Real-Time Water Quality Deployment Report

Outer Cove Brook Stations

July 16 to August 27, 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 July 16, 2012, 2 real-time water quality monitoring instruments were redeployed for the fourth 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 July 16, 2012 until removal on August 27, 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 July 16 through to August 27, 2012 is summarized in Table 2.

Table 2: Comparison rankings Outer Cove Brook below Airport July 16 – August 27, 2012

Station	**Date**	**Action**	**Comparison Ranking**				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
Below Airport	July 16 2012	Deployment	Fair	Good	Good	Excellent	Good
	August 27 2012	Removal	Excellent	Good	Good	Excellent	Marginal

Outer Cove Brook, Newfoundland and Labrador

- At the Outer Cove Brook below Airport station, water temperature probe ranked as 'fair', this is likely a result of not allowing the QA sonde enough time to temperature stabilize before taking the reading. The parameter rankings for pH, specific conductivity, dissolved oxygen and turbidity all ranked within 'good' to 'excellent' at deployment. For the initial readings to a deployment period, this is a very good overall ranking.

- At removal, temperature and dissolved oxygen ranked 'excellent', while pH and specific conductivity ranked as 'good' and turbidity ranked 'marginal' which may be a result of the algae build-up after a ~35 day deployment. Overall the data at the removal stage of deployment was true.
- Deployment and removal comparison ranking for **Outer Cove Brook at Clovelly Golf Course** for the period of July 16 through to August 27, 2012 is summarized in Table 3.

Table 3: Comparison rankings Outer Cove Brook at Clovelly Golf Course July 16 – August 27, 2012

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Clovelly Golf Course	July 16 2012	Deployment	Excellent	Excellent	Good	Excellent	Excellent
	August 27 2012	Removal	Excellent	Excellent	Good	Excellent	Poor

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

- At removal, temperature, pH, specific conductivity and dissolved oxygen all ranked within 'excellent' to 'good'. The turbidity values ranked 'poor', likely a result of buildup of fouling from natural aquatic growth after a ~35 day deployment.

- 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.

Data Interpretation

- The following graphs and discussion illustrate water quality-related events from July 16 to August 27, 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 12.2°C to 22°C during this deployment period (Figure 2). The average temperature during this deployment period was 15.74°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 warmer air temperatures; the water temperatures are warmer than the previous deployment period and remain more constant throughout the deployment. When comparing the last deployment water temperature average of 14.02°C to the current deployment period average of 15.74°C, it is evident that the temperatures have increased slightly this month.
- Water Temperature is a very important parameter and it has the ability to influence other parameters that are measured by the water quality instruments.
- Evidence of rainfall during this deployment period can be noted on the graph by the peaks in stage. Rainfall can reduce the temperature of the brook slightly for a couple of hours or days depending on the amount. This is visible on July 28, 2012 a peak in stage corresponds with a drop in water temperature directly after.

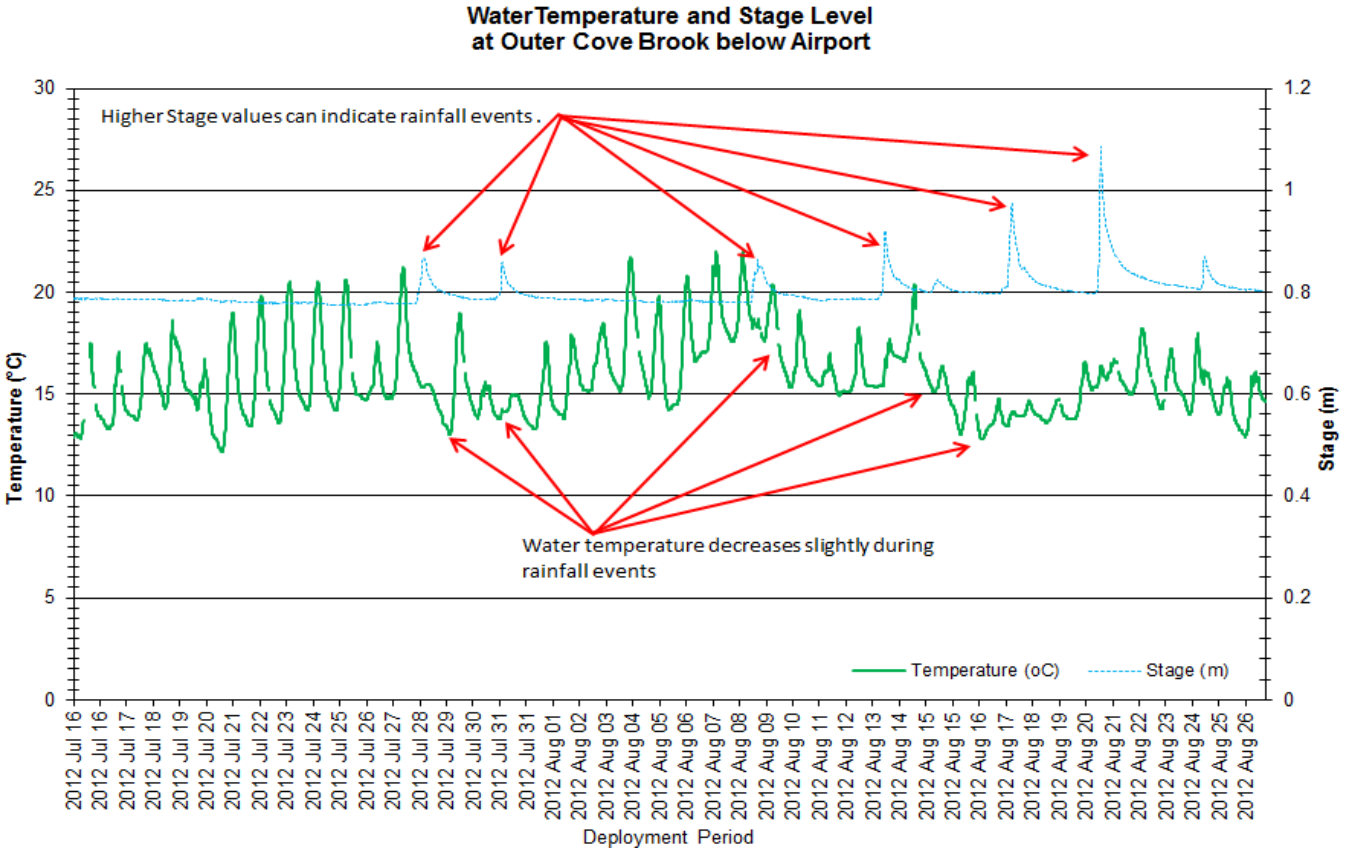

Figure 2: Water temperature and Stage Level at Outer Cove Brook below Airport

pH

- pH values ranged between 6.07 and 6.92 pH units throughout this deployment period (Figure 3). The average pH reading during this time was 6.52.
- During the deployment, the pH values at this station sit just above the minimum CCME Guideline for the Protection of Aquatic Life (between 6.5 and 9 pH units) until several rainfall events starting on August 8, 2012, when the pH values decrease for the remainder of the deployment period. This is a natural occurrence between rainfall and pH levels.
- The CCME guideline provides a basis by which to judge the overall health of the brook. Naturally, all streams and brooks are different, in the case of Outer Cove Brook below Airport's it is within the normal range for stream water in St. John's.

