Real-Time Water Quality Deployment Report

Outer Cove Brook Stations

June 13 to July 16, 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 June 13, 2012, 2 real-time water quality monitoring instruments were redeployed for the third 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 June 13, 2012 until removal on July 16, 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 June 13 through to July 16, 2012 is summarized in Table 2.

Table 2: Comparison rankings Outer Cove Brook below Airport June 13 – July 16, 2012

Station	**Date**	**Action**	**Comparison Ranking**				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
Below Airport	June 13 2012	Deployment	Good	Excellent	Excellent	Good	Good
	July 16 2012	Removal	Excellent	Good	Good	Excellent	Good

Outer Cove Brook, Newfoundland and Labrador

- At the Outer Cove Brook below Airport station, temperature, pH, specific conductivity, dissolved oxygen and turbidity ranked 'excellent' to 'good' at deployment.

- At removal, temperature and dissolved oxygen continued to rank 'excellent', while pH, specific conductivity and turbidity ranked 'good'. After a ~34 day 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 June 13 through to July 16, 2012 is summarized in Table 3.

Table 3: Comparison rankings Outer Cove Brook at Clovelly Golf Course June 13 – July 16, 2012

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Clovelly Golf Course	June 13 2012	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	July 16 2012	Removal	Excellent	Excellent	Excellent	Excellent	Good

- At the Outer Cove Brook Clovelly Golf Course station, all parameters ranked 'excellent' at deployment on the instrument.

- At removal, temperature, pH, specific conductivity and dissolved oxygen all ranked within 'excellent'. The turbidity values ranked 'good', likely a result of bio-fouling from natural aquatic growth during deployment. We can be confident 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 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.

- 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 June 13 to July 16, 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.

Outer Cove Brook below Airport

Water Temperature

- Water temperature ranged from 7.10 °C to 21.10°C during this deployment period (Figure 2). The average temperature during this deployment period was 14.02 °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 2.
- This time of year has generally warmer air temperatures; therefore the water temperatures are warmer than the previous deployment period and remain more constant. This is evident when comparing last deployments water temperature average of 9.78°C to the current deployment period average of 14.02°C.
- Water Temperature is a very important parameter and it influences other parameters that are monitored with the water quality instruments.
- There is evidence of rainfall on the water temperature on June 27, 2012 and again on July 6 through to 8, 2012. Rainfall can reduce the temperature of the brook slightly for a couple of hours or days depending on the amount.

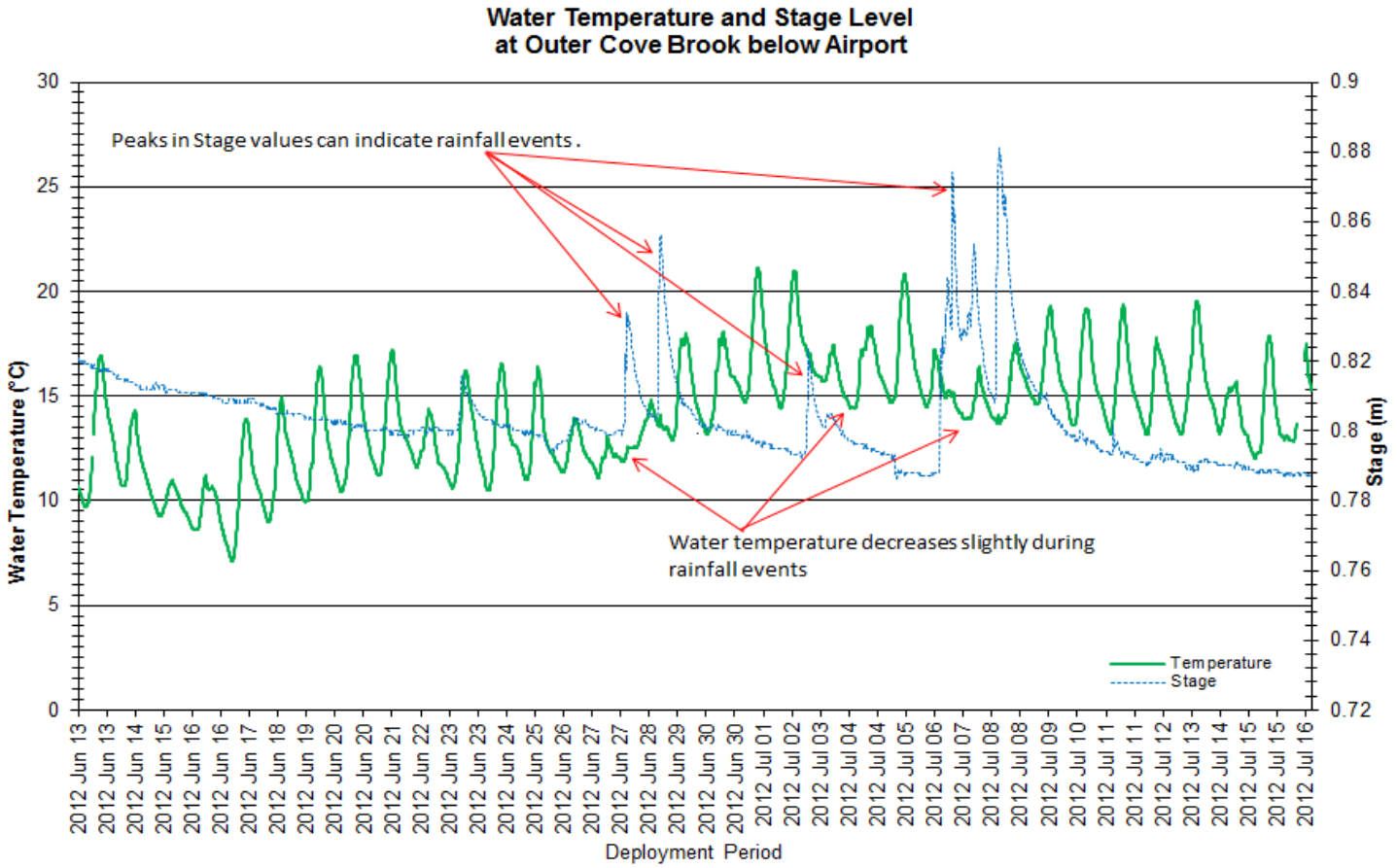

Figure 2: Water temperature and Stage Level at Outer Cove Brook below Airport

pH

- pH ranges between 6.25 and 6.96 pH units throughout this deployment period (Figure 3). The average pH reading during this time was 6.65.
- 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 July 6, 2012.
- 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.

