Real-Time Water Quality Deployment Report

Outer Cove Brook Stations

May 9 to June 13, 2012

Newfoundland Labrador

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

Contents

General

- Department of Environment and Conservation staff monitors the real-time web pages regularly.
- 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.
- On May 9, 2012, 2 real-time water quality monitoring instruments were redeployed for the second time in Outer Cove Brook located within the City of St. John's (see Figure 1). The instruments are scheduled to be deployed for 30 to 40 days.
- 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 deployment period between May 9, 2012 until removal on June 13, 2012

Figure 1. Outer Cove Brook Stations within the City of St. John's

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: 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 comparison ranking for **Outer Cove Brook below Airport** for the period of May 9 through to June 13, 2012 is summarized in Table 2.

Table 2: Comparison rankings Outer Cove Brook below Airport May 9 – June 13, 2012

Station	**Date**	**Action**	**Comparison Ranking**				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
Below Airport	May 9 2012	Deployment	Excellent	Good	Fair	Excellent	Excellent
	June 13 2012	Removal	Excellent	Excellent	Excellent	Good	Excellent

Outer Cove Brook, Newfoundland and Labrador

- At the Outer Cove Brook below Airport station, temperature, dissolved oxygen and turbidity ranked 'excellent' at deployment while pH ranked 'good' and conductivity ranked 'fair'. For the first deployment of freshly calibrated instruments this is a very good overall ranking.

- At removal, temperature, pH, dissolved oxygen and turbidity continued to rank 'excellent', while dissolved oxygen ranked 'good'. After ~35 days deployment the sonde continued to provide data that when compared with the classification table (Table 1) indicated accurate and reliable data.
- Deployment and removal comparison ranking for **Outer Cove Brook at Clovelly Golf Course** for the period of May 9 through to June 13, 2012 is summarized in Table 3.

Table 3: Comparison rankings Outer Cove Brook at Clovelly Golf Course May 9 – June 13, 2012

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Clovelly Golf Course	May 9 2012	Deployment	Excellent	Excellent	Marginal	Unable to Rank	Excellent
	June 13 2012	Removal	Excellent	Good	Excellent	Excellent	Excellent

- At the Outer Cove Brook Clovelly Golf Course station, temperature, pH and turbidity ranked within 'excellent' at deployment, while specific conductivity ranked 'marginal'. Dissolved oxygen was unable to be ranked at this time due to the probe malfunctioning. On May 18, 2012 this instrument was switched with an instrument with a functioning DO sensor hence the ability for DO readings for the reminder of the deployment period.

- At removal, temperature, pH, specific conductivity, dissolved oxygen and turbidity values all ranked within 'excellent' and 'good'. Therefore there can be confidence that the data provided during this deployment period is accurate and correct.

- This 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 large 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.

- During this deployment period there was intermittent missing data. This can be contributed to communication problems between the datalogger and the satellite, or drop outs in connection to the satellite due to transmission problems. These issues are something that improves with station age, and ongoing adjustments to the electronics by Water Survey of Canada.

Data Interpretation

- The following graphs and discussion illustrate water quality-related events from May 9 to June 13 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.

Outer Cove Brook below Airport

Water Temperature

- Water temperature ranged from 6.20 °C to 16.90°C during this deployment period (Figure 2). The average temperature during this deployment period was 9.78 °C.
- There is a natural diurnal pattern to the water temperature data when graphed, this is the response to the air temperature around the water as day turns to night and night turns to day. Day temperatures are generally higher and night temperatures are generally lower. This pattern is visible on Figure 2.
- This deployment period provides a more constant water temperature display. As the air temperatures increase so does the water temperatures coming into the warmer summer months.
- Water Temperature is an important parameter as it influences other parameters.
- There is evidence of rainfall or runoff influence on water temperature in several events throughout this deployment period. Rainfall and/or runoff has the ability to decrease water temperature for a short period of time. This is evident on May 13 -14, 2012, May 19 – 20, 2012, May 24 – 25, 2012 and June 6 -7, 2012.

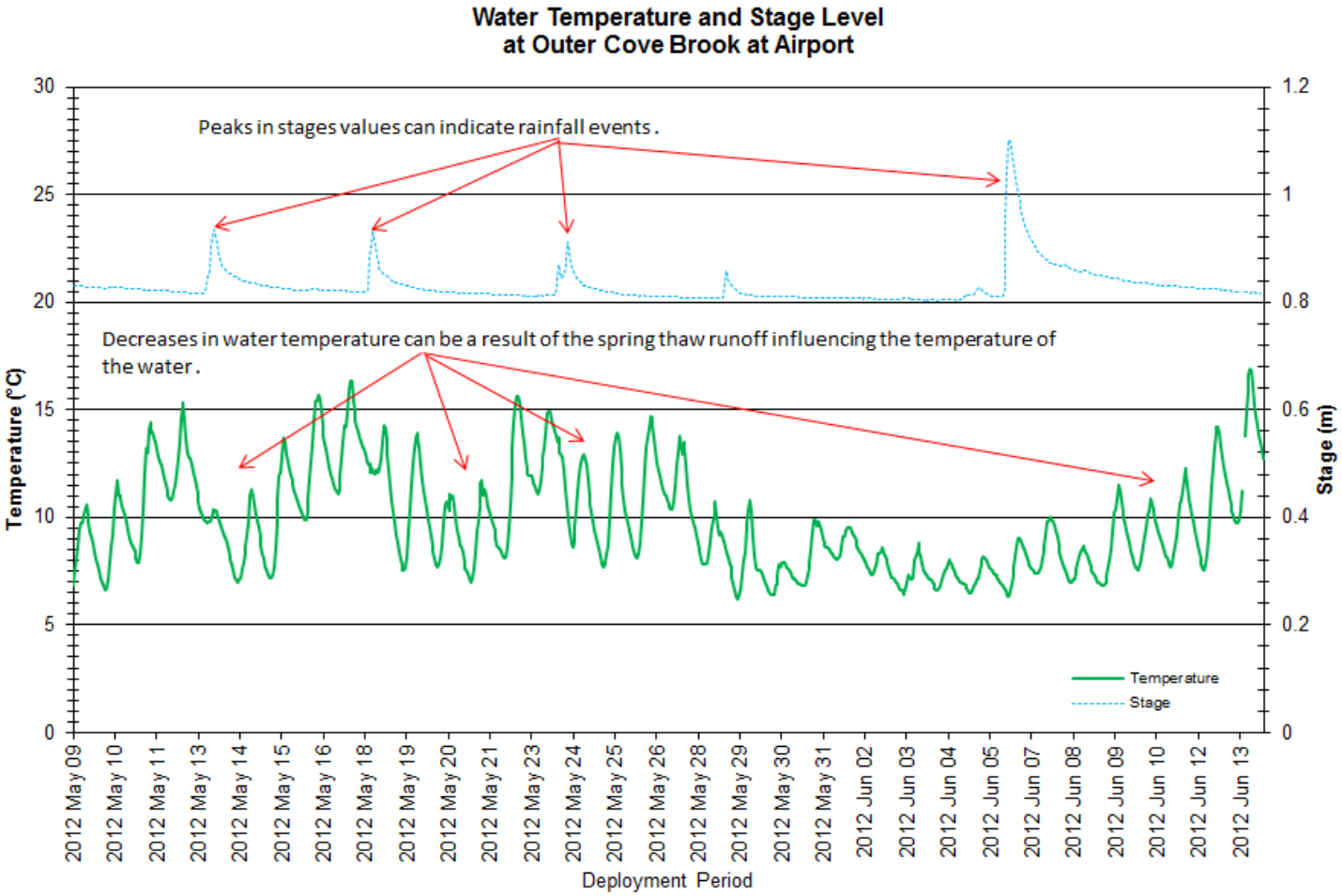

Figure 2: Water temperature and Stage Level at Outer Cove Brook below Airport

pH

- pH ranges between 5.83 and 6.88 pH units throughout this deployment period (Figure 3). The average pH reading during this time was 6.71
- 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 a rainfall event on June 5. After June 5 the pH values drop slightly along with the increased flow in the brook, however the pH values start to increase at the end of the deployment period.
- 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's it is within the normal range for stream water in St. John's.
- Stage levels indicate increases in stream level during the deployment period; it is unclear whether it is due to rainfall or runoff from the surrounding banks. Sometimes rainfall and/or runoff can influence the pH values to a lower pH level, hence slightly increasing the acidity of the stream for a short time.