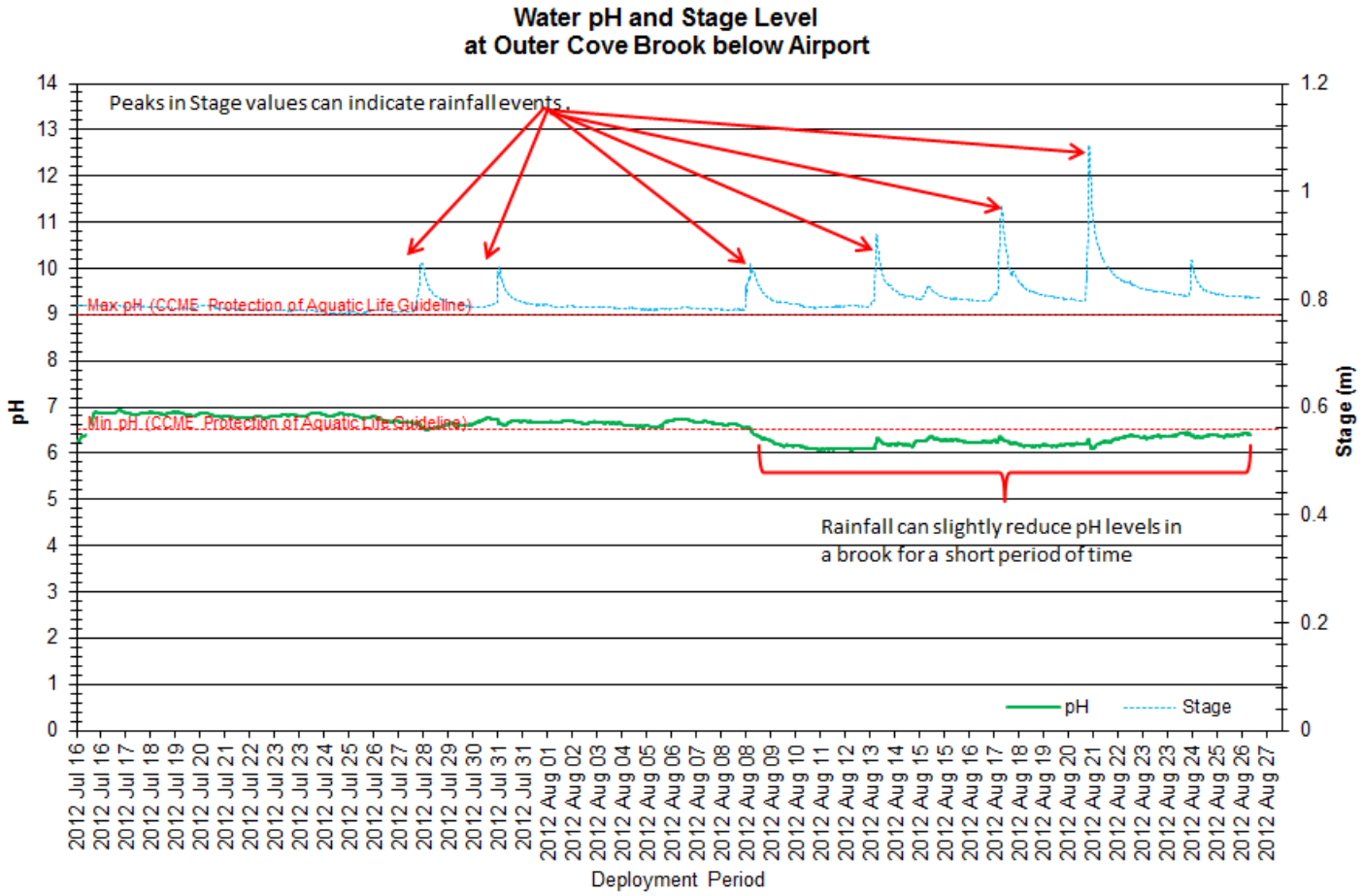

Figure 3: pH & stage level at Outer Cove Brook below Airport

Specific Conductivity & TDS

- The conductivity levels were within 126.4µS/cm and 689.0µS/cm during this deployment period. The average conductivity level was ~ 479.2µS/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 at this time of year.
- Rainfall events can have the effect of diluting and lowering conductance levels, this is evident on Figure 4 as the stage levels rise the specific conductance levels drop periodically. For example, August 8, 2012 a peak in stage corresponds with a drop in specific conductance.
- 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 and generally always mirrors specific conductivity.

