Real-Time Water Quality Deployment Report

Voisey's Bay Network

June 7 to July 12, 2017

Newfoundland Labrador

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

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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 to Reid Pond; Camp Pond Brook; Tributary to Lower Reid Brook; and Lower Reid Brook.

On June 7, 2017, Vale Environment and Water Resources Management Division 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 July 12, 2017. This was the first deployment for 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 dependant; 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	June 7	Deployment	Good	Poor	Good	Excellent	Excellent
	July 12	Removal	N/A	N/A	N/A	N/A	N/A
Camp Pond Brook	June 7	Deployment	Excellent	Marginal	Good	Excellent	Excellent
	July 12	Removal	Excellent	Good	Good	Excellent	Marginal
Reid Brook below Tributary	June 7	Deployment	Excellent	Excellent	Good	Excellent	Excellent
	July 12	Removal	Excellent	Fair	Excellent	Excellent	Excellent
Tributary to Reid Brook	June 7	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	July 12	Removal	Excellent	Fair	Excellent	Poor	Poor

- **Reid Brook at Outlet of Reid Pond**

  At deployment, dissolved oxygen and turbidity ranked as 'excellent'. Temperature and conductivity ranked as 'Good', while pH ranked as 'Poor'. The discrepancy in pH values is likely attributable to the instrument not having sufficient time to acclimate; pH values rose steadily over the first few hours of deployment before stabilizing (see Figure 4). When Vale Environment staff returned to this site for removal, the field instrument was found to be out of the water and so comparison rankings at removal could not be determined.

- **Camp Pond Brook below Camp Pond**

  At deployment, temperature, dissolved oxygen, and turbidity were 'Excellent', pH was 'Marginal', and conductivity was 'Good'. The discrepancy between pH values is likely due to the instrument having insufficient time to acclimatize and stabilize. At removal, temperature and dissolved oxygen were 'Excellent', pH and conductivity were 'Good', while turbidity was 'Marginal'. The discrepancy in turbidity values may be attributed to sediment build-up around the instrument following rainfall events.

- **Reid Brook below Tributary**

  At deployment, water quality parameters all ranked as either 'Excellent' or 'Good'. At removal, temperature, conductivity, dissolved oxygen, and turbidity all ranked as 'Excellent', while pH was 'Fair'.

- **Tributary to Reid Brook**

  At deployment, all water quality parameters were ranked as either 'Excellent' or 'Good'. At removal, temperature and conductivity were 'Excellent', while pH was 'Fair' and dissolved oxygen and turbidity were 'Poor'.

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 of the sensors.

Data Interpretation

The following graphs and discussion illustrate significant water quality-related events from June 7th to July 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.

Reid Brook at Outlet of Reid Pond produced data that indicated that the field instrument was out of the water from July 5th onwards. Therefore, data from July 5th, 2017 through to July 12th, 2017 is not representative of conditions in Reid Brook during that period and thus has been removed from the dataset and subsequent graphs.

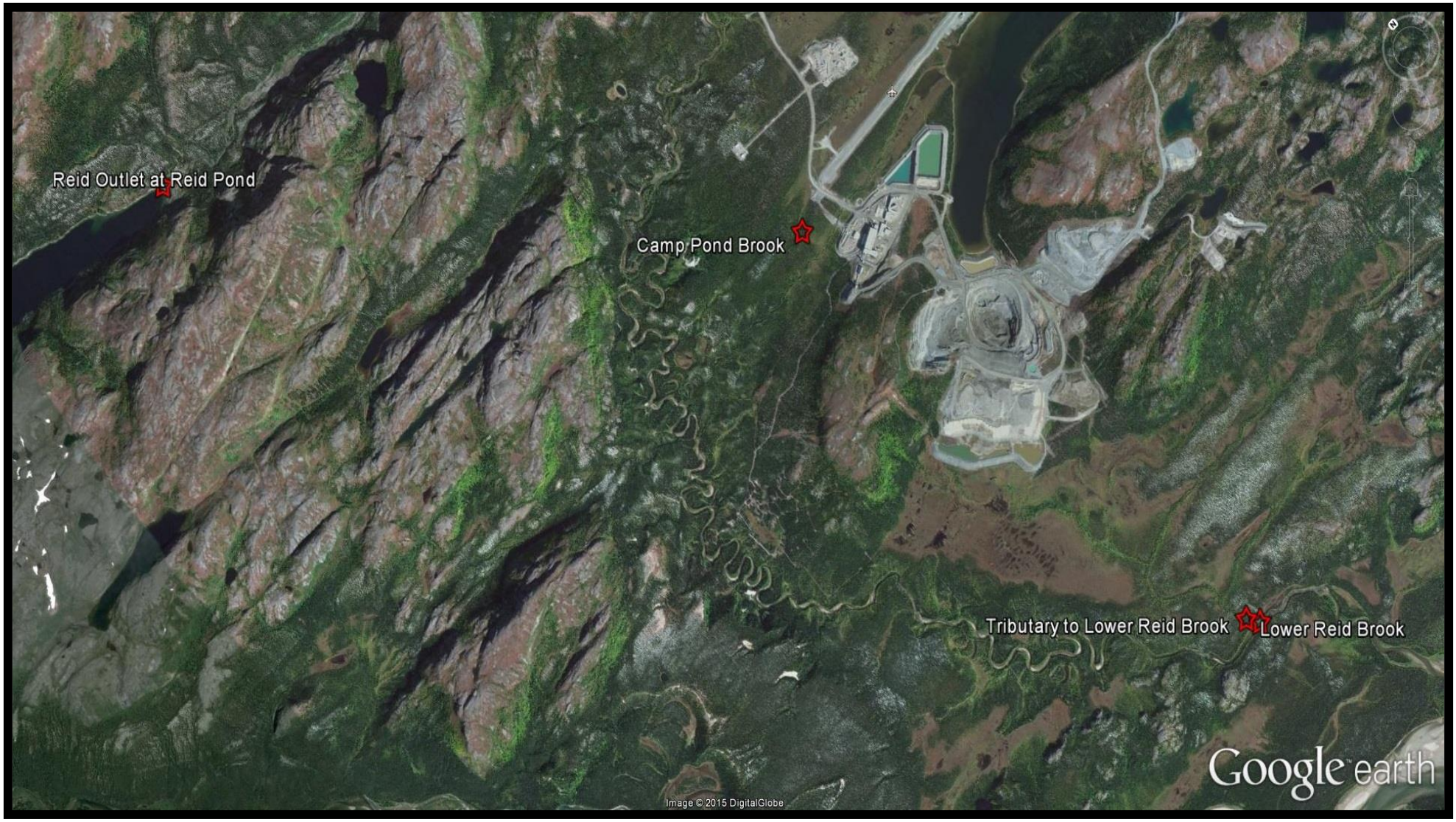

Figure 1: Voisey's Bay Network Station Locations

Reid Brook at Outlet of Reid Pond

Water Temperature

Over the deployment period the water temperature ranged from 0.6 ^{o}C to 9.74 ^{o}C, with a median value of 2.92^{o}C (Figure 2). The very stable water temperature at the beginning of deployment can be attributed to the Reid Pond still being covered with ice. From June 26th onwards, temperature starts to increase more rapidly, which is to be expected as the air temperatures start to warm into the summer months (Figure 3).

Significant increases in water temperature occurred on June 30th, July 1st and July 4th (Figure 2). It is likely a result of the warmer air temperatures occurring during the same time frame. This water body takes longer to acclimatize to changes in temperature as it is a larger surface area than the brooks.

Please note 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. Mean Air Temperature on Figure 3 was collected at the Nain Weather Station by Environment Canada.

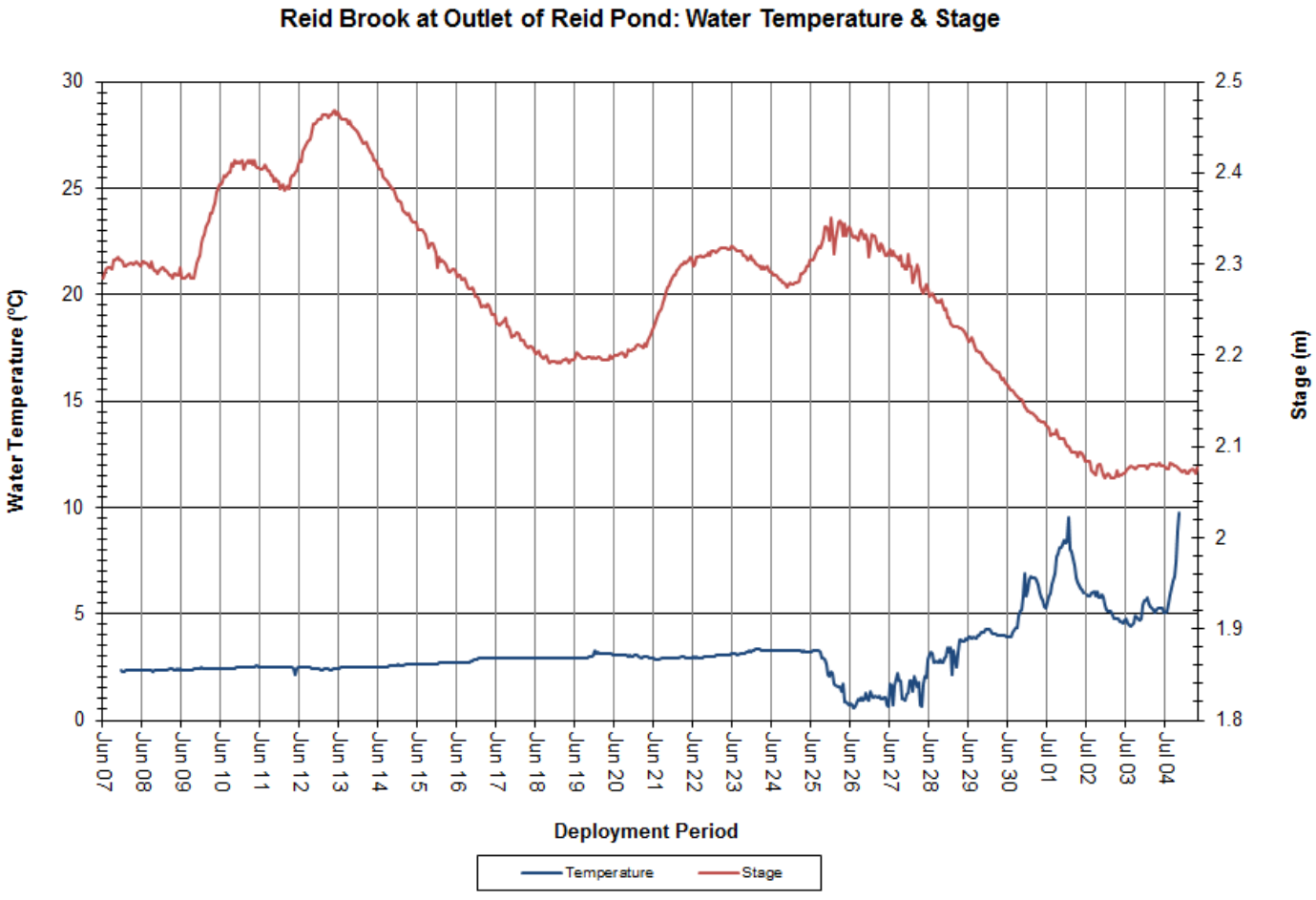

Figure 2: Water Temperature & Stage at Reid Brook at Outlet of Reid Pond

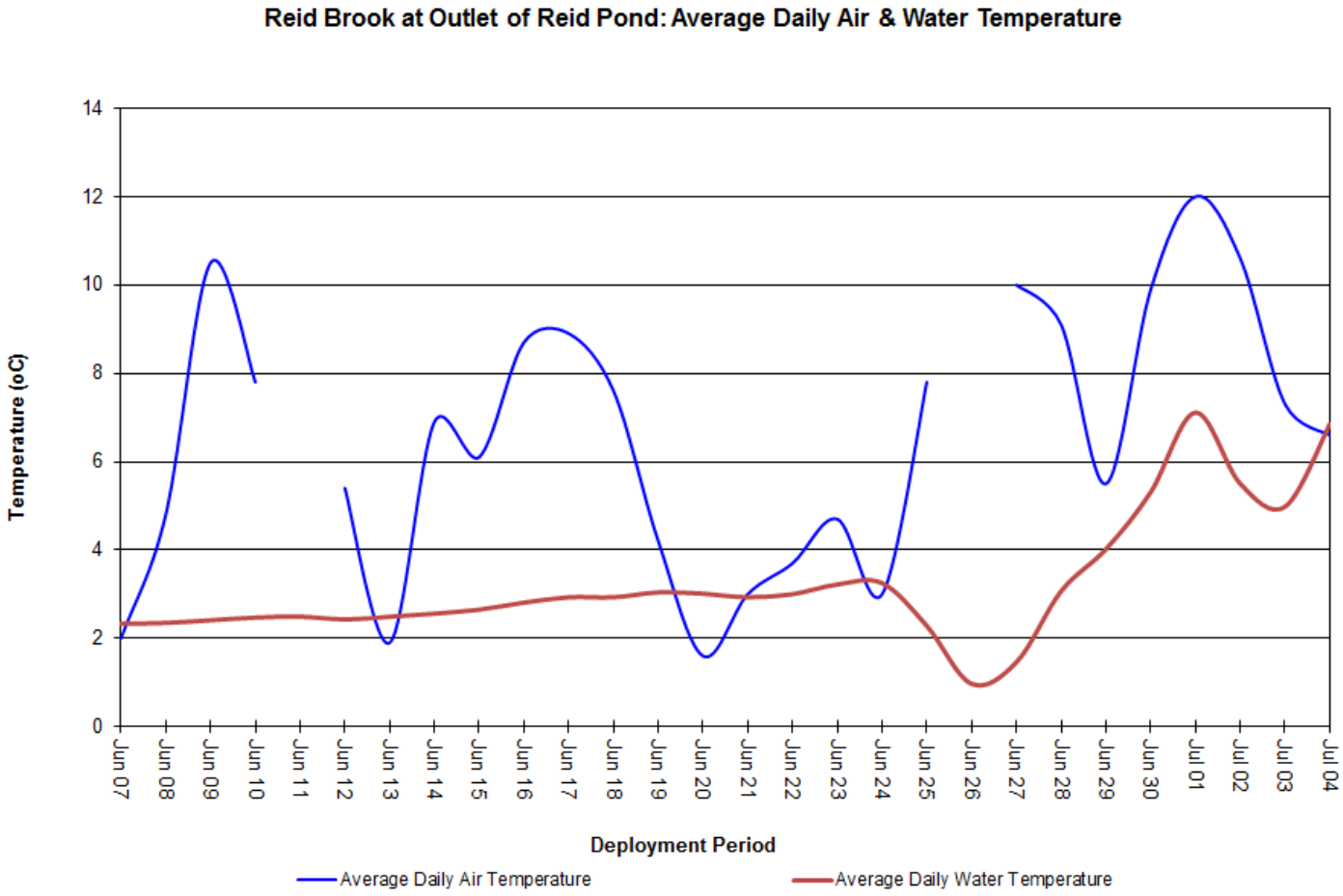

Figure 3: Average Daily Water Temperature at Reid Brook at Outlet of Reid Pond and Average Daily Air Temperature at Nain Weather Station

pH

Throughout the deployment period, pH values ranged from 5.34 pH units to 6.37 pH units, with a median value of 6.22 pH units (Figure 4).

pH levels are quite consistent during the deployment period. pH data for this site is consistently below the minimum Guideline for Protection of Aquatic Life.

Please note 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.

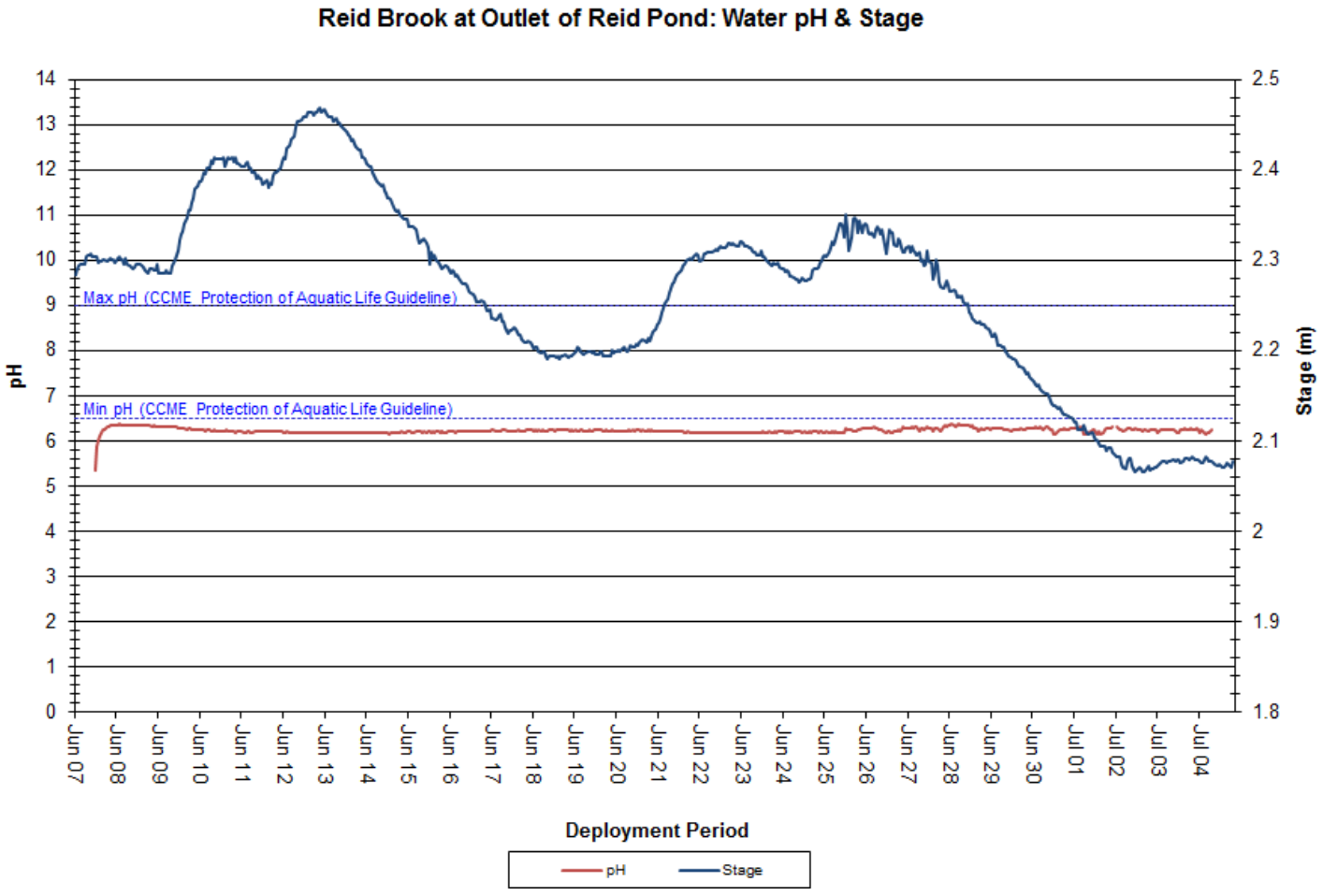

Figure 4: pH and Stage at Reid Brook at Outlet of Reid Pond

Specific Conductivity

The conductivity levels ranged from 9.4µS/cm to 13.3µS/cm during this deployment period, with a median value of 12.6µS/cm. Conductivity at Reid Brook remains very stable; this is to be expected as this is pristine in nature and a larger distance from any anthropogenic disturbances that could affect water quality.

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

Please note 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.

