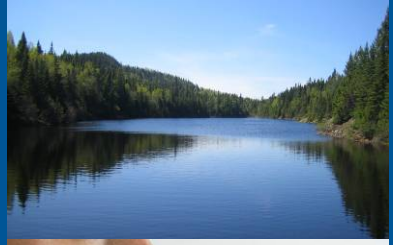







# Real-Time Water Quality Report

# Outer Cove Brook Network

**Deployment Period**
**September 25 to November 8, 2012**

Newfoundland Labrador

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

*Outer Cove Brook, Newfoundland and Labrador*

Prepared by:

Kyla Brake
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 - 3899
Fax No.: (709) 729 - 0320
kbrake@gov.nl.ca

## 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 45-day period from deployment on September 25, 2012 until removal on November 8, 2012.

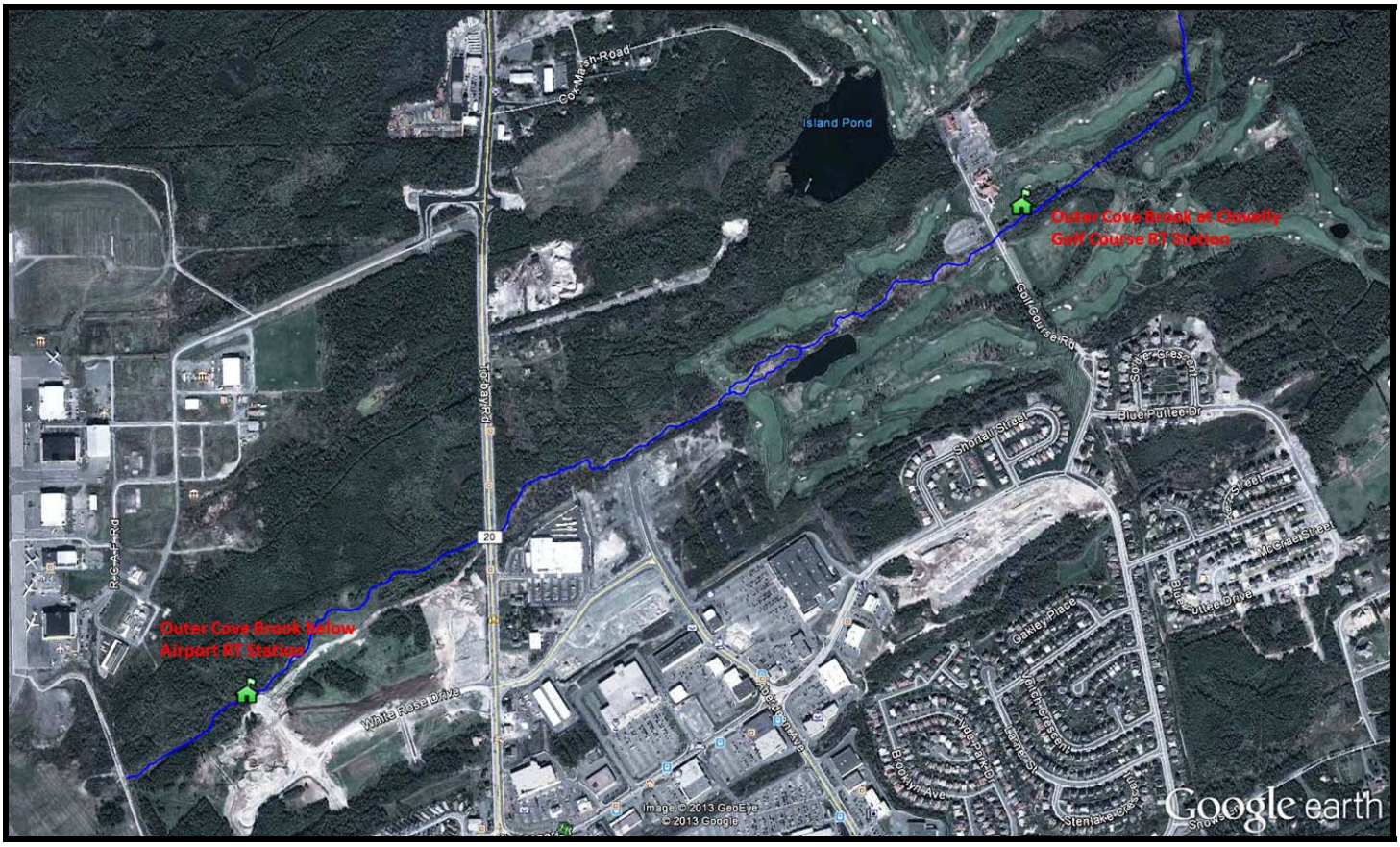


**Figure 1: Outer Cove Brook Real-Time Water Quality and Quantity Stations.**

## 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 September 25 through to November 8, 2012 is summarized in Table 2.

**Table 2: Instrument performance rankings for Outer Cove Brook below Airport September 25 – November 8, 2012**

| **Station** | **Date** | **Action** | **Comparison Ranking** | | | | |
|---|---|---|---|---|---|---|---|
| | | | **Temperature** | **pH** | **Conductivity** | **Dissolved Oxygen** | **Turbidity** |
| **Below Airport** | Sept 25 2012 | Deployment | Excellent | Good | Excellent | Excellent | Marginal |
| | Nov 8 2012 | Removal | Excellent | Excellent | Fair | Excellent | Excellent |

- During the Outer Cove Brook below Airport station deployment, temperature, pH, conductivity and dissolved oxygen sensors ranked 'good' to 'excellent'. The turbidity sensor's 'marginal' ranking indicates that there was either debris interfering, or there may be an issue with the sensor. Overall, the data being produced was reliable and accurate at the start of deployment.

- During removal, temperature, pH, dissolved oxygen and turbidity ranked as 'excellent', while specific conductivity ranked as 'fair'. The decreased accuracy of the specific conductivity sensor may be due to an issue with the QA/QC sonde. The improvement in the turbidity ranking from deployment (marginal) to removal (excellent) indicates that the initial sensor ranking may indeed have been due to debris, and provides reassurance of the accuracy of the turbidity data during the deployment period. Overall the data at the end of deployment was reliable.
- Deployment and removal instrument performance rankings for **Outer Cove Brook at Clovelly Golf Course** for the period of September 25 through to November 8, 2012 is summarized in Table 3.

**Table 3: Instrument performance rankings for Outer Cove Brook at Clovelly Golf Course September 25 – November 8, 2012**

| Station | Date | Action | Comparison Ranking | | | | |
|---|---|---|---|---|---|---|---|
| | | | Temperature | pH | Conductivity | Dissolved Oxygen | Turbidity |
| Clovelly Golf Course | Sept 25 2012 | Deployment | Excellent | Good | Excellent | Good | Good |
| | Nov 8 2012 | Removal | Excellent | Excellent | Fair | Excellent | Poor |

- At the Outer Cove Brook Clovelly Golf Course station, all parameters ranked 'excellent' to 'good' at deployment on the instrument. This ensures confidence in the set-up and data at deployment.

- At removal, temperature, pH, and dissolved oxygen all ranked 'excellent'. The turbidity sensor ranked as 'poor', likely the result of fouling or debris from natural aquatic growth after the ~45 day deployment, as values near the end of deployment were all elevated (Figure 12). The specific conductivity sensor ranked 'fair' during removal from both stations. Analysis of the removal data from both stations indicates that there may have been a calibration issue with the specific conductivity sensor on the QA/QC sonde as readings taken with this sonde were consistently off from field readings at both stations by ~ 20 uS/cm. Overall, the data at the end of deployment was reliable.

- 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 blocks any of the other sensors.

## Deployment Notes

- Transmission errors occurred sporadically throughout the deployment period at both stations, resulting in data gaps in the graphs shown in this report. Environment Canada has been notified of these transmission gaps, and will make adjustments to the setup as needed to minimize these errors.