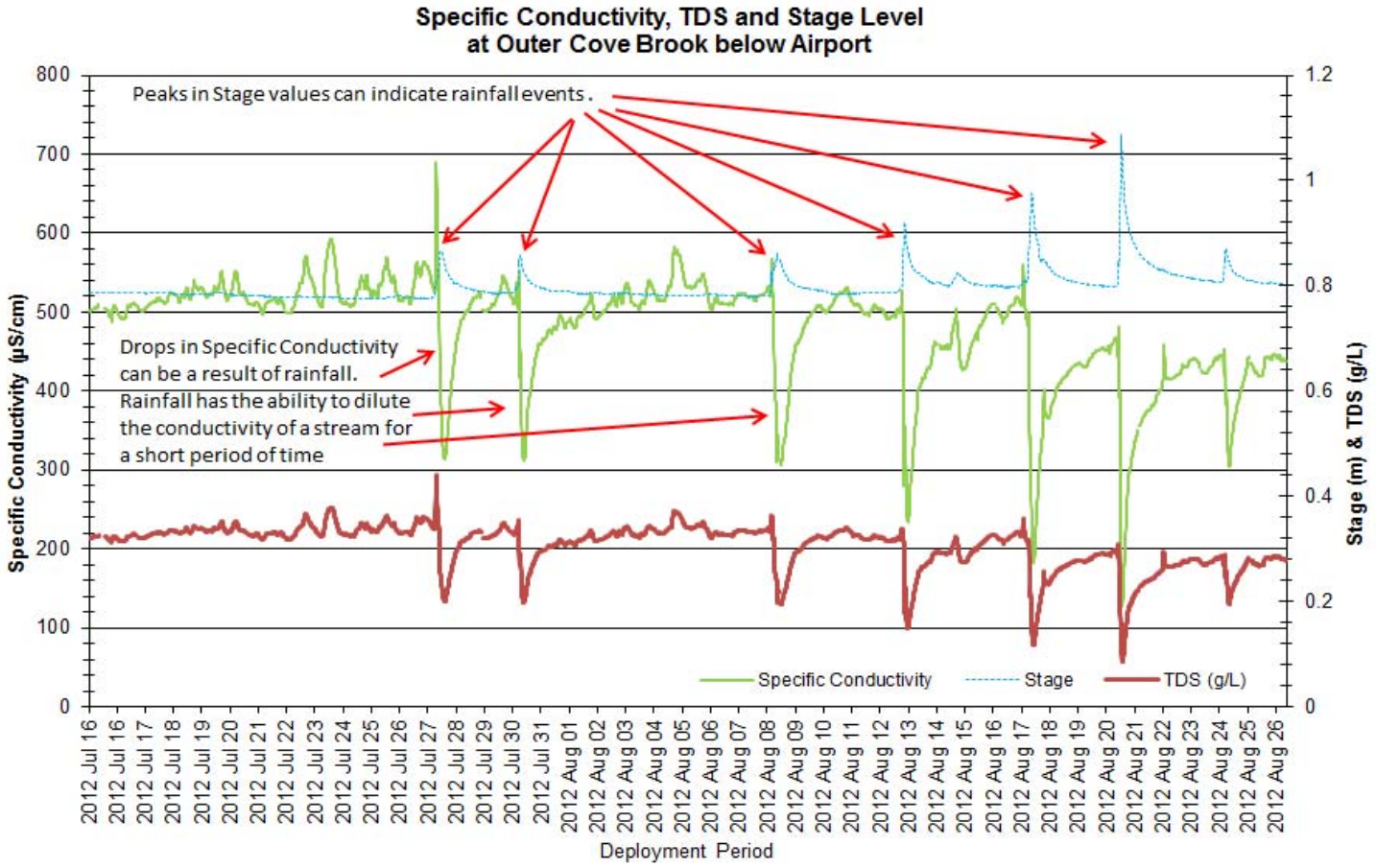

Figure 4: Specific conductivity, TDS and stage levels at Outer Cove Brook below Airport

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 water temperature of the water body.
- The Dissolved Oxygen % Sat levels within this deployment period were within 84.7–95.3% Sat, with an average DO (% Sat) of 90.7%Sat. The Dissolved Oxygen mg/L levels 7.89mg/L–9.71mg/L, with an average DO mg/L level of 9.00mg/L.
- The DO mg/L values can be compared against the CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l and 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). This is just a guide and it is normal to see fluctuation in dissolved oxygen levels daily, monthly and seasonally.
- The drop in DO mg/L on August 4, 2012 corresponds with the slightly higher water temperatures at that same time. DO values will also be higher in daytime hours than nighttime hours due to the aquatic plants conducting photosynthesis and using more oxygen from the water.
- Dissolved Oxygen percent saturation remains constant during the deployment period. Dissolved oxygen mg/L content fluctuates with the water temperature changes. As water temperature increases the DO mg/L levels decrease and vs. versa, for example from August 15 – 19, 2012 the water temperatures are slightly lower and the DO mg/L values increase during that same period.

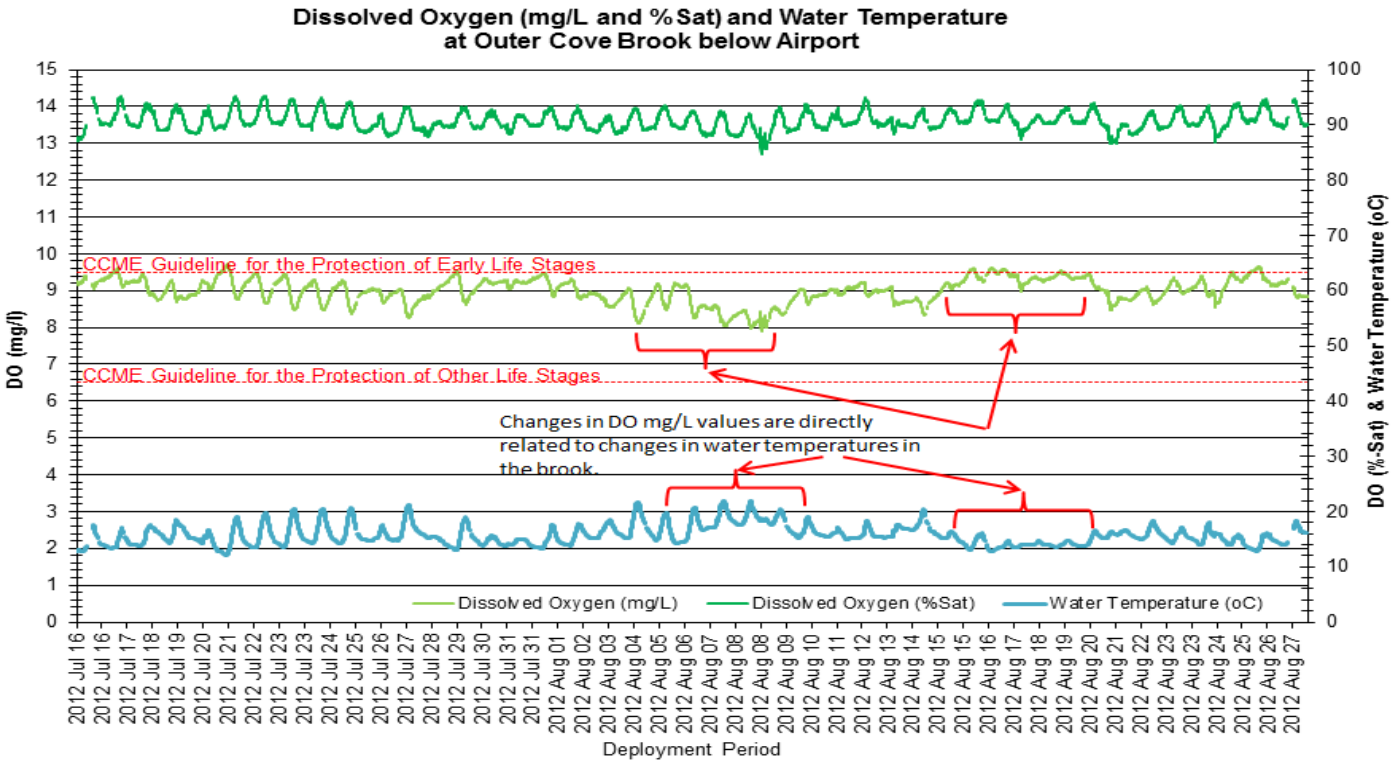

Figure 5: Dissolved Oxygen (mg/L & % sat) and Water Temperature at Outer Cove Brook below Airport

Turbidity

- The deployment location of this instrument was the best possible site within the brook, however there is a significant amount of algae present in the brook at this location. As the water temperatures increase, the algae/aquatic growth in this area also increases. We know through experience that high algal growth can interfere with a turbidity sensor. One evident sign is the turbidity readings don't stabilize and the readings resemble a block of peaks on the graph (as indicated in fig 6 on July 22 to July 28, 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, this is not a valid turbidity reading.
- The turbidity readings during this deployment ranged within 1.9 NTU to 1208.0 NTU, with a average value of 40.1NTU (Figure 6).