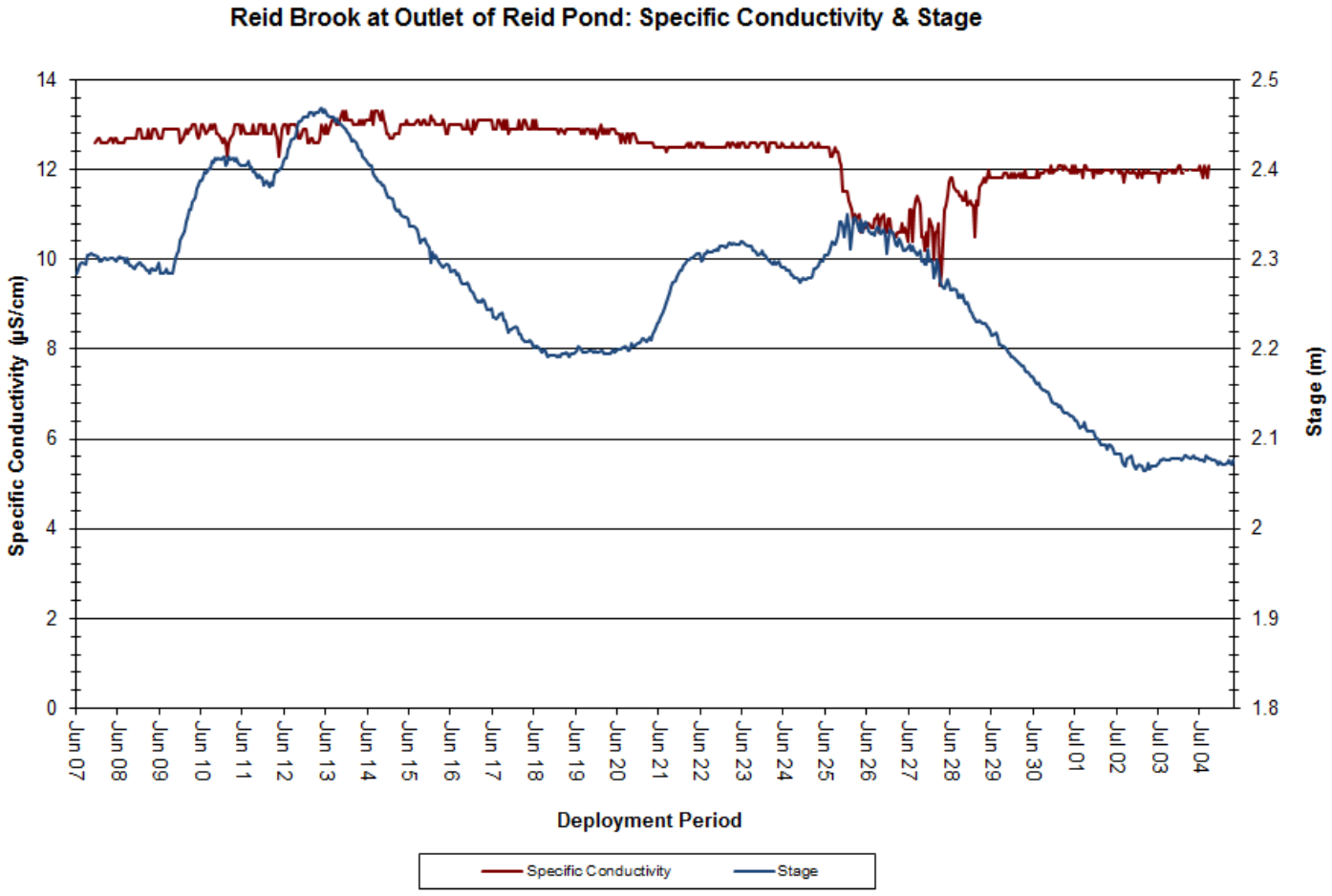

Figure 5: Specific Conductivity and Stage at Reid Brook at Outlet of Reid Pond

Dissolved Oxygen (mg/L & % Saturation)

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

During deployment, dissolved oxygen concentration levels ranged from 11.53mg/L to 12.39mg/L, with a median value of 12.23mg/L. Percent saturation levels for dissolved oxygen ranged from 84.0% saturation to 103.5% saturation, with a median of 90.9% saturation (Figure 6).

All dissolved oxygen concentration values remained above the CCME's Guideline for the Protection of Early Life Stages (9.5 mg/L). As spring changes to summer, there was a natural increase in water temperature, which in turn results in decreased dissolved oxygen concentrations.

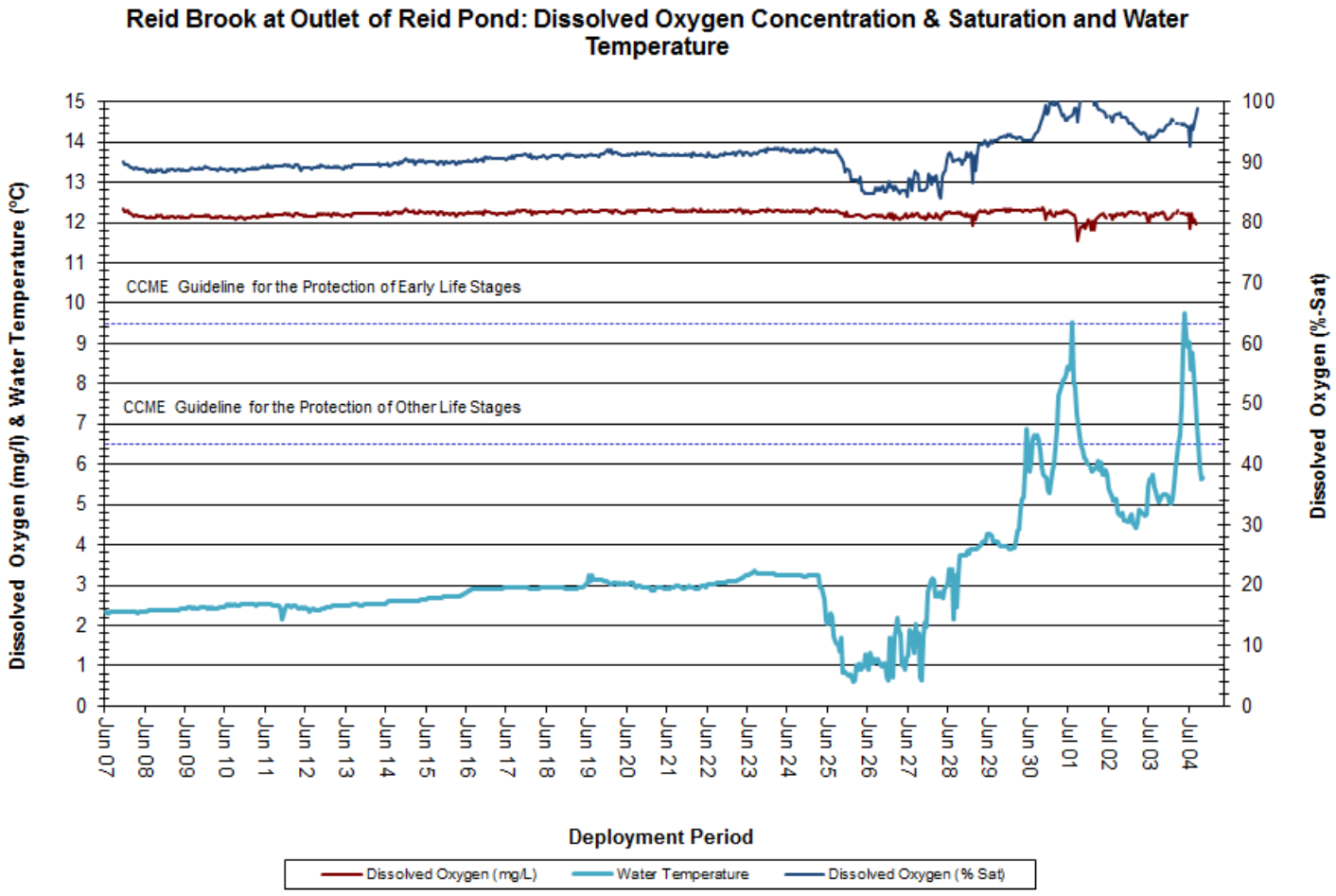

Figure 6: Dissolved Oxygen (mg/L & % Sat) and Water Temperature at Reid Brook at Outlet of Reid Pond

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.

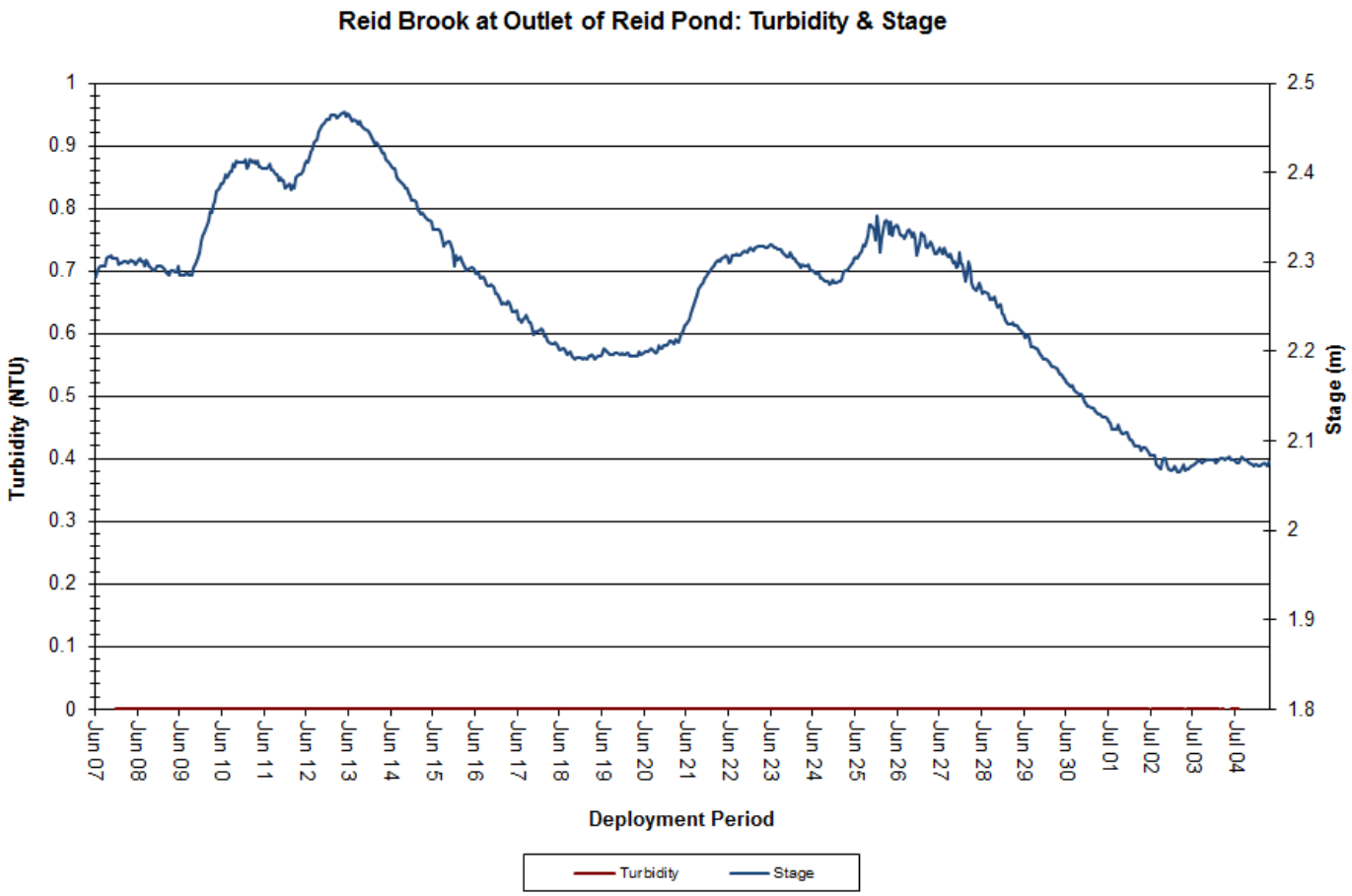

Figure 7: Turbidity and Stage at Reid Brook at Outlet of Reid Pond

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.

During deployment, stage values ranged from 2.07m to 2.47m, with a median value of 2.29m. Flow values ranged from 4.26m^3/s to 12.52m^3/s, with a median value of 8.09m^3/s. Precipitation data was obtained from Nain Weather Station. Precipitation amounts during the deployment period ranged from 0.0 mm to 17.0 mm on June 20th, 2017.

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.

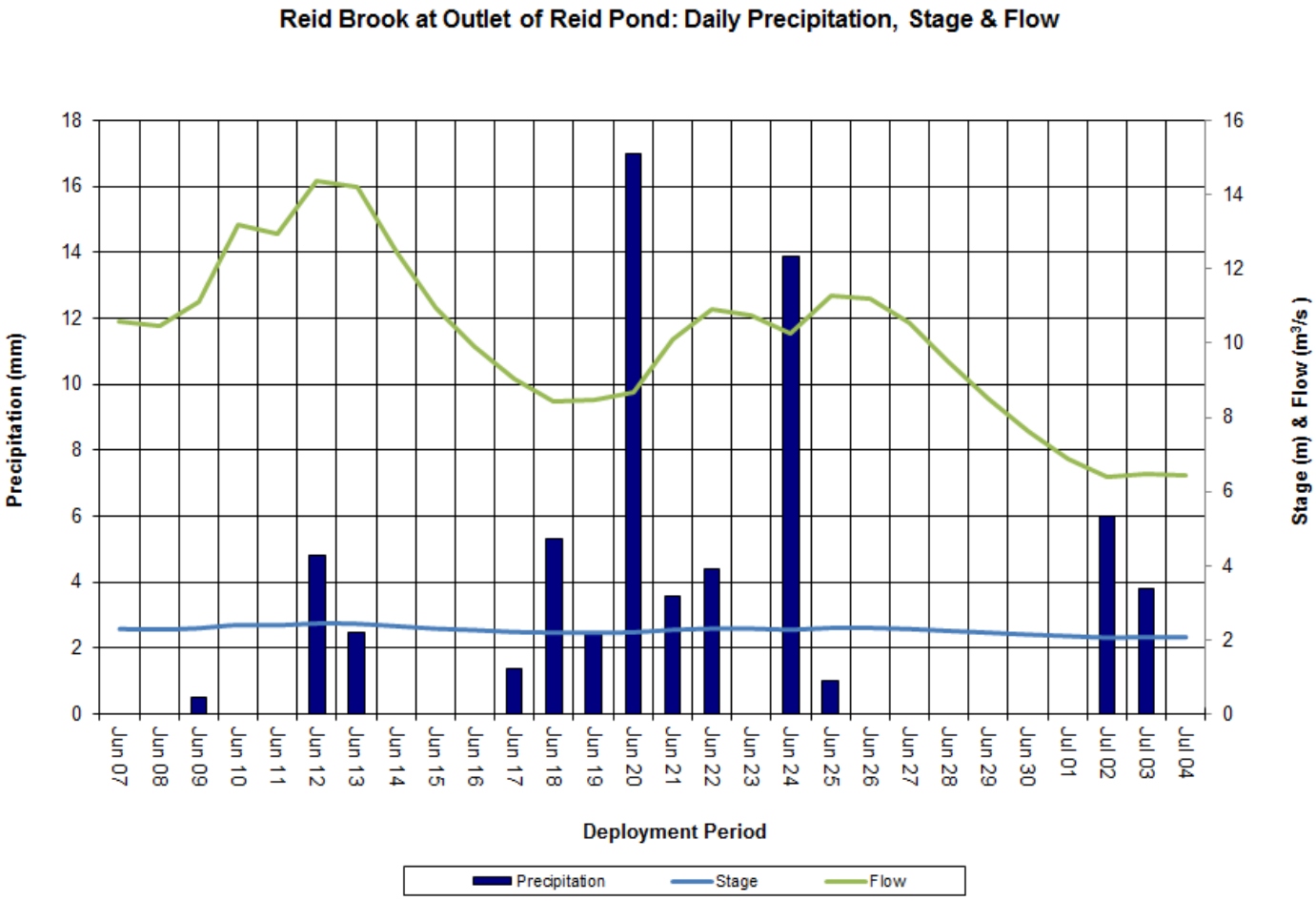

Figure 8: Daily Stage and Flow data from Reid Brook at Outlet of Reid Pond and Total Daily Precipitation from Nain Weather Station

Re

Camp Pond Brook below Camp Pond

Water Temperature

Over the deployment period, water temperature ranged from 5.45°C to 18.50°C, with a median value of 10.24 °C (Figure 9).

The water temperature at this station displays diurnal variations. There is a gradual increase in the water temperature throughout this deployment. This is to be expected as the air temperature increases with the change from spring to summer (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.

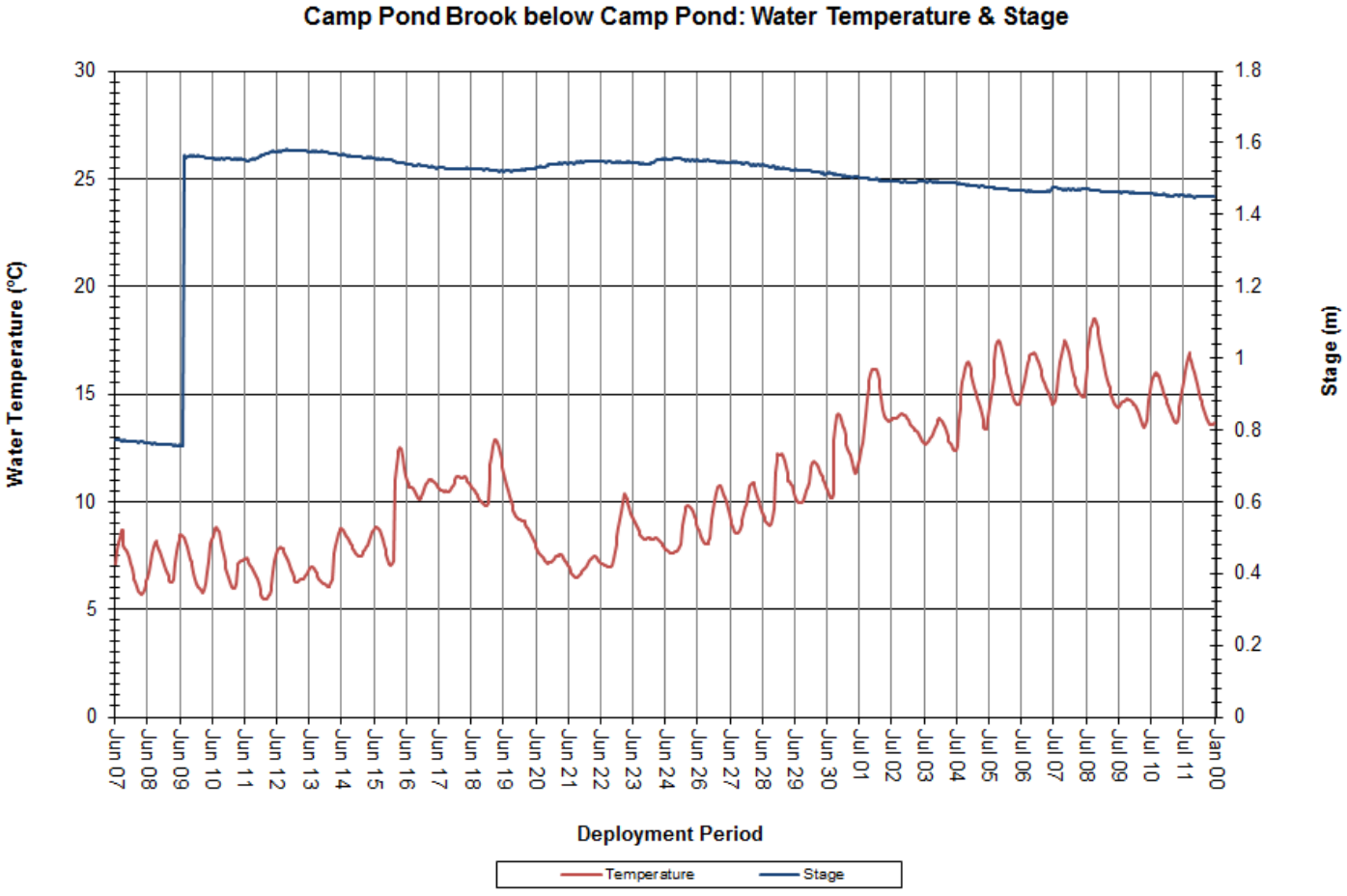

Figure 9: Water Temperature & Stage at Camp Pond Brook below Camp Pond

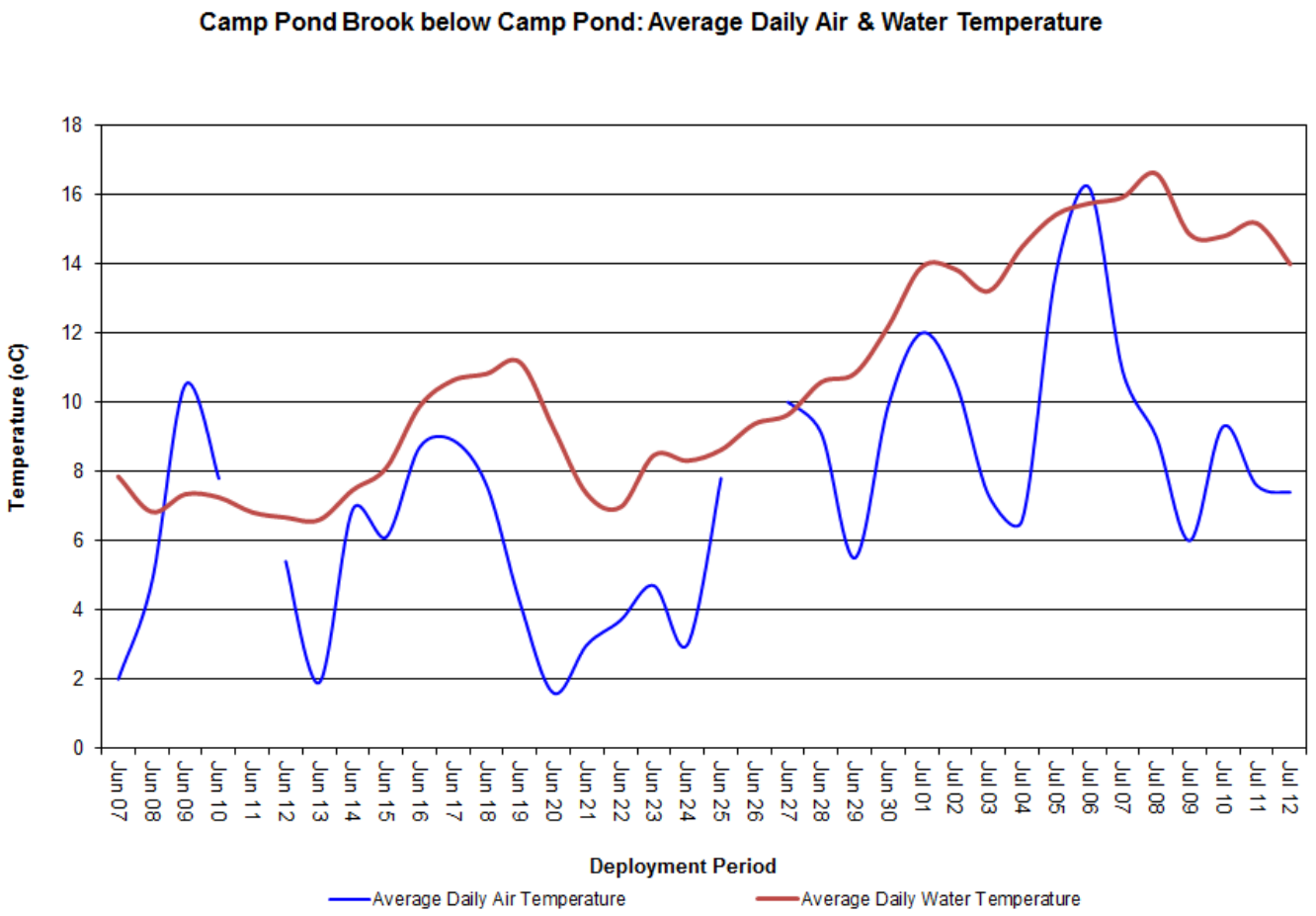

Figure 10: Average Daily Water Temperature at Camp Pond Brook below Camp Pond and Average Daily Air Temperature at Nain Weather Station

pH

Over the deployment period, pH values ranged from 5.84 pH units to 6.76 pH units, with a median value of 6.58 pH units (Figure 11).

