

# **Real-Time Water Quality Report**

# **Outer Cove Brook Network**

Deployment Period December 19, 2013 to January 21, 2014



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

Prepared by:

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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 32-day period from deployment on December 19, 2013 until removal on January 21, 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).

	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		

#### Table 1: Instrument Performance Ranking classifications for deployment and removal

- 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 December 19, 2013 through to January 21, 2014 are summarized in Table 2.

Table 2: Instrument performance rankings for Outer Cove Brook below Airport Dec 19, 2013 – Jan 21, 2014

Station	Data	Action	Comparison Ranking					
	Date	Action	Temperature	рН	Conductivity	Dissolved Oxygen	Turbidity	
Below Airport	Dec 19 2013	Deployment	Good	Fair	Excellent	Fair	Fair	
	Jan 21 2014	Removal	Excellent	Excellent	Excellent	Fair	Excellent	

• At the Outer Cove Brook below Airport station at the point of deployment, the conductivity sensor ranked 'excellent' while temperature ranked 'good'. The pH, dissolved oxygen and turbidity

sensors all ranked 'fair'. These low rankings may be due to the sonde readings not having stabilized before the values were recorded.

- At removal, temperature, pH, conductivity and turbidity all ranked 'excellent', while dissolved oxygen again ranked 'fair'. This may indicate an issue with the dissolved oxygen sensor, as it ranked 'fair' on both deployment and removal.
- Deployment and removal instrument performance rankings for Outer Cove Brook at Clovelly Golf Course for the period of December 19, 2013 through to January 21, 2014 are summarized in Table 3.

Table 3: Instrument performance rankings for Outer Cove Brook at Clovelly Golf Course Dec 19, 2013 – Jan 21, 2014

Station			Comparison Ranking					
	Date	Action	Temperature	рН	Conductivity	Dissolved Oxygen	Turbidity	
Clovelly Golf Course	Dec 19 2013	Deployment	Good	Good	Excellent	Good	Good	
	Jan 21 2014	Removal	Excellent	Fair	Excellent	Fair	Excellent	

- During the Outer Cove Brook Clovelly Golf Course station deployment, the conductivity sensor ranked 'excellent' while the pH, temperature, turbidity and dissolved oxygen sensors ranked 'good' when compared to the freshly calibrated QA/QC sonde.
- At removal, temperature, conductivity and turbidity ranked 'excellent', while pH and dissolved oxygen ranked 'fair'. Sensor drift may have been an issue with pH and dissolved oxygen. There may also be an issue with the dissolved oxygen sensor on the sonde used for QA/QC as both stations reported only 'fair' rankings for dissolved oxygen sensors upon removal.
- 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 both stations. Transmission loss gaps generally occurred for an hour at a time.
- Low flow conditions were observed at Outer Cove Brook during sonde deployment. Shore fast ice
  was noted at both locations in the vicinity of the stations, thus ice may have been a factor during
  the deployment.

# **Data Interpretation**

- The following graphs and discussion illustrate water quality-related events from December 19, 2013 to January 21, 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 and supplemented with information from 'The Weather Network' when EC data was not available.
- Erratic, rapid rise and fall of stage values during periods of cold ambient air temperatures indicate ice is covering the stage monitoring equipment, as was the case for the Clovelly station December 24-26, 2013.

## **Outer Cove Brook below Airport**

#### Water Temperature

- Water temperature ranged from -0.1°C to 4.30°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. During deployment, the temperature decreased to freezing before rising again near the end of deployment due to abnormally warm air temperatures.
- 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.



#### Water Temperature and Stage Level at Outer Cove Brook below Airport

Figure 2: Quarter-hourly water temperature (°C) and stage level (m) values at Outer Cove Brook below Airport for the deployment period December 19, 2013 to January 21, 2014.

рΗ

- Throughout this deployment period pH values ranged between 6.16 pH units and 7.14 pH units (Figure 3). The maximum value is notably higher than during previous deployments.
- During the deployment, the pH values at this station are above the minimum CCME Guideline for the Protection of Aquatic Life (between 6.5 and 9 pH units) for the majority of the deployment, dropping below the guideline after precipitation events such as those on January 6<sup>th</sup>, 12<sup>th</sup> and 17<sup>th</sup> (Figure 3). 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 during this deployment remained around 7.00 pH units, which is high for this stream, dipping lower during precipitation events, which is normal.
- A similar high pH trend was noted during March-April 2013, and was suspected to be due to a discharge into the brook upstream of the station. The station will be monitored closely and the possible inputs will be investigated further.



