Real-Time Water Quality Report

Outer Cove Brook Network

Deployment Period
March 6 to April 9, 2013

Newfoundland Labrador

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

Outer Cove Brook, Newfoundland and Labrador

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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 33-day period from deployment on March 6, 2013 until removal on April 9, 2013.

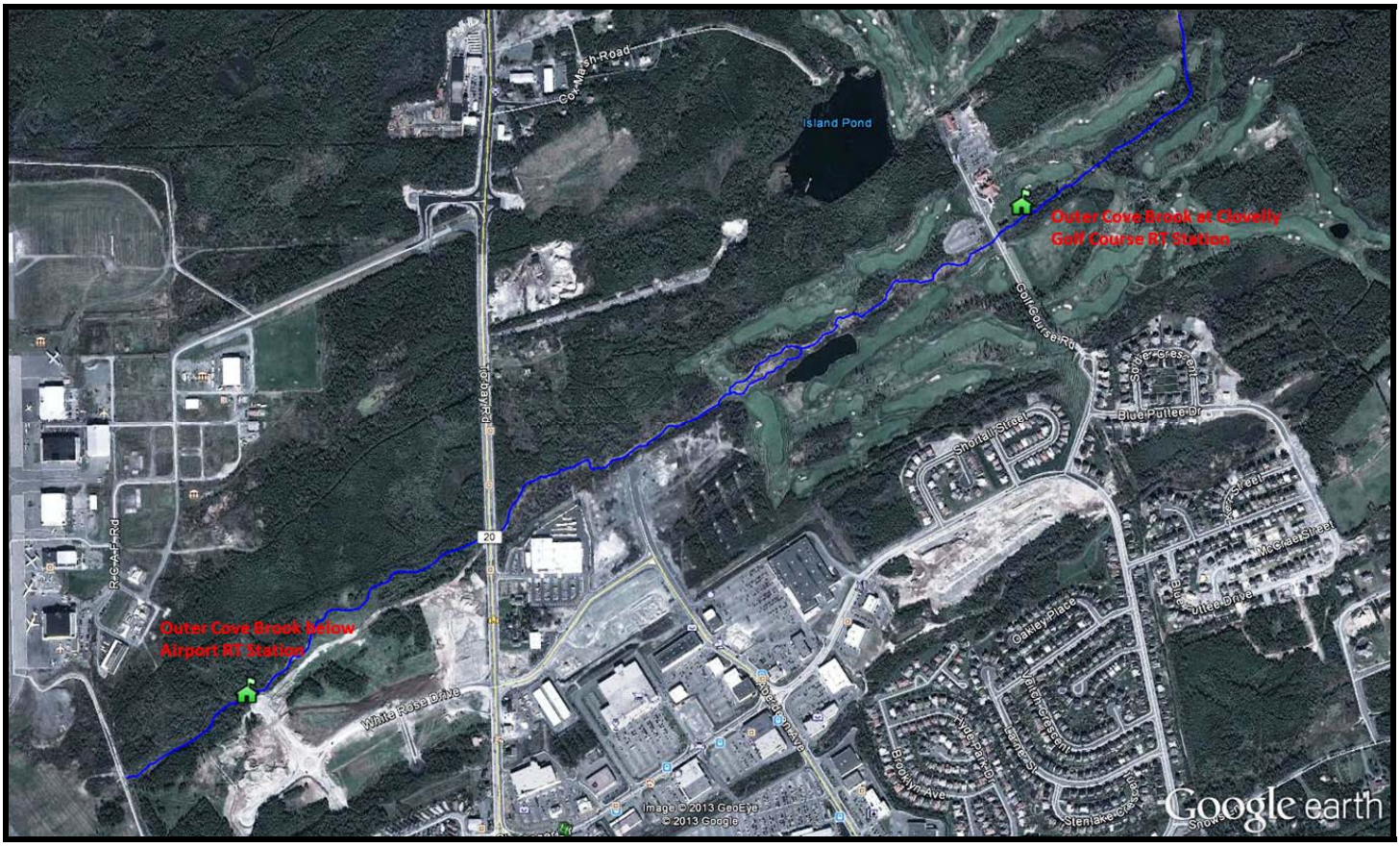

Figure 1: Outer Cove Brook Real-Time Water Quality and Quantity Stations.

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 March 6, 2013 through to April 9, 2013 are summarized in Table 2.

Table 2: Instrument performance rankings for Outer Cove Brook below Airport Mar. 6, 2013 – Apr. 9, 2013

Station	**Date**	**Action**	**Comparison Ranking**				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
Below Airport	Mar 6 2013	Deployment	Excellent	Excellent	Good	Excellent	Excellent
	Apr 9 2013	Removal	Excellent	Good	Good	Excellent	Poor*

- At the Outer Cove Brook below Airport station at the point of deployment, all sensors ranked 'good' to 'excellent'. Overall, the data being produced was reliable and accurate at the start of deployment.

- At removal, temperature and dissolved oxygen ranked as 'excellent', while pH and conductivity ranked as 'good'. The turbidity sensor ranked as 'poor' as was expected after observing a constant rise in turbidity values over the month, reaching the maximum and error value of 3000#, indicative of sensor blockage. When the sonde was removed, heavy growth of a 'fur-like' slime substance coated the sonde casing and the sensors. For photos of the biofouling, please see appendix 1.

- Deployment and removal instrument performance rankings for **Outer Cove Brook at Clovelly Golf Course** for the period of March 6, 2013 through to April 9, 2013 are summarized in Table 3.

Table 3: Instrument performance rankings for Outer Cove Brook at Clovelly Golf Course Mar. 6, 2013 - Apr 9, 2013

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Clovelly Golf Course	Mar 6 2013	Deployment	Excellent	Good	Good	Excellent	Good
	Apr 9 2013	Removal	Good	Excellent	Excellent	Excellent	Poor

- During the Outer Cove Brook Clovelly Golf Course station deployment, all sensors ranked 'excellent' or 'good' when compared to the freshly calibrated QA/QC sonde.

- At removal, pH, dissolved oxygen and conductivity all ranked 'excellent', while temperature ranked as 'good'. The turbidity sensor ranked as 'poor', and analysis of the turbidity data at this site shows that biofouling is an issue. The presence of a brown 'film' was noted on the sensors.

- 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

- Transmission errors occurred during the deployment period at both stations, resulting in data gaps in the graphs shown in this report. At the below airport station, a significant gap in transmitted data occurred March 23 to April 5. During this time period, little or no data was transmitted. Transmissions were restored by EC on April 5, 2013. At the Clovelly Golf Course station, cable issues caused loss of transmissions from March 6 until March 8.

Data Interpretation

- The following graphs and discussion illustrate water quality-related events from March 6 to April 9, 2013 at the Outer Cove Brook Stations.
- As the above mentioned transmission errors for the below Airport station were significant in length, the internally stored data water quality data from the sonde is interpreted for this station. Thus, stage values are missing for the transmission gap period of March 23 to April 5, 2013.
- 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 and supplemented with information from 'The Weather Network' when EC data was not available.

Outer Cove Brook below Airport

Water Temperature

- Water temperature ranged from 0.44°C to 6.61°C during this deployment period (Figure 2). No ice was present around the sonde or field cable during removal.
- Water temperatures fluctuate just above 0°C, as expected during the spring months, with an increase in temperatures noted during the last week of the deployment. This is consistent with ambient air temperatures over this time period.
- Water temperatures display diurnal variations, typical of shallow streams and ponds which are highly influenced by natural diurnal variations in ambient air temperatures.
- Water temperature is a very important parameter and it has the ability to influence other parameters that are measured by the water quality instrument.

