Real-Time Water Quality Report

Outer Cove Brook Network

Deployment Period
May 14, 2014 to June 16, 2014

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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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 34-day period from deployment on May 14, 2014 until removal on June 16, 2014.

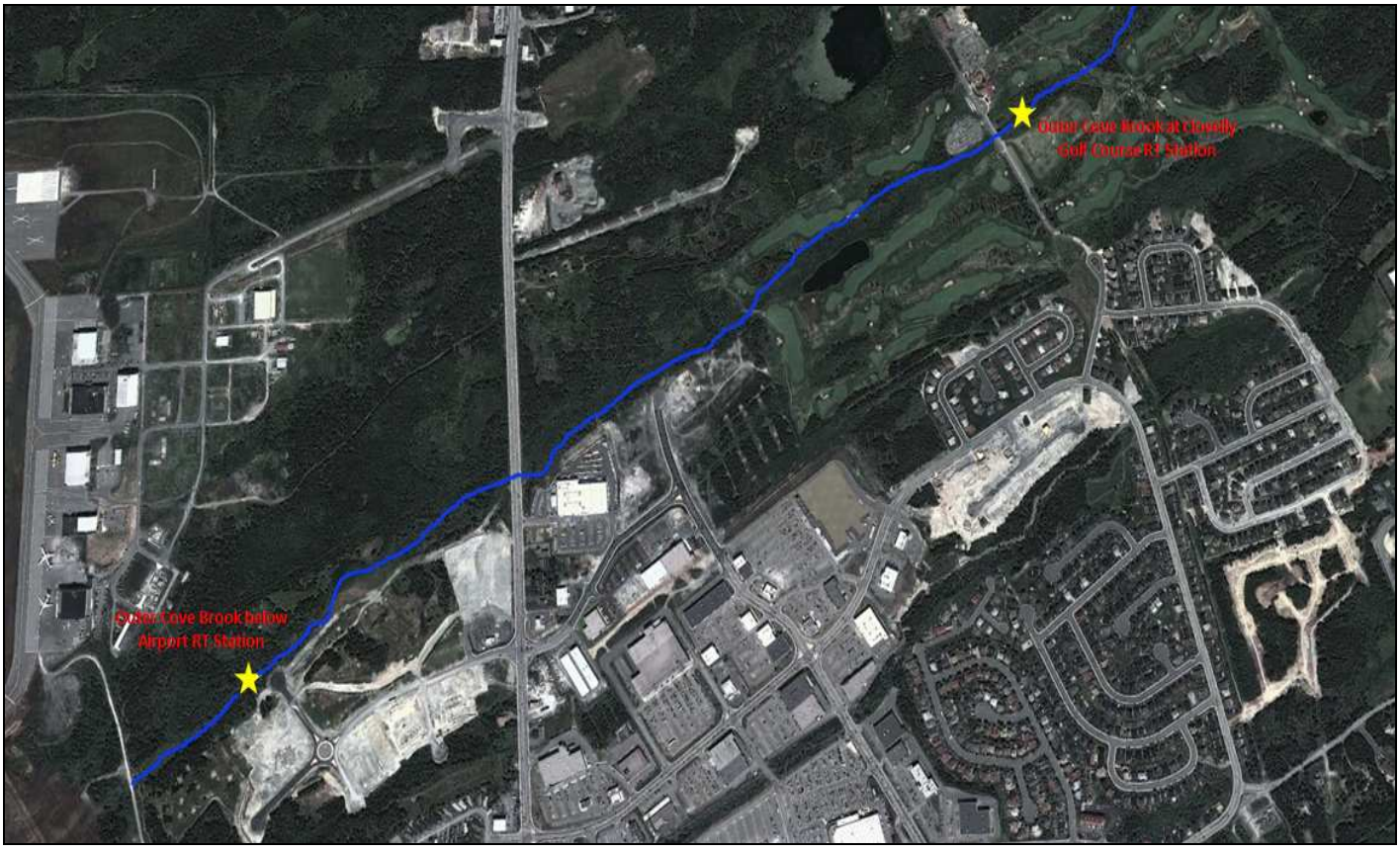

Figure 1: Outer Cove Brook Real-Time Water Quality and Quantity Stations.

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 May 14, 2014 to June 16, 2014 are summarized in Table 2.

Table 2: Instrument performance rankings for Outer Cove Brook below Airport May 14, 2014 – June 16, 2014

Station	**Date**	**Action**	**Comparison Ranking**				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
Below Airport	**May 14 2014**	**Deployment**	Excellent	Fair	Good	Excellent	Excellent
	June 16 2014	**Removal**	Good	Marginal	Good	Poor	Poor

- During the Outer Cove Brook below Airport station deployment, water temperature, dissolved oxygen and turbidity all ranked as 'excellent'. pH ranked as 'fair' while conductivity data ranked as 'good'. The 'fair' ranking for pH readings during deployment may have been a result of the pH sensor still stabilizing in the brook while the reading was recorded. Some instruments need extra time to acclimatize to the stream when deployed.

- At removal, water temperature and conductivity ranked as 'good', while pH ranked as 'marginal'. 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. The turbidity self-cleaning arm was unable to clean the sensors due to the amount of algae that was present.

- Deployment and removal instrument performance rankings for **Outer Cove Brook at Clovelly Golf Course** for the period of May 14, 2014 to June 16, 2014 are summarized in Table 3.

Table 3: Instrument performance rankings for Outer Cove Brook at Clovelly Golf Course May 14, 2014 to June 16, 2014

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Clovelly Golf Course	May 14 2014	Deployment	Excellent	Good	Good	Fair	Good
	June 16 2014	Removal	Good	Good	Good	Excellent	Excellent

- Comparison of the field sonde and QAQC data during the deployment at Outer Cove Brook Clovelly Golf Course indicated the following: temperature data was ranked as 'excellent'; pH, conductivity and turbidity data all ranked as 'good'; Dissolved oxygen ranked as 'fair'. This ranking may indicate that the internal temperature had not reached its optimum level when the DO reading was taken.

- At removal the comparison between the sondes indicated that, temperature, pH and conductivity data was ranked 'good', while dissolved oxygen and turbidity data ranked as 'excellent' at the end of the deployment period. These ranks are reasonably good for an instrument that has spent 34 days in the water.

- 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. High amounts of algae also use larger amount of oxygen present in the water column.

Issues or Concerns during deployment

On May 26th the transmission between Outer Cove Brook at Clovelly Golf Course was lost. The data had dropped out for approximately 3 days then started to transmit again. Unfortunately on June 3rd , it was identified that the instrument was malfunctioning and it was removed from the brook for repairs. During this time there was no collection of data at this station. Therefore, the data for Outer Cove Brook at Clovelly Golf Course stops on June 3rd. The dates are continued in the parameter graphs to show the respective deployment period.

There were several short transmission errors during this deployment period at the Outer Cove Brook below Airport station. 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 among a large cover of trees, which may interfere with transmission as well.

Due to the excessive amount of unidentified slime-like algae present in Outer Cove Brook during spring and early summer. Outer Cove Brook below Airport is being considered for bi-weekly cleaning visits to clean and remove as much of the algae from the instrument as possible. This will allow the instrument to provide as accurate and correct water quality data as possible during these high algae times.

Data Interpretation

The following graphs and discussion illustrate water quality-related events from May 14, 2014 through to June 16, 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 3.8°C to 16.70°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.

The lower water temperatures indicated on the graph also correspond with increases in stage. This can indicate that there was a rainfall 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.

