Real-Time Water Quality Deployment Report

Voisey's Bay Network

July 13 to August 12, 2017

Newfoundland Labrador

Government of Newfoundland & Labrador

Department of Municipal Affairs and Environment

Water Resources Management Division

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Prepared by:
Brenda Greene
Environmental Scientist
Water Resources Management Division
Department of Municipal Affairs & Environment
brendagreene@gov.nl.ca

Real Time Water Quality Monitoring

Staff with the Department of Municipal Affairs and Environment monitors the real-time web pages regularly.

This deployment report discusses water quality related events occurring at four stations in the Voisey's Bay Network: Reid Brook at Outlet of Reid Pond; Camp Pond Brook below Camp Pond; Tributary to Reid Brook; and Reid Brook below Tributary.

On July 13, 2017, Vale Environment staff deployed real-time water quality monitoring instruments at the four real-time stations in the Voisey's Bay network. Instruments were removed by Vale Environment Staff on August 12, 2017. This was the second deployment of the 2017 season.

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. This procedure is based on the approach used by the United States Geological Survey.

At deployment and removal, a QA/QC instrument is temporarily deployed alongside the field instrument. Values for temperature, pH, conductivity, dissolved oxygen and turbidity are compared between the two instruments**.** Based on the degree of difference between parameters recorded by the field instrument and QA/QC instrument at deployment and at removal, a qualitative statement is made about the data quality (Table 1).

Table 1: Ranking classifications for deployment and removal

	Rank				
Parameter	**Excellent**	**Good**	**Fair**	**Marginal**	**Poor**
Temperature (oC)	<=+/-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 instrument is the most important. All other parameters can be broken down into three groups: temperature dependent; temperature compensated; and temperature independent. Because the temperature sensor is not isolated from the rest of the instrument, the entire instrument must be at the same temperature before the 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 rankings for the Voisey's Bay Network stations are summarized in Table 2.

Table 2: Comparison rankings for Voisey's Bay Network stations

Station Voisey's Bay	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Reid Brook at Outlet	July 13	Deployment	Excellent	N/A*	Excellent	Excellent	Excellent
	August 12	Removal	Excellent	Excellent	Excellent	Excellent	N/A*
Camp Pond Brook	July 13	Deployment	Excellent	N/A*	Excellent	Excellent	Excellent
	August 12	Removal	Excellent	Excellent	Poor	Excellent	N/A*
Reid Brook below Tributary	July 13	Deployment	Excellent	Fair	Excellent	Excellent	Excellent
	August 12	Removal	Excellent	Excellent	Excellent	Excellent	N/A*
Tributary to Reid Brook	July 13	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	August 12	Removal	Excellent	Excellent	Excellent	Excellent	N/A*

*Note: N/A = sensor failure

- **Reid Brook at Outlet of Reid Pond**
    - At deployment, temperature, conductivity, dissolved oxygen and turbidity all ranked as 'excellent', while the pH ranking was 'N/A' due to a sensor failure. Vale Environment staff replaced the field sonde at this location with their QA/QC sonde. The pH value provided by this instrument much more closely matched the grab sample result for pH.
    - At removal, temperature, pH, conductivity and dissolved oxygen all ranked as 'excellent', while turbidity was 'N/A'. Turbidity readings were off at all stations during removal, and so discrepancies are being attributed to a sensor failure on the QA/QC instrument.
- **Camp Pond Brook below Camp Pond**
    - At deployment, temperature, conductivity, dissolved oxygen and turbidity were all 'excellent', while pH was 'N/A'. The QA/QC instrument used at this location was the same instrument that was replaced at Reid Brook at Outlet of Reid Pond because of an inaccurate pH reading. The field sonde and grab sample pH values were much closer together, giving a QA/QC ranking of 'good'.
    - At removal, temperature, pH and dissolved oxygen were 'excellent', while conductivity was 'poor' and turbidity was 'N/A'. The discrepancy in conductivity could have been due to placement of the QA/QC sonde in comparison to the field sonde, or the sondes being given insuffient time to acclimate. Turbidity readings were off at all stations during removal, and so discrepancies are being attributed to a sensor failure on the QA/QC instrument.

- **Reid Brook below Tributary**
    - At deployment, temperature, conductivity, dissolved oxygen and turbidity all ranked as 'excellent', while pH was 'fair'. This discrepancy is likely due to the QA/QC sonde not being given sufficient time to acclimate and stabilize before a reading was taken.
    - At removal, temperature, pH, conductivity and dissolved oxygen all ranked as 'excellent', while turbidity was 'N/A'. Turbidity readings were off at all stations during removal, and so discrepancies are being attributed to a sensor failure on the QA/QC instrument.
- **Tributary to Reid Brook**
    - At deployment, all water quality parameters were ranked as either 'Excellent' or 'Good'.
    - At removal, temperature, pH, conductivity and dissolved oxygen were 'excellent', while turbidity was 'N/A'. Turbidity readings were off at all stations during removal, and so discrepancies are being attributed to a sensor failure on the QA/QC instrument.

It is important to note that, in general, there are several conditions under which a less than ideal QA/QC ranking may be obtained. These include, but are not limited to: placement of the QA/QC sonde in relation to the field sonde; the amount of time each sonde is given to stabilize before readings are recorded; and deteriorating performance of one or more sensors.

Data Interpretation

The following graphs and discussion illustrate significant water quality-related events from July 13th to August 12th, 2017 in the Voisey's Bay Real-Time Water Quality Monitoring Network.

With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion below adhere to stringent QA/QC protocol. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

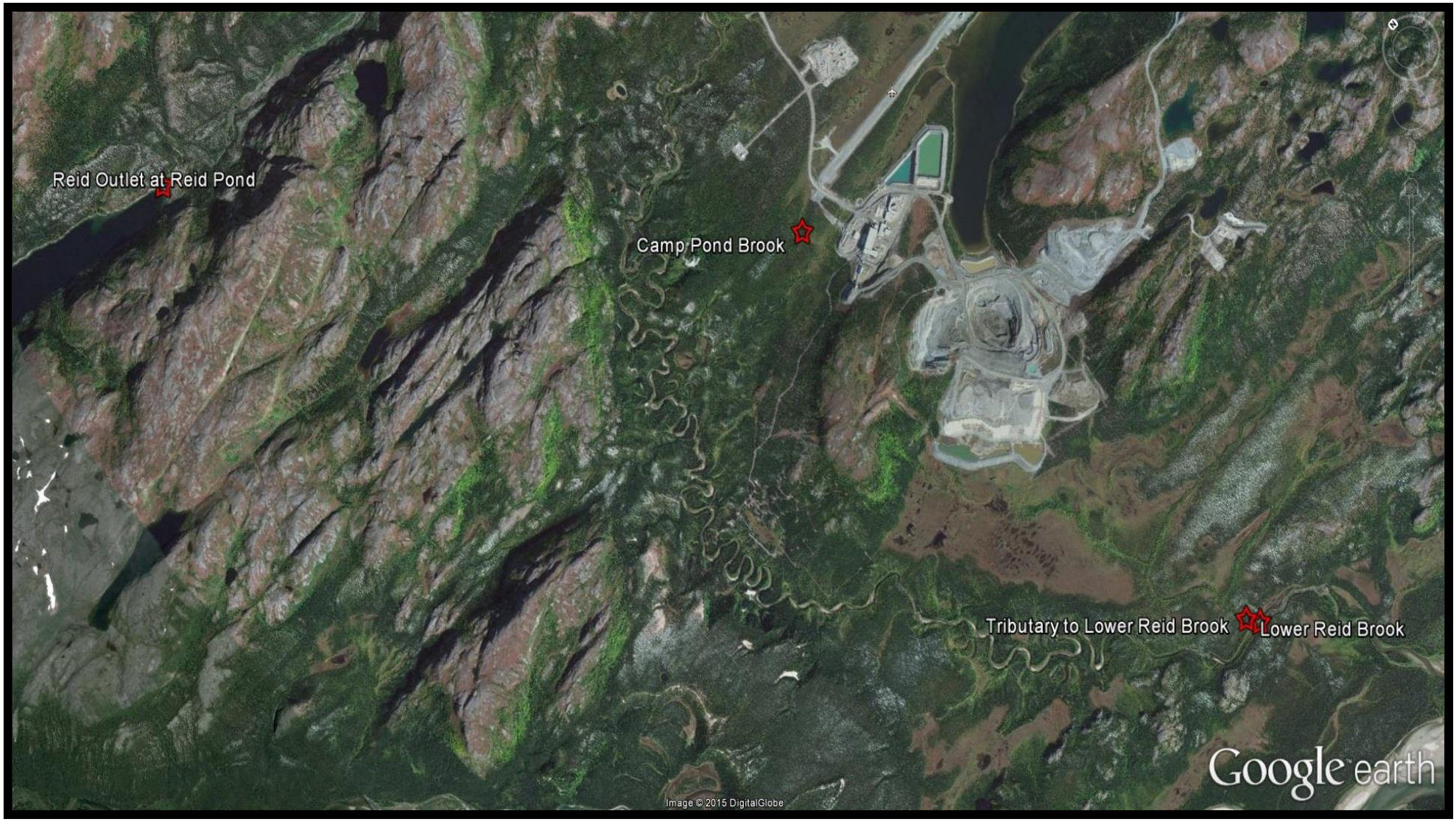

Figure 1: Voisey's Bay Network Station Locations

Reid Brook at Outlet of Reid Pond

Water Temperature

Over the deployment period, water temperature ranged from 7.82 ^{o}C to 14.86 ^{o}C, with a median value of 10.30^{o}C (Figure 2). Temperature increased over the course of deployment, which is to be expected with higher ambient air temperatures during the summer months (Figure 3).

Significant increases in water temperature occurred on July 18th, July 26th and August 4th (Figure 2). This is likely a result of the warmer air temperatures occurring during the same time frame (Figure 3). This water body takes longer to acclimatize to changes in temperature as it has a larger surface area than the brooks.

Please note that the stage data is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC. Average Daily Air Temperature was retrieved from Environment Canada's Weather Station in Nain.

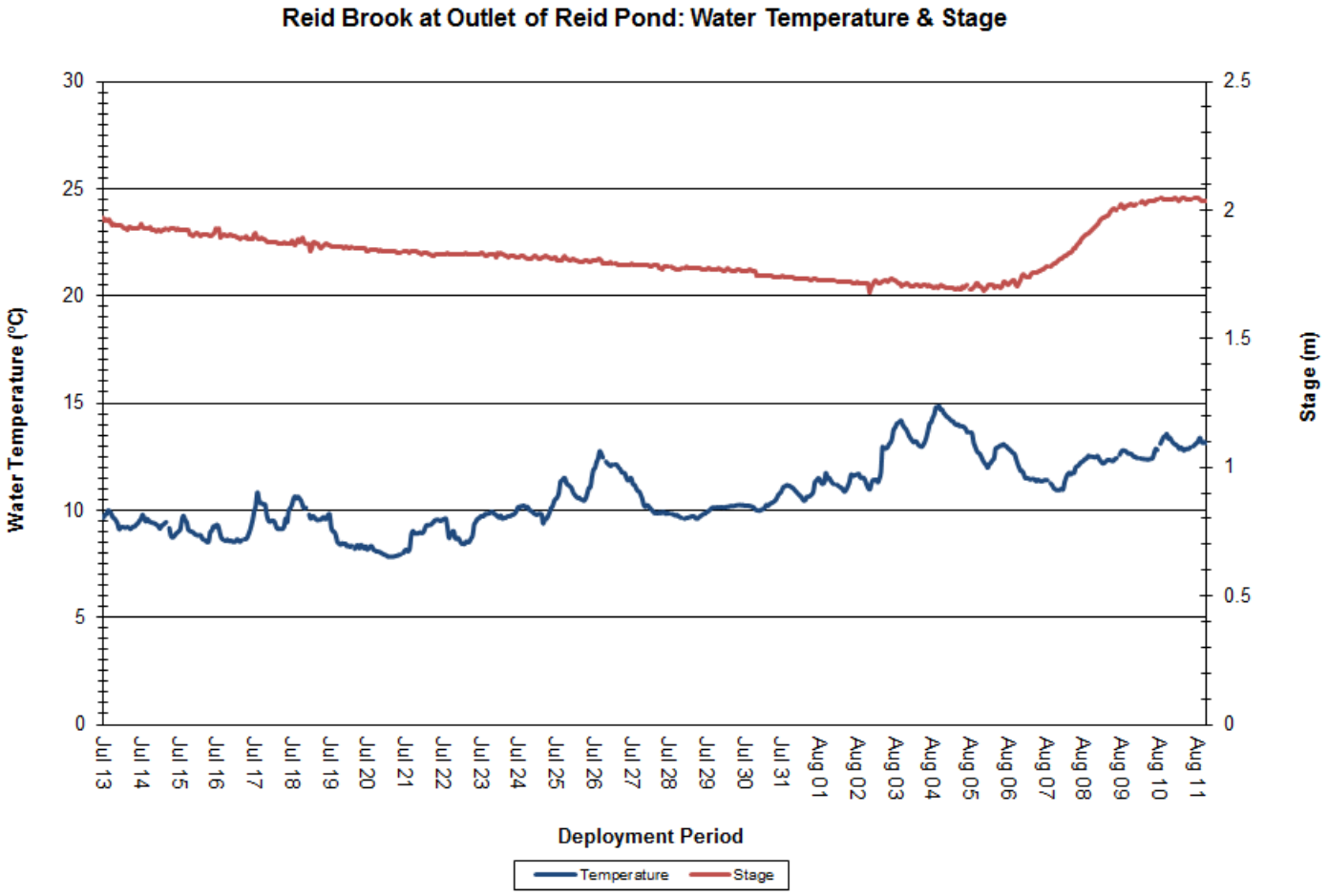

Figure 2: Water Temperature & Stage at Reid Brook at Outlet of Reid Pond

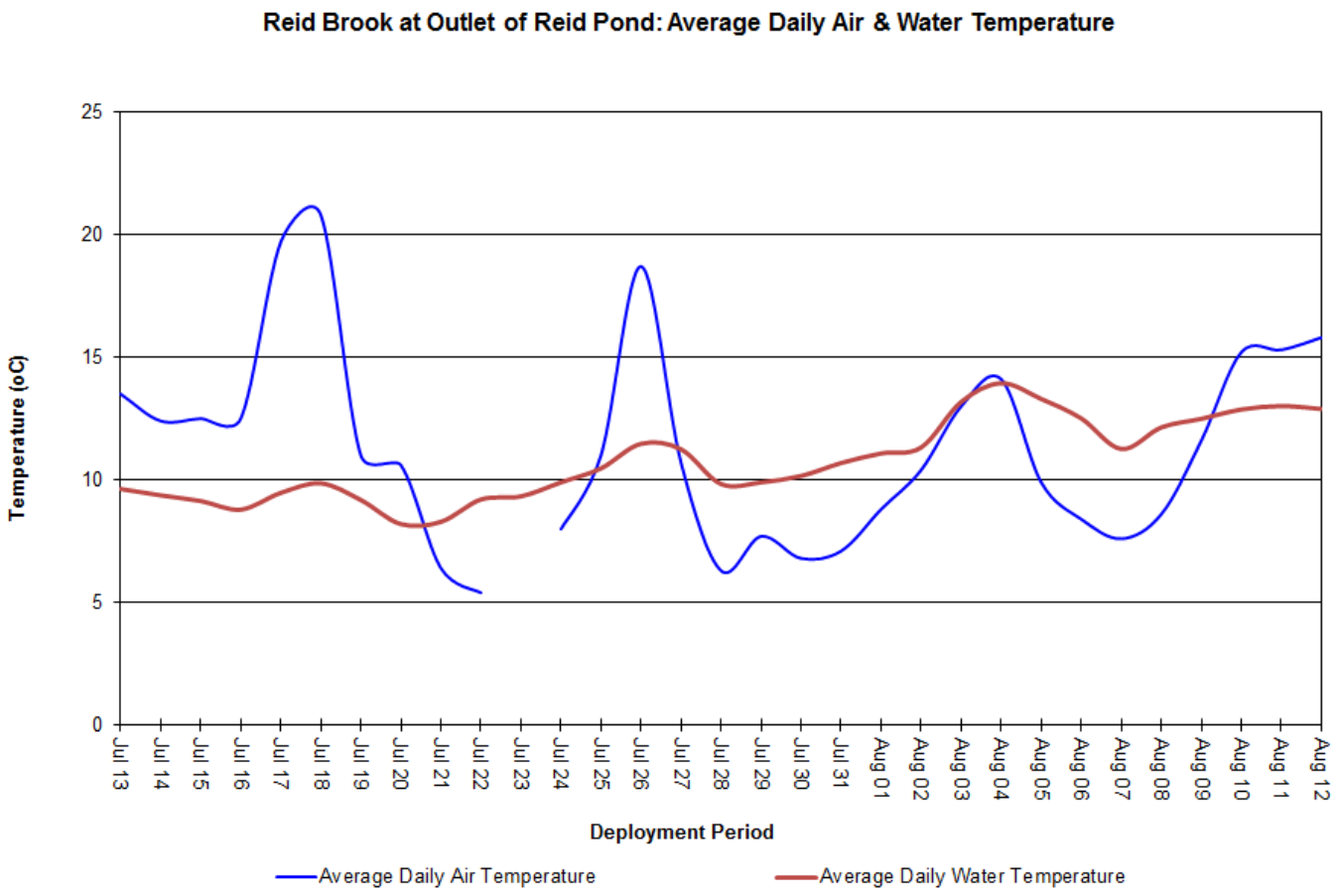

Figure 3: Average Daily Water Temperature at Reid Brook at Outlet of Reid Pond and Average Daily Air Temperature at Nain Weather Station

pH

Over the deployment period, pH values ranged from 6.57 to 7.22 pH units, with a median value of 6.88 pH units (Figure 4).

pH levels are quite consistent across the deployment period, and fall within the CCME Guidelines for Protection of Aquatic Life.

Please note that the stage data used below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

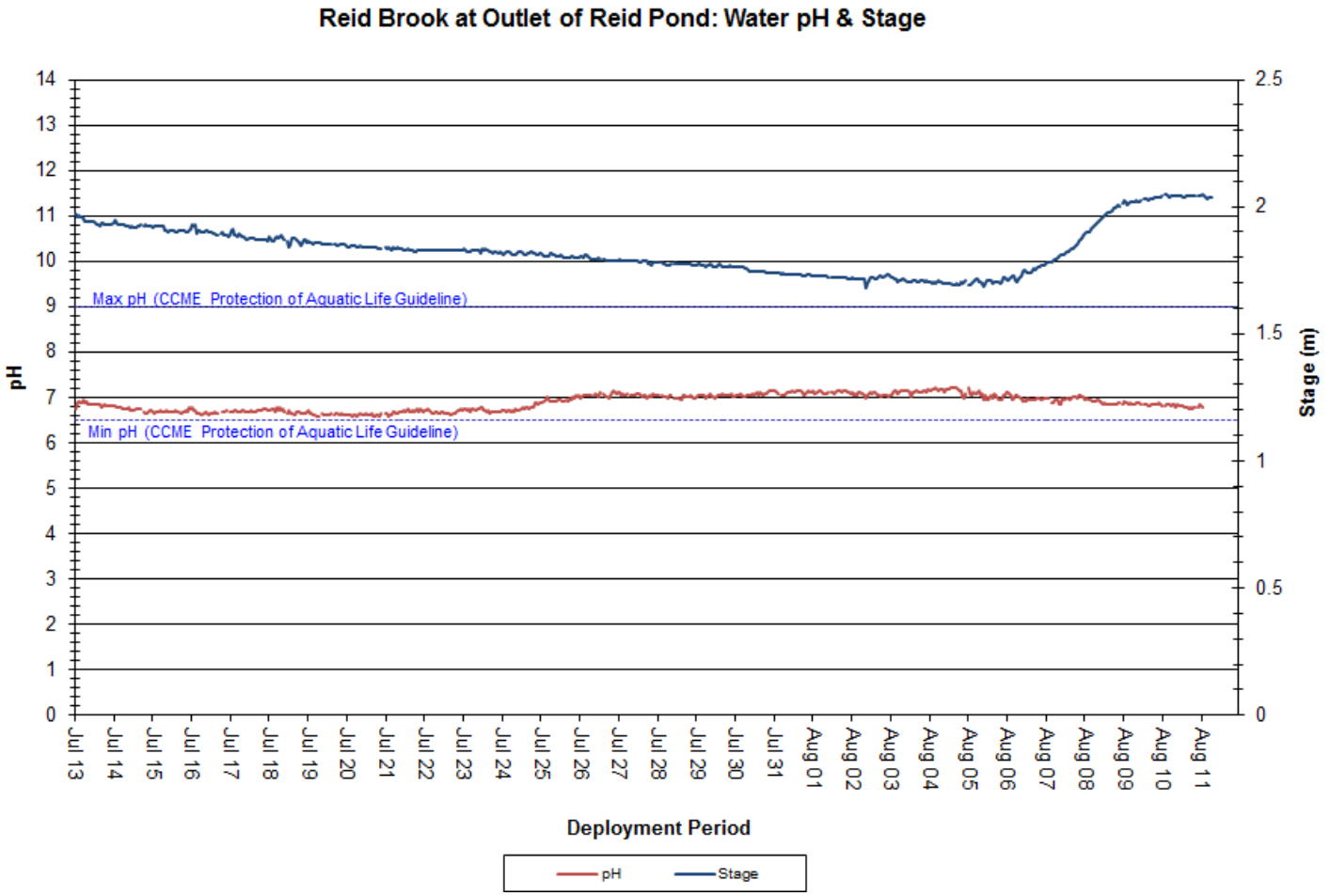

Figure 4: pH & Stage at Reid Brook at Outlet of Reid Pond

Specific Conductivity

Over the deployment period, conductivity levels ranged from 11.8µS/cm to 12.4µS/cm, with a median value of 12.1µS/cm. Conductivity remains very stable at Reid Brook; this is to be expected as this site is pristine and quite far from any anthropogenic disturbances that could affect water quality.