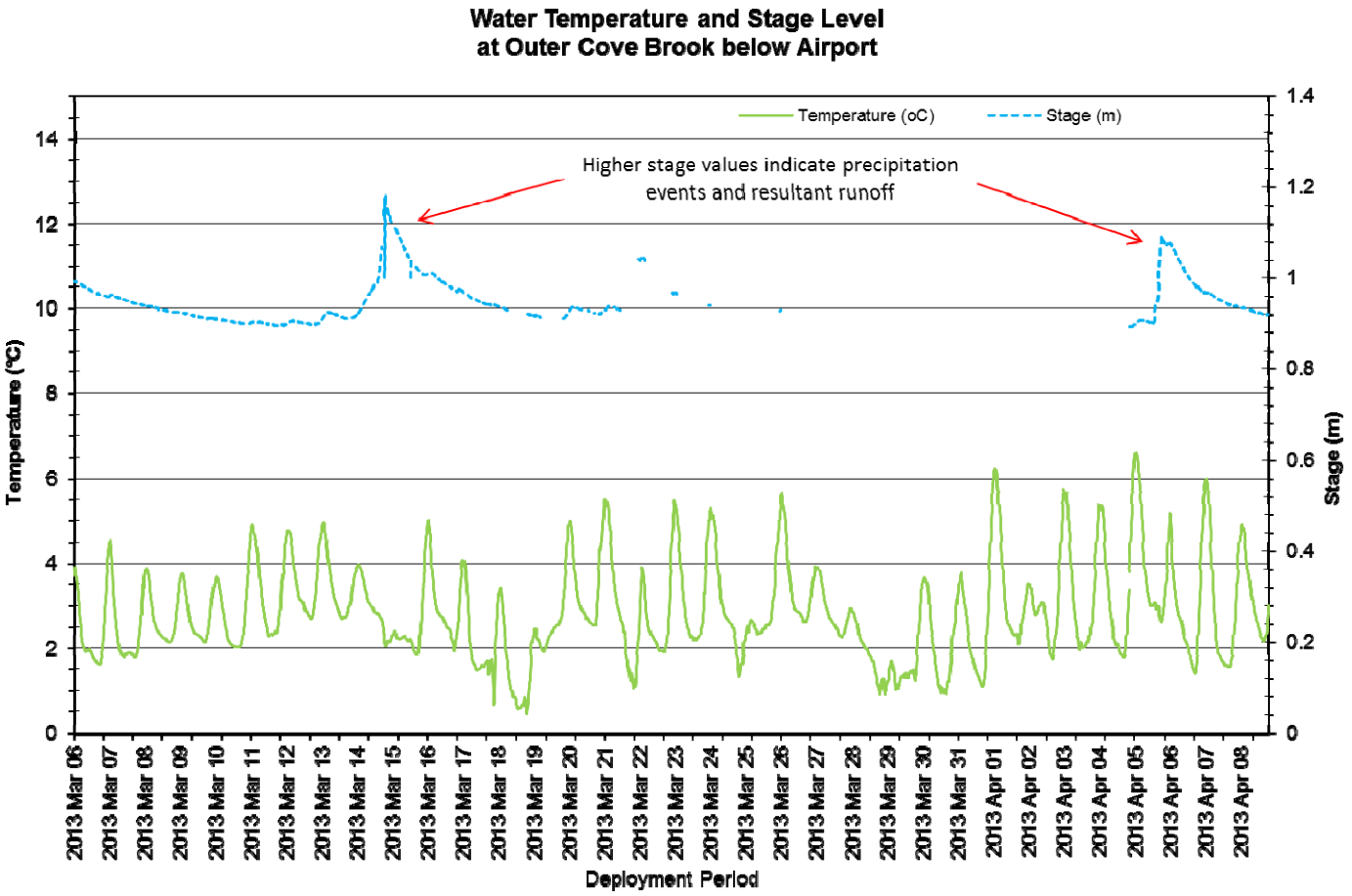

Figure 2: Quarter-hourly water temperature (°C) and stage level (m) values at Outer Cove Brook below Airport for the deployment period March 6, 2013 to April 9, 2013.

pH

- Throughout this deployment period pH values ranged between 6.30 pH units and 7.29 pH units (Figure 3).
- During the deployment, the pH values at this station hover around the minimum CCME Guideline for the Protection of Aquatic Life (between 6.5 and 9 pH units) up until March 26. From March 26 to April 6, the pH rises and hovers around 7.0 pH units. This indicates an issue with the water quality at this station during this time period. From April 6 to April 9, the pH lowers to again hover around 6.5 pH units due to a precipitation event. This is a 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. In the case of Outer Cove Brook below Airport, pH is within the normal range for stream water in St. John's. However, some event influenced the water quality at this site March 26 to April 6, resulting in an abnormal increase in pH.

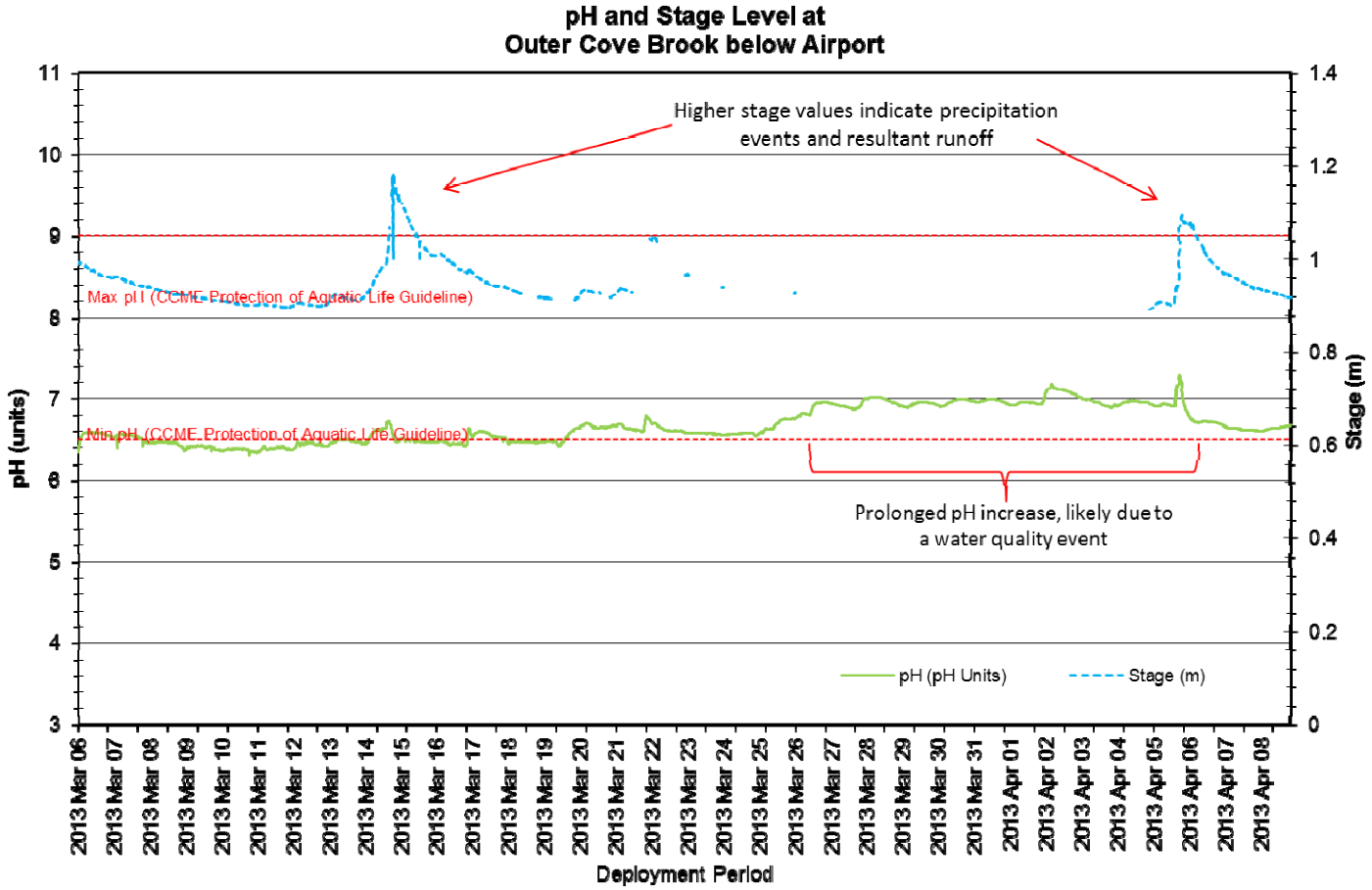

Figure 3: Quarter-hourly pH (pH units) and stage level (m) values at Outer Cove Brook below Airport for the deployment period March 6, 2013 to April 9, 2013.

Specific Conductivity & TDS

- The conductivity levels were within 241 µS/cm and 1194 µS/cm during this deployment period. TDS ranged from 0.2 g/L to 0.8 g/L.
- Cold temperatures and snowfall events during winter months can have the effect of increasing conductance levels due to the addition of salt to roadways. Through wind, snowmelt and rainfall, these salts are carried into the water system, increasing the specific conductance.
- Generally, rainfall events, such as that which occurred on March 14 (see Figure 4), can have the effect of diluting and lowering conductance levels. When stage levels rise, the specific conductance levels drop in correlation as the increased amount of water in the river system dilutes the solids present there, thus generally decreasing the specific conductivity readings.
- 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.