## Data Interpretation

- The following graphs and discussion illustrate water quality-related events from September 25 to November 8, 2012 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 was compiled from WRMD's Pippy Park Weather Station and Environment Canada's station at St. John's Airport.

## Outer Cove Brook below Airport

### Water Temperature

- Water temperature ranged from 6.9°C to 18.4°C during this deployment period (Figure 2).
- An overall decrease in water temperatures is evident from the graph and consistent with ambient air temperatures over this time period as winter approaches.
- Water temperatures display large 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 instruments.

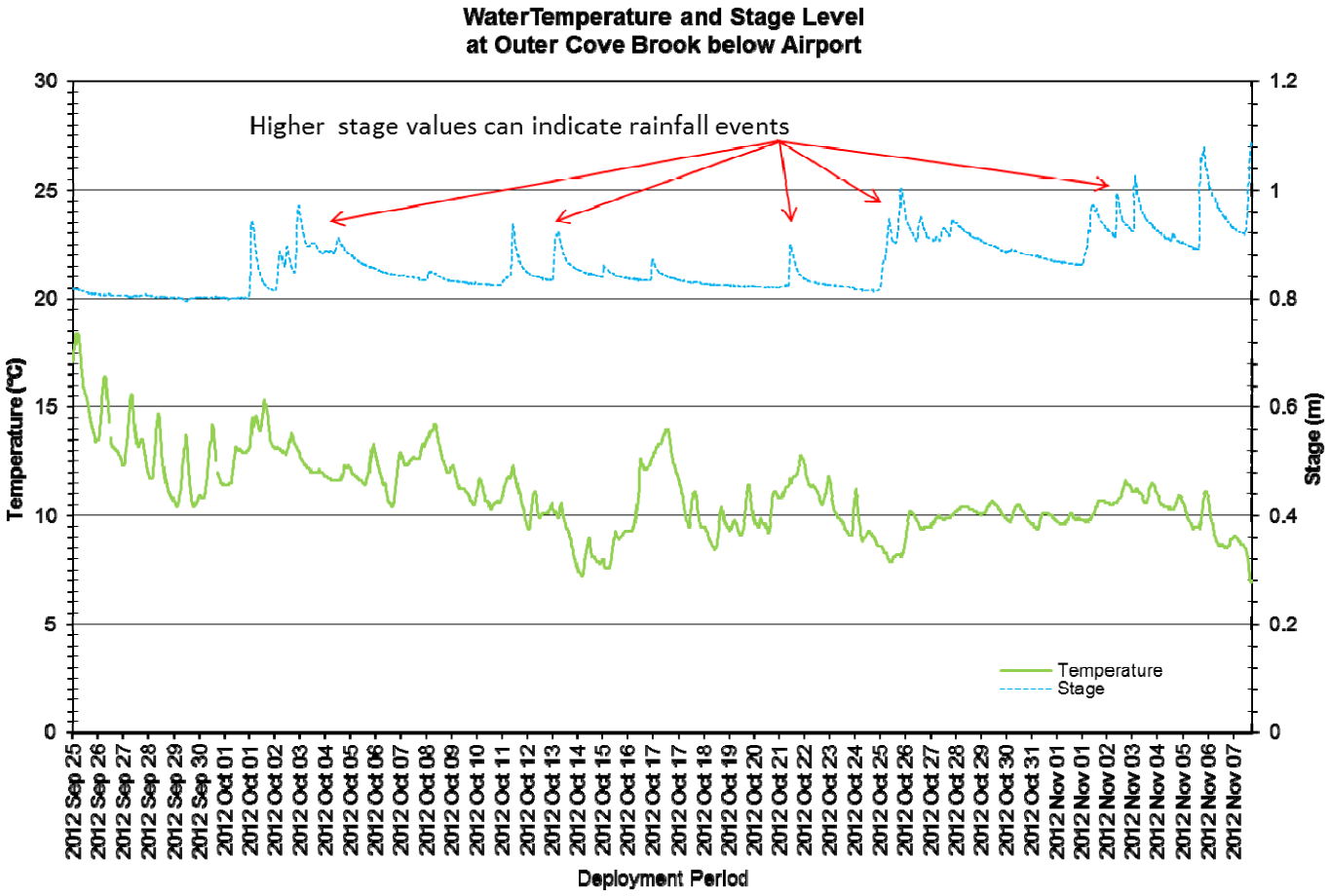


**Figure 2: Quarter-hourly water temperature (°C) and Stage Level (m) values at Outer Cove Brook below Airport for the deployment period September 25 to November 8, 2012.**

**pH**

- Throughout this deployment period pH values ranged between 6.15 and 6.86 pH units (Figure 3).
- During the deployment, the pH values at this station sit just above the minimum CCME Guideline for the Protection of Aquatic Life (between 6.5 and 9 pH units) until several rainfall events starting on October 1, 2012, when the pH values decrease for the remainder of the deployment period. 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.

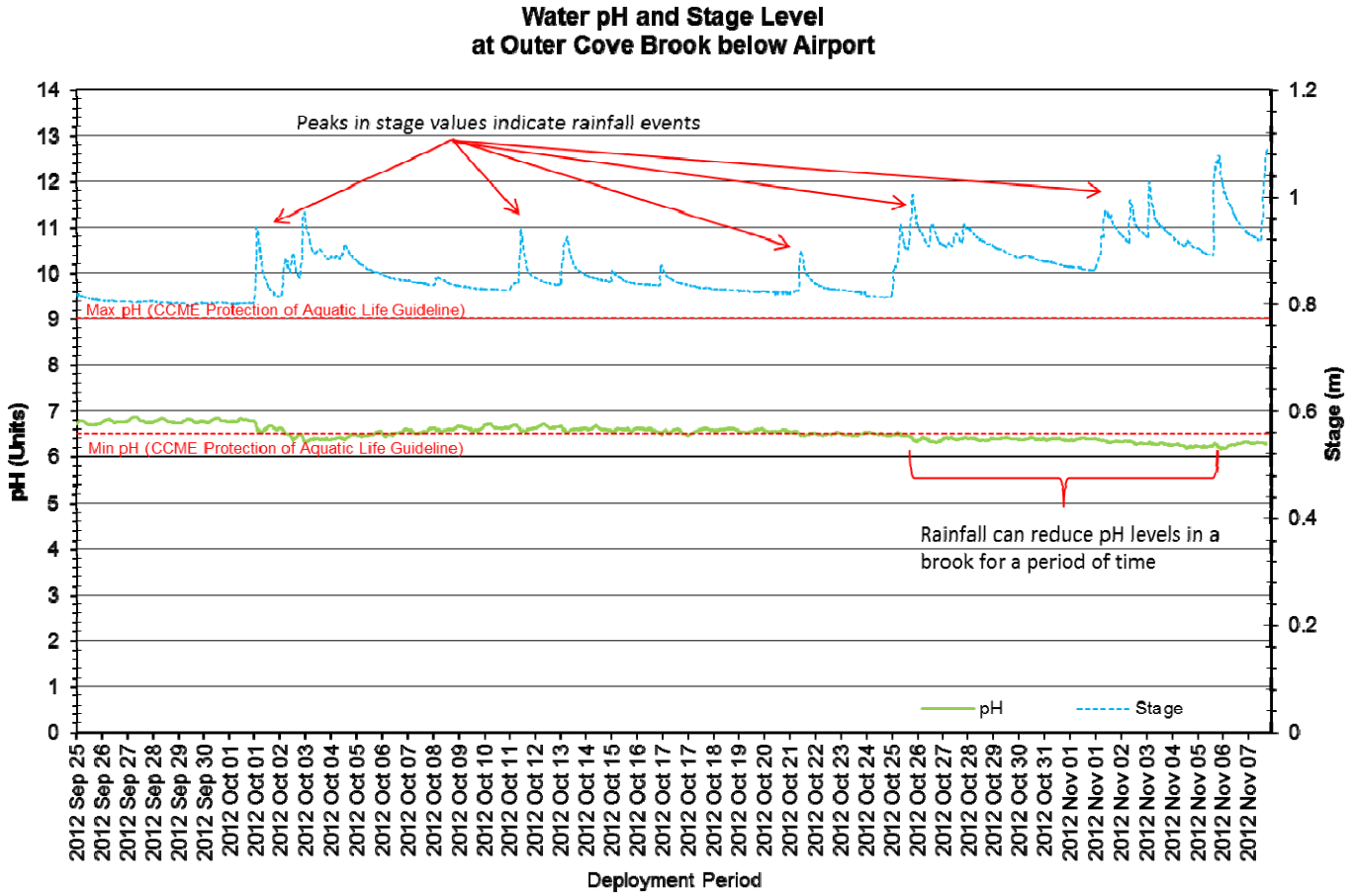


**Figure 3: Quarter-hourly pH (pH units) and Stage Level (m) values at Outer Cove Brook below Airport for the deployment period September 25 to November 8, 2012.**