The relationship between conductivity and stage level is generally inversed. When stage levels decrease, specific conductance levels increase in response, as the decreased amount of water in the river system concentrates solids that are present. Similarly, as stage levels rise, conductivity levels will decrease in response (Figure 5).

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

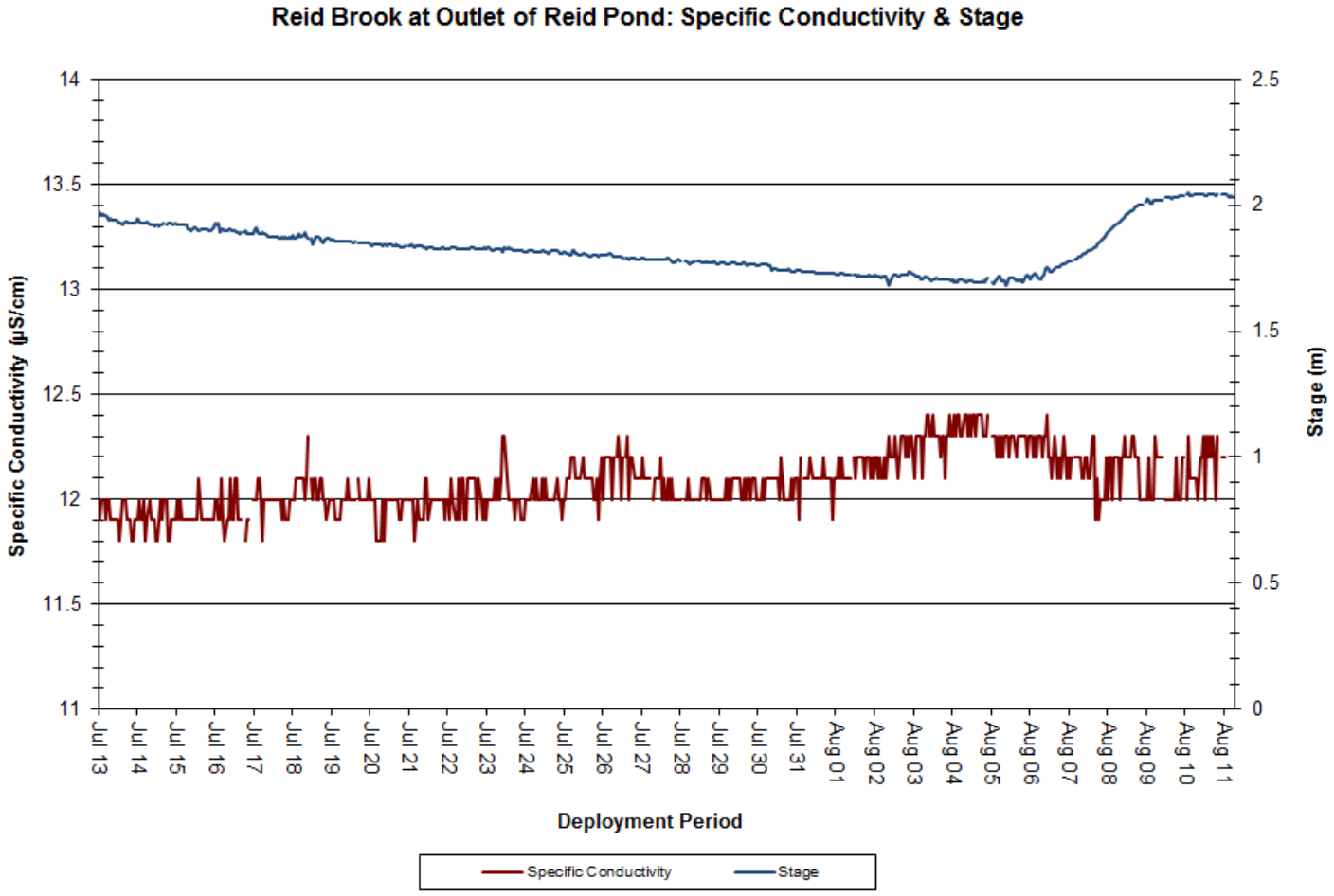

Figure 5: Specific Conductivity & Stage at Reid Brook at Outlet of Reid Pond

Dissolved Oxygen

The water quality instrument measures dissolved oxygen concentration (mg/L) with a dissolved oxygen probe. The instrument then calculates percent saturation (% Sat) taking into account water temperature.

Over the deployment period, dissolved oxygen concentration ranged from 10.64mg/L to 12.12mg/L, with a median value of 11.54mg/L. Percent saturation levels ranged from 99.4% to 107.6% saturation, with a median value of 102.9% saturation (Figure 6).

Dissolved oxygen levels were slowly decreasing over the course of deployment, a trend that is to be expected as water temperatures increase. A waterbody will have higher dissolved oxygen levels at cooler temperatures, and vice versa. Dissolved oxygen concentrations remained above the CCME's Guideline for the Protection of Early Life Stages (9.5 mg/L) for the duration of deployment.

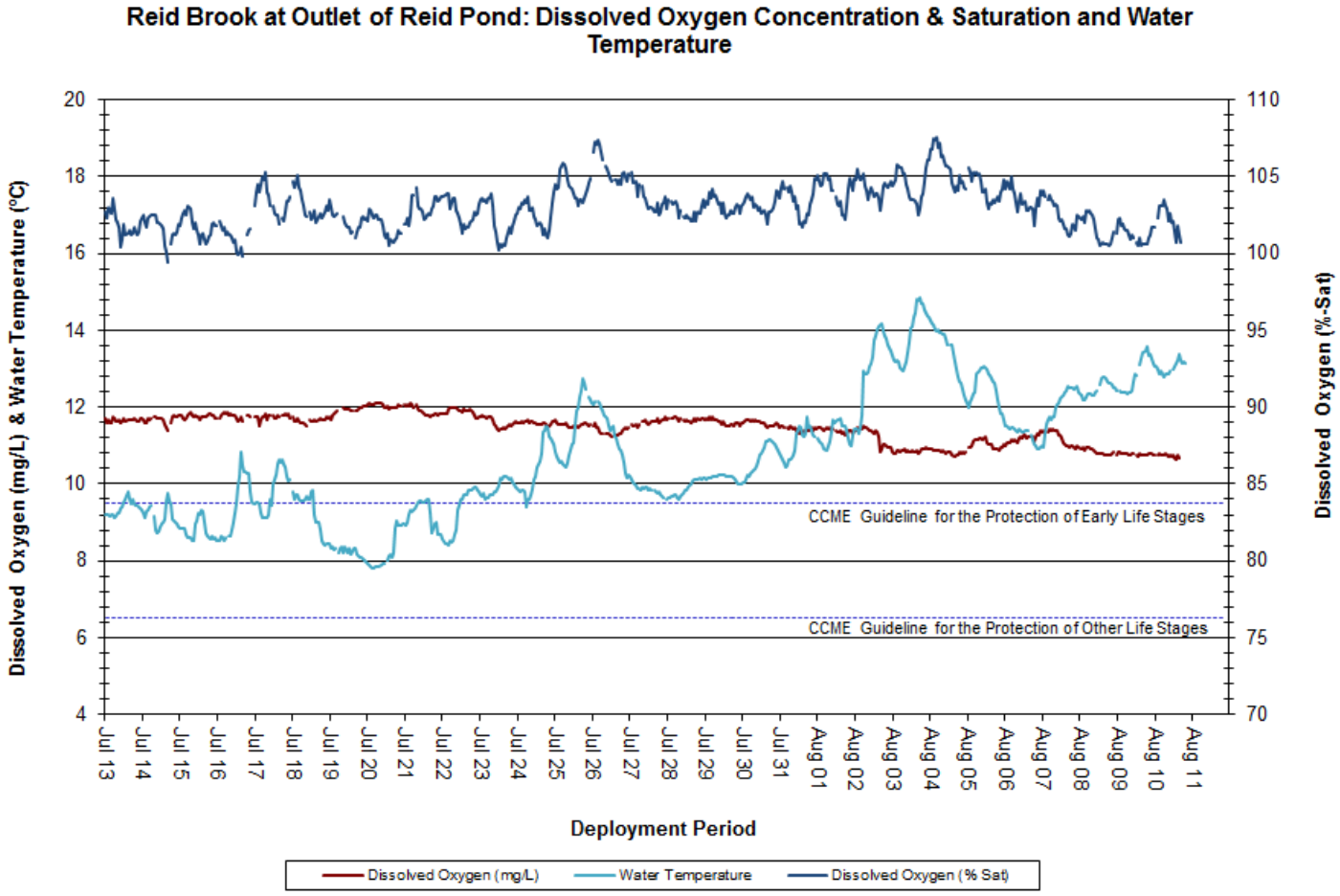

Figure 6: Dissolved Oxygen (mg/L & % Sat) and Water Temperature at Reid Brook at Outlet of Reid Pond

Turbidity

Turbidity levels during deployment remained at 0.0 NTU (Figure 7). A median value of 0.0 NTU indicates there was very little natural background turbidity at this station during this deployment period.

All water bodies have a natural level of turbidity. A significant increase in turbidity is of concern when monitoring brooks. Higher turbidity readings would normally be expected during heavy rainfall or runoff events. Generally, turbidity levels increase for a short period of time and then return to within a baseline range.

Turbidity values can also increase when there is a decrease in water level, which causes natural material in the water body to become concentrated.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

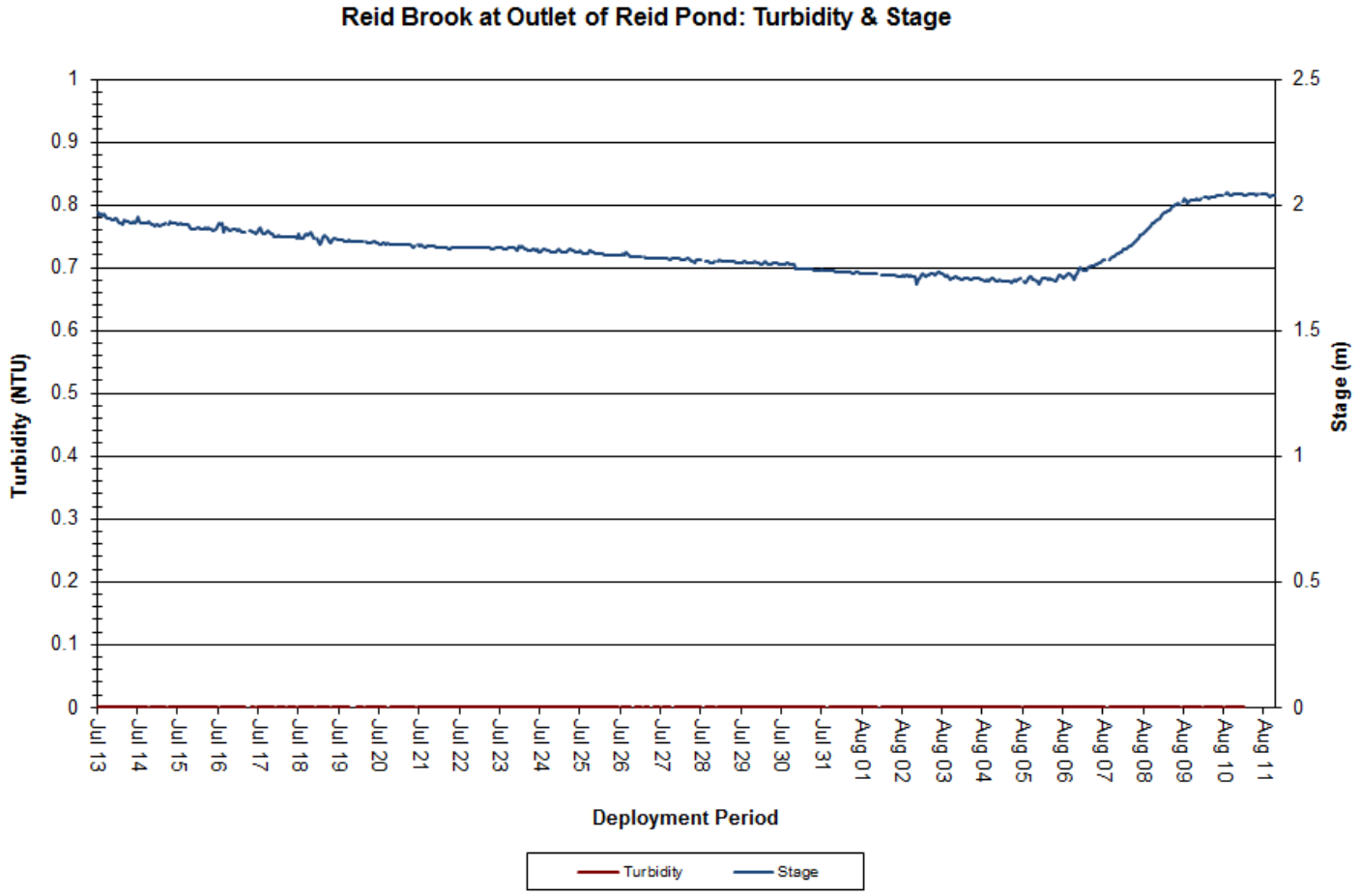

Figure 7: Turbidity & Stage at Reid Brook at Outlet of Reid Pond

Stage, Flow & Precipitation

Stage is an important parameter, as it provides an estimation of water level at the station and can explain some of the events that are occurring with other parameters (e.g. specific conductivity, DO, and turbidity). Stage will generally increase during rainfall events (Figure 8) and during any surrounding snow or ice melt; however, direct snowfall will not cause a significant increase in stage.

Over the deployment period, stage values ranged from 1.68m to 2.05m, with a median value of 1.82m. Flow values ranged from 0.79m^3/s to 3.99m^3/s, with a median value of 1.63m^3/s. Precipitation data was obtained from Nain Weather Station. Precipitation amounts during the deployment period ranged from 0.0 mm to 23.8 mm on August 8th, 2017.

Please note that the stage data graphed below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

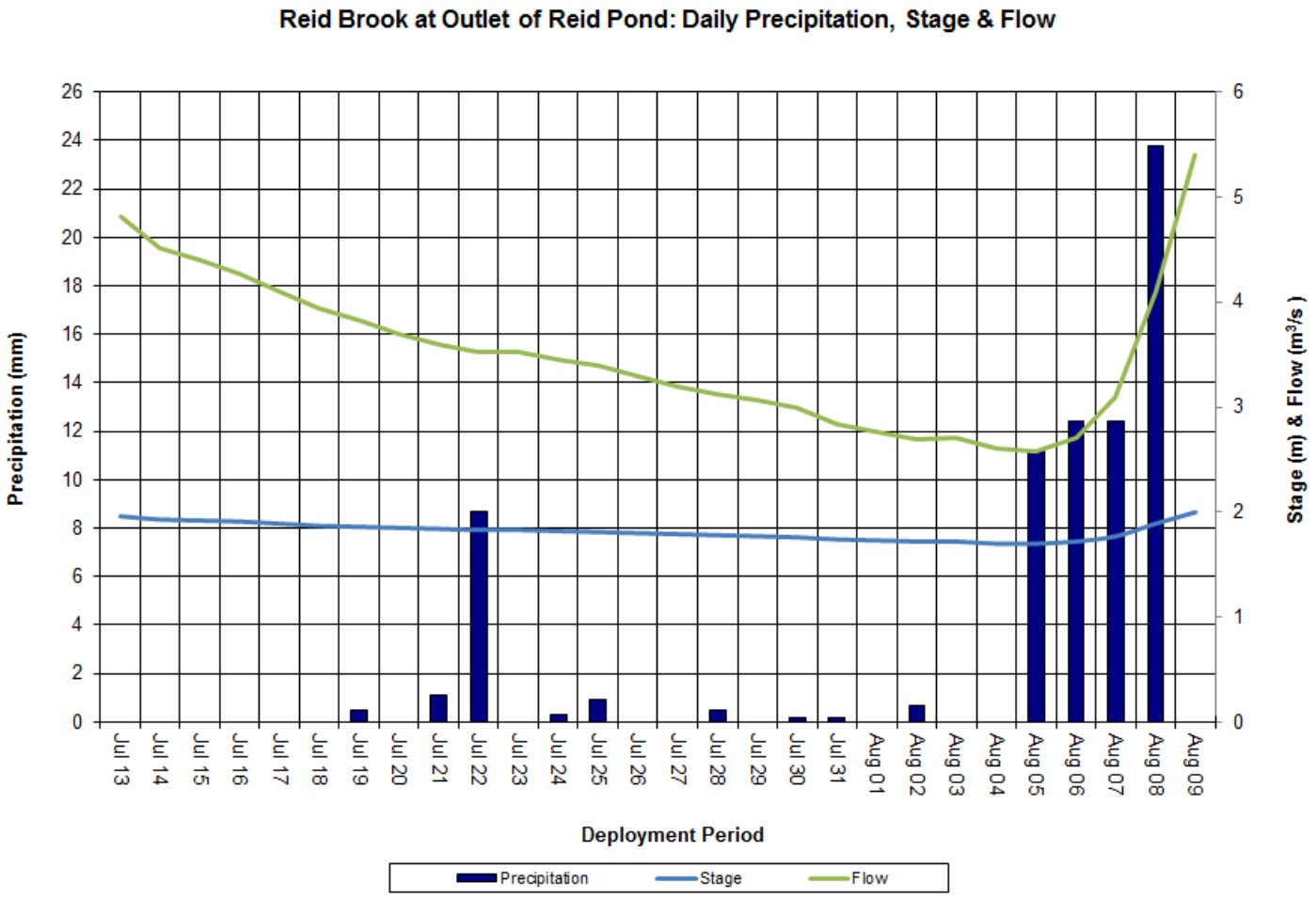

Figure 8: Daily Stage and Flow data from Reid Brook at Outlet of Reid Pond and Total Daily Precipitation from Nain Weather Station

Camp Pond Brook below Camp Pond

Water Temperature

Over the deployment period, water temperature ranged from 10.71°C to 20.52°C, with a median value of 14.76 °C (Figure 9).

The water temperature at this station displays diurnal variations. There is a slow gradual increase in water temperature over the course of deployment. This is to be expected as air temperature increases through the summer months (Figure 10).

This stream is sensitive to changes in the ambient air temperature and fluctuates considerably depending on the weather and time of day. This station typically has the highest water temperatures and greatest fluctuations when compared to the other stations in the network.

Please note that the stage data graphed below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