#### pH and Stage Level at Outer Cove Brook below Airport

Figure 3: Quarter-hourly pH (pH units) and stage level (m) values at Outer Cove Brook below Airport for the deployment period December 19, 2013 to January 21, 2014.

#### **Specific Conductivity & TDS**

- The conductivity levels were within 337 µS/cm and 2600 µS/cm during this deployment period. TDS ranged from 0.2150 g/L to 1.6600 g/L. These values are notably higher than those of the previous deployment period.
- Generally, rainfall events, such as that which occurred on January 17<sup>th</sup> (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.
- 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 increases on December 22<sup>nd</sup> and January 12<sup>th</sup> are in response to cold winter temperatures.
- 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.



#### Specific Conductance, TDS and Stage Level at Outer Cove Brook below Airport

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 December 19, 2013 to January 21, 2014.

### Dissolved Oxygen

- The instrument measures dissolved oxygen (mg/L) directly then calculates percent saturation (% Sat.).
- The Dissolved Oxygen % Sat levels within this deployment period were within 74.3% Sat–88.9% Sat. Dissolved Oxygen (mg/L) measured 10.46 mg/L to 12.85 mg/L. Water temperatures were cooler during this deployment period, resulting in higher oxygen levels.
- The DO mg/L values are above the minimum DO CCME guideline for early life stages throughout this deployment period (Figure 5), as the colder water during winter months can hold more oxygen. There is a notable decrease in oxygen mg/L values near the end of the deployment when water temperatures were warmer, thus decreasing the oxygen values.
- A drop in dissolved oxygen on January 6-7<sup>th</sup> corresponds to a sharp increase in conductivity at this time. The decrease is likely due to the large amount of salts present in the brook, lowering the amount of oxygen the water can hold.
- Dissolved Oxygen percent saturation remains relatively constant throughout the deployment period. 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 warmer water can hold less oxygen.



Dissolved Oxygen (mg/L & % Sat) and Water Temperature at Outer Cove Brook below Airport

Figure 5: Quarter-hourly dissolved oxygen (mg/L & % sat) and water temperature (°C) values at Outer Cove Brook below Airport for the deployment period December 19, 2013 to January 21, 2014.

## 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.
- The turbidity readings during this deployment ranged within 0.0 NTU to 194.2 NTU (Figure 6).
- 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. Sudden increases in turbidity for single readings may indicate debris is blocking the turbidity sensor.



Turbidity and Stage Level at Outer Cove Brook below Airport

Figure 6: Quarter-hourly turbidity (NTU) and stage level (m) values at Outer Cove Brook below Airport for the deployment period December 19, 2013 to January 21, 2014.

## 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 rain events (Figure 7) due to increased runoff from the surrounding area. However, snowfall will not cause stage to rise significantly as it is not runoff into the river. This is noted in Figure 7, December 19-30<sup>th</sup>, 2013.
- 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 0.81m to 1.34m.



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 December 19, 2013 to January 21, 2014.

# 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 decreases).
- 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 decreased, there were correspondingly cooler 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.
- 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. These salts can also briefly decrease dissolved oxygen values.
- The pH observed during this deployment is higher than normal for this waterbody. This may indicate an influence of some sort on the brook upstream of the real-time station. It should be noted that a similar increase in pH was recorded during Spring of 2013. Environment Canada's Enforcement Division has been contacted and is investigating the issue as the brook is likely being impacted by activities at St. John's International Airport, which falls under federal jurisdiction. WRMD is assisting with the investigation of this water quality issue.

## **Outer Cove Brook at Clovelly Golf Course**

#### Water Temperature

- Water temperature ranged from -0.06°C to 4.18°C during this deployment period (Figure 8). This
  is notably cooler than the previous deployment, and is normal during winter months.
- 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.
- 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.



#### Water Temperature and Stage Level at Outer Cove Brook at Clovelly Golf Course

Figure 8: Quarter-hourly water temperature (°C) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period December 19, 2013 to January 21, 2014.

### pН

- Throughout this deployment period pH values ranged between 6.16 pH units and 6.84 pH units (Figure 9).
- During the deployment, the pH values at this station are above the minimum CCME Guideline for the Protection of Aquatic Life (between 6.5 and 9 pH units), decreasing at times due to the addition of precipitation. There are notable drops on January 12<sup>th</sup> and 15<sup>th</sup>, related to precipitation events. 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 was higher than normal during this deployment period.



pH and Stage Level at Outer Cove Brook at Clovelly Golf Course

Figure 9: Quarter-hourly pH (pH units) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period December 19, 2013 to January 21, 2014.