### Specific Conductivity & TDS

- The conductivity levels were within 132.3 µS/cm and 508 µS/cm during this deployment period. TDS ranged from 0.0898 to 0.3250 g/L.
- Rainfall events (indicated by increased stage levels) can have the effect of diluting and lowering conductance levels, as is evident on Figure 4. 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 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.

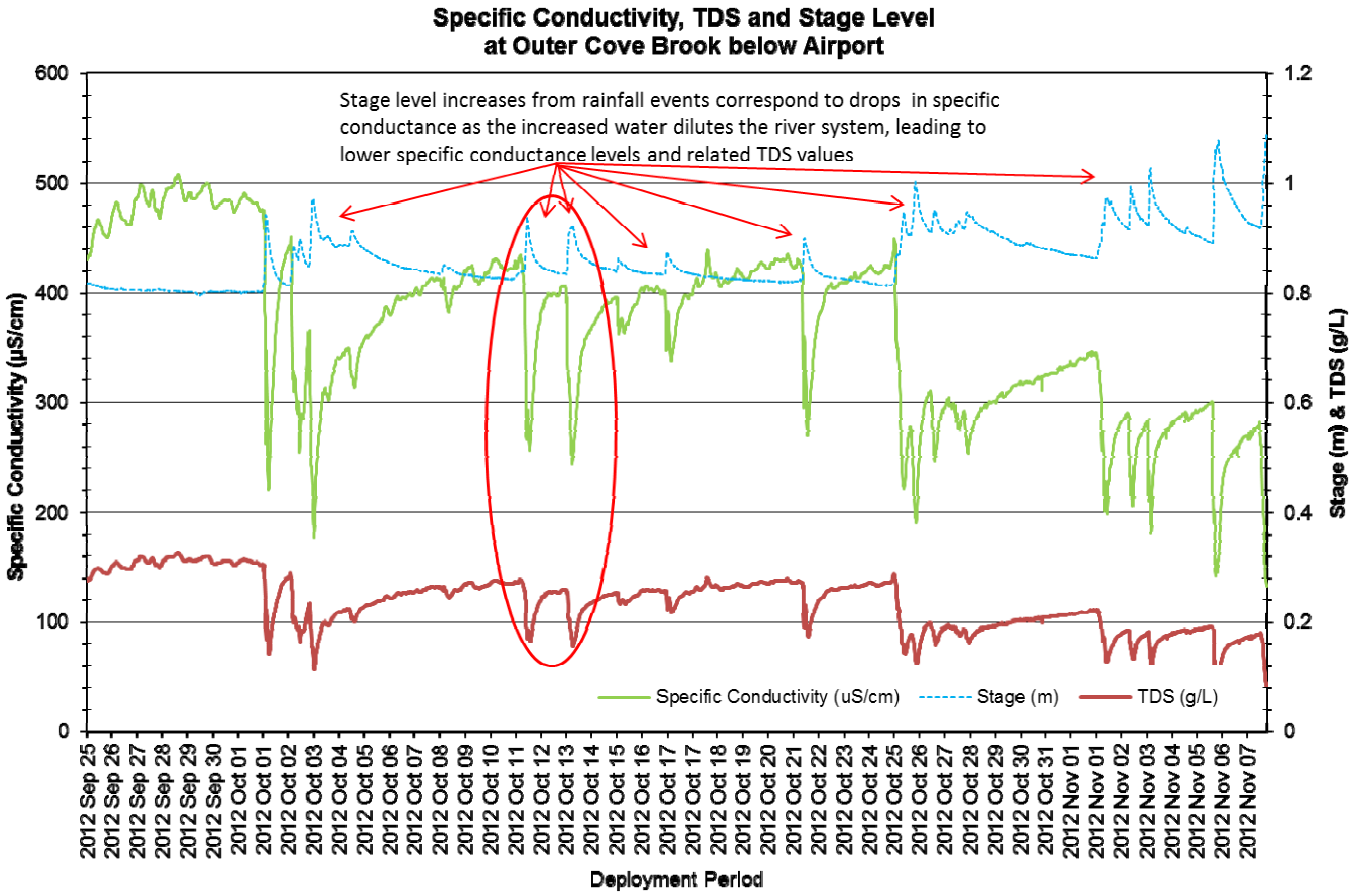


**Figure 4: Quarter-hourly specific conductivity (uS/cm), TDS (g/L) and stage (m) values at Outer Cove Brook below Airport for the deployment period September 25 to November 8, 2012.**

### 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 86.6–98.1% Sat. Dissolved Oxygen (mg/L) measured 8.90–11.18 mg/L. The DO mg/L values are above the minimum DO CCME guideline for early life stages the majority of the time, dropping below only when water temperatures decrease.
- Dissolved Oxygen percent saturation remains constant during the deployment period. 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 warmer water can hold less oxygen. This trend was observed during the deployment period as evident in Figure 5, particularly on October 17, 2012.