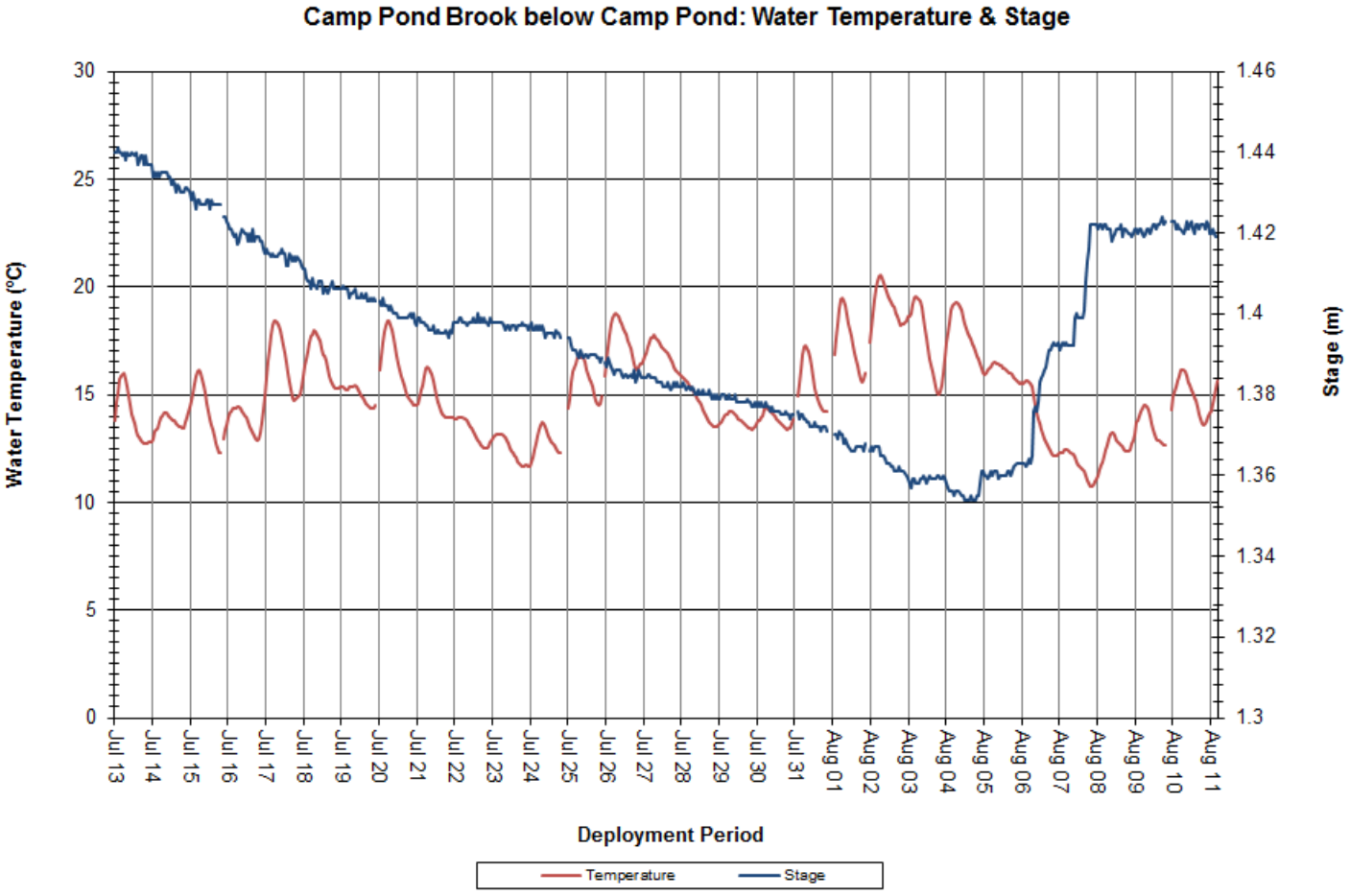

Figure 9: Water Temperature & Stage at Camp Pond Brook below Camp Pond

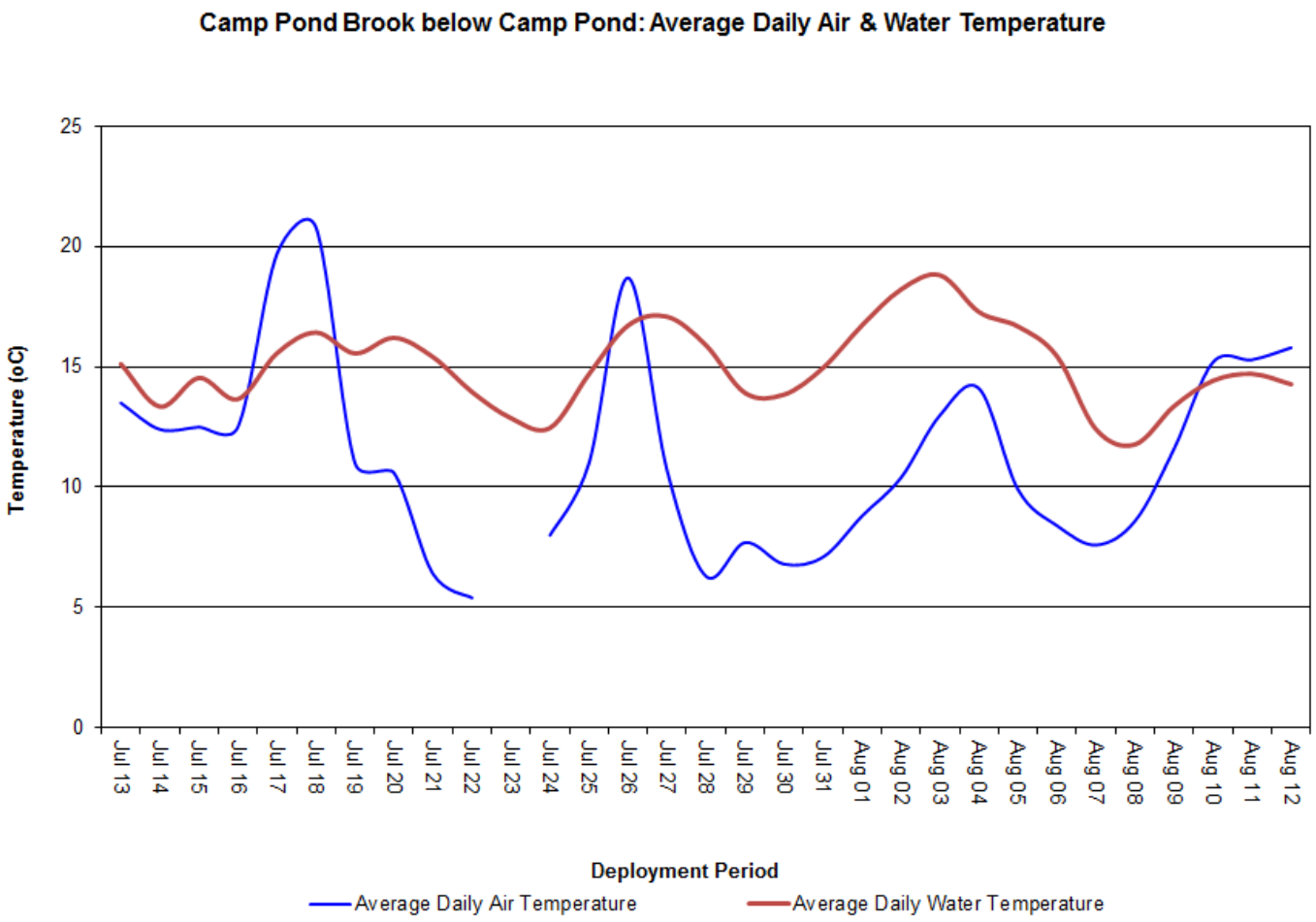

Figure 10: Average Daily Water Temperature at Camp Pond Brook below Camp Pond and Average Daily Air Temperature at Nain Weather Station

pH

Over the deployment period, pH values ranged from 6.67 to 7.12 pH units, with a median value of 6.93 pH units (Figure 11).

The pH levels are consistent during deployment, staying within the Guidelines for the Protection of Aquatic Life.

Natural events such as rainfall and snow melt will alter the pH of a brook for a period of time - pH levels will decrease slightly during and after high stage levels. This is a natural process.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

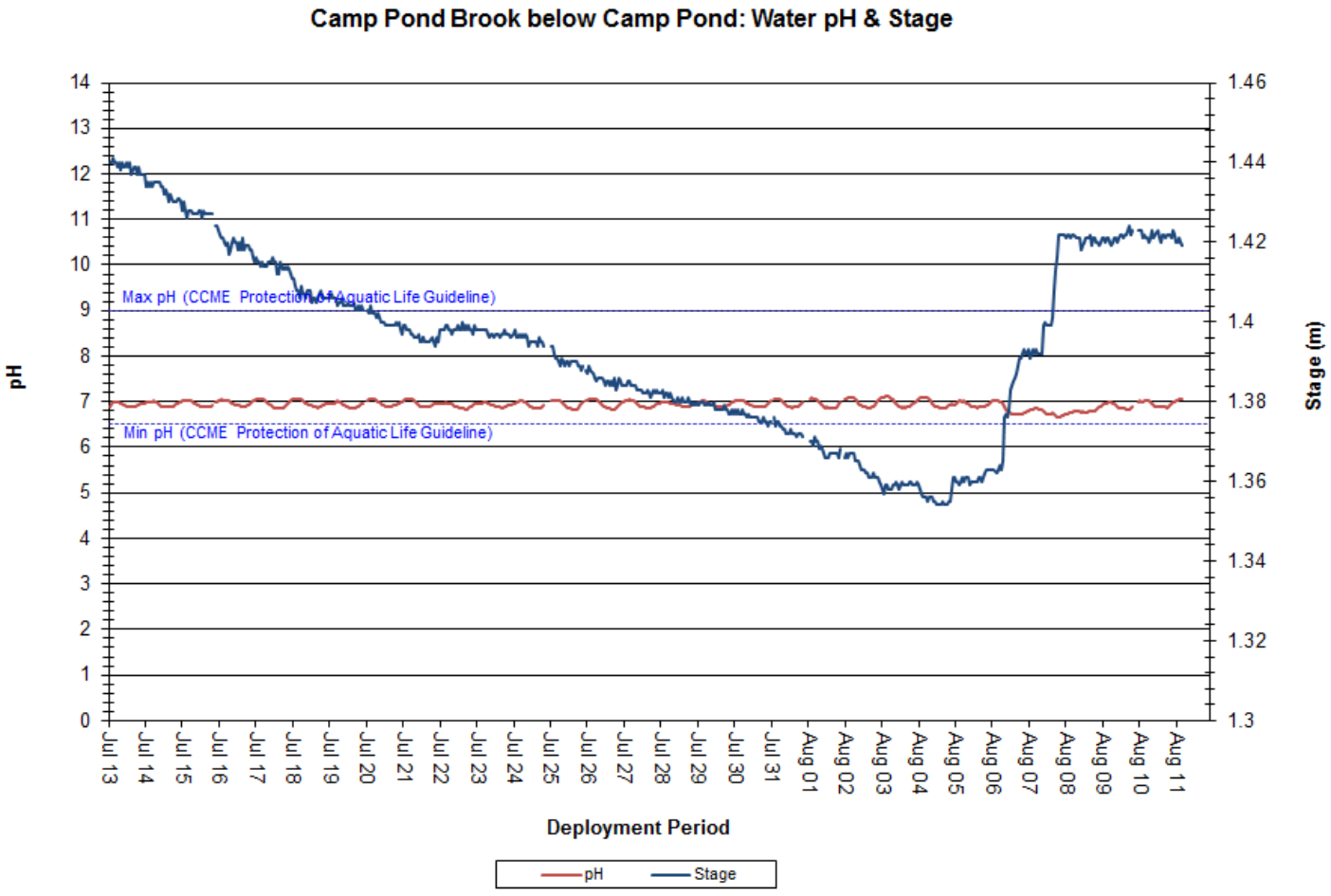

Figure 11: Water pH & Stage at Camp Pond Brook below Camp Pond

Specific Conductivity

Specific conductivity ranged from 28.1 µS/cm to 45.8 µS/cm, with a median value of 31.1 µS/cm (Figure 12).

Heavy rainfall from August 5th through August 8th (Figure 15) corresponds with several sharp increases in conductivity levels. This indicates that additional suspended material was entering the brook during this period of time.

Over the entire deployment period conductivity levels are slowly increasing. This increase correlates with decreasing water levels, which cause suspended materials in the water column to become more concentrated.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

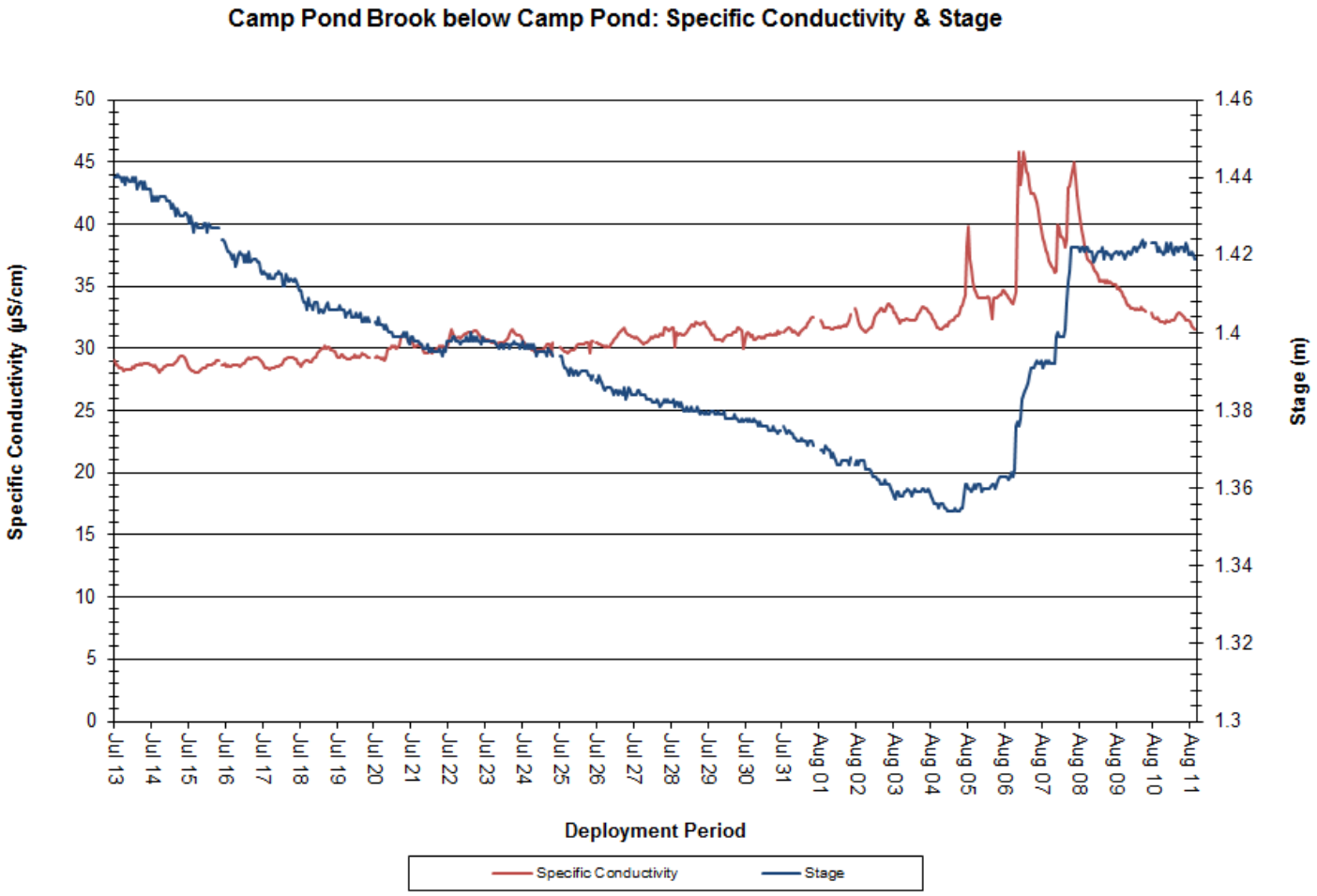

Figure 12: Specific Conductivity & Stage at Camp Pond Brook below Camp Pond

Dissolved Oxygen (mg/L & % Saturation)

Dissolved oxygen concentration levels ranged from 8.61 to 10.72 mg/L, with a median value of 9.87 mg/L. Saturation of dissolved oxygen ranged from 90.7% to 103.9% saturation, with a median value of 96.6% (Figure 13).

Dissolved oxygen concentrations fell below the CCME Guideline for the Protection of Early Life Stages (9.5mg/L) at various points during the deployment period. These occurrences generally correspond with warmer water temperatures (Figure 13). This is expected as water temperature directly influences the level of dissolved oxygen present in the water column.

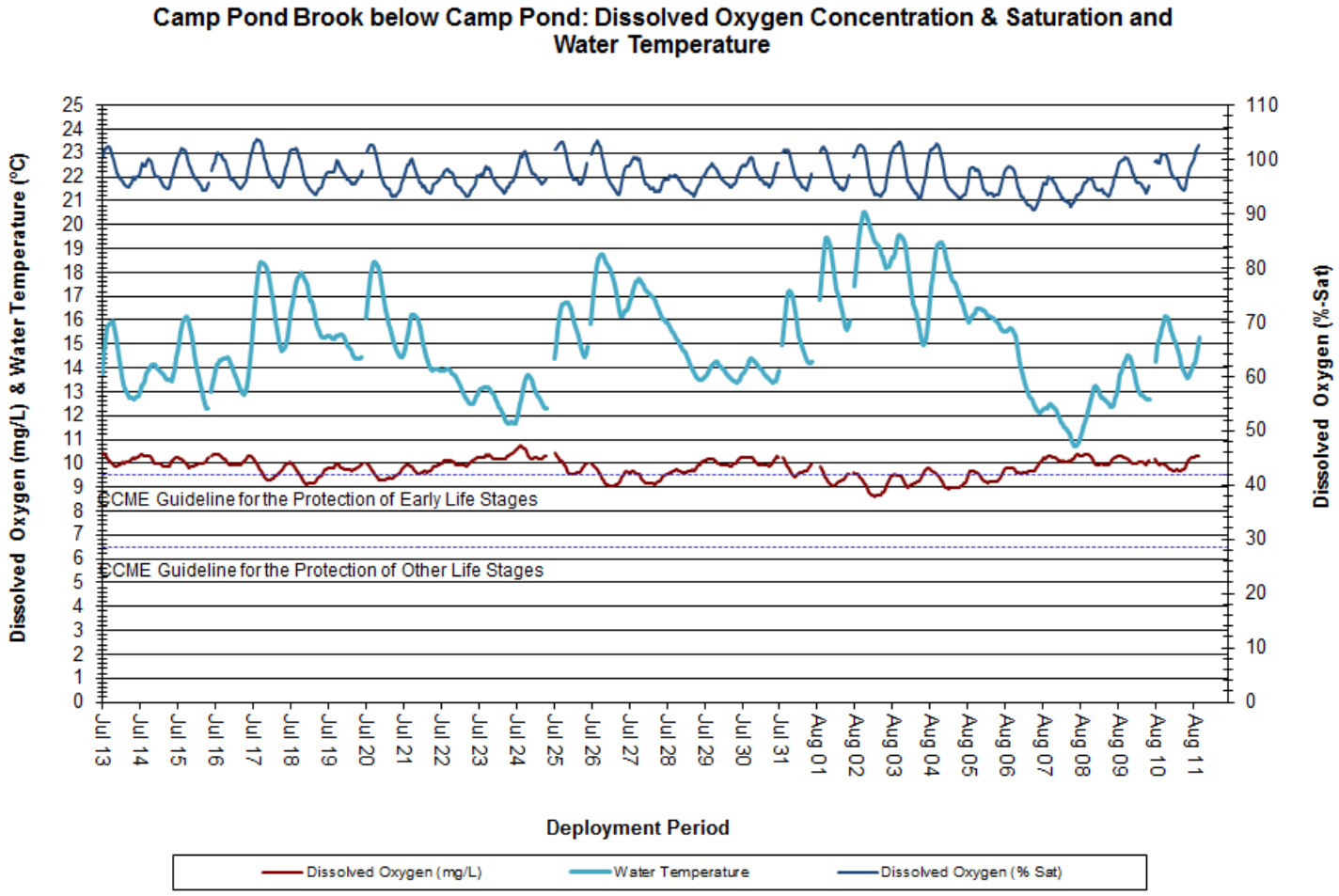

Figure 13: Dissolved Oxygen & Water Temperature at Camp Pond Brook below Camp Pond

Turbidity

Across the deployment period, turbidity ranged from 0.0NTU to 1509.0NTU, with a median value of 0.0NTU (Figure 14). A median value of 0.0NTU indicates there is very little natural background turbidity at this station.

The few turbidity spikes observed during this deployment period are short-lived and correlate closely with heavy rainfall events from August 5th through August 8th (Figure 15). Turbidity levels return to background levels following this rainfall event.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

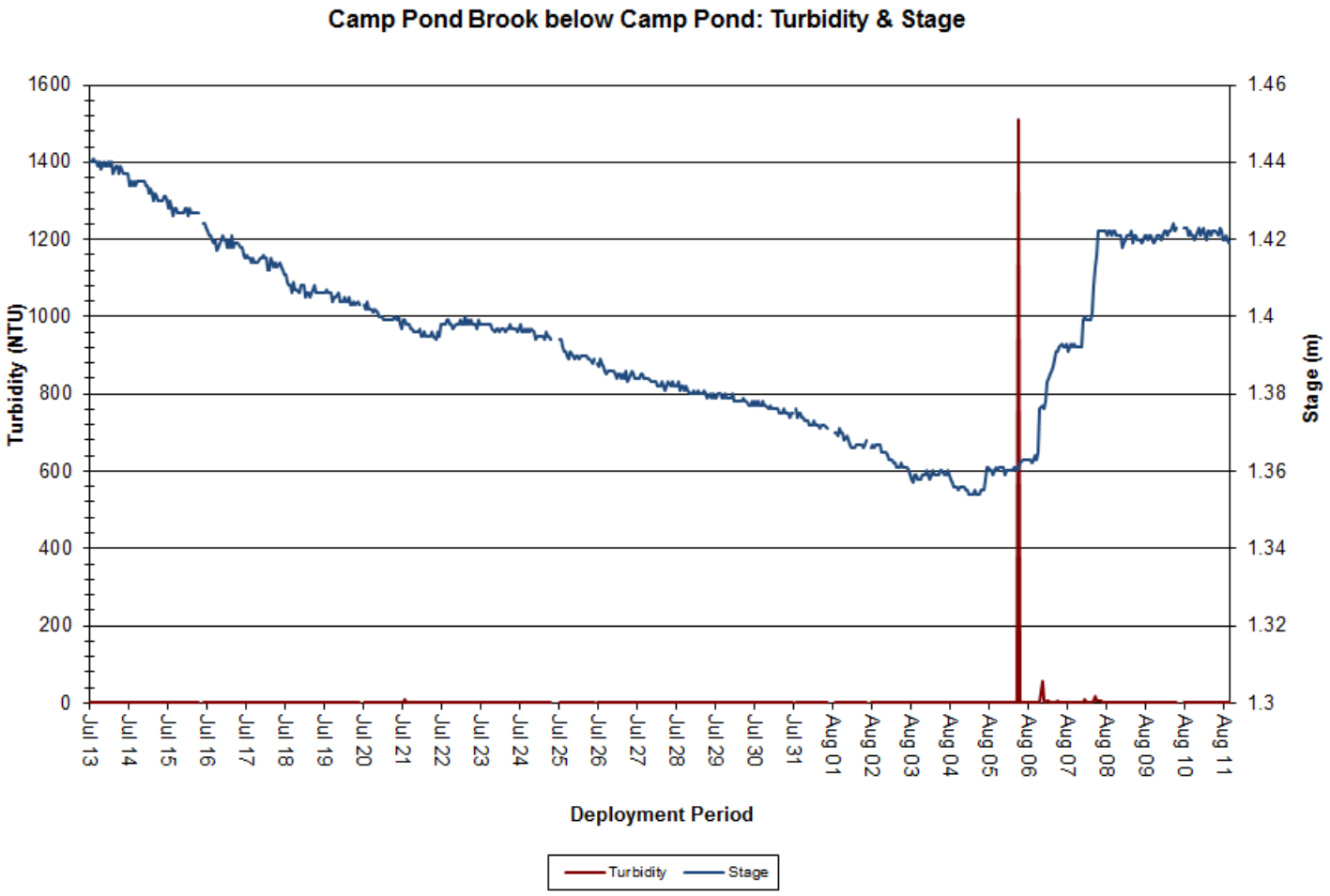

Figure 14: Turbidity & Stage at Camp Pond Brook below Camp Pond

Stage, Flow and Precipitation

Stage values ranged from 1.35m to 1.44m, with a median value of 1.40m.

Flow ranged from 0.17 to 0.49m^3/s, with a median value of 0.33m^3/s.

Precipitation occurs on 14 days during the deployment period, ranging from 0.0mm to 23.8mm. Extended heavy precipitation events from August 5th through August 8th correlate with increases in both stage and flow.