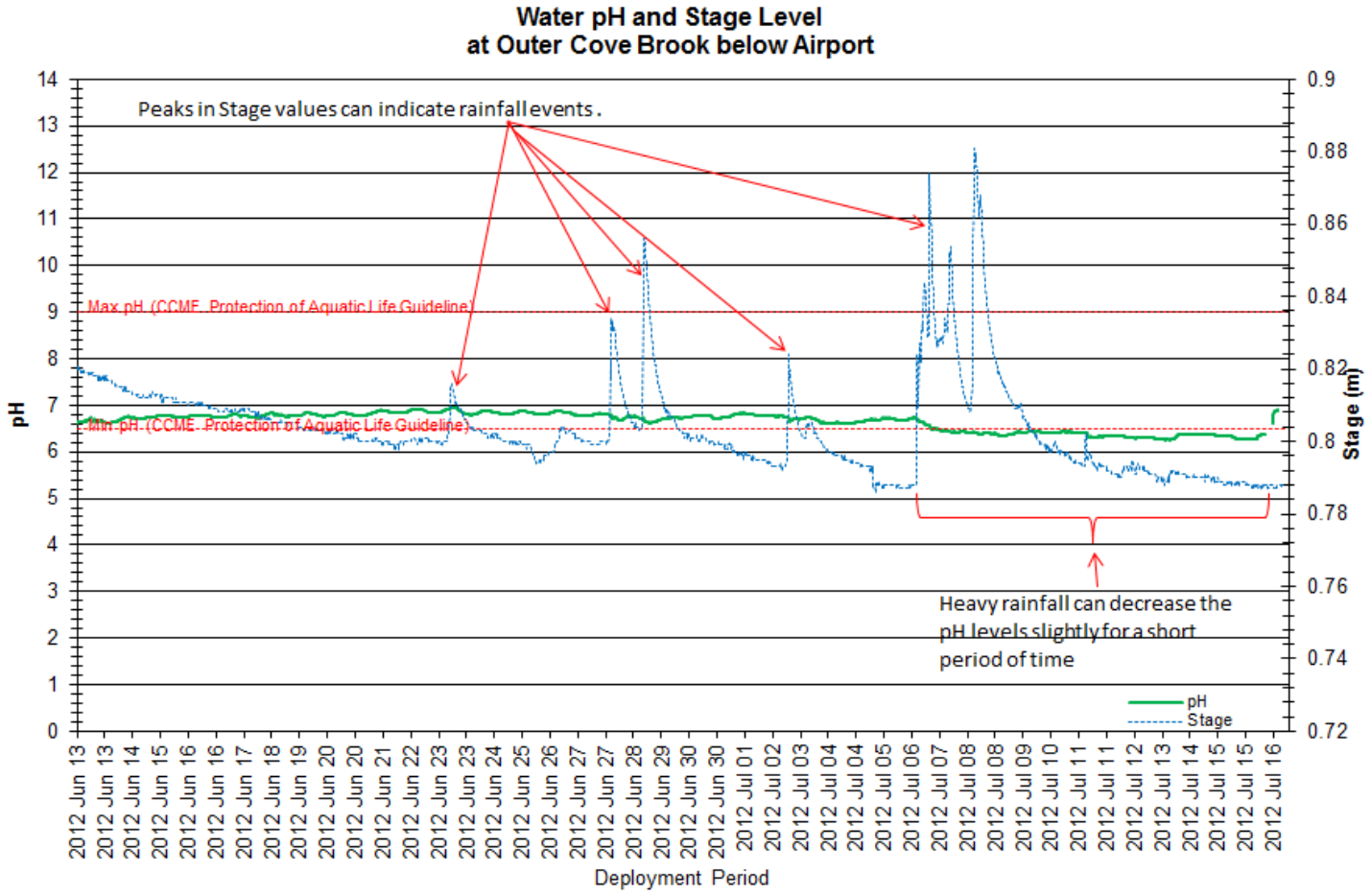

Figure 3: pH & stage level at Outer Cove Brook below Airport

Specific Conductivity & TDS

- The conductivity levels were within 297.0µS/cm and 635.0µS/cm during this deployment period. The average conductivity level was ~ 479.1µS/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 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.

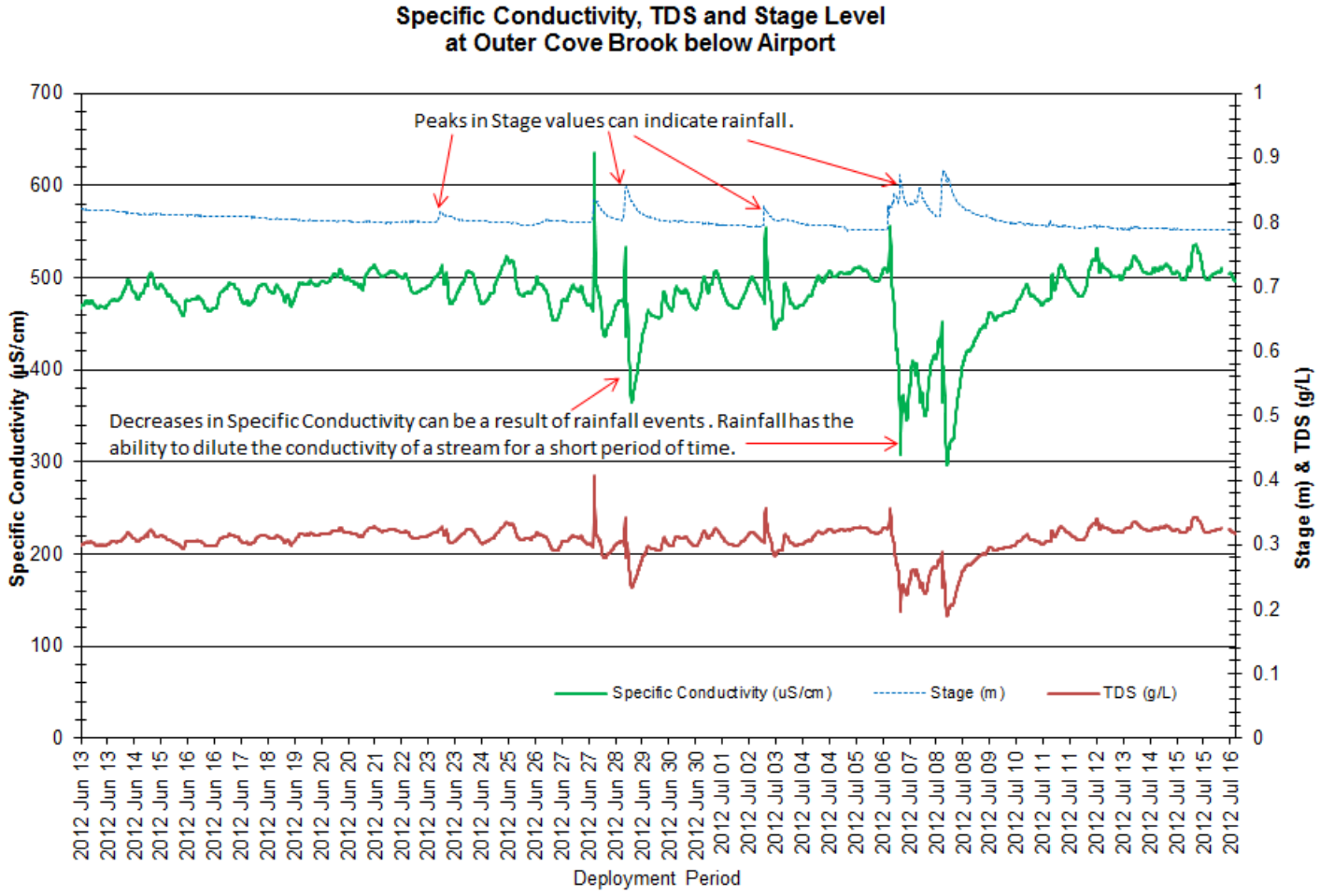

Figure 4: Specific conductivity, TDS and stage levels at Outer Cove Brook below Airport