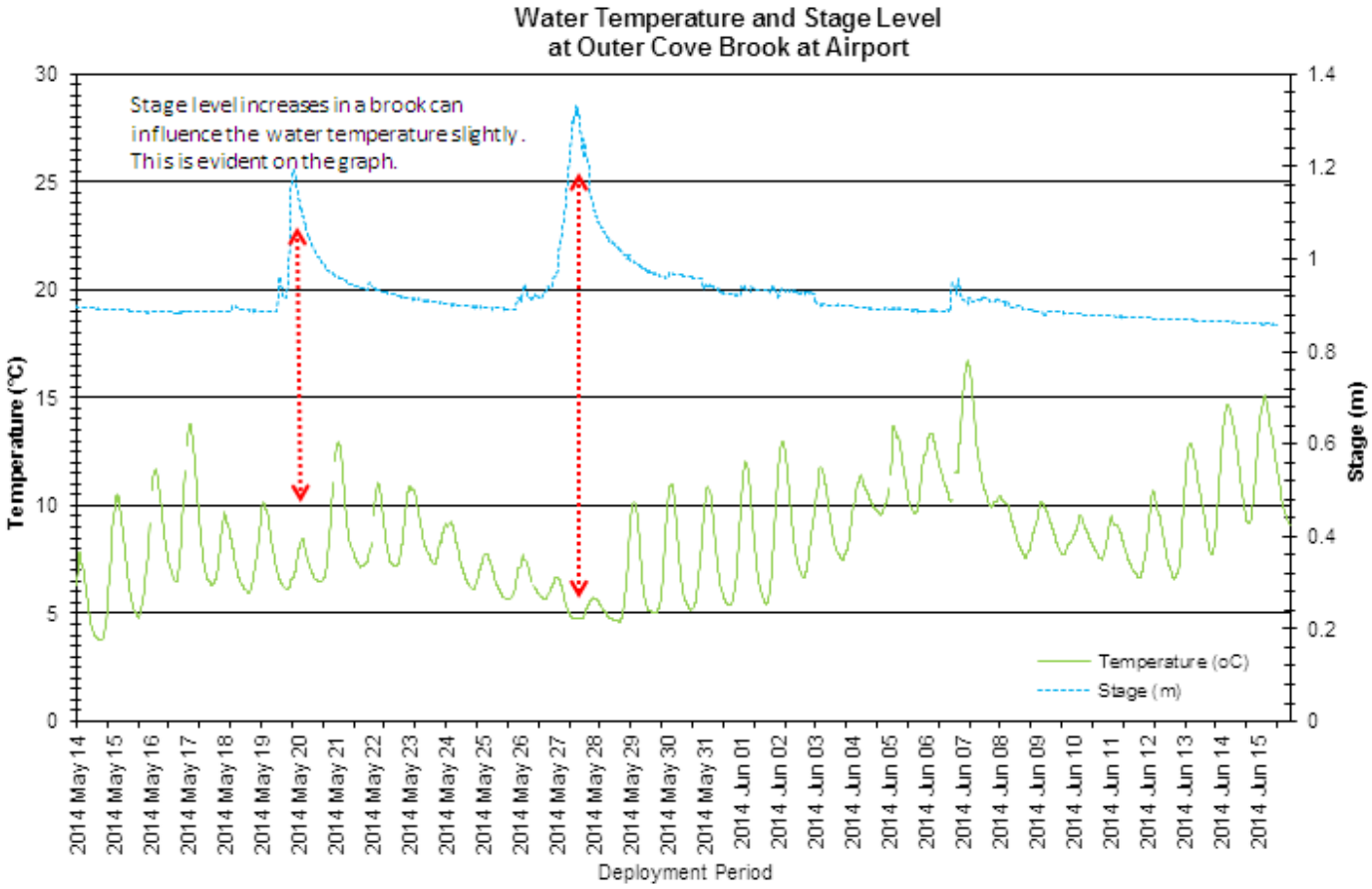

Figure 2: Water temperature (°C) and stage level (m) values at Outer Cove Brook below Airport.

pH

Throughout this deployment period pH values ranged between 6.17 pH units and 7.42 pH units (Figure 3).

During this deployment, the pH values at this station were generally above the minimum CCME Guideline for the Protection of Aquatic Life (between 6.5 and 9 pH units).

The events on May 20th, May 27th, and June 7th of slight dips in pH levels also 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 6.84 units, which was slightly higher than last month.

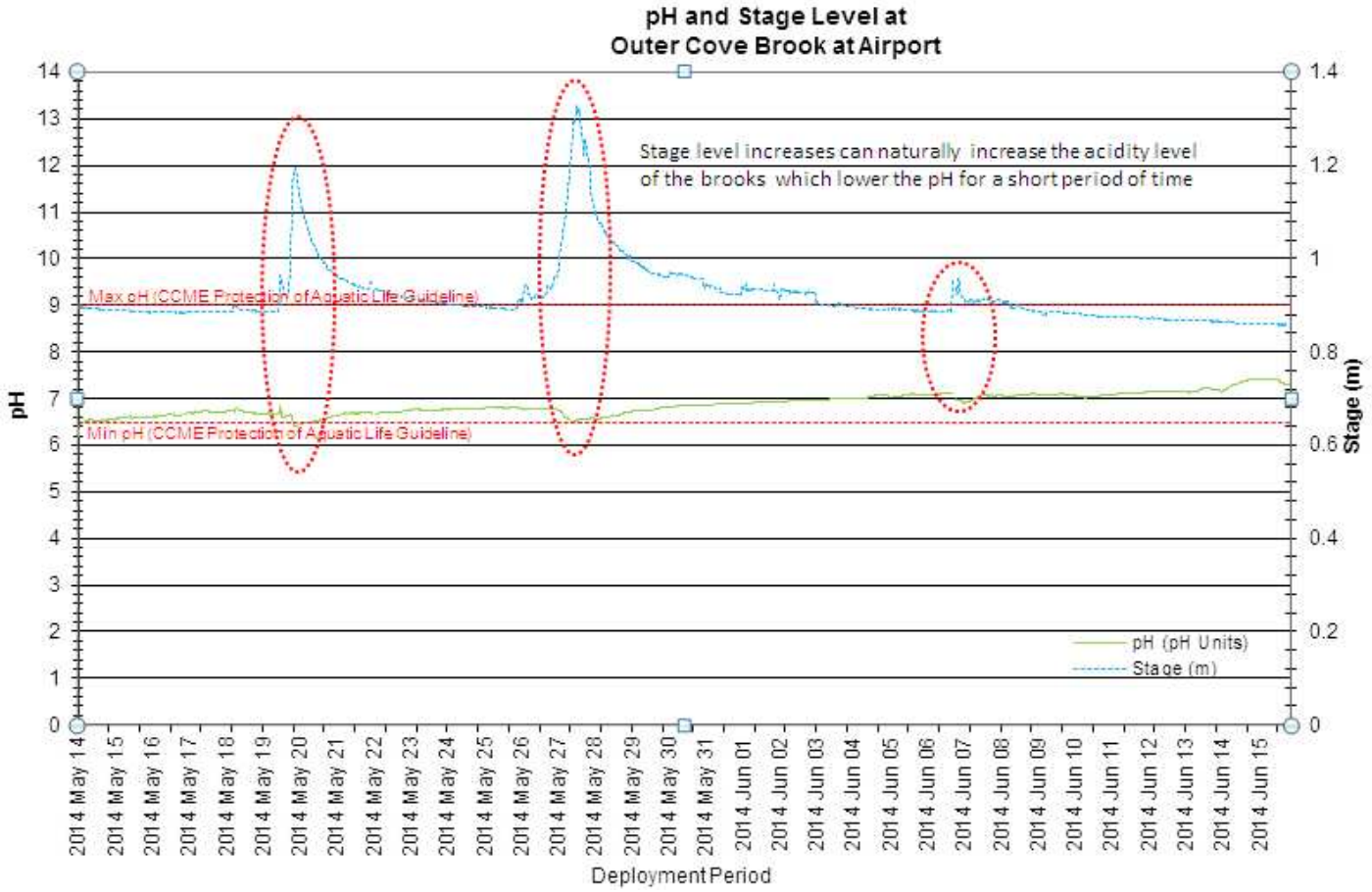

Figure 3: pH (pH units) and stage level (m) values at Outer Cove Brook below Airport

Specific Conductivity & TDS

The conductivity levels were within 143.3 µS/cm and 590.0 µS/cm during this deployment period. TDS ranged from 0.0917 g/L to 0.3780 g/L.