Please note the stage data graphed below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

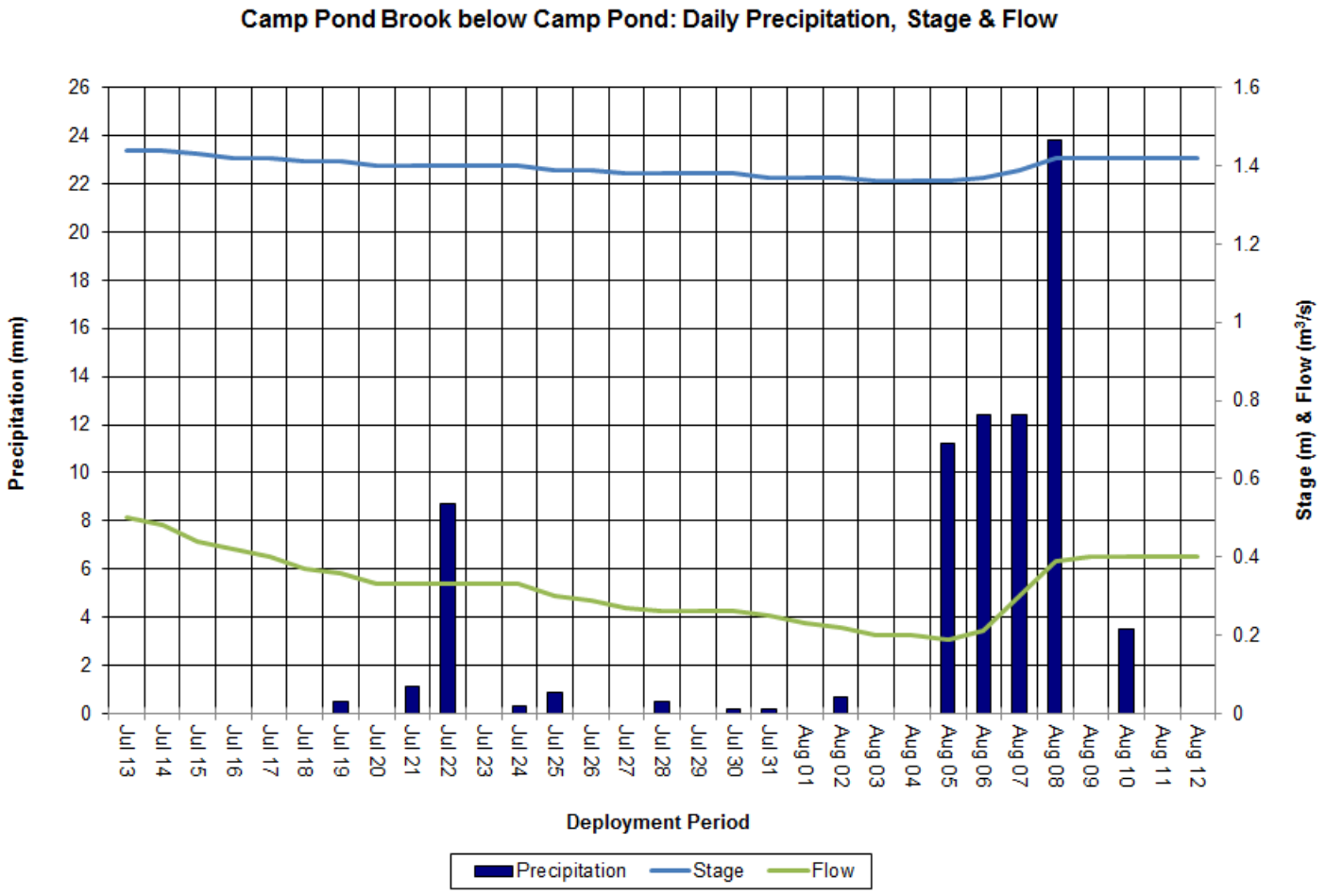

Figure 15: Daily Stage & Flow data from Camp Pond Brook below Camp Pond and Total Daily Precipitation from Nain Weather Station

Reid Brook below Tributary

Water Temperature

Over the deployment period, water temperature ranged from 9.07 ^{o}C to 16.81 ^{o}C, with a median value of 11.98^{o}C (Figure 16).

Water temperature at this station displays diurnal variations, and gradually increased over the course of deployment. This is to be expected as air temperatures also increase (Figure 17).

This graph displays the relationship between stage and water temperature. As stage decreases up to August 5th, water temperatures generally increase. An increase in stage and decrease in water temperature from August 5th through August 8th correlates to a heavy precipitation event (Figure 22). As stage begins to decrease after August 8th, water temperature begins to increase again.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

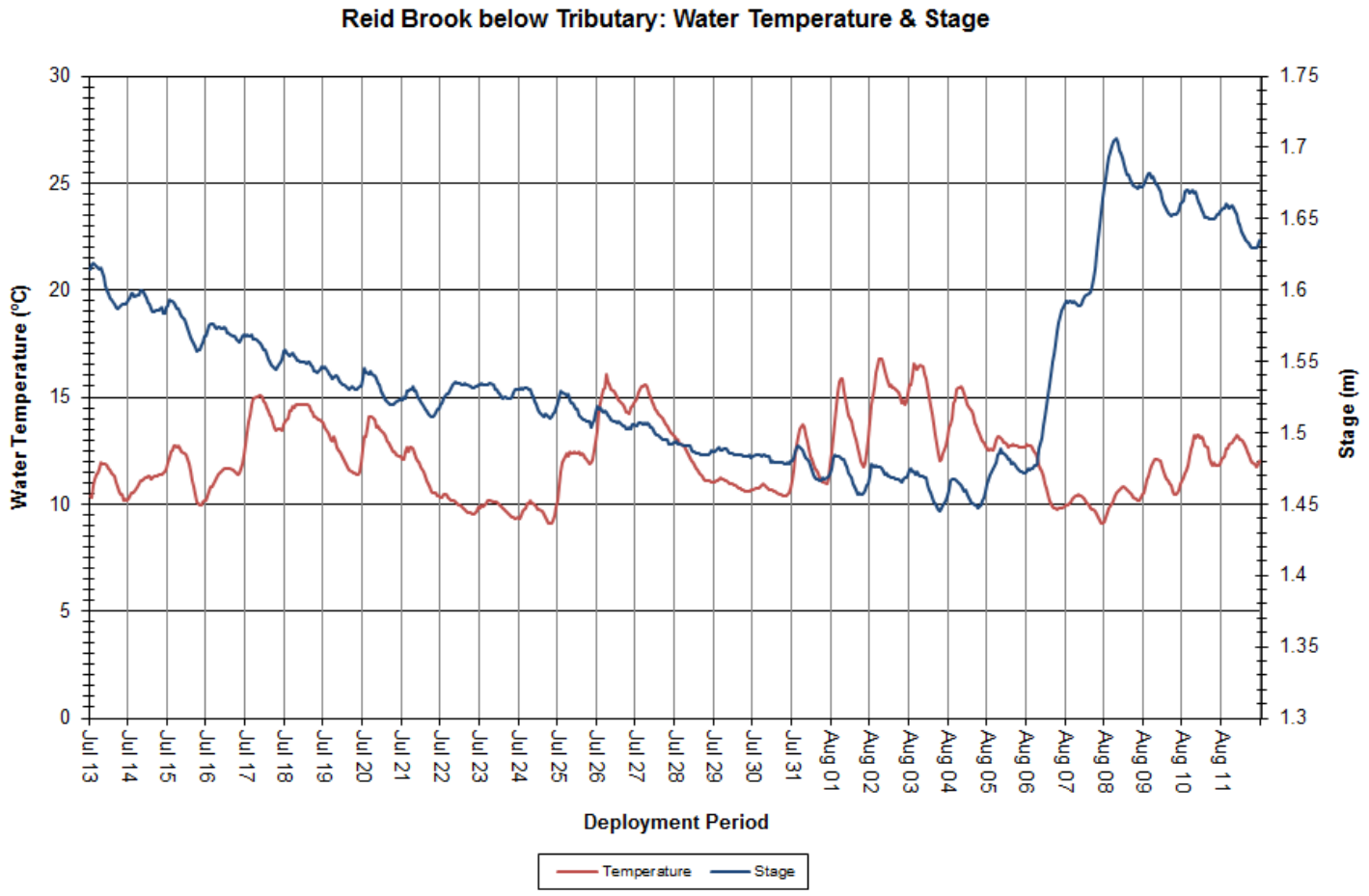

Figure 16: Water Temperature & Stage at Reid Brook below Tributary

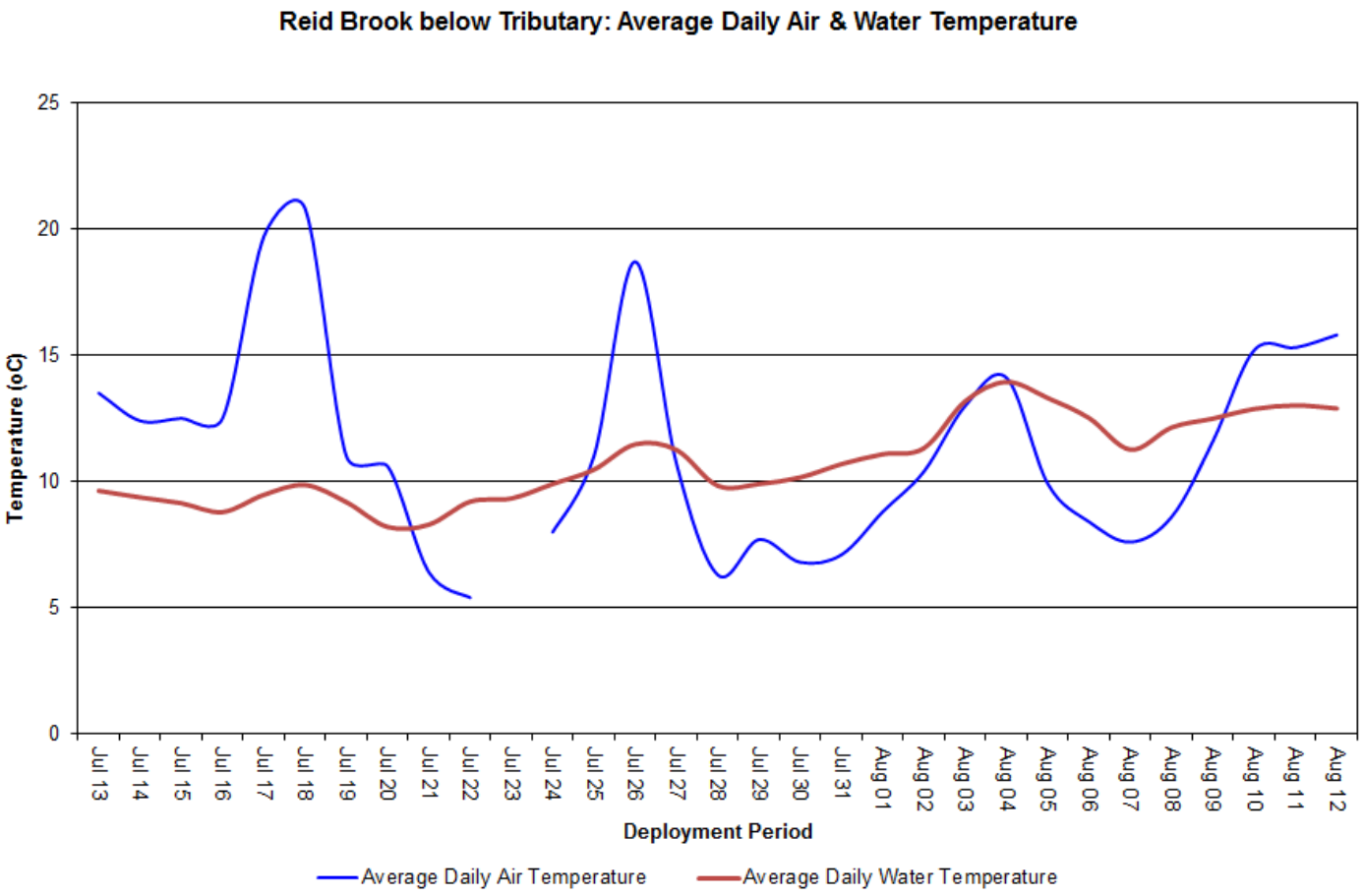

Figure 17: Average Daily Water Temperature at Reid Brook below Tributary and Average Daily Air Temperature from Nain Weather Station

pH

During deployment, pH ranged from 6.59 to 7.48 pH units, with a median value of 7.15 (Figure 18).

pH remains within the CCME Guidelines for the Protection of Aquatic Life for the duration of deployment. The significant decrease in pH levels around August 6th correlates closely with a heavy precipitation event, which can cause a water body to become slightly more acidic. pH returns to background levels after the precipitation event ends around August 10th. Overall, pH levels at this station are reasonably consistent.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

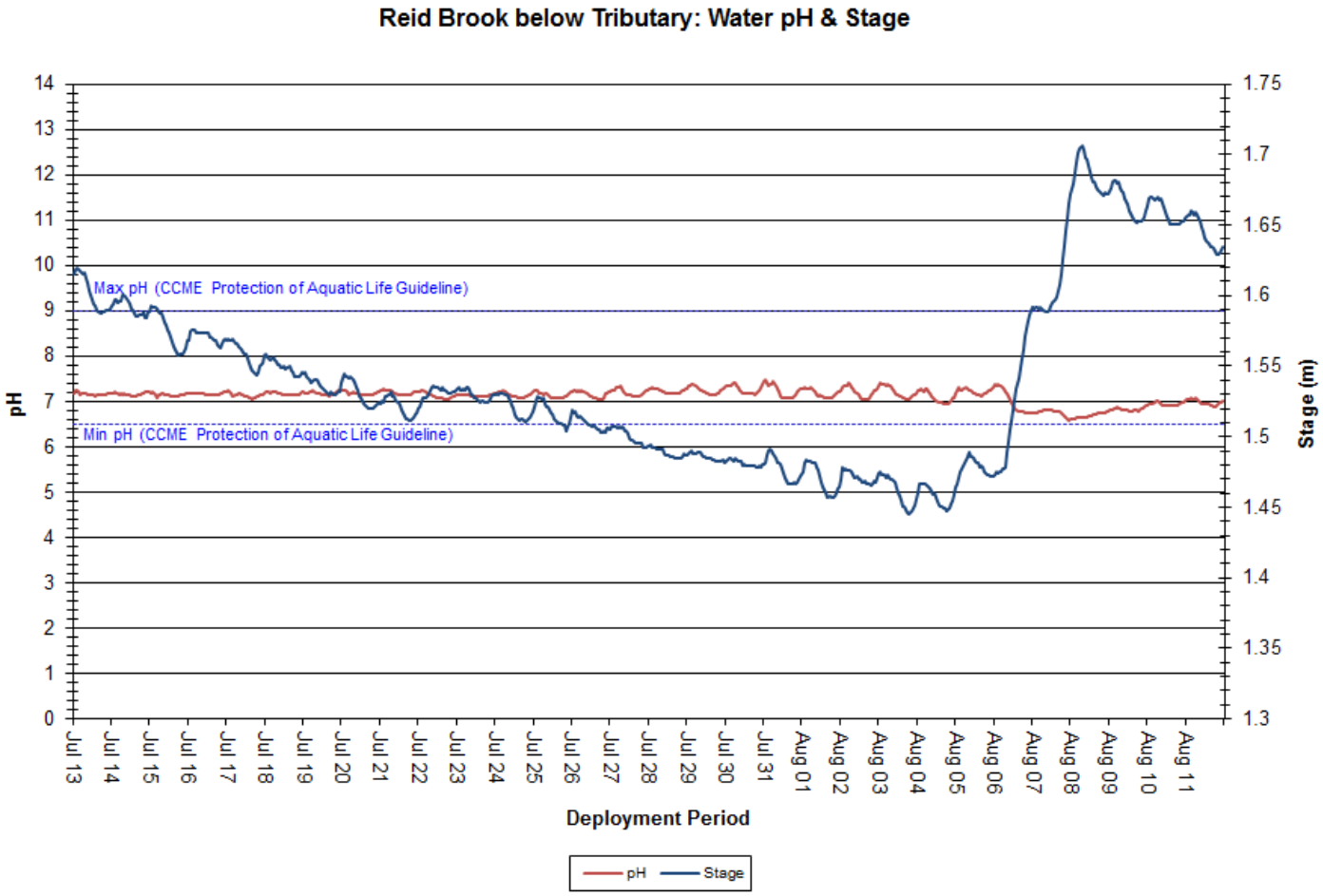

Figure 18: pH & Stage at Reid Brook below Tributary

Specific Conductivity

Specific conductivity ranged from 26.3µS/cm to 36.7µS/cm, with a median value of 30.5µS/cm (Figure 19).

Stage and specific conductivity exhibit an inverse relationship in the graph below: as one parameter increases, the other decreases. This is likely a result of dissolved solids being flushed through the brook for short periods of time. For example, a significant rainfall event between August 5th and August 8th (Figure 22) increased stage and decreased conductivity simultaneously.

Over the deployment period, conductivity levels gradually increase; this trend is to be expected as water levels decline with the change in season (Figure 19). An obvious exception is during the precipitation event from August 5th through August 8th whereby the conductivity levels dropped, after which conductivity again exhibits an increasing trend.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

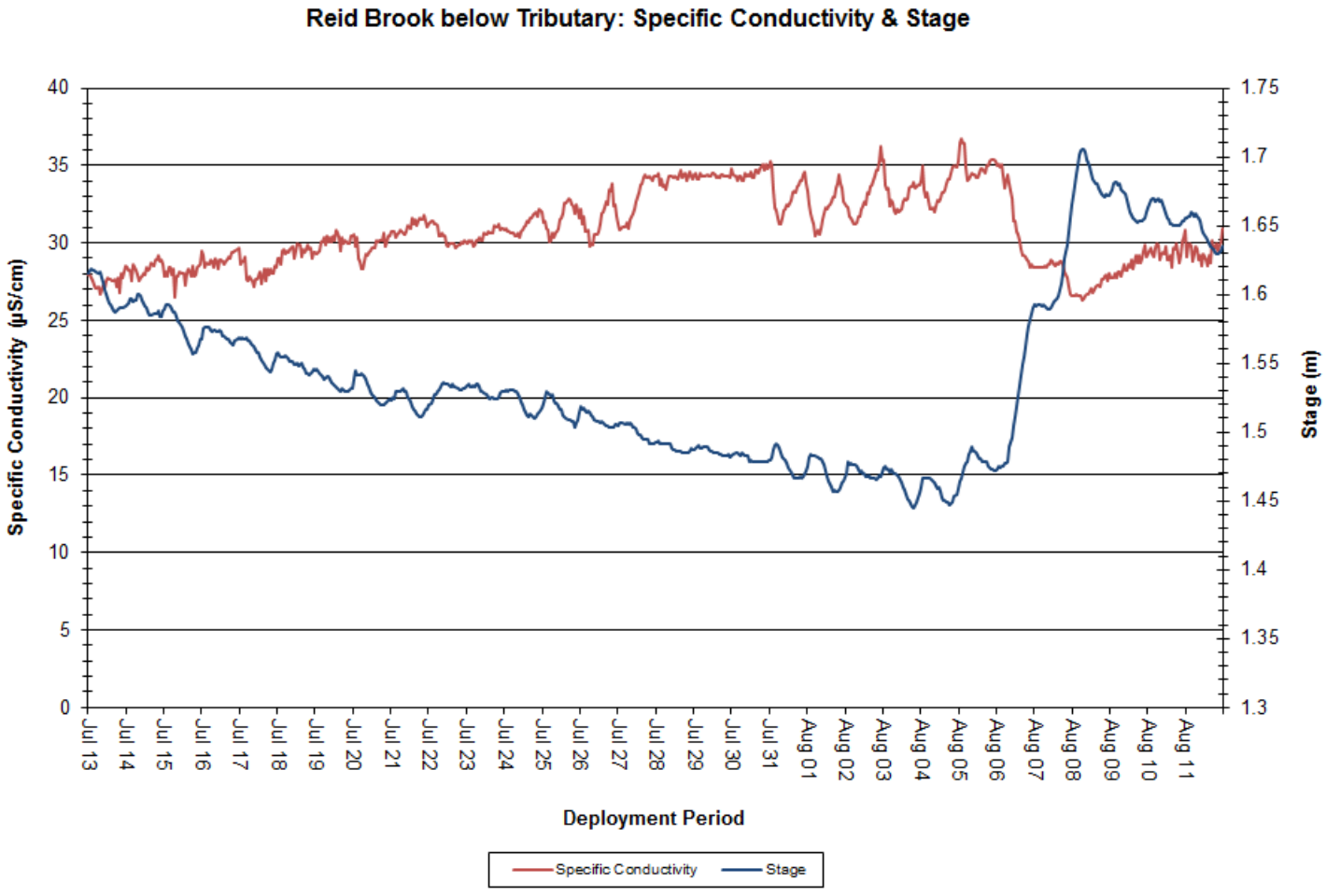

Figure 19: Specific Conductivity & Stage at Reid Brook below Tributary

Dissolved Oxygen

Dissolved oxygen content ranged from 9.79 to 11.64mg/L, with a median value of 10.81 mg/L. The saturation of dissolved oxygen ranged from 97.1% to 108.9% saturation, with a median value of 99.8% (Figure 20).

Dissolved oxygen concentrations remained above the CCME Guideline for the Protection of Early Life Stages (9.5mg/L) for the duration of deployment. Dissolved oxygen levels were reasonably consistent, with small changes that correlate closely with changes in water temperature at the same time. Dissolved oxygen levels are generally lower at warmer water temperatures, and vice versa.

