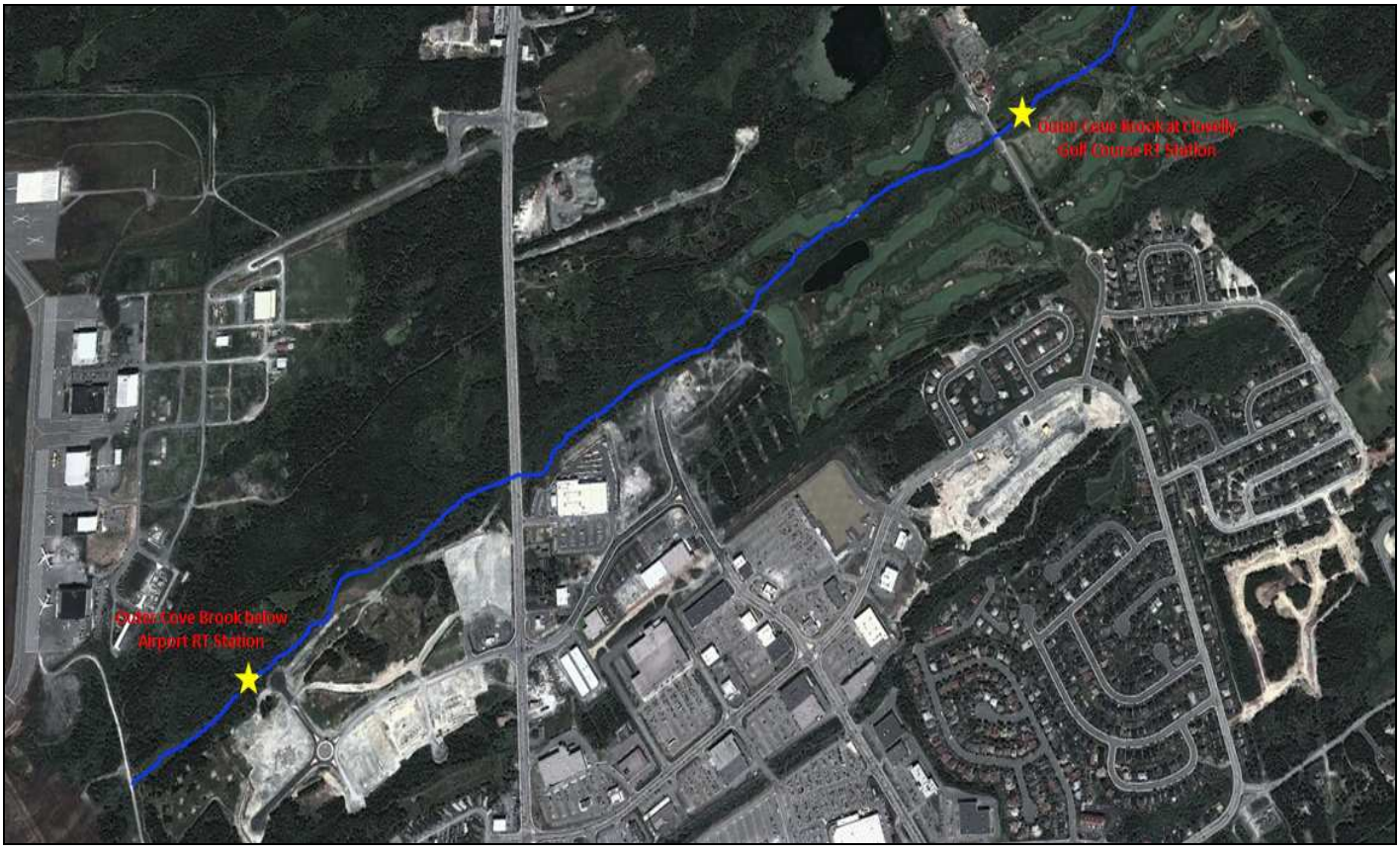


Figure 1: Outer Cove Brook Real-Time Water Quality and Quantity Stations.

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).

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.

Deployment and removal instrument performance rankings for **Outer Cove Brook below Airport** for the period of April 8, 2014 to May 14, 2014 are summarized in Table 2.

Table 2: Instrument performance rankings for Outer Cove Brook below Airport April 8, 2014 – May 14, 2014

Station	**Date**	**Action**	**Comparison Ranking**				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
Below Airport	**April 8 2014**	**Deployment**	Good	Good	Good	Poor	Excellent
	May 14 2014	**Removal**	Fair	Good	Excellent	Poor	Poor

- During the Outer Cove Brook below Airport station deployment, temperature, pH and conductivity data all ranked as 'good'. Turbidity ranked as 'excellent'. Dissolved oxygen ranked as 'poor' during deployment. The poor ranking for DO readings during deployment may have been a result of the internal temperature not reaching is optimum level before the DO reading was taken.

Outer Cove Brook, Newfoundland and Labrador

- At removal, temperature ranked as 'fair', pH ranked as 'good', conductivity ranked the highest at 'excellent'. Dissolved oxygen and turbidity ranked 'poor'. It should be noted that during removal the probes of the instrument were completely covered with algae. The lower rankings were likely a result of the fouling that was present on the probe at the time of removal (pictures in Appendix B).

- Deployment and removal instrument performance rankings for **Outer Cove Brook at Clovelly Golf Course** for the period of April 8, 2014 to May 14, 2014 are summarized in Table 3.

Table 3: Instrument performance rankings for Outer Cove Brook at Clovelly Golf Course April 8, 2014 – May 14, 2014.

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Clovelly Golf Course	April 8 2014	Deployment	Good	Excellent	Good	Good	Good
	May 14 2014	Removal	Excellent	Excellent	Good	Marginal	Excellent

- During the Outer Cove Brook Clovelly Golf Course station deployment, temperature, conductivity, dissolved oxygen and turbidity data all ranked as 'good' and pH ranked as 'excellent'.

- At removal, temperature, pH and turbidity ranked 'excellent', while conductivity ranked as 'good' and dissolved oxygen ranked as 'marginal'. These ranks are reasonably good for an instrument that has spent 37 days in the water. The lower DO ranking was likely a result of the fouling that was present on the probe at the time of removal (pictures in Appendix B).

- Outer Cove Brook has a large amount of algae growing and it was very hard to select a location for the sonde where the probes wouldn't be influenced by the long hair-like algae. The algae may cause issues periodically if it becomes tangled around the turbidity sensor or block the sensors on the conductivity probe.

Deployment Notes

There were several short transmission errors during this deployment period at the Outer Cove Brook below Airport stations. Due to the nature of the data transmission it is not uncommon to have the data drop out for period at a time. This station sits right among a large cover of trees, which may interfere with transmission as well.

Data Interpretation

The following graphs and discussion illustrate water quality-related events from April 8, 2014 through to May 14, 2014 at the Outer Cove Brook Stations.

With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion below adhere to this stringent QA/QC protocol. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request from Water Survey of Canada.

Precipitation data from the deployment period was retrieved from Environment Canada's weather station at St. John's Airport.

Outer Cove Brook below Airport

Water Temperature

Water temperature ranged from 1.0°C to 9.90°C during this deployment period (Figure 2).

There are noticeable increases and decreases in the water temperature during the deployment period. This is consistent with ambient air temperatures over this time period, generally increasing during daylight hours and cooling overnight. This is typical of shallow streams which are highly influenced by natural diurnal variations in ambient air temperatures.

The higher water temperatures indicated on the graph also correspond with increases in stage. This can indicate that there was a rainfall or snow melt event during those particular times.

The water temperatures at this station still display diurnal variations even in the cooler months. Shallow streams and ponds are highly influenced by natural diurnal variations in the surrounding air temperatures.

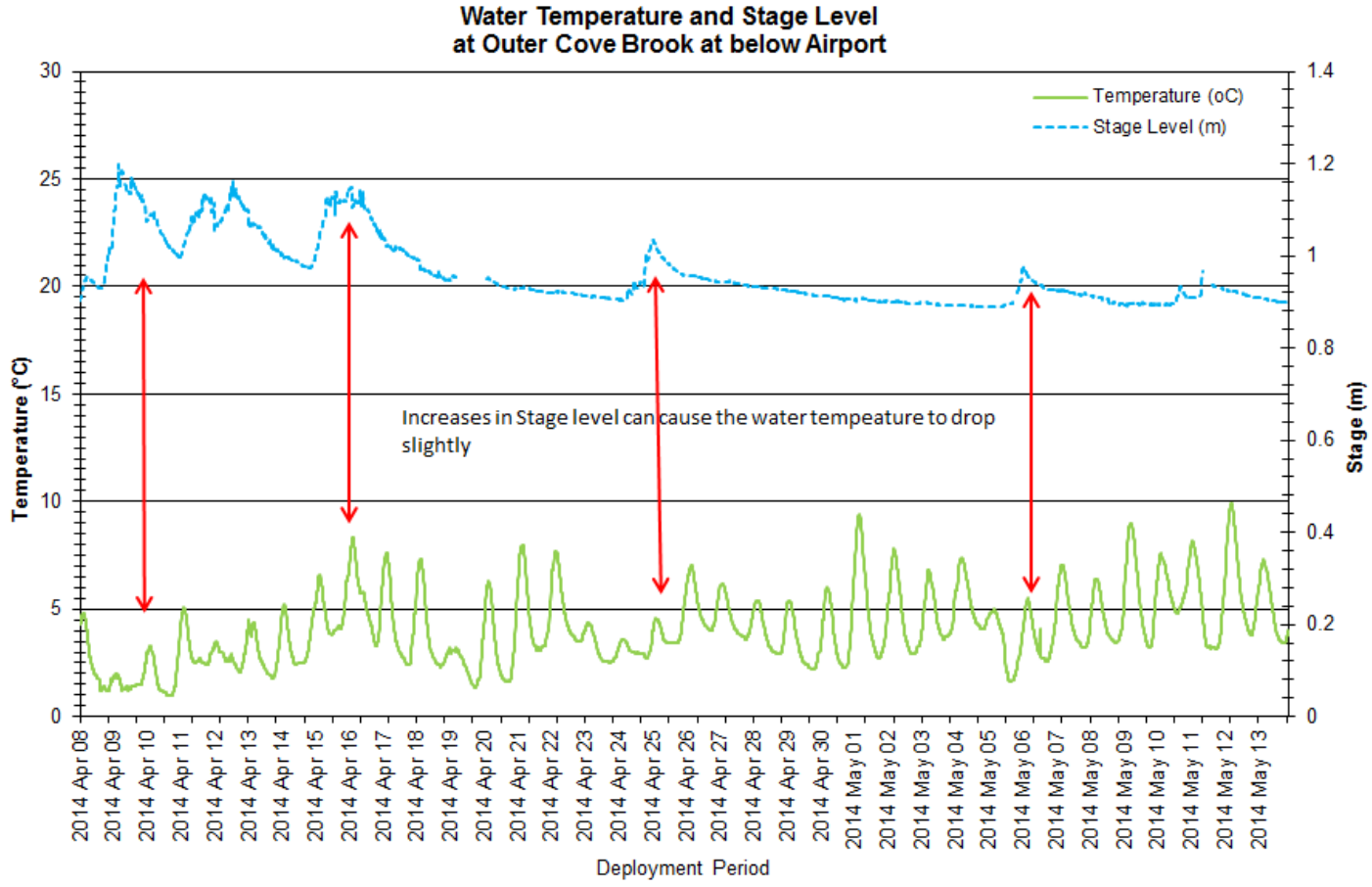


Figure 2: Quarter-hourly water temperature (°C) and stage level (m) values at Outer Cove Brook below Airport.

pH

Throughout this deployment period pH values ranged between 6.12 pH units and 6.85 pH units (Figure 3).