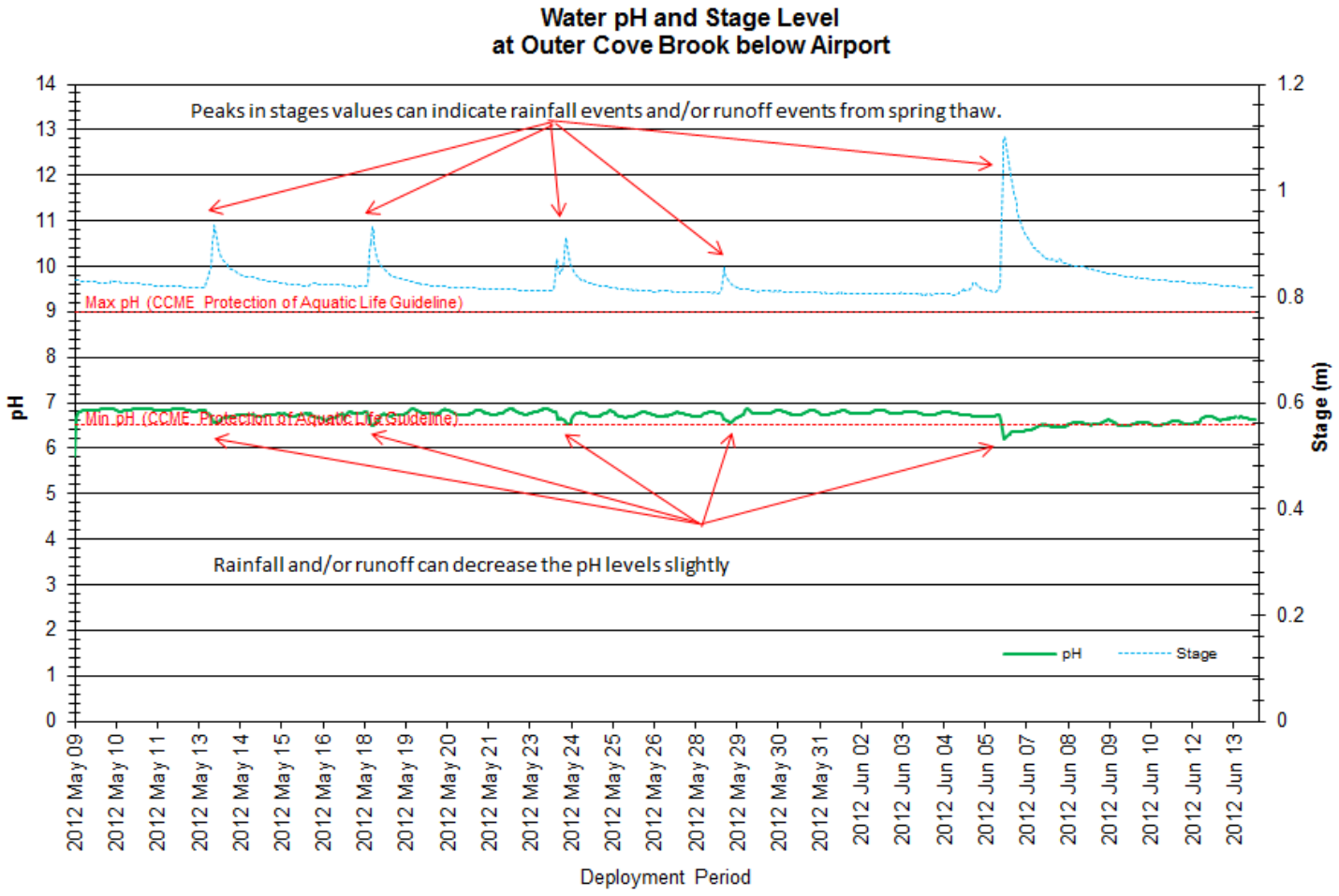

Figure 3: pH & stage level at Outer Cove Brook below Airport

Specific Conductivity & TDS

- The conductivity levels range between 133.6µS/cm and 540.0µS/cm during this deployment period. The average conductivity level was ~ 457.9µS/cm.
- The graph below (Figure 4) indicates several dips in the conductivity level during the deployment period. When compared to the stage values it is evident that the dips occur during higher stage levels. Increased stage levels can be related to rainfall events and/or runoff events after spring thaw.
- Rainfall events & spring thaw can have the effect of lowering conductance levels, which is evident on Figure 4 as the stage increases, the conductance decreases.
- Total Dissolved Solids (TDS), is a calculated parameter that the instrument populates. TDS is calculated by an algothrim that utilizes the data from Specific Conductivity and Water Temperature to produce a TDS.