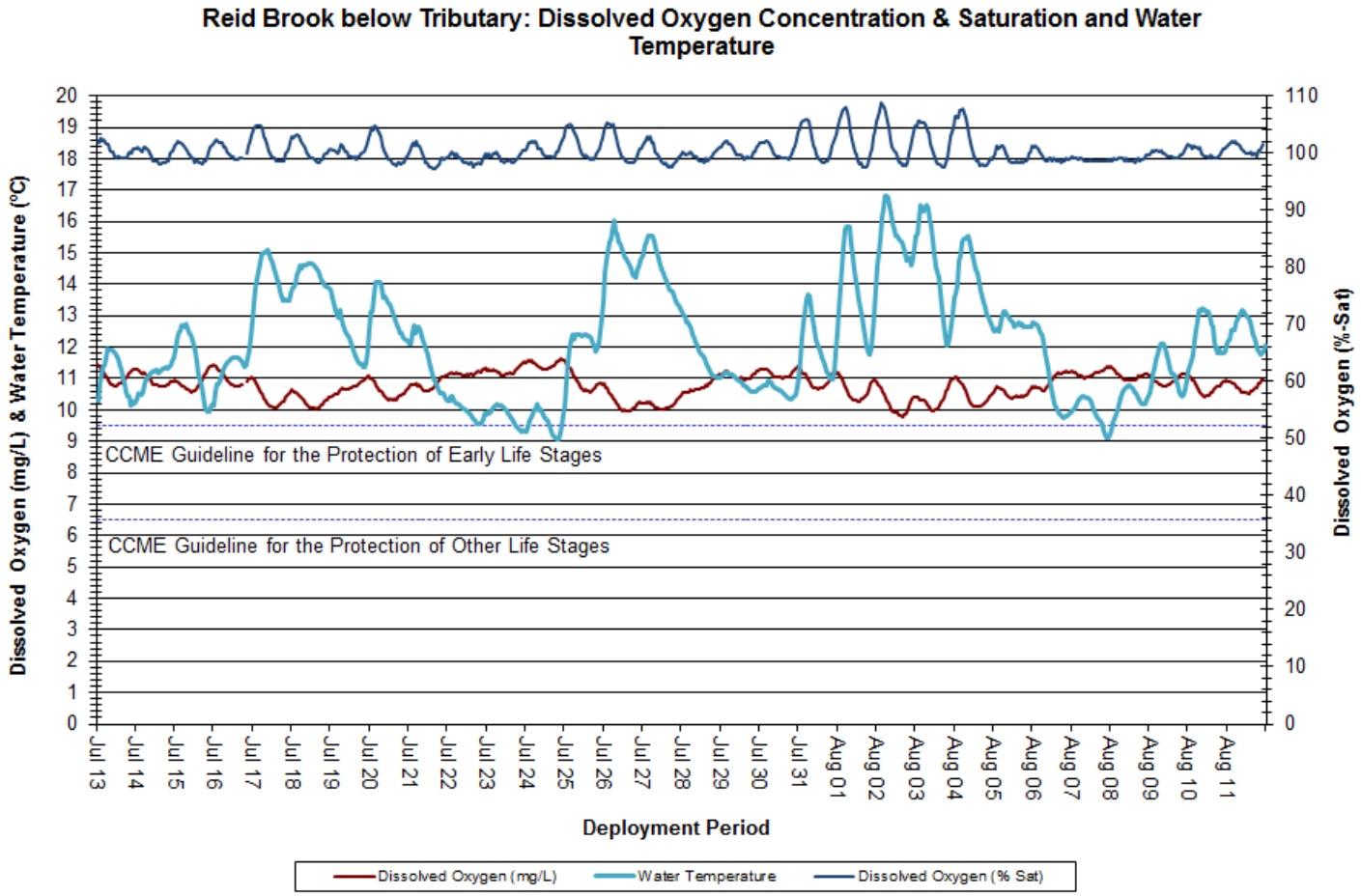

Figure 20: Dissolved Oxygen & Water Temperature at Reid Brook below Tributary

Turbidity

During deployment, turbidity ranged from 0.0 to 54.6 NTU, with a median value of 1.0 NTU (Figure 21). A median value of 1.0 NTU indicates that there is a small level of background turbidity at this station.

Turbidity was quite variable at this station for the duration of deployment. The larger turbidity events correlate with increases in stage (Figure 21) and are likely the result of precipitation events (Figure 22), which can cause mixing of solids in the water column.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

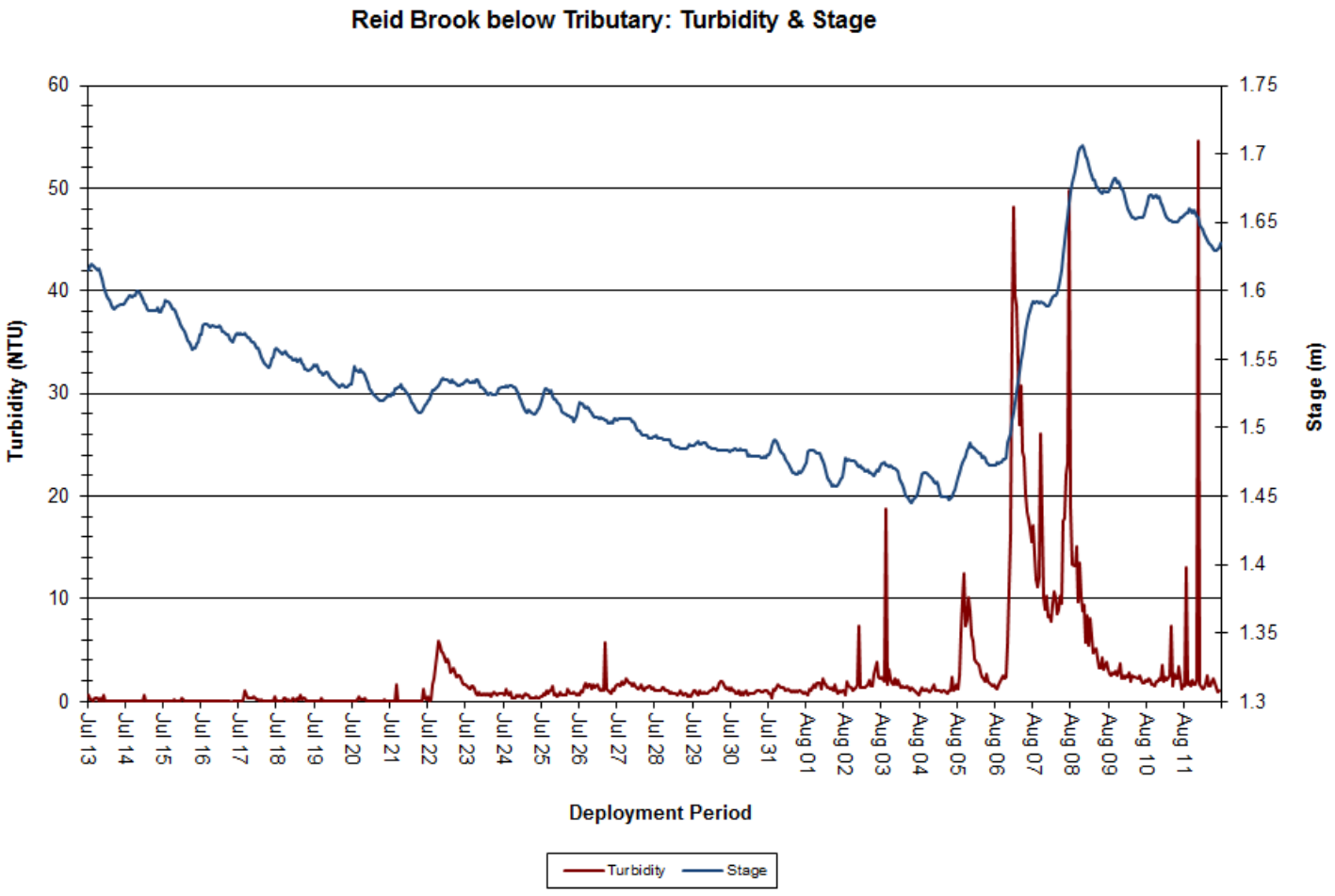

Figure 21: Turbidity & Stage at Reid Brook below Tributary

Stage, Flow and Precipitation

Stage ranged from 1.45m to 1.71m, with a median of 1.53m.

Flow ranged from 1.53m^3/s to 8.28m^3/s, with a median value of 2.83m^3/s.

Stage, flow and precipitation are graphed below to show the relationship between rainfall and water level (Figure 22). Increases in stage (m) and flow (m³/s) are closely linked to precipitation events.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

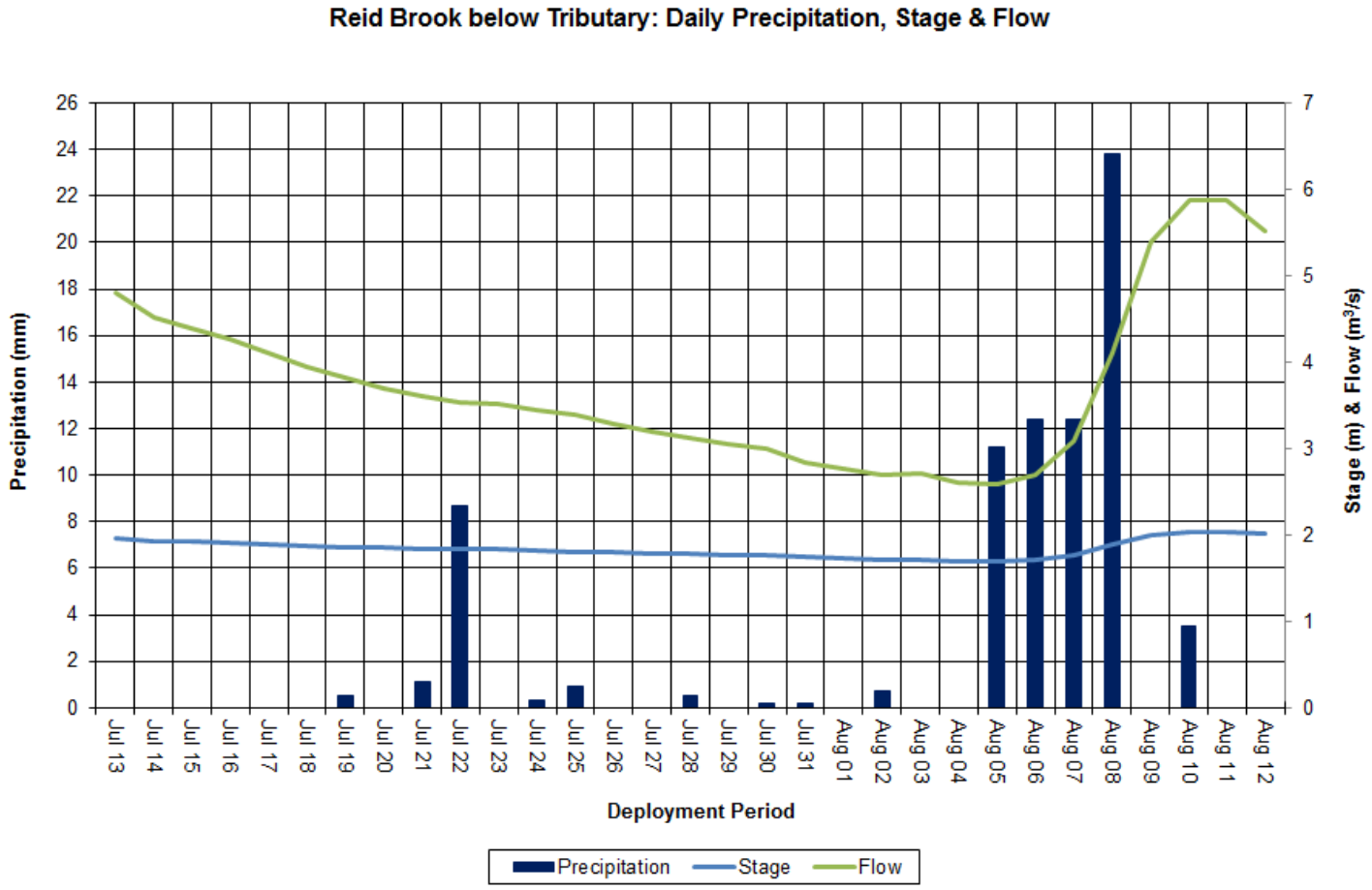

Figure 22: Daily Stage & Flow data from Reid Brook below Tributary and Total Daily Precipitation from Nain Weather Station

Tributary to Reid Brook

Water Temperature

Water temperature ranged from 8.90°C to 14.40°C, with a median value of 11.45°C (Figure 23). Streams and brooks are sensitive to changes in the ambient air temperature, thus water temperature will fluctuate considerably depending on the weather and the time of day (Figure 24).

Water temperature data on this graph displays a natural diurnal pattern. As expected, water temperature increased slowly and gradually over the course of deployment.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

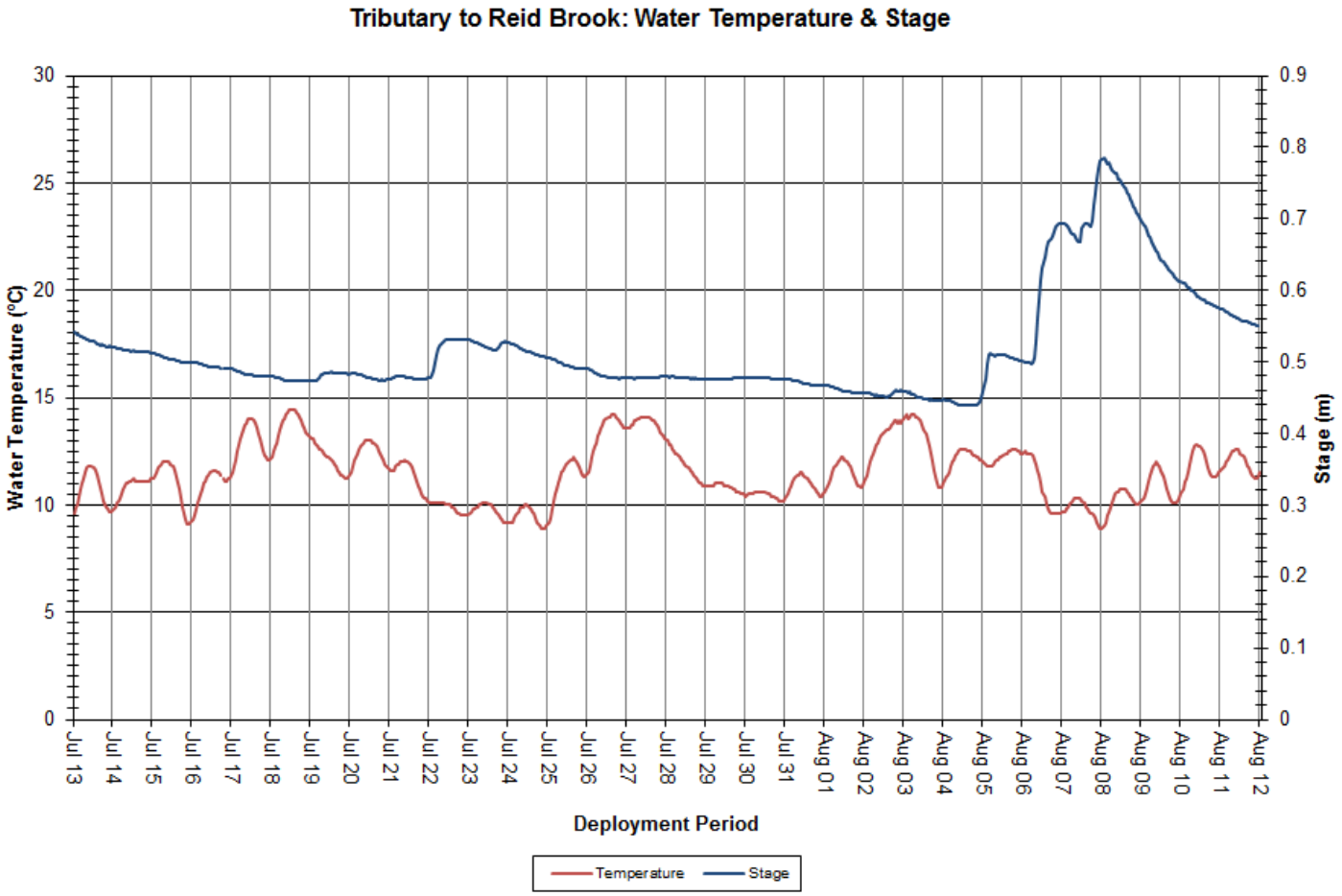

Figure 23: Water Temperature and Stage at Tributary to Reid Brook

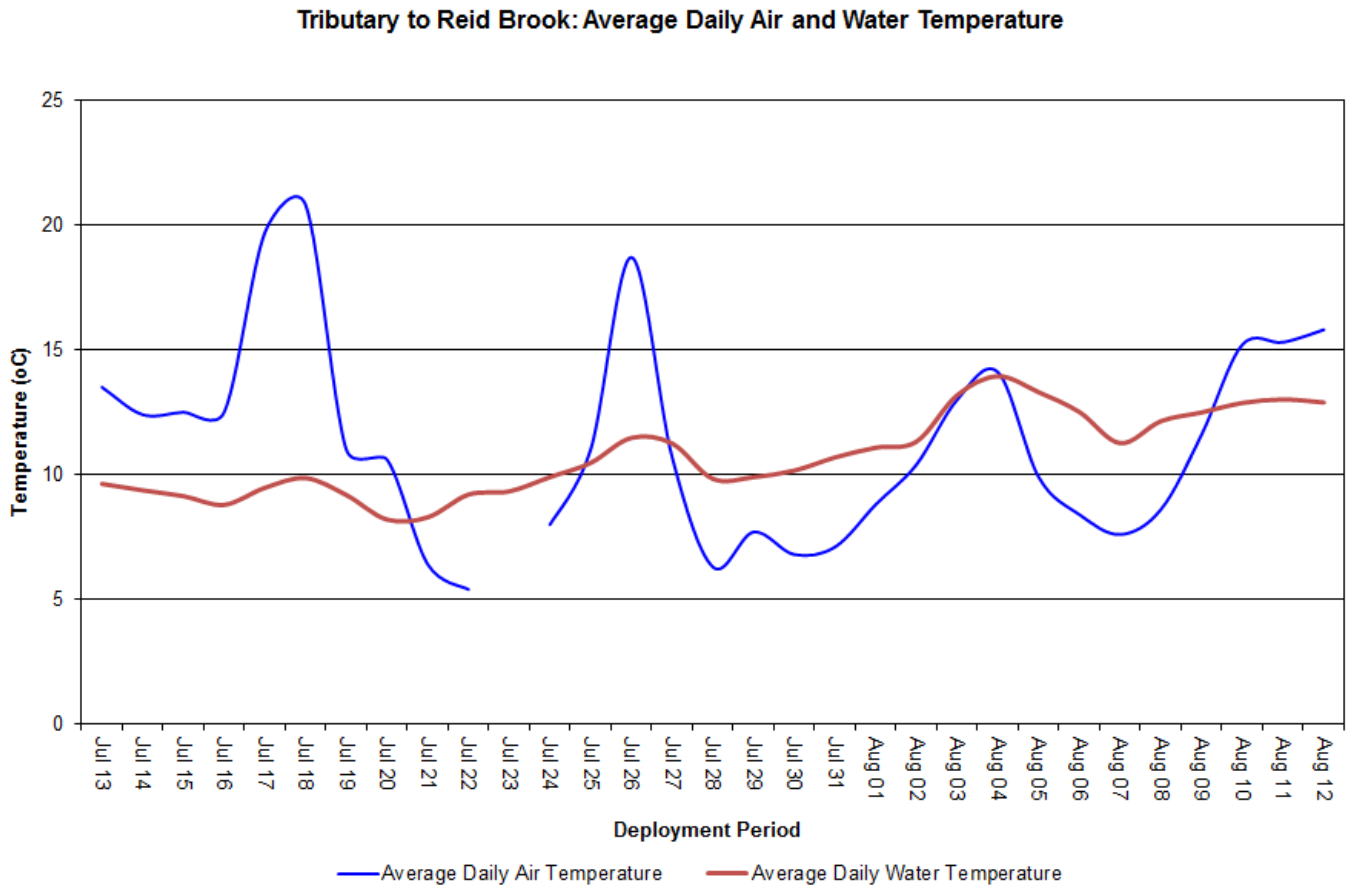

Figure 24: Average Daily Water Temperature at Tributary to Reid Brook and Average Daily Air Temperature from Nain Weather Station

pH

Over deployment, pH ranged from 6.15 to 6.97 pH units, with a median value of 6.83 (Figure 25).

Stage increases often indicate a rainfall event; rainfall will cause pH values to decrease for a short period of time (Figure 29). This is evidenced by decreases in pH values from August 5th through August 8th (Figure 25).

pH values remain within the CCME Guidelines for the Protection of Aquatic Life for the majority of deployment, with the exception of following heavy rainfall around August 6th. pH levels increase again following this precipitation event and rise to within the CCME Guideline by the end of deployment.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

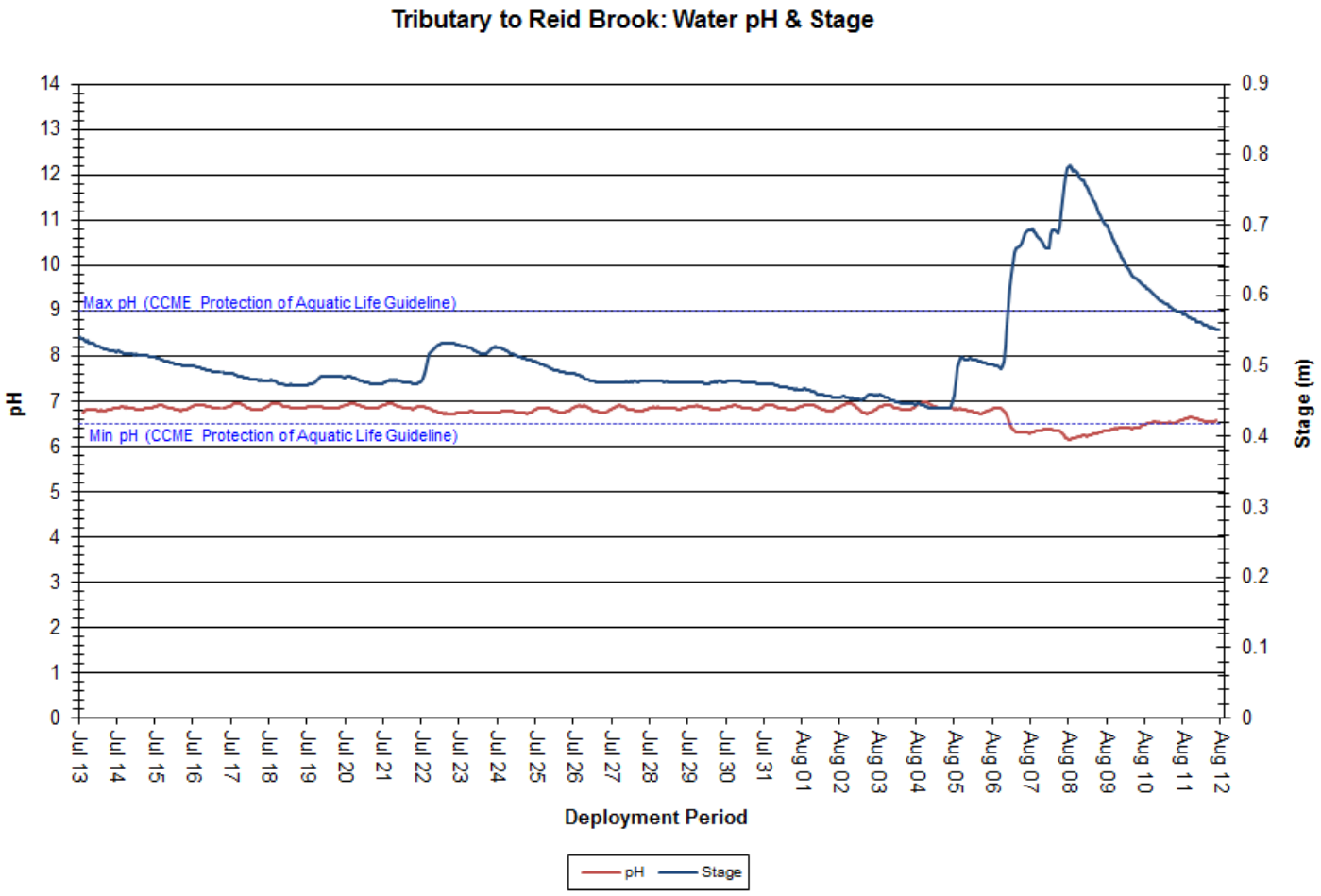

Figure 25: pH & Stage Level at Tributary to Reid Brook

Specific Conductivity

Specific conductivity ranged from 23.5µS/cm to 40.9µS/cm, with a median value of 31.9µS/cm (Figure 26).