During the deployment, the pH values at this station fall just below the minimum CCME Guideline for the Protection of Aquatic Life (between 6.5 and 9 pH units) until the end of April where the pH levels increase to slightly above the minimum CCME Guideline for the Protection of Aquatic Life.

The events that where the pH levels dip on April 11th, April 25th, May 6th and May 12th correspond with stage increases. This can be explained by the natural correlation between rainfall and pH levels.

The CCME guideline provides a basis by which to judge the overall health of the brook. Naturally, all streams and brooks are different. During this deployment period the median pH level was 6.47 units, which was slightly lower than last month (more acidic than previous deployment month).

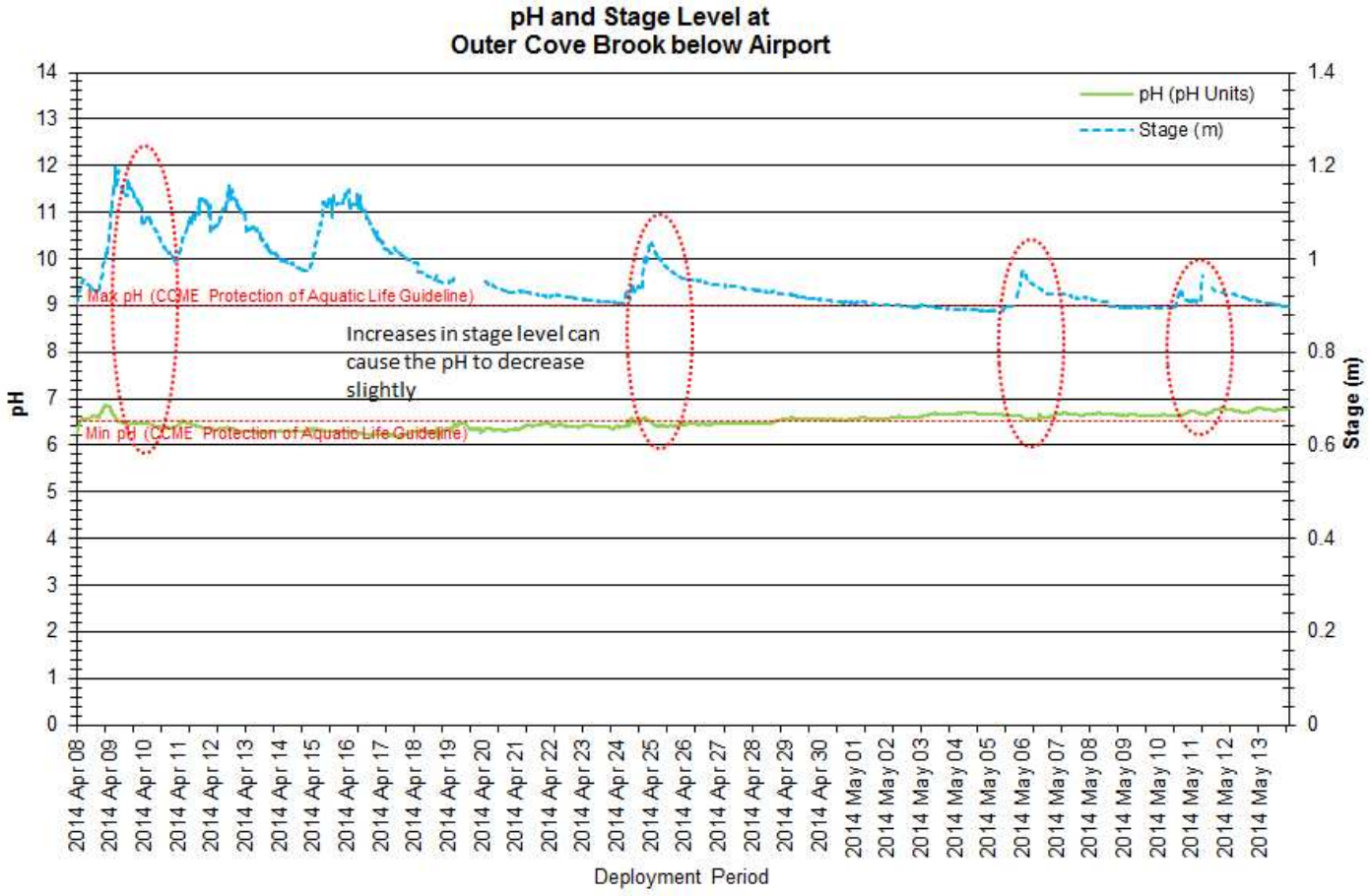


Figure 3: Quarter-hourly pH (pH units) and stage level (m) values at Outer Cove Brook below Airport

Specific Conductivity & TDS

The conductivity levels were within 304 µS/cm and 1926.0 µS/cm during this deployment period. TDS ranged from 0.1950 g/L to 1.200 g/L.

Higher stage level can flush the salts into the brook leading to higher conductivity levels. Data on April 9th, April 25th, May 6th and May 12st (see Figure 4) display the initial peak of conductivity and then the lower levels. When stage levels rise, the specific conductance levels drop in response as the increased amount of water in the river system dilutes the solids present.

Total Dissolved Solids (TDS), is a parameter that the instrument calculates by an algothrim that utilizes the data from specific conductivity and water temperature to produce a TDS value and generally always mirrors specific conductivity.

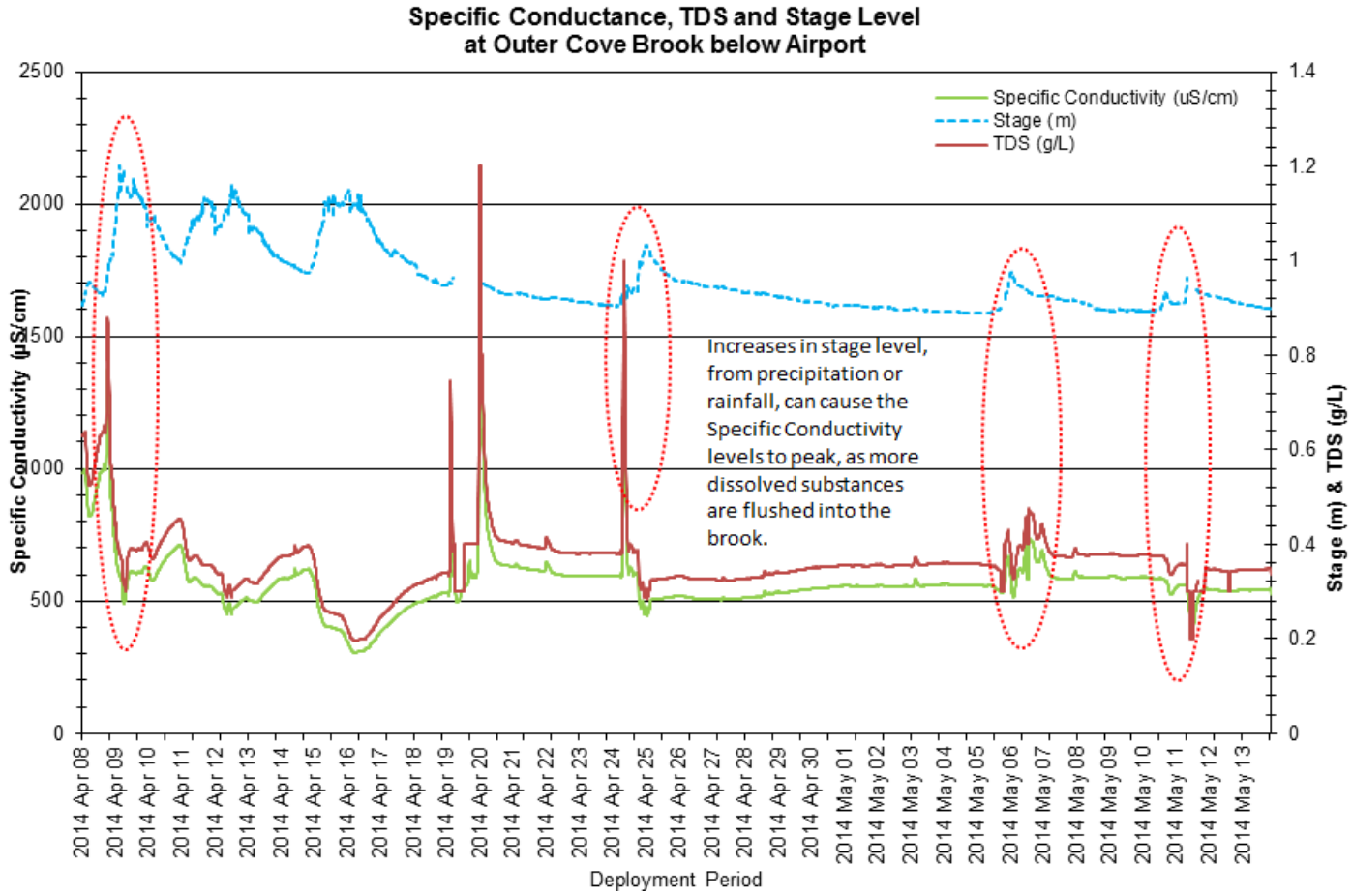


Figure 4: Quarter-hourly specific conductivity (µS/cm), TDS (g/L) and stage (m) values at Outer Cove Brook below Airport.

Dissolved Oxygen

The instrument measures dissolved oxygen (mg/L) then calculates percent saturation (% Sat).

The Dissolved Oxygen % Sat levels within this deployment period were within 52.4 % Sat–82.4 % Sat. Dissolved Oxygen (mg/L) measured 6.81 mg/L to 11.06 mg/L.

The calculated minimum levels for the dissolved oxygen are not representative of the water quality at this brook. All the sensors had fouling present, ultimately creating 'false' DO readings (Pictures in Appendix B).

For the beginning of the deployment the DO mg/L values remain just above the minimum DO CCME guideline for early life stages (Figure 5). As the instrument become more fouled with the slime-like algae the DO probe was unable to provide accurate readings of the brook. From May 2nd through to May 14th, 2014 the data for dissolved oxygen is not a true representation of the water quality.