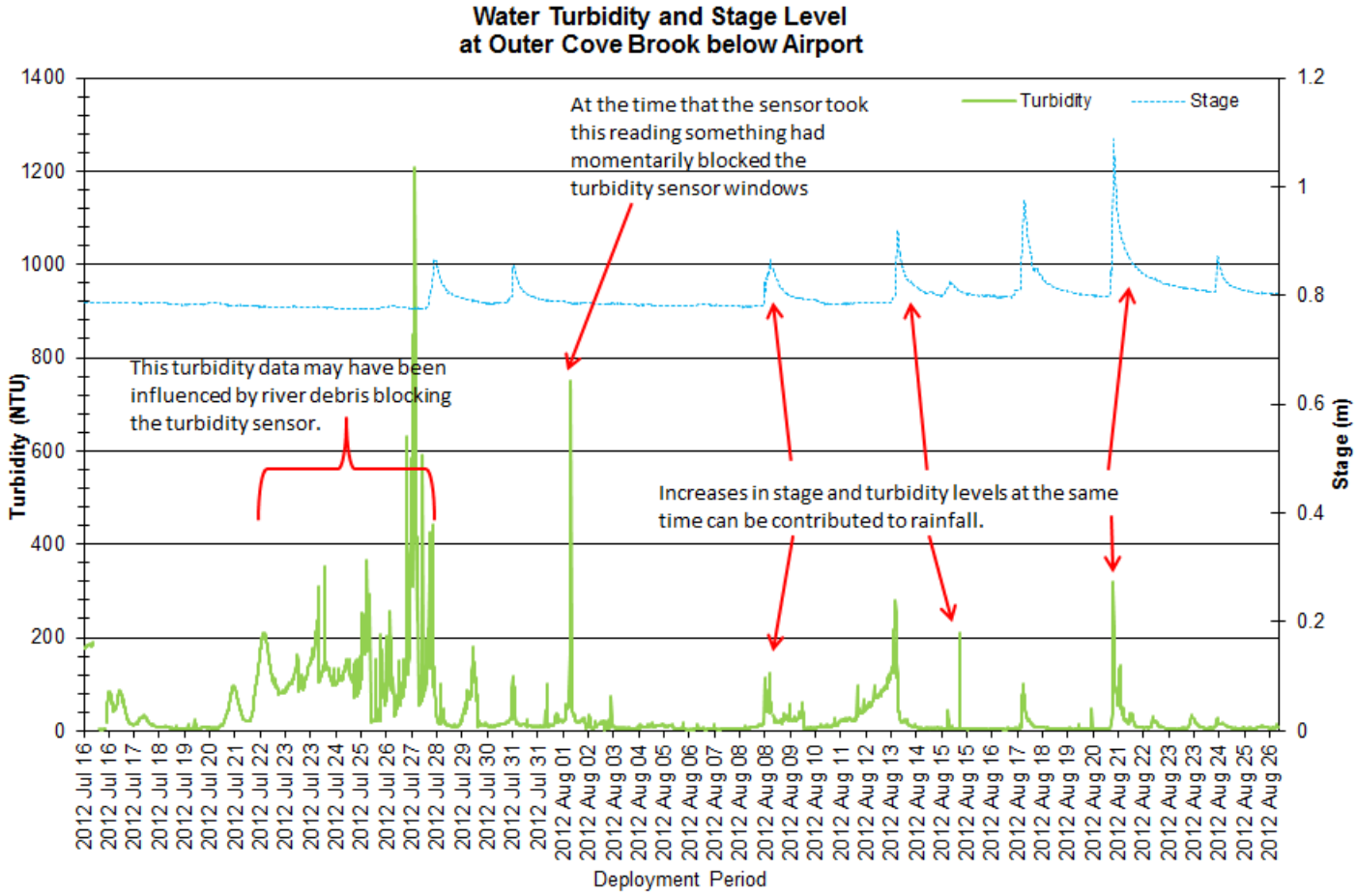

Figure 6: Turbidity and stage level at Outer Cove Brook below Airport

Stage

- The below graph includes precipitation data from the Pippy Park weather station, based on the outskirts of Pippy Park. Due to the St. John's International Airport's weather station being offline at the present time, Pippy Park is the closest weather station for the Outer Cove Brook stations that provides average precipitation data capable of comparing it with water quality events.
- 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, being that it is the middle of summer, the only true moisture at that time would have been rainfall, no snow.

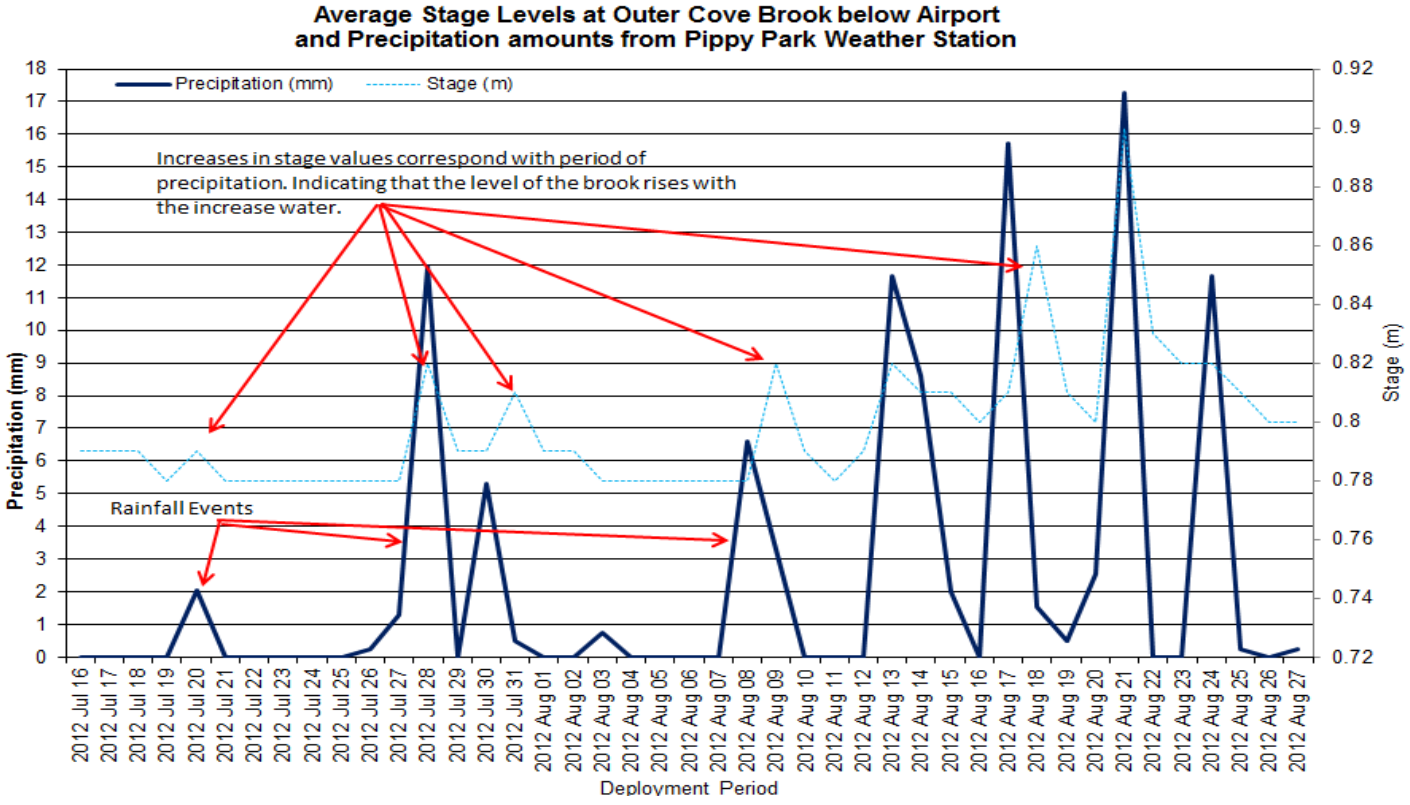

Figure 7: Stage Level at Outer Cove Brook below Airport and Precipitation amounts from Pippy Park Weather Station