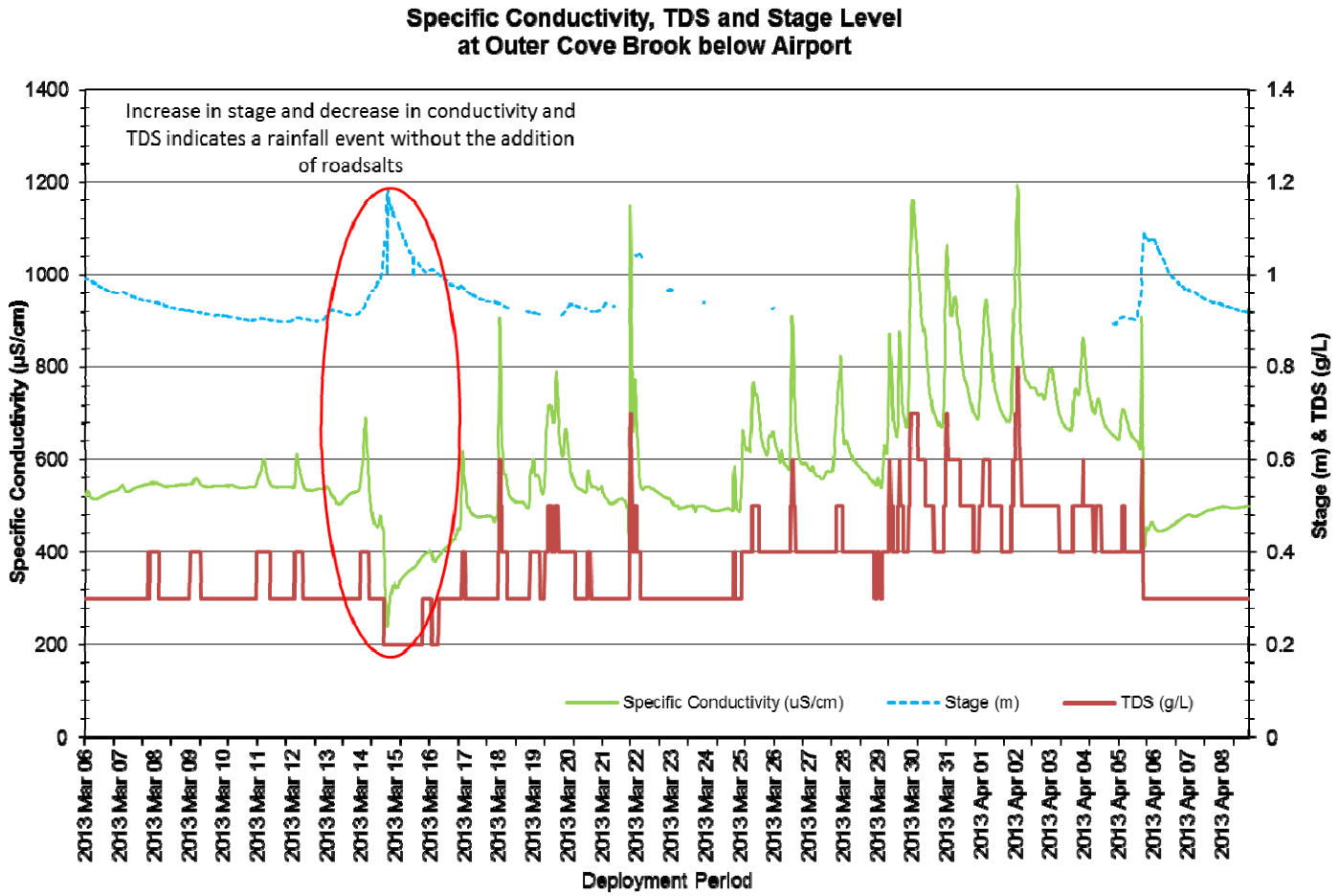

Figure 4: Quarter-hourly specific conductivity (µS/cm), TDS (g/L) and stage (m) values at Outer Cove Brook below Airport for the deployment period March 6, 2013 to April 9, 2013.

Dissolved Oxygen

- The instrument measures percent saturation directly, then calculates dissolved oxygen (mg/L) using the percent saturation and water temperature values.
- The Dissolved Oxygen % Sat levels within this deployment period were within 9.8% Sat–87.3% Sat. Dissolved Oxygen (mg/L) measured 1.36 mg/L to 12.01 mg/L. The DO mg/L values are above the minimum DO CCME guideline for early life stages for the majority of the deployment, but dip below this threshold on April 3 and April 5 (see Figure 5). This coincides with the increase in pH values observed during this time period, and is likely associated with a water quality issue at this time.
- Dissolved Oxygen percent saturation fluctuates throughout the deployment period as the presence of dissolved salts in the water influences oxygen saturation. Dissolved oxygen mg/L content fluctuates with the water temperature changes. Small decreases in dissolved oxygen values are inversely related to increases in water temperature as colder water can hold more oxygen.

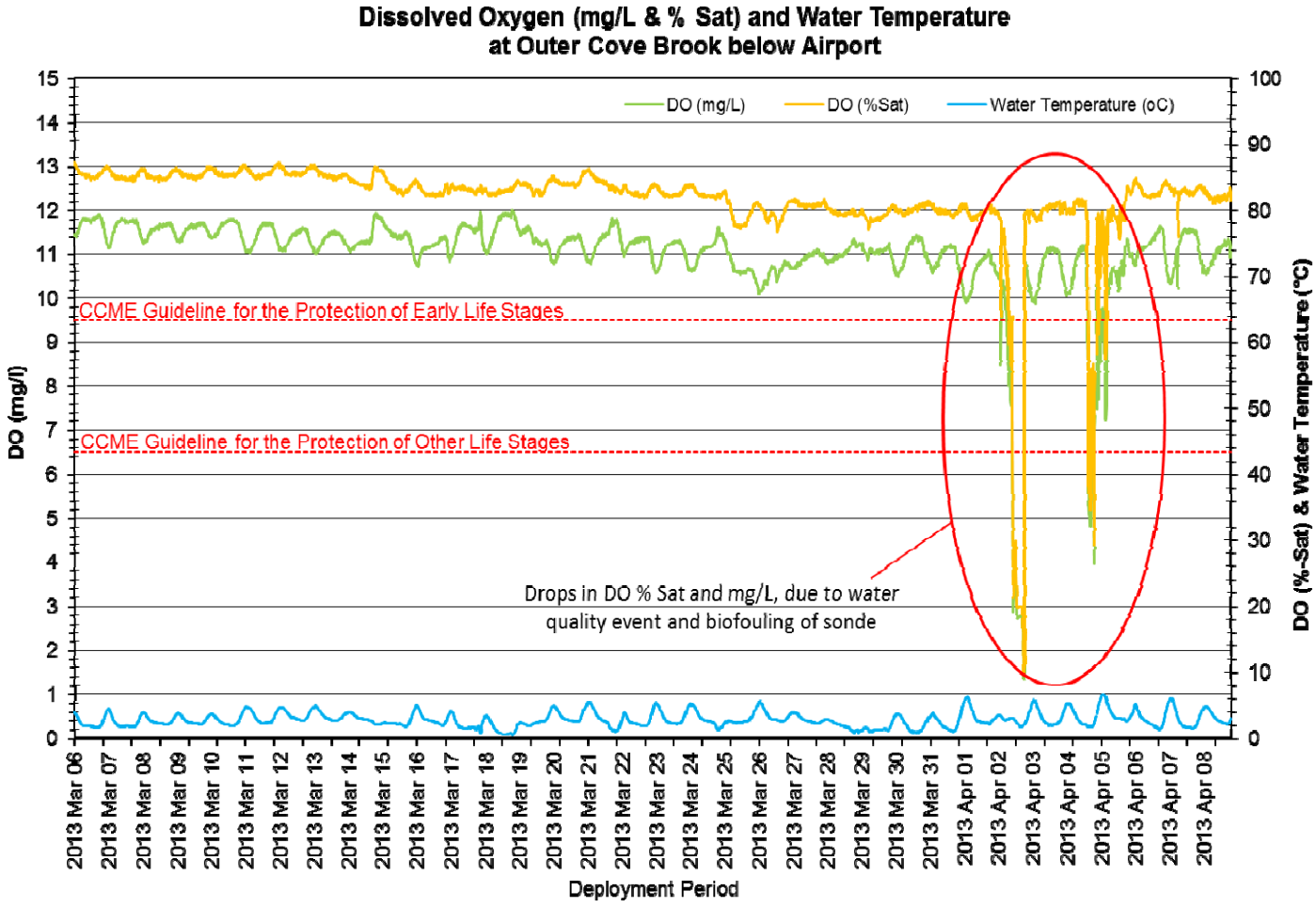

Figure 5: Quarter-hourly dissolved oxygen (mg/L & % sat) and water temperature (°C) values at Outer Cove Brook below Airport for the deployment period March 6, 2013 to April 9, 2013.