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. This is evident on Figure 4 on May 20th, May 27th and a small one on June 7th.

Towards the end of the deployment the conductivity levels start to climb, this may be a result of the slight decrease in stage level. As stage drops there is a higher concentration of dissolved substances present in the brook and therefore higher conductivity levels. There is also the possibility that the climbing conductivity levels at the end of deployment are related to fouling of the conductivity sensor.

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.

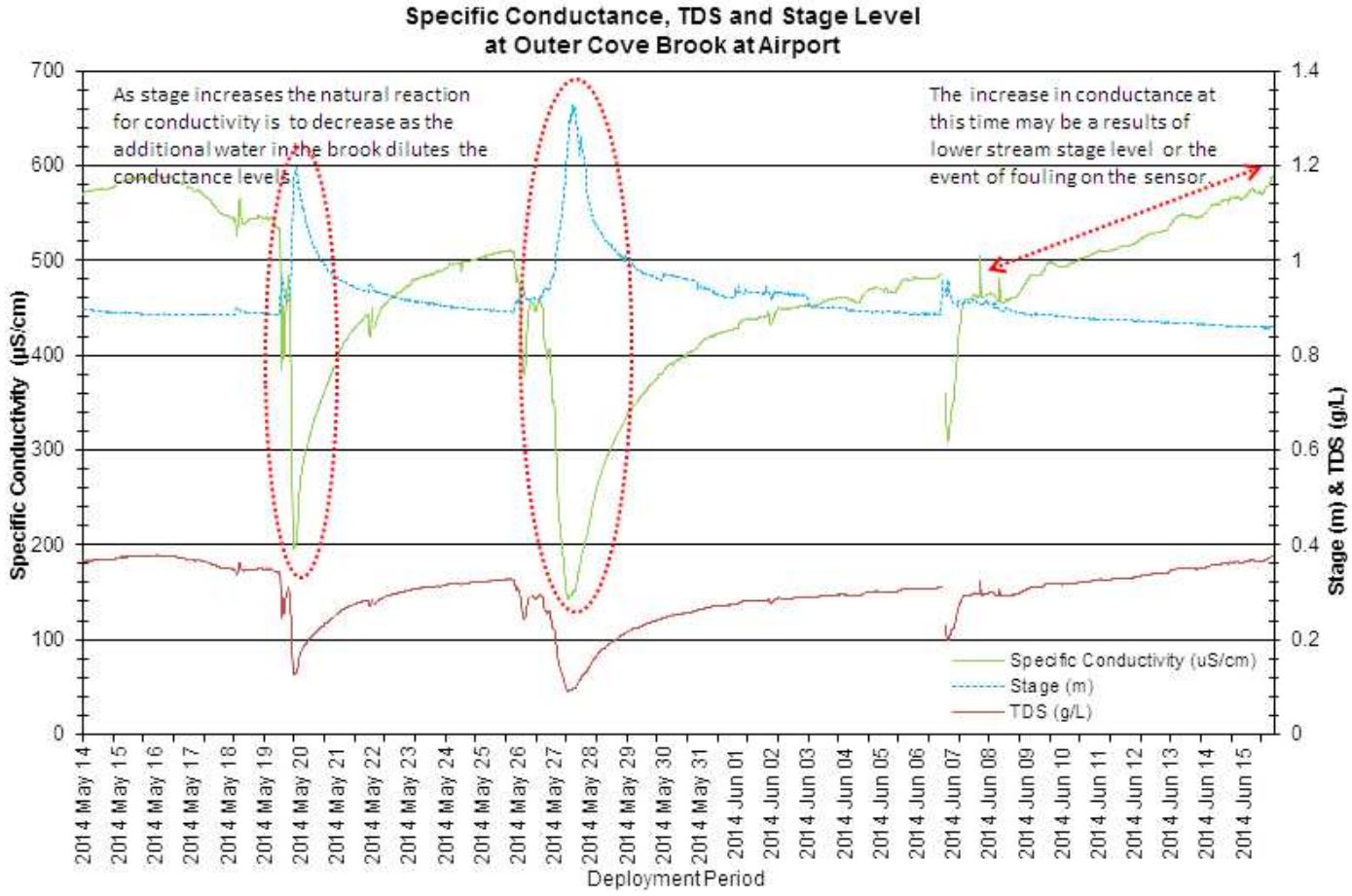

Figure 4: Specific conductivity (µS/cm), TDS (g/L) and stage (m) values at Outer Cove Brook below Airport.

Dissolved Oxygen

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

The Dissolved Oxygen % Sat levels within this deployment period were within 0.2% Sat to 91% Sat. Dissolved Oxygen (mg/L) measured 0.03 mg/L to 11.58 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 due to the fouling blocking the sensors ability to record accurate and correct values.

For the beginning of the deployment, the DO mg/L values remain generally above the minimum DO CCME guideline for early life stages (Figure 5). As the instrument becomes more fouled with the slime-like algae the DO probe was unable to provide accurate readings. From May 27th through to the end of the deployment the data for dissolved oxygen should not be included in any statistical analysis.