Conclusions

- Generally in natural environments, climate and weather conditions contribute in large part to the variation in water quality parameters. During this deployment it can be assumed that many of the differences in the parameters data that is displayed on the graphs, was related to the intermittent precipitation events and small climatic changes of the seasons (i.e. temperature increases).
- Water Temperature is warmer this deployment period and remains reasonably constant throughout the deployment period; this is to be expected as the air temperatures rise over the summer months and then stabilize as the summer comes to an end. pH remains constant without any significant events, the decrease in pH in August corresponds with the intermittent peaks in stage levels over that same time (indicating influence from rainfall). Specific Conductivity displays numerous drops in the concentration levels which can also be explained by the increase in stage levels, as it would be assumed rainfall is diluting the specific conductivity levels. The Dissolved Oxygen values remain at a constant, expected level, the DO mg/L data displays the influence of water temperature on dissolved oxygen on August 4 through to August 8, 2012. The turbidity readings for this deployment period display a significant relationship with the stage increases, as more debris and material is flushed into the brook during rainfall events the turbidity sensor is able to capture that on several occasions, for example August 8, 2012.

Outer Cove Brook at Clovelly Golf Course

Water Temperature

- Water temperature ranged from 12.31°C to 22.14°C during this deployment period (Figure 8). The average temperature during this deployment period was 16.52°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 that the instrument logs; some of the sensors on the instrument are also temperature dependent. Therefore it is important that that water temperature is taken into consideration for some water quality events.
- Water temperature during this deployment period is influenced from the increases in stage as displayed on the graph. Overall water temperature remains constant throughout the deployment period. The peaks in stage correspond with the decreases in water temperature; rainfall has the ability to lower water temperature for short periods of time. For example increase in stage on August 17 2012 corresponds with a drop in water temperature at the same time.

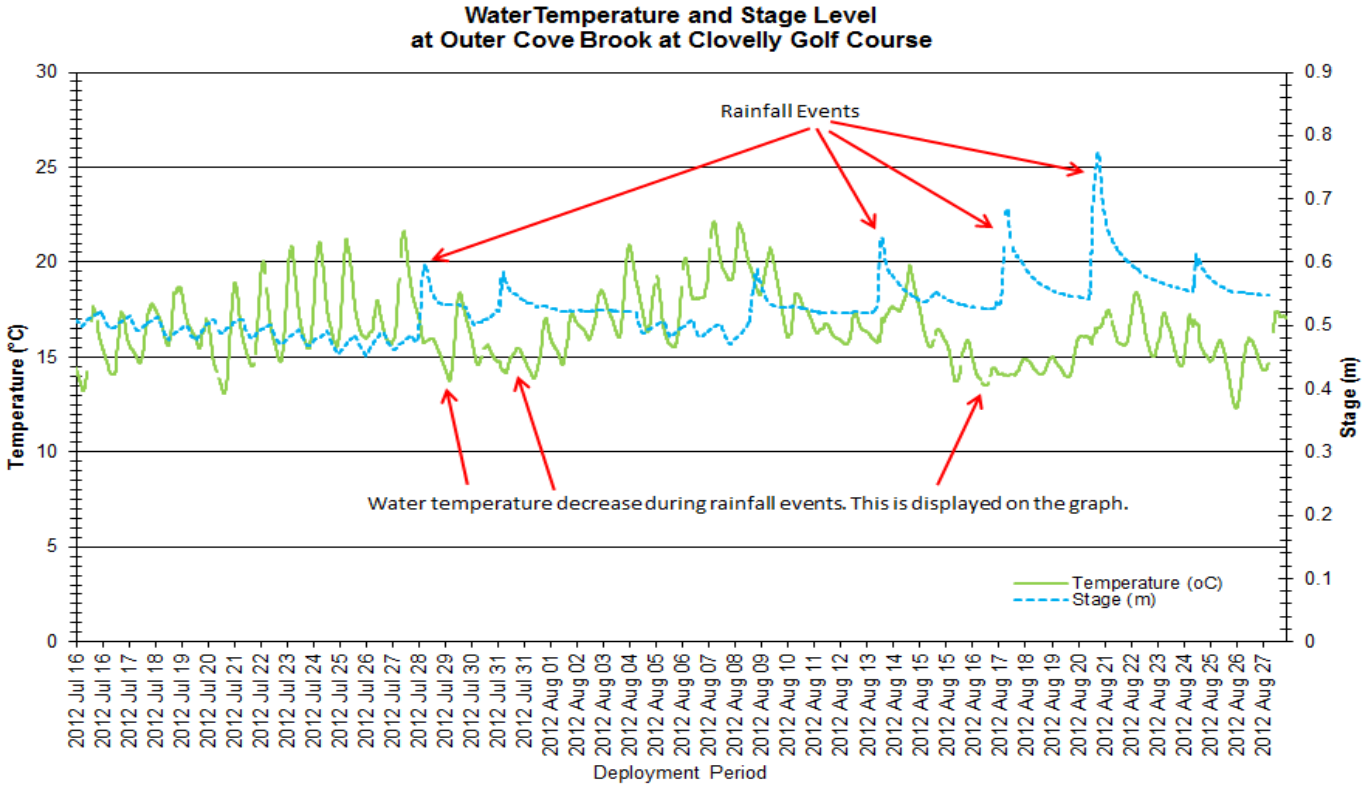

Figure 8: Water temperature and stage level at Outer Cove Brook at Clovelly Golf Course

pH

- pH ranged between 6.14 and 6.62 pH units throughout this deployment period (Figure 9). The average pH reading during this time was 6.45 (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. Sometimes rainfall can impact the pH values to drop to a lower pH, hence slightly increasing the acidity of the stream for a short time, as noted on August 20, 2012 where the pH levels drop during a high stage event.