Turbidity

- Outer Cove Brook below Airport contains a significant amount of algae. High algal growth, biofouling, or leaf and grass debris can interfere with turbidity measurements as they block the sensor.
- The turbidity sensor can read a turbidity value between 0 NTU and 3000 NTU. If a reading hits 3000NTU it is identified as an error reading and thus is not a true turbidity value. Values at the end of this deployment period had reached 3000, and thus this data was removed as it was incorrect due to biofouling as evident on the sonde during removal.
- The turbidity readings during this deployment ranged within 0.1 NTU to 464 NTU. Data from March 27 to removal on April 9 were excluded as the values were incorrect due to biofouling.
- Several precipitation events and corresponding stage increases led to fluctuating turbidity values (see Figure 6) as sediment and debris were resuspended into the water column.
- This sensor received a 'poor' performance ranking at removal due to the large amount of biofouling occurring around the sensors and on the casing (see Appendix 1). The substance which fouled the sensors was a thick, whitish-brown 'furry slime', which coated all the equipment in the water as well as the river bed and surrounding vegetation.

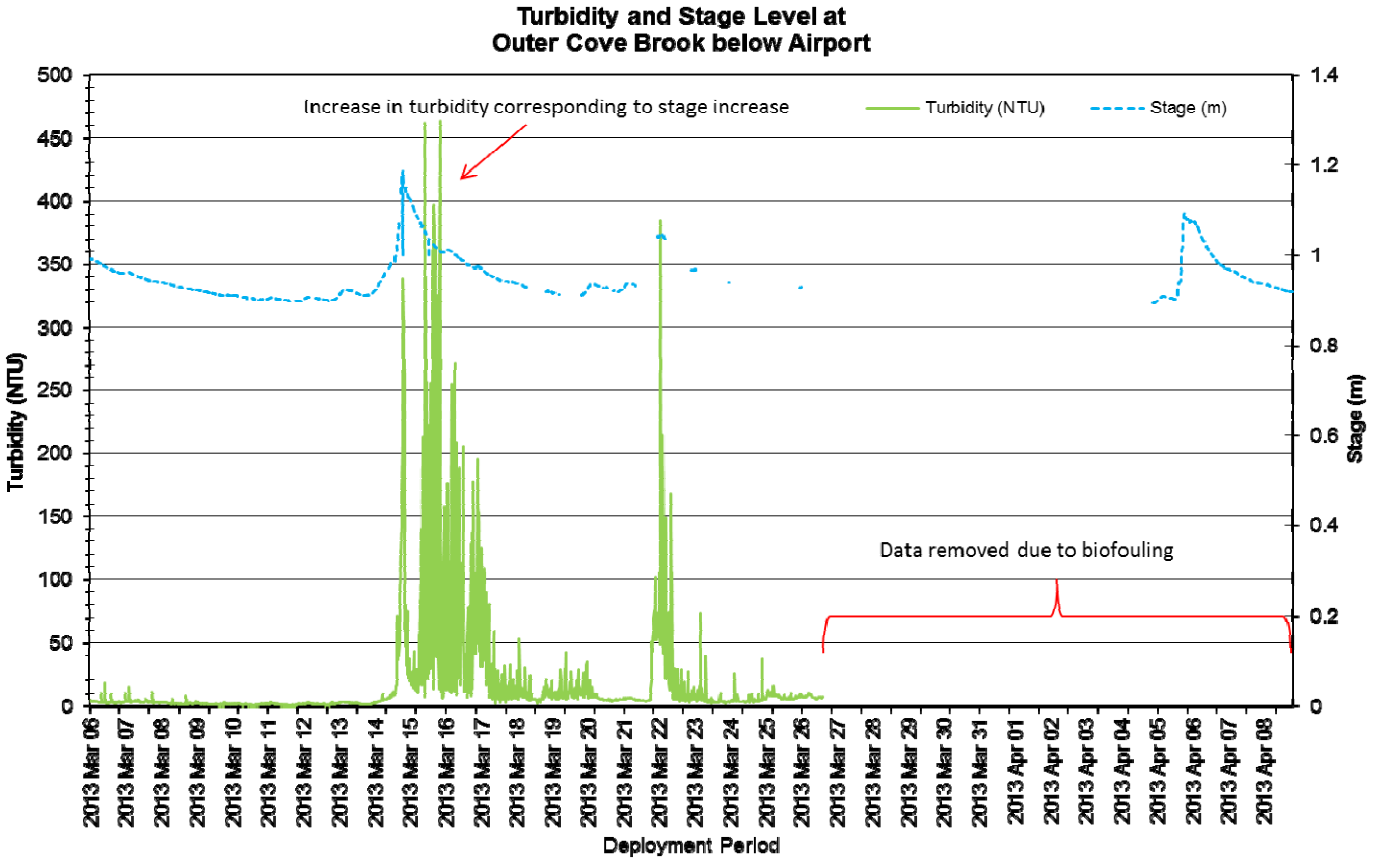

Figure 6: Quarter-hourly turbidity (NTU) and stage level (m) values at Outer Cove Brook below Airport for the deployment period March 6, 2013 to April 9, 2013.

Stage

- Stage values are based on a vertical reference that is unique to each station. As a result, absolute values of stage are not comparable between stations, but relative changes in stage are.
- Stage provides an estimation of water level at the station and can explain some of the changes that are occurring with other parameters (i.e. Specific Conductivity, DO, turbidity). Stage increases during precipitation events (Figure 7) due to increased runoff from the surrounding area.
- Precipitation data was obtained from Environment Canada's St. John's Airport weather station and supplemented with data from 'The Weather Network' when EC data was unavailable.
- During the deployment period, the stage ranged from 0.89m to 1.19m. The large gap in data March 23 to April 5 is due to transmission issues at this station.
- During sonde removal, all ice and snow was gone from the river and river bank.