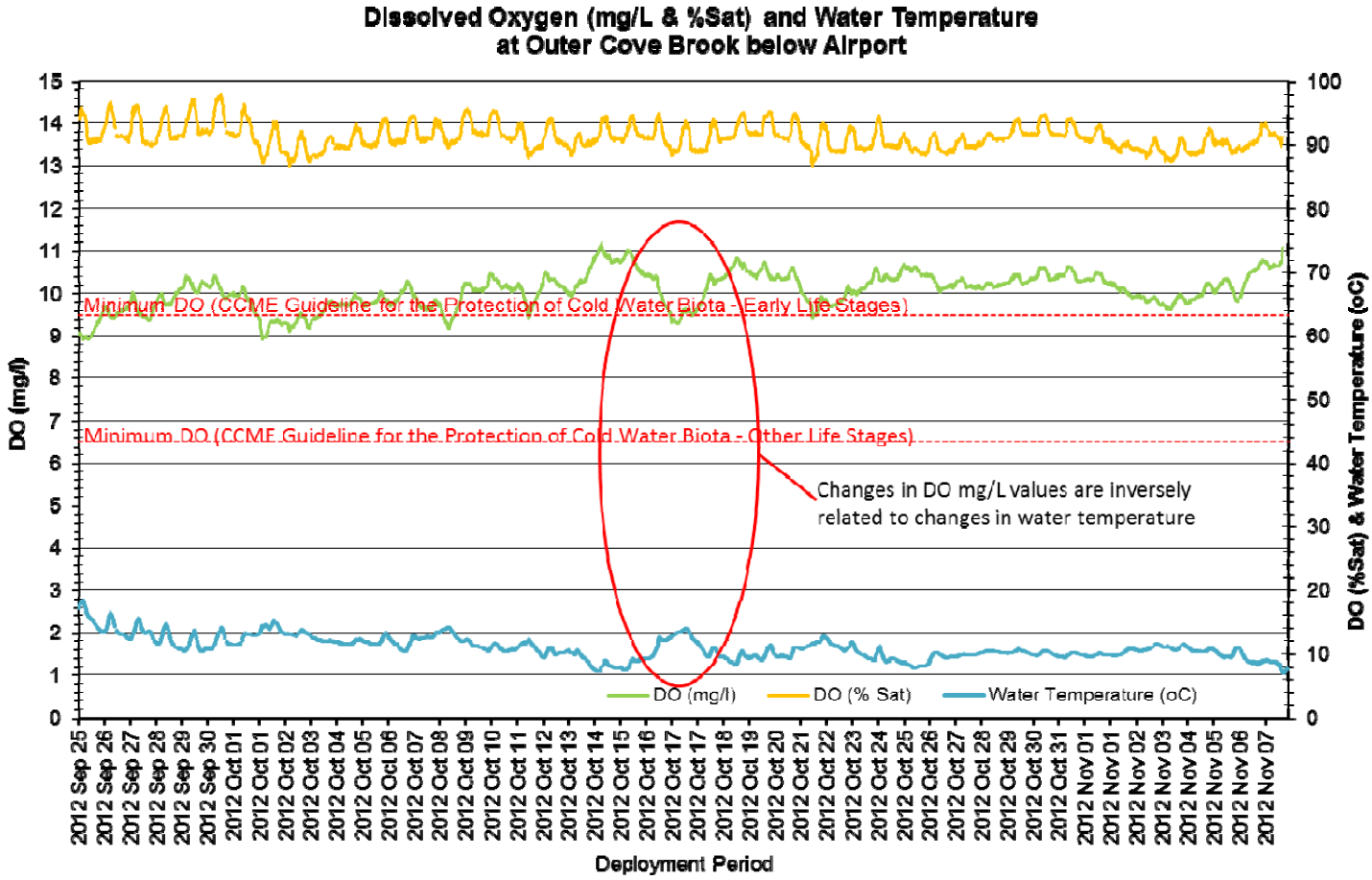


**Figure 5: Quarter-hourly dissolved oxygen (mg/L & % sat) and water temperature values at Outer Cove Brook below Airport for the deployment period September 25 to November 8, 2012.**

## Turbidity

- Outer Cove Brook below Airport contains a significant amount of algae. High algal growth or leaf 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.
- The turbidity readings during this deployment ranged within 0 NTU to 368.7 NTU.
- Increased turbidity values near the end of the deployment are likely due to heavy rainfall or are the result of algae or debris blocking the sensor. Other turbidity events during the deployment period coincide with rainfall events as runoff resuspends the river's sediments into the water column.

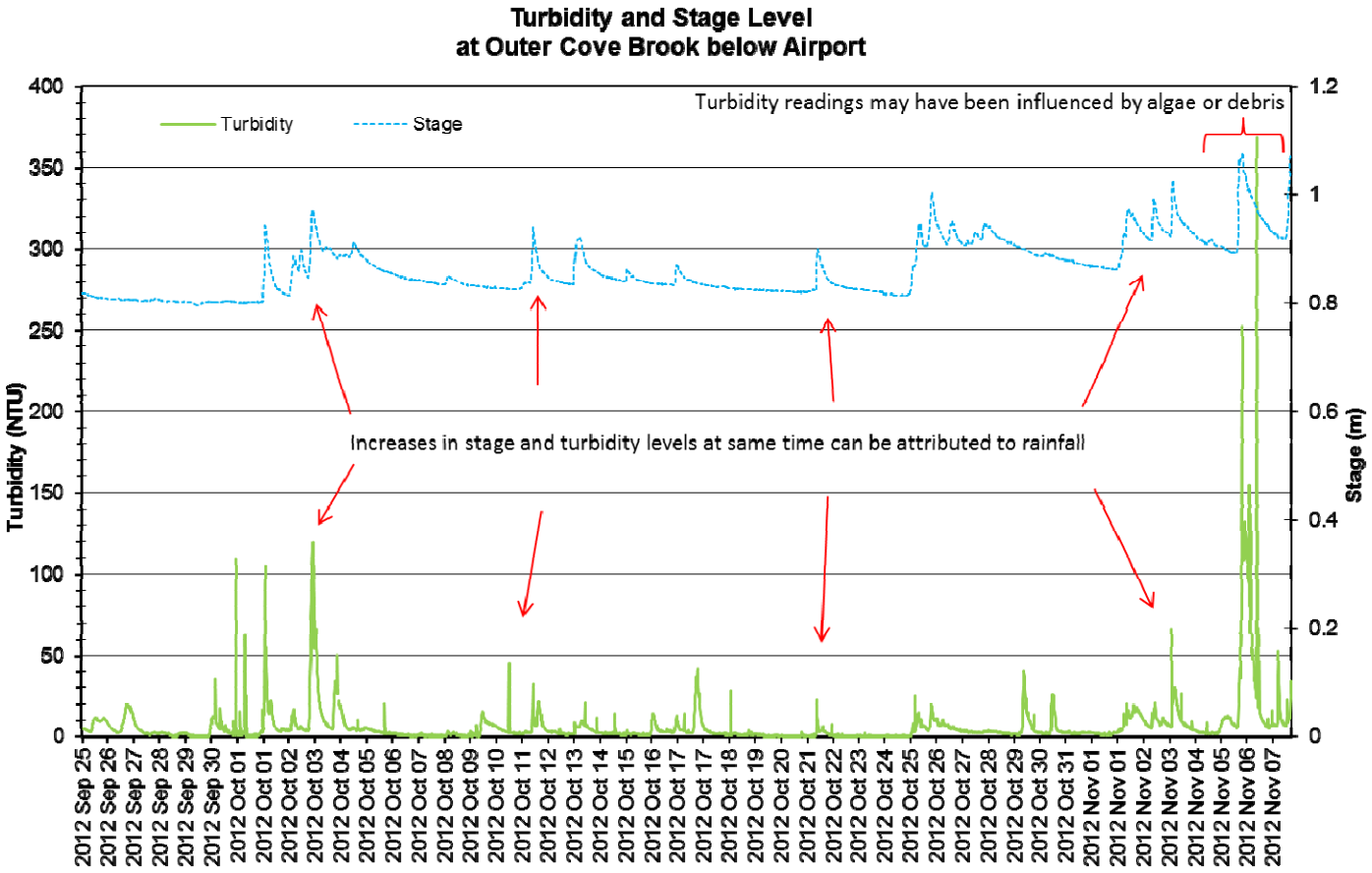


**Figure 6: Quarter-hourly turbidity (NTU) and stage level (m) values at Outer Cove Brook below Airport for the deployment period September 25 to November 8, 2012.**

## 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.
- Precipitation data from Environment Canada's St. John's Airport weather station and WRMD's weather station at Pippy Park were combined for this report due to precipitation reporting errors at Pippy Park.
- 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 rainfall events due to increased runoff from the surrounding area.
- During the deployment period, the stage ranged from 0.80m to 1.09m. During sonde removal, the marshy area surrounding the river was saturated and heavy rainfall was experienced, coinciding with the high stage and precipitation values recorded on this day.