Specific conductance and stage generally exhibit an inverse relationship: as one parameter increases, the other decreases. An increased amount of water in the river system dilutes solids causing a decrease in conductivity, and vice versa. Precipitation events over the course of deployment (Figure 29) likely influenced decreases in specific conductivity on the same dates, most notably on July 22nd and again from August 5th through August 8th.

There is also a gradual increase in conductivity across the deployment period. This is to be expected as air temperatures increase and evaporation occurs in the brook, in turn causing dissolved particulate matter to become concentrated.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

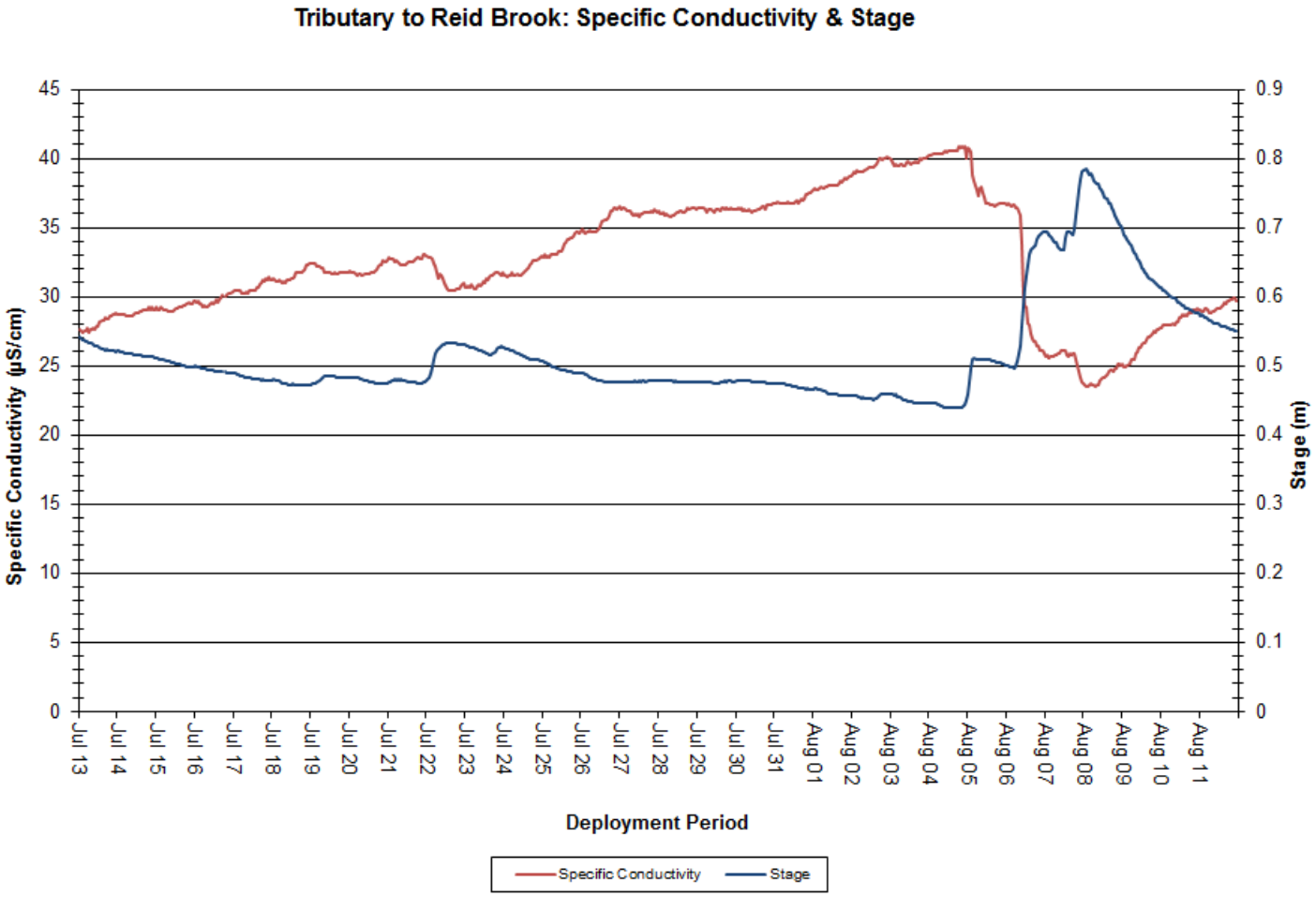

Figure 26: Specific Conductivity & Stage at Tributary to Reid Brook

Dissolved Oxygen

Dissolved oxygen content ranged from 9.79 to 11.41mg/L, with a median value of 10.63mg/L. The saturation of dissolved oxygen ranged from 95.3% to 100.6% saturation, with a median value of 97.1% (Figure 27).

Dissolved oxygen levels remained above the CCME Guidelines for the Protection of Early/Other Life Stages for the duration of deployment.

Dissolved oxygen data displays a diurnal pattern. During nightfall, dissolved oxygen levels are higher as cooler temperatures allow for more DO to be stored in the water column. During daytime hours, dissolved oxygen levels are lower; warmer water temperatures and photosynthesis by aquatic plants results in less dissolved oxygen in the water column.

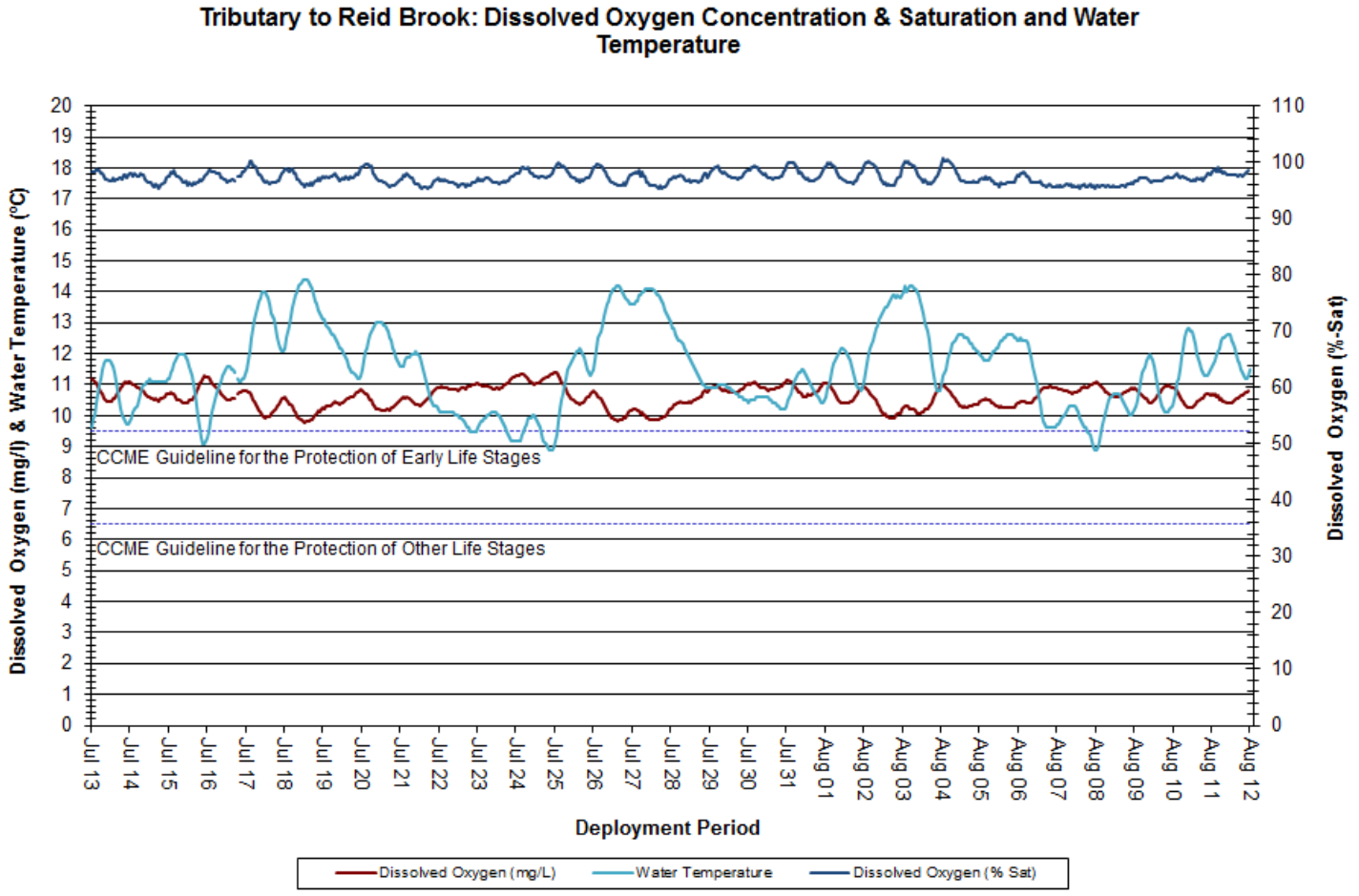

Figure 27: Dissolved Oxygen Concentration & Water Temperature at Tributary to Reid Brook

Turbidity

During deployment, turbidity ranged from 0.0 to 52.4 NTU, with a median value of 0.0 NTU (Figure 28). A median value of 0.0 NTU indicates that there was very little natural background turbidity at this station.

There are a number of low and high turbidity events at this station. Many of the larger turbidity events correlate with an increase in stage, which further correlate with rainfall events (Figure 29). An increase in water volume serves to stir up solid materials in the water column, in turn increasing turbidity. This site is particularly prone to variable turbidity, as it has a sandy-clay bottom that is easily disturbed by precipitation events.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

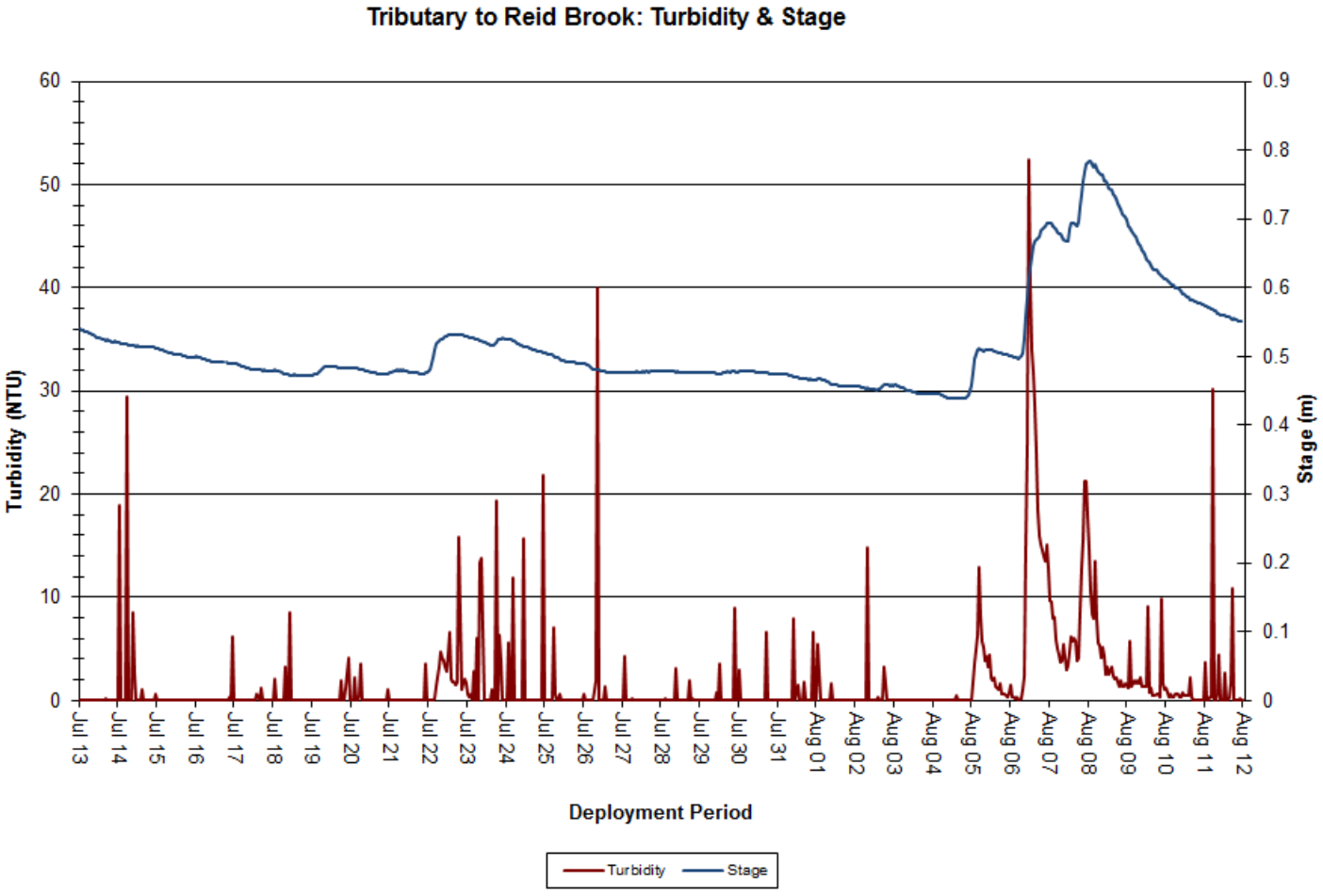

Figure 28: Turbidity & Stage at Tributary to Reid Brook

Stage, Flow and Precipitation

Stage ranged from 0.44m to 0.78m, with a median value of 0.49m.

Flow ranged from 0.11 to 1.34m^3/s, with a median value of 0.18m^3/s.

Stage, flow and precipitation are graphed below to show the relationship between rainfall and water level (Figure 29). Increases in stage and flow generally correlate with precipitation events.

Please note that the stage and streamflow data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

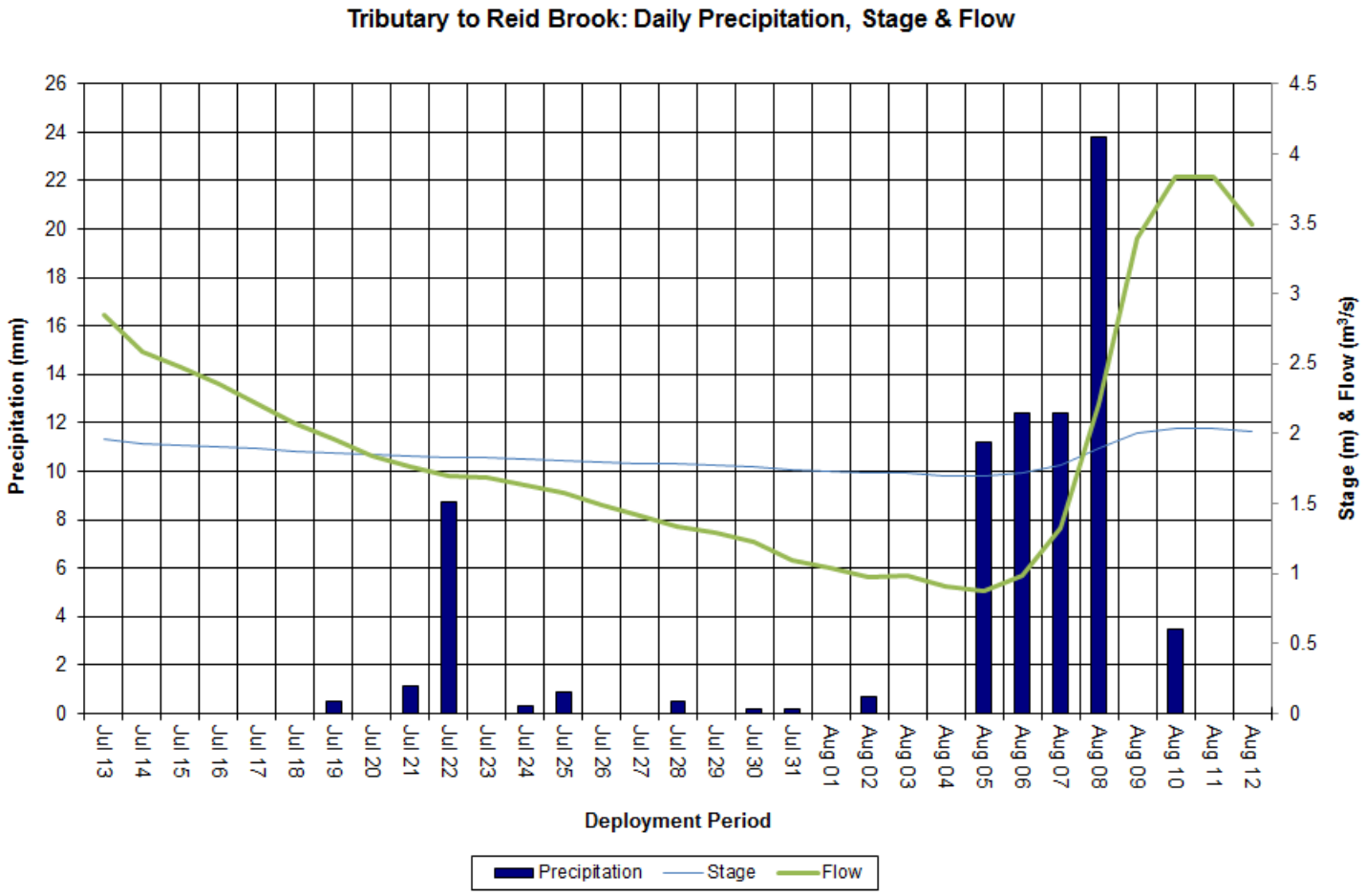

Figure 29: Daily Stage & Flow data from Tributary to Reid Brook and Total Daily Precipitation from Nain Weather Station

Conclusions

Water temperatures across all stations ranged from a minimum of 7.82°C at Reid Brook at Outlet of Reid Pond to a maximum of 20.52°C at Camp Pond Brook below Camp Pond. Overall, water temperature was increasing across the network. Stations at Camp Pond Brook, Tributary to Reid Brook, and Reid Brook below Tributary are more sensitive to changes in the ambient air temperatures as these sites are brooks with continuously moving water. In contrast, Reid Brook at Outlet of Reid Pond is a large pond with a high surface area and deeper, slower-moving water.

pH values across all stations ranged from a minimum of 6.15pH units at Tributary to Reid Brook to a maximum of 7.48pH units at Reid Brook below Tributary. pH values at all stations were relatively consistent. Changes in pH values often coincided with changes in stage brought on by rainfall events.

Specific conductivity across all stations ranged from a minimum of 11.8µS/cm Reid Brook at Outlet of Reid Pond to a maximum of 45.8µS/cm at Camp Pond Brook below Camp Pond. Conductivity values at Reid Brook at Outlet of Reid Pond were the lowest across the network. Camp Pond Brook below Camp Pond maintains the highest median value at 31.1 µS/cm, which is to be expected given the station's proximity to the Voisey's Bay mine site and increased potential for roadway runoff and other anthropogenic influences.

Dissolved oxygen levels across all stations ranged from a minimum of 8.61mg/L at Camp Pond Brook below Camp Pond to a maximum of 12.12mg/L at Reid Brook at Outlet of Reid Pond. Dissolved oxygen is lower at this time of year and varies diurnally as water temperature is greatly affected by ambient air temperature. Dissolved oxygen levels remained above the CCME Guideline for the Protection of Early Life Stages at all stations, with the exception of several occasions across the deployment period at Camp Pond Brook below Camp Pond.

Turbidity levels across all stations ranged from a minimum of 0.0 NTU at all stations to a maximum of 1509.0NTU at Camp Pond Brook below Camp Pond. Turbidity levels showed natural increases and decreases corresponding to stage and precipitation events.

Overall, the changes in water quality parameters over the course of this deployment can be explained by natural events. Camp Pond Brook below Camp Pond does have the potential for anthropogenic influences as the site is the closest to the inhabited area. It is important to note that during a change (a decrease or increase) in water quality, change only occurs for a short period of time and then water quality parameters return to baseline.