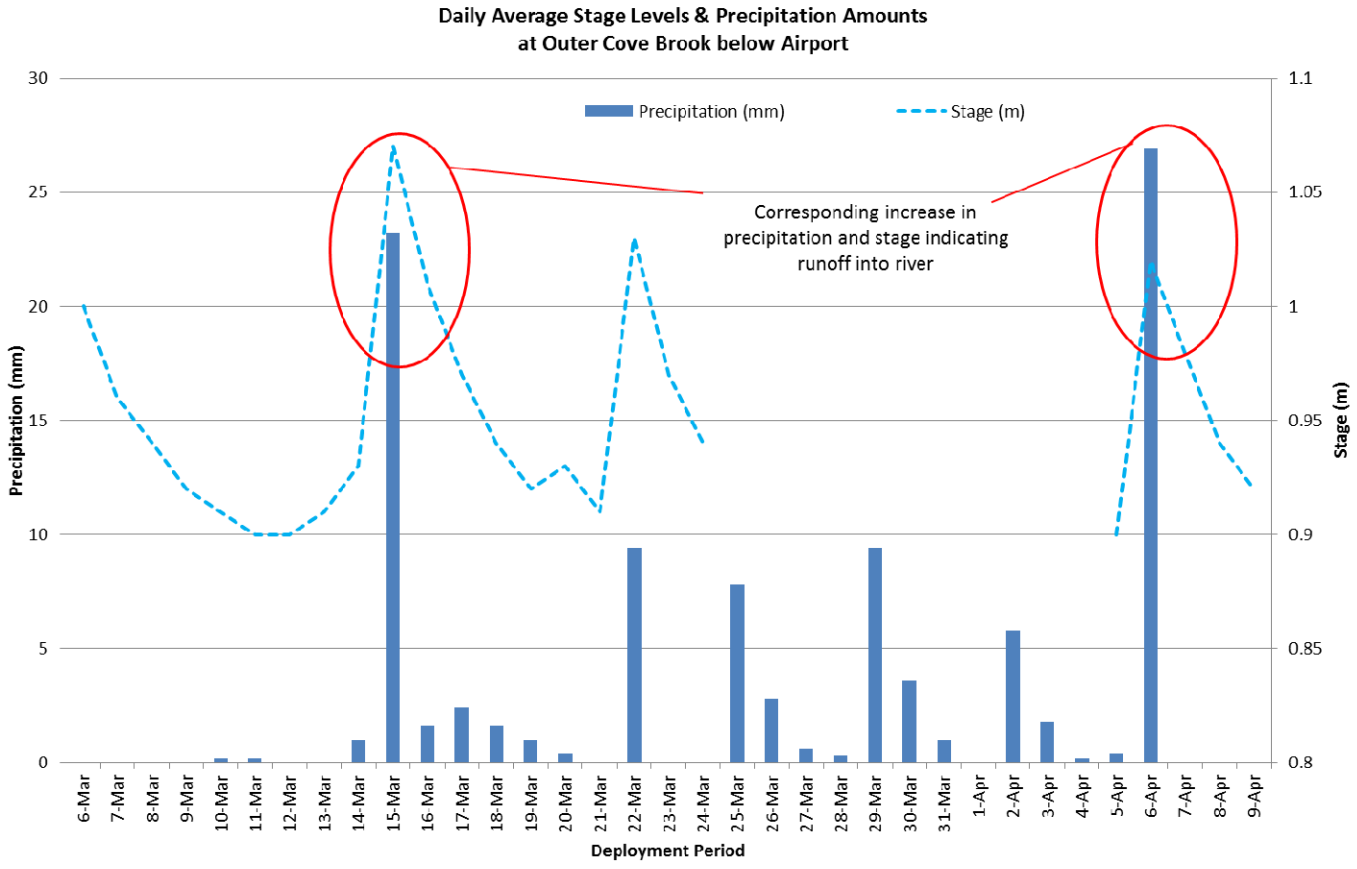

Figure 7: Daily average stage values (m) at Outer Cove Brook below Airport and daily total precipitation values (mm) from Environment Canada's St. John's Airport Station for the deployment period March 6, 2013 to April 9, 2013.

Conclusions

- Generally in natural environments, climate and weather conditions contribute in large part to the variation in water quality parameters. During this deployment it was evident that many of the changes in the parameter data displayed on the graphs, was related to the intermittent precipitation events and small climatic changes of the seasons (i.e. temperature increases).
- Precipitation events during the deployment period led to related fluctuations in stage, which thus influenced the values of turbidity, pH, specific conductance, and TDS. As ambient air temperatures were low during the winter months, there were correspondingly low water temperatures, which in turn increased the amount of dissolved oxygen in the water.
- The majority of turbidity events were correlated with increases in stage and thus precipitation events. High turbidity values at removal and a 'poor' sensor ranking are explained by the presence of a thick slime coating the casing, probe, and all rocks and vegetation in the river.
- The addition of road salt to roadways and runways during periods of snowfall and low ambient air temperatures led to increases in specific conductance and TDS as the salts were washed into the river system. This indicates that this river is influenced by runoff upstream of the station.
- It is evident from the pH, DO and turbidity data that some event or input into the river has occurred upstream of this monitoring station. This is evident in each of these parameters for the period of March 26 to April 6, 2013. The prolific 'slime' substance coating the river and equipment is further evidence that a definite water quality event took place in this river system.

Outer Cove Brook at Clovelly Golf Course

Water Temperature

- Water temperature ranged from -0.02°C to 7.42°C during this deployment period (Figure 8). All ice and snow was gone from the river and riverbank.
- Water temperatures fluctuate just above 0°C, as expected during the spring months, with an increase in temperatures noted during the last week of the deployment. This is consistent with ambient air temperatures over this time period.
- Water temperatures display diurnal variations, typical of shallow streams and ponds which are highly influenced by natural diurnal variations in ambient air temperatures.
- Water temperature is a very important parameter and it has the ability to influence other parameters that are measured by the water quality instrument.

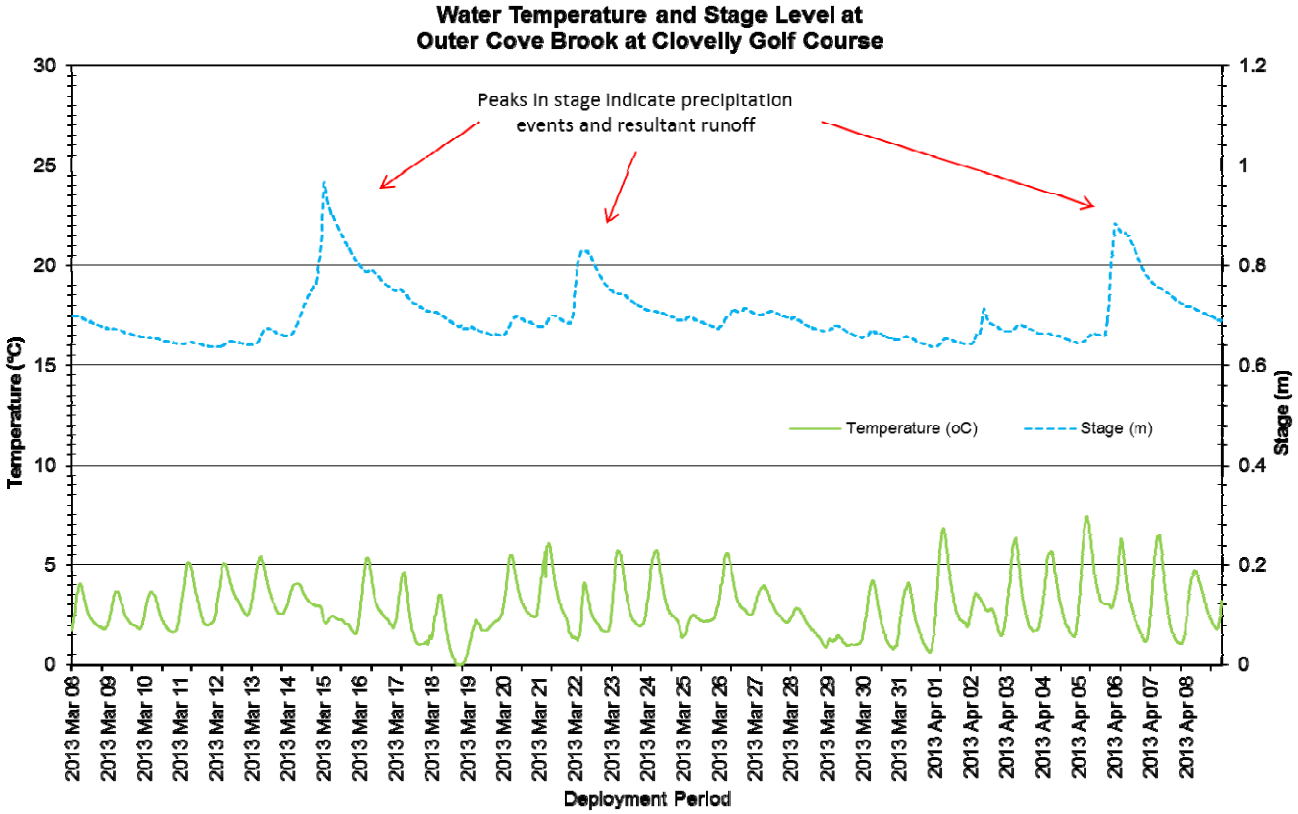

Figure 8: Quarter-hourly water temperature (°C) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period March 8 to April 9, 2013.

pH

- Throughout this deployment period pH values ranged between 6.33 pH units and 6.96 pH units (Figure 9).
- During the deployment, the pH values at this station hover around the minimum CCME Guideline for the Protection of Aquatic Life (between 6.5 and 9 pH units) up until March 26. From March 26 to April 6, the pH rises and hovers around 6.9 pH units. This indicates an issue with the water quality at this station during this time period, and is consistent with the data at the below Airport station, indicating this event affected a large portion of the river.
- The CCME guideline provides a basis by which to judge the overall health of the brook. Naturally, all streams and brooks are different. In the case of Outer Cove Brook at Clovelly Golf Course, pH is within the normal range for stream water in St. John's. However, some event influenced the water quality at this site March 26 to April 9, resulting in an abnormal increase in pH.