The pH levels are consistent during deployment, staying mainly within the Guideline for 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.

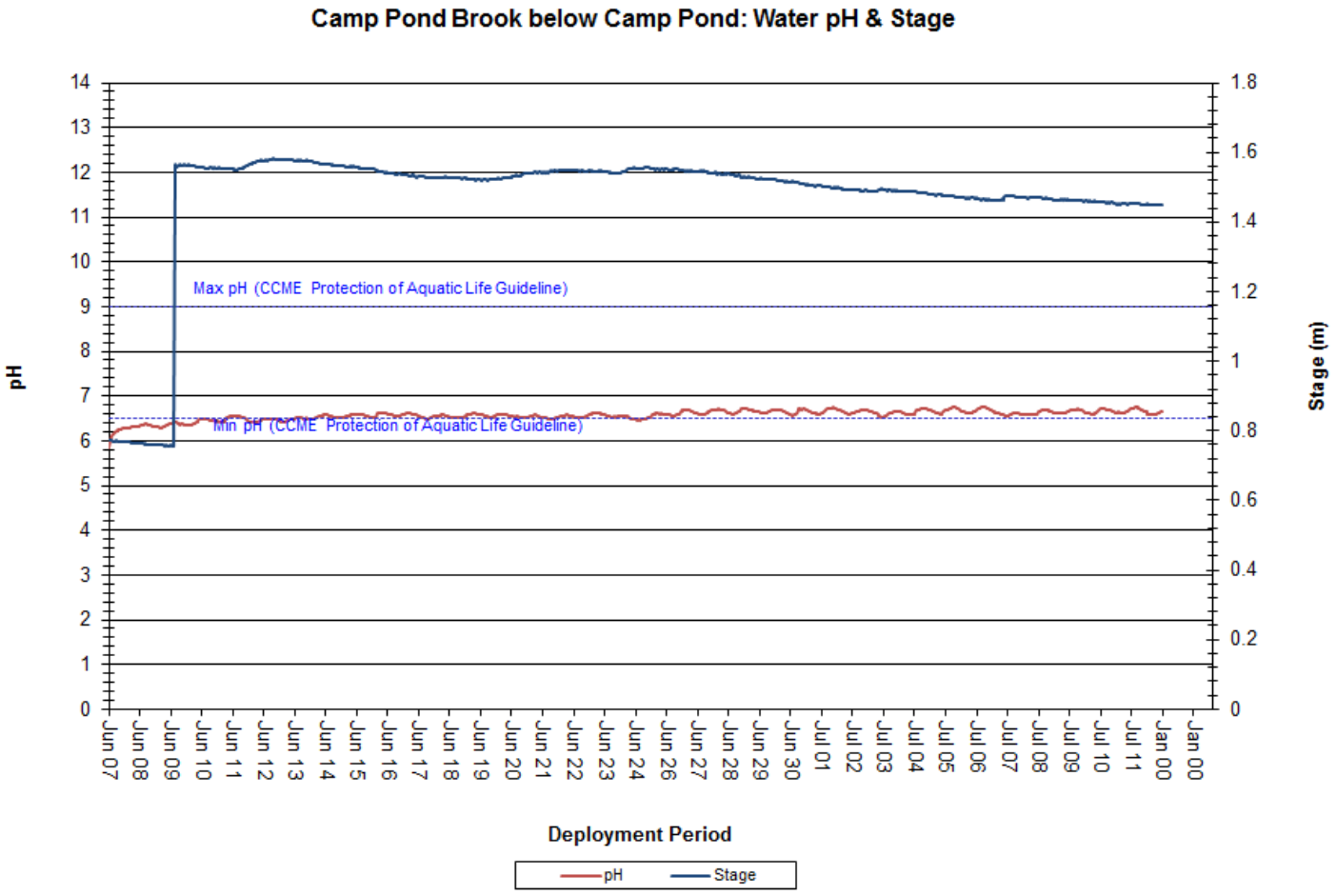

Figure 11: Water pH & Stage at Camp Pond Brook below Camp Pond

Specific Conductivity

Specific conductivity ranged from 21.2µS/cm to 44.9µS/cm, with a median value of 32.1µS/cm (Figure 12).

On July 7th, there is a rainfall event (Figure 15), which corresponds with a sharp increase in conductivity levels, indicating that additional suspended material was entering the brook for a short period of time.

Over the entire deployment period the conductivity levels are slowly increasing. Conductivity levels can also increase with a decrease in water level. A decrease in water level can concentrate the present suspended material 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.

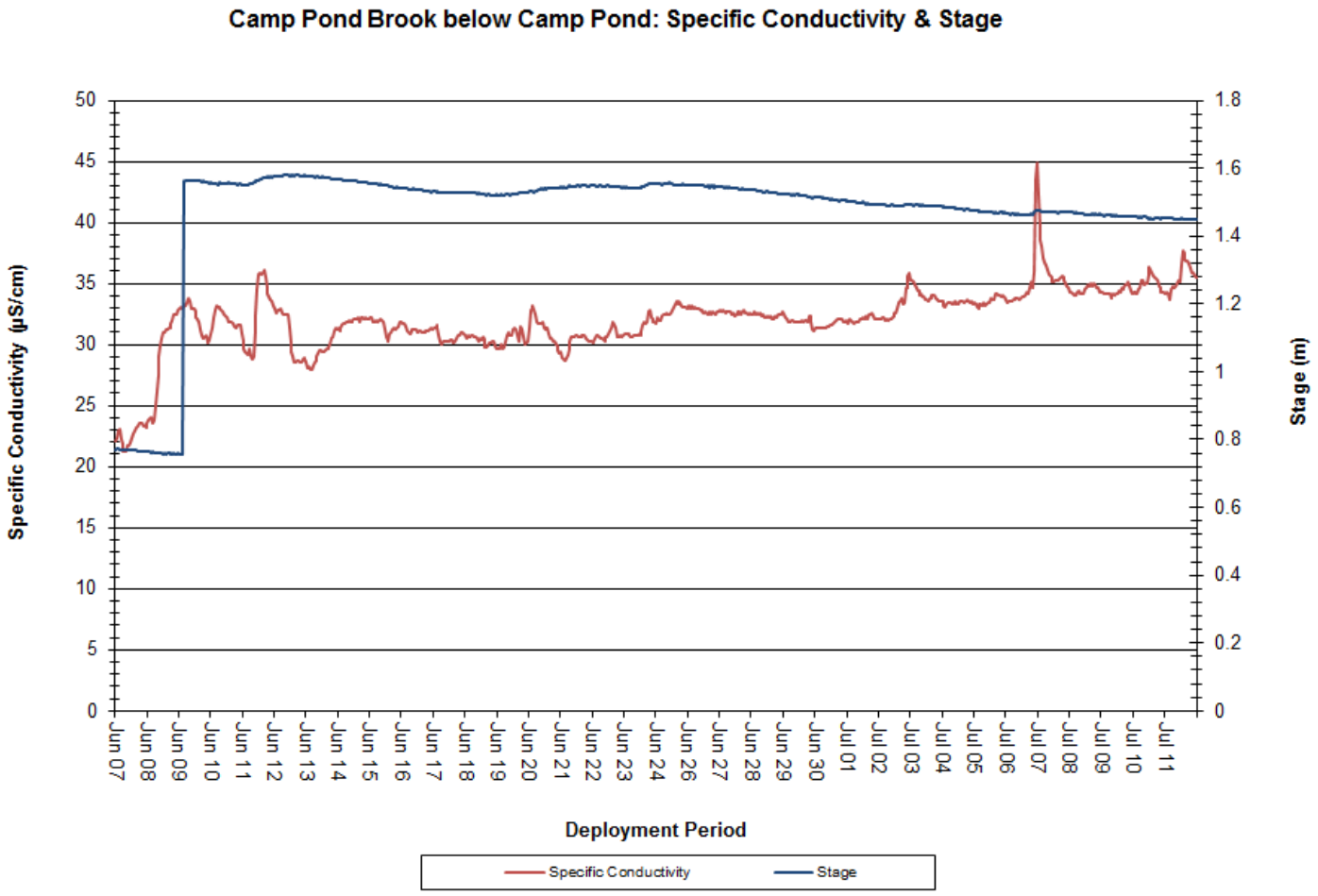

Figure 12: Specific Conductivity & Stage at Camp Pond Brook below Camp Pond

Dissolved Oxygen (mg/L & % Saturation)

During deployment, dissolved oxygen concentration levels ranged from 9.10 mg/L to 11.79 mg/L, with a median value of 10.82 mg/L. Saturation of dissolved oxygen ranges from 87.7% saturation to 103.8% saturation (Figure 13).

Dissolved oxygen concentrations dipped below the CCME guideline of 9.5mg/L at several points during the deployment period. These occurrences correspond with warmer water temperatures during the deployment period (Figure 13). This is expected as water temperature directly influences the level of dissolved oxygen present in the water column. As temperature slowly increases from June 26th onwards, dissolved oxygen concentrations slowly decrease.

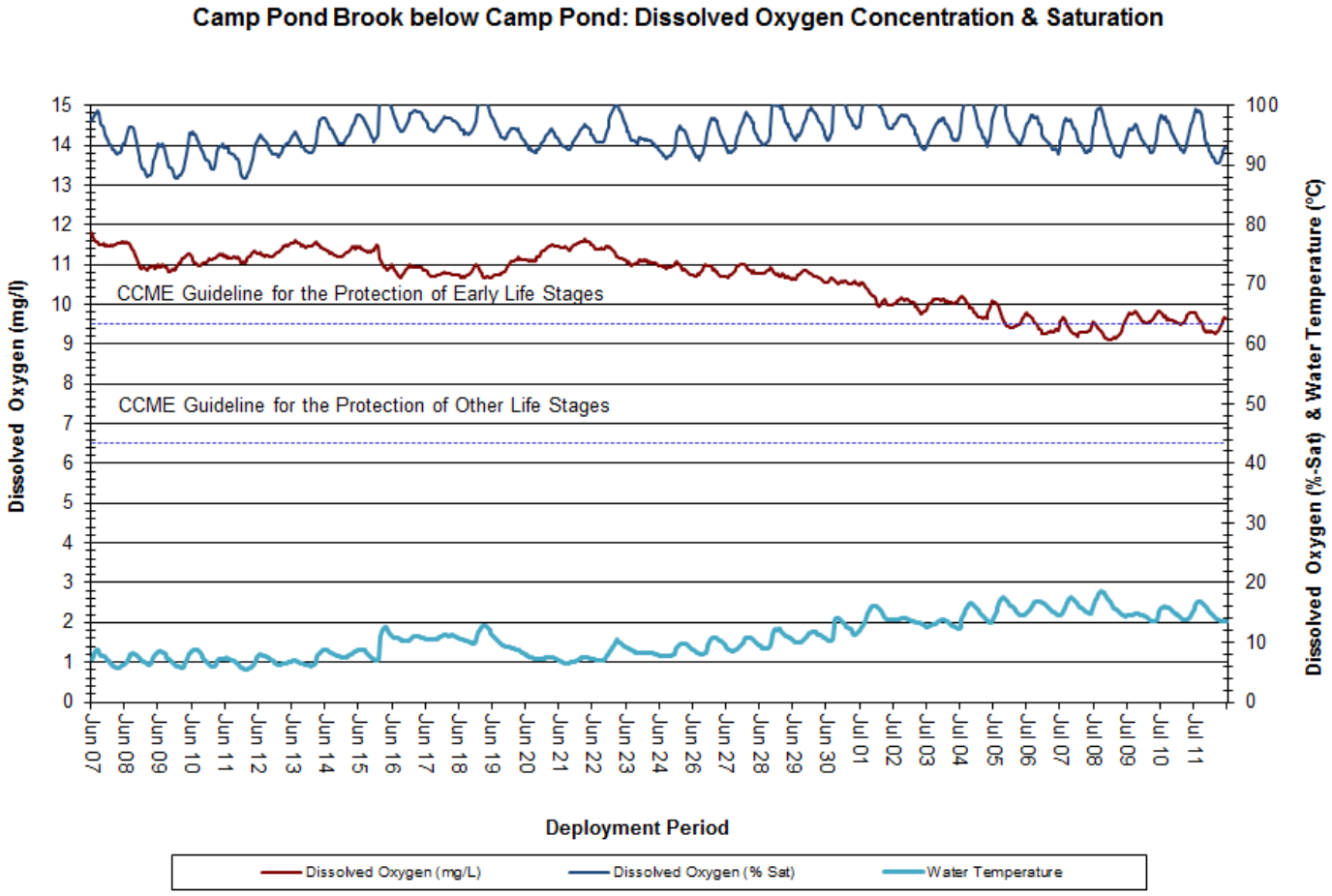

Figure 13: Dissolved Oxygen & Water Temperature at Camp Pond Brook below Camp Pond

Turbidity

Across the deployment period, turbidity ranged from 0.0NTU to 29.8NTU, with a median value of 1.9NTU (Figure 14). A median value of 1.9NTU indicates there is some natural background turbidity at this station.

The few turbidity spikes during this deployment period are very low. This type of turbidity change could be caused by anything in the water body (e.g. bubbles, drifting algae, or sunlight scattering). The turbidity peaks observed on June 24th and July 7th correlate closely with rainfall events (Figure 15). Turbidity data from July 8th onward were removed from the dataset. Following heavy rainfall, turbidity levels did not return to baseline levels, which points to either sediment build-up around the instrument or a sensor failure.

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.

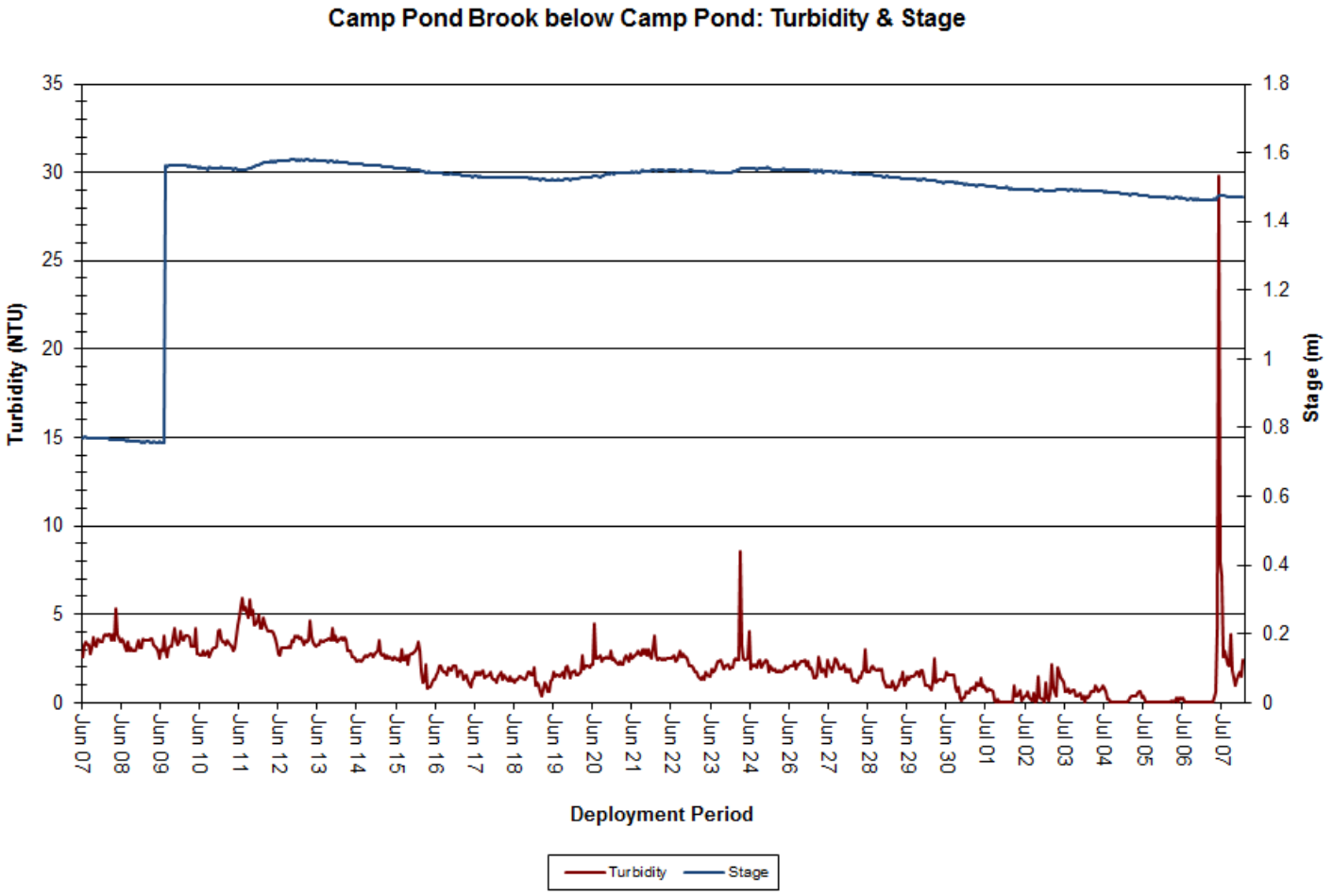

Figure 14: Turbidity & Stage at Camp Pond Brook below Camp Pond

Stage, Streamflow and Precipitation

Precipitation occurred on 17 days during the deployment period, ranging from 0.0mm to 17mm. The largest rainfall event occurred on June 20th, which correlates with a noticeable increase in flow but had little impact on turbidity. In contrast, precipitation events on June 24th and July 7th had a small impact on stream flow, but a much greater impact on turbidity.

During the deployment period, stage values ranged from 0.75m to 1.58m. Stream flow ranged from 0.54m^3/s to 1.48m^3/s.

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.