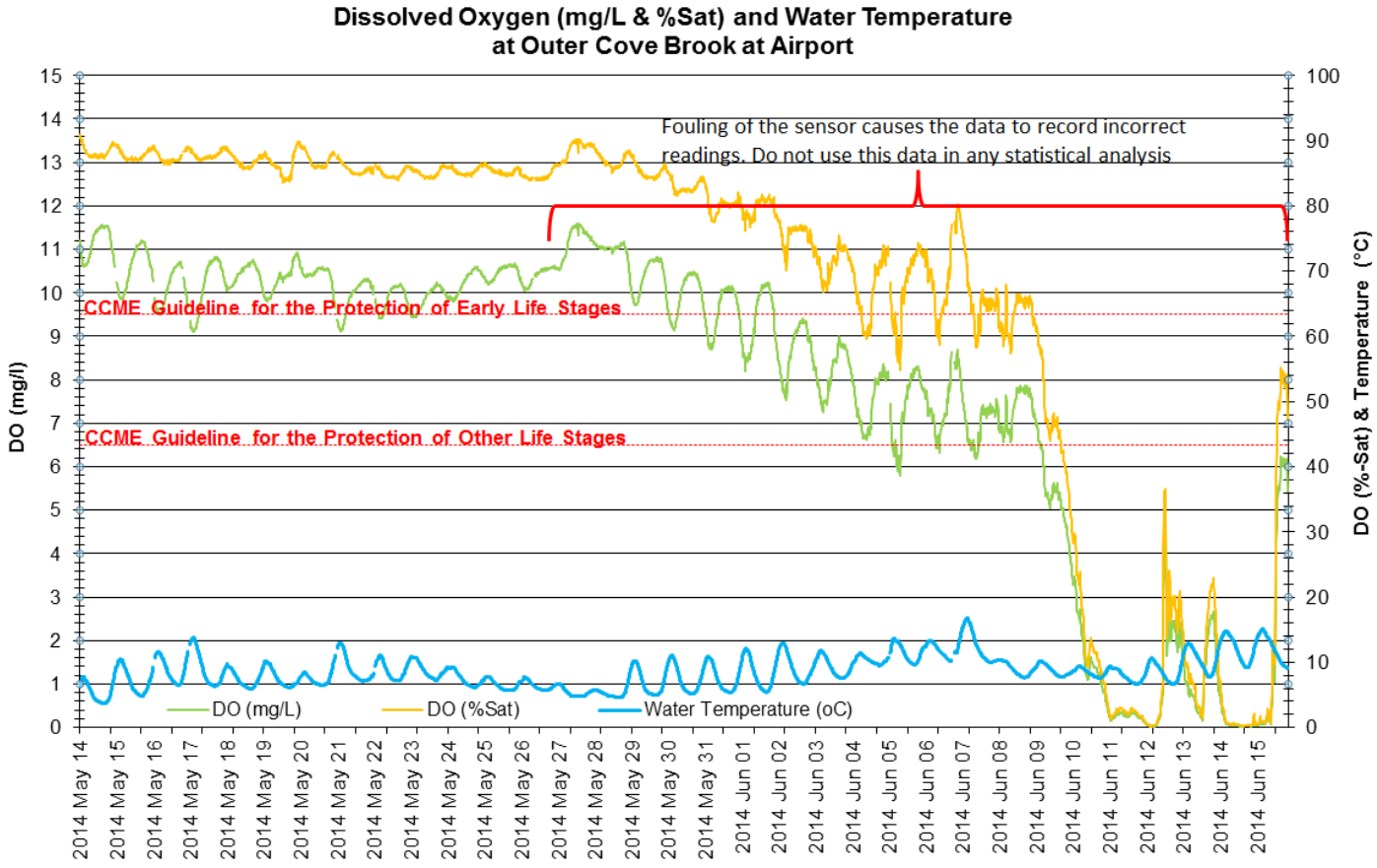

Figure 5: Dissolved oxygen (mg/L & % sat) and water temperature (°C) values at Outer Cove Brook below Airport.

Turbidity

Turbidity levels during this deployment period ranged within 0.0 NTU and 2568 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 in the deployment period correlate with increases in stage potentially from precipitation (Figure 6). Precipitation can increase the presence of suspended material in water as seen on May 20th and May 28th. The data from May 30th to June 1st represents likely fouling at that time and not an actual turbidity increase in the brook.

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 May 27th onto the end of the deployment period the turbidity data is not a true representation of the brook.

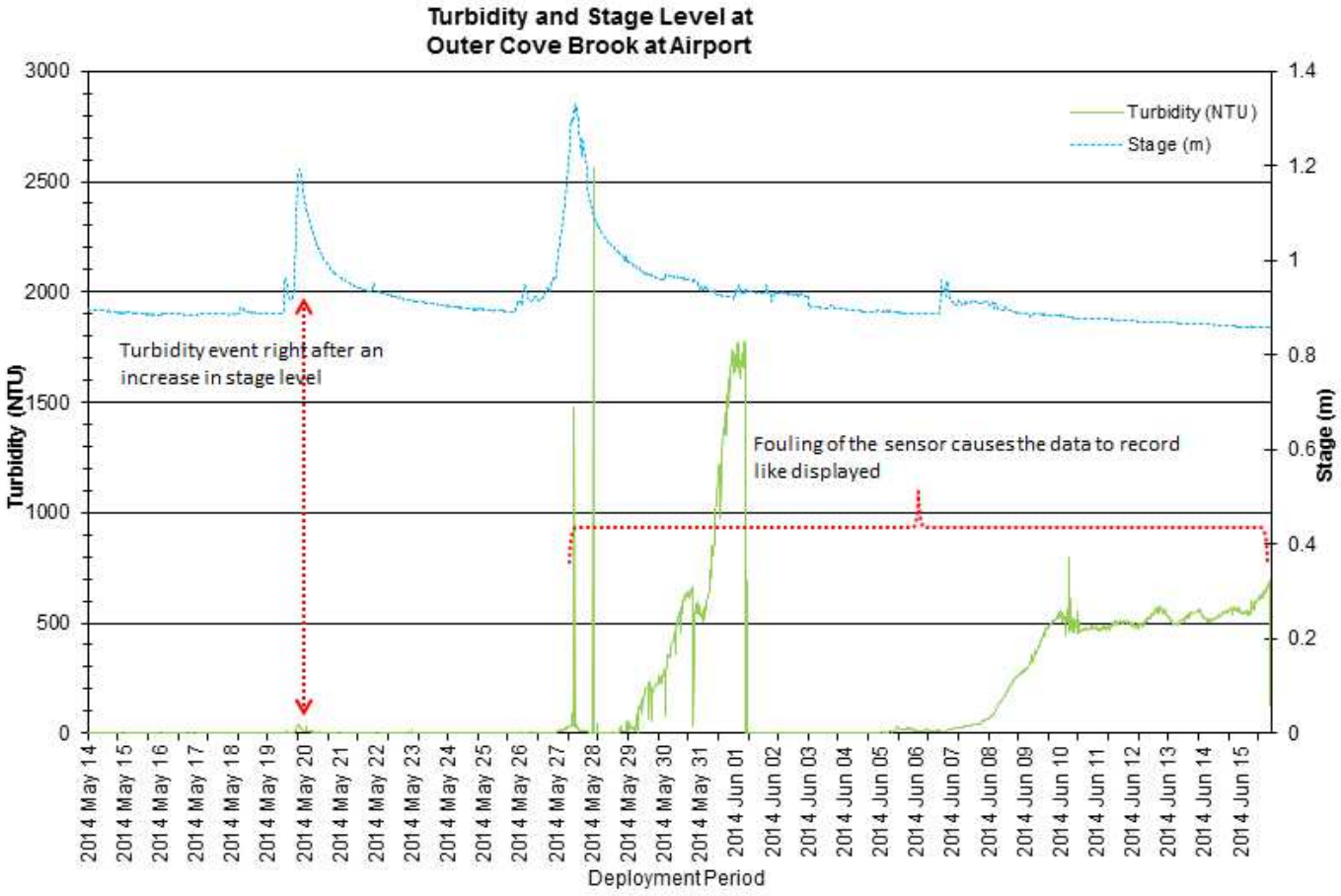

Figure 6: Turbidity (NTU) and stage level (m) values at Outer Cove Brook below Airport.

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 0.86m to 1.33m. The larger peaks in stage do correspond with substantial rainfall events as noted on Figure 7.