Dissolved Oxygen

- The instrument calculates two individual dissolved oxygen readings; percent saturation dissolved oxygen and dissolved oxygen in mg/L. Dissolved Oxygen in mg/L is calculated by taking into consideration the dissolved oxygen % sat and the temperature of the water body.
- The Dissolved Oxygen % Sat levels within this deployment period were within 83.3 – 95.0% Sat, with an average DO (% Sat) of 88.8%Sat. The Dissolved Oxygen mg/L levels 8.02mg/L – 10.723mg/L, with an average DO mg/L level of 9.15mg/L.
- The DO mg/L values can be compared with the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l and minimum 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). However this is just a guide and it is normal to see fluctuation in dissolved oxygen levels.
- The drop in DO mg/L in late June corresponds with the slightly higher water temperatures at that time.
- 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 vs. versa.

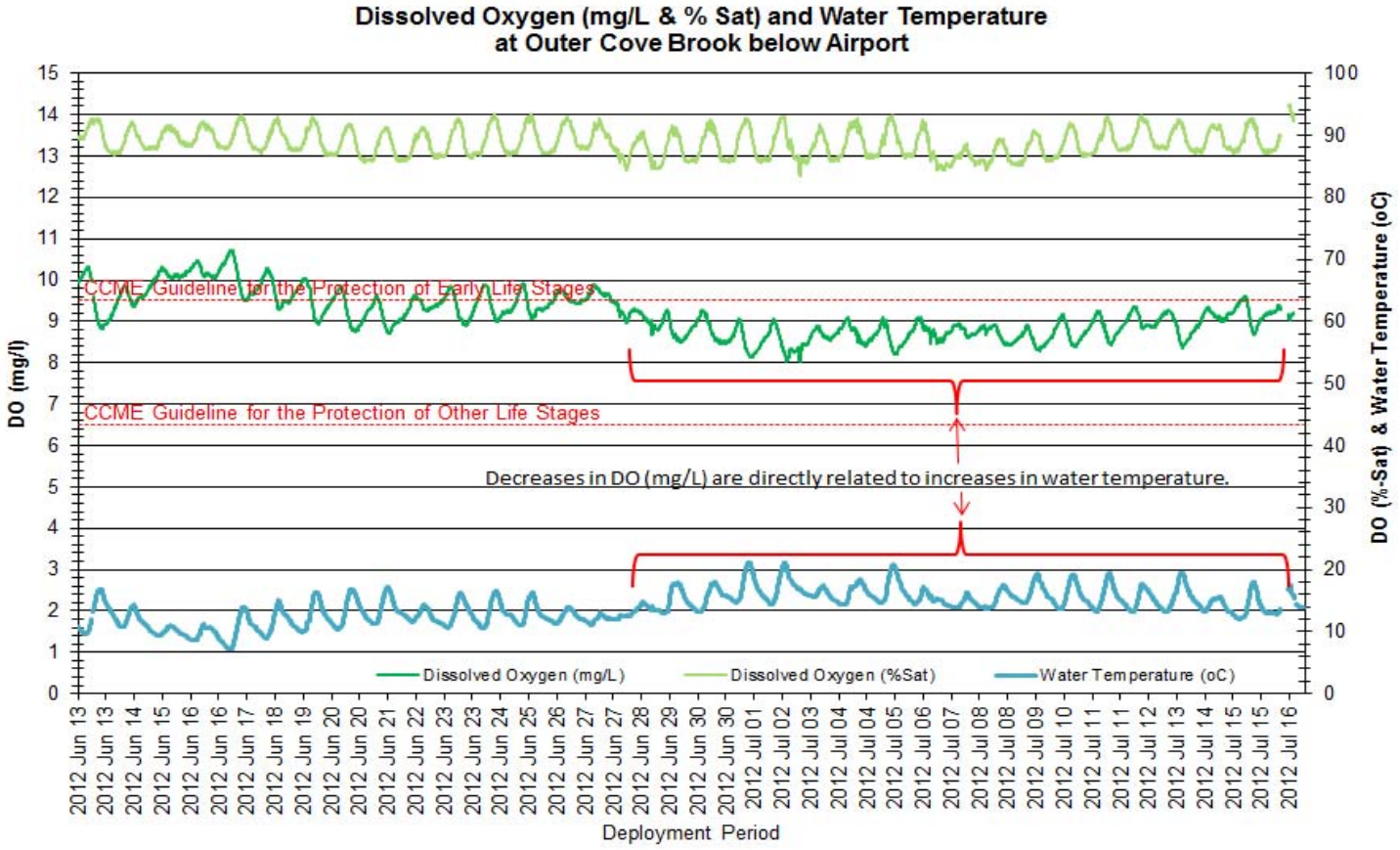

Figure 5: Dissolved Oxygen (mg/L & % sat) and Water Temperature at Outer Cove Brook below Airport

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 prevents the turbidity readings from dropping and the readings resemble a block of peaks on the graph (as indicated in fig 6 around July 5-6, 2012).
- 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 a median value of 26.5NTU (Figure 6).
- The turbidity readings from June 30, 2012 to July 7, 2012 and July 11 to July 12, 2012 are a result of stream debris blocking the turbidity sensor. These values are inaccurate and should not be used in any statistical analysis.