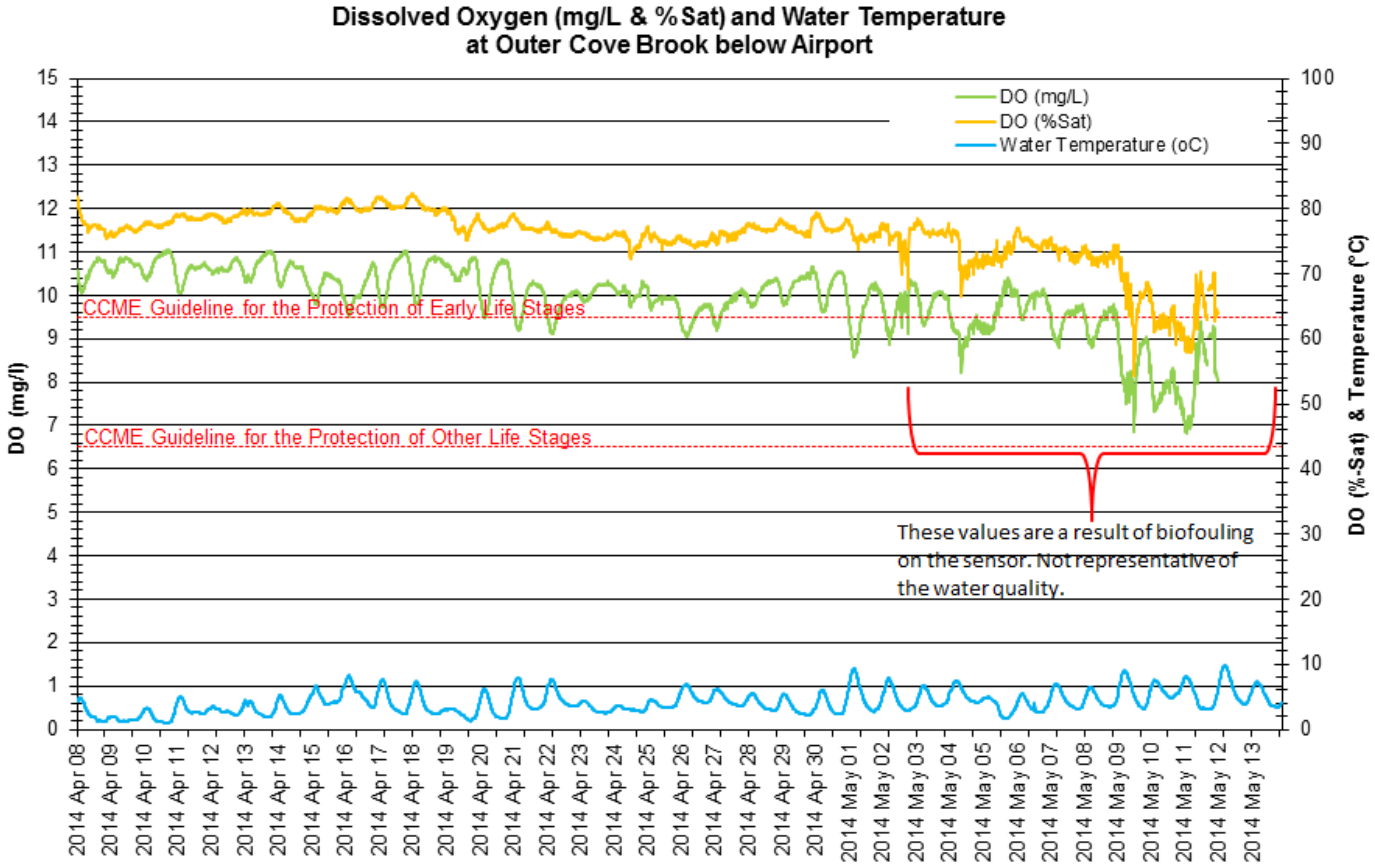


Figure 5: Quarter-hourly dissolved oxygen (mg/L & % sat) and water temperature (°C) values at Outer Cove Brook below Airport.

Turbidity

Turbidity levels during this deployment period ranged within 0.3 NTU and 363.2 NTU (Figure 6).

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 turbidity events at the beginning of the deployment period correlate with increases in stage potentially from precipitation and/or runoff events (Figure 6). Rainfall and precipitation can have the ability of increasing the presence of suspended material in water.

During this deployment period there was a built-up of slime-like algae that had covered the sensors on the instrument. By the time the instrument was removed for calibration and cleaning the fouling had started to interfere with the data being recorded. From April 26th, 2014 through to May 14th, 2014 the turbidity data is not a true representation of the water quality.

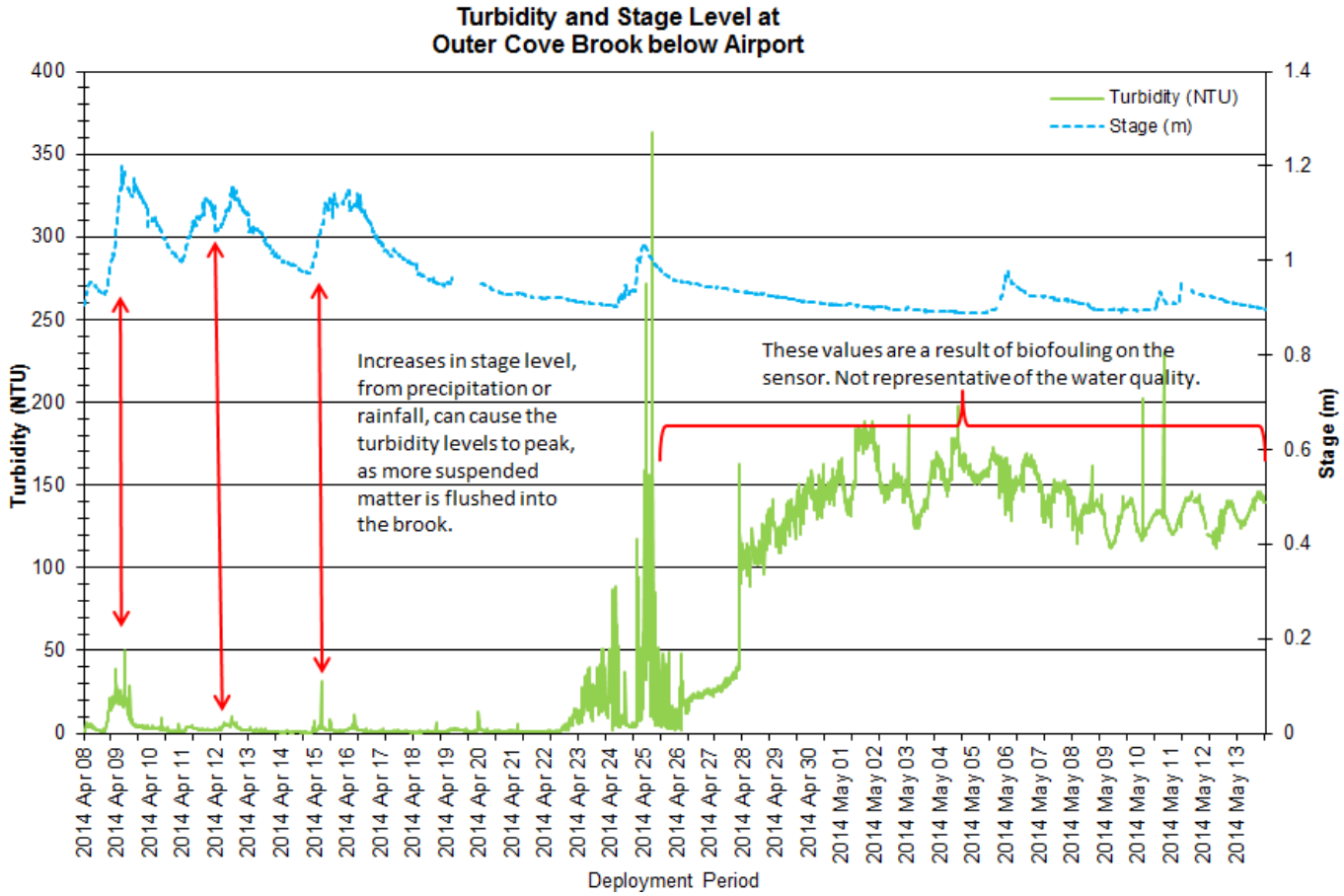


Figure 6: Quarter-hourly turbidity (NTU) and stage level (m) values at Outer Cove Brook below Airport.

Stage

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).

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 stage to rise significantly.

Precipitation data was obtained from Environment Canada's St. John's Airport weather station.

During the deployment period, the stage values ranged from 0.89m to 1.20m. The larger peaks in stage do correspond with sufficient rainfall events as noted on Figure 7.

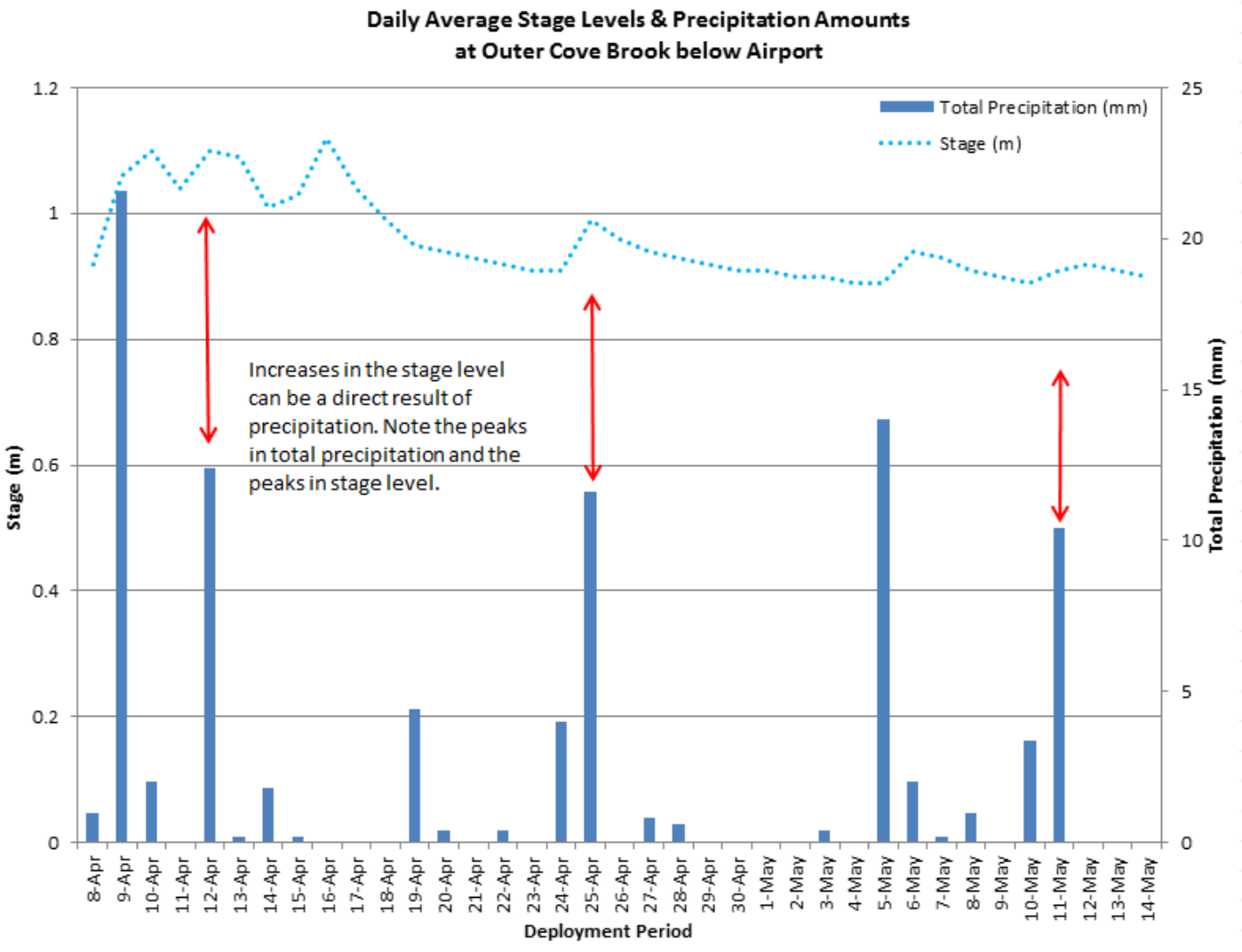


Figure 7: Daily average stage values (m) at Outer Cove Brook below Airport and daily total precipitation values (mm) from Environment Canada's St. John's Airport Station.