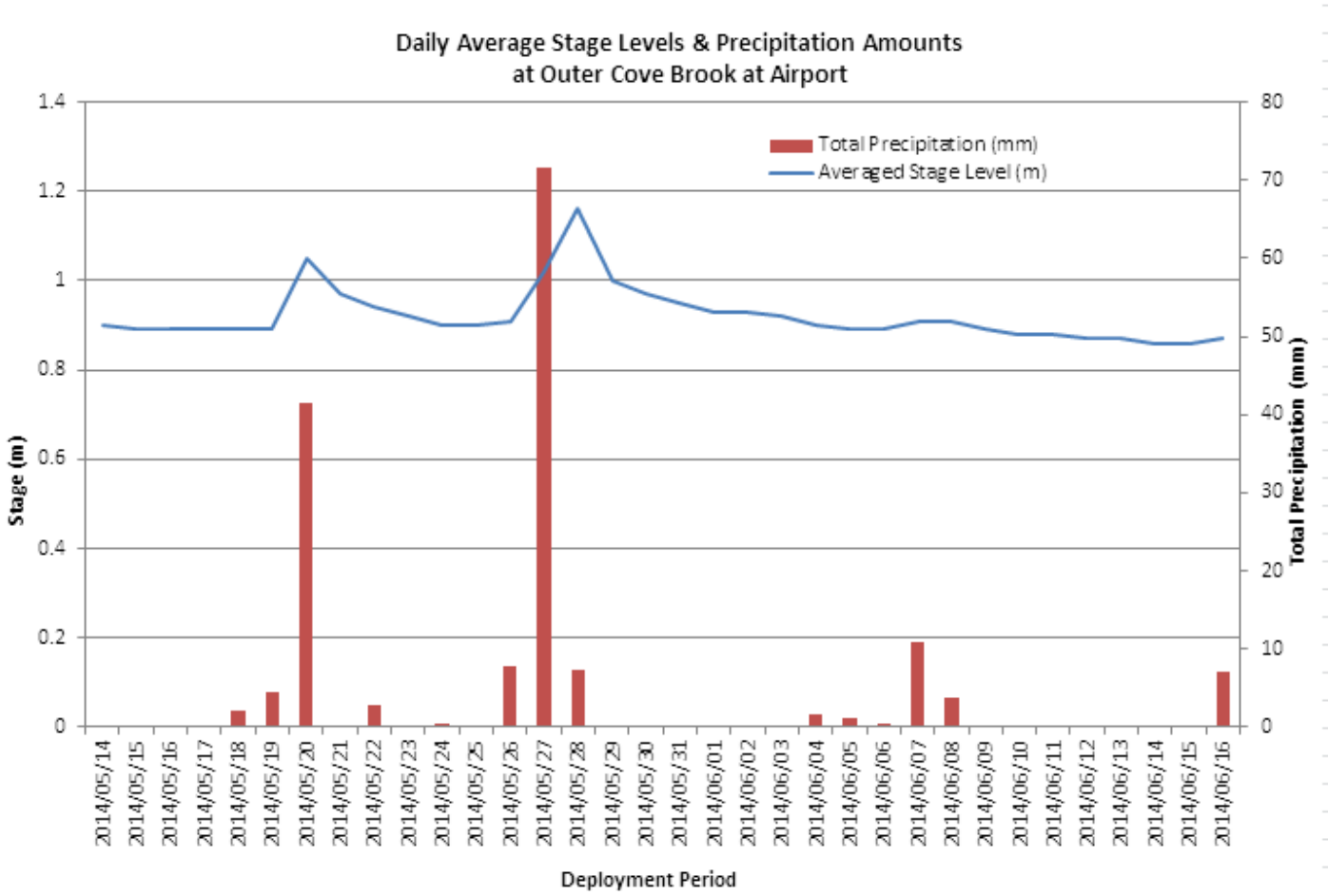

Figure 7: Daily average stage values (m) at Outer Cove Brook below Airport and daily total precipitation values (mm) from Environment Canada's St. John's Airport Station.

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 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. When reviewing the graphs as a whole it is evident that the precipitation events on May 20th, May 27th and June 7th caused varying effects with the water quality parameters. 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 increased it caused the water temperature to increase. Water temperature directly affects the amount of dissolved oxygen present in the brook during those times and it is natural to see a slight decrease in dissolved oxygen levels with warmer water temperatures.

- Toward the end of this deployment the level of biofouling present on the instrument affected the raw data being transmitted. At removal of the instrument, there was a large amount of slime-like algae present in the brook that is not evident all year round. Environment Canada was notified of the presence of this algae and provided with pictures of the brook. 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 3.72 ^{o}C to 15.39 ^{o}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. This deployment period has higher water temperature values than the previous month. This is expected as the air temperature increases with natural climatic changes.

This deployment period did not provide a full period of data due to instrument malfunction. Therefore, there is only data at the beginning of the deployment. It is difficult to provide an overview of the water temperature at this station with this limited amount of data.

Water temperature on these water quality instruments is a very important parameter and it has the ability to influence other parameters.

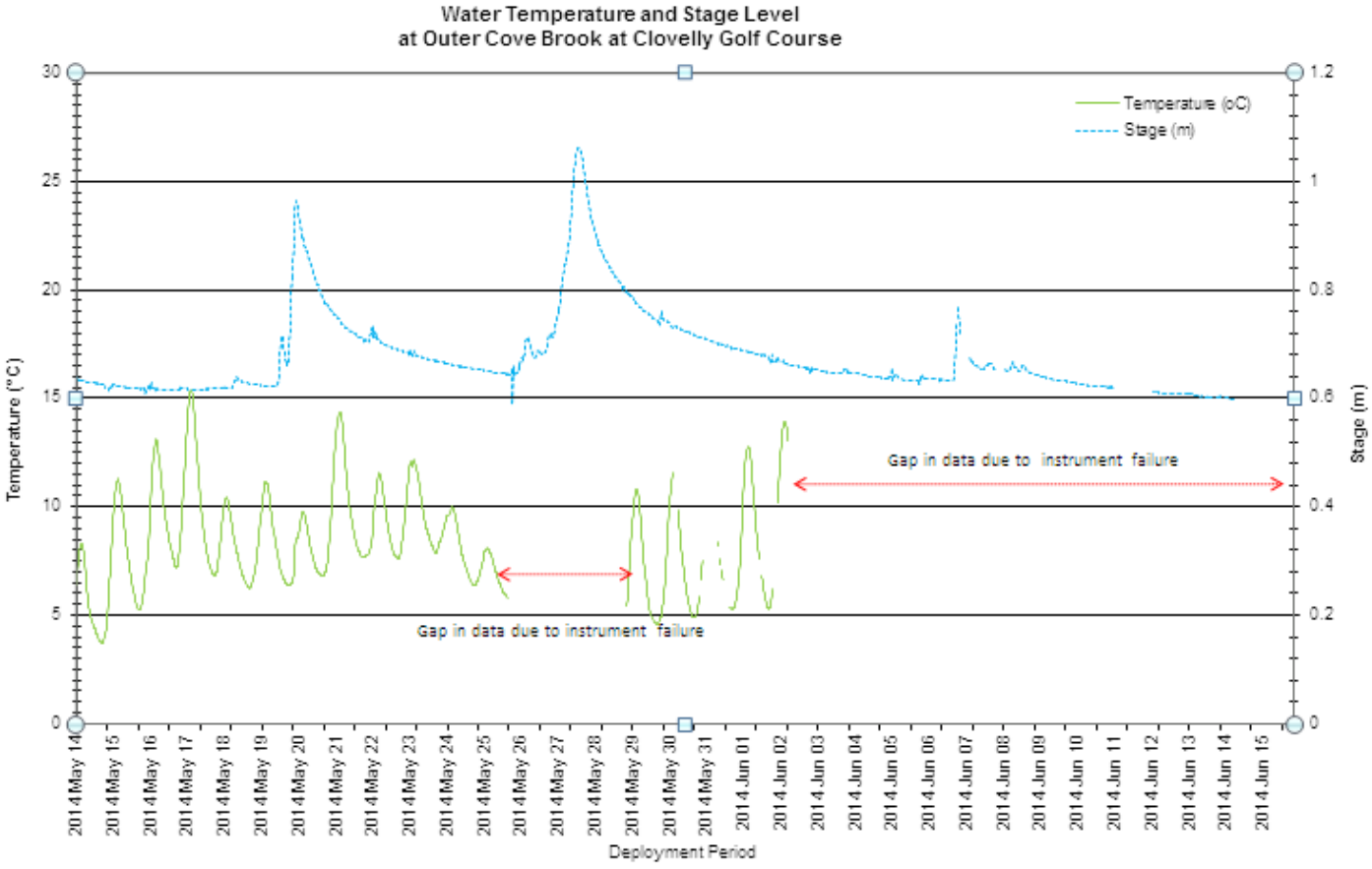

Figure 8: Water temperature (℃) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course.

pH

Throughout this deployment period pH values ranged between 6.05 pH units and 9.10 pH units (Figure 9).