#### **Specific Conductivity & TDS**

- The conductivity levels were within 423 µS/cm and 3406 µS/cm during this deployment period. TDS ranged from 0.2710 g/L to 2.1800 g/L. This is notably higher than during the previous deployment.
- 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 increases on December 22<sup>nd</sup> and January 12<sup>th</sup> are in response to winter temperatures and road salt application.
- Generally, rainfall events, such as that which occurred on January 17th (see Figure 10), 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.



# Specific Conductance, TDS and Stage Level at Outer Cove Brook at Clovelly Golf Course

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 December 19, 2013 to January 21, 2014.

### 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 67.2% Sat–87.2% Sat. Dissolved Oxygen (mg/L) measured 9.80 mg/L to 12.46 mg/L. Water temperatures were cooler during this deployment period, resulting in higher oxygen levels.
- The DO mg/L values are above the minimum DO CCME guideline for early life stages throughout this deployment period (Figure 11), as the colder water during winter months can hold more oxygen. There is a notable decrease in oxygen mg/L values near the end of the deployment when water temperatures were warmer, thus decreasing the oxygen values.
- A drop in dissolved oxygen on January 6-7<sup>th</sup> corresponds to a sharp increase in conductivity at this time. The decrease is likely due to the large amount of salts present in the brook, lowering the amount of oxygen the water can hold.
- Dissolved Oxygen percent saturation remains relatively constant throughout the deployment period, with diurnal fluctuations. 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.



Dissolved Oxygen (mg/L & % Sat) and Water Temperature at Outer Cove Brook at Clovelly Golf Course

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 December 19, 2013 to January 21, 2014.

## 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 and thus is not a valid turbidity reading.
- The turbidity readings during this deployment ranged within 1.3 NTU to 91.8 NTU (Figure 12). Fluctuations in turbidity values were correlated with increases in stage and thus precipitation events. Data was removed from December 30<sup>th</sup> to January 4<sup>th</sup> due to sensor error or blockage as the data was reading 3000NTU.



#### Turbidity and Stage Level at Outer Cove Brook at Clovelly Golf Course

Figure 12: Quarter-hourly turbidity (NTU) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period December 19, 2013 to January 21, 2014.

## 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 rain events (Figure 13) due to increased runoff from the surrounding area. However, snowfall will not cause stage to rise significantly as it is not runoff into the river. This is noted in Figure 13, December 19-30<sup>th</sup>, 2013.
- 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 0.51m to 1.77m. Ice was an issue at this station December 24-26<sup>th</sup>, as evident in the erratic data recorded during this period (see Figure 8).



#### Daily Average Stage Levels & Precipitation Amounts at Outer Cove Brook at Clovelly Golf Course

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 for the deployment period December 19, 2013 to January 21, 2014.

## **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 decreased, there were correspondingly cooler water temperatures, which in turn
  increased the amount of dissolved oxygen in the water.
- Dissolved oxygen values at this site fluctuate diurnally, increasing values during the day and decreasing values into the night, indicating a relationship between the oxygen levels and sunlight.
- Specific conductivity and TDS are notably higher at this station than at the below airport station. Numerous increases in these parameters during deployment indicate the addition of salts to the roadways upstream of this station. Increases did occur at the below airport station but were smaller in magnitude, indicating possible inputs having occurred between the two stations. These salts can also briefly decrease dissolved oxygen values.
- Generally, dissolved oxygen, pH and water temperatures are lower while turbidity, conductivity and TDS values are higher at this station than at the below airport station.

## **Conclusions – Outer Cove Brook Network**

During this deployment period, the median water temperature at the upstream station (below Airport) of 0.7°C was higher than that of the downstream station (at Clovelly Golf Course) of 0.04°C. The median pH value of 6.83 below the Airport is higher than the Clovelly station median of 6.57. These median values are higher than those of the previous deployment. The specific conductivity medians were notably different with 486 uS/cm reported below the airport and 642 uS/cm reported at the golf course. These values are also higher than the previous deployment. Dissolved oxygen at the upstream station (below Airport) had a median of 84.7%Sat during the deployment period, while the downstream station (Clovelly Golf Course) had a lower median of 78.3%Sat. The lower oxygen levels at the downstream Clovelly station occur at night, indicating an interaction with the prolific aquatic grass growth which cannot synthesize oxygen and replenish the dissolved oxygen in the water at night. The median turbidity value below the airport was 0 NTU while at Clovelly Golf Course the median was 2.4 NTU. Turbidity spikes related to stage increases generally reach a higher magnitude and are more variable at the Clovelly station.

# Appendix

# **Parameter Station Comparison Graphs**





#### Outer Cove Brook, Newfoundland and Labrador



NF02ZM0365 - Outer Cove Brook at Clovelly Golf Course

#### Outer Cove Brook, Newfoundland and Labrador