Outer Cove Brook, Newfoundland and Labrador

Conclusion

- As with many shallow brooks and streams, precipitation events play a role in influencing the parameters within the water body. This brook also flows through significant developed areas, including residential zones, golf courses and within the boundaries of heavily trafficked road ways, which can influence the parameter levels that are recorded.

- It is evident by the parameter data recorded that precipitation events during this deployment period have influenced fluctuations in stage. Precipitation can also impact the turbidity, pH, specific conductivity, and TDS in the brook. An influx of rainfall will dilute conductivity and TDS, and increase turbidity. pH values dropped (acidity increases) potentially with an increase in runoff from the surrounding environment with higher dissolved substances present.

- As ambient air temperatures decreased it caused the water temperature to drop. Water temperature directly affects the amount of dissolved oxygen present in the brook during those times.

- Toward the end of this deployment the level of biofouling present on the instrument affected the raw data being transmitted. At this deployment there was a large amount of hair-like algae present in the brook that is not evident all year round. Environment Canada was notified of the algae and provided with pictures of the algae. Environment Canada will also be forwarded the grab sample results taken on deployment for additional investigation.

Outer Cove Brook at Clovelly Golf Course

Water Temperature

Water temperature ranged from 0.49°C to 10.75°C during this deployment period (Figure 8).

Water temperature in this brook displays a typical variation in pattern over the deployment period. Water temperature is influenced by air temperature. Over the course of the deployment period the water temperature drops to 0°C or below several times.

The lower water temperatures indicated on the graph also correspond with increases in stage. This can indicate that there was rainfall or snow melt during those particular times. Overall the water temperature for this deployment period is slowly increasing as the air temperatures respond to seasonal changes.

Water temperature is a very important parameter and it has the ability to influence other parameters that are measured by the water quality instrument.

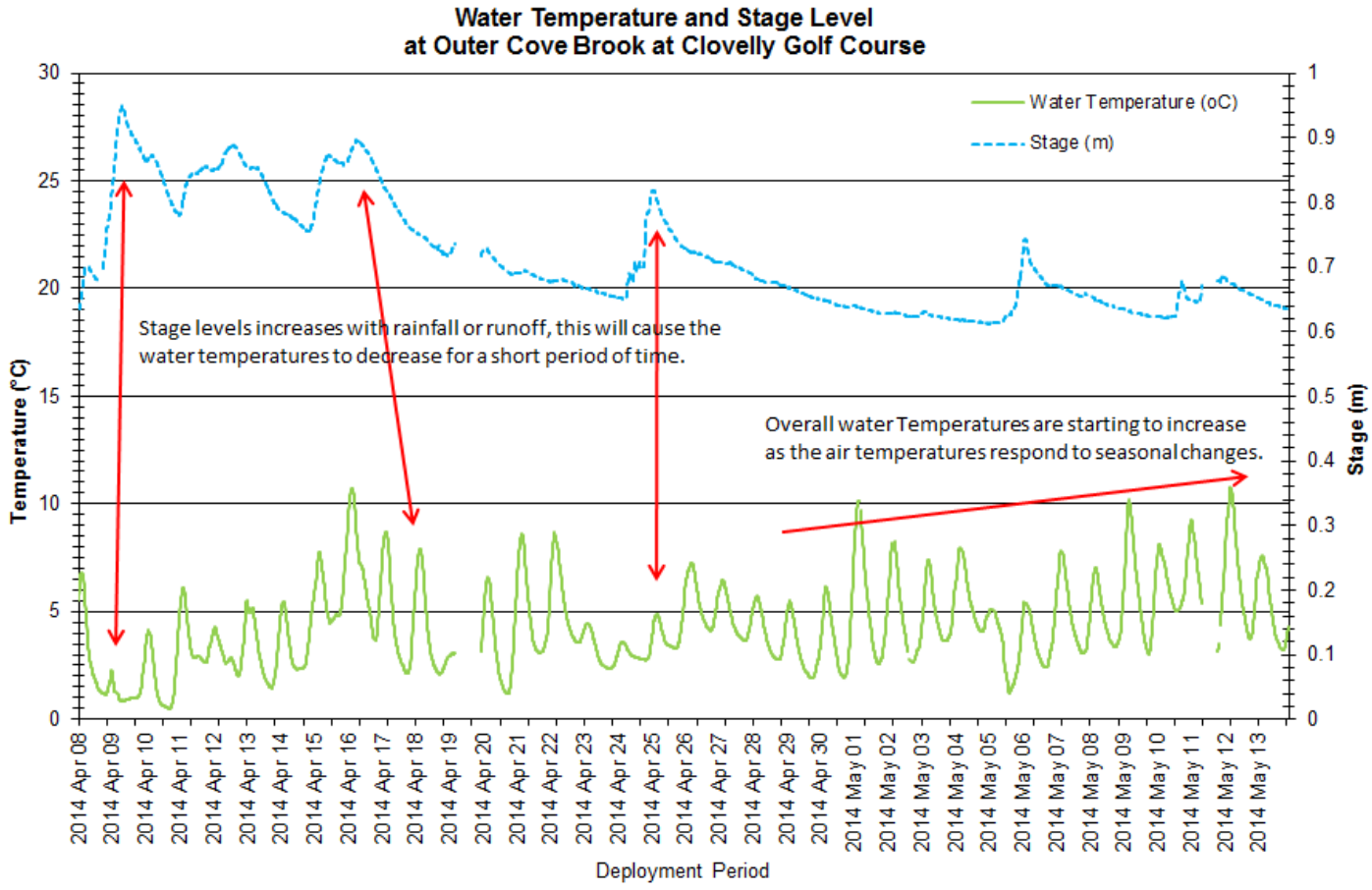


Figure 8: Quarter-hourly water temperature (℃) an d stage level (m) values at Outer Cove Brook at Clovelly Golf Course.

pH

Throughout this deployment period pH values ranged between 6.20 pH units and 6.80 pH units (Figure 9).

During the deployment, the pH values at this station fall just below the minimum CCME Guideline for the Protection of Aquatic Life (between 6.5 and 9 pH units) until the end of April where the pH levels increase to slightly above the minimum CCME Guideline for the Protection of Aquatic Life.

The pH levels dip on April 10th and 13th, April 17th, April 26th and May 7th correspond with stage increases. This can be explained by the natural occurrence between rainfall and pH levels.

The CCME guideline provides a basis by which to judge the overall health of the brook. Naturally, all streams and brooks are different. During this deployment period the median pH level was 6.55 units.

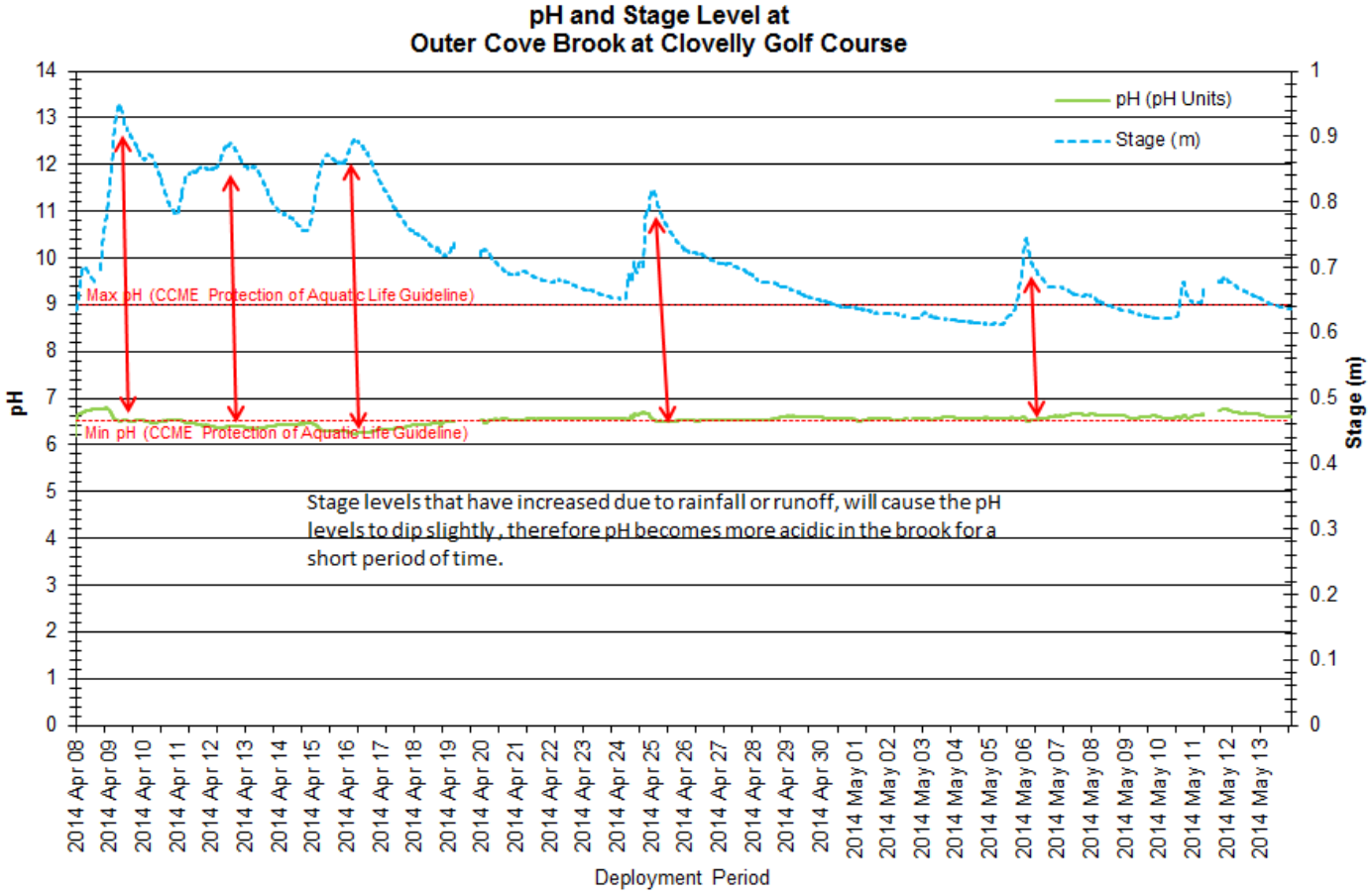


Figure 9: Quarter-hourly pH (pH units) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course.