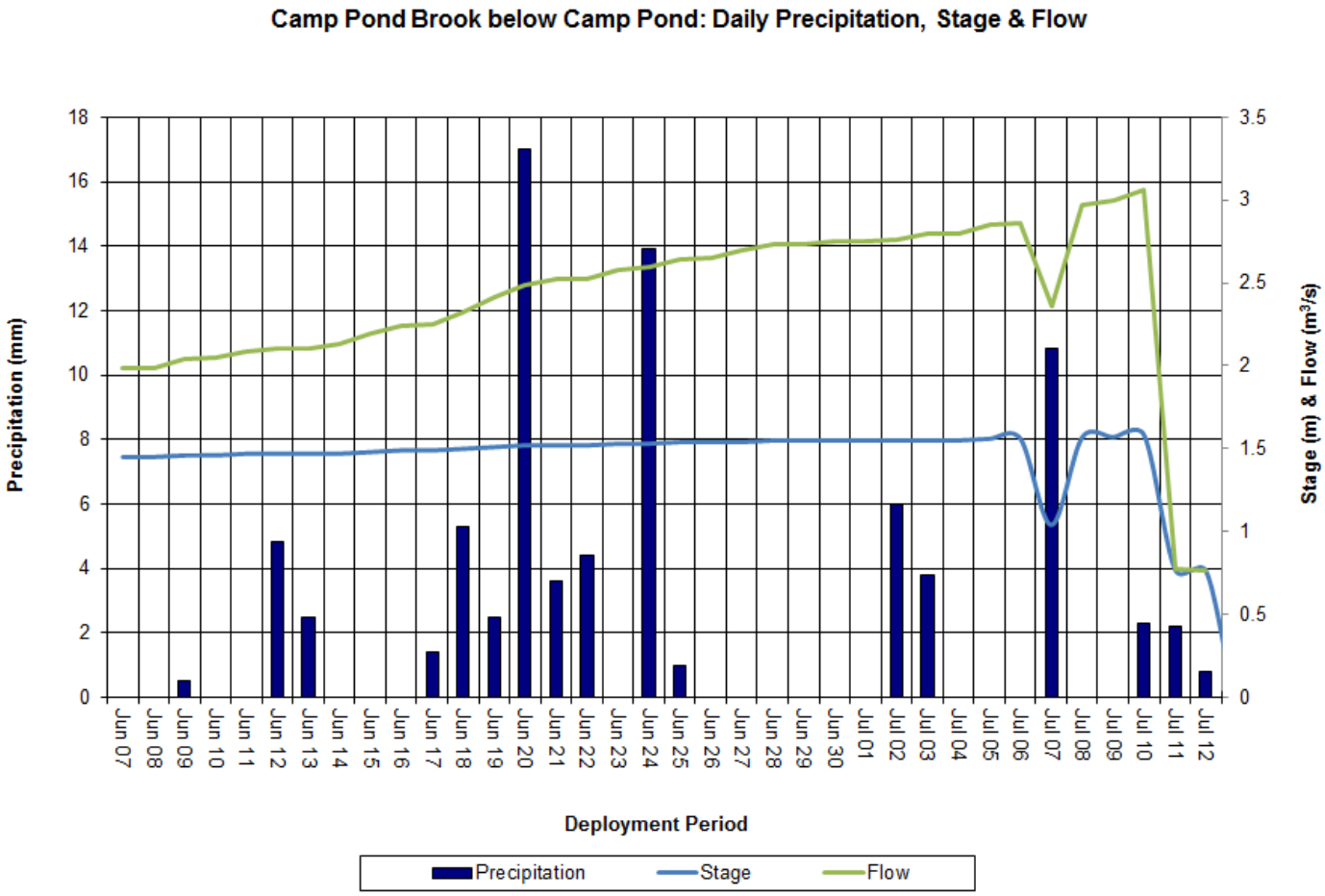

Figure 15: Daily Stage and Flow data from Camp Pond Brook below Camp Pond and Total Daily Precipitation from Nain Weather Station

Reid Brook below Tributary

Water Temperature

Over the deployment period, water temperature ranged from 3.66 ^{o}C to 14.34 ^{o}C, with a median value of 7.87^{o}C (Figure 16).

Water temperature at this station displays diurnal variations, and there is a gradual increase in the water temperature throughout this 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 from June 24 onwards, water temperature increases from June 24 onwards.

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.

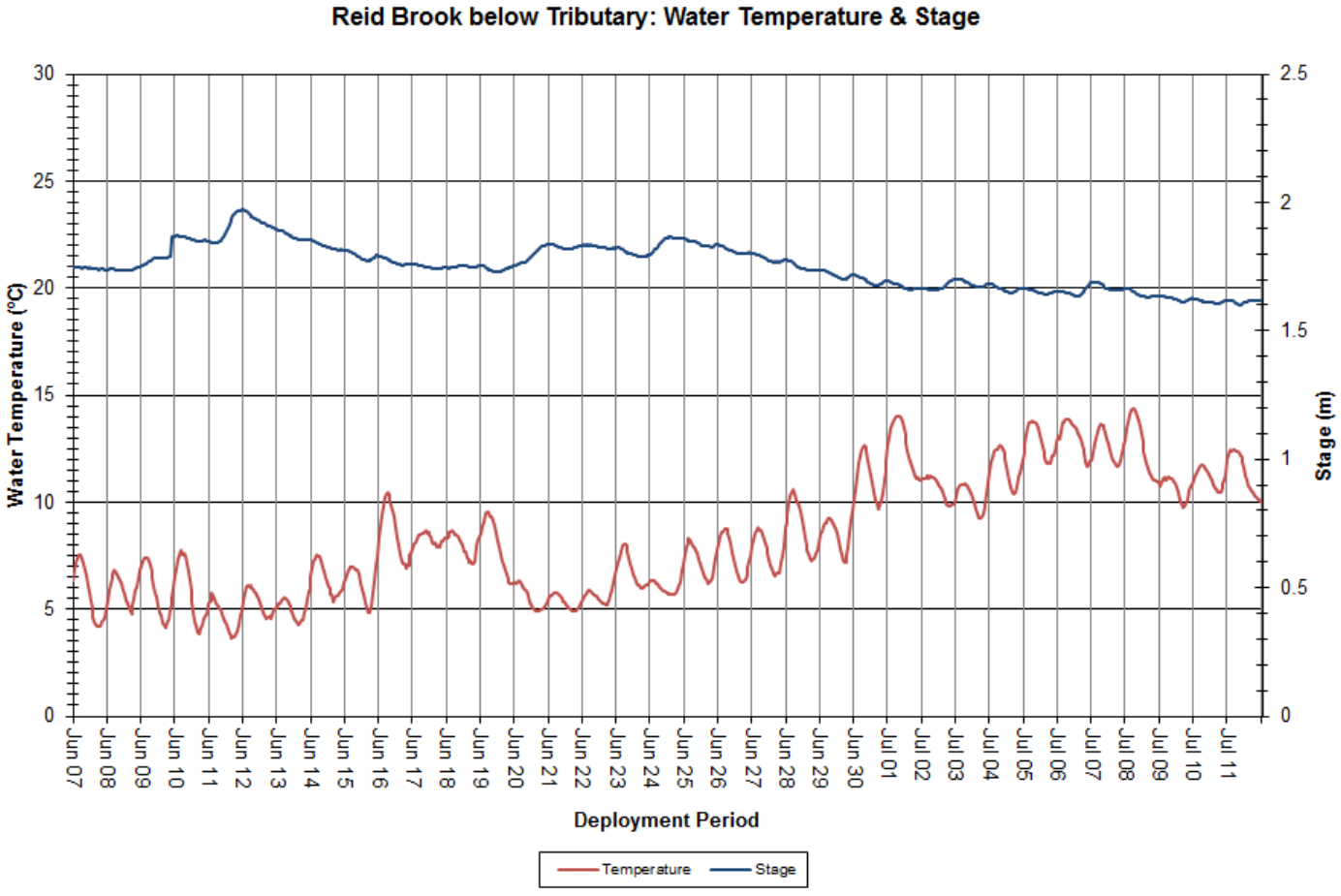

Figure 16: Water Temperature & Stage at Reid Brook below Tributary

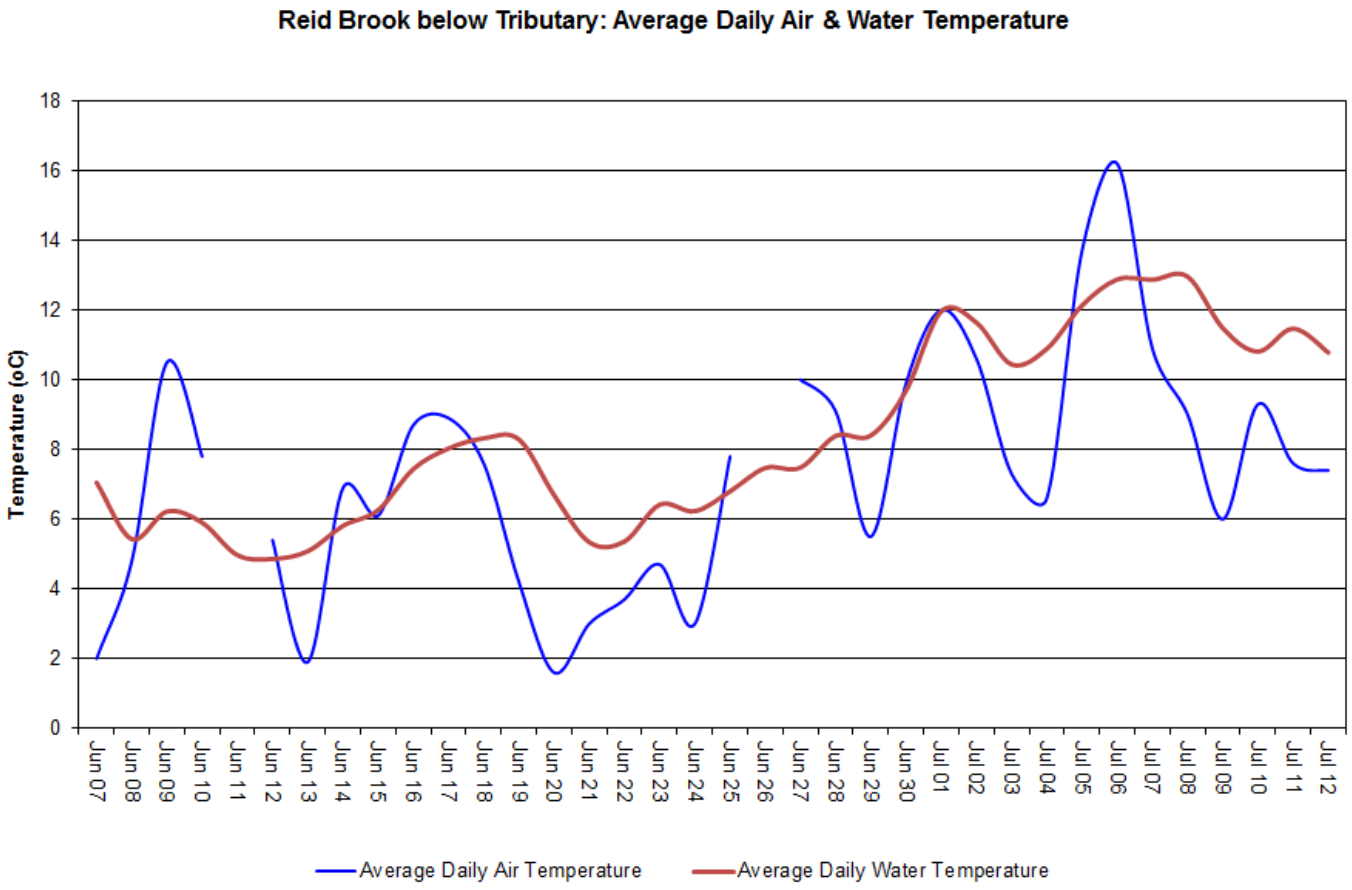

Figure 17: Average Daily Water Temperature at Reid Brook below Tributary and Average Daily Air Temperature from Nain Weather Station

pH

During deployment, pH ranged from 6.06 pH units to 6.73 pH units, with a median value of 6.49 (Figure 18).

pH frequently dips below the minimum CCME guidelines for the protection of aquatic life, and these dips generally correspond with increases in stage. Stage increases are likely a result of precipitation events, which in turn cause water bodies to become slightly more acidic. 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.

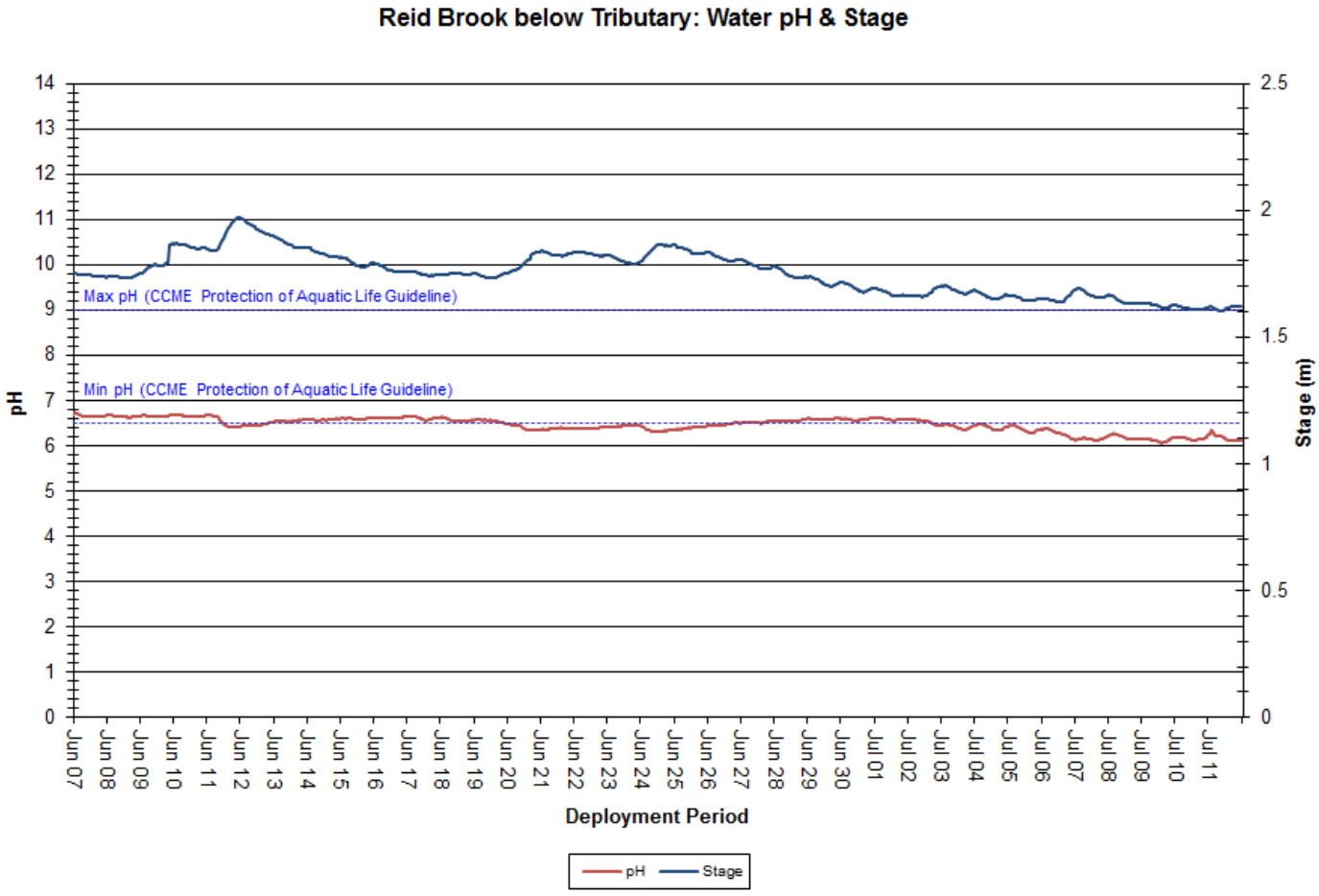

Figure 18: pH & Stage at Reid Brook below Tributary

Specific Conductivity

Specific conductivity ranged from 16.1µS/cm to 25.2µS/cm, with a median value of 19.6µS/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, on June 24th a significant rainfall event occurs (Figure 22), which increases stage and decreases 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).

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.

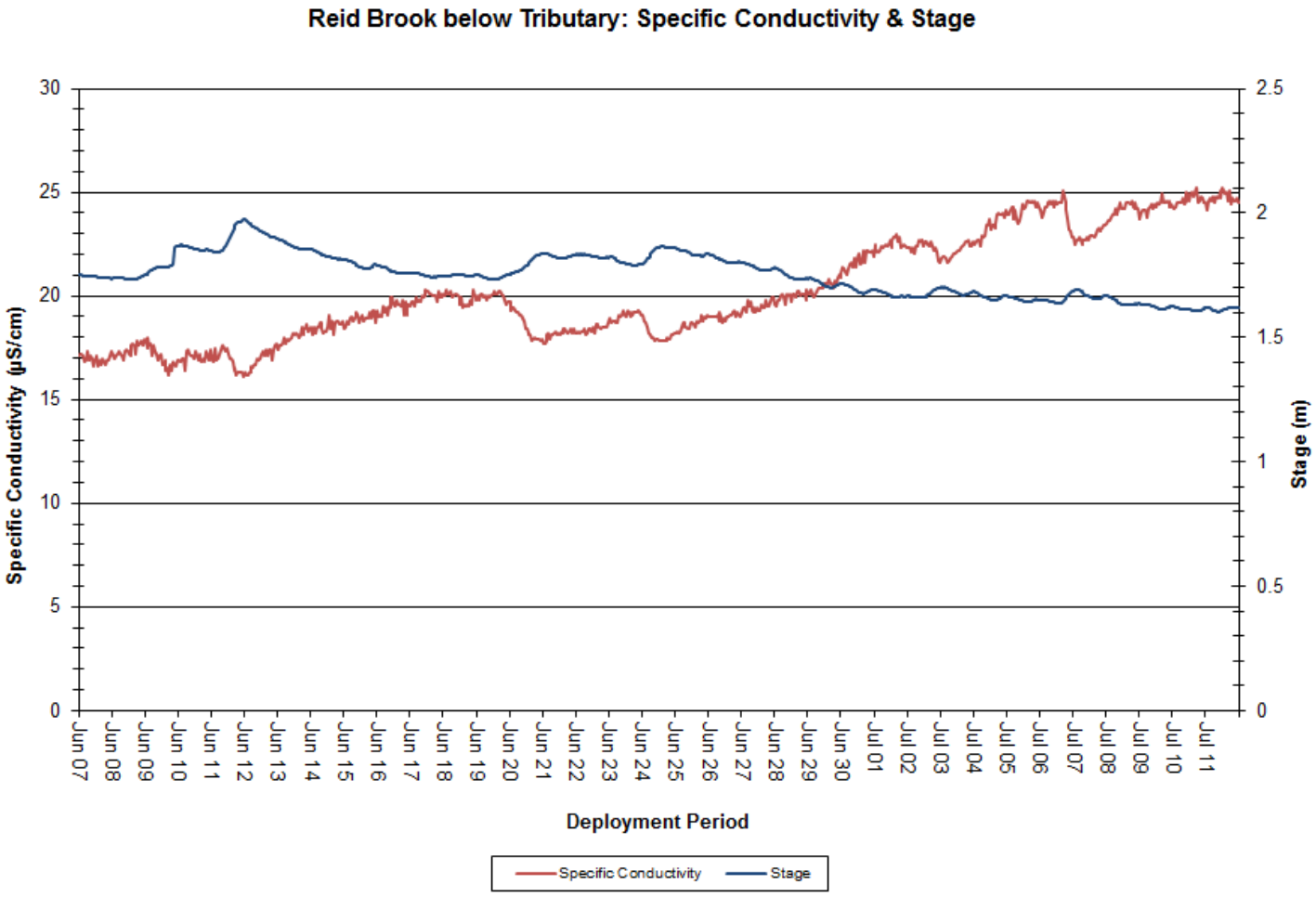

Figure 19: Specific Conductivity & Stage at Reid Brook below Tributary

Dissolved Oxygen

Dissolved oxygen content ranged from 9.78 mg/L to 12.62 mg/L during deployment, with a median value of 11.48 mg/L. The saturation of dissolved oxygen ranges from 93.3% to 100.2%, with a median value of 96.3% (Figure 20).

Dissolved oxygen concentration remained above the CCME guideline of 9.5mg/L. Dissolved oxygen levels were reasonably consistent, with small changes that correlate closely with changes in water temperature at the same time.