During the deployment, the pH values at this station were generally along the minimum CCME Guideline for the Protection of Aquatic Life (between 6.5 and 9 pH units) for the majority of deployment period. An event with the instrument caused the loss of data from June 2, 2014 toward the end of deployment.

There is a pH event on May 16, 2014 that cannot be explained and corresponds with a turbidity event at the same time (Figure 12). pH levels rose to 9.10 pH units, which is not a common event in a urban brook.

The pH levels dip on May 20th to 21st. This corresponds with a stage increase during the same time period. This is a natural occurrence and can be explained by the natural relationship 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 6.59 units.

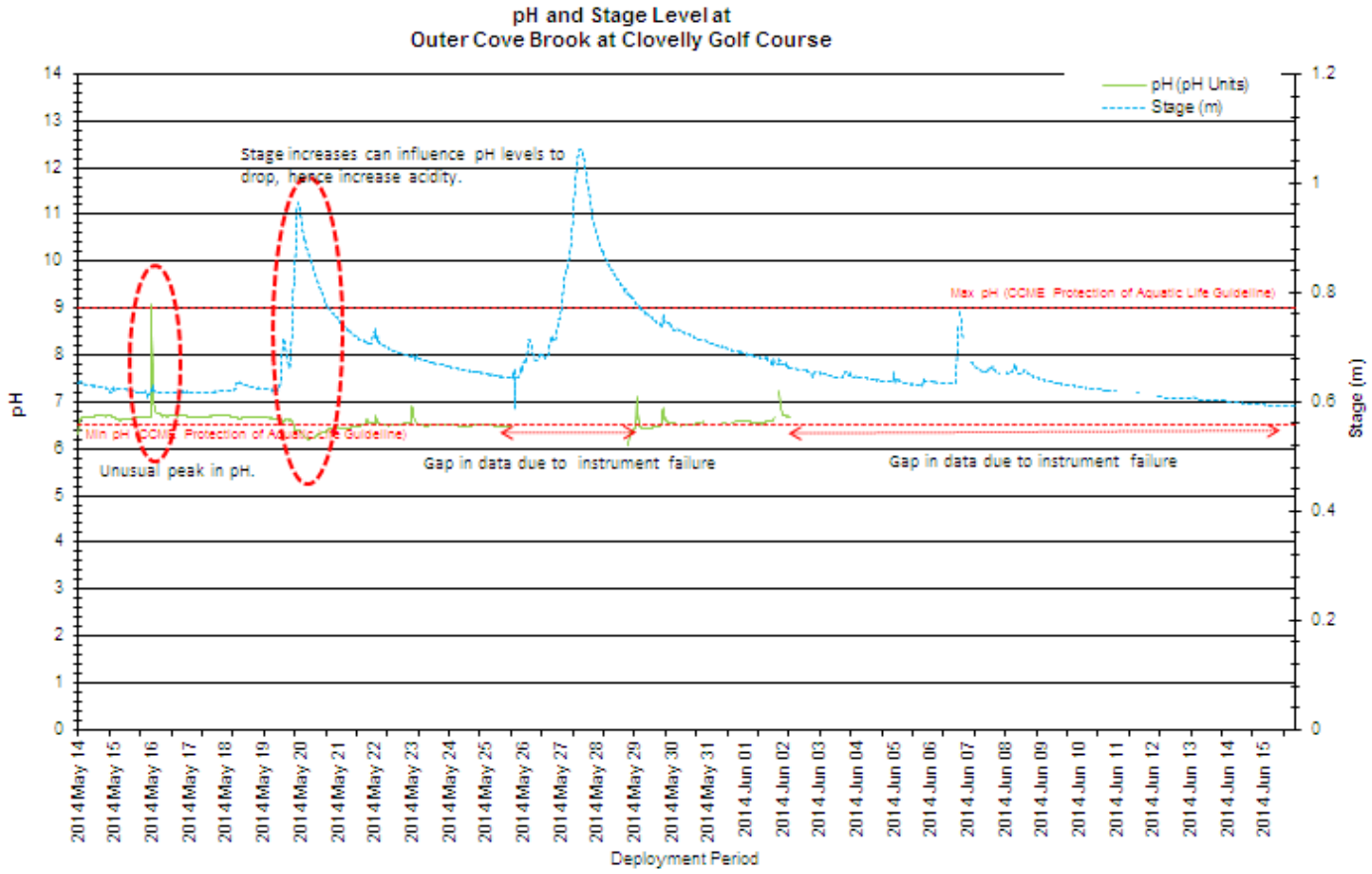

Figure 9: pH (pH units) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course.

Specific Conductivity & TDS

The conductivity levels were within 241.0 µS/cm and 658.0 µS/cm during this deployment period. TDS ranged from 0.1540 g/L to 0.4210 g/L.

The peak in conductivity on May 19th and 20th (see Figure 10), corresponds with a drop in stage level at the same time. The conductivity probe measures the dissolved particles present in a water body, when there is an increase in stage it can indicate that there was rainfall. Rainfall saturates the brook and flushes the dissolved particles from the water column diluting the conductivity levels for a short period of time.

Due to the instrument malfunction there was no additional conductivity events captured.

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.