Specific Conductivity & TDS

The conductivity levels were within 339.0 µS/cm and 2211.0 µS/cm during this deployment period. TDS ranged from 0.2170 g/L to 1.4200 g/L.

The peaks in conductivity on April 9th, April 25th, May 6th and May 12st (see Figure 10), correspond with the higher stage levels. The presence of inorganic dissolved solids such as road salt and material are washed into the brook and increase the 'normal' levels of conductivity.

During the colder winter months of the year, the city roads are salted heavily. As the ice and snow thaws the residual salts are flushed into surrounding rivers and brooks.

Total Dissolved Solids (TDS), is a parameter that the instrument calculates by an algothrim that utilizes the data from specific conductivity and water temperature to produce a TDS value and generally always mirrors specific conductivity.

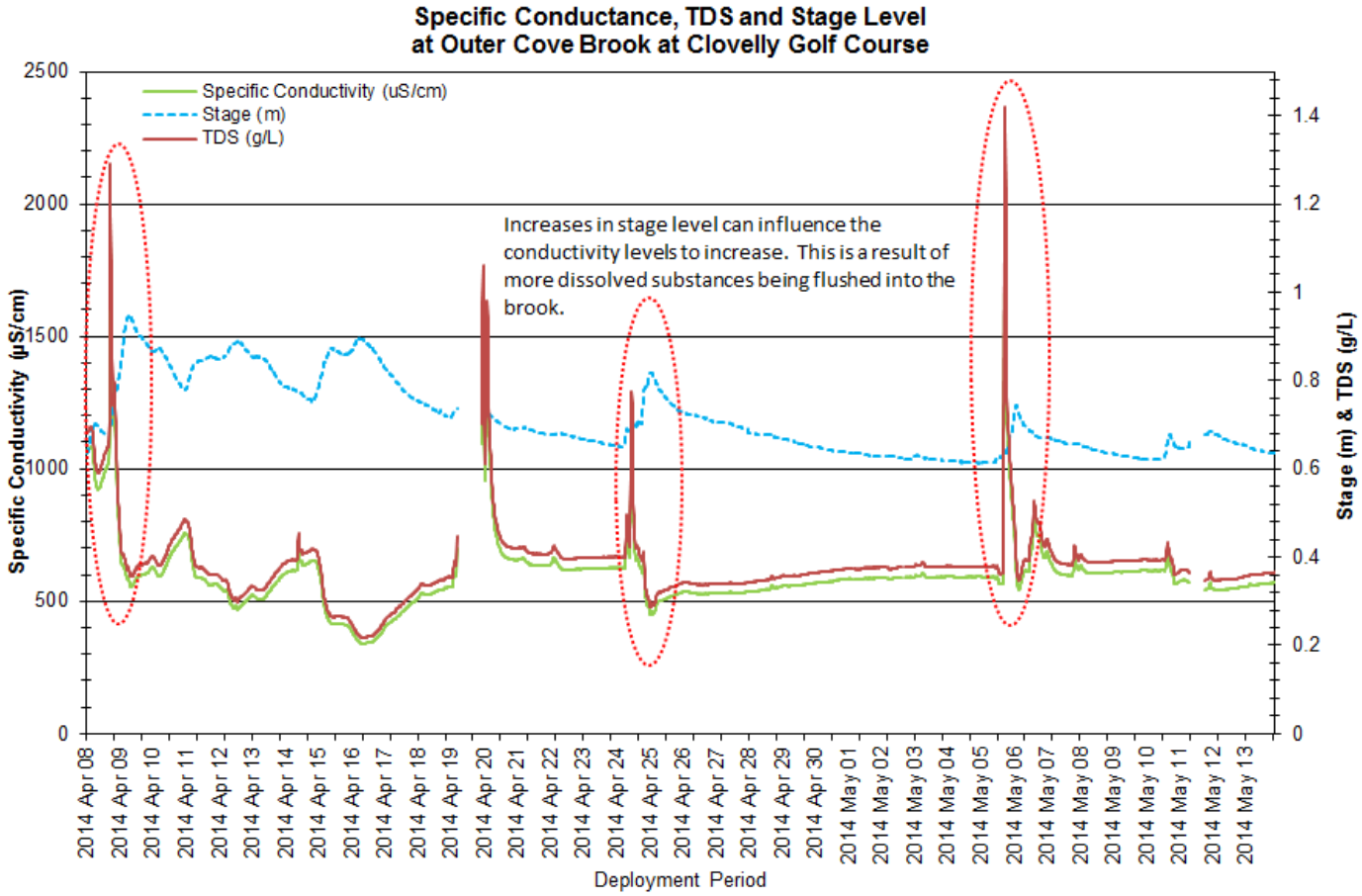


Figure 10: Quarter-hourly specific conductivity (uS/cm), TDS (g/L) and stage (m) values at Outer Cove Brook at Clovelly Golf Course.

Dissolved Oxygen

The instrument measures dissolved oxygen (mg/L) then calculates percent saturation (% Sat).

The Dissolved Oxygen %Sat levels within this deployment period were within 68.9 %Sat to 83.1 %Sat. Dissolved Oxygen (mg/L) measured 7.92 mg/L to 11.02 mg/L. Dissolved oxygen levels at this brook are a little lower than would be expected at this time; there is a possibility that the large amount of algae is consuming a higher amount of Dissolved Oxygen (Figure 11).

During removal of the instrument there was evidence of the similar brown hair-like algae – that was present upstream at Outer Cove Brook below Airport (Pictures in Appendix B). The coverage of the algae at this site was not as extreme (~30%) although it was still present on the sonde probes and the instrument required extensive cleaning.

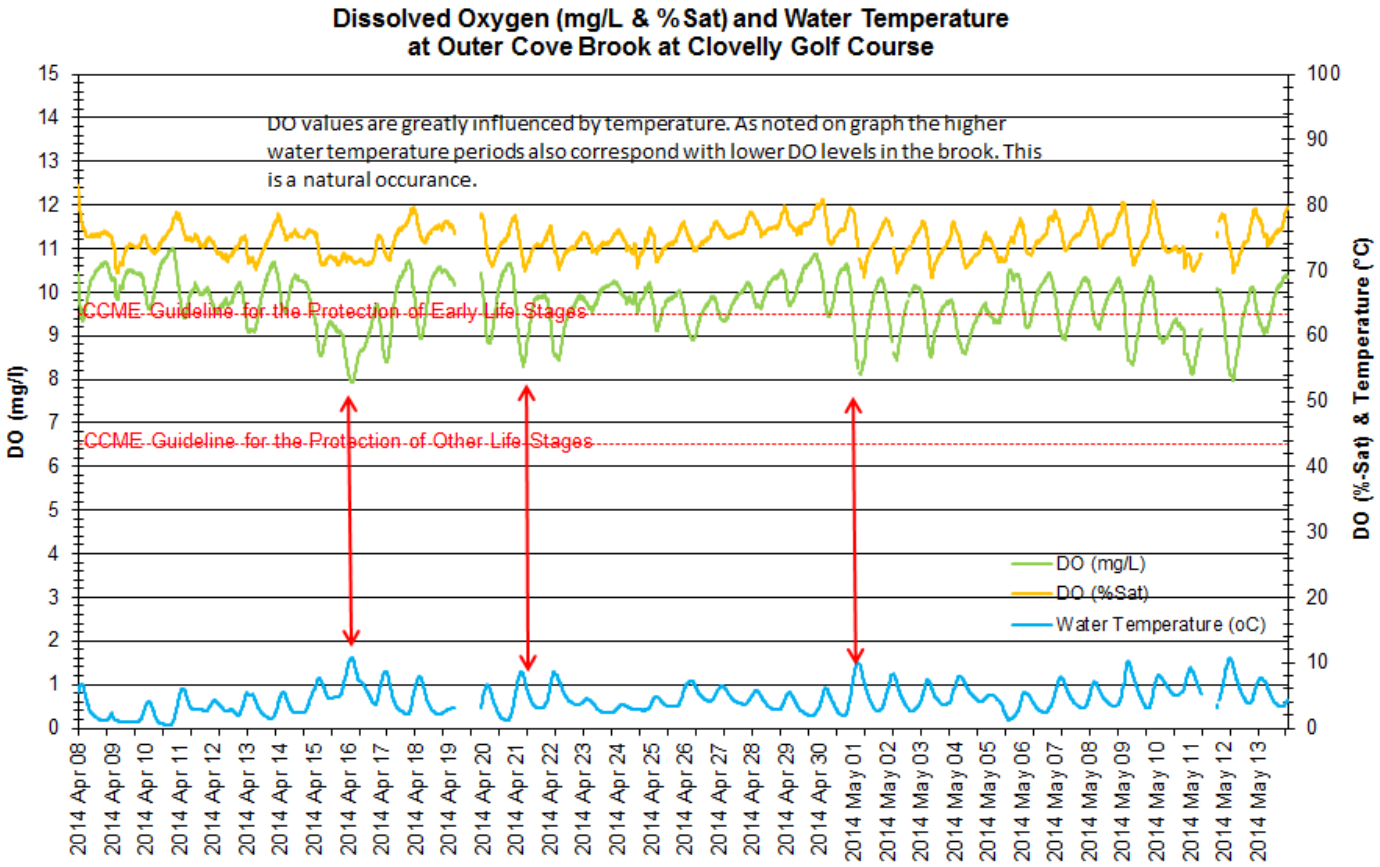


Figure 11: Quarter-hourly dissolved oxygen (mg/L & % sat) and water temperature (℃) values at Outer Cove Brook at Clovelly Golf Course.

Turbidity

Turbidity levels during this deployment period ranged within 0.7 NTU and 56.2 NTU (Figure 12).

At particular times in the year Outer Cove Brook can contain significant amounts of algae. High algal growth, biofouling, or leaf and grass debris can interfere with a turbidity sensor as the particles can block the sensor and affect the turbidity value.

The turbidity sensor on this instrument can read turbidity values between 0.0 NTU and 3000 NTU. However a turbidity reading of 3000 NTU is always identified as an error reading and during data grooming will be removed from the data set so to ensure it is not included in any statistical analysis.

As depicted on the graph there were several turbidity events during deployment. The higher turbidity readings, for example April 9th, events on April 15th and 16th, April 25th and May 6th correspond with stage fluctuations at those times.