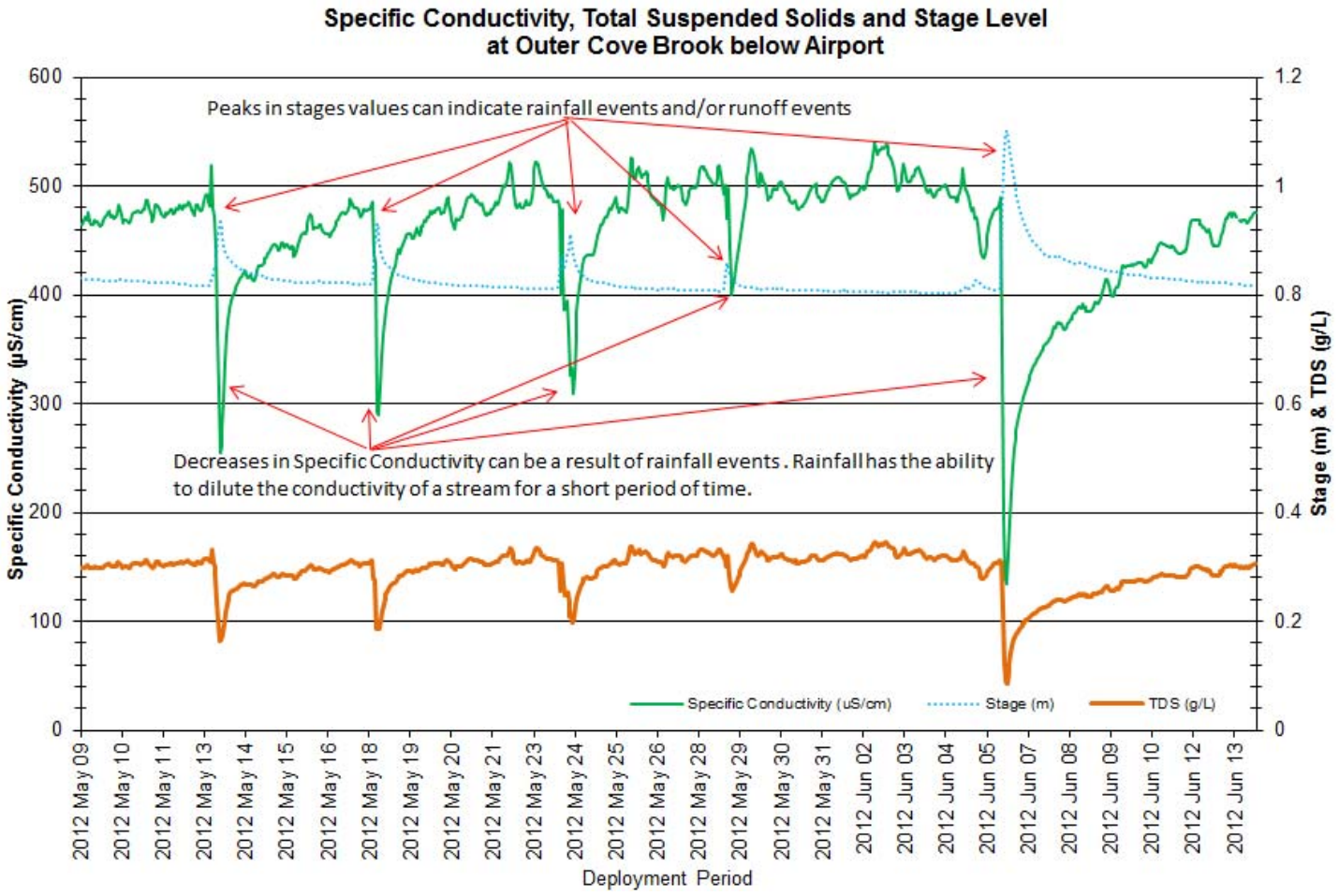

Figure 4: Specific conductivity, TDS and stage levels at Outer Cove Brook below Airport

Dissolved Oxygen

- The instrument calculates two individual dissolved oxygen readings; percent saturation dissolved oxygen and dissolved oxygen in mg/L.
- The Dissolved Oxygen % Sat levels within this deployment period were within 82.8 – 95.9 % Sat, with an average DO (% Sat) of 90.4%Sat. The Dissolved Oxygen mg/L levels 8.73mg/L – 11.29mg/L, with an average DO mg/L level of 10.26mg/L.
- The DO values were above both the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l and maximum guideline for Early Life Stage Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in red on the graph in Figure 5.
- The drops in DO mg/L in May are noted to be directly related to water temperature levels at those times.
- Dissolved Oxygen percent saturation remains constant during the deployment period. Dissolved oxygen mg/L content fluctuates with the water temperature changes. As temperature increases the DO mg/L levels decrease and vice versa.

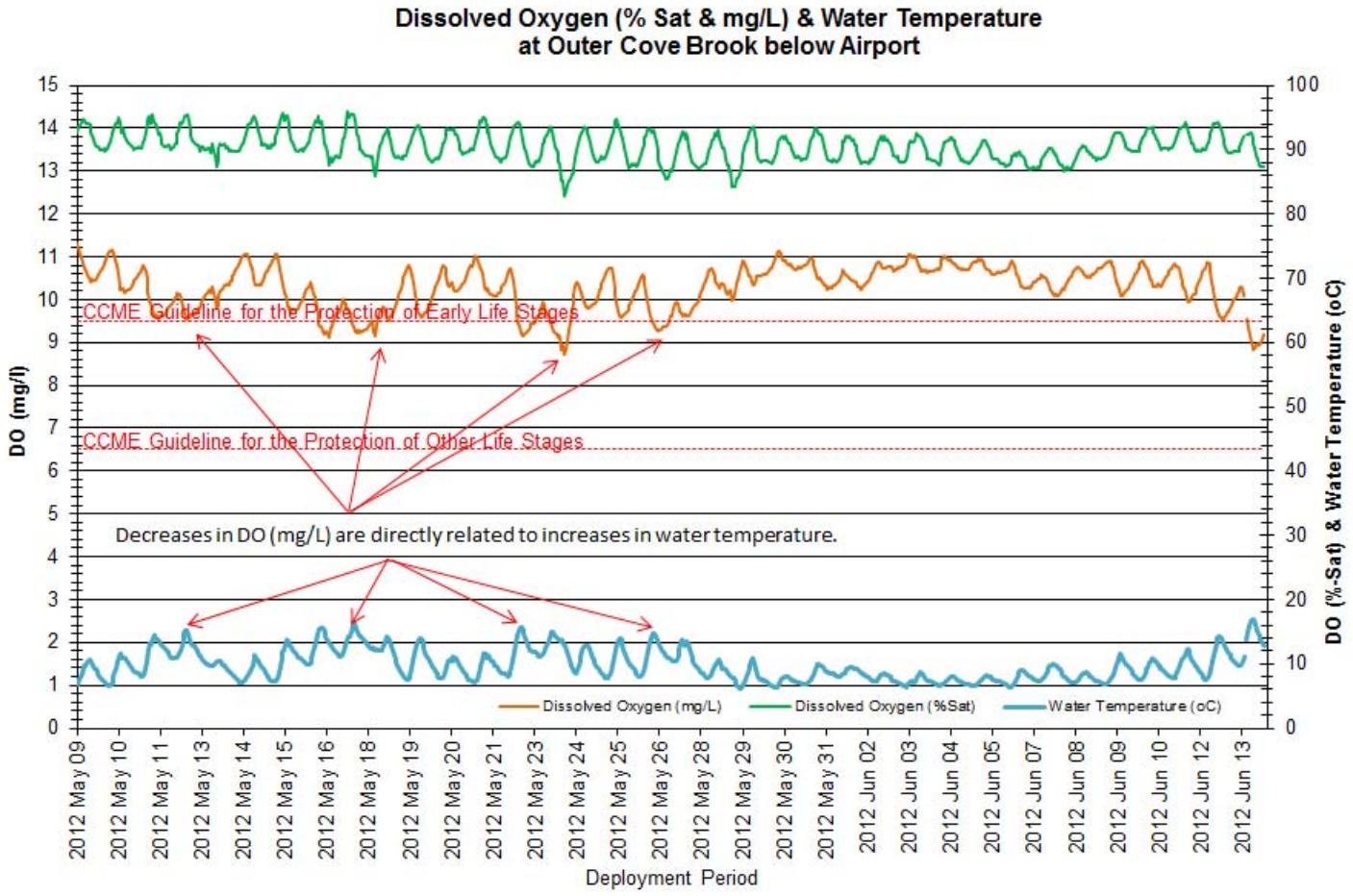

Figure 5: Dissolved Oxygen (mg/L & % sat) and Water Temperature at Outer Cove Brook below Airport

Turbidity

- When selecting a location for deployment of the instrument, it is imperative that there is minimal influence from the surrounding natural environment. For example, one would want to select a site that is away from high algal areas that can block the turbidity sensor and interfere with the turbidity readings.
- This location was the best site along the brook for the station, however there is still a significant amount of algae present in the water body. As the water temperatures increase, the algae buildup also increases, the influence of algae on a turbidity sensor is demonstrated in Figure 6.
- 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, not a valid turbidity reading.
- The turbidity readings during this deployment ranged within 0.0 NTU to 1535.0 NTU, with an average of 26.5NTU (Figure 6).
- The turbidity readings on May 31, 2012 (2966NTU, 2811NTU, 3000NTU) are a result of stream debris blocking the turbidity sensor. These values are inaccurate and should not be used in any statistical analysis.