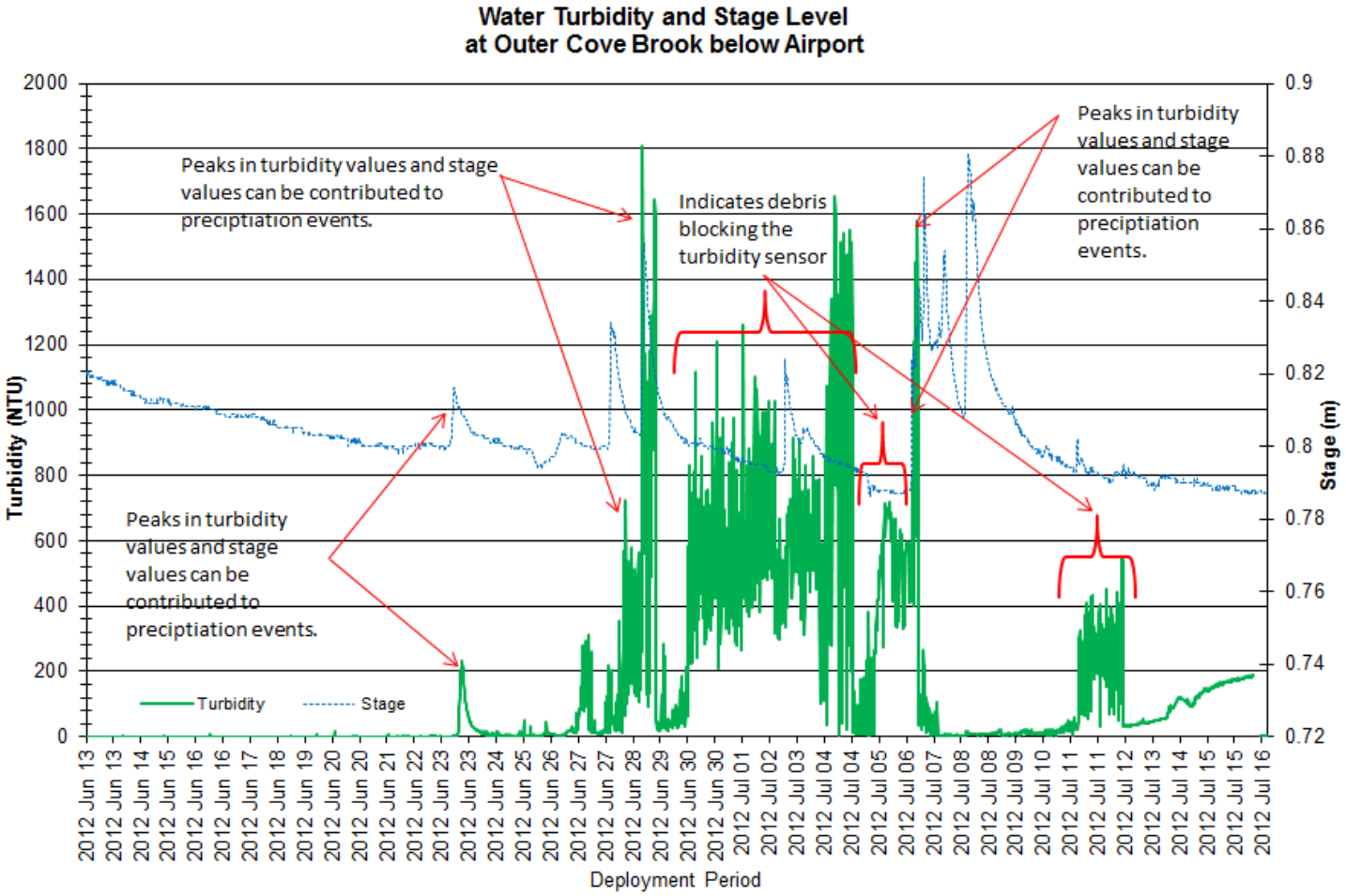

Figure 6: Turbidity and stage level at Outer Cove Brook below Airport

Stage

- The below graph includes precipitation data from the Pippy Park Weather Station, located on the outskirts of Pippy's Park. This is one of the closer weather stations for the Outer Cove Brook stations that provides precipitation data.
- 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 a response to the rainfall events that occurred during this deployment period.

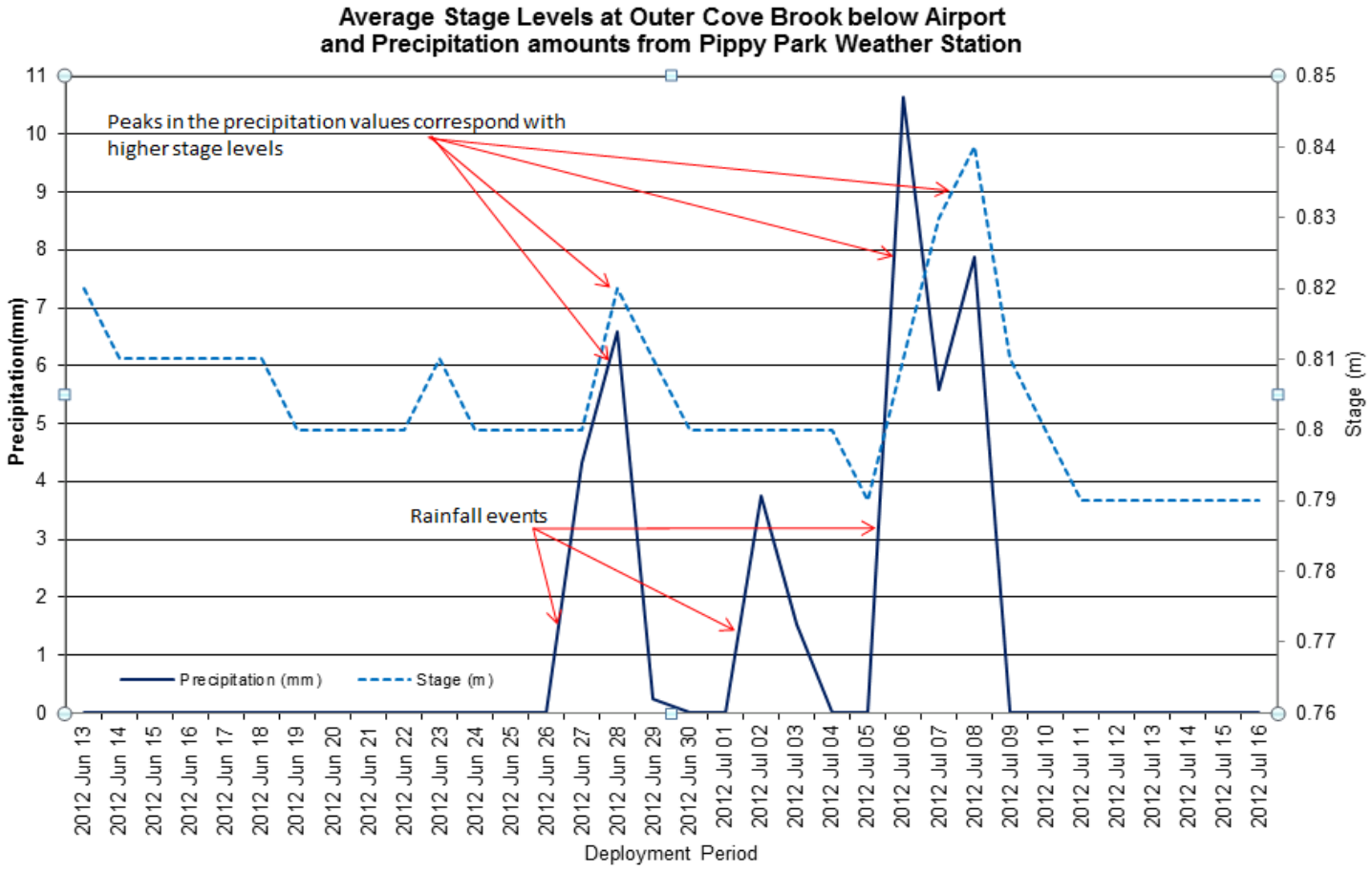

Figure 7: Stage Level at Outer Cove Brook below Airport and Precipitation amounts from Pippy Park Weather Station

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 differences in data visible on each parameter graphs, were related to the intermittent precipitation events.
- Water Temperature is warmer this deployment period and continues to gradually increase during deployment; this is to be expected as the air temperatures rise over the summer months. pH remains constant without any significant events, the decrease in pH in July corresponds with the large increase in stage level at that same time, indicating influence from rainfall. Specific Conductivity displays several drops in the concentration levels which can also be explained by the increase in stage (i.e. precipitation). The Dissolved Oxygen values remain at a constant, expected level with DO %Sat, and DO mg/L displays the influence of water temperature towards the end of June and into early July. The turbidity readings this deployment period were largely influenced by debris blocking the sensor. However it is still evident on the graph of turbidity peaks in relation to stage peaks and how higher stage flows can actually flush the debris from the sensor as noted on July 7, 2012 after a high stage flow.