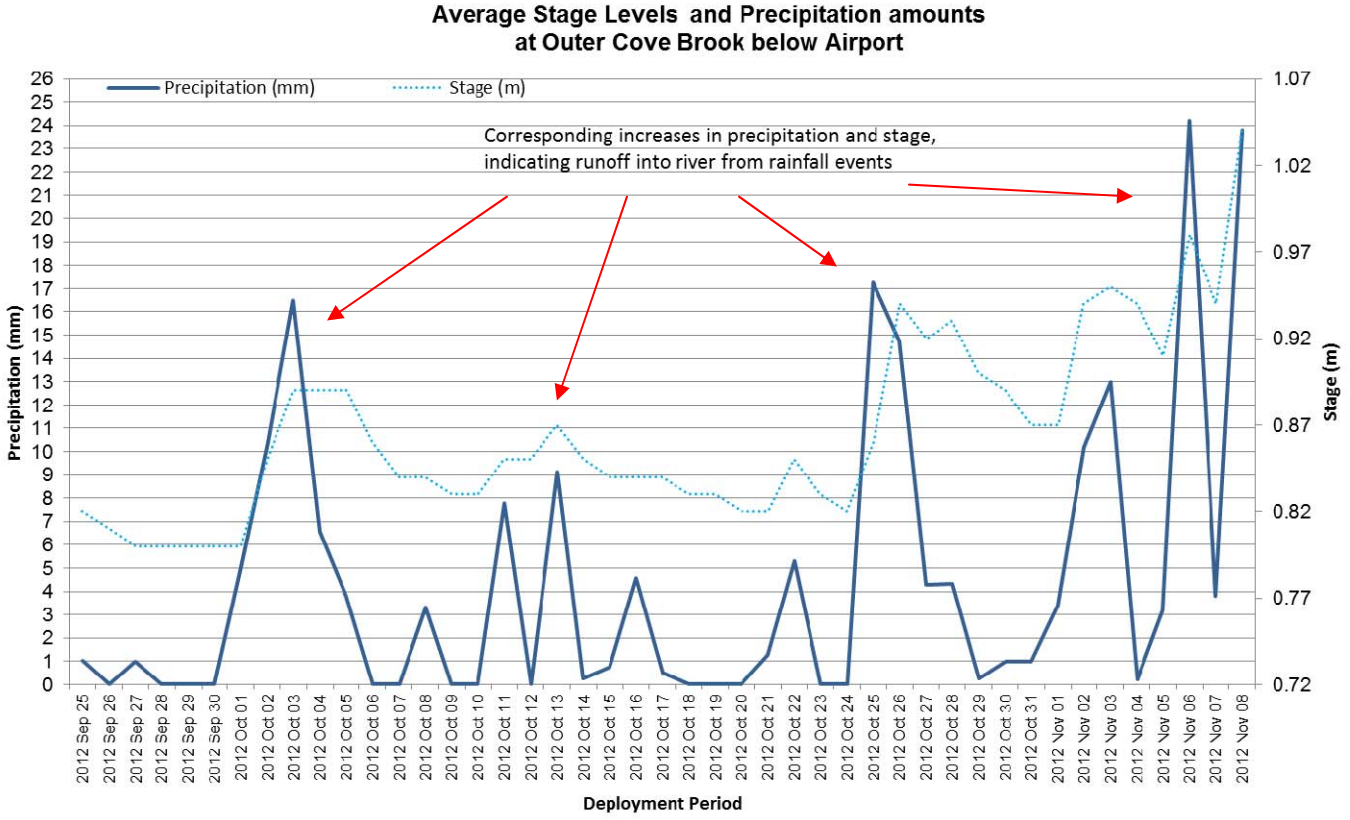


**Figure 7: Daily average stage values (m) at Outer Cove Brook below Airport and daily total precipitation values (mm) from Pippy Park weather station and Environment Canada's St. John's Airport Station for the deployment period September 25 to November 8, 2012. Precipitation values from Sept 25- Oct 31 are from WRMD's weather station in Pippy Park, while Oct 31 to November 8 values are from Environment Canada's St. John's Airport Station.**

## 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 differences in the parameter data displayed on the graphs, were related to the intermittent precipitation events and small climatic changes of the seasons (i.e. temperature decreases).
- The numerous rainfall 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 decreased into the fall months, there was a corresponding decrease in water temperature, 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 rainfall. During the end of the deployment period, a persistent increase in turbidity was evident. This is likely due to leaf debris or biofouling from the excessive algae. Care will be taken during the next deployment to place the probe away from algae if possible.

## Outer Cove Brook at Clovelly Golf Course

### Water Temperature

- Water temperature ranged from 6.80°C to 18.68°C during this deployment period (Figure 8).
- An overall decrease in water temperatures is evident from the graph and consistent with ambient air temperatures over this time period as winter approaches.
- Water temperatures display large 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 instruments.

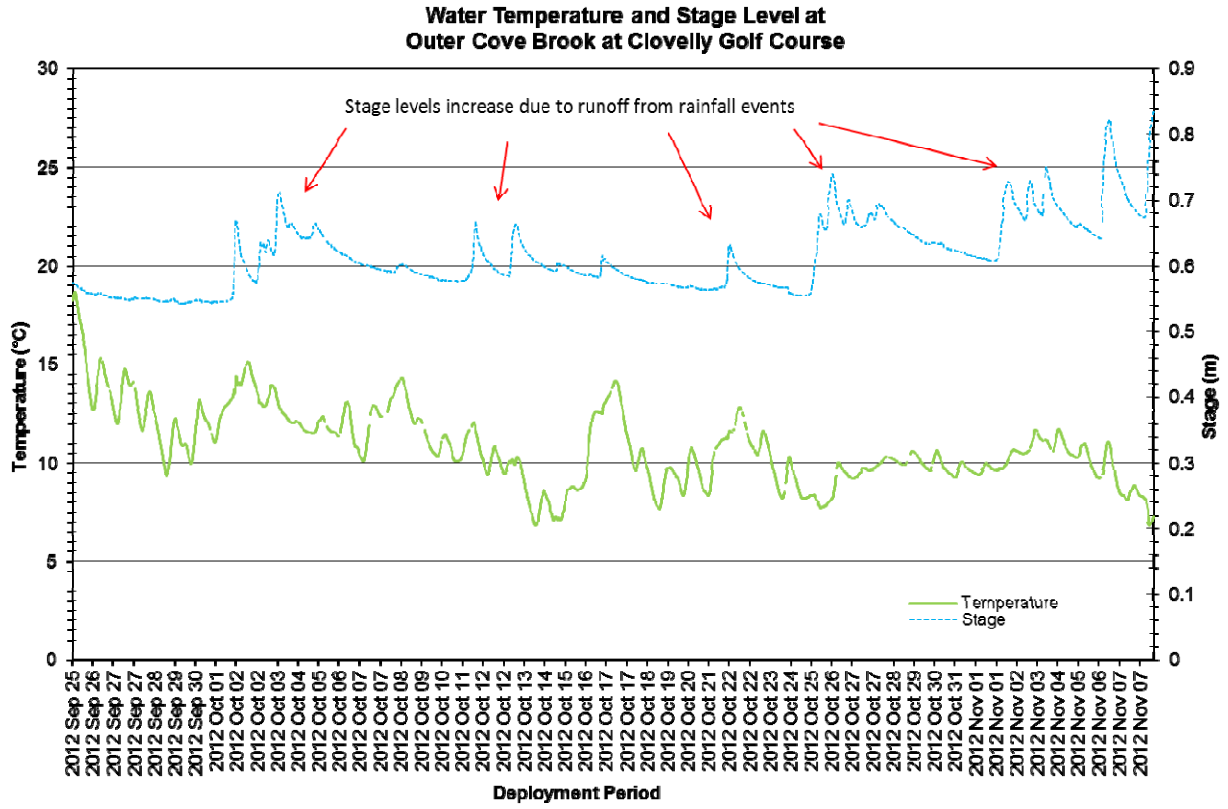


**Figure 8: Quarter-hourly water temperature (°C) and Stage Level (m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period September 25 to November 8, 2012.**

**pH**

- Throughout this deployment period pH values ranged between 6.18 and 6.78 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) until several rainfall events starting on October 1, 2012, when the pH values decrease for the remainder of the deployment period. 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 at Clovelly Golf Course, pH is within the normal range for stream water in St. John's.