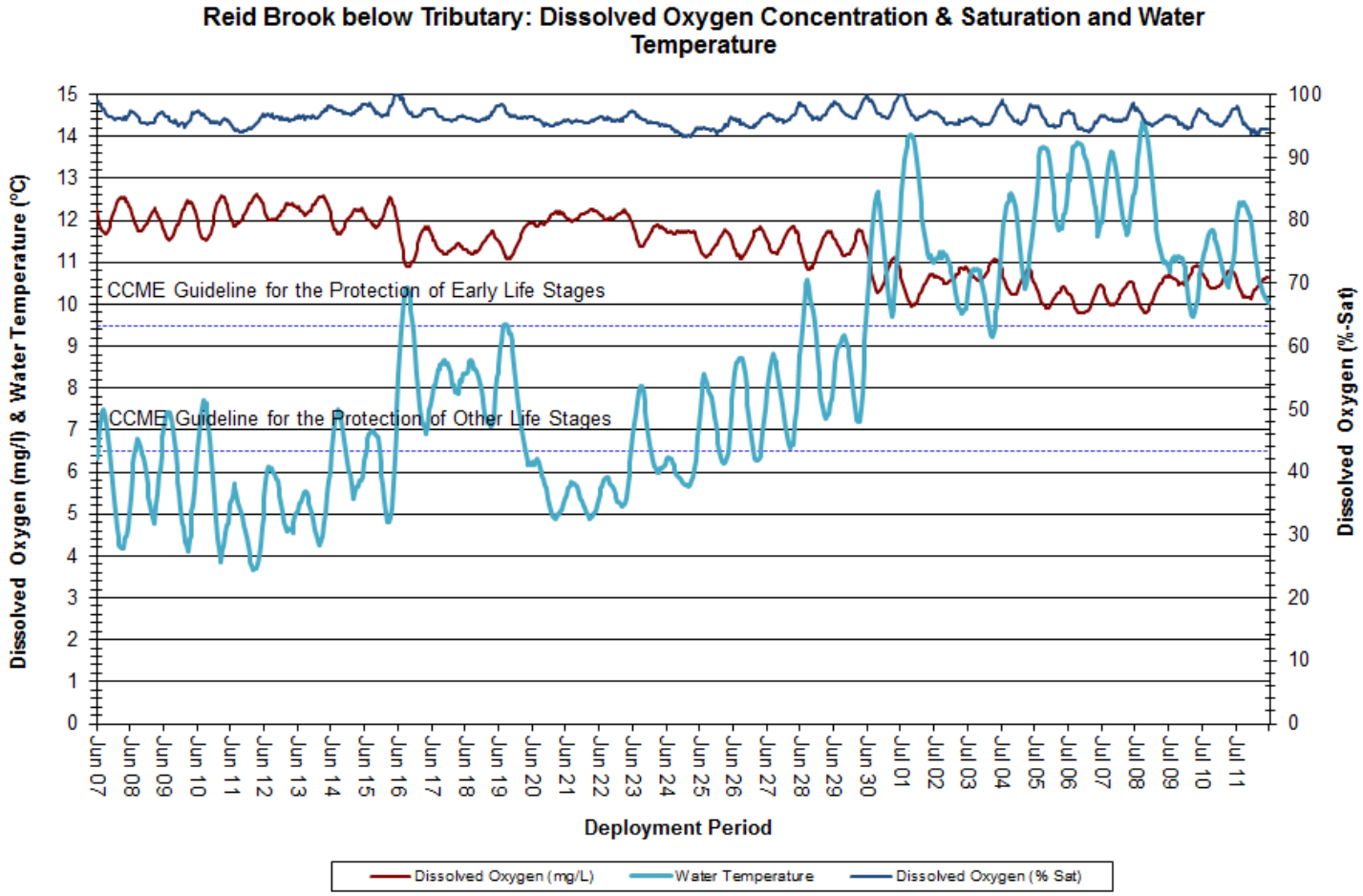

Figure 20: Dissolved Oxygen and Water Temperature at Reid Brook below Tributary

Turbidity

During deployment, turbidity ranged from 0.5 NTU to 47.2 NTU, with a median value of 3.4 NTU (Figure 21).

Turbidity was quite variable at this station for the duration of deployment. Some of the larger turbidity events correlate with an increase in stage (Figure 21) and are likely a result of precipitation (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.

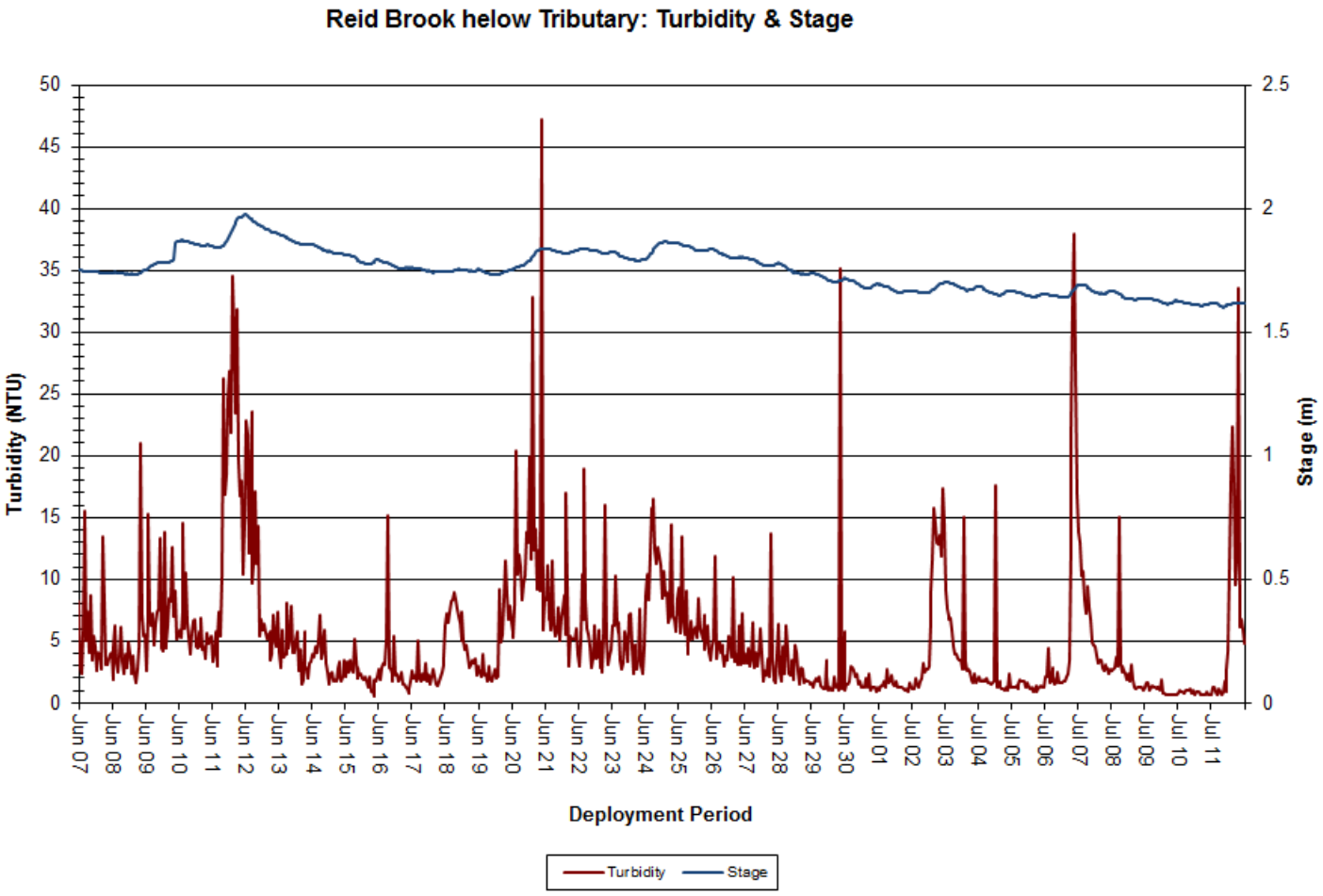

Figure 21: Turbidity and Stage at Reid Brook below Tributary

Stage, Flow and Precipitation

Stage, flow and precipitation are graphed below to show the relationship between rainfall and water level (Figure 22). It is evident that peaks in stage (m) and flow (m^3/s) are closely linked to precipitation events.

During deployment, stage values ranged from 1.60m to 1.97m, with a median of 1.75m. Flow ranged from 4.51m^3/s to 21.06m^3/s, with a median value of 9.80m^3/s.

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.

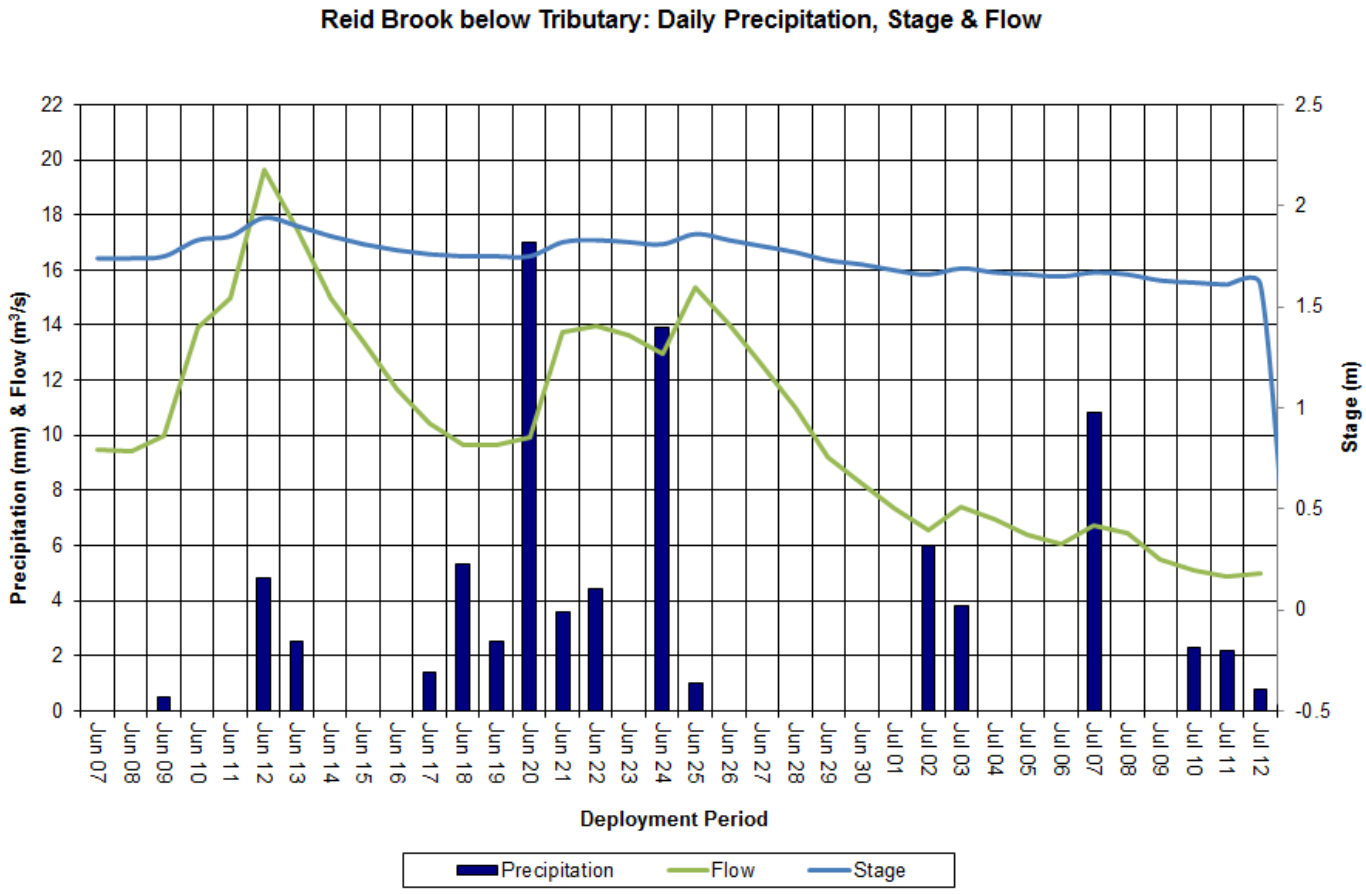

Figure 22: Daily Stage and Flow data from Reid Brook below Tributary and Total Daily Precipitation from Nain Weather Station

Tributary to Reid Brook

Water Temperature

Water temperature ranged from 3.70°C to 14.50°C, with a median value of 8.20°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 gradually over the course of deployment with the change from spring to summer.

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.

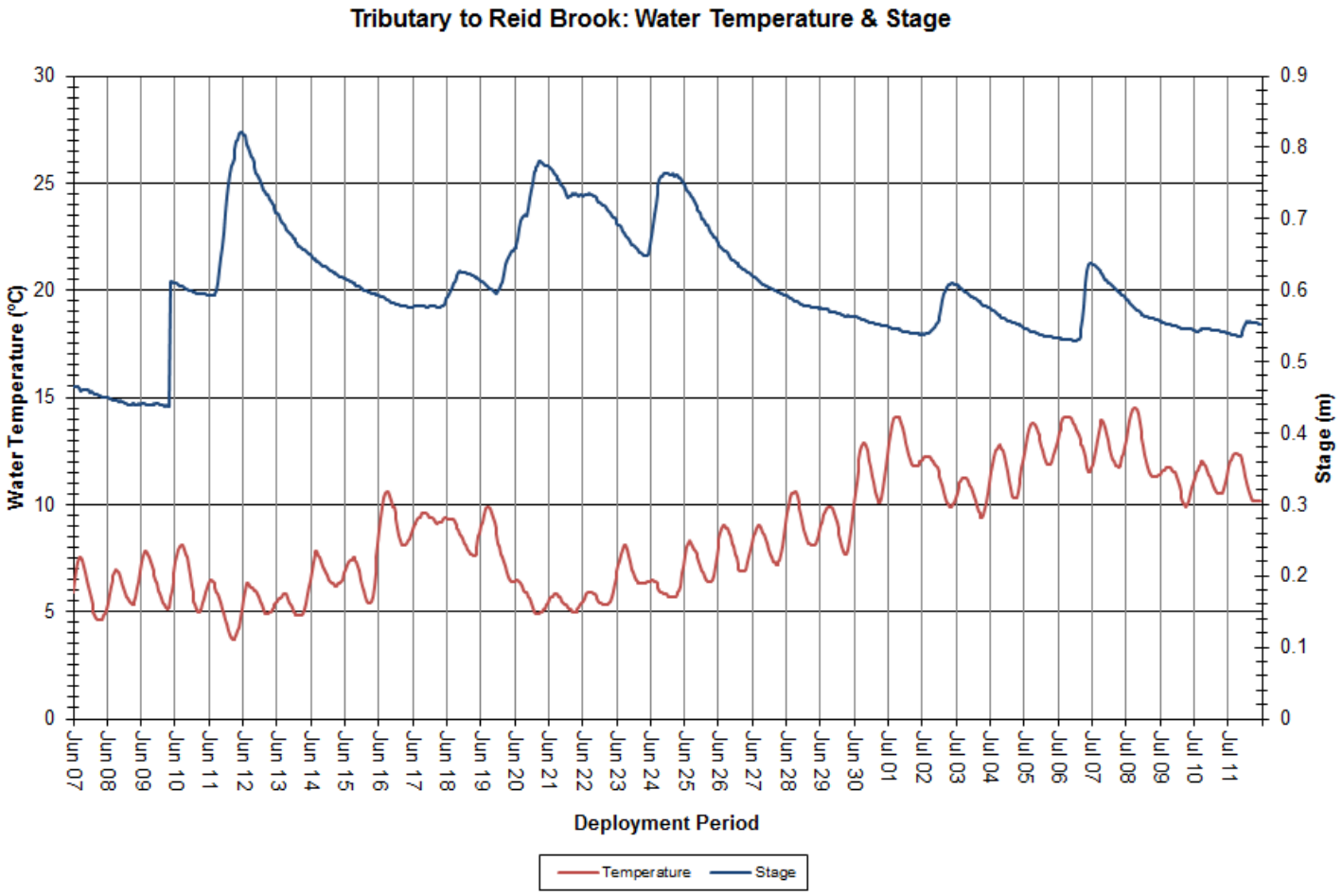

Figure 23: Water Temperature and Stage at Tributary to Reid Brook

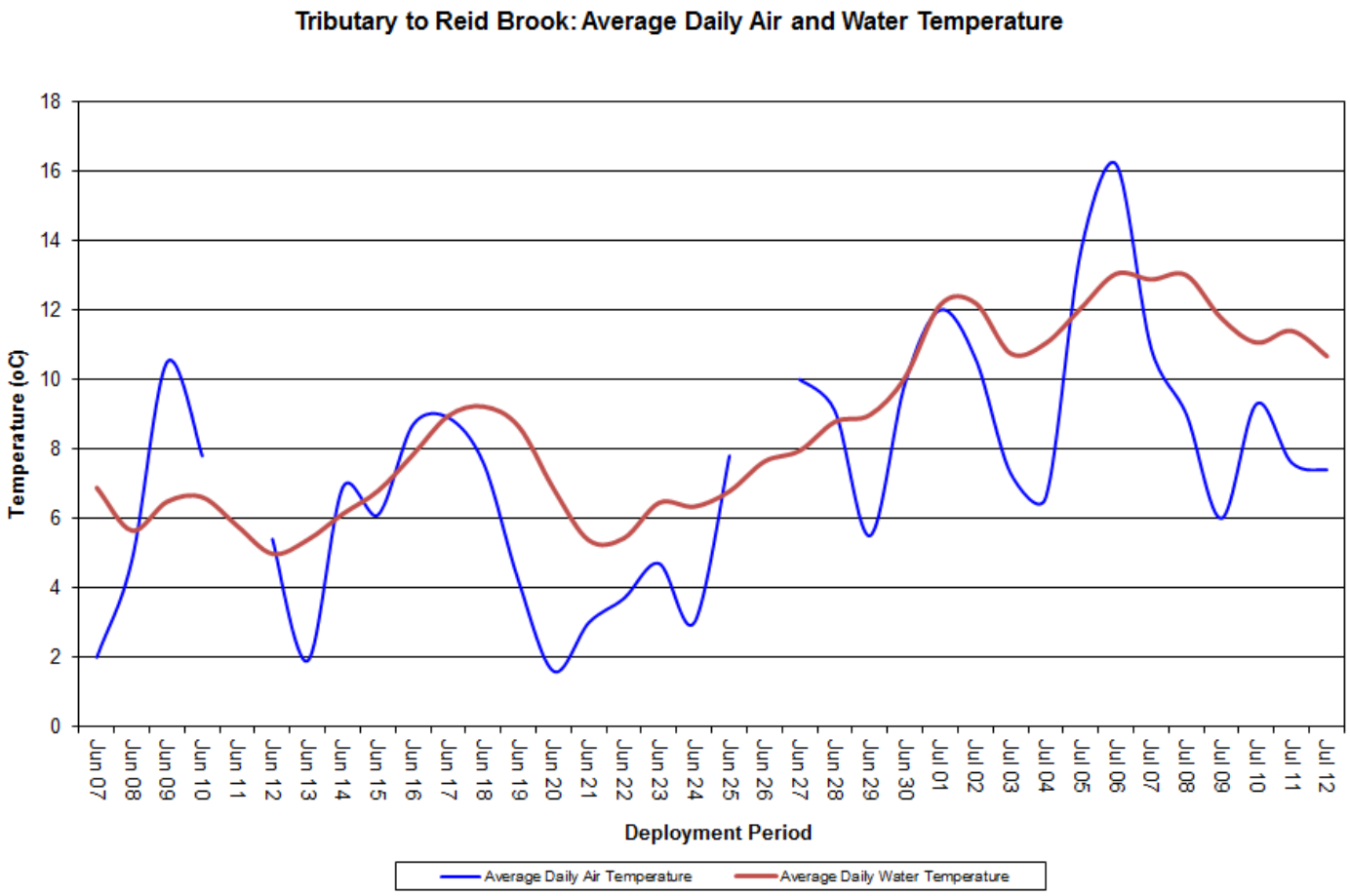

Figure 24: Average Daily Water Temperature at Tributary to Reid Brook and Average Daily Air Temperature from Nain Weather Station

pH

Over deployment, pH ranged from 6.18 pH units to 6.71 pH units, with a median value of 6.52 (Figure 25).

Stage increases often indicate a rainfall event; rainfall will cause pH values to decrease for a short period of time (Figure 25). This is evidenced by decreases in pH values on June 12th and 13th, June 21st, June 25th, July 3rd and July 7th, 2017.

Over the course of deployment, pH values fluctuate above and below the CCME guideline.

Please note 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.