Outer Cove Brook at Clovelly Golf Course

Water Temperature

- Water temperature ranged from 6.68°C to 22.0°C during this deployment period (Figure 8). The average temperature during this deployment period was 14.92°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.

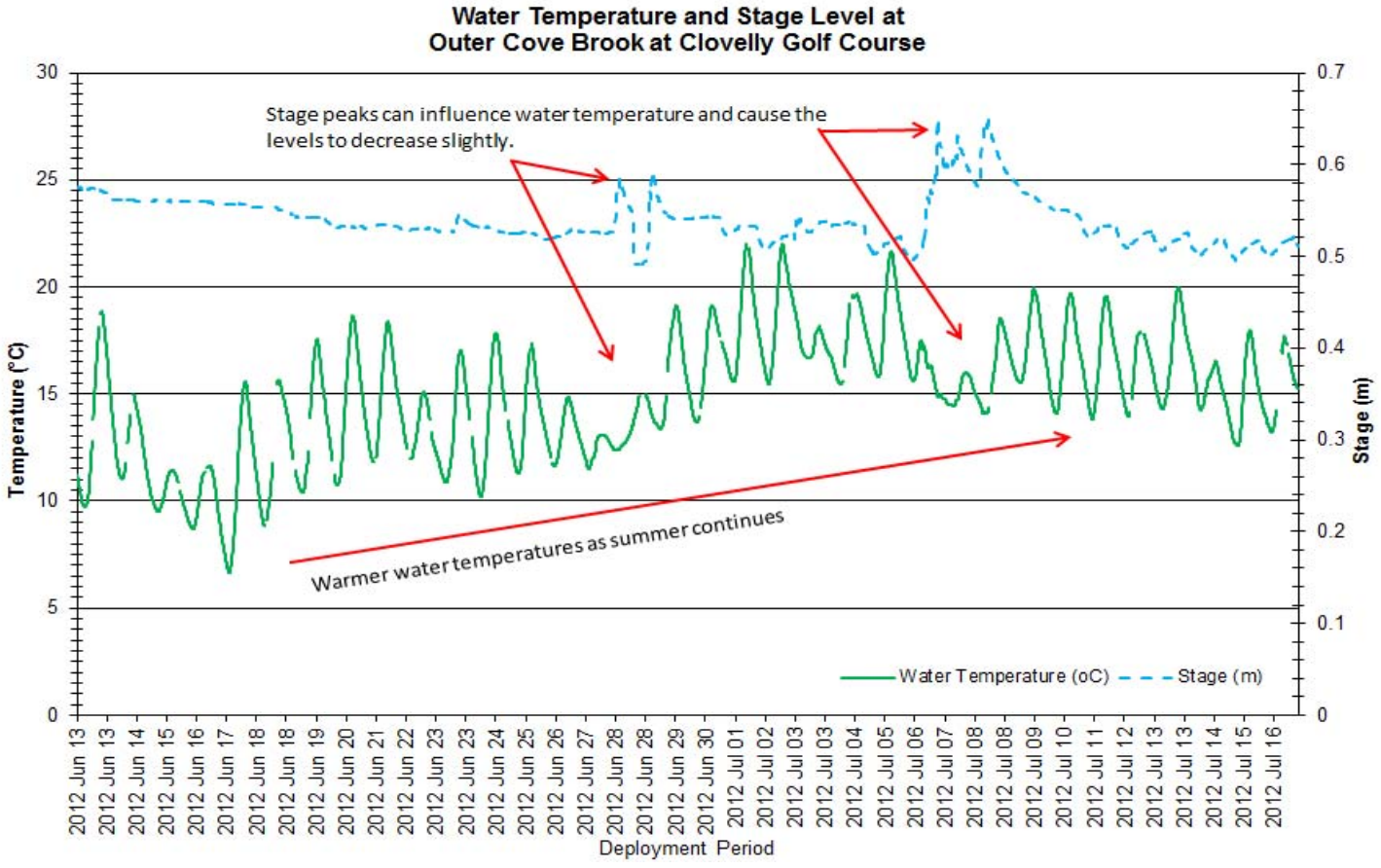

Figure 8: Water temperature and stage level at Outer Cove Brook at Clovelly Golf Course

pH

- pH ranged between 6.35 and 6.80 pH units throughout this deployment period (Figure 9). The average pH reading during this time was 6.53 (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 water 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.