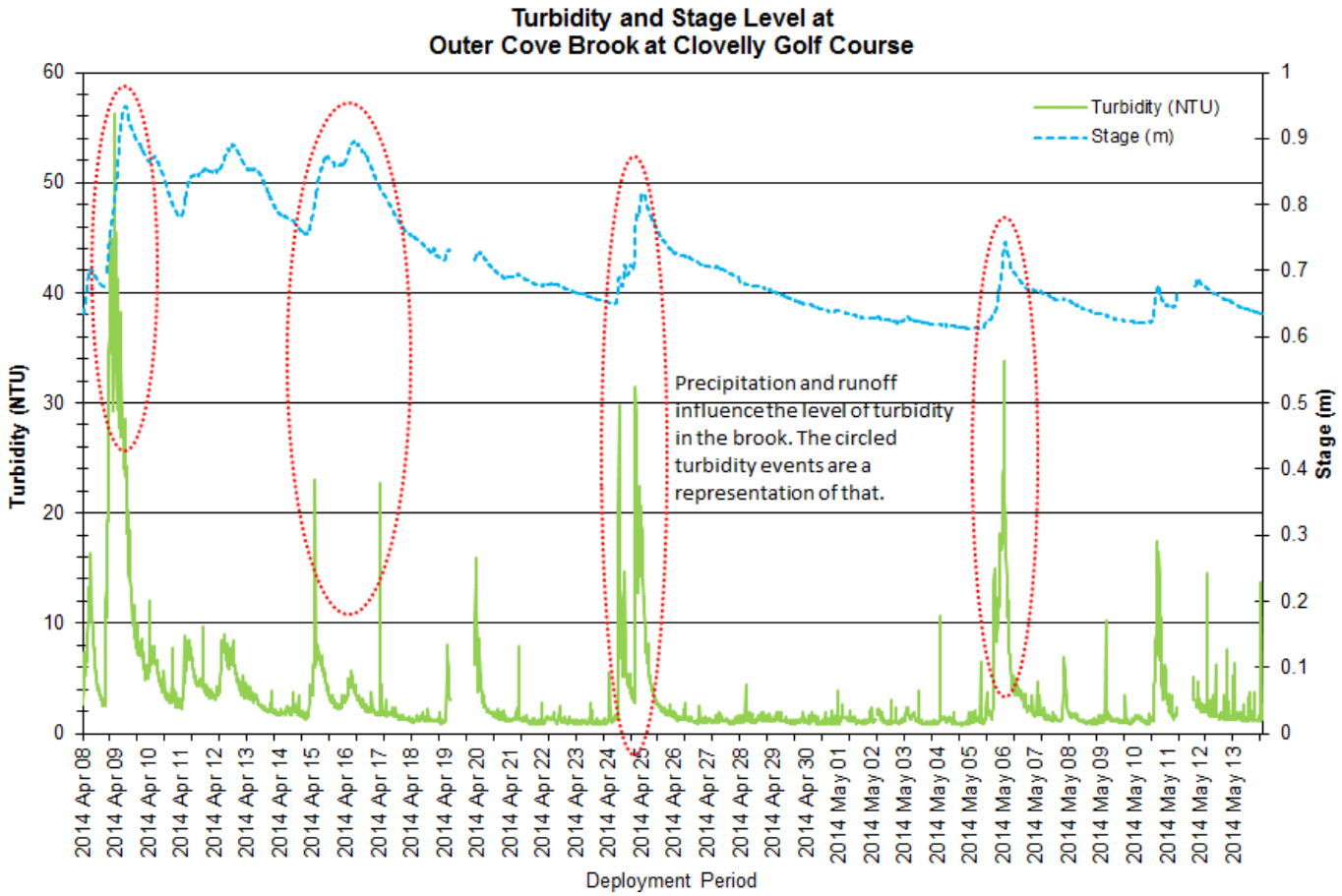


Figure 12: Quarter-hourly turbidity (NTU) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course.

Stage

The below graph includes precipitation data from St. John's International Airport weather station.

Stage can be defined as the height or elevation of the stream's water surface above a reference elevation (sea level, gauge 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).

It is not unusual to see Stage vary throughout the deployment period (Figure 13). Stage is directly influenced by rainfall and subsequent runoff from the surrounding environment.

The peaks in Stage in Figure 13 were a response to the rainfall events or snowmelt events that occurred during this deployment period. Stage levels during this deployment ranged within a minimum of 0.61m and a maximum of 0.95m.

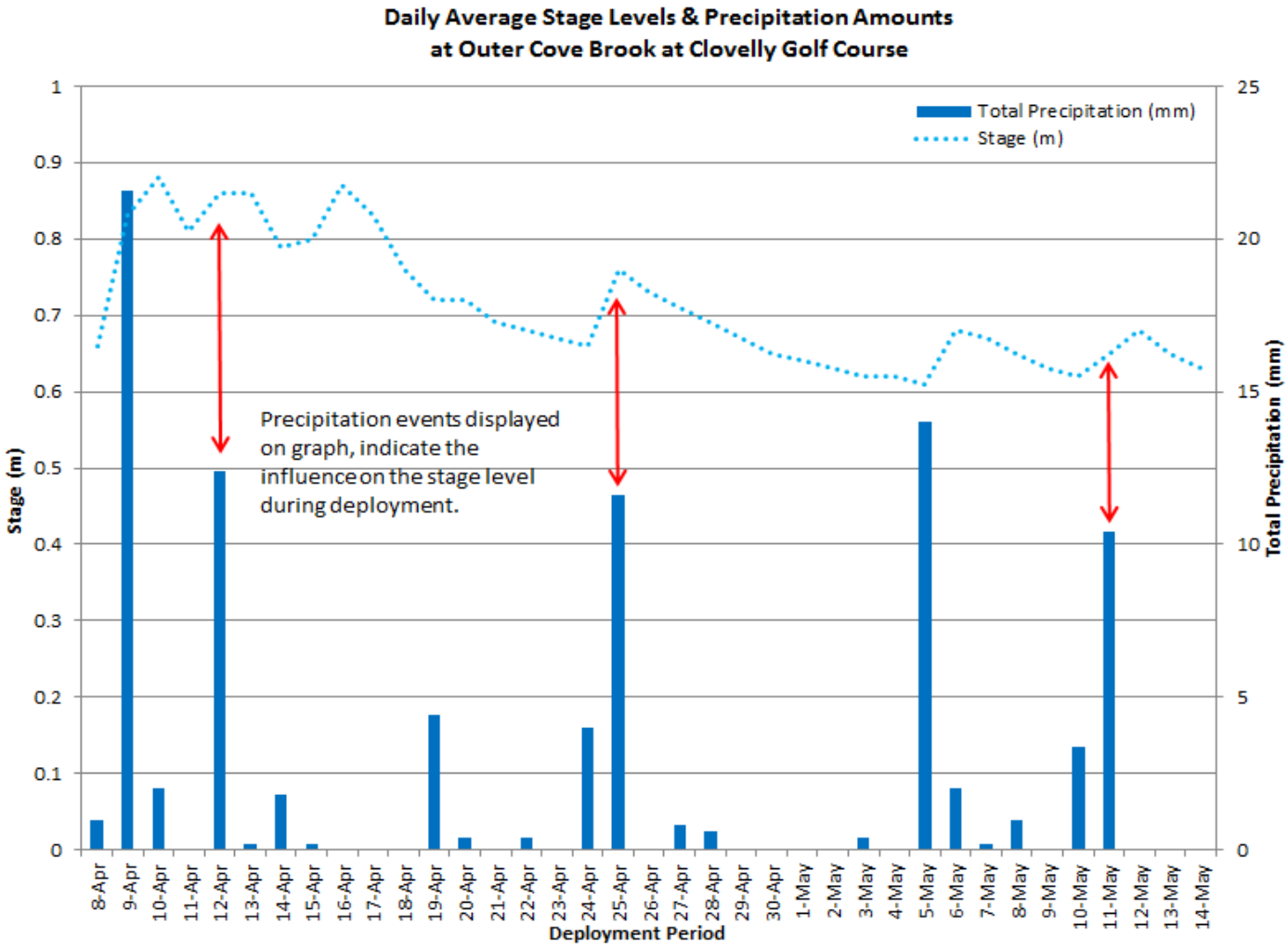


Figure 13: Daily average stage values (m) at Outer Cove Brook at Clovelly Golf Course and daily total precipitation values (mm) from Environment Canada's St. John's Airport Station.

Outer Cove Brook, Newfoundland and Labrador

Conclusion

- As with many shallow brooks and streams, precipitation events play a role in influencing the parameters within the water body. This brook also flows through significant developed areas, including residential zones, golf courses and within the boundaries of heavily trafficked road ways, which can influence the water quality parameters.

- It is evident by the parameter data recorded that precipitation events during this deployment period have influenced fluctuations in stage. Precipitation can also impact the turbidity, pH, specific conductivity, and TDS in the brook. An influx of rainfall will dilute conductivity and TDS, and increase turbidity. pH values dip (acidity increases) likely due to an increase in runoff from the surrounding environment that contains higher dissolved substances.

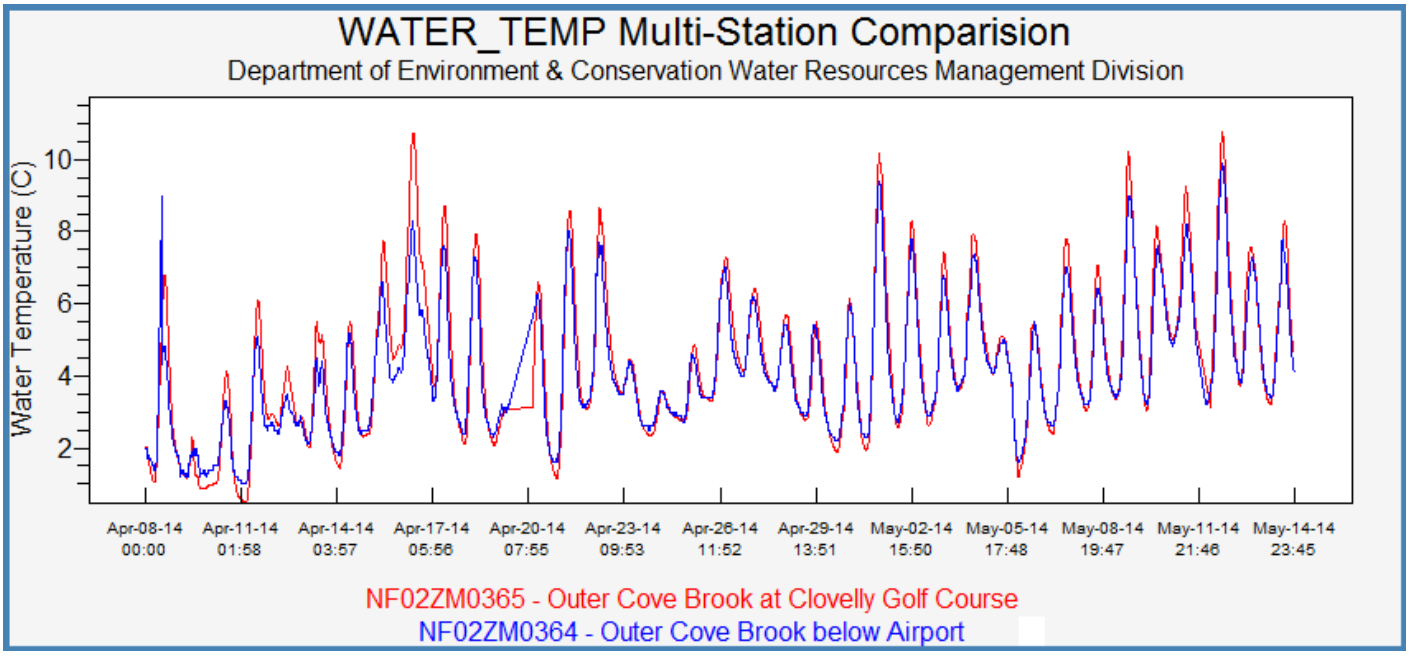
- As ambient air temperatures increase it reflects in the water temperatures. Water temperature directly affects the amount of dissolved oxygen present in the brook during those times.