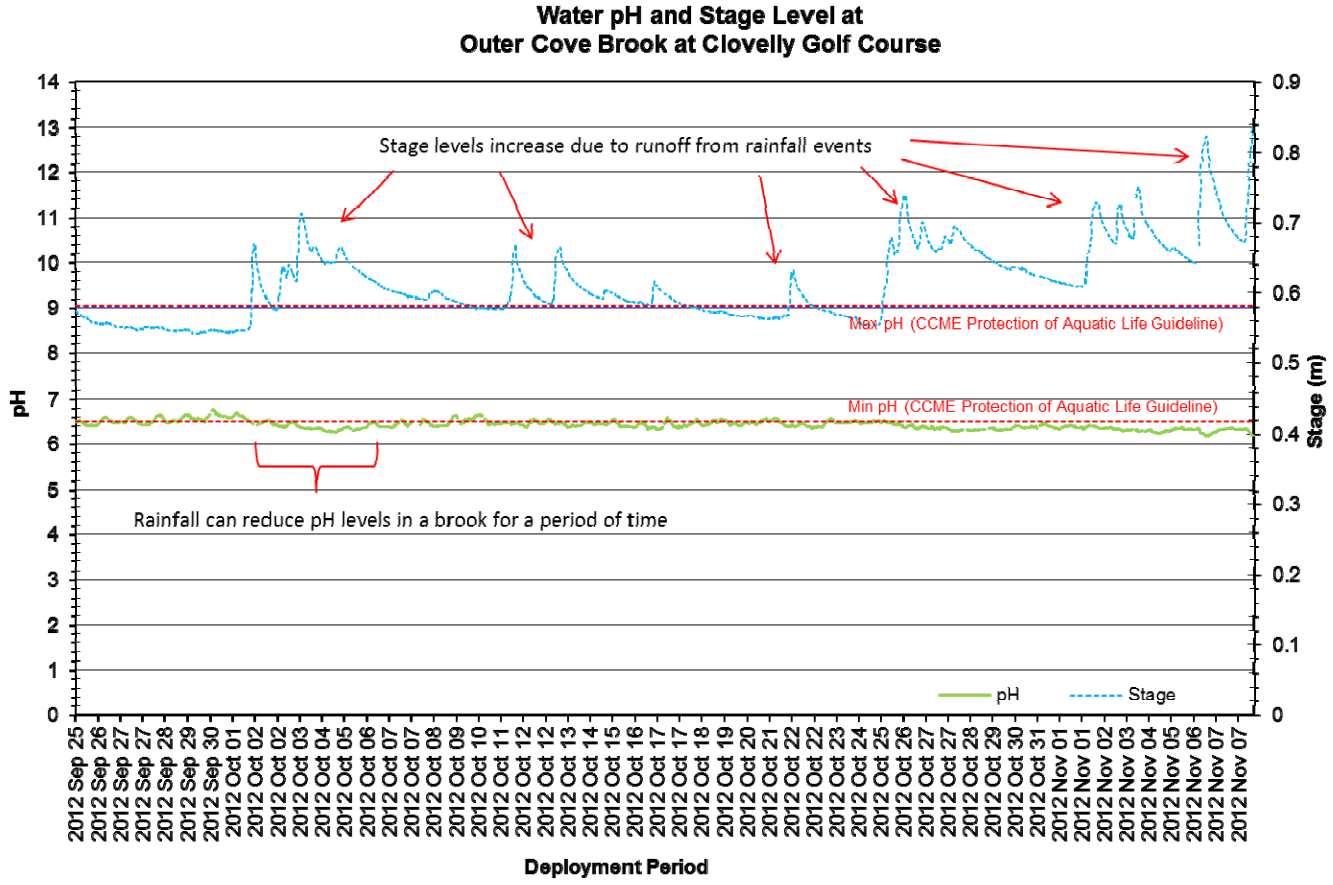


**Figure 9: Quarter-hourly pH (pH units) and Stage Level (m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period September 25 to November 8, 2012.**

## Specific Conductivity

- The conductivity levels were within 171.0µS/cm and 447.0µS/cm during this deployment period. TDS ranged from 0.1095 to 0.2860 g/L.
- The graph below (Figure 10) indicates several dips in the conductivity level during the deployment period. Rainfall events can have the effect of lowering specific conductance levels, which is evident on Figure 10 as the stage increases the conductance decreases.
- An overall decrease in specific conductivity and TDS over the deployment period is noted. This may be due to increased dilution from numerous rainfall events or general decrease of suspended solids in the river as the increased flows flush solids out of the river system.
- 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.

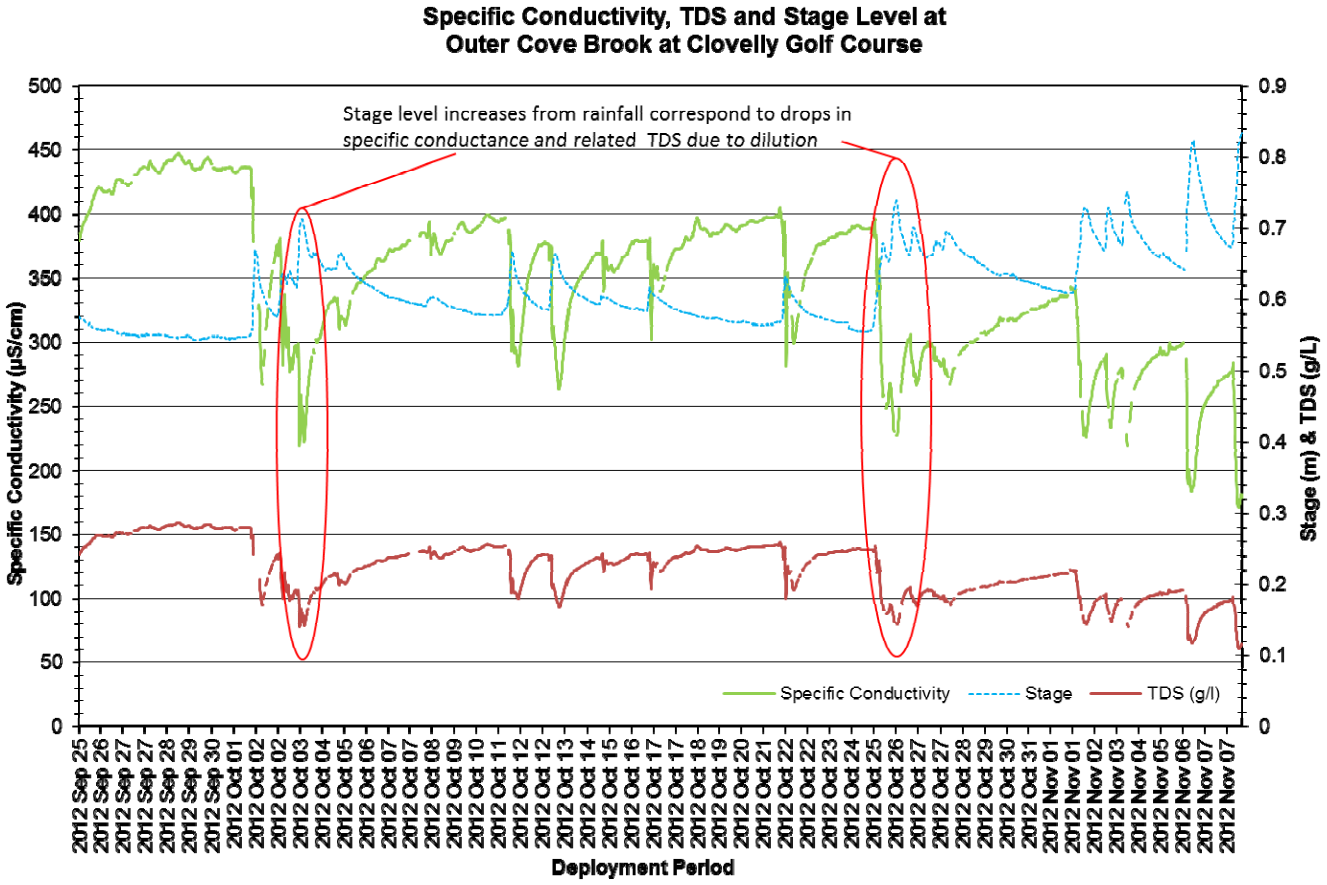


**Figure 10: Quarter-hourly specific conductivity (uS/cm), TDS (g/L) and stage (m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period September 25 to November 8, 2012.**

### 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 75.6–102.4% Sat. Dissolved Oxygen (mg/L) measured 7.46-11.32 mg/L.
- Dissolved Oxygen percent saturation remains constant during the deployment period. 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 warmer water can hold less oxygen. This trend was observed during the deployment period as evident in Figure 11, particularly on October 17, 2012.