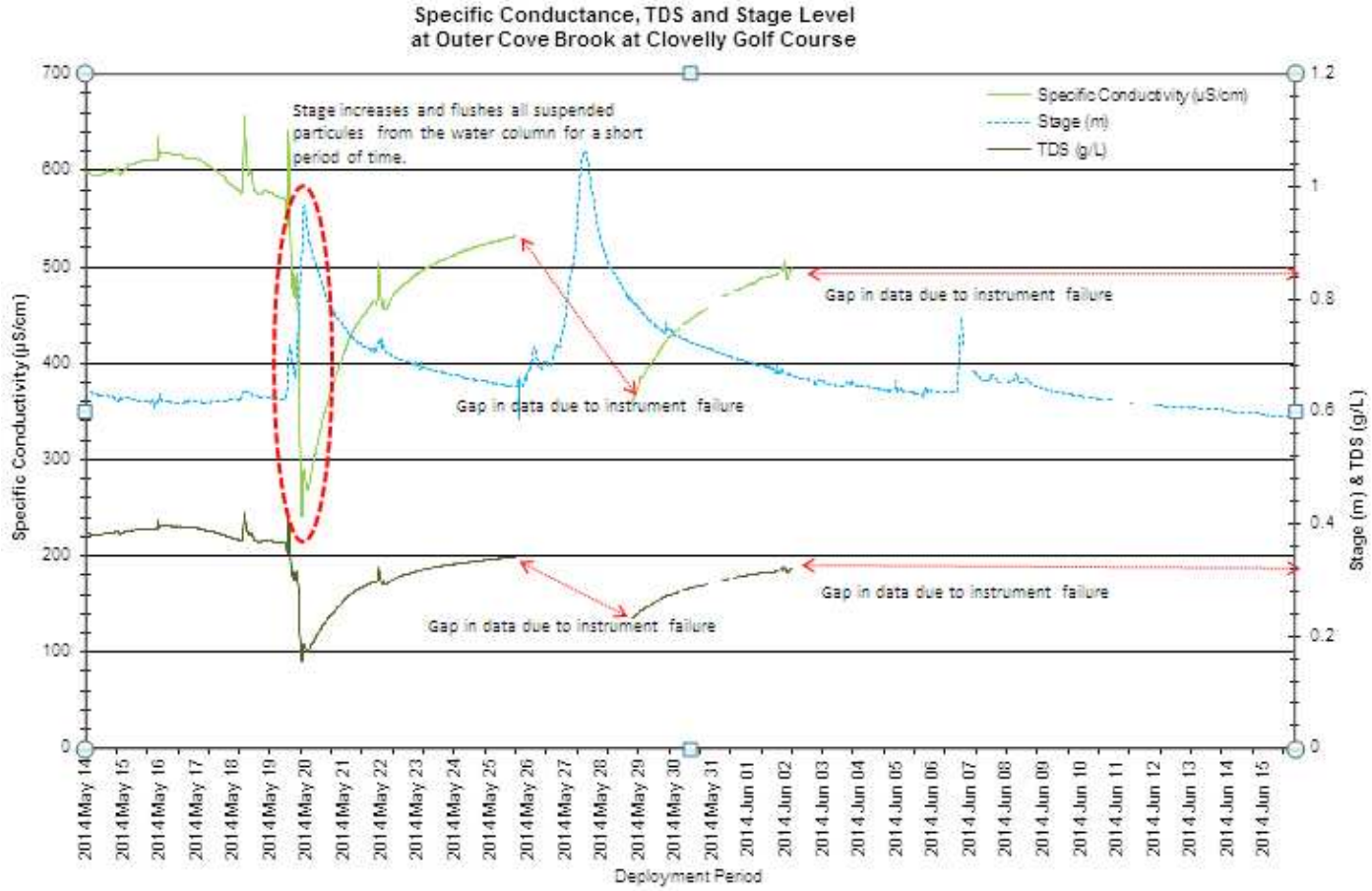

Figure 10: Specific conductivity (uS/cm), TDS (g/L) and stage (m) values at Outer Cove Brook at Clovelly Golf Course.

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 59 %Sat to 85.4 %Sat. Dissolved Oxygen (mg/L) measured 5.91 mg/L to 10.63 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).

It should also be noted that the warmer water temperatures reduce the amount of dissolved oxygen a water body can hold. It can be seen on May 17th and May 21st, as the water temperatures increases (probably at the peak time of the day) the water dissolved oxygen levels dip.

During removal, the instrument was compared against a freshly calibrated QAQC instrument and the DO readings when compared where within the 'Good' ranking.

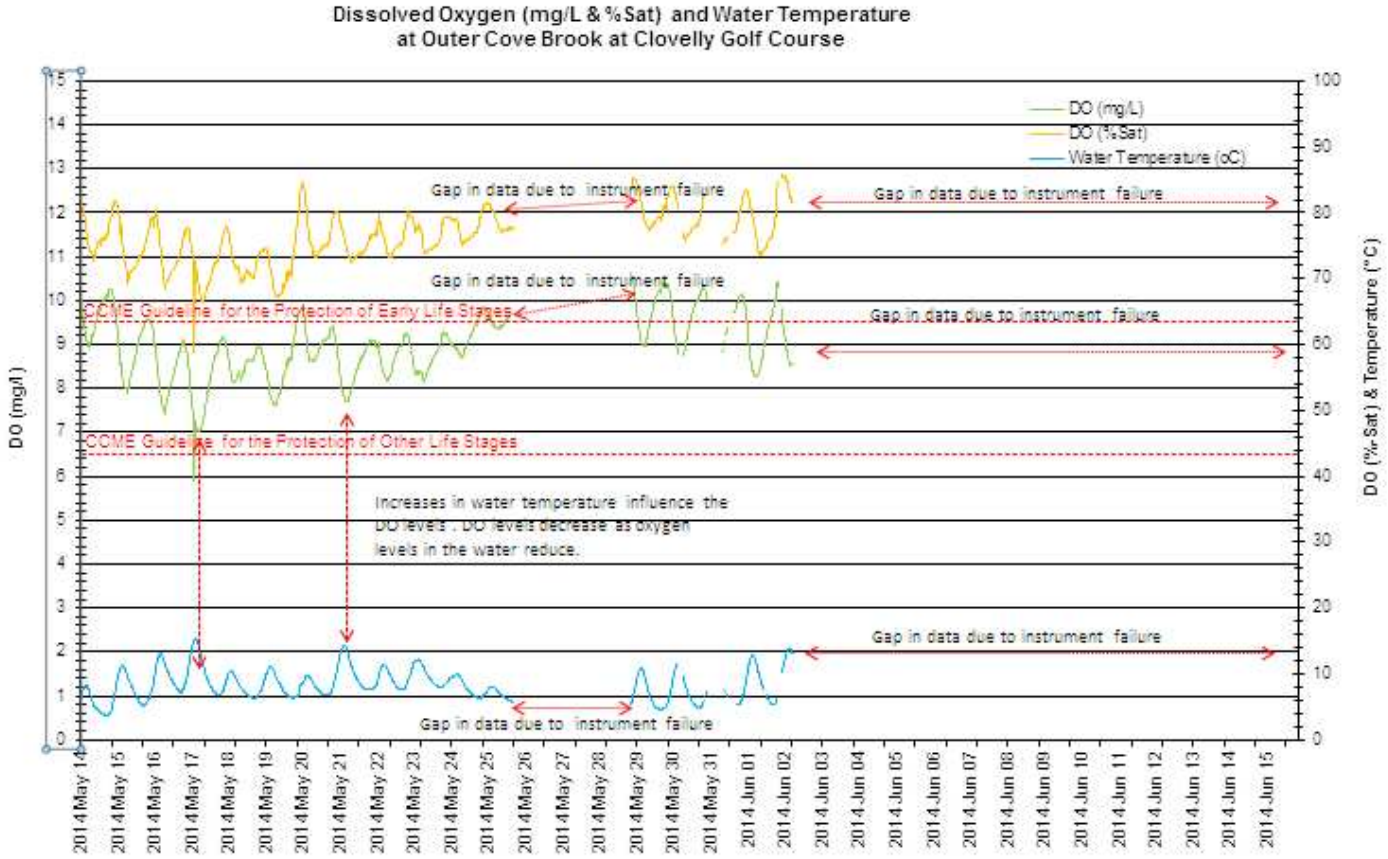

Figure 11: Dissolved oxygen (mg/L & % sat) and water temperature (℃) values at Outer Cove Brook at Clovelly Golf Course.

Turbidity

Turbidity levels during this deployment period ranged within 0.0 NTU and 87.8 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 highest turbidity reading on May 20th corresponds with a large stage increase at the same time. The turbidity event on May 16th corresponds with the high pH reading on Figure 9, something occurred on this date that caused turbidity and pH levels to increase.

During the removal of this instrument it was discovered that about 15 meters upstream a culvert was being rebuilt. The stream water was being diverted and there was activity on-going in the brook. It is possible that the turbidity events on the graph below are a result of the disturbance upstream.