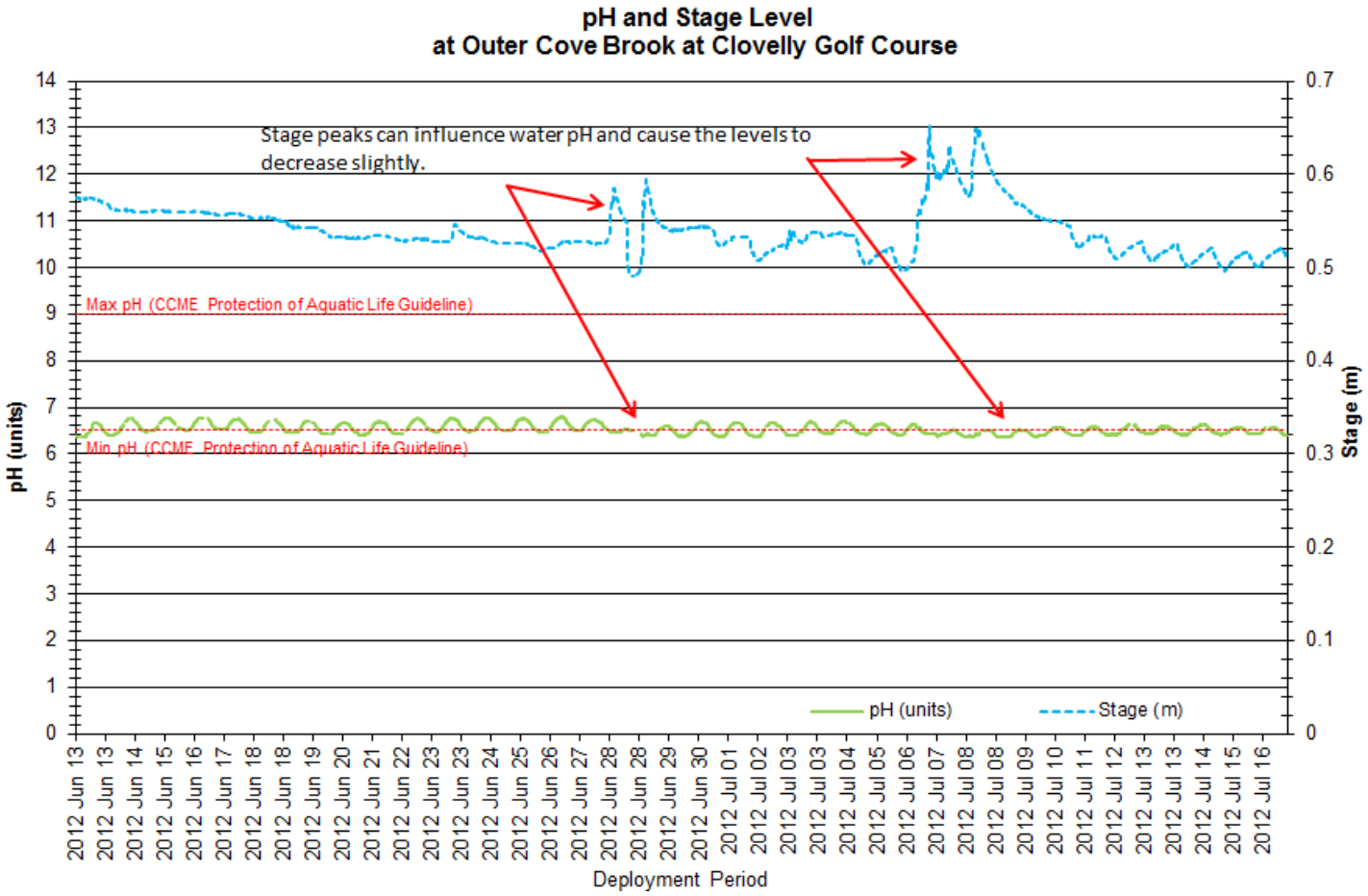

Figure 9: pH and stage level at Outer Cove Brook at Clovelly Golf Course

Specific Conductivity

- The conductivity levels were within 293.0µS/cm and 477.0µS/cm during this deployment period. The average conductivity level was ~ 439.6µS/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.
- Rainfall events 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.

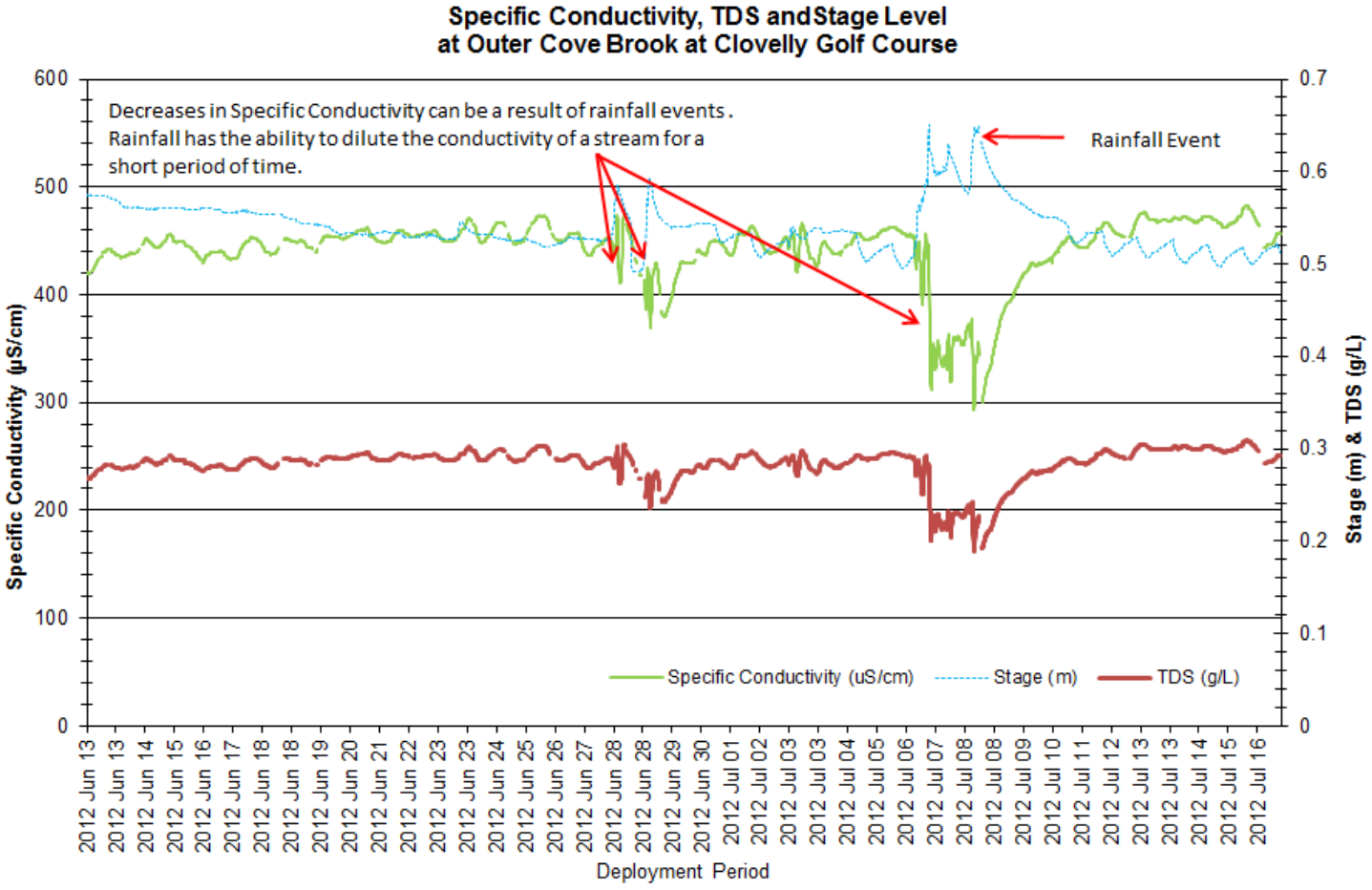

Figure 10: Specific conductivity, TDS and stage levels at Outer Cove Brook at Clovelly Golf Course

Dissolved Oxygen

- 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 59.3 – 113.1% Sat, with an average DO (% Sat) of 86.2%Sat. The Dissolved Oxygen mg/L levels 5.68mg/L – 12.03mg/L, with an average DO mg/L level of 8.73mg/L.
- The DO mg/L values are within the CCME Guidelines for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l and the CCME 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 levels are directly related to water temperature levels at those times. Dissolved oxygen mg/L content fluctuates with the water temperature. As temperature increases the DO mg/L levels decrease and vice versa.