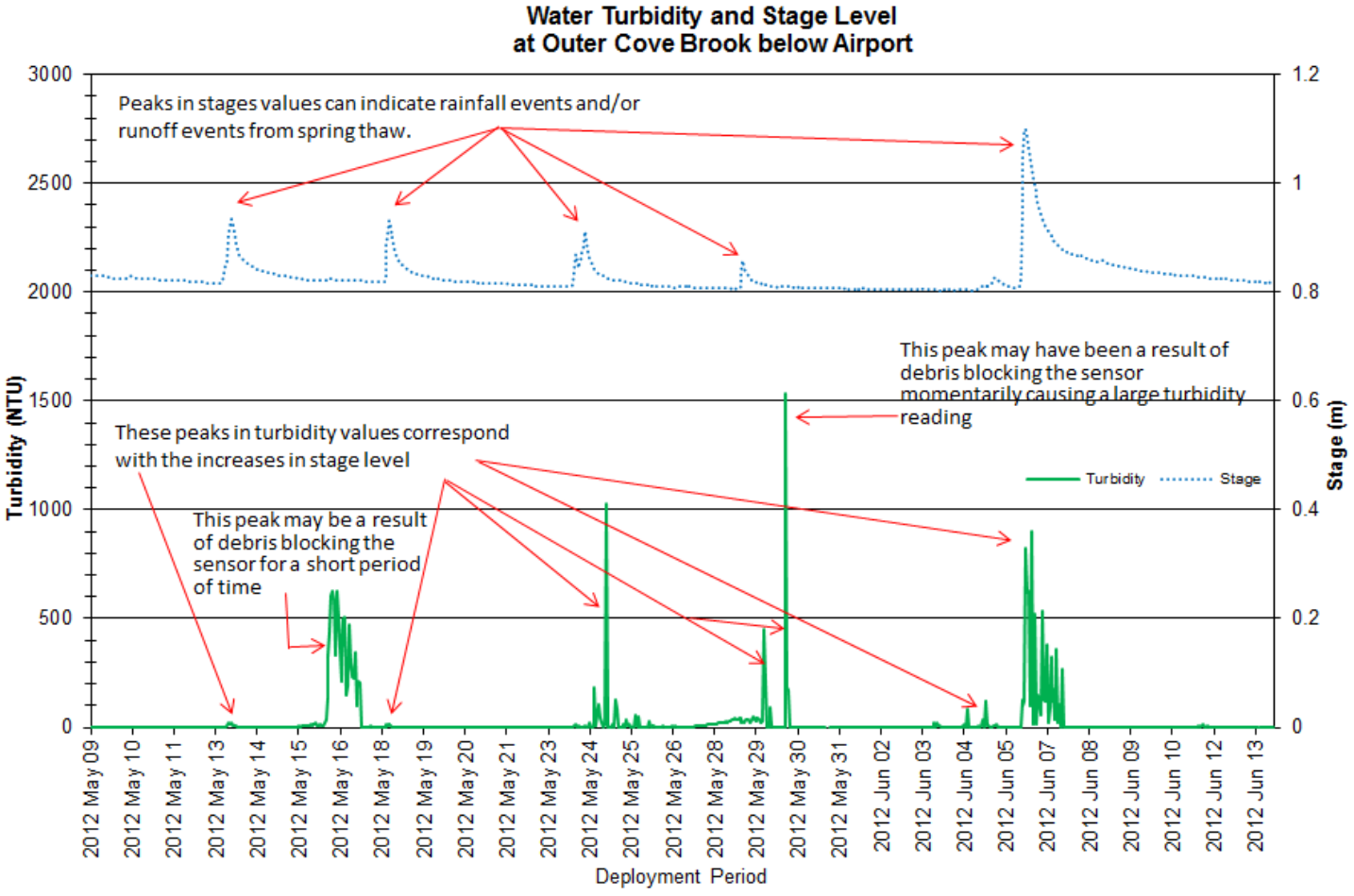

Figure 6: Turbidity and stage level at Outer Cove Brook below Airport

Stage

- Due to the unavailability of St. John's International Airport's weather precipitation data, the below graph includes precipitation data from the Pippy Park Weather Station, based on the outskirts of Pippy's Park. This was the next closest weather station for the Outer Cove Brook stations.
- 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).
- It is not unusual to see Stage vary throughout the deployment period (Figure 7). Stage is directly influenced by rainfall and any runoff from the surrounding environment.
- The peaks in Stage in Figure 7 were most likely a response to the rainfall events that occurred during this deployment period.

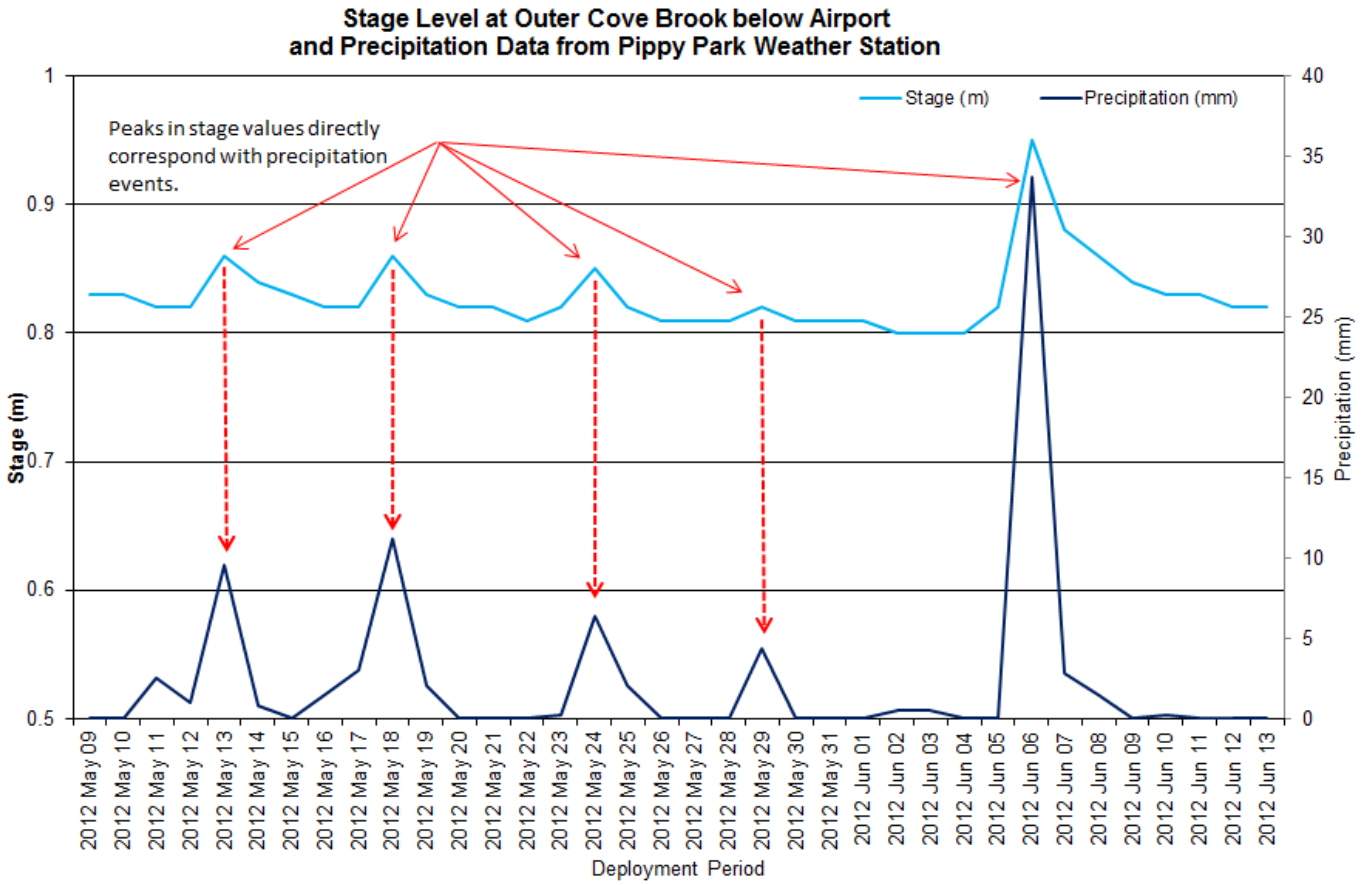

Figure 7: Stage Level at Outer Cove Brook below Airport and Precipitation Data from Pippy Park Weather Station

Conclusions

- Generally in natural environments, climate and weather conditions contribute to a large part to the variation in water quality parameters. During this deployment it can be assumed that many of the changes in data, were related to the intermittent precipitation events.
- Water Temperature continues to gradually increase during the deployment period, which would be expected as the air temperature rises in the summer months. pH remains constant without any significant events, the small dips in pH correspond with the increases in stage levels at the same times. Specific Conductivity displays several drops in the concentration levels which can also be explained by increases in stage (i.e. precipitation). The Dissolved Oxygen values remain at a constant, expected level with DO %Sat and DO mg/L staying above both CCME guidelines. The turbidity graph did display peaks in turbidity levels, however they can be explained by increased stage levels and in turn, interference from stream debris.