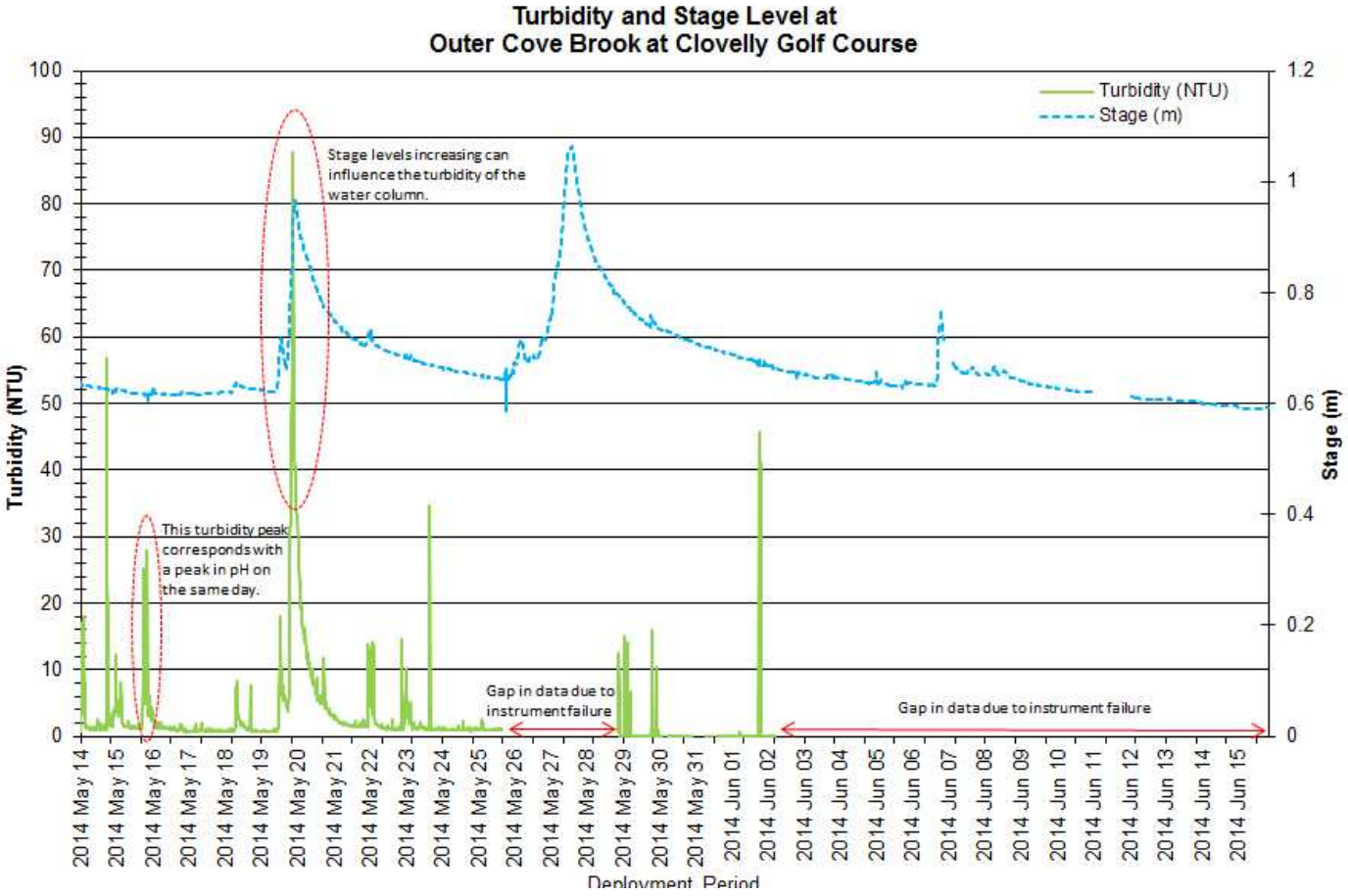

Figure 12: Turbidity (NTU) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course.

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. This is evident on May 20th, May 27th and again on June 7th, as both parameters have spikes in the data.

Stage levels during this deployment ranged within a minimum of 0.59m and a maximum of 1.06m.

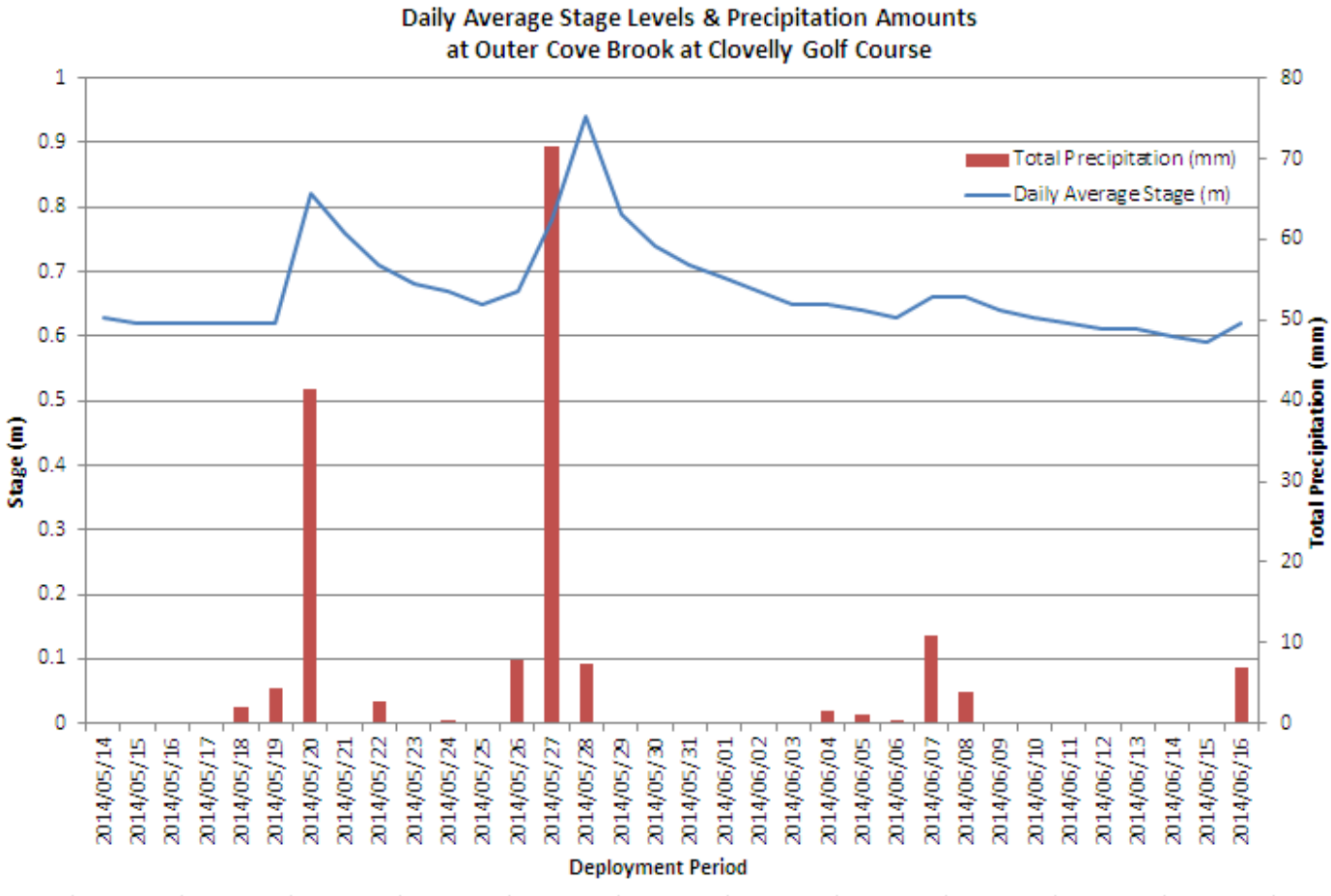

Figure 13: Daily average stage values (m) at Outer Cove Brook at Clovelly Golf Course and daily total precipitation values (mm) from Environment Canada's St. John's Airport Station.

Conclusion

- Unfortunately with this stations short deployment period it was very hard to determine any real events or relationships between the water quality parameters and any surrounding influences.
- There is visual evidence that the large spikes in stage level where a result of several rainfall events as displayed on Figure 13. Rainfall events such as those displayed on Figure 13 can influence changes in water temperatures, conductivity, dissolved oxygen and turbidity in the water column.
- This brook 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 in the areas of turbidity increases or conductivity increases when runoff from residential areas is a factor.
- As ambient air temperatures increase with the seasonal changes it should reflect in the water temperature. Water temperature directly affects the amount of dissolved oxygen present in the brook
- Dissolved Oxygen present in the water at this site is lower than expected. It is possible that the large amount of algae in the stream and the warmer water temperatures, are influencing the lower levels of dissolved oxygen.