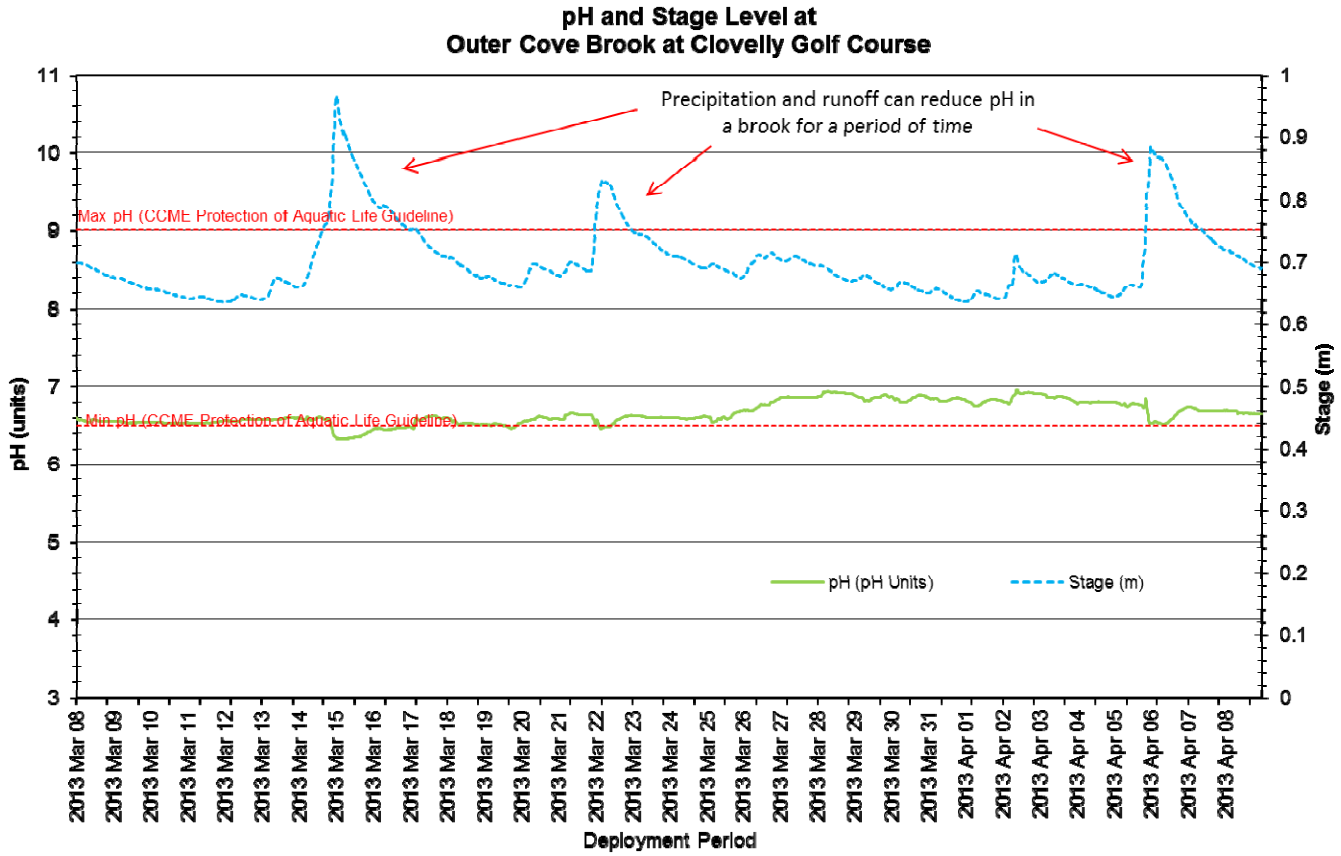

Figure 9: Quarter-hourly pH (pH units) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period March 8 to April 9, 2013.

Specific Conductivity & TDS

- The conductivity levels were within 287 µS/cm and 2099 µS/cm during this deployment period. TDS ranged from 0.2 g/L to 1.3 g/L. These values are notably lower than those of the previous deployment period.
- Cold temperatures and snowfall events during winter months can have the effect of increasing conductance levels due to the addition of salt to roadways. Through wind, snowmelt and rainfall, these salts are carried into the water system, increasing the specific conductance. The increase on March 31 (see Figure 10) is in response to snowfall March 25 to 31.
- Generally, rainfall events, such as that which occurred on March 14, can have the effect of diluting and lowering conductance levels. When stage levels rise, the specific conductance levels drop in correlation as the increased amount of water in the river system dilutes the solids present there, thus generally decreasing the specific conductivity readings.
- 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 mirrors specific conductivity.

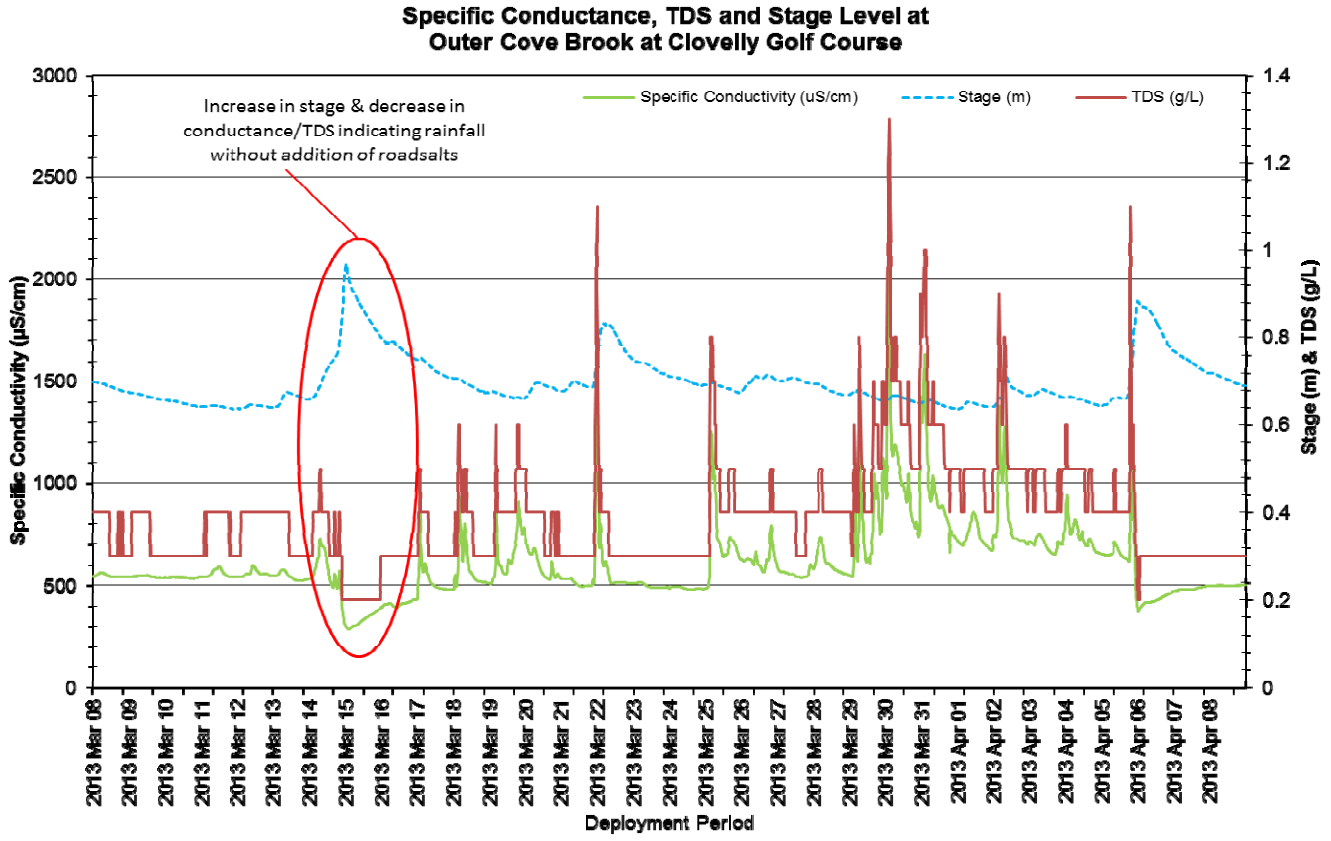

Figure 10: Quarter-hourly specific conductivity (uS/cm), TDS (g/L) and stage (m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period March 8 to April 9, 2013.