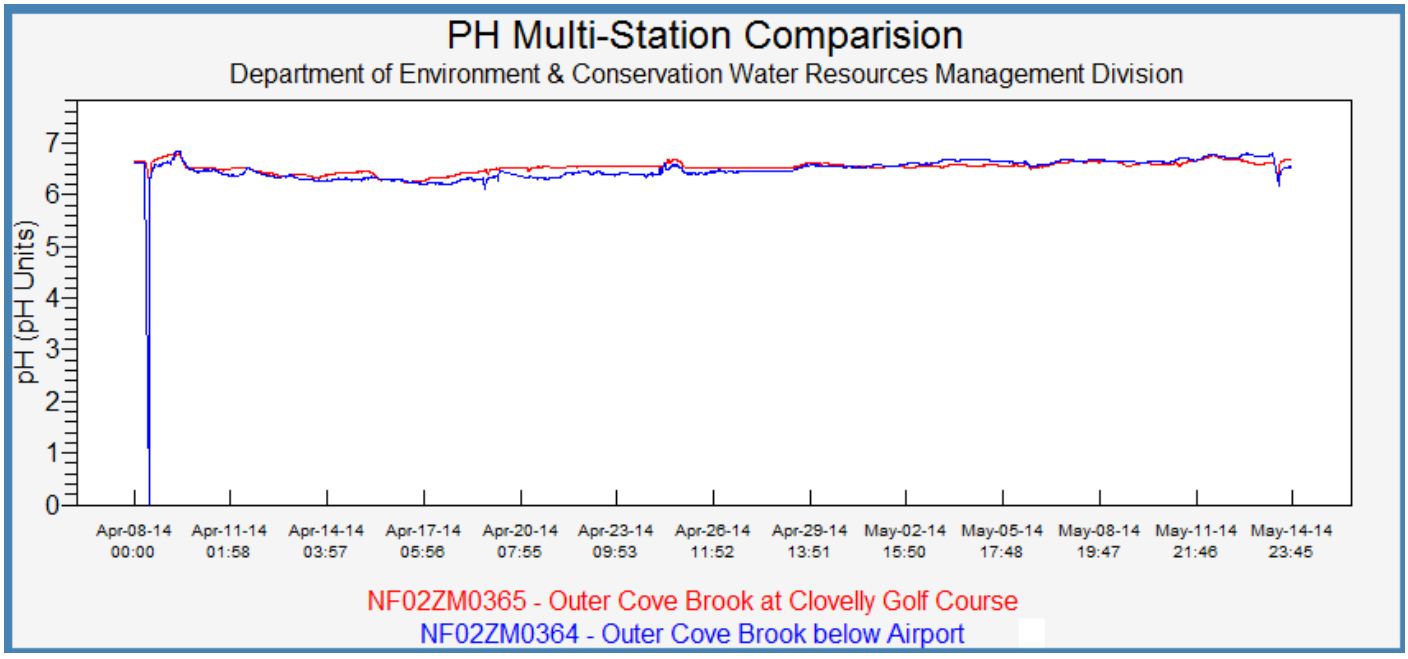
- Dissolved Oxygen present in the water at this site is lower than expected. It is possible that the large amount of algae existing on the stream bed is absorbing the DO.

- Specific conductivity is slightly higher at this station than the below airport station. This brook has the potential for a larger influence of salt runoff; this station captures the runoff from residential areas and alongside heavily trafficked roadways.