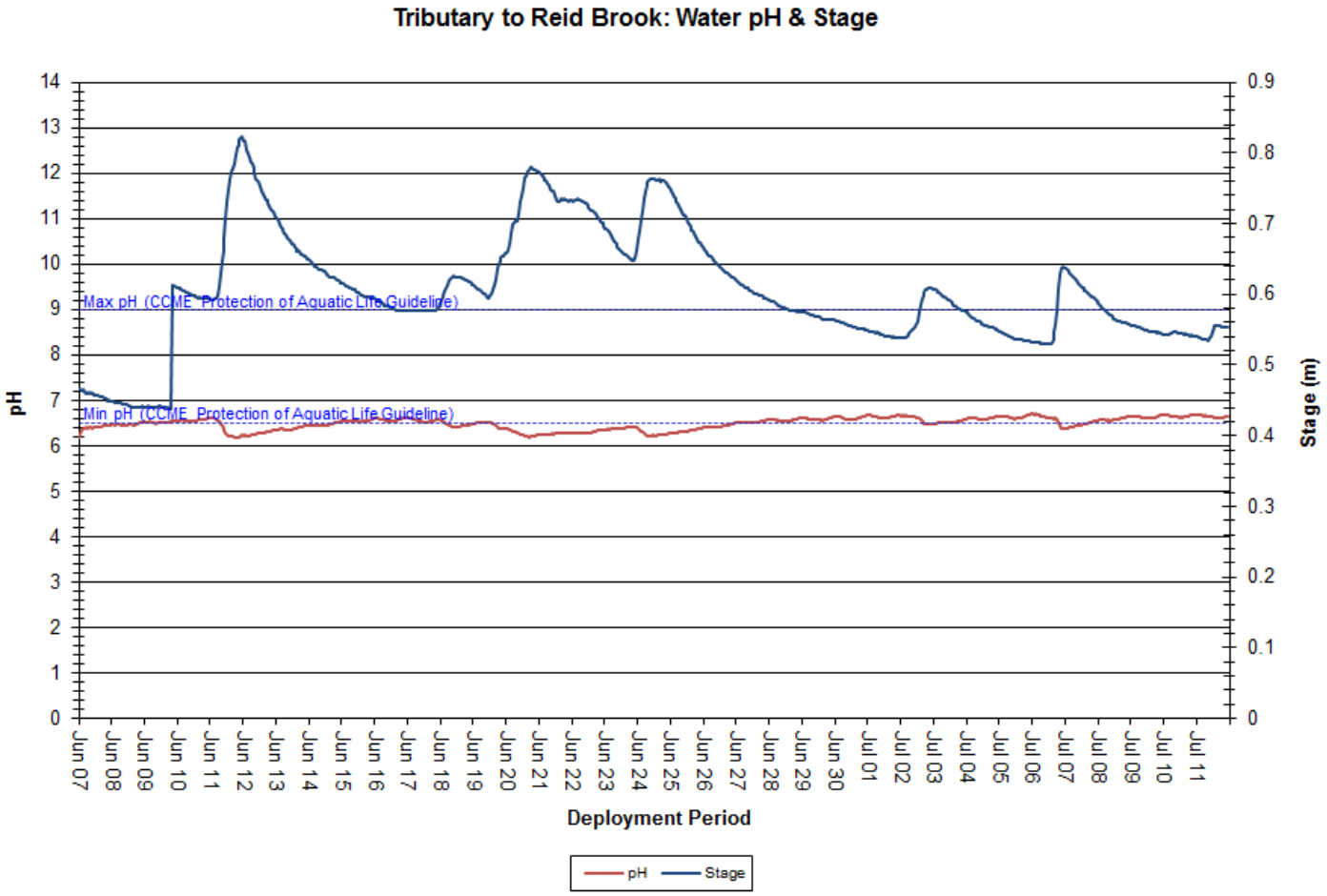

Figure 25: pH & Stage Level at Tributary to Reid Brook

Specific Conductivity

Over the course of deployment, specific conductivity ranged from 2.5µS/cm to 25.1µS/cm, with a median value of 19.0µS/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. Rainfall events over the course of deployment (Figure 29) likely influenced the decrease in specific conductivity on the same dates.

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

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.

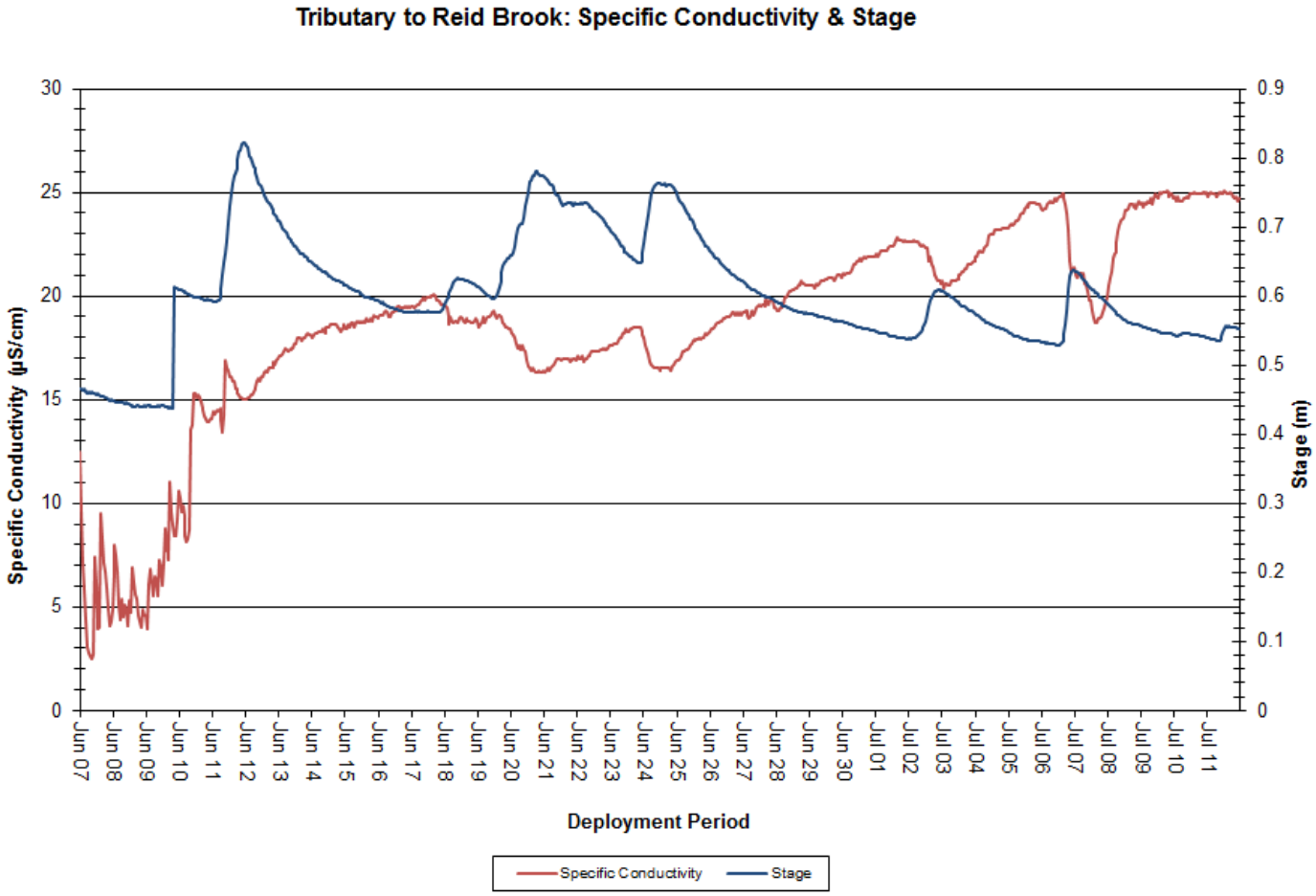

Figure 26: Specific Conductivity & Stage at Tributary to Reid Brook

Dissolved Oxygen

Over the deployment period, dissolved oxygen ranged from 9.66mg/L to 12.55mg/L, with a median value of 11.30mg/L. The saturation of dissolved oxygen ranged from 93.1% to 98.7% (Figure 27).

Dissolved oxygen levels remained above the CCME guidelines for the protection of early/other life stages.

Dissolved oxygen data displays a diurnal pattern. During nightfall, the dissolved oxygen levels are higher as cooler temperatures allow for more DO to be stored in the water column. During the day time dissolved oxygen levels are lower. This is a result of warmer water temperatures and aquatic plants photosynthesizing resulting in less dissolved oxygen in the water column.

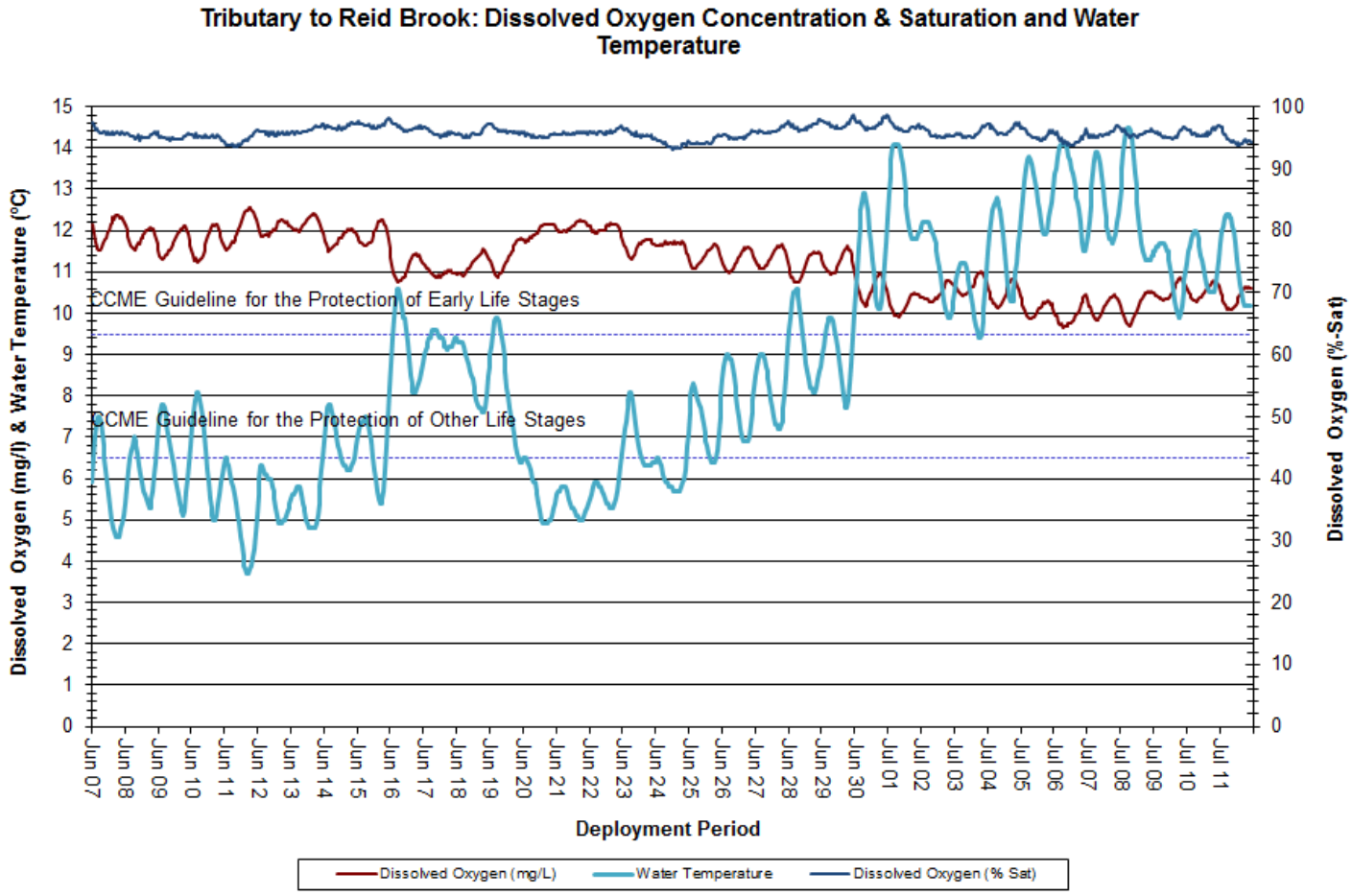

Figure 27: Dissolved Oxygen Concentration and Water Temperature at Tributary to Reid Brook

Turbidity

During deployment, turbidity ranged from 0.0 NTU to 48.4 NTU, with a median value of 0.9 NTU (Figure 28). A median value of 0.9 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 correlates 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.

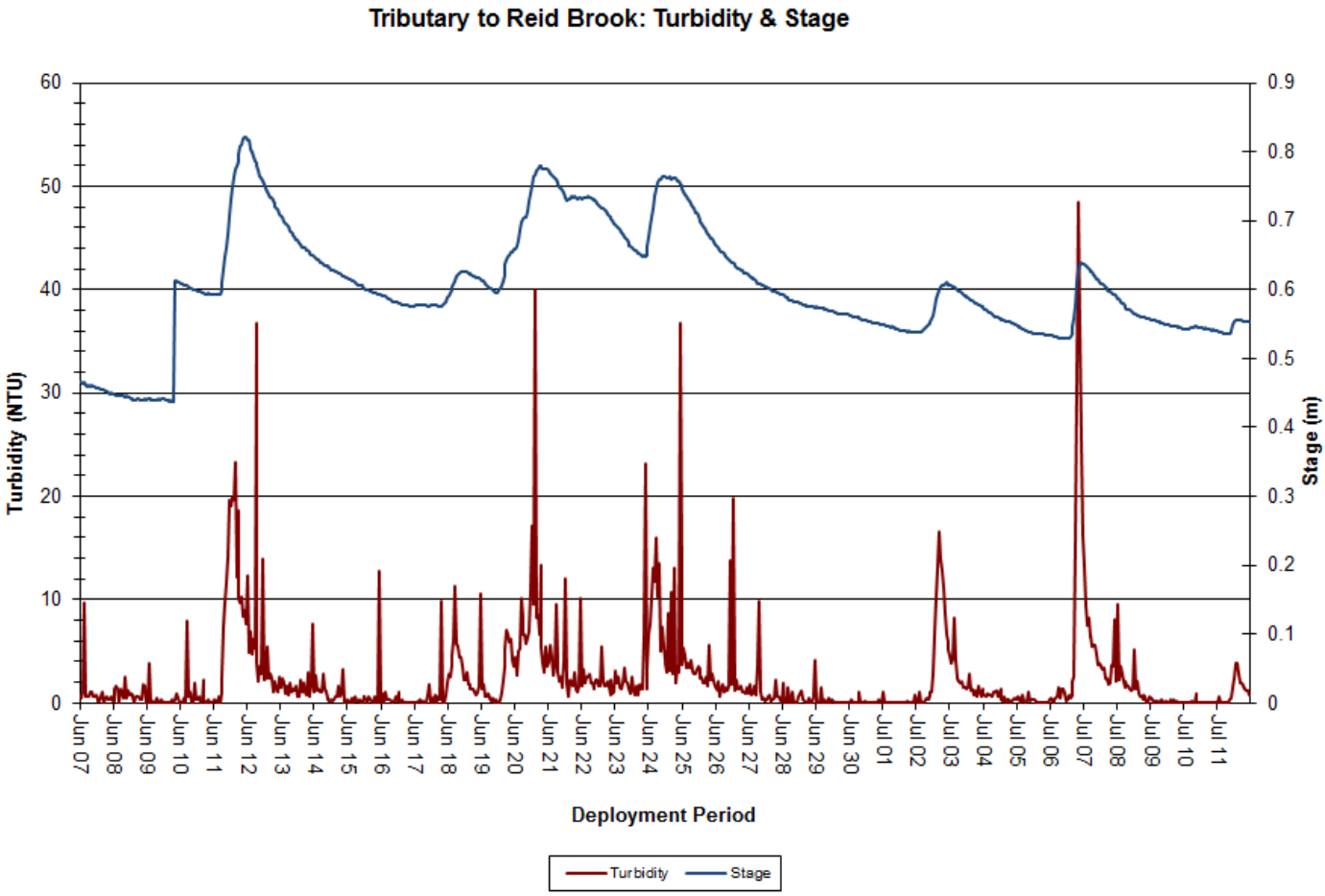

Figure 28: Turbidity & Stage at Tributary to Reid Brook

Stage, Flow and Precipitation

During deployment, stage values ranged from 0.44m to 0.82m, with a median value of 0.59m. Flow ranged from 0.11m^3/s to 1.64m^3/s, with a median value of 0.41m^3/s.

Stage, flow and precipitation are graphed below to show the relationship between rainfall and water level (Figure 29). It is evident that the peaks in stage and flow data are closely related to precipitation.

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.

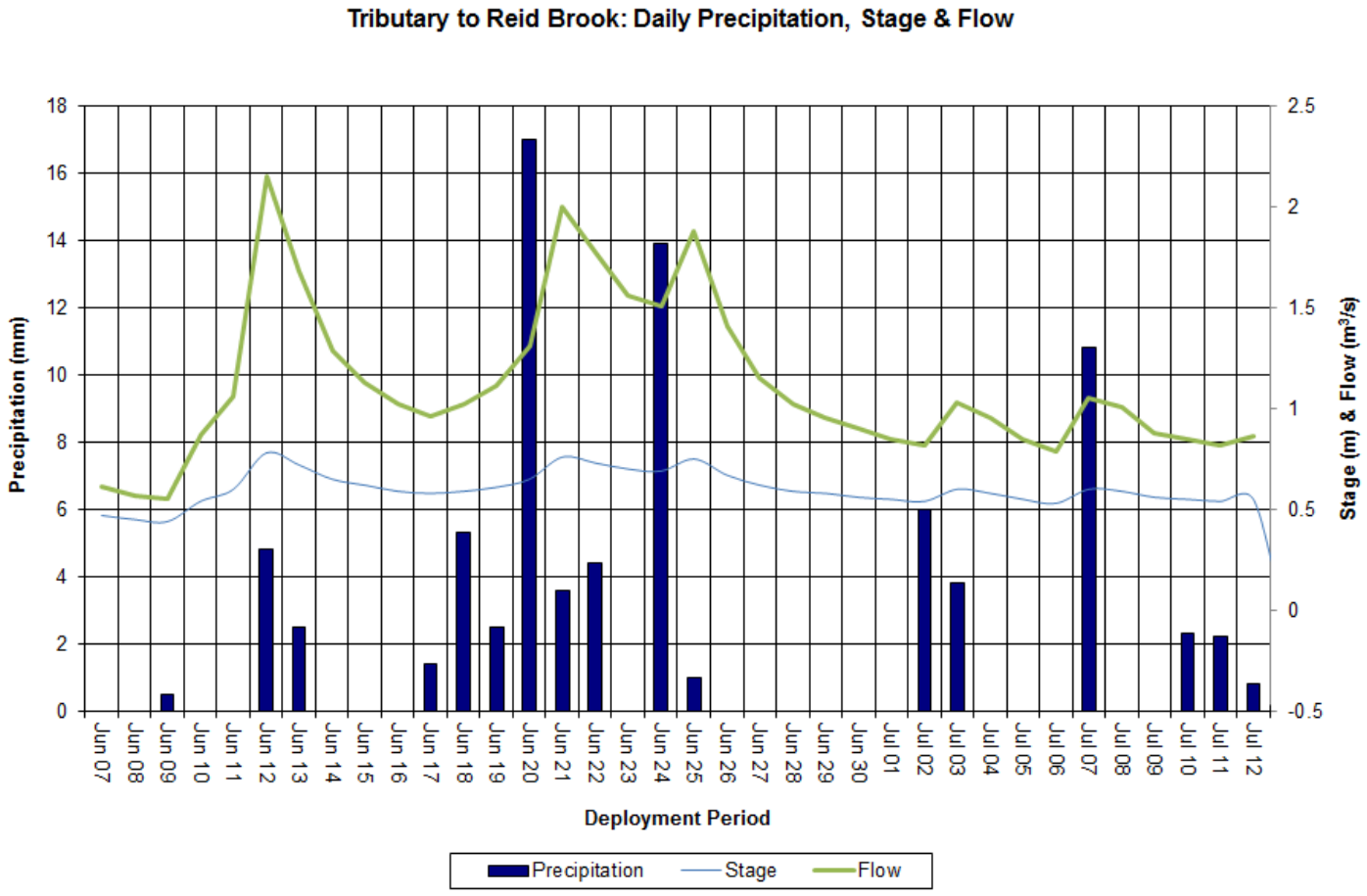

Figure 29: Daily Stage and Flow data from Tributary to Reid Brook and Total Daily Precipitation from Nain Weather Station

Conclusions

Water temperatures across all stations ranged from a minimum of 0.60°C at Reid Brook at Outlet of Reid Pond to a maximum of 18.50°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 5.34pH units at Reid Brook below Reid Pond to a maximum of 6.76pH units at Camp Pond Brook below Camp Pond. 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 2.5µS/cm at Tributary to Reid Brook to a maximum of 44.9µS/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 32.1 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 9.10 mg/l at Camp Pond Brook below Camp Pond to a maximum of 12.62 mg/l at Reid Brook below Tributary. 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 brief occasions at Camp Pond Brook below Camp Pond between July 6th and July 12th.

Turbidity levels across all stations ranged from a minimum of 0.0 NTU at three stations to a maximum of 48.4NTU at Tributary to Reid Brook. Turbidity levels showed natural increases and decreases corresponding to stage and precipitation events, with the exception of Camp Pond Brook below Camp Pond, where turbidity levels did not return to baseline following a heavy rainfall event.

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.