Outer Cove Brook at Clovelly Golf Course

Water Temperature

- Water temperature ranged from 6.01 to 17.91°C during this deployment period (Figure 8). The average temperature during this deployment period was 10.02°C.
- There is a natural diurnal pattern to the water temperature data when graphed, this is the response to the air temperature around the water as day turns to night and night turns to day. Day temperatures are generally higher and night temperatures are generally lower. This pattern is visible on Figure 8.
- Water Temperature is an important factor as it influences other parameters; some of the sensors on the instrument are temperature dependent.
- Water temperature during this deployment period is influenced from the increases in stage but overall remains constant. The peaks in stage correspond with the decreases in water temperature; rainfall can lower water temperature for short periods of time.

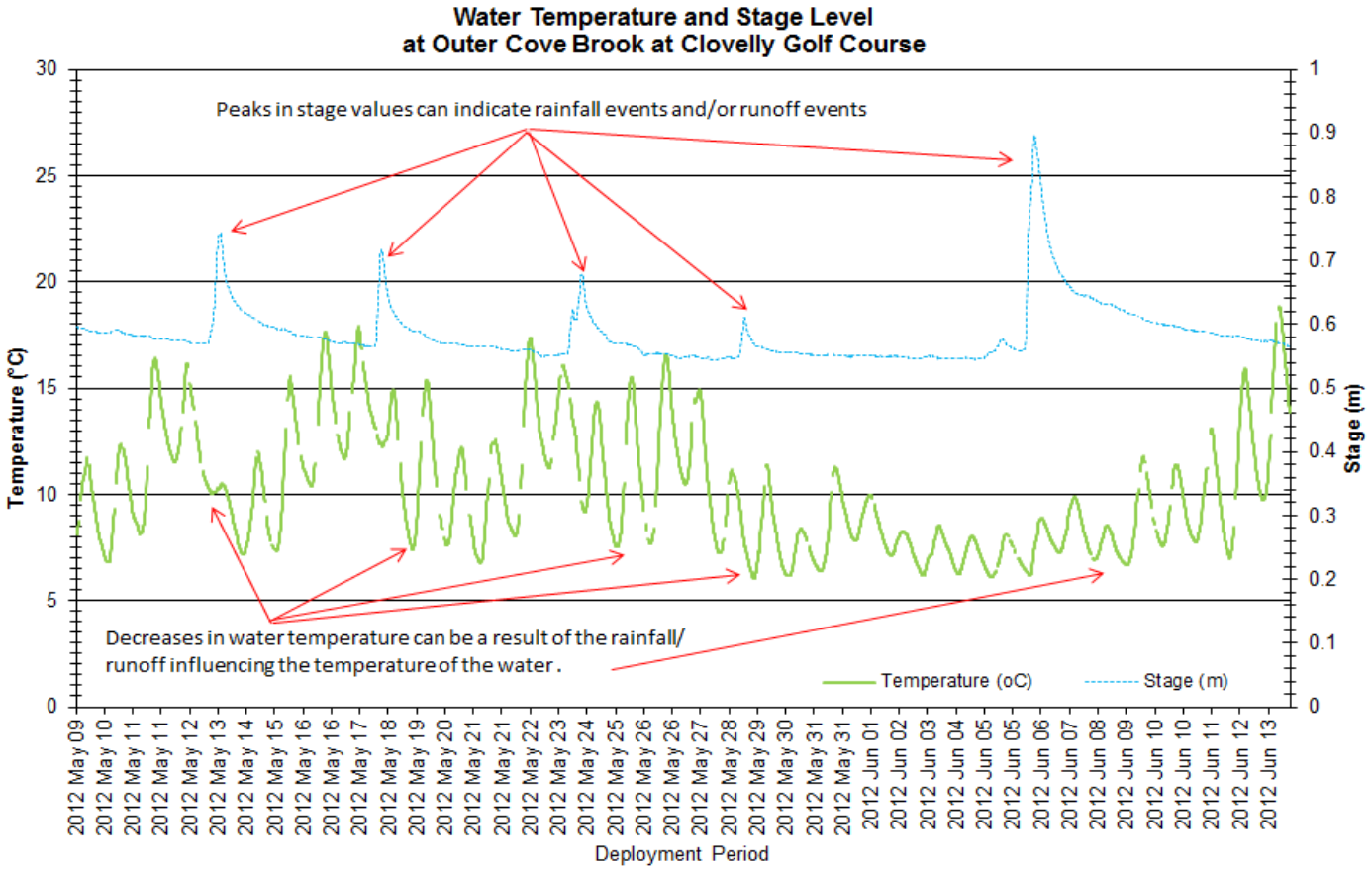

Figure 8: Water temperature and stage level at Outer Cove Brook at Clovelly Golf Course

pH

- pH ranges between 6.19 and 6.96 pH units throughout this deployment period (Figure 9). The average pH reading during this time was 6.58 (pH units).
- During the deployment, the pH values at this station are close to the minimum CCME Guideline for the Protection of Aquatic Life (minimum guideline is 6.5 pH units). 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 the stream is within the normal range for stream water.
- The pH values at this station remain steady and constant during the deployment period.
- Stage levels indicate rises in the level of the brook during the deployment period; stage increases are generally related to rainfall or runoff from the surrounding banks. Sometimes rainfall and/or runoff can impact the pH values to drop to a lower pH, hence slightly increasing the acidity of the stream for a short time.