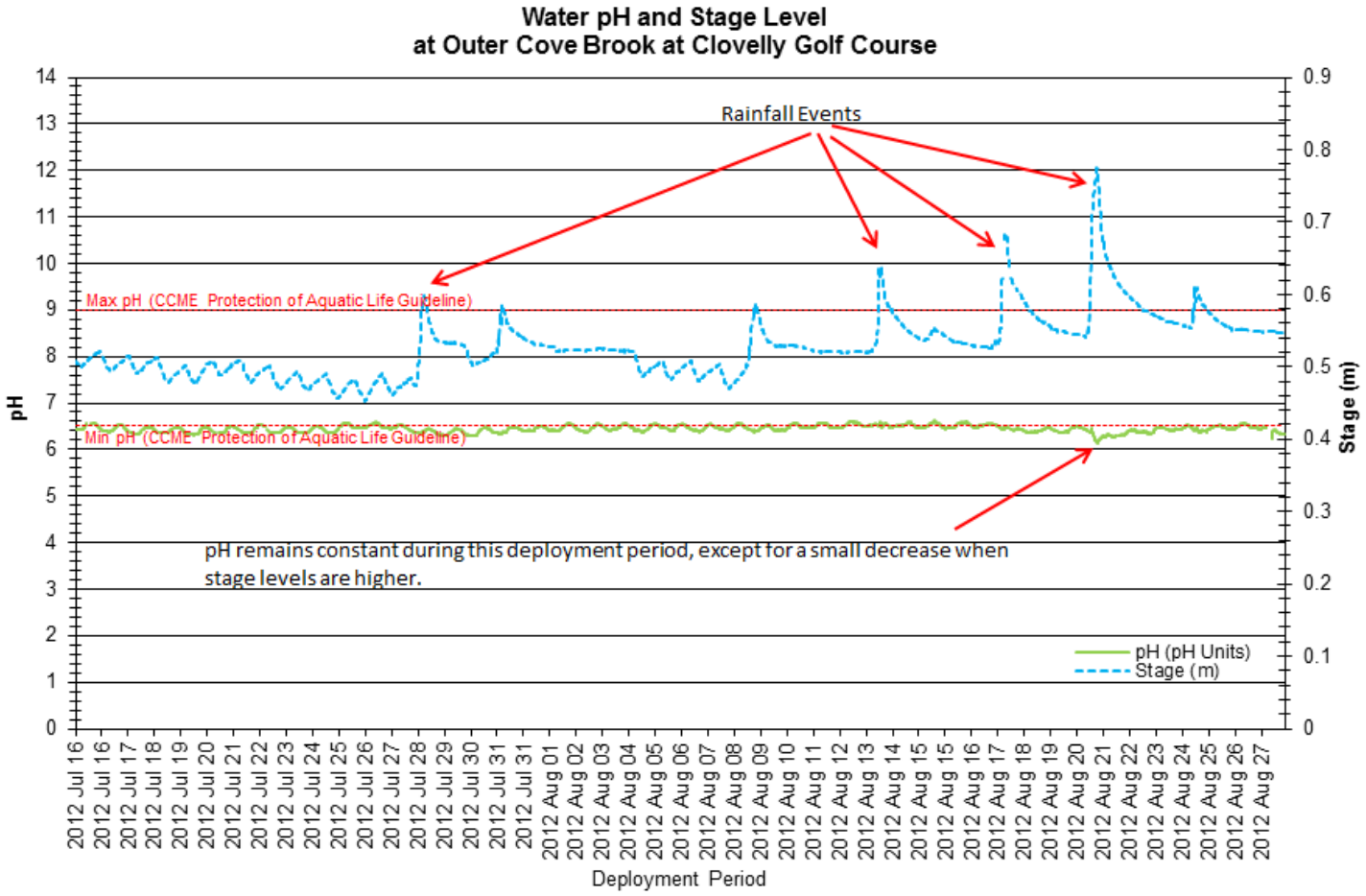

Figure 9: pH and stage level at Outer Cove Brook at Clovelly Golf Course

Specific Conductivity

- The conductivity levels were within 211.0µS/cm and 483.0µS/cm during this deployment period. The average conductivity level was ~ 430.1µS/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. For example on August 13, 2012 the drop in specific conductivity corresponds with high stage level at that time.
- Rainfall events can have the effect of lowering specific 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.

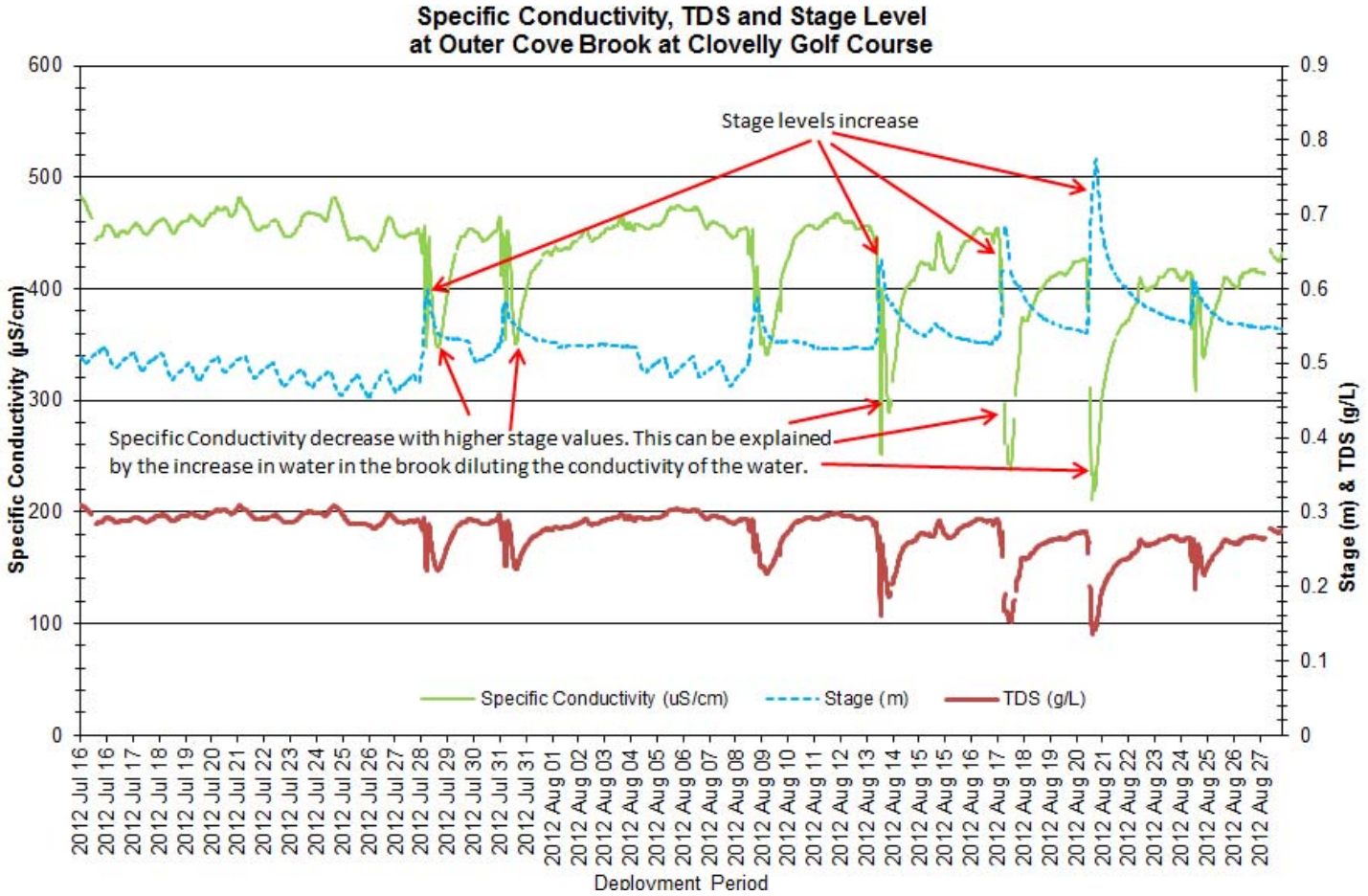

Figure 10: Specific conductivity, TDS and stage levels at Outer Cove Brook at Clovelly Golf Course

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 63.0–101.1% Sat, with an average DO (% Sat) of 80.7%Sat. The Dissolved Oxygen mg/L levels 5.83mg/L–9.75mg/L, with an average DO mg/L level of 7.85mg/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 changes. As temperature increases the DO mg/L levels decrease and vs. versa.