APPENDIX A: Comparison Graphs

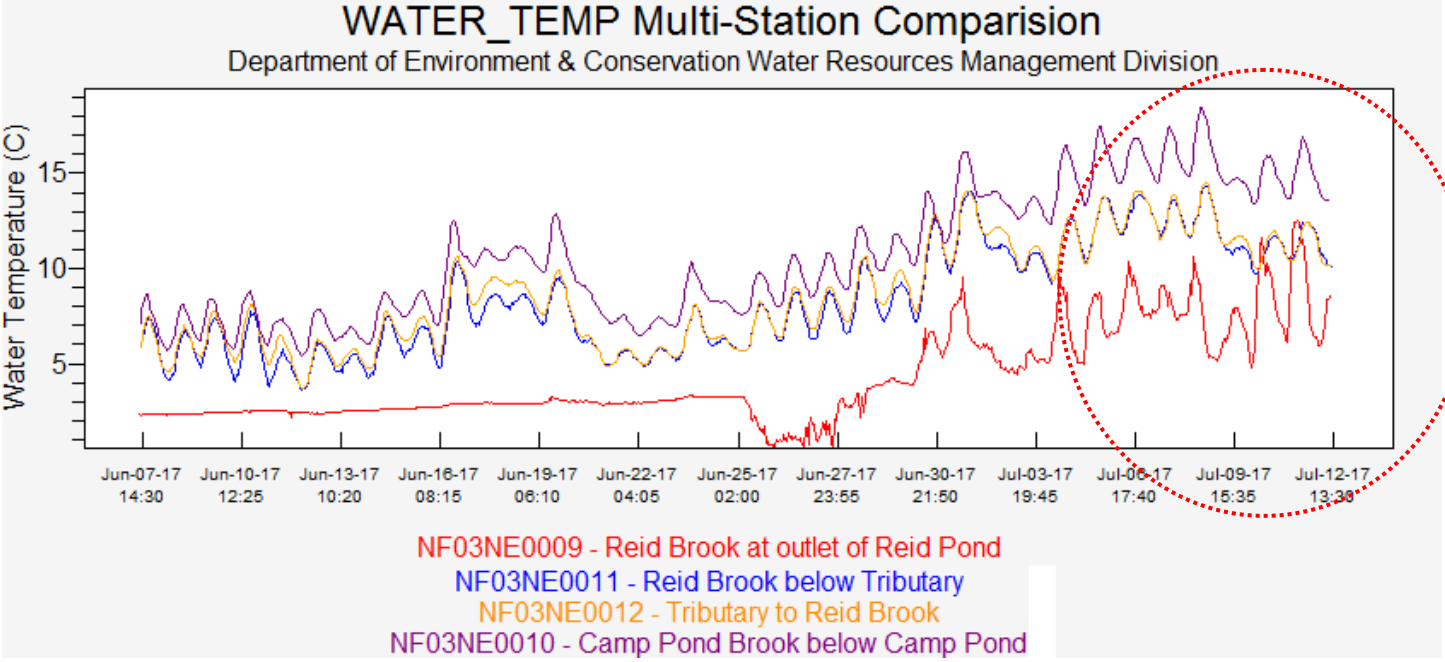

Figure A1: Comparison of Water Temperature (^{0}C) between all Real-Time Stations in Voisey's Bay. Data for Reid Brook at Outlet of Reid Pond from July 5 through July 12 has been removed from analysis because the instrument was out of the water.

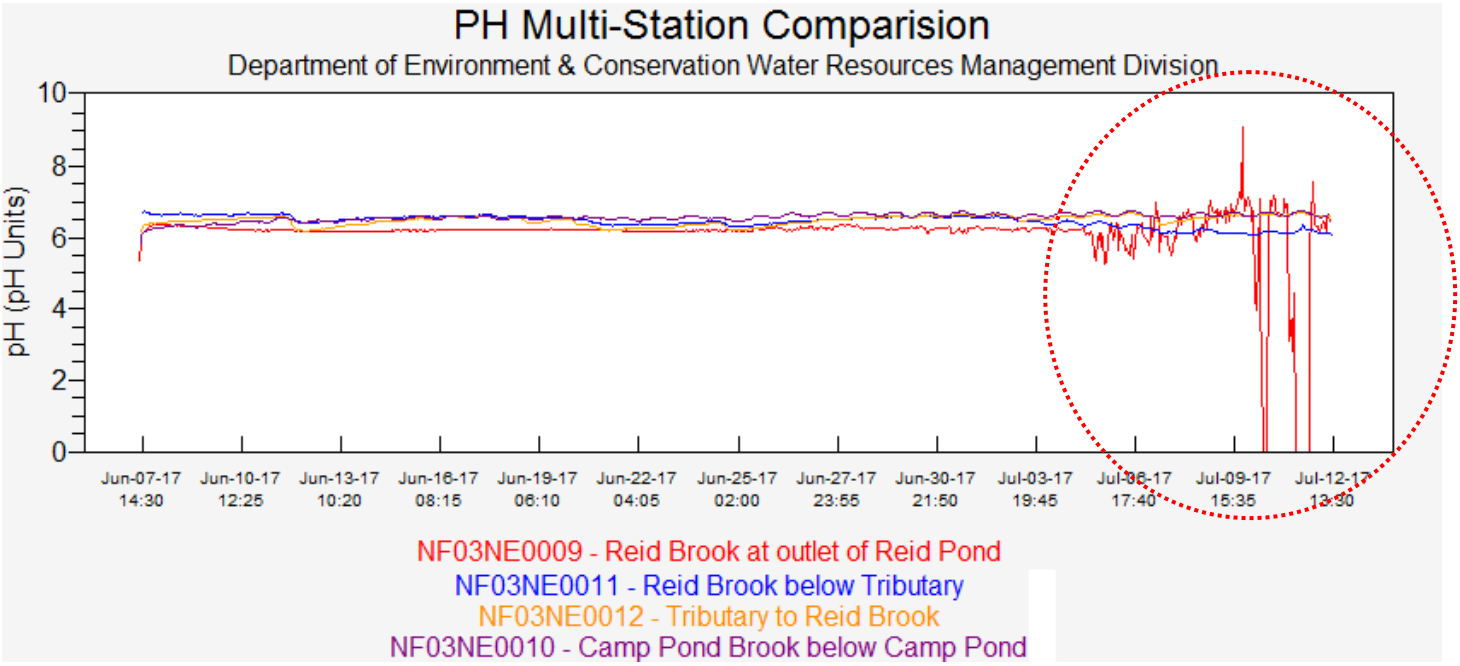

Figure A2: Comparison of pH between all Real-Time Stations in Voisey's Bay. Data for Reid Brook at Outlet of Reid Pond from July 5 through July 12 has been removed from analysis because the instrument was out of the water.

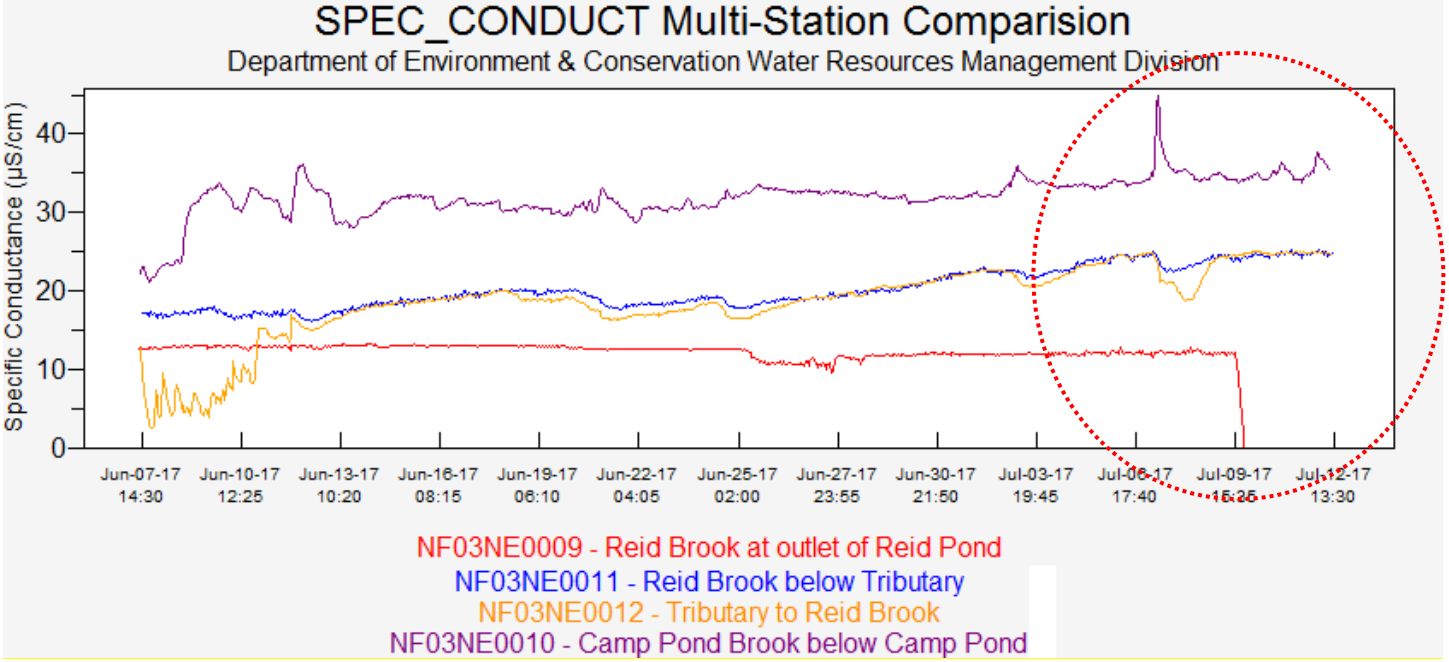

Figure A3: Comparison of Specific Conductivity (µS/cm) between all Real-Time Stations in Voisey's Bay. Data for Reid Brook at Outlet of Reid Pond from July 5 through July 12 has been removed from analysis because the instrument was out of the water.

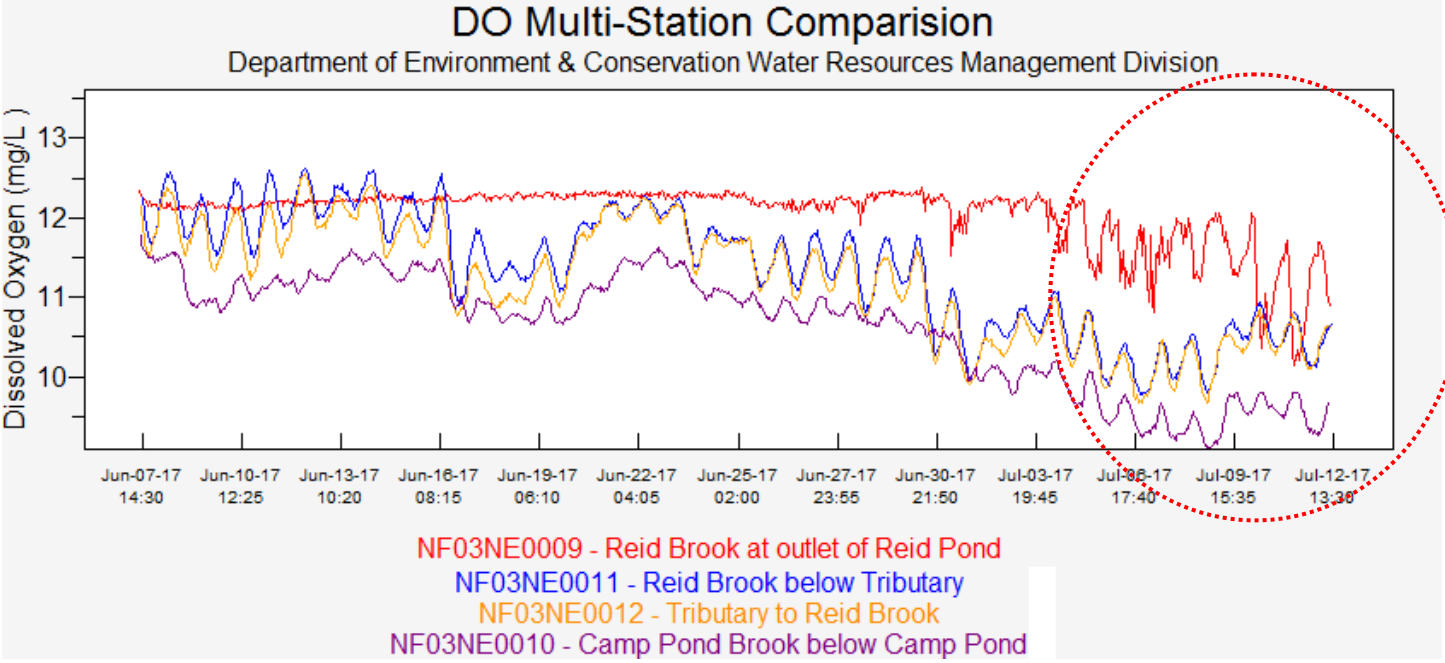

Figure A4: Comparison of Dissolved Oxygen (mg/L) between all Real-Time Stations in Voisey's Bay. Data for Reid Brook at Outlet of Reid Pond from July 5 through July 12 has been removed from analysis because the instrument was out of the water.

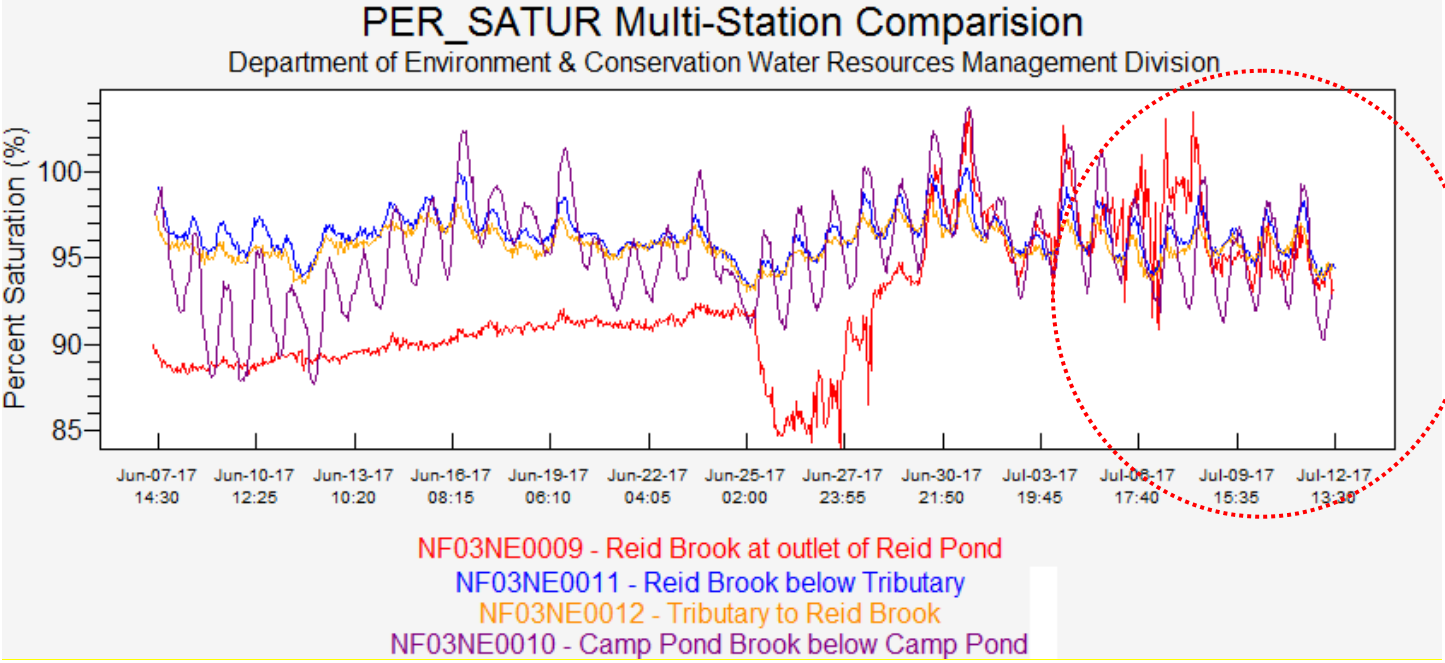

Figure A5: Comparison of Dissolved Oxygen (% Sat) between all Real-Time Stations in Voisey's Bay. Data for Reid Brook at Outlet of Reid Pond from July 5 through July 12 has been removed from analysis because the instrument was out of the water.

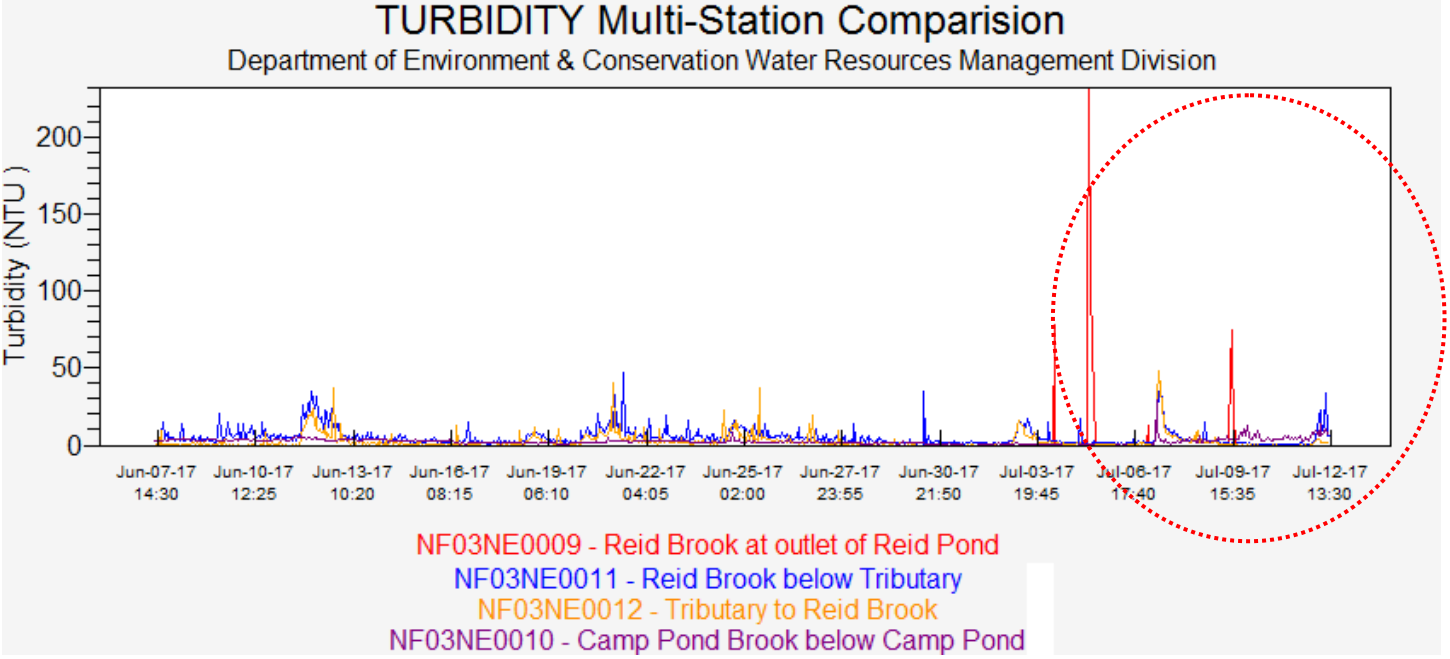

Figure A6: Comparison of Turbidity (NTU) between all Real-Time Stations in Voisey's Bay. Data for Reid Brook at Outlet of Reid Pond from July 5 through July 12 has been removed from analysis because the instrument was out of the water.