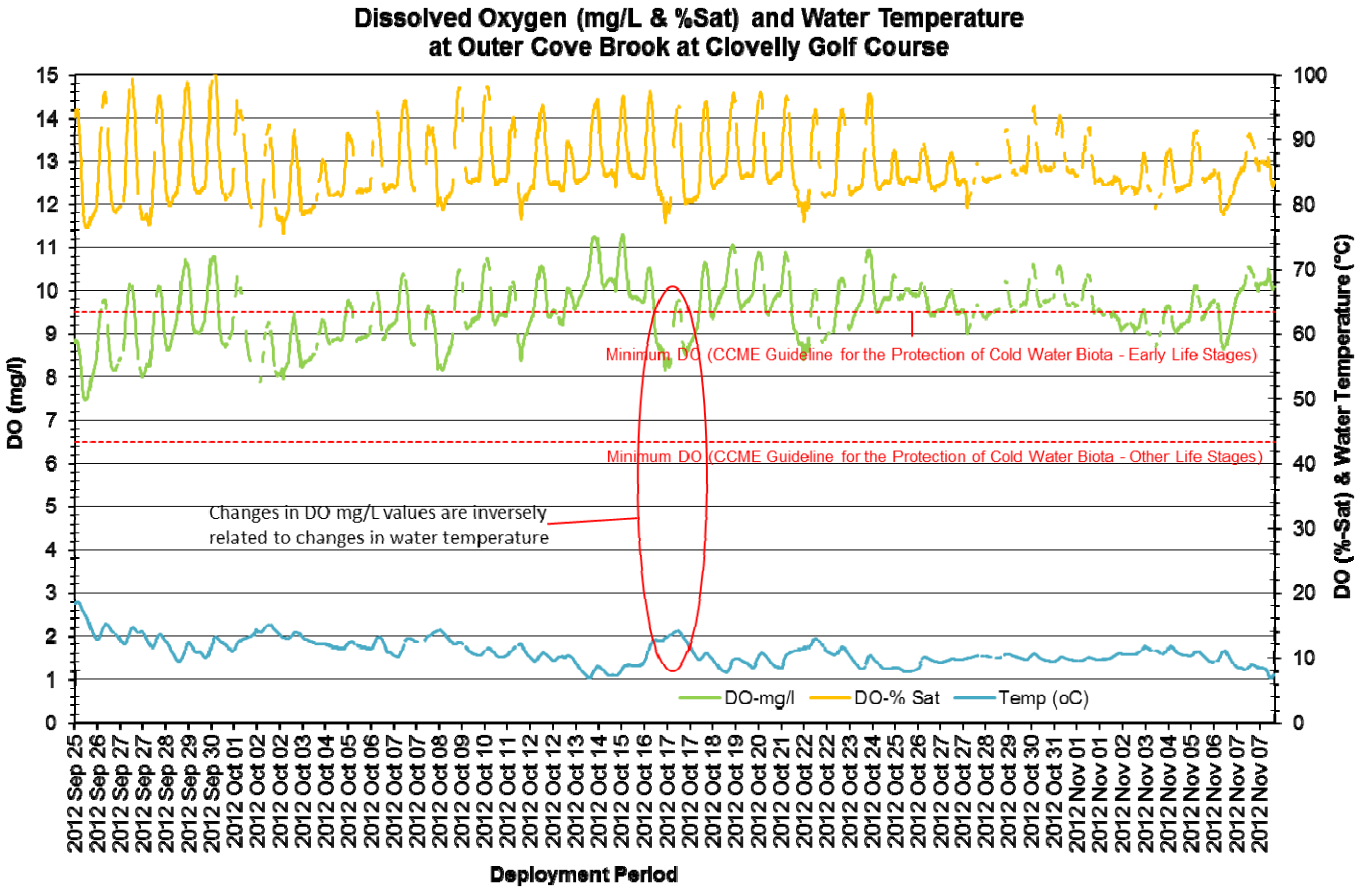


**Figure 11: Quarter-hourly dissolved oxygen (mg/L & % sat) and water temperature values at Outer Cove Brook at Clovelly Golf Course for the deployment period September 25 to November 8, 2012.**

## Turbidity

- Outer Cove Brook contains a significant amount of algae. High algal growth or leaf debris 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 0 NTU to 436 NTU.
- The majority of turbidity events are the result of rainfall. Two prolonged turbidity events, labeled in Figure 12, may be an indication of sensor interference by algae or leaf litter. When high flows flush out the river, the debris is dislodged and turbidity again decreases.

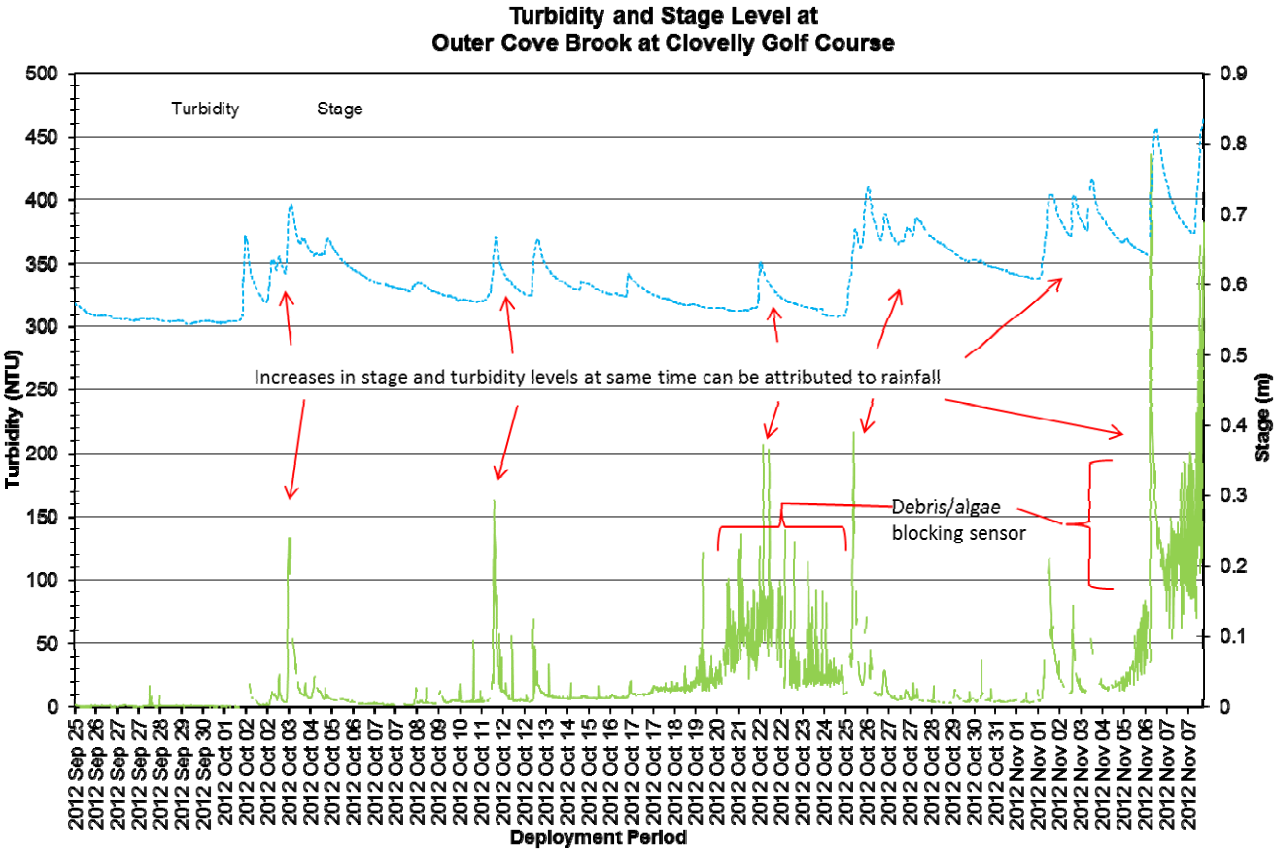


**Figure 12: Quarter-hourly turbidity (NTU) and stage level(m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period September 25 to November 8, 2012.**