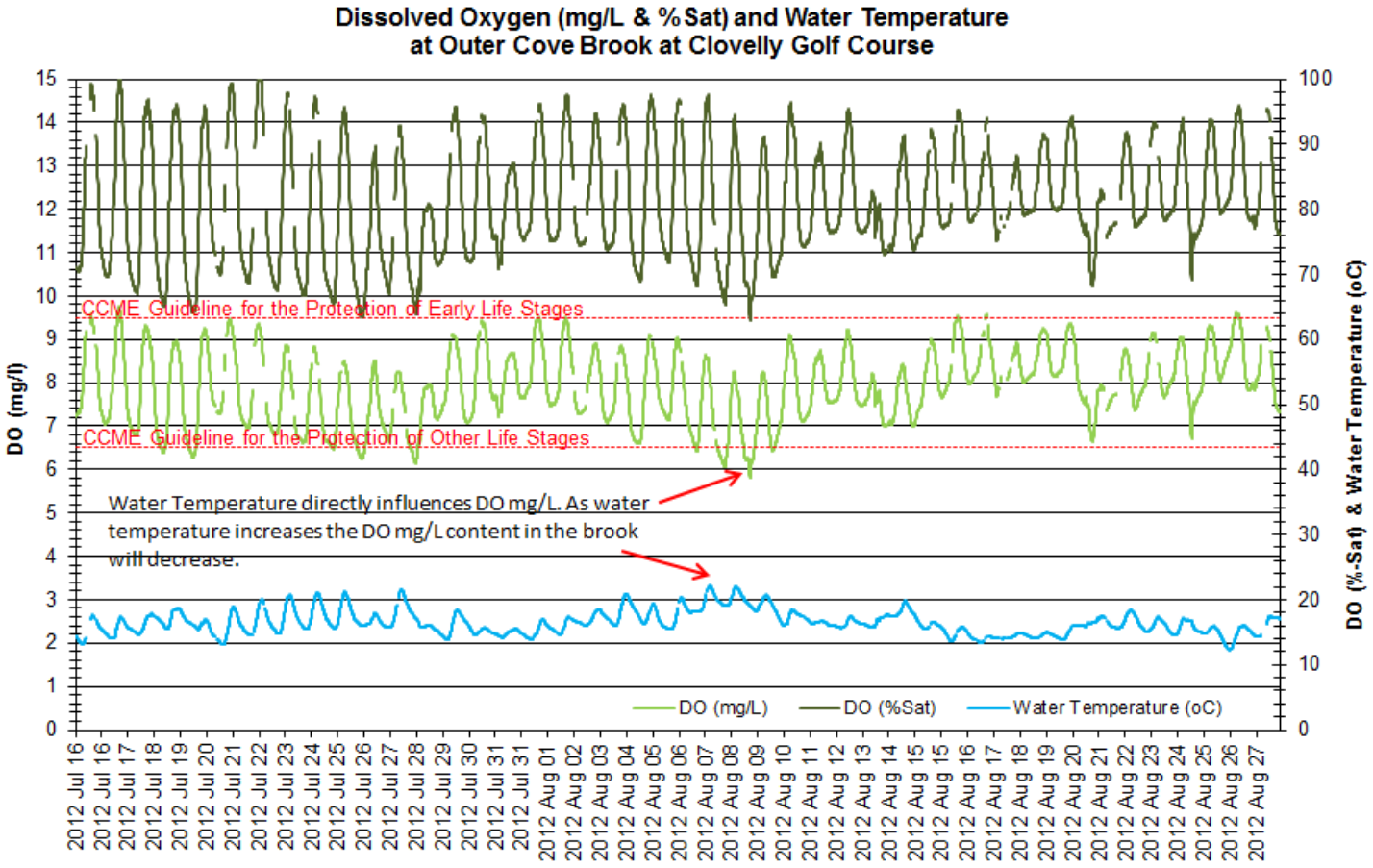

Figure 11: Dissolved Oxygen (mg/L & % sat) and Water Temperature at Outer Cove Brook at Clovelly Golf Course

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 0.8 NTU to 157.3 NTU, with a turbidity average of 3.9 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 August 14, 2012 to August 16, 2012 is likely a result of debris blocking the sensor, these values are inaccurate and should not be used in any statistical analysis.