References

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Swanson, H.A., and Baldwin, H.L., (1965) "A Primer on Water Quality" U.S. Geological Survey. Retrieved from: http://ga.water.usgs.gov/edu/characteristics.html

APPENDIX A

Comparison Graphs

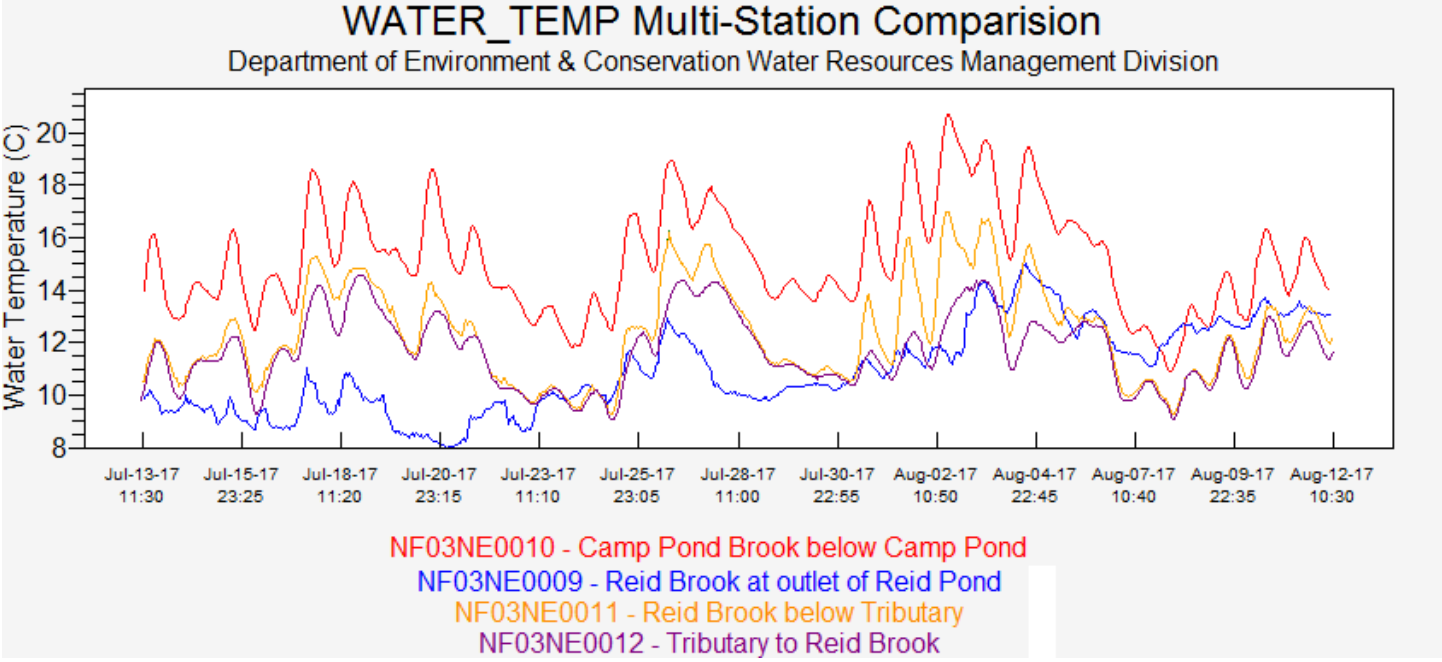

Figure A1: Comparison of Water Temperature (^{0}C) between all Real-Time Stations in Voisey's Bay.

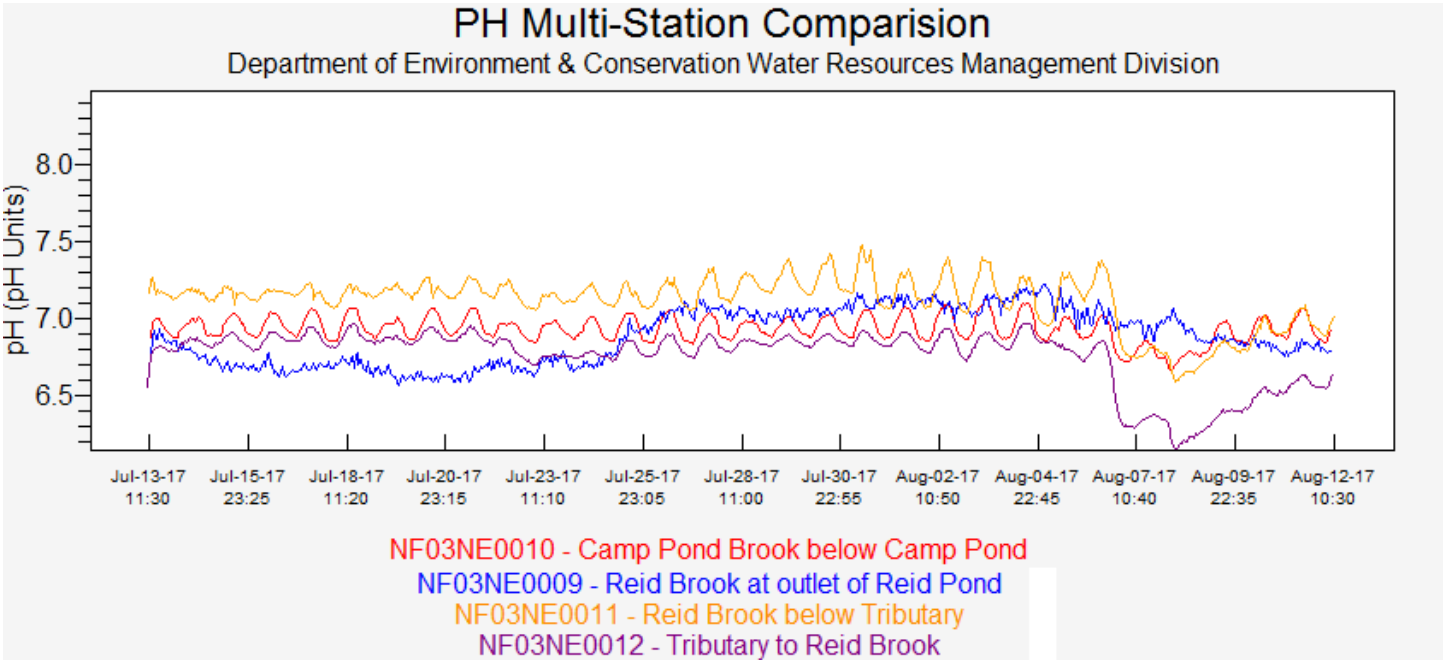

Figure A2: Comparison of pH between all Real-Time Stations in Voisey's Bay.

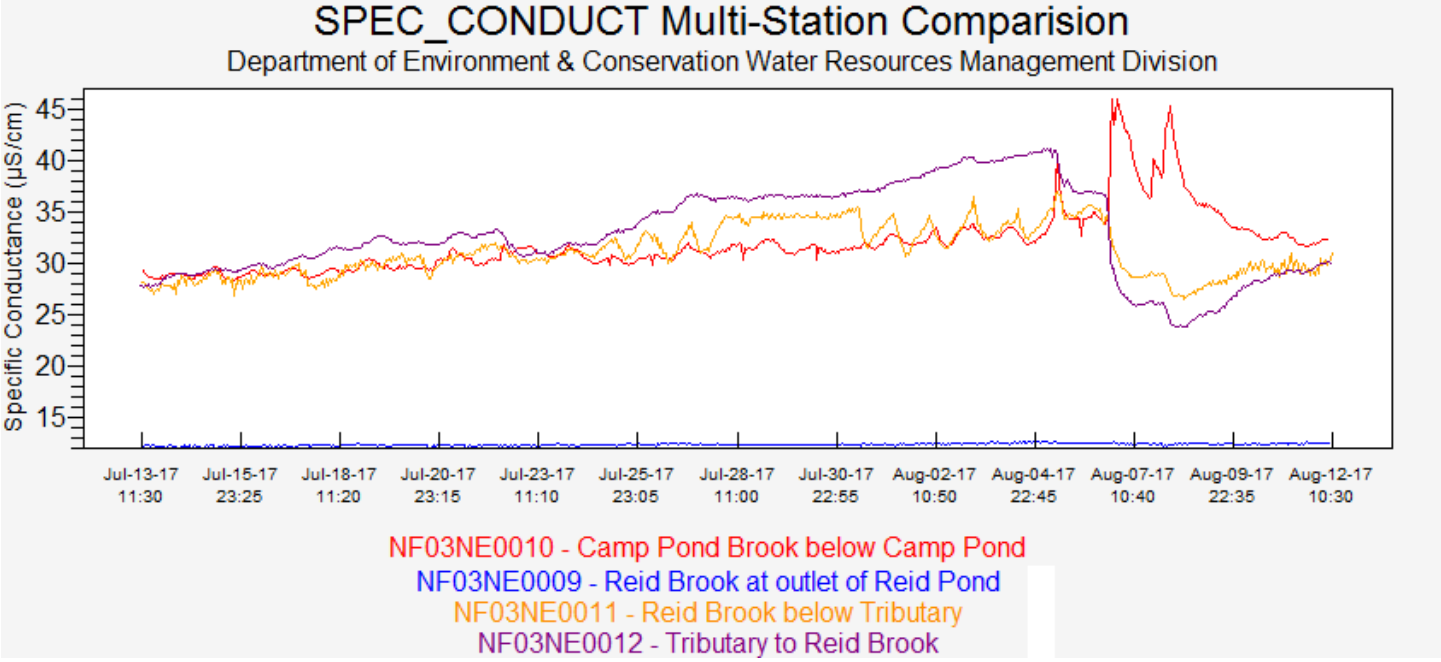

Figure A3: Comparison of Specific Conductivity (µS/cm) between all Real-Time Stations in Voisey's Bay.

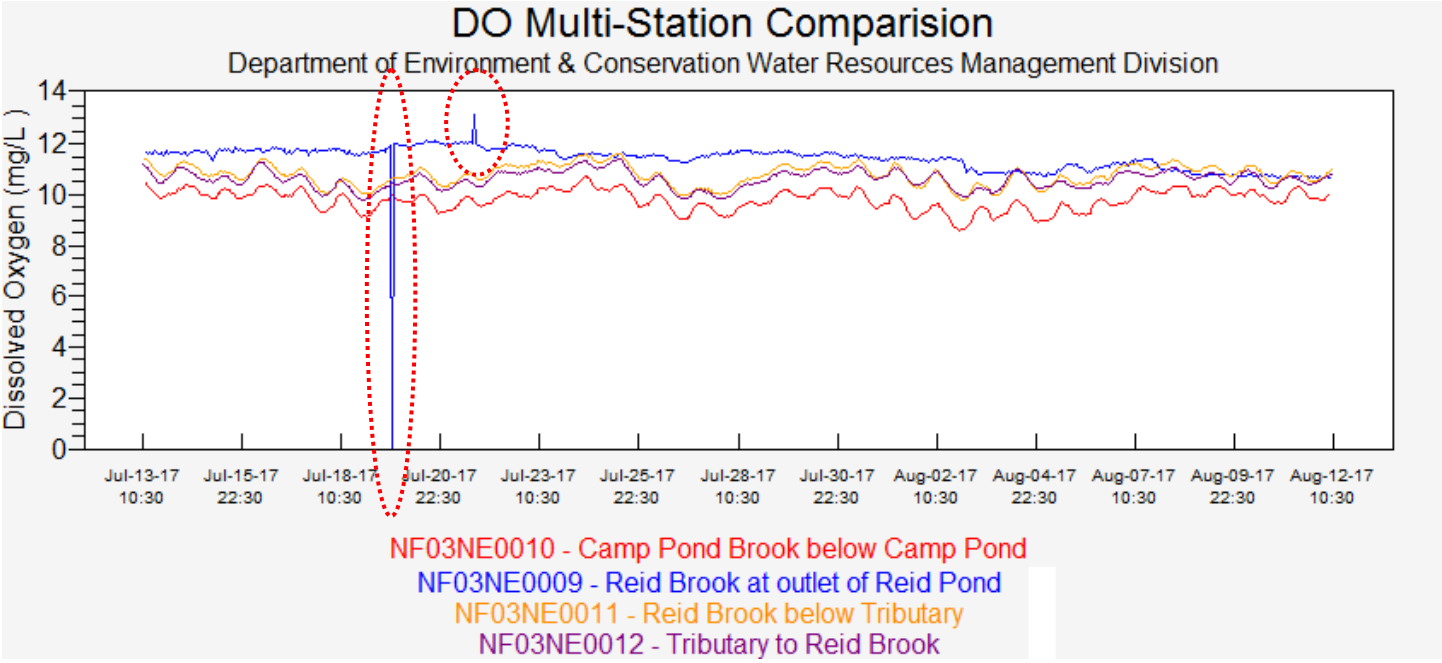

Figure A4: Comparison of Dissolved Oxygen (mg/L) between all Real-Time Stations in Voisey's Bay. Circled data points for Reid Brook at Outlet of Reid Pond have been removed from analysis for QA/QC purposes.

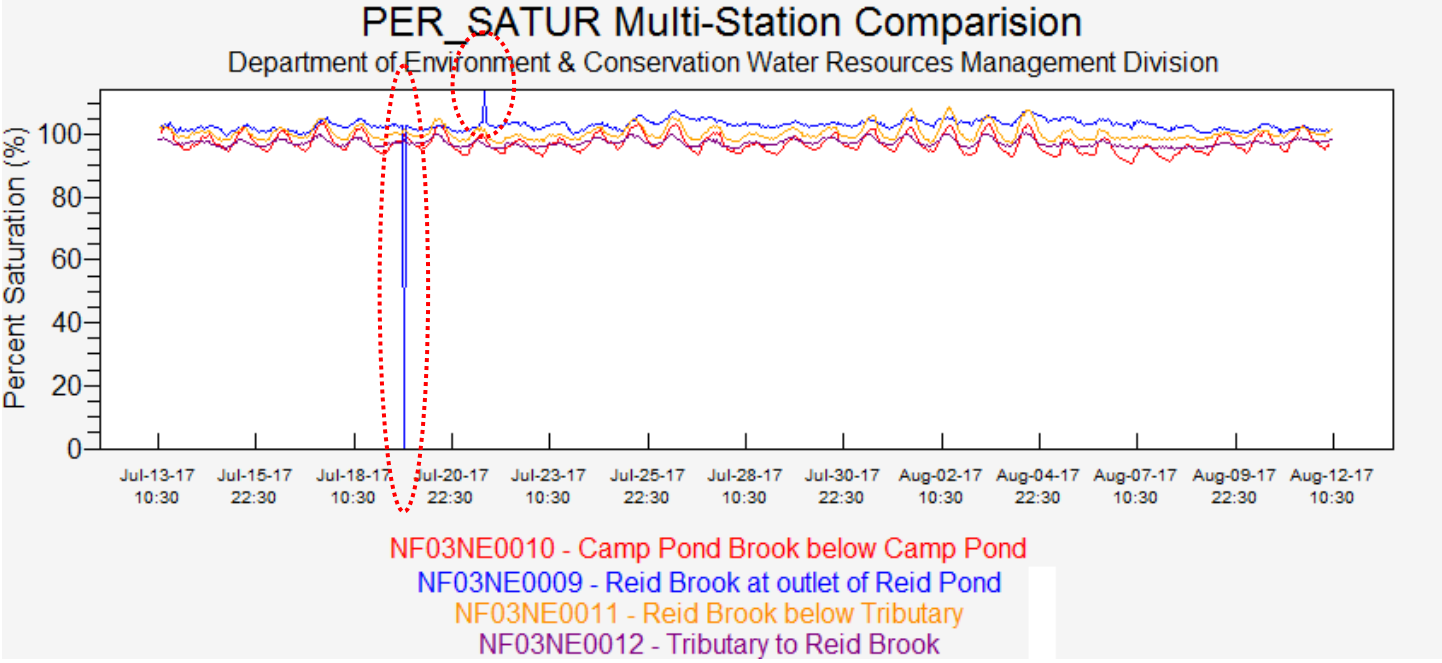

Figure A5: Comparison of Dissolved Oxygen (% Sat) between all Real-Time Stations in Voisey's Bay. Circled data points for Reid Brook at Outlet of Reid Pond have been removed from analysis for QA/QC purposes.

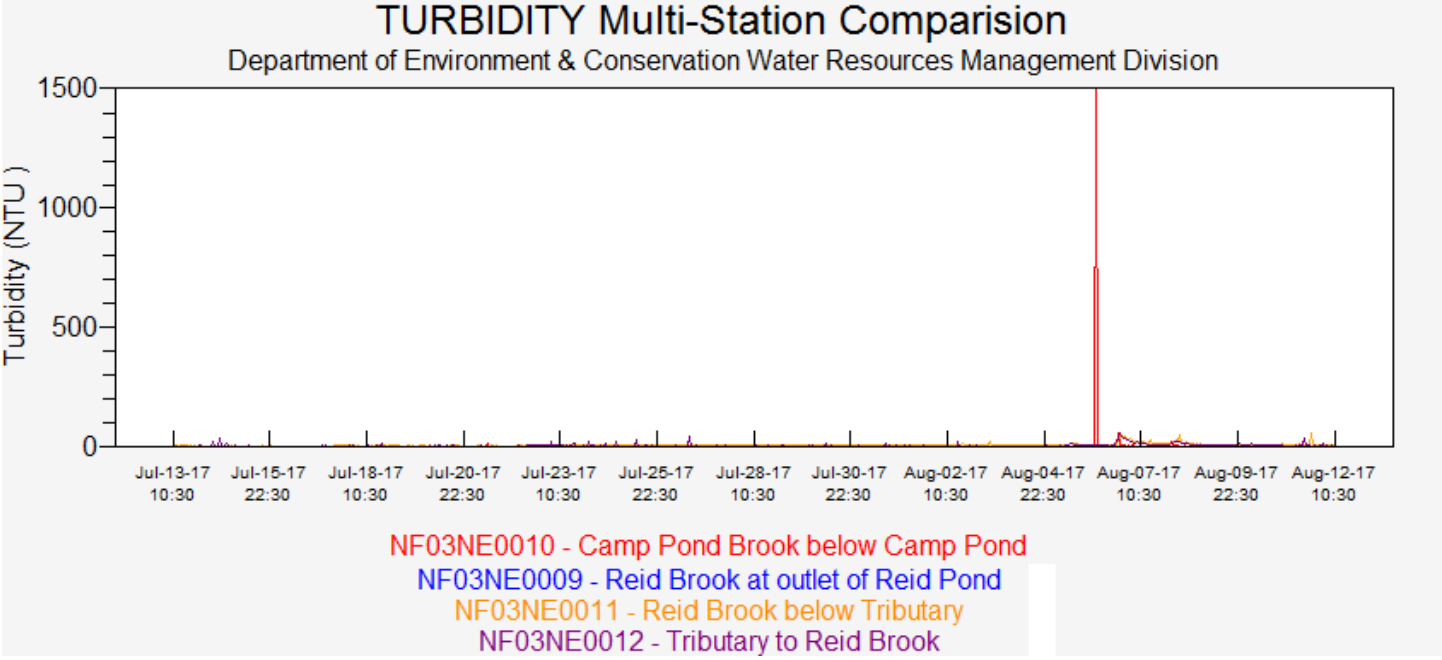

Figure A6: Comparison of Turbidity (NTU) between all Real-Time Stations in Voisey's Bay.

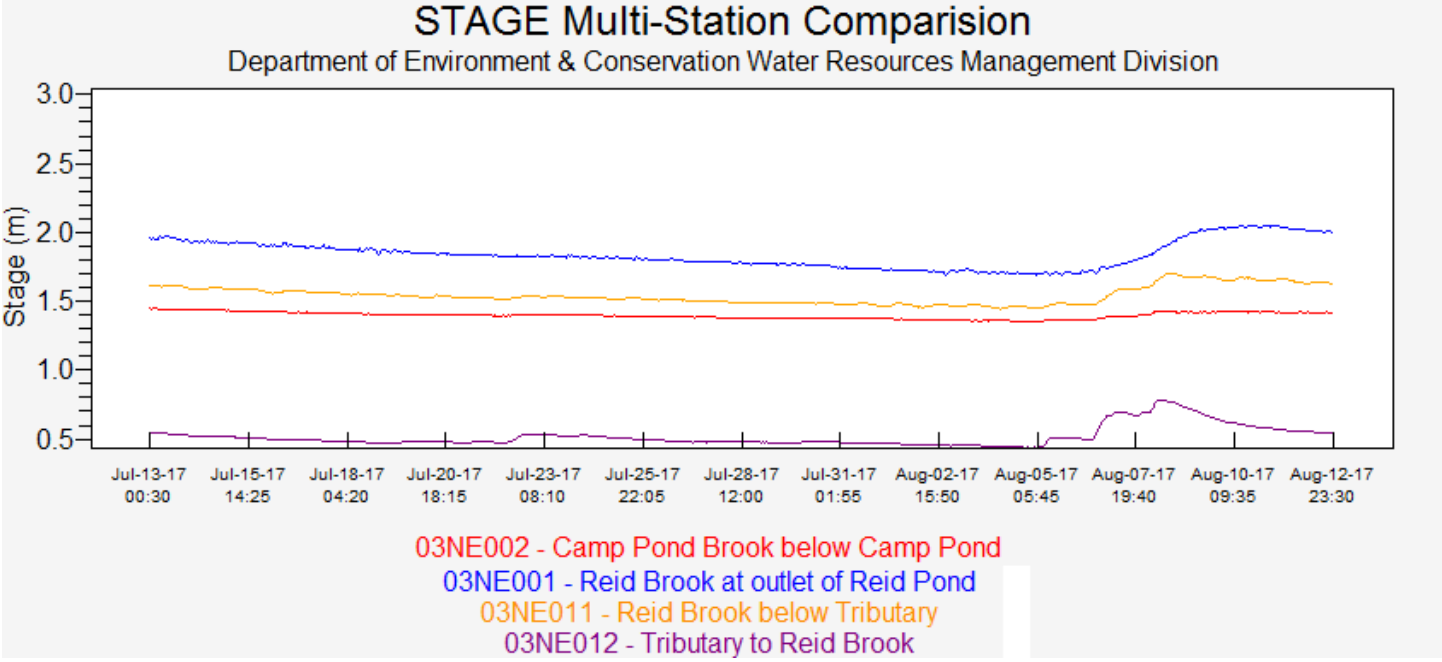

Figure A7: Comparison of Stage (m) between all Real-Time Stations in Voisey's Bay. Please note that stage data is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data.