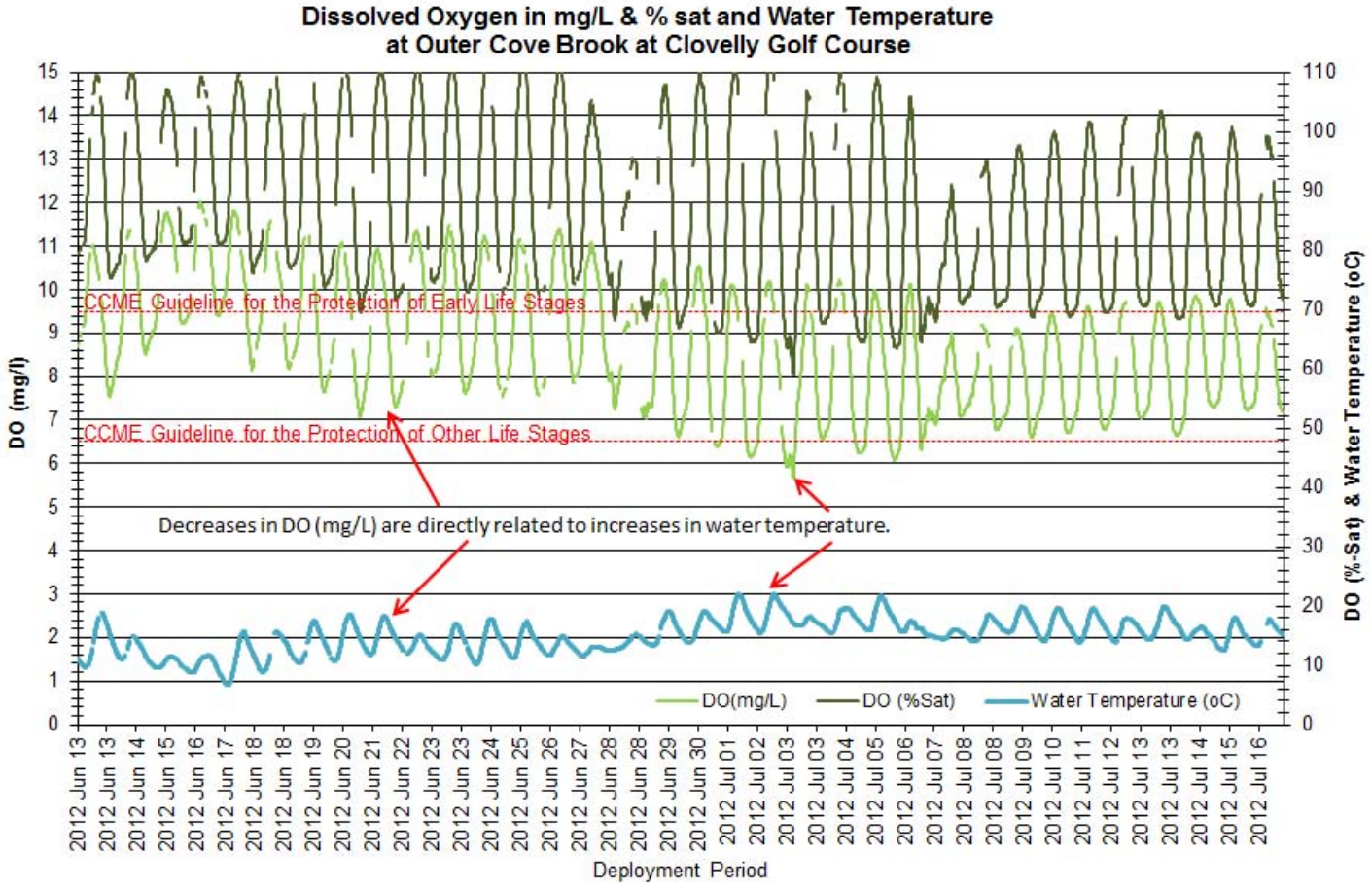

Figure 11: Dissolved Oxygen (mg/L & % sat) and Water Temperature at Outer Cove Brook at Clovelly Golf Course

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 377.3 NTU, with a turbidity average of 20.3 NTU (Figure 12).
- Some of the turbidity peaks during this deployment period are likely a result of higher stage levels after rainfall. The turbidity data from July 6, 2012 to July 11, 2012 is likely a result of debris blocking the sensor, these values are inaccurate and should not be used in any statistical analysis.