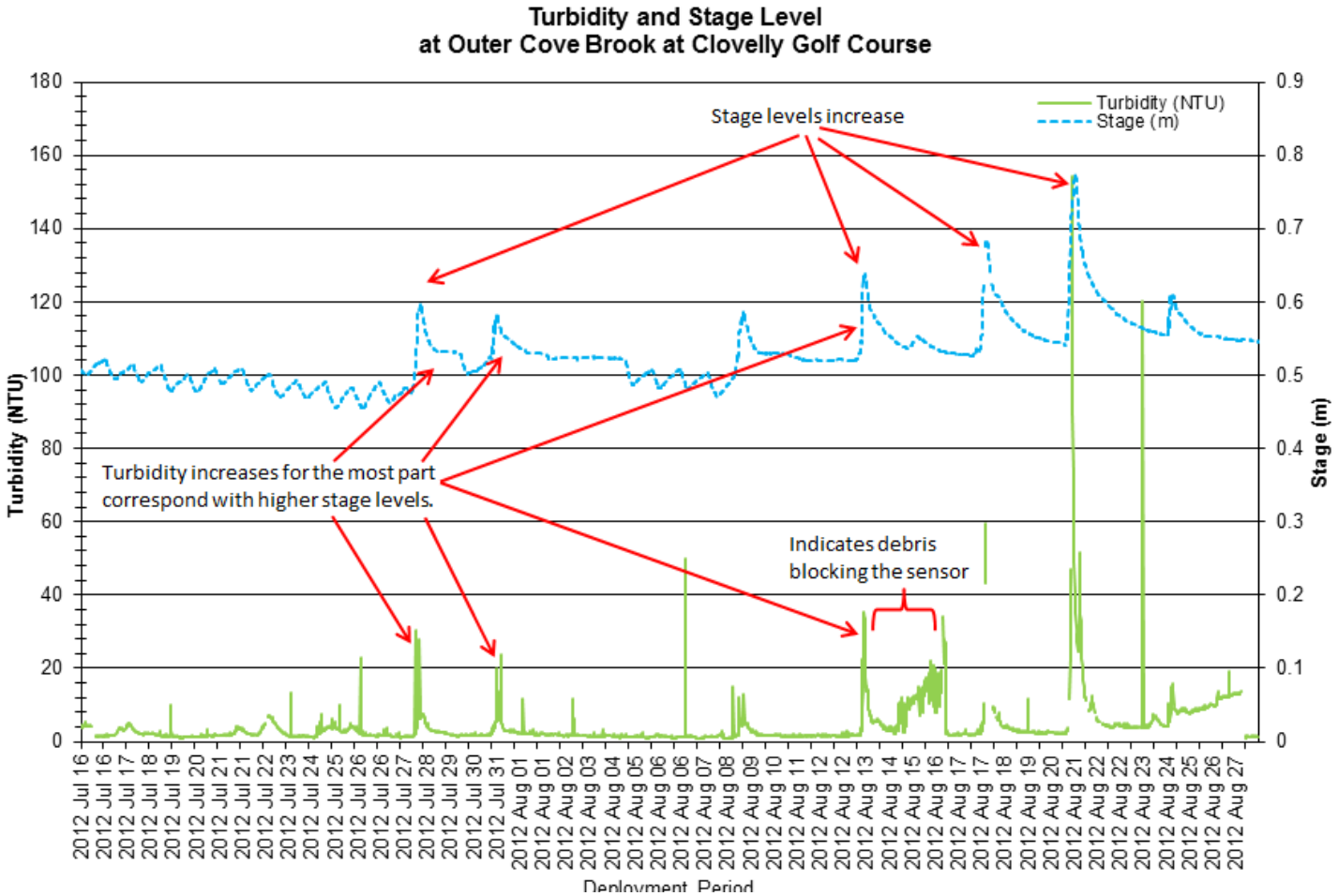

Figure 12: Turbidity and stage level at Outer Cove Brook at Clovelly Golf Course

Stage

- The below graph includes daily precipitation data from the Pippy Park Weather Station, based on the outskirts of Pippy Park. This was the closest weather station for the Outer Cove Brook station that was providing precipitation data at this time.
- 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.

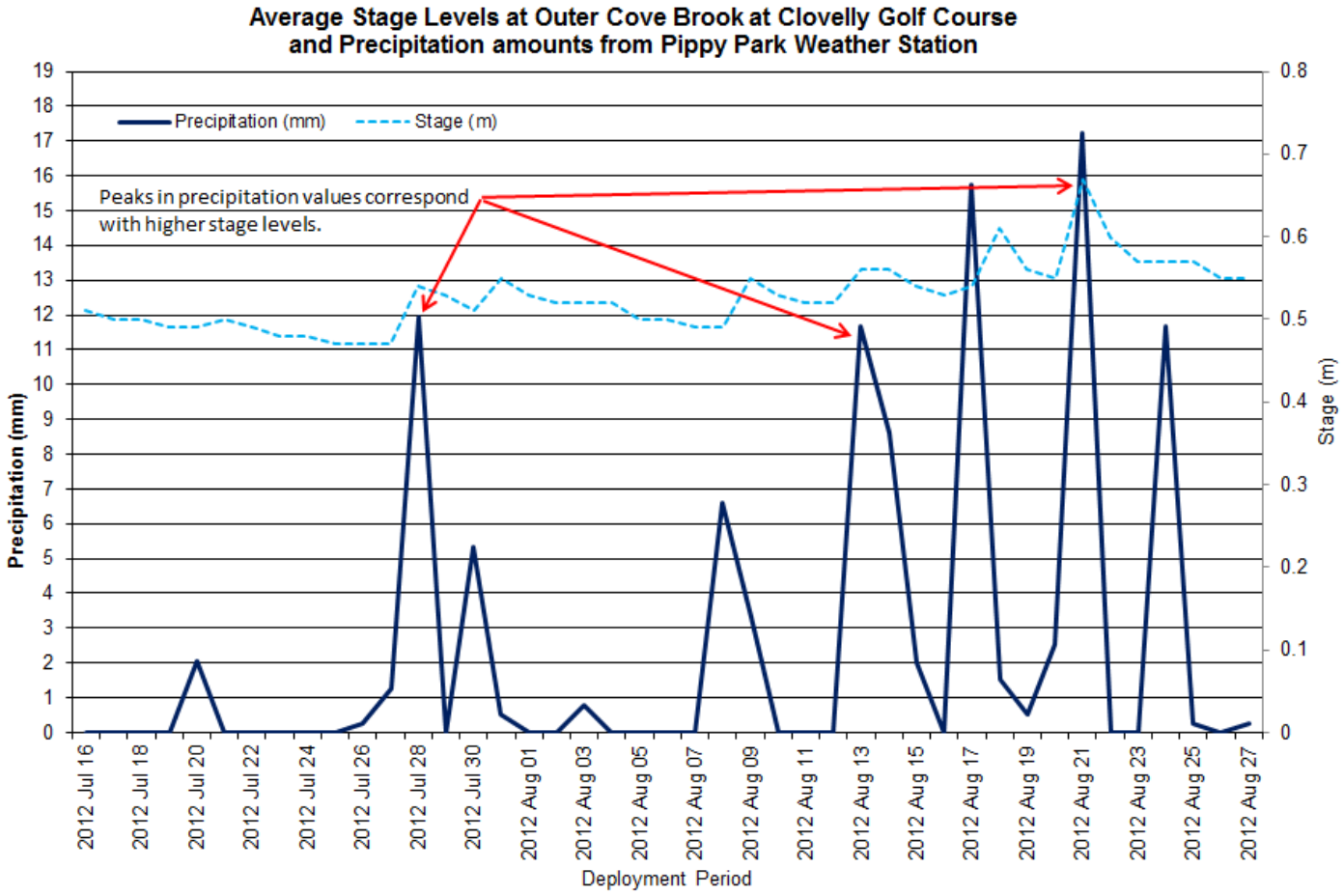

Figure 13: Stage Level at Outer Cove at Clovelly Golf Course and Precipitation data from Pippy Park Weather Station

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 the warmer climate at this time. pH remains constant without any significant events. Specific Conductivity displays intermittent drops in levels which are linked to corresponding precipitation events. Dissolved Oxygen remains constant throughout the deployment period, the small decreases in DO mg/L can be linked to the increases in water temperature at 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.
- During this deployment period the median water temperature at the upstream station (Outer Cove Brook below Airport) of 15.40°C was very similar to that of the downstream station (Outer Cove Brook at Clovelly Golf Course) of 16.25°C. Water temperature for both of the stations remained constant during the deployment period, as air temperatures stabilized towards the end of the summer months. It should also be noted that there is considerably more aquatic growth present in the downstream station which can also create warmer water temperatures during the daylight hours. The median pH values for both was also comparable with, Outer Cove Brook below Airport's median at 6.60 and Outer Cove Brook at Clovelly Golf Course reading 6.45, 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 504.0µS/cm with the Outer Cove Brook at Clovelly Golf Course recording a median of 447.0µS/cm. Both conductivity medians are comparable and indicate no significant difference in specific conductivity as the water moves downstream. Dissolved Oxygen at the upstream station (Outer Cove Brook below Airport) had a median of 90.4%Sat during the deployment period, the downstream station (Outer Cove Brook at Clovelly Golf Course) had a lower median of 79.3%Sat. Both stations have close DO medians and there is no significant difference between them, however the downstream station does have considerably more aquatic growth in the stream which can increase the use of oxygen present in the water. The turbidity median values between the downstream and upstream station are slightly different. The upstream station (Outer Cove Brook below Airport) has a turbidity median of 11.0NTU with the downstream station (Outer Cove Brook at Clovelly Golf Course) holding a median of 2.0NTU. There is not a large difference between the medians, however the turbidity does decrease slightly as the water moves downstream.

Prepared by:
Tara Clinton
Department of Environment and Conservation
Water Resources Management Division
Phone: 709.729.5925