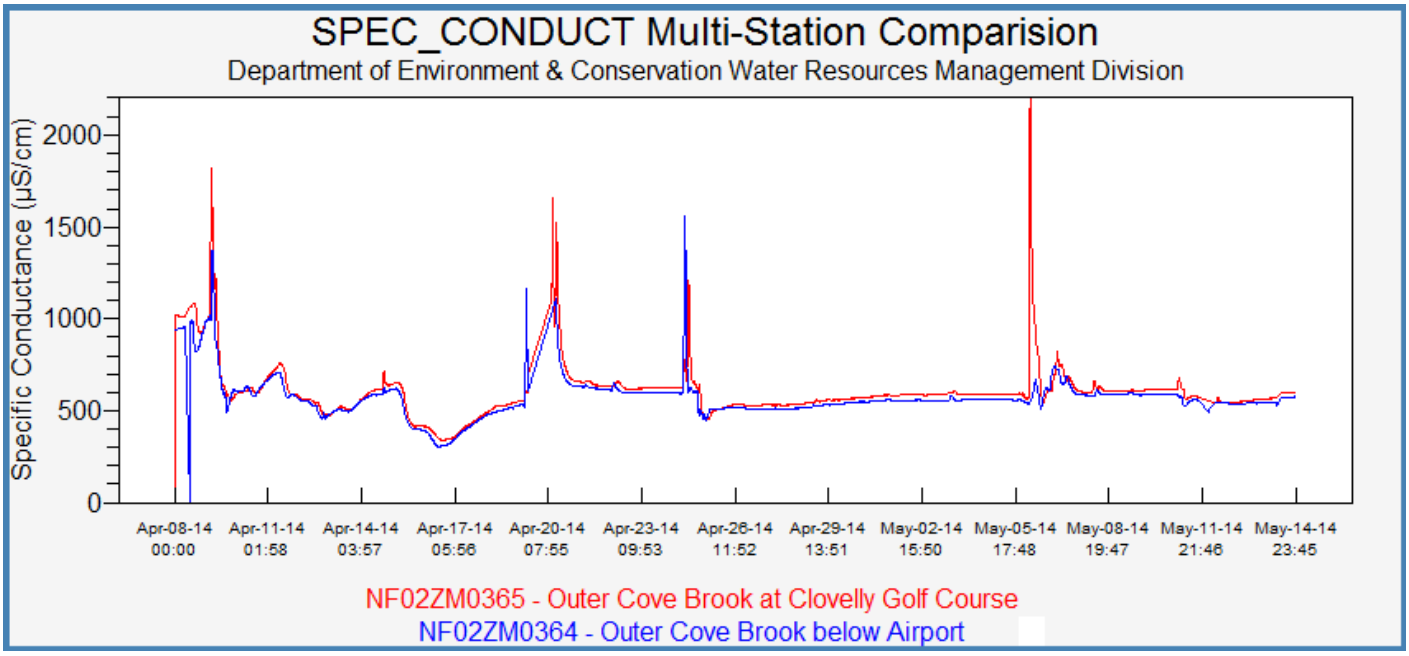
Appendix A

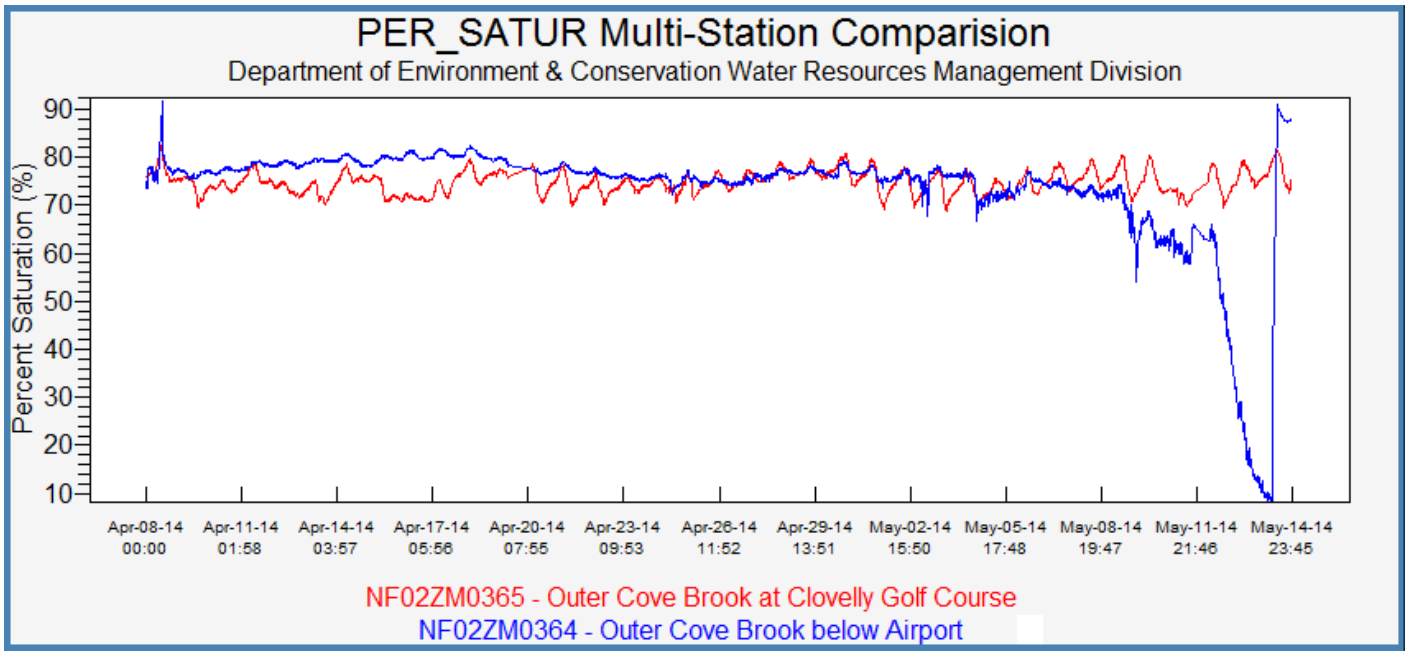
Parameter Station Comparison Graphs



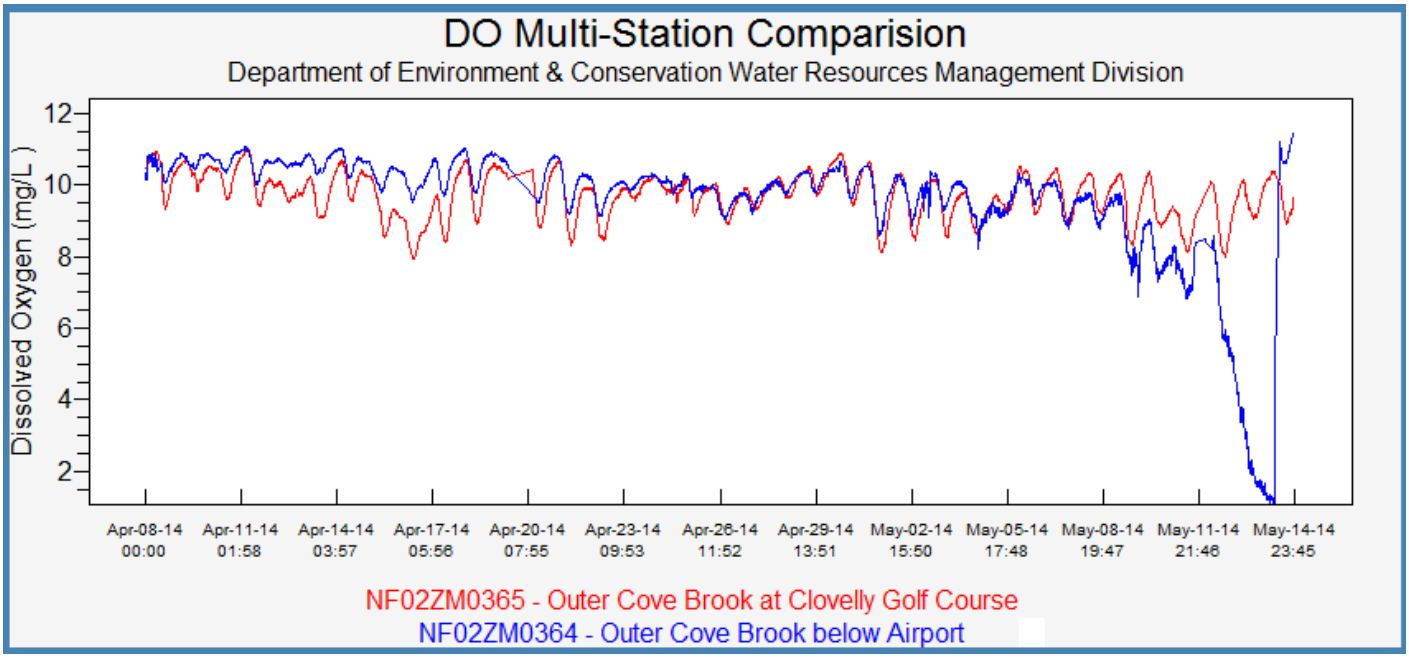


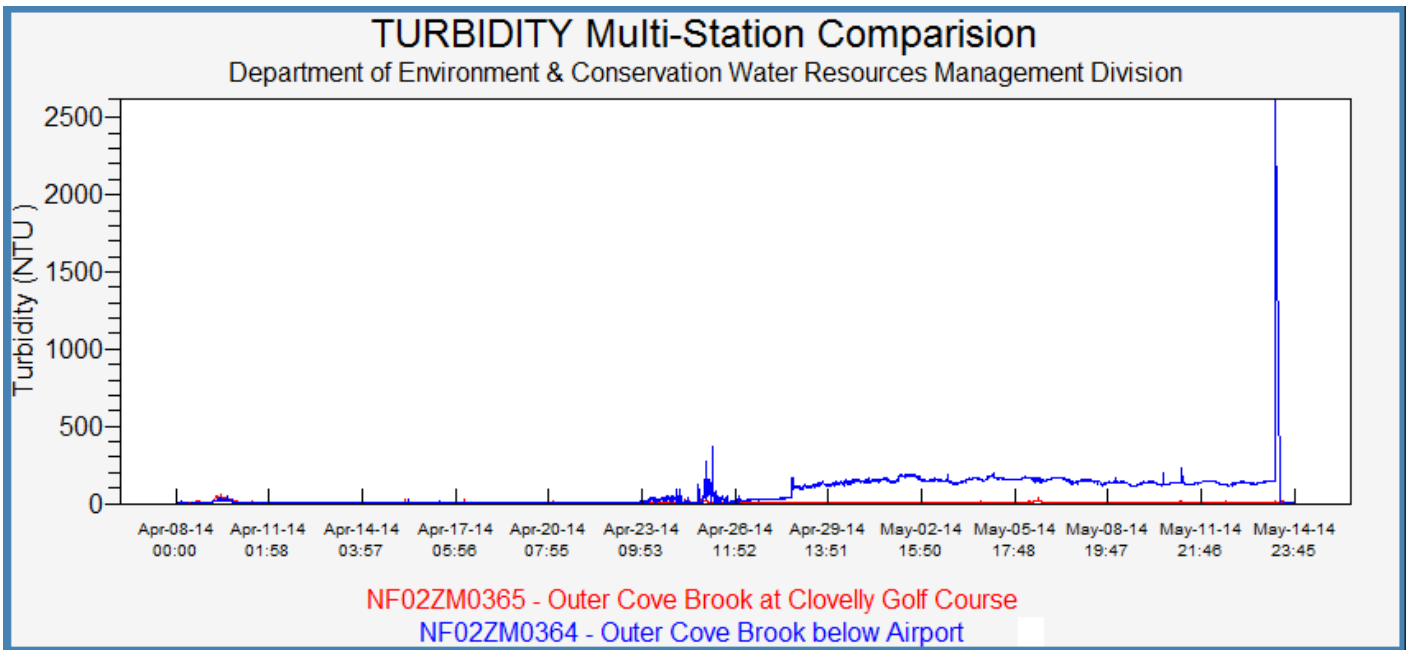
Outer Cove Brook, Newfoundland and Labrador



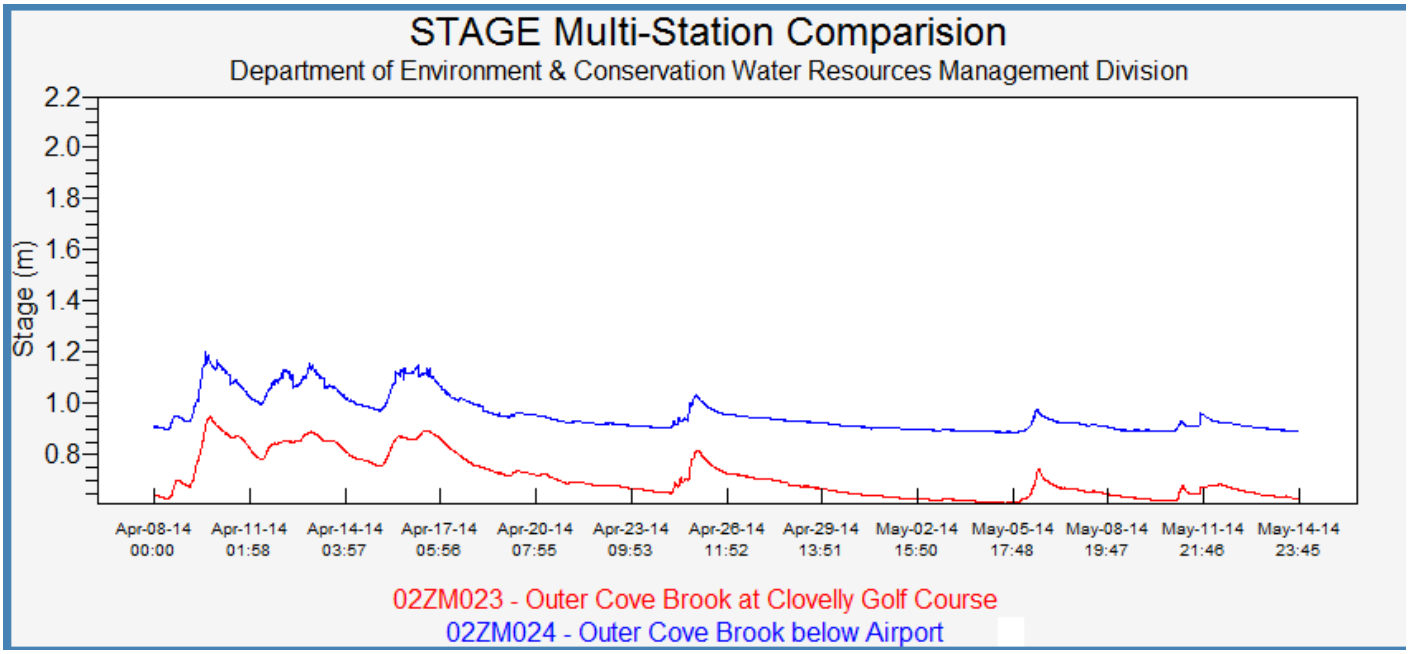


Outer Cove Brook, Newfoundland and Labrador



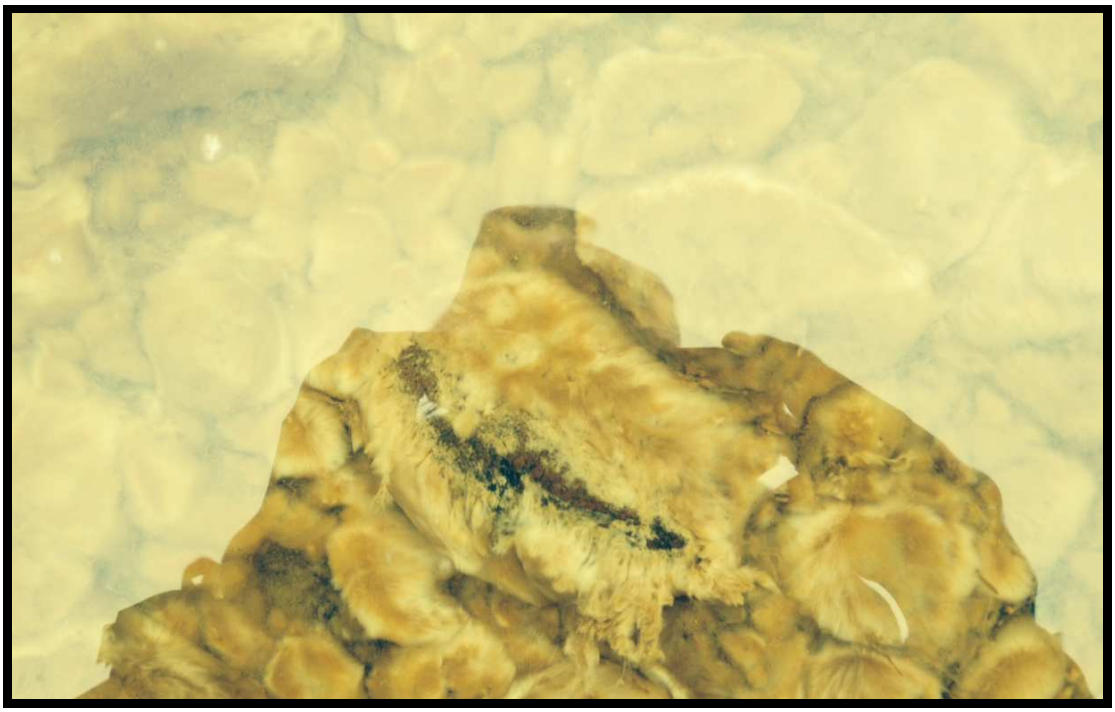


Outer Cove Brook, Newfoundland and Labrador



Appendix B

Pictures of biofouling on Outer Cove Brook at Airport Station instrument



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Outer Cove Brook, Newfoundland and Labrador

Outer Cove Brook, Newfoundland and Labrador

Pictures of biofouling on Outer Cove Brook at Clovelly Golf Course Station instrument

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