Dissolved Oxygen

- The instrument measures percent saturation directly, then calculates dissolved oxygen (mg/L) using the percent saturation and water temperature values.
- The Dissolved Oxygen % Sat levels within this deployment period were within 68.4% Sat–81.2% Sat. Dissolved Oxygen (mg/L) measured 8.58 mg/L to 11.27 mg/L. The DO mg/L values are above the minimum DO CCME guideline for early life stages for the majority of the deployment, but dip below this threshold on several occasions, notably April 1st to 6th (see Figure 11). This coincides with the increase in pH values observed during this time period, and is likely due to a water quality issue at this time.
- Dissolved Oxygen percent saturation fluctuates throughout the deployment period as the presence of dissolved salts in the water influences oxygen saturation. Dissolved oxygen mg/L content fluctuates with the water temperature changes. Decreases in dissolved oxygen values are inversely related to increases in water temperature as colder water can hold more oxygen.

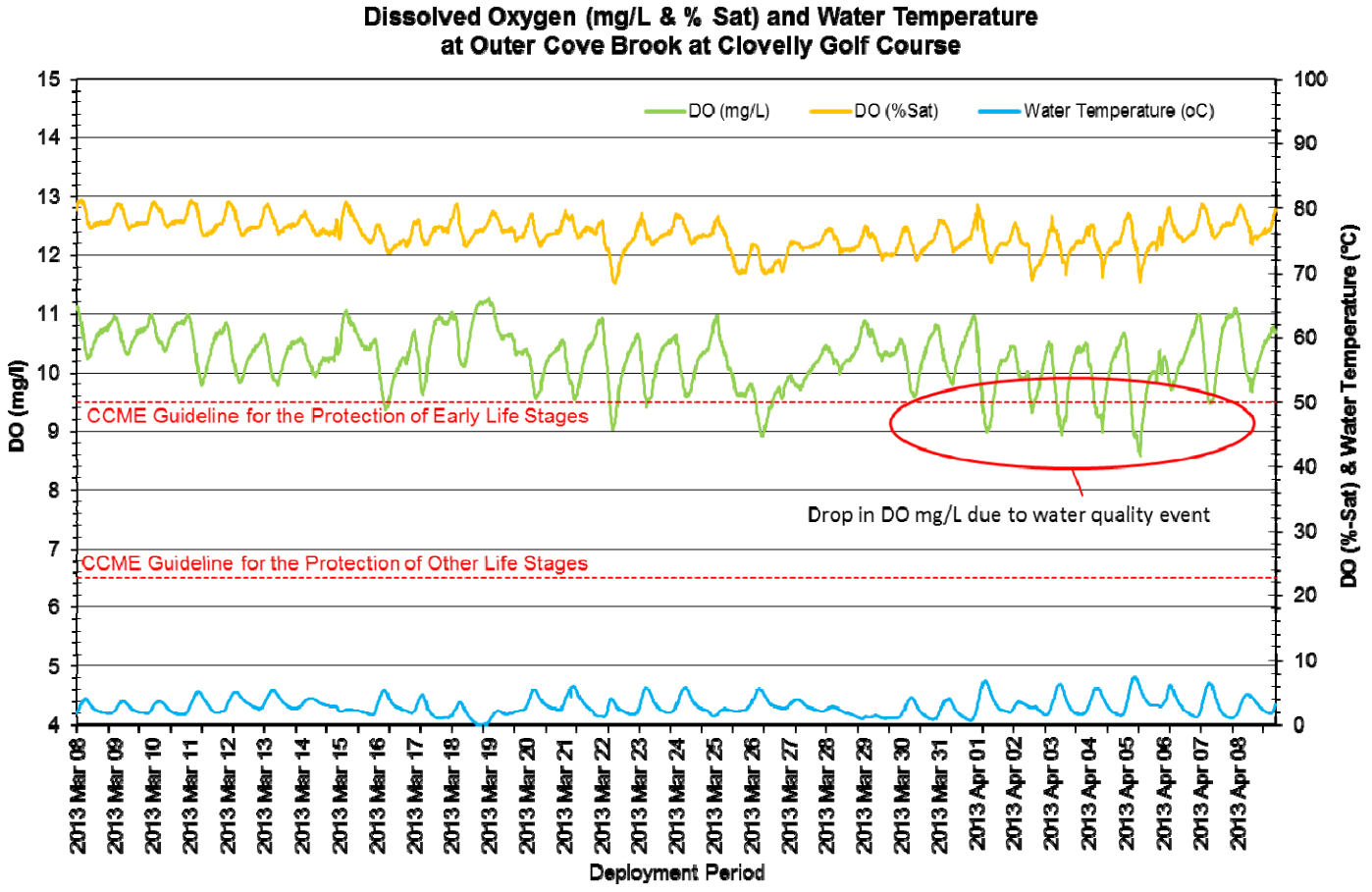

Figure 11: Quarter-hourly dissolved oxygen (mg/L & % sat) and water temperature (°C) values at Outer Cove Brook at Clovelly Golf Course for the deployment period March 8 to April 9, 2013.

Turbidity

- Outer Cove Brook contains a significant amount of algae. High algal growth in the summer or leaf debris during all seasons can interfere with turbidity measurements as they block the sensor.
- The turbidity sensor can read turbidity values between 0 NTU and 3000 NTU. If a turbidity reading hits 3000NTU it is always identified as an error reading, this is not a valid turbidity reading.
- The turbidity readings during this deployment ranged within 4.2 NTU to 327.5 NTU (Figure 12).
- This sensor was cleaned on March 21 to determine whether or not the steadily increasing turbidity values were due to biofouling. Once the brown slime was cleaned from the sensor, turbidity dropped down, indicating the sensor had been fouled. The 'poor' sensor reading at removal indicates that biofouling is an interfering factor at this location.
- Several precipitation events and corresponding stage increases led to fluctuating turbidity values as sediment and debris were resuspended into the water column.