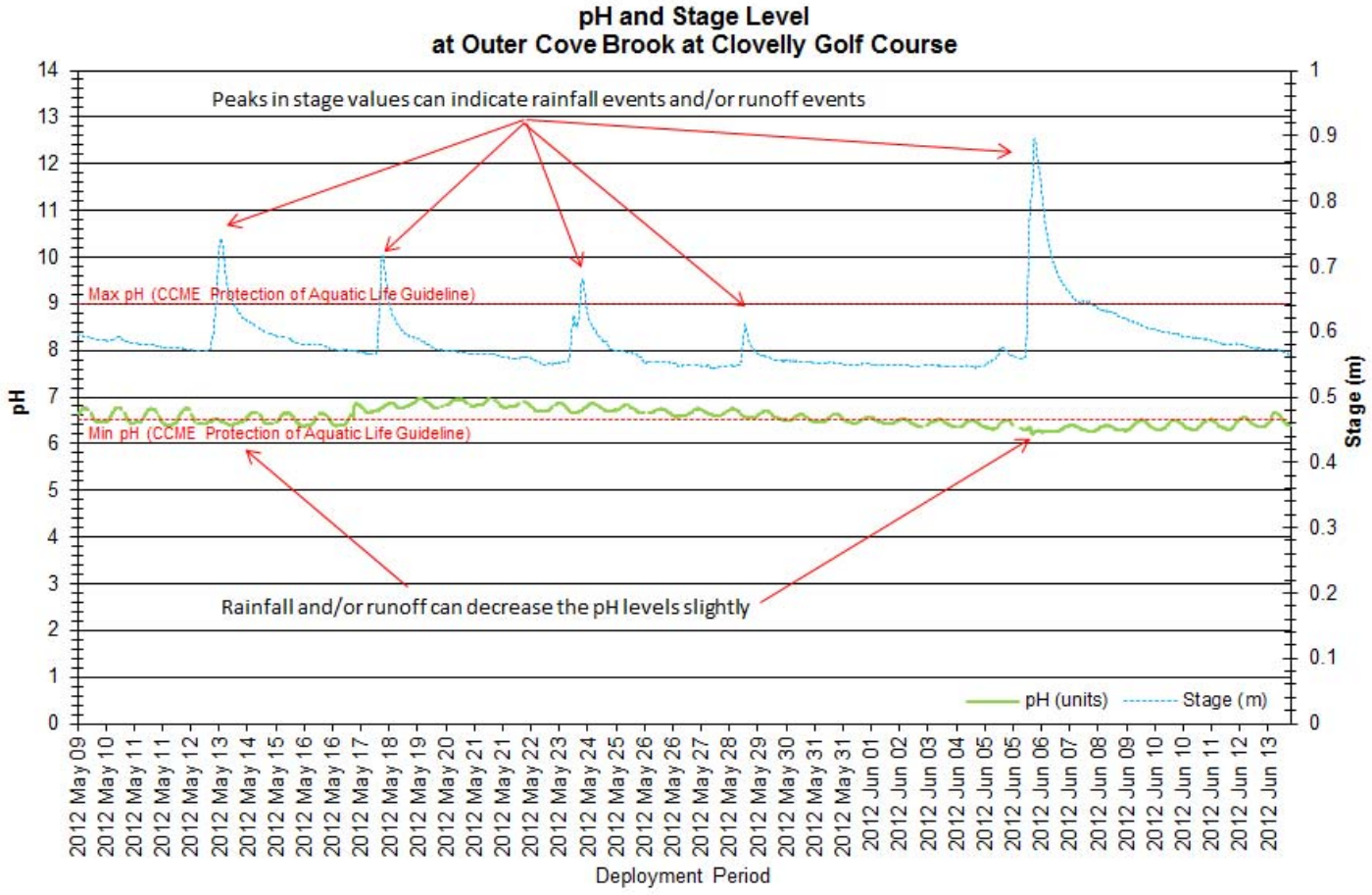

Figure 9: pH and stage level at Outer Cove Brook at Clovelly Golf Course

Specific Conductivity

- The conductivity levels ranged between 172.1µS/cm and 489.0µS/cm during this deployment period. The average conductivity level was ~ 428.6µS/cm.
- The graph below (Figure 10) indicates several dips in the conductivity level during the deployment period. When compared to the stage values it is evident that the dips occur during higher stage levels. Increased stage levels can be related to rainfall events and/or runoff events after spring thaw.
- Rainfall events & spring thaw can have the effect of lowering conductance levels, which is evident on Figure 10 as the stage increases the conductance decreases.
- Total Dissolved Solids (TDS), is a calculated parameter that the instrument populates. TDS is calculated by an algothrim that utilizes the data from Specific Conductivity and Water Temperature to produce a TDS value.

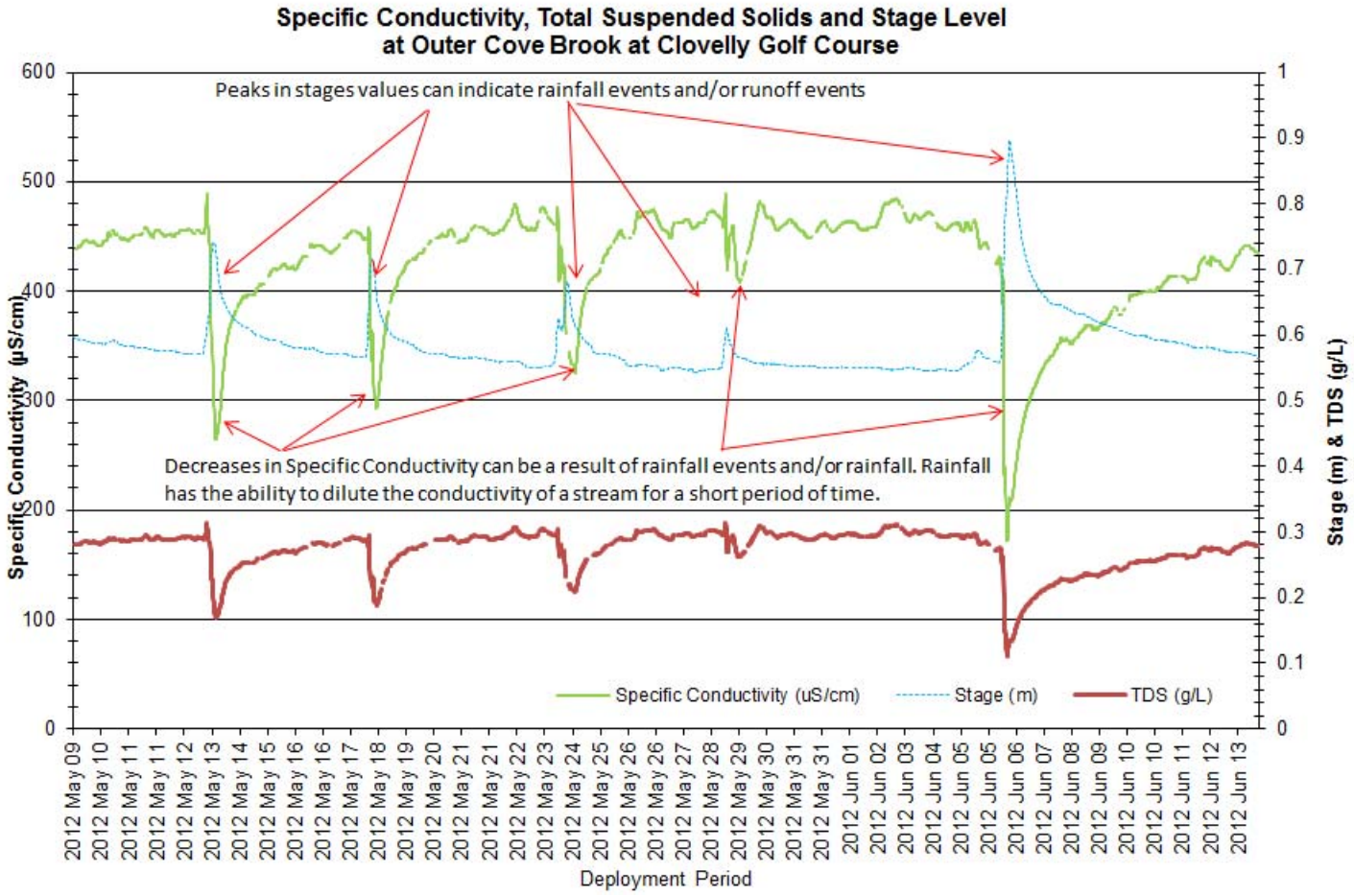

Figure 10: Specific conductivity, TDS and stage levels at Outer Cove Brook at Clovelly Golf Course

Dissolved Oxygen

- During this deployment period the instrument failed to record dissolved oxygen readings until May 17, 2012. At which point the instrument was changed out with another that had a functioning DO sensor.
- The instrument calculates two individual dissolved oxygen readings; percent saturation dissolved oxygen and dissolved oxygen in mg/L.
- The Dissolved Oxygen % Sat levels within this deployment period were within 70.3 – 108.5% Sat, with an average DO (% Sat) of 88.3%Sat. The Dissolved Oxygen mg/L levels 7.32mg/L – 11.97mg/L, with an average DO mg/L level of 9.68mg/L.
- The DO values are above the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l. With DO (mg/L) just on the maximum guideline for Early Life Stage Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in red on the graph in Figure 11.
- The lower DO mg/L around May 17-28, 2012 is noted to be directly related to water temperature levels at those times. Dissolved Oxygen percent saturation remains constant during the deployment period. Dissolved oxygen mg/L content fluctuates with the water temperature changes. As temperature increases the DO mg/L levels decrease and vice versa.