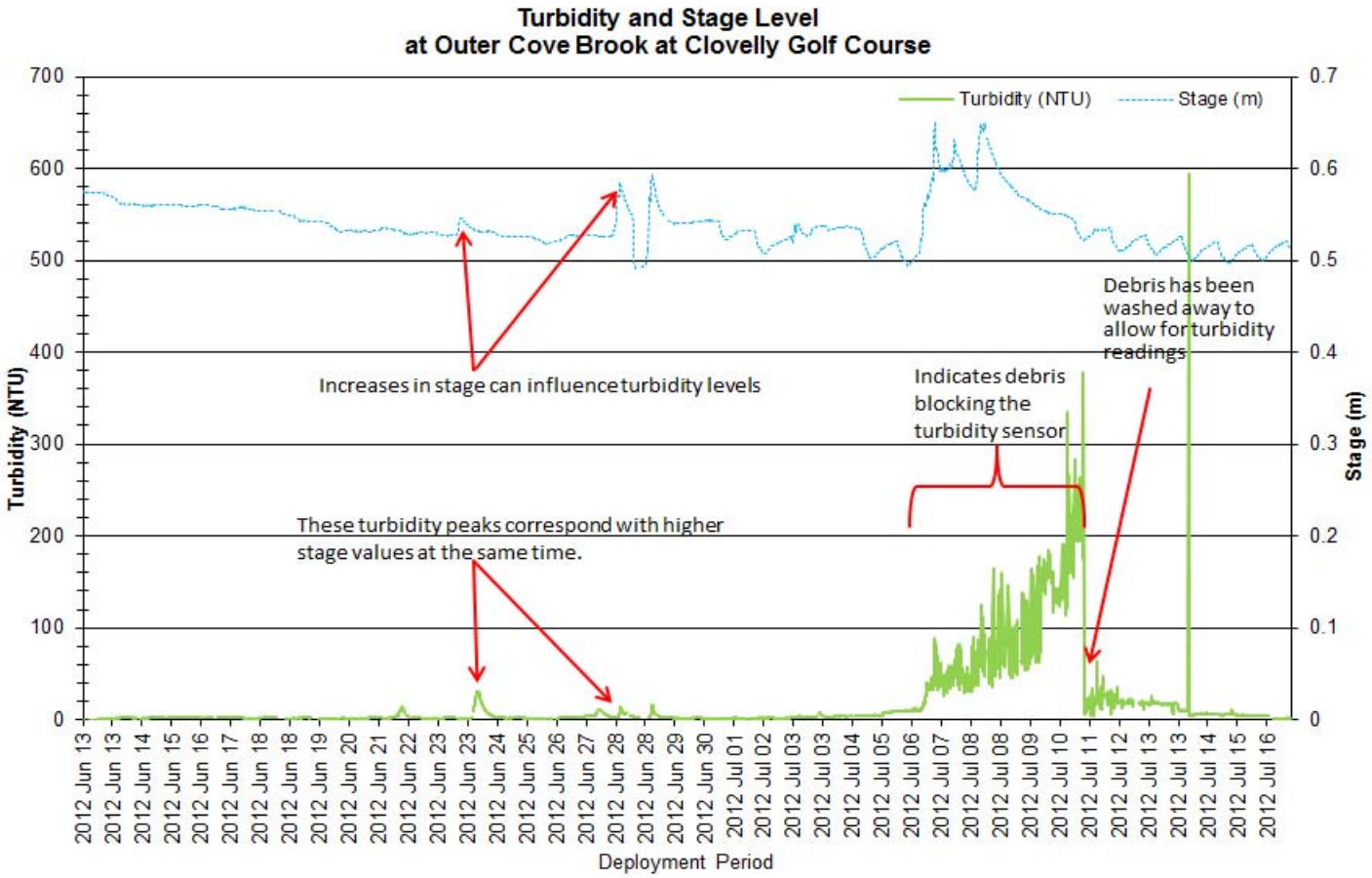

Figure 12: Turbidity and stage level at Outer Cove Brook at Clovelly Golf Course

Stage

- The below graph includes precipitation data from the Pippy Park Weather Station, based on the outskirts of Pippy Park. This is one of the closer weather stations for the Outer Cove Brook station that was providing precipitation data.
- 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.

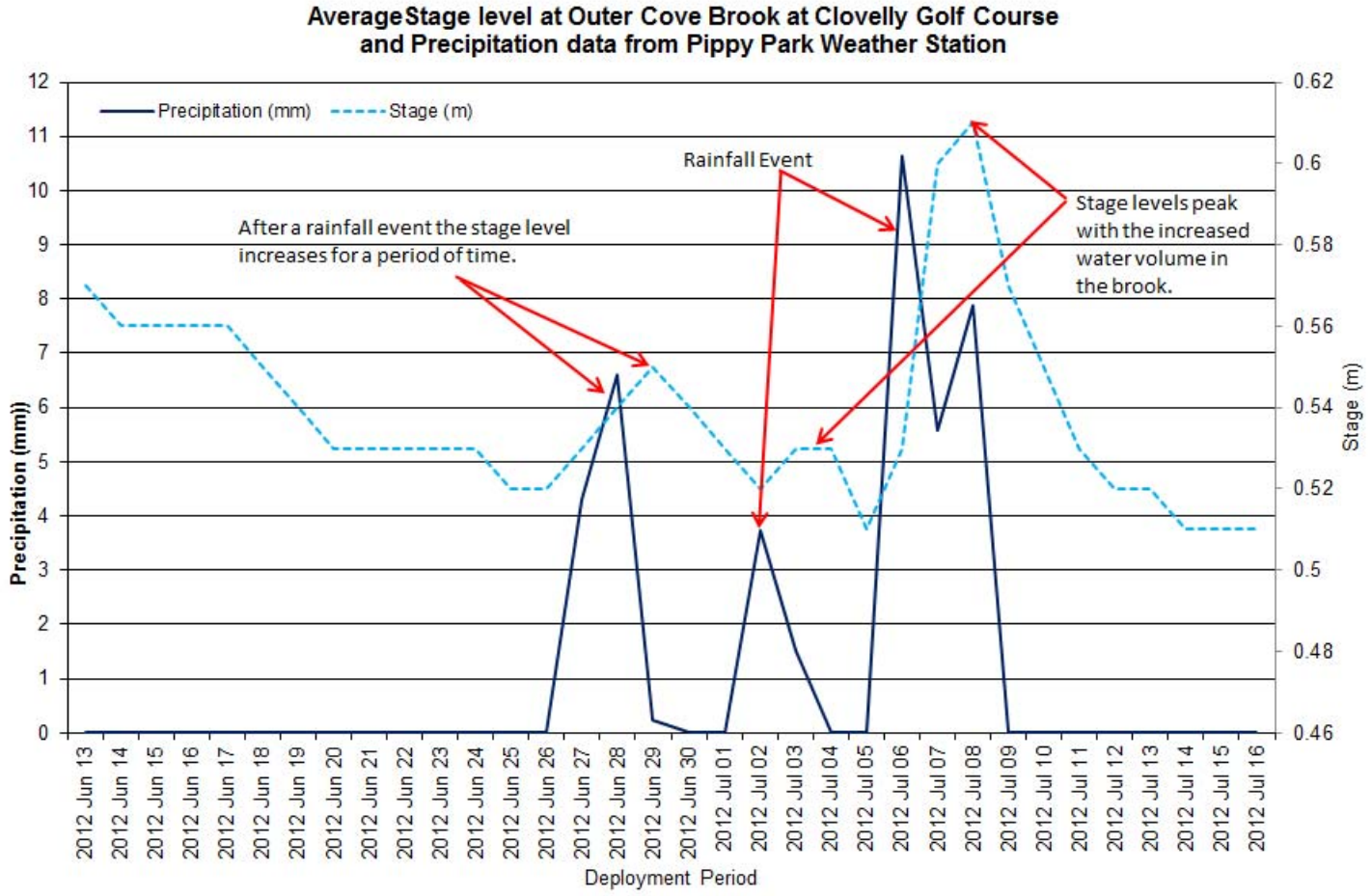

Figure 13: Stage Level at Outer Cove at Clovelly Golf Course and Precipitation data from Pippy Park Weather Station

Conclusions

- During this deployment it can be assumed that many of the events that occurred were related to the intermittent precipitation events. Generally in natural environments, climate and weather conditions contribute to a large part to the variation in water quality parameters.
- 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 a precipitation event and the dilution of the brook during that time. Dissolved Oxygen slightly decreases as the deployment period goes on, however the small decreases in DO mg/L can be linked to the increases in water temperature during those times. 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 larger blocks of higher turbidity readings are generally related to river debris (i.e. leaf litter, algae, sticks) blocking the sensors ability to stabilize and provide accurate turbidity readings for that period of time.
- During this deployment period the median water temperature at the upstream station (Outer Cove Brook below Airport) of 14.00°C was very similar to that of the downstream station (Outer Cove Brook at Clovelly Golf Course) of 15.05°C. Water temperature for both of the stations increased over the course of the deployment period as air temperatures increased. There is considerably more aquatic growth in the downstream which can also create warmer water temperatures. The median pH values for both stations was also comparable, Outer Cove Brook below Airport's median was 6.73 and Outer Cove Brook at Clovelly Golf Course median was 6.51, 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 486.0µS/cm with the Outer Cove Brook at Clovelly Golf Course had a median of 449.0µS/cm. Both conductivity medians are similar 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 88.4 %Sat during the deployment period, the downstream station (Outer Cove Brook at Clovelly Golf Course) had a lower median of 83.3 %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 utilize the DO present in the water. The turbidity median values between the downstream and upstream station are slightly different. The upstream station (Outer Cove Brook below Airport) has a turbidity median of 13.1 NTU with the downstream station (Outer Cove Brook at Clovelly Golf Course) holding a median of 2.5 NTU. There is not a large difference between the medians, however the turbidity does decrease slightly as the water moves downstream.

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