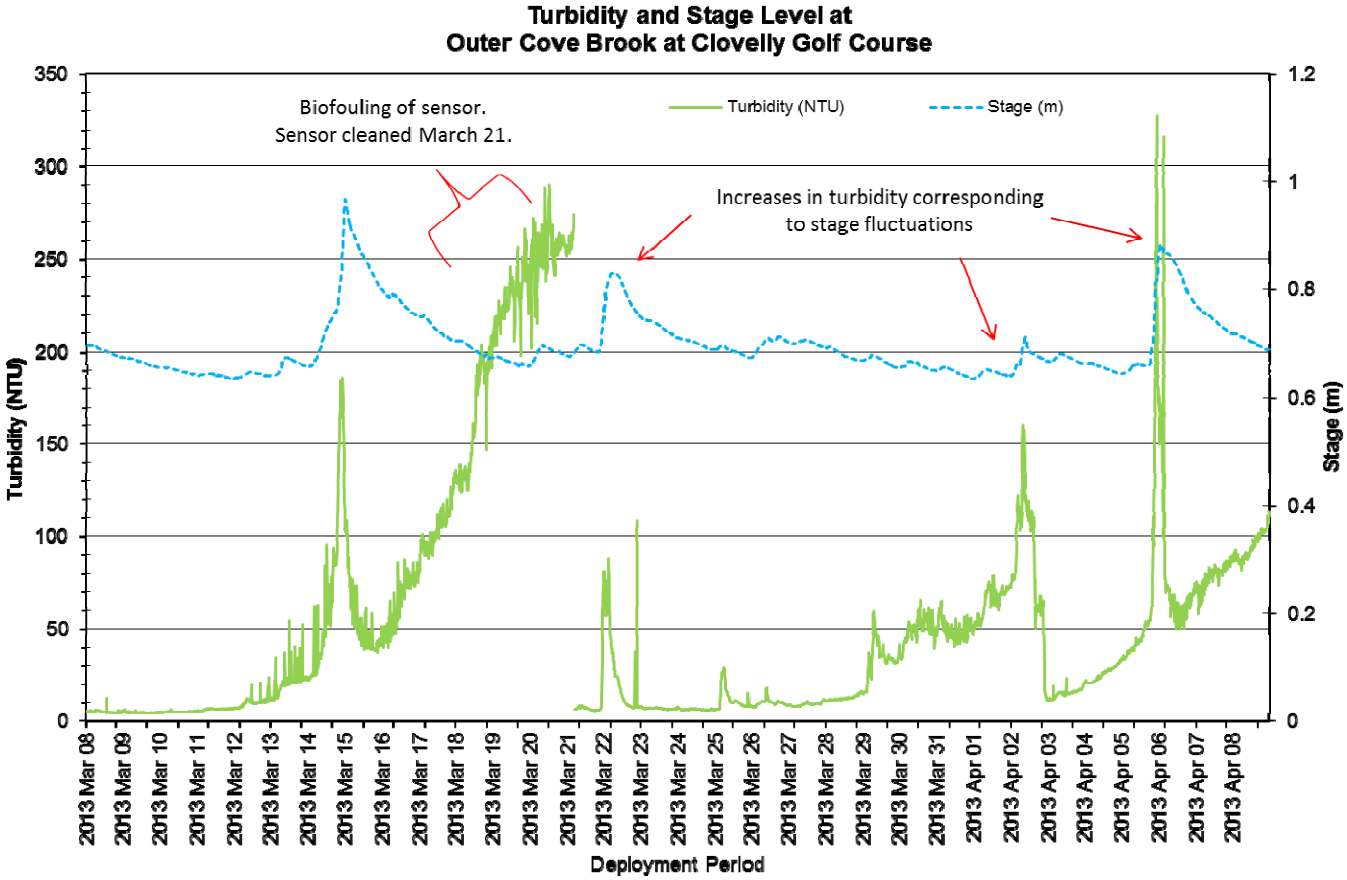

Figure 12: Quarter-hourly turbidity (NTU) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period March 8 to April 9, 2013.

Stage

- Stage values are based on a vertical reference that is unique to each station. As a result, absolute values of stage are not comparable between stations, but relative changes in stage are.
- Stage 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 increases during precipitation events due to increased runoff from the surrounding area (see Figure 13).
- Precipitation data was obtained from Environment Canada's St. John's Airport weather station and supplemented with data from 'The Weather Network' when EC data was unavailable.
- During the deployment period, the stage values ranged from 0.64m to 0.97m.
- During sonde removal, all ice and snow was gone from the river and river bank.

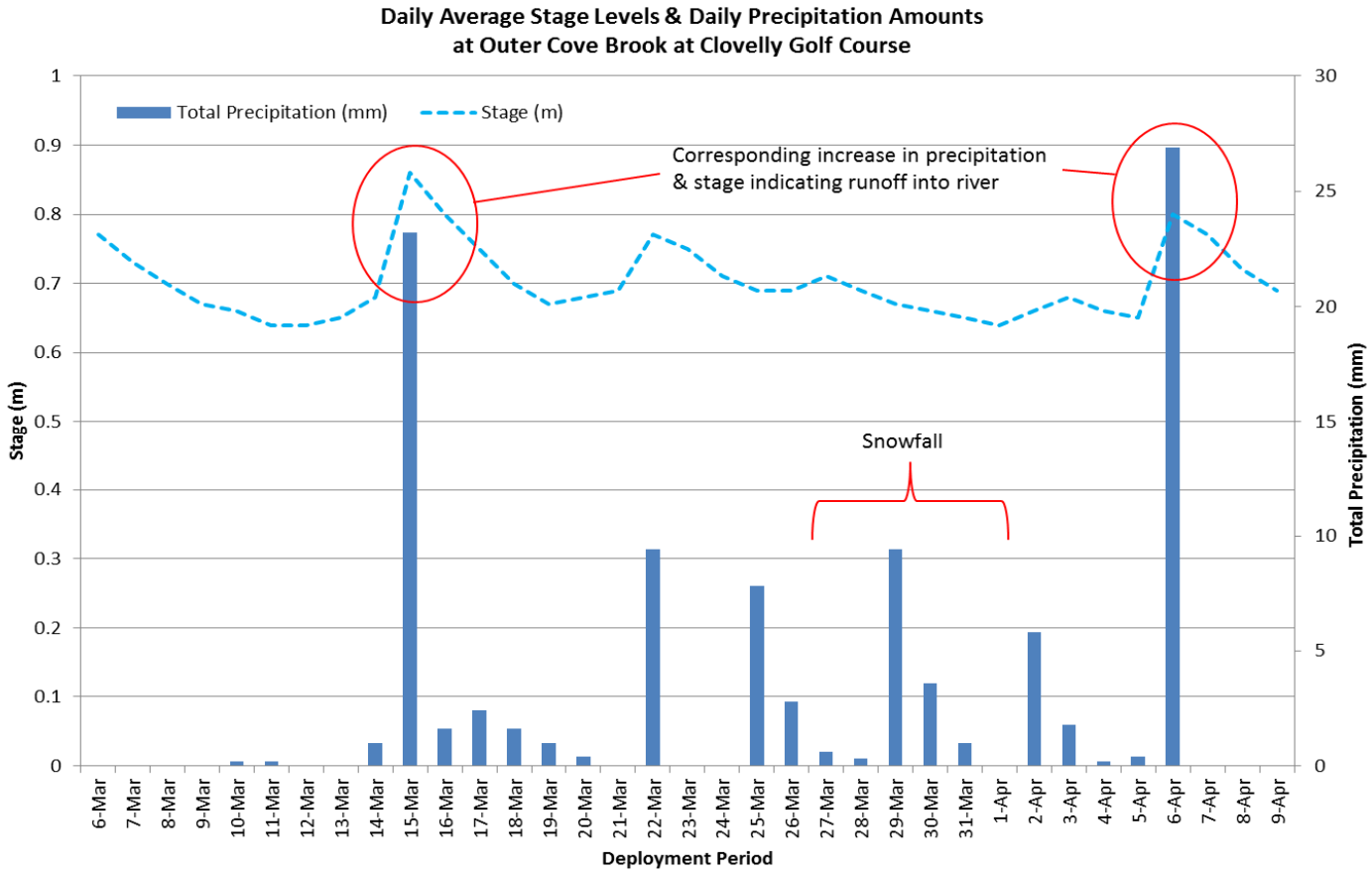

Figure 13: Daily average stage values (m) at Outer Cove Brook below Airport and daily total precipitation values (mm) from Environment Canada's St. John's Airport Station for the deployment period March 6 to April 9, 2013.

Conclusions – Outer Cove Brook at Clovelly Golf Course

- Precipitation events during the deployment period led to related fluctuations in stage, which thus influenced the values of turbidity, pH, specific conductance, and TDS. As ambient air temperatures were low during the winter months, there were correspondingly low water temperatures, which in turn increased the amount of dissolved oxygen in the water.
- High turbidity values at removal and a 'poor' sensor ranking are explained by the presence of a thin layer of brownish slime coating the sensors. To prove the presence of biofouling at this site, the sensor was cleaned on March 21st after a steady climb in turbidity values, and resulted in a drop in turbidity values.
- It is evident from the pH, DO and turbidity data that some event or input into the river has occurred upstream of this monitoring station. This is evident in each of these parameters for the period of March 26 to April 6, 2013, and consistent with the findings at the upstream station below the airport. While there was no thick coating of slime at the Clovelly station, the abnormal chemical changes occurring at the same time as the airport station indicate that some input or condition occurred upstream of the airport station, whose influences and impacts are noticeable downstream at the Clovelly station.

Conclusions – Outer Cove Brook Network

During this deployment period, the median water temperature at the upstream station (below Airport) of 2.64°C was very similar to that of the downstream station (at Clovelly Golf Course) of 2.61°C. The median pH values for both were also comparable with below Airport's median at 6.61 and Clovelly Golf Course reading 6.60, and thus no significant change in pH from the upstream to the downstream station. The specific conductivity medians were similar at both stations with 543 uS/cm reported below the airport and 553.5 uS/cm reported at the golf course. It should be noted that higher specific conductivity values were recorded at the golf course, reaching a maximum value of 2099 uS/cm, compared to the maximum value of 1194 uS/cm below the Airport. This indicates more influence from road salts at the golf course station as it is downstream of a developed commercial development area and roadways. Dissolved oxygen at the upstream station (below Airport) had a median of 82.9%Sat during the deployment period, while the downstream station (Clovelly Golf Course) had a lower median of 76.1%Sat. This lower oxygen content at the downstream station may be due the presence of more salts in water at this station, as indicated by specific conductance values, which lowers the amount of oxygen the water can hold. A comparison of turbidity cannot be made between stations as both stations had significant biofouling. It is evident from all the data, in particular pH and DO, that some event impacting water quality at both stations occurred previous to April 9th and this should be investigated further.

Appendix

During the removal of the instrument at the below Airport station on April 9, 2013, a thick coating of a whiteish-brown ‘slime’ was noted attached to the vegetation, substrate, and equipment in the water.