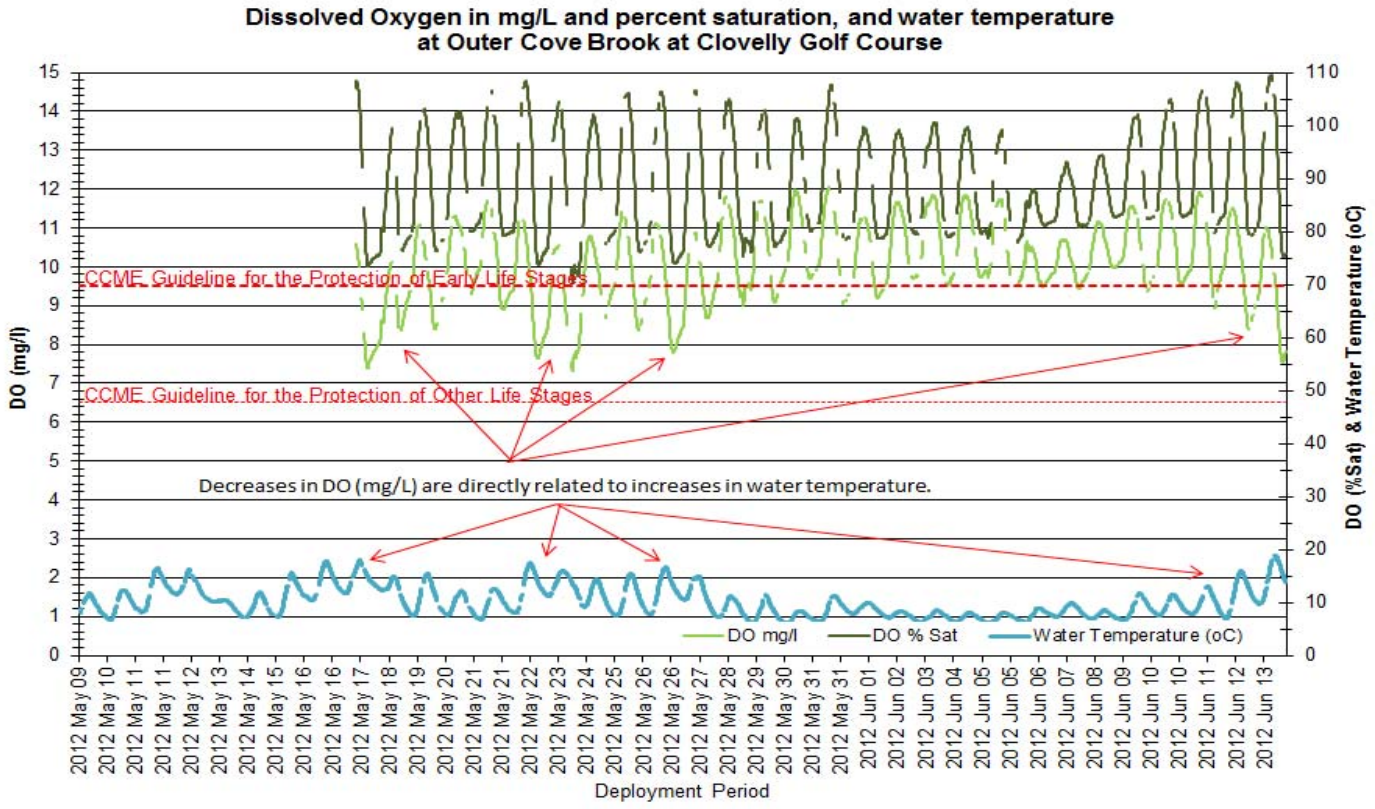

Figure 11: Dissolved Oxygen (mg/L & % sat) and Water Temperature at Outer Cove Brook at Clovelly Golf Course

Turbidity

- When selecting a location for deployment of the instrument, it is imperative that there is minimal influence from the surrounding natural environment. For example, one would want to select a site that is away from high algal growth that can block the turbidity sensor and interfere with the accuracy of the turbidity readings.
- This location was the best site for water level; unfortunately the brook streambed is completely covered by algae. As the water temperatures increase and water levels drop, there may be more evidence of algae interference at this station.
- 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 0.0 NTU to 1088.0 NTU, with a turbidity average of 41.4 NTU (Figure 12).
- The turbidity increase on May 31, 2012 until June 6, 2012 appears to be a result of debris blocking the turbidity sensor. However, it appears that after the rainfall event on June 6, 2012 the debris was washed clear of the probe allowing the readings to stabilize.
- The other high turbidity readings during this deployment period can be linked to the higher stage levels after rainfall. As organic matter and natural minerals are washed into the brook, the suspended matter in the water column will increase.