## 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.
- Precipitation data from Environment Canada's St. John's Airport weather station and WRMD's weather station at Pippy Park were combined for this report due to precipitation reporting errors at Pippy Park.
- 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 rainfall events due to increased runoff from the surrounding area.
- During the deployment period, the stage ranged from 0.54m to 0.84m. During sonde removal, the marshy area surrounding the river was saturated and heavy rainfall was experienced, coinciding with the high stage and precipitation values recorded on this day.
- The peaks in stage in Figure 13 directly correspond with the rainfall events that occurred during this deployment period, thus we know that these stage increases are due to natural water level fluctuations.

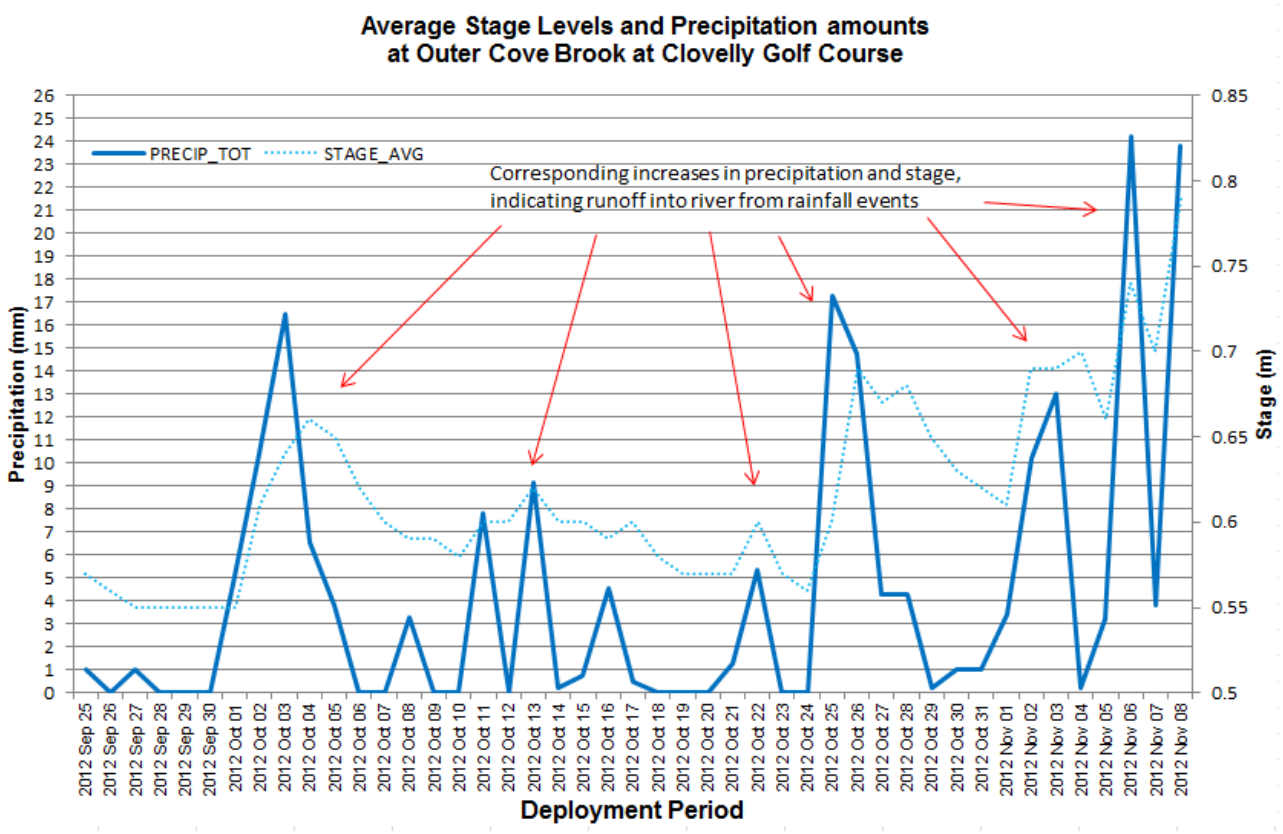


**Figure 13: Daily average stage values (m) at Outer Cove Brook below Airport and daily total precipitation values (mm) from Pippy Park weather station and Environment Canada's St. John's Airport Station for the deployment period September 25 to November 8, 2012. Precipitation values from Sept 25-Oct 31 are from WRMD's weather station in Pippy Park, while Oct 31-Nov 8 values are from Environment Canada's St. John's Airport Station.**

## Conclusions – Outer Cove Brook at Clovelly Golf Course

- During this deployment it is evident that many of the water quality events that occurred were related to the intermittent precipitation events, as shown throughout the figures. Generally in natural environments, climate and weather conditions account for the majority of variation in water quality parameters.
- Water Temperature steadily decreased during the deployment period, which would be expected as the ambient air temperature decreases during the fall season.
- Despite the specific conductivity probes 'fair' performance ranking at removal, the data displays intermittent drops in levels which accurately correlated to corresponding precipitation events. Dissolved Oxygen remains constant throughout the deployment period, increasing or decreasing in small increments as water temperatures rise and fall.
- Increases in stage level can explain the peaks in the turbidity values during the deployment period. As organic matter and natural minerals are washed into the brook the suspended matter in the water column will increase and the turbidity sensor and the specific conductivity sensor will pick up these additional changes in the water body. The turbidity sensors 'poor' performance ranking at removal is due to debris blocking the sensor on the field sonde, as evident in Figure 12.

## Conclusions – Outer Cove Brook Network

During this deployment period the median water temperature at the upstream station (Outer Cove Brook below Airport) of 10.70°C was very similar to that of the downstream station (Outer Cove Brook at Clovelly Golf Course) of 10.62°C. The median pH values for both was also comparable with, Outer Cove Brook below Airport's median at 6.52 and Outer Cove Brook at Clovelly Golf Course reading 6.44, there was no significant change in pH from the upstream to the downstream station. The Specific Conductivity median at Outer Cove Brook below Airport was 386 µS/cm with the Outer Cove Brook at Clovelly Golf Course recording a median of 372 µS/cm. Both conductivity medians are comparable and indicate no significant difference in specific conductivity as the water moves downstream. Dissolved Oxygen at the upstream station (Outer Cove Brook below Airport) had a median of 90.9%Sat during the deployment period, the downstream station (Outer Cove Brook at Clovelly Golf Course) had a lower median of 84.3%Sat. Both stations have close DO medians and there is no significant difference between them, however the downstream station does have considerably more aquatic growth in the stream which can increase the use of oxygen present in the water. The turbidity median values of 2.4 NTU at Outer Cove Brook below Airport and 6.8 NTU at Outer Cove Brook at Clovelly Golf Course indicate that turbidity does increase slightly as the water moves downstream.

Prepared by:
Kyla Brake
Department of Environment and Conservation
Water Resources Management Division
Phone: 709.729.3899