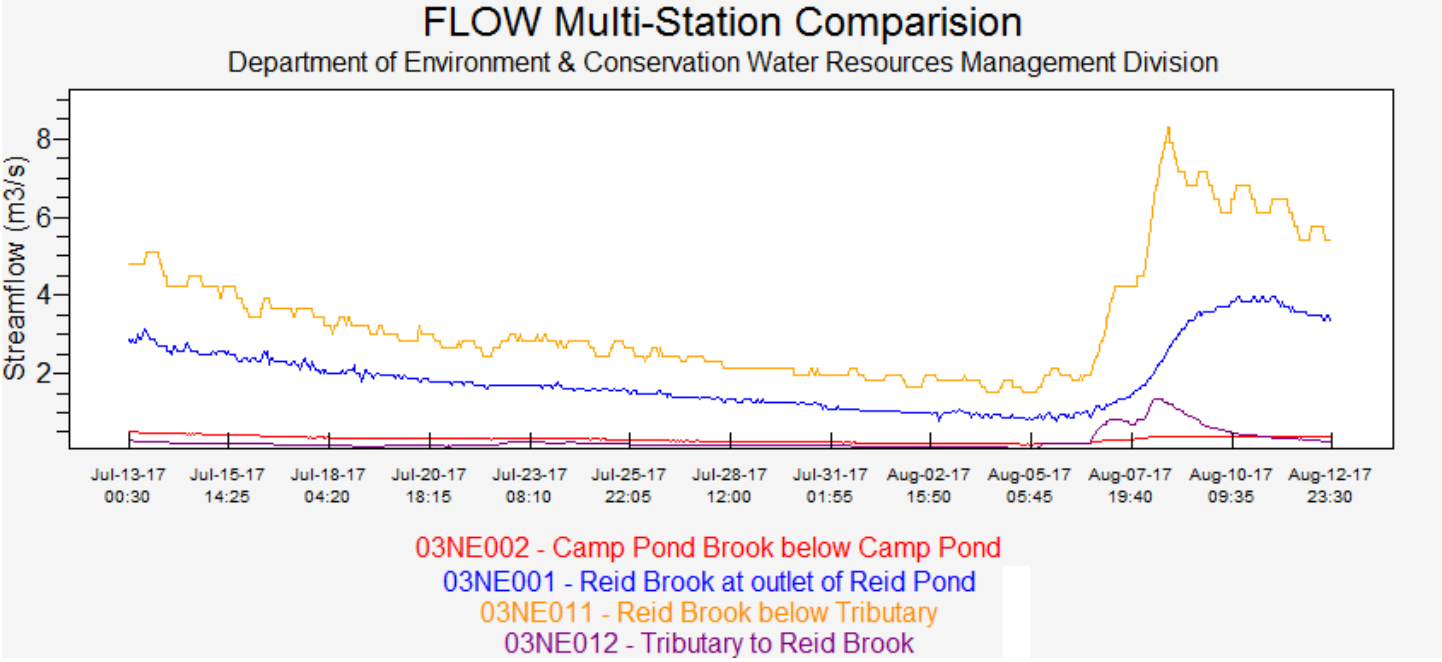

Figure A8: Comparison of Flow (m^3/s) between all Real-Time Stations in Voisey's Bay. Please note that flow data is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data.

APPENDIX B

Water Parameter Description

Water Parameter Description

Dissolved Oxygen: The amount of Dissolved Oxygen (DO) (mg/l or % saturation) in the water is vital to aquatic organisms for their survival. The concentration of DO is affected by such things as water temperature, water depth and flow (e.g., aeration by rapids, riffles etc.), consumption by aerobic organisms, consumption by inorganic chemical reactions, consumption by plants during darkness, and production by plants during the daylight (CCME 2014).

Flow: Flow (m3/s) is a measure of how quickly a volume of water is displaced in streams, rivers, and other channels.

pH: pH is the measure of hydrogen ion activity and affects: (i) the availability of nutrients to aquatic life; (ii) the concentration of biochemical substances dissolved in water; (iii) the efficiency of hemoglobin in the blood of vertebrates; and (iv) the toxicity of pollutants. Changes in pH can be attributed to industrial effluence, saline inflows or aquatic organisms involved in the photosynthetic cycling of CO_2 (CCME 2014).

Specific conductivity: Specific conductivity (µS/cm) is a measure of water's ability to conduct electricity, with values normalized to a water temperature of 25°C. Specific conductance indicates the concentration of dissolved solids (such as salts) in the water, which can affect the growth and reproduction of aquatic life. Specific conductivity is affected by rainfall events, the composition of inflowing tributaries and their associated geology, saline inflow (e.g., road salt), agricultural run-off and industrial inputs (Swanson and Baldwin 1965).

Stage: Stage (m) is the elevation of the water surface and is often used as a surrogate for the more difficult to measure flow.

Temperature: Essential to the measurement of most water quality parameters, temperature (°C) controls most processes and dynamics of limnology. Water temperature is influenced by such things as ambient air temperature, solar radiation, meteorological events, industrial effluence, wastewater, inflowing tributaries, as well as water body size and depth (OTT Hydromet 2017).

Total Dissolved Solids: Total Dissolved Solids (TDS) (g/l) is a measure of alkaline salts dissolved in water or in fine suspension and can affect the growth and reproduction of aquatic life. It is affected by rainfall events, the composition of inflowing tributaries and their associated geology, saline inflow (e.g., road salt), agricultural run-off and industrial inputs (CCME 2014; Swanson and Baldwin 1965).

Turbidity: Turbidity (NTU) is a measure of the translucence of water and indicates the amount of suspended material in the water. Turbidity is caused by any substance that makes water cloudy (e.g., soil erosion, micro-organisms, vegetation, chemicals, etc.) and can correspond to precipitation events, high stage, and floating debris near the sensor (Sadar, 2017).

APPENDIX C

Grab Sample Results

Maxxam Job #: B7F1470
Report Date: 2017/07/27

Department of Municipal Affairs and Environment
Site Location: VOISEYS BAY INORGANICS
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
ETN557 Reid Brook at Outlet of Reid Pond								
Sampling Date 2017/07/13 12:00								
Matrix W								
Sample # 2017-6404-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Calculated TDS	10	1.0	mg/L	N/A	2017/07/26	2017/07/26		5077581
Hardness (CaCO3)	4.3	1.0	mg/L	N/A	2017/07/20	2017/07/20		5077574
Nitrate (N)	0.062	0.050	mg/L	N/A	2017/07/24	2017/07/24		5077577
Inorganics								
Conductivity	12	1.0	uS/cm	N/A	2017/07/19	2017/07/19	KMC	5080171
Bromide (Br-)	<1.0	1.0	mg/L	N/A	2017/07/25	2017/07/25	FD	5085319
Total Alkalinity (Total as CaCO3)	5.5	5.0	mg/L	N/A	2017/07/25	2017/07/25	NRG	5082176
Dissolved Chloride (Cl)	1.5	1.0	mg/L	N/A	2017/07/24	2017/07/24	NRG	5084069
Colour	10	5.0	TCU	N/A	2017/07/24	2017/07/24	NRG	5084075
Dissolved Fluoride (F-)	<0.10	0.10	mg/L	N/A	2017/07/19	2017/07/19	KMC	5080181
Total Kjeldahl Nitrogen (TKN)	0.16	0.10	mg/L	+/- <RDL	2017/07/20	2017/07/24	BMO	5083417
Nitrite (N)	<0.010	0.010	mg/L	N/A	2017/07/24	2017/07/24	NRG	5084082
Nitrogen (Ammonia Nitrogen)	<0.050	0.050	mg/L	N/A	2017/07/25	2017/07/25	NRG	5088632
Dissolved Organic Carbon (C)	1.8	0.50	mg/L	N/A	2017/07/21	2017/07/21	SMT	5084335
Total Organic Carbon (C)	2.0	0.50	mg/L	N/A	2017/07/21	2017/07/21	SMT	5084331
pH	6.77	N/A	pH	N/A	2017/07/19	2017/07/19	KMC	5080169
Total Phosphorus	0.004	0.004	mg/L	N/A	2017/07/21	2017/07/21	ASP	5084238
Dissolved Sulphate (SO4)	<2.0	2.0	mg/L	N/A	2017/07/24	2017/07/24	NRG	5082165
Turbidity	0.33	0.10	NTU	N/A	2017/07/25	2017/07/25	JMV	5088631
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	<0.000013	0.000013	mg/L	N/A	2017/07/24	2017/07/25	ARS	5086880
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	0.065	0.0050	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Antimony (Sb)	<0.0010	0.0010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Arsenic (As)	<0.0010	0.0010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Barium (Ba)	0.0023	0.0010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Boron (B)	<0.050	0.050	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Cadmium (Cd)	<0.000010	0.000010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Calcium (Ca)	1.3	0.10	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Chromium (Cr)	<0.0010	0.0010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Copper (Cu)	<0.0020	0.0020	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Iron (Fe)	<0.050	0.050	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Lead (Pb)	<0.00050	0.00050	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Magnesium (Mg)	0.26	0.10	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Manganese (Mn)	<0.0020	0.0020	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Nickel (Ni)	<0.0020	0.0020	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Potassium (K)	<0.10	0.10	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473

Maxxam Analytics International Corporation o/a Maxxam Analytics 200 Bluewater Rd, Suite 105, Bedford, Nova Scotia Canada B4B 1G9 Tel: 902-420-0203 Toll-free: 800-565-7227 Fax: 902-420-8612 www.maxxamanalytics.com

Maxxam Job #: B7F1470
Report Date: 2017/07/27

Department of Municipal Affairs and Environment
Site Location: VOISEYS BAY INORGANICS
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
ETN557 Reid Brook at Outlet of Reid Pond								
Sampling Date 2017/07/13 12:00								
Matrix W								
Sample # 2017-6404-00-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Selenium (Se)	<0.0010	0.0010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Sodium (Na)	0.73	0.10	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Strontium (Sr)	0.0046	0.0020	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Uranium (U)	<0.00010	0.00010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Zinc (Zn)	<0.0050	0.0050	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473

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Maxxam Job #: B7F1470
Report Date: 2017/07/27

Department of Municipal Affairs and Environment
Site Location: VOISEYS BAY INORGANICS
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
ETN558 Camp Pond Brook below Camp Pond								
Sampling Date 2017/07/13 12:15								
Matrix W								
Sample # 2017-6405-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Calculated TDS	24	1.0	mg/L	N/A	2017/07/26	2017/07/26		5077581
Hardness (CaCO3)	12	1.0	mg/L	N/A	2017/07/20	2017/07/20		5077574
Nitrate (N)	<0.050	0.050	mg/L	N/A	2017/07/24	2017/07/24		5077577
Inorganics								
Conductivity	36	1.0	uS/cm	N/A	2017/07/19	2017/07/19	KMC	5080171
Bromide (Br-)	<1.0	1.0	mg/L	N/A	2017/07/25	2017/07/25	FD	5085319
Total Alkalinity (Total as CaCO3)	10	5.0	mg/L	N/A	2017/07/25	2017/07/25	NRG	5082176
Dissolved Chloride (Cl)	3.0	1.0	mg/L	N/A	2017/07/24	2017/07/24	NRG	5084069
Colour	24	5.0	TCU	N/A	2017/07/24	2017/07/24	NRG	5084075
Dissolved Fluoride (F-)	<0.10	0.10	mg/L	N/A	2017/07/19	2017/07/19	KMC	5080181
Total Kjeldahl Nitrogen (TKN)	0.17	0.10	mg/L	+/- <RDL	2017/07/20	2017/07/24	BMO	5083417
Nitrite (N)	<0.010	0.010	mg/L	N/A	2017/07/24	2017/07/24	NRG	5084082
Nitrogen (Ammonia Nitrogen)	<0.050	0.050	mg/L	N/A	2017/07/25	2017/07/25	NRG	5088632
Dissolved Organic Carbon (C)	3.2	0.50	mg/L	N/A	2017/07/21	2017/07/21	SMT	5084335
Total Organic Carbon (C)	3.9	0.50	mg/L	N/A	2017/07/21	2017/07/21	SMT	5084331
pH	7.05	N/A	pH	N/A	2017/07/19	2017/07/19	KMC	5080169
Total Phosphorus	0.010	0.004	mg/L	+/- 0.004	2017/07/21	2017/07/21	ASP	5084238
Dissolved Sulphate (SO4)	4.4	2.0	mg/L	N/A	2017/07/24	2017/07/24	NRG	5082165
Turbidity	0.85	0.10	NTU	N/A	2017/07/25	2017/07/25	JMV	5088631
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	<0.000013	0.000013	mg/L	N/A	2017/07/24	2017/07/25	ARS	5086880
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	0.11	0.0050	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Antimony (Sb)	<0.0010	0.0010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Arsenic (As)	<0.0010	0.0010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Barium (Ba)	0.0058	0.0010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Boron (B)	<0.050	0.050	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Cadmium (Cd)	<0.000010	0.000010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Calcium (Ca)	3.3	0.10	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Chromium (Cr)	<0.0010	0.0010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Copper (Cu)	0.0033	0.0020	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Iron (Fe)	0.25	0.050	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Lead (Pb)	<0.00050	0.00050	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Magnesium (Mg)	0.97	0.10	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Manganese (Mn)	0.013	0.0020	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Nickel (Ni)	0.028	0.0020	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Potassium (K)	0.51	0.10	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473

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Maxxam Job #: B7F1470
Report Date: 2017/07/27

Department of Municipal Affairs and Environment
Site Location: VOISEYS BAY INORGANICS
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
ETN558 Camp Pond Brook below Camp Pond								
Sampling Date 2017/07/13 12:15								
Matrix W								
Sample # 2017-6405-00-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Selenium (Se)	<0.0010	0.0010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Sodium (Na)	2.1	0.10	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Strontium (Sr)	0.018	0.0020	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Uranium (U)	<0.00010	0.00010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Zinc (Zn)	<0.0050	0.0050	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473

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Maxxam Job #: B7F1470
Report Date: 2017/07/27

Department of Municipal Affairs and Environment
Site Location: VOISEYS BAY INORGANICS
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
ETN559 Reid Brook below Tributary								
Sampling Date 2017/07/13 10:50								
Matrix W								
Sample # 2017-6406-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Calculated TDS	20	1.0	mg/L	N/A	2017/07/26	2017/07/26		5077581
Hardness (CaCO3)	9.5	1.0	mg/L	N/A	2017/07/20	2017/07/20		5077574
Nitrate (N)	<0.050	0.050	mg/L	N/A	2017/07/24	2017/07/24		5077577
Inorganics								
Conductivity	28	1.0	uS/cm	N/A	2017/07/19	2017/07/19	KMC	5080171
Bromide (Br-)	<1.0	1.0	mg/L	N/A	2017/07/25	2017/07/25	FD	5085319
Total Alkalinity (Total as CaCO3)	9.5	5.0	mg/L	N/A	2017/07/25	2017/07/25	NRG	5082176
Dissolved Chloride (Cl)	2.4	1.0	mg/L	N/A	2017/07/24	2017/07/24	NRG	5084069
Colour	43	5.0	TCU	N/A	2017/07/24	2017/07/24	NRG	5084075
Dissolved Fluoride (F-)	<0.10	0.10	mg/L	N/A	2017/07/19	2017/07/19	KMC	5080181
Total Kjeldahl Nitrogen (TKN)	0.16	0.10	mg/L	+/- <RDL	2017/07/20	2017/07/24	BMO	5083417
Nitrite (N)	<0.010	0.010	mg/L	N/A	2017/07/24	2017/07/24	NRG	5084082
Nitrogen (Ammonia Nitrogen)	<0.050	0.050	mg/L	N/A	2017/07/25	2017/07/25	NRG	5088632
Dissolved Organic Carbon (C)	4.6	0.50	mg/L	N/A	2017/07/21	2017/07/21	SMT	5084335
Total Organic Carbon (C)	4.9	0.50	mg/L	N/A	2017/07/21	2017/07/21	SMT	5084331
pH	7.01	N/A	pH	N/A	2017/07/19	2017/07/19	KMC	5080169
Total Phosphorus	0.011	0.004	mg/L	+/- 0.004	2017/07/21	2017/07/21	ASP	5084238
Dissolved Sulphate (SO4)	<2.0	2.0	mg/L	N/A	2017/07/24	2017/07/24	NRG	5082165
Turbidity	1.5	0.10	NTU	N/A	2017/07/25	2017/07/25	JMV	5088631
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	<0.000013	0.000013	mg/L	N/A	2017/07/24	2017/07/25	ARS	5086880
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	0.22	0.0050	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Antimony (Sb)	<0.0010	0.0010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Arsenic (As)	<0.0010	0.0010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Barium (Ba)	0.0054	0.0010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Boron (B)	<0.050	0.050	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Cadmium (Cd)	<0.000010	0.000010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Calcium (Ca)	2.5	0.10	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Chromium (Cr)	<0.0010	0.0010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Copper (Cu)	<0.0020	0.0020	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Iron (Fe)	0.62	0.050	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Lead (Pb)	<0.00050	0.00050	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Magnesium (Mg)	0.81	0.10	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Manganese (Mn)	0.0083	0.0020	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Nickel (Ni)	0.0065	0.0020	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Potassium (K)	0.27	0.10	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473

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Maxxam Job #: B7F1470
Report Date: 2017/07/27

Department of Municipal Affairs and Environment
Site Location: VOISEYS BAY INORGANICS
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
ETN559 Reid Brook below Tributary								
Sampling Date 2017/07/13 10:50								
Matrix W								
Sample # 2017-6406-00-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Selenium (Se)	<0.0010	0.0010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Sodium (Na)	2.0	0.10	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Strontium (Sr)	0.014	0.0020	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Uranium (U)	<0.00010	0.00010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Zinc (Zn)	<0.0050	0.0050	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473

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Report Date: 2017/07/27

Department of Municipal Affairs and Environment
Site Location: VOISEYS BAY INORGANICS
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
ETN560 Tributary to Reid Brook								
Sampling Date 2017/07/13 10:30								
Matrix W								
Sample # 2017-6407-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Calculated TDS	20	1.0	mg/L	N/A	2017/07/26	2017/07/26		5077581
Hardness (CaCO3)	9.5	1.0	mg/L	N/A	2017/07/20	2017/07/20		5077574
Nitrate (N)	<0.050	0.050	mg/L	N/A	2017/07/24	2017/07/24		5077577
Inorganics								
Conductivity	30	1.0	uS/cm	N/A	2017/07/19	2017/07/19	KMC	5080171
Bromide (Br-)	<1.0	1.0	mg/L	N/A	2017/07/25	2017/07/25	FD	5085319
Total Alkalinity (Total as CaCO3)	10	5.0	mg/L	N/A	2017/07/25	2017/07/25	NRG	5082176
Dissolved Chloride (Cl)	1.7	1.0	mg/L	N/A	2017/07/24	2017/07/24	NRG	5084069
Colour	43	5.0	TCU	N/A	2017/07/24	2017/07/24	NRG	5084075
Dissolved Fluoride (F-)	<0.10	0.10	mg/L	N/A	2017/07/19	2017/07/19	KMC	5080181
Total Kjeldahl Nitrogen (TKN)	0.17	0.10	mg/L	+/- <RDL	2017/07/21	2017/07/21	BMO	5084251
Nitrite (N)	<0.010	0.010	mg/L	N/A	2017/07/24	2017/07/24	NRG	5084082
Nitrogen (Ammonia Nitrogen)	0.072	0.050	mg/L	N/A	2017/07/26	2017/07/26	NRG	5090733
Dissolved Organic Carbon (C)	4.9	0.50	mg/L	N/A	2017/07/21	2017/07/21	SMT	5084335
Total Organic Carbon (C)	5.7	0.50	mg/L	N/A	2017/07/21	2017/07/21	SMT	5084331
pH	7.22	N/A	pH	N/A	2017/07/19	2017/07/19	KMC	5080169
Total Phosphorus	<0.004	0.004	mg/L	N/A	2017/07/21	2017/07/21	ASP	5084238
Dissolved Sulphate (SO4)	<2.0	2.0	mg/L	N/A	2017/07/24	2017/07/24	NRG	5082165
Turbidity	1.4	0.10	NTU	N/A	2017/07/25	2017/07/25	JMV	5088636
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	<0.000013	0.000013	mg/L	N/A	2017/07/24	2017/07/25	ARS	5086880
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	0.11	0.0050	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Antimony (Sb)	<0.0010	0.0010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Arsenic (As)	<0.0010	0.0010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Barium (Ba)	0.0044	0.0010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Boron (B)	<0.050	0.050	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Cadmium (Cd)	<0.000010	0.000010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Calcium (Ca)	2.5	0.10	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Chromium (Cr)	<0.0010	0.0010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Copper (Cu)	<0.0020	0.0020	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Iron (Fe)	0.34	0.050	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Lead (Pb)	<0.00050	0.00050	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Magnesium (Mg)	0.82	0.10	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Manganese (Mn)	0.0052	0.0020	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Nickel (Ni)	0.0065	0.0020	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Potassium (K)	0.29	0.10	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473

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Maxxam Job #: B7F1470
Report Date: 2017/07/27

Department of Municipal Affairs and Environment
Site Location: VOISEYS BAY INORGANICS
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
ETN560 Tributary to Reid Brook								
Sampling Date 2017/07/13 10:30								
Matrix W								
Sample # 2017-6407-00-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Selenium (Se)	<0.0010	0.0010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Sodium (Na)	2.1	0.10	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Strontium (Sr)	0.014	0.0020	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Uranium (U)	<0.00010	0.00010	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473
Total Zinc (Zn)	<0.0050	0.0050	mg/L	N/A	2017/07/19	2017/07/19	BAN	5079473

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