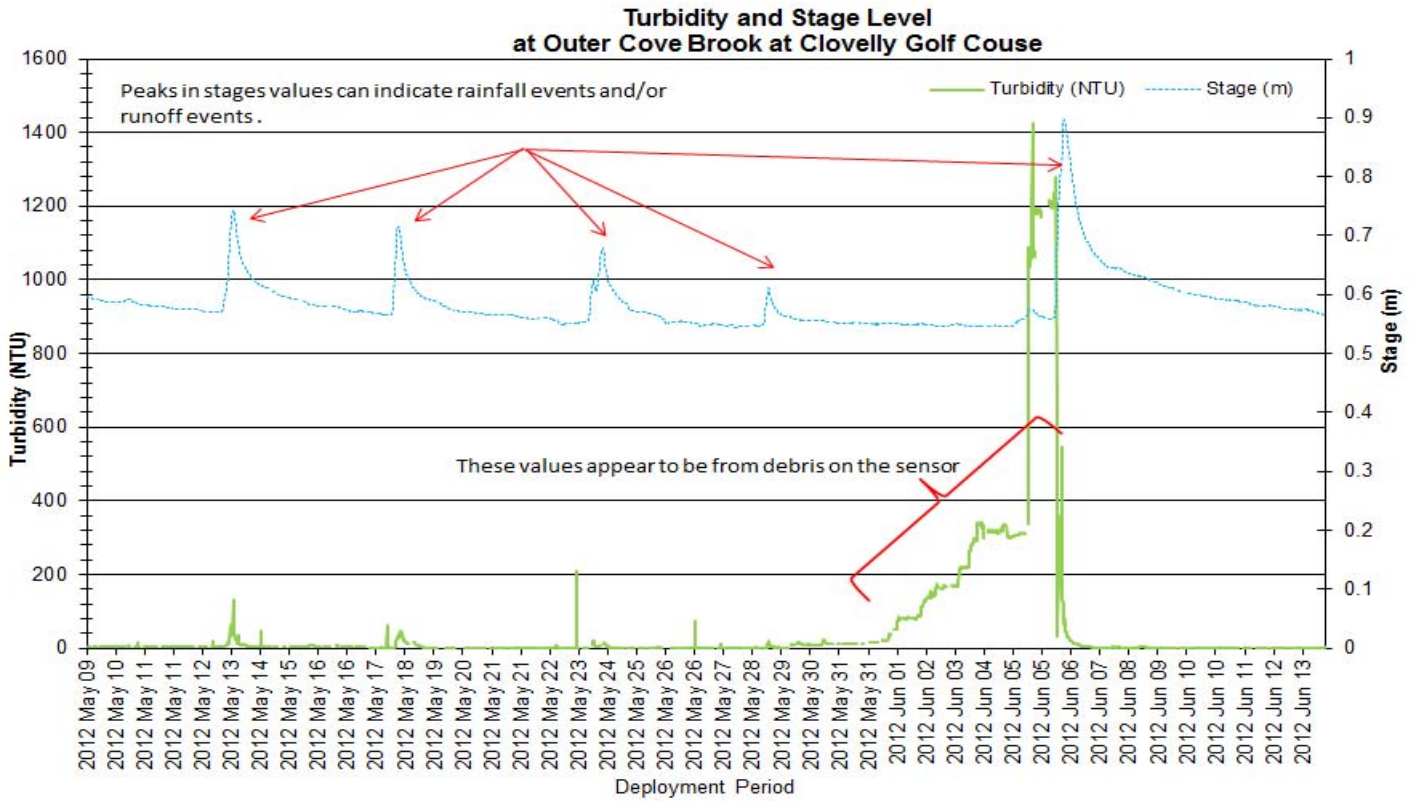

Figure 12: Turbidity and stage level at Outer Cove Brook at Clovelly Golf Course

Stage

- Due to the unavailability of St. John's International Airport's weather precipitation data, the below graph includes precipitation data from the Pippy Park Weather Station, based on the outskirts of Pippy Park. This was the next closest weather station for the Outer Cove Brook station.
- 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).
- It is not unusual to see Stage vary throughout the deployment period. Stage is directly influenced by rainfall and any runoff from the surrounding areas.
- The peaks in Stage in Figure 13 directly correspond with the rainfall events that occurred during this deployment period.

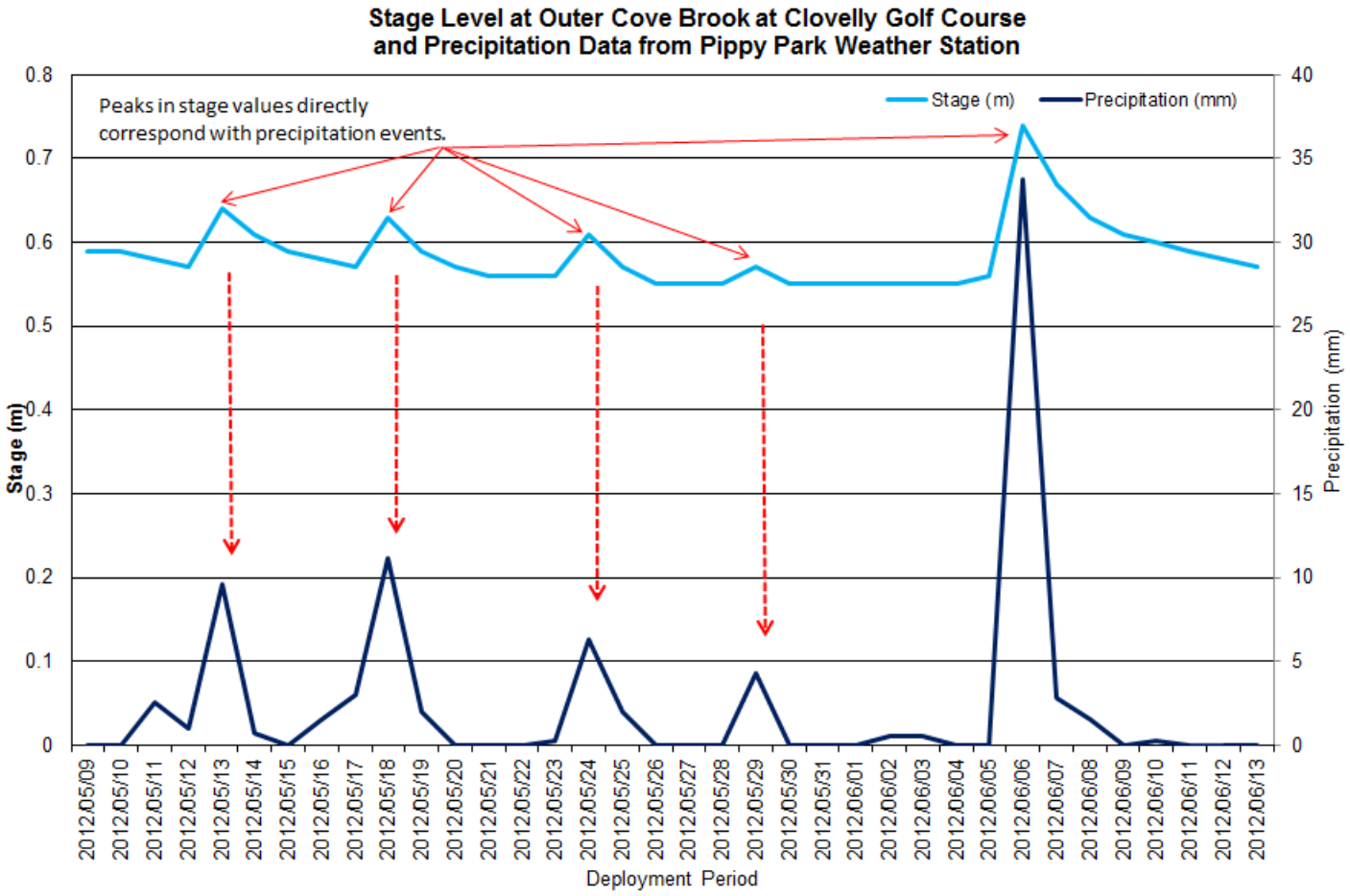

Figure 13: Stage Level at Outer Cove at Clovelly Golf Course and Precipitation Data from Pippy Park Weather Station

Conclusions

- Generally in natural environments, climate and weather conditions contribute in a large part to the variation in water quality parameters. During this deployment it can be assumed that many of the events that occurred were related to the intermittent precipitation events.
- Water Temperature continues to increase during the deployment period, which would be expected during this time as air temperature increases. pH remains constant without any significant events. Specific Conductivity displays several drops in the concentration of the readings which are linked to the increase in stage (i.e. due to precipitation). Dissolved Oxygen provides a constant reading throughout, the small decreases in DO mg/L can be linked to the increases in water temperature at those times. Increases in stage level can also 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.
- During this deployment period the average water temperature at the upstream station (Outer Cove Brook below Airport) of 9.78°C was very similar to that of the downstream station (Outer Cove Brook at Clovelly Golf Course) of 10.02°C. Water temperature for both of the brooks increased over the course of the deployment period as air temperatures increased. The average pH value for both brooks was also close with Outer Cove Brook below Airport's average at 6.71 and Outer Cove Brook at Clovelly Golf Course reading 6.58, there was no significant change in pH from the upstream to the downstream station. The Specific Conductivity average at Outer Cove Brook below Airport was 457.9µS/cm with the Outer Cove Brook at Clovelly Golf Course had an average of 428.6µS/cm. Both conductivity averages are close and indicate no significant difference in specific conductivity as the water moves downstream. Dissolved Oxygen at the upstream station (Outer Cove Brook below Airport) was averaged at 90.4 %Sat during the deployment period, the downstream station (Outer Cove Brook at Clovelly Golf Course) had a lower average of 88.3 %Sat. Both stations have close DO averages and there is no significant difference between them, however the downstream station does have considerably more aquatic growth in the stream which can utilize the DO present in the water. Turbidity averages between the downstream and upstream station are slightly different. The upstream station (Outer Cove Brook below Airport) has a turbidity average of 26.5 NTU with the downstream station (Outer Cove Brook at Clovelly Golf Course) holding an average of 41.4 NTU. There is not a significant different between the averages, however the turbidity does increase slightly as the water moves downstream. Turbidity is influenced greatly by rainfall and runoff events.

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