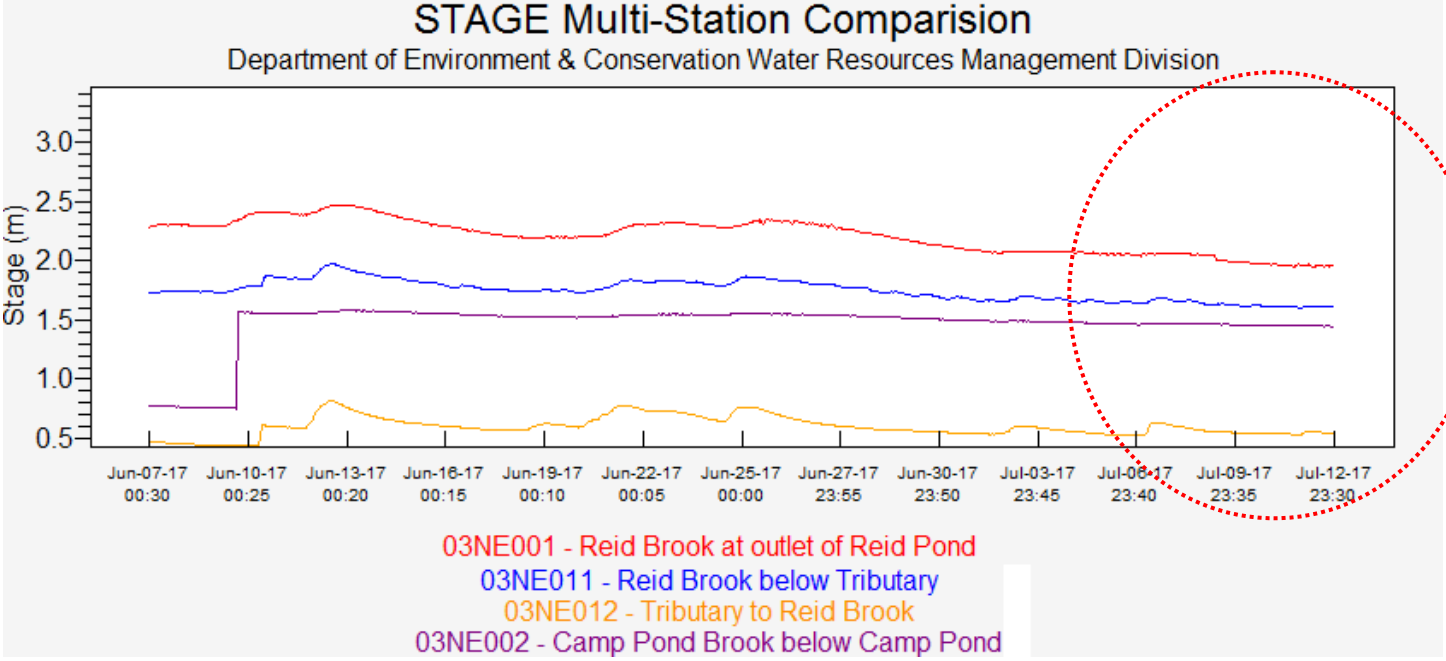

Figure A7: Comparison of Stage (m) between all Real-Time Stations in Voisey's Bay. Data for Reid Brook at Outlet of Reid Pond from July 5 through July 12 has been removed from analysis because the instrument was out of the water. Please note that stage data is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data.

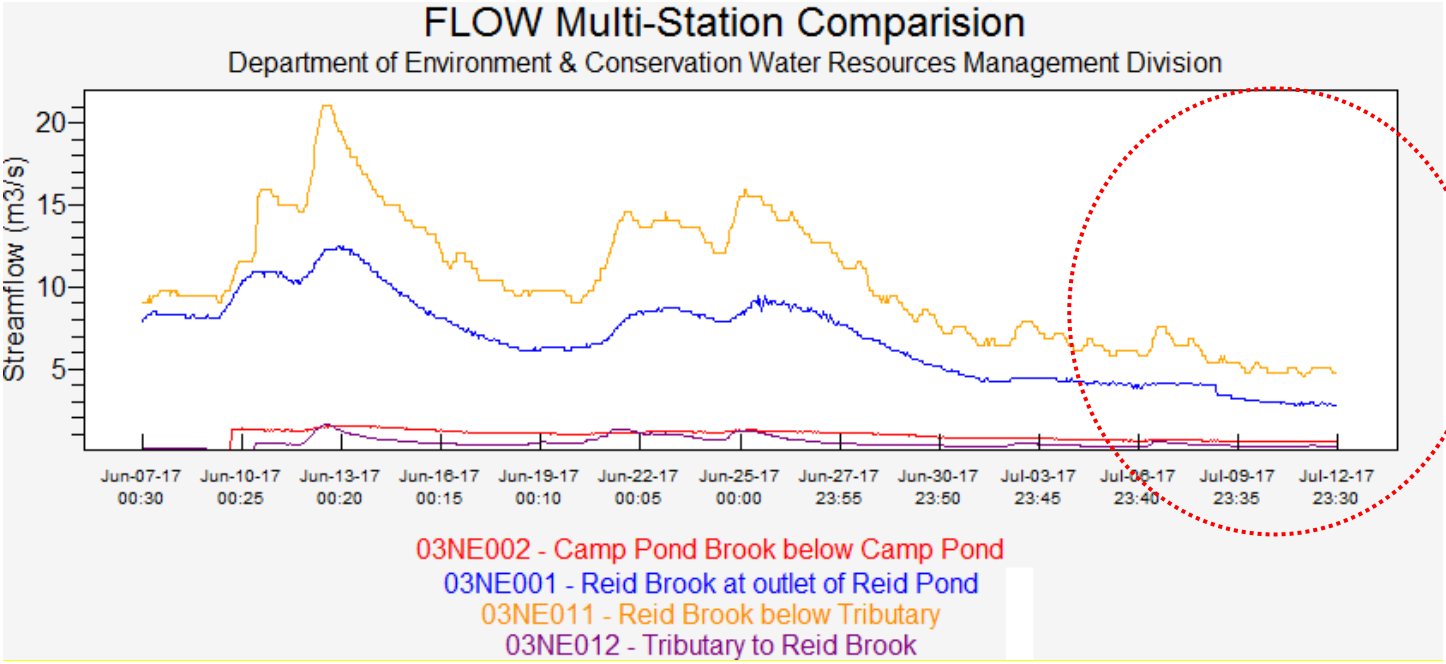

Figure A8: Comparison of Flow (m^3/s) between all Real-Time Stations in Voisey's Bay. Data for Reid Brook at Outlet of Reid Pond from July 5 through July 12 has been removed from analysis because the instrument was out of the water. Please note that flow data is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data.

APPENDIX B: Water Parameter Description

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 #: B7C1527
Report Date: 2017/06/20

Department of Municipal Affairs and Environment
Site Location: VOISEY'S BAY RT STATIONS
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
ENW515 Reid Brook at Outlet of Reid Pond								
Sampling Date 2017/06/08 12:00								
Matrix W								
Sample # 2017-6400-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Calculated TDS	10	1.0	mg/L	N/A	2017/06/20	2017/06/20		5025029
Hardness (CaCO3)	4.5	1.0	mg/L	N/A	2017/06/15	2017/06/15		5025022
Nitrate (N)	0.078	0.050	mg/L	N/A	2017/06/20	2017/06/20		5025025
Inorganics								
Conductivity	13	1.0	uS/cm	N/A	2017/06/15	2017/06/15	JMV	5029032
Bromide (Br-)	<1.0	1.0	mg/L	N/A	2017/06/16	2017/06/16	FD	5029811
Total Alkalinity (Total as CaCO3)	6.0	5.0	mg/L	N/A	2017/06/19	2017/06/19	MCN	5031789
Dissolved Chloride (Cl)	1.4	1.0	mg/L	N/A	2017/06/19	2017/06/19	MCN	5031796
Colour	8.7	5.0	TCU	N/A	2017/06/19	2017/06/19	MCN	5031806
Dissolved Fluoride (F-)	<0.10	0.10	mg/L	N/A	2017/06/15	2017/06/15	JMV	5029033
Total Kjeldahl Nitrogen (TKN)	<0.10	0.10	mg/L	N/A	2017/06/15	2017/06/16	BMO	5029352
Nitrite (N)	<0.010	0.010	mg/L	N/A	2017/06/19	2017/06/19	MCN	5031813
Nitrogen (Ammonia Nitrogen)	<0.050	0.050	mg/L	N/A	2017/06/20	2017/06/20	NRG	5034335
Dissolved Organic Carbon (C)	1.5	0.50	mg/L	N/A	2017/06/16	2017/06/16	SMT	5031380
Total Organic Carbon (C)	1.6	0.50	mg/L	N/A	2017/06/16	2017/06/16	SMT	5031351
pH	6.70	N/A	pH	N/A	2017/06/15	2017/06/15	JMV	5029031
Total Phosphorus	<0.004	0.004	mg/L	N/A	2017/06/15	2017/06/16	ASP	5029353
Dissolved Sulphate (SO4)	<2.0	2.0	mg/L	N/A	2017/06/19	2017/06/19	MCN	5031803
Turbidity	0.14	0.10	NTU	N/A	2017/06/15	2017/06/15	JMV	5031116
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	<0.000013	0.000013	mg/L	N/A	2017/06/15	2017/06/16	ARS	5029520
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	0.044	0.0050	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Antimony (Sb)	<0.0010	0.0010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Arsenic (As)	<0.0010	0.0010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Barium (Ba)	0.0020	0.0010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Boron (B)	<0.050	0.050	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Cadmium (Cd)	<0.000010	0.000010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Calcium (Ca)	1.3	0.10	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Chromium (Cr)	<0.0010	0.0010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Copper (Cu)	<0.0020	0.0020	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Iron (Fe)	<0.050	0.050	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Lead (Pb)	<0.00050	0.00050	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Magnesium (Mg)	0.28	0.10	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Manganese (Mn)	<0.0020	0.0020	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Nickel (Ni)	<0.0020	0.0020	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Potassium (K)	<0.10	0.10	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013

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 #: B7C1527
Report Date: 2017/06/20

Department of Municipal Affairs and Environment
Site Location: VOISEY'S BAY RT STATIONS
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
ENW515 Reid Brook at Outlet of Reid Pond								
Sampling Date 2017/06/08 12:00								
Matrix W								
Sample # 2017-6400-00-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Selenium (Se)	<0.0010	0.0010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Sodium (Na)	0.77	0.10	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Strontium (Sr)	0.0051	0.0020	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Uranium (U)	<0.00010	0.00010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Zinc (Zn)	0.0056	0.0050	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013

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 #: B7C1527
Report Date: 2017/06/20

Department of Municipal Affairs and Environment
Site Location: VOISEY'S BAY RT STATIONS
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
ENW516 Camp Pond Brook below Camp Pond								
Sampling Date 2017/06/08 13:00								
Matrix W								
Sample # 2017-6401-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Calculated TDS	15	1.0	mg/L	N/A	2017/06/20	2017/06/20		5025029
Hardness (CaCO3)	7.3	1.0	mg/L	N/A	2017/06/15	2017/06/15		5025022
Nitrate (N)	<0.050	0.050	mg/L	N/A	2017/06/20	2017/06/20		5025025
Inorganics								
Conductivity	23	1.0	uS/cm	N/A	2017/06/15	2017/06/15	JMV	5029032
Bromide (Br-)	<1.0	1.0	mg/L	N/A	2017/06/16	2017/06/16	FD	5029811
Total Alkalinity (Total as CaCO3)	8.2	5.0	mg/L	N/A	2017/06/19	2017/06/19	MCN	5031789
Dissolved Chloride (Cl)	2.3	1.0	mg/L	N/A	2017/06/19	2017/06/19	MCN	5031796
Colour	29	5.0	TCU	N/A	2017/06/19	2017/06/19	MCN	5031806
Dissolved Fluoride (F-)	<0.10	0.10	mg/L	N/A	2017/06/15	2017/06/15	JMV	5029033
Total Kjeldahl Nitrogen (TKN)	0.11	0.10	mg/L	+/- <RDL	2017/06/15	2017/06/16	BMO	5029352
Nitrite (N)	<0.010	0.010	mg/L	N/A	2017/06/19	2017/06/19	MCN	5031813
Nitrogen (Ammonia Nitrogen)	<0.050	0.050	mg/L	N/A	2017/06/20	2017/06/20	NRG	5034335
Dissolved Organic Carbon (C)	3.2	0.50	mg/L	N/A	2017/06/16	2017/06/16	SMT	5031380
Total Organic Carbon (C)	3.4	0.50	mg/L	N/A	2017/06/16	2017/06/16	SMT	5031351
pH	6.78	N/A	pH	N/A	2017/06/15	2017/06/15	JMV	5029031
Total Phosphorus	<0.004	0.004	mg/L	N/A	2017/06/15	2017/06/16	ASP	5029353
Dissolved Sulphate (SO4)	<2.0	2.0	mg/L	N/A	2017/06/19	2017/06/19	MCN	5031803
Turbidity	0.94	0.10	NTU	N/A	2017/06/15	2017/06/15	JMV	5029073
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	<0.000013	0.000013	mg/L	N/A	2017/06/15	2017/06/16	ARS	5029520
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	0.092	0.0050	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Antimony (Sb)	<0.0010	0.0010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Arsenic (As)	<0.0010	0.0010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Barium (Ba)	0.0038	0.0010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Boron (B)	<0.050	0.050	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Cadmium (Cd)	<0.000010	0.000010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Calcium (Ca)	1.9	0.10	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Chromium (Cr)	<0.0010	0.0010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Copper (Cu)	0.0021	0.0020	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Iron (Fe)	0.17	0.050	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Lead (Pb)	<0.00050	0.00050	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Magnesium (Mg)	0.61	0.10	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Manganese (Mn)	0.0044	0.0020	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Nickel (Ni)	0.012	0.0020	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Potassium (K)	0.35	0.10	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013

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Maxxam Job #: B7C1527
Report Date: 2017/06/20

Department of Municipal Affairs and Environment
Site Location: VOISEY'S BAY RT STATIONS
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
ENW516 Camp Pond Brook below Camp Pond								
Sampling Date 2017/06/08 13:00								
Matrix W								
Sample # 2017-6401-00-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Selenium (Se)	<0.0010	0.0010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Sodium (Na)	1.4	0.10	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Strontium (Sr)	0.010	0.0020	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Uranium (U)	<0.00010	0.00010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Zinc (Zn)	0.0074	0.0050	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013

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Department of Municipal Affairs and Environment
Site Location: VOISEY'S BAY RT STATIONS
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
ENW517 Reid Brook below Tributary								
Sampling Date 2017/06/08 14:05								
Matrix W								
Sample # 2017-6402-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Calculated TDS	14	1.0	mg/L	N/A	2017/06/20	2017/06/20		5025029
Hardness (CaCO3)	6.3	1.0	mg/L	N/A	2017/06/15	2017/06/15		5025022
Nitrate (N)	<0.050	0.050	mg/L	N/A	2017/06/20	2017/06/20		5025025
Inorganics								
Conductivity	19	1.0	uS/cm	N/A	2017/06/16	2017/06/16	JMV	5029651
Bromide (Br-)	<1.0	1.0	mg/L	N/A	2017/06/16	2017/06/16	FD	5029811
Total Alkalinity (Total as CaCO3)	6.7	5.0	mg/L	N/A	2017/06/19	2017/06/19	MCN	5031789
Dissolved Chloride (Cl)	2.0	1.0	mg/L	N/A	2017/06/19	2017/06/19	MCN	5031796
Colour	44	5.0	TCU	N/A	2017/06/19	2017/06/19	MCN	5031806
Dissolved Fluoride (F-)	<0.10	0.10	mg/L	N/A	2017/06/16	2017/06/16	JMV	5029654
Total Kjeldahl Nitrogen (TKN)	<0.10	0.10	mg/L	N/A	2017/06/15	2017/06/17	BMO	5029352
Nitrite (N)	<0.010	0.010	mg/L	N/A	2017/06/19	2017/06/19	MCN	5031813
Nitrogen (Ammonia Nitrogen)	<0.050	0.050	mg/L	N/A	2017/06/20	2017/06/20	NRG	5034335
Dissolved Organic Carbon (C)	3.9	0.50	mg/L	N/A	2017/06/16	2017/06/16	SMT	5031380
Total Organic Carbon (C)	4.5	0.50	mg/L	N/A	2017/06/16	2017/06/16	SMT	5031351
pH	6.66	N/A	pH	N/A	2017/06/16	2017/06/16	JMV	5029649
Total Phosphorus	0.005	0.004	mg/L	+/- 0.004	2017/06/15	2017/06/16	ASP	5029353
Dissolved Sulphate (SO4)	<2.0	2.0	mg/L	N/A	2017/06/19	2017/06/19	MCN	5031803
Turbidity	0.92	0.10	NTU	N/A	2017/06/15	2017/06/15	JMV	5029073
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	<0.000013	0.000013	mg/L	N/A	2017/06/15	2017/06/16	ARS	5029520
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	0.14	0.0050	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Antimony (Sb)	<0.0010	0.0010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Arsenic (As)	<0.0010	0.0010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Barium (Ba)	0.0034	0.0010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Boron (B)	<0.050	0.050	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Cadmium (Cd)	<0.000010	0.000010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Calcium (Ca)	1.7	0.10	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Chromium (Cr)	0.0014	0.0010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Copper (Cu)	<0.0020	0.0020	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Iron (Fe)	0.36	0.050	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Lead (Pb)	<0.00050	0.00050	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Magnesium (Mg)	0.53	0.10	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Manganese (Mn)	0.0061	0.0020	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Nickel (Ni)	0.0048	0.0020	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Potassium (K)	0.21	0.10	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013

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Maxxam Job #: B7C1527
Report Date: 2017/06/20

Department of Municipal Affairs and Environment
Site Location: VOISEY'S BAY RT STATIONS
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
ENW517 Reid Brook below Tributary								
Sampling Date 2017/06/08 14:05								
Matrix W								
Sample # 2017-6402-00-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Selenium (Se)	<0.0010	0.0010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Sodium (Na)	1.3	0.10	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Strontium (Sr)	0.0087	0.0020	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Uranium (U)	<0.00010	0.00010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Zinc (Zn)	0.0063	0.0050	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013

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Maxxam Job #: B7C1527
Report Date: 2017/06/20

Department of Municipal Affairs and Environment
Site Location: VOISEY'S BAY RT STATIONS
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
ENW518 Tributary to Reid Brook								
Sampling Date 2017/06/08 14:45								
Matrix W								
Sample # 2017-6403-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Calculated TDS	14	1.0	mg/L	N/A	2017/06/20	2017/06/20		5025029
Hardness (CaCO3)	6.2	1.0	mg/L	N/A	2017/06/15	2017/06/15		5025022
Nitrate (N)	<0.050	0.050	mg/L	N/A	2017/06/20	2017/06/20		5025025
Inorganics								
Conductivity	19	1.0	uS/cm	N/A	2017/06/15	2017/06/15	JMV	5029032
Bromide (Br-)	<1.0	1.0	mg/L	N/A	2017/06/16	2017/06/16	FD	5029811
Total Alkalinity (Total as CaCO3)	6.7	5.0	mg/L	N/A	2017/06/19	2017/06/19	MCN	5031789
Dissolved Chloride (Cl)	2.2	1.0	mg/L	N/A	2017/06/19	2017/06/19	MCN	5031796
Colour	44(1)	10	TCU	N/A	2017/06/19	2017/06/19	MCN	5031806
Dissolved Fluoride (F-)	<0.10	0.10	mg/L	N/A	2017/06/15	2017/06/15	JMV	5029033
Total Kjeldahl Nitrogen (TKN)	0.11	0.10	mg/L	+/- <RDL	2017/06/15	2017/06/16	BMO	5029352
Nitrite (N)	<0.010	0.010	mg/L	N/A	2017/06/19	2017/06/19	MCN	5031813
Nitrogen (Ammonia Nitrogen)	<0.050	0.050	mg/L	N/A	2017/06/20	2017/06/20	NRG	5034335
Dissolved Organic Carbon (C)	4.5	0.50	mg/L	N/A	2017/06/16	2017/06/16	SMT	5031380
Total Organic Carbon (C)	5.2	0.50	mg/L	N/A	2017/06/16	2017/06/16	SMT	5031351
pH	6.69	N/A	pH	N/A	2017/06/15	2017/06/15	JMV	5029031
Total Phosphorus	0.008	0.004	mg/L	+/- 0.004	2017/06/15	2017/06/16	ASP	5029353
Dissolved Sulphate (SO4)	<2.0	2.0	mg/L	N/A	2017/06/19	2017/06/19	MCN	5031803
Turbidity	0.89	0.10	NTU	N/A	2017/06/15	2017/06/15	JMV	5029073
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	<0.000013	0.000013	mg/L	N/A	2017/06/15	2017/06/16	ARS	5029520
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	0.12	0.0050	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Antimony (Sb)	<0.0010	0.0010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Arsenic (As)	<0.0010	0.0010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Barium (Ba)	0.0033	0.0010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Boron (B)	<0.050	0.050	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Cadmium (Cd)	<0.000010	0.000010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Calcium (Ca)	1.6	0.10	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Chromium (Cr)	<0.0010	0.0010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Copper (Cu)	<0.0020	0.0020	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Iron (Fe)	0.37	0.050	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Lead (Pb)	<0.00050	0.00050	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Magnesium (Mg)	0.53	0.10	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Manganese (Mn)	0.0061	0.0020	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Nickel (Ni)	0.0051	0.0020	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Potassium (K)	0.20	0.10	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013

(1) Elevated reporting limit due to sample matrix.

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Maxxam Job #: B7C1527
Report Date: 2017/06/20

Department of Municipal Affairs and Environment
Site Location: VOISEY'S BAY RT STATIONS
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
ENW518 Tributary to Reid Brook								
Sampling Date 2017/06/08 14:45								
Matrix W								
Sample # 2017-6403-00-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Selenium (Se)	<0.0010	0.0010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Sodium (Na)	1.3	0.10	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Strontium (Sr)	0.0088	0.0020	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Uranium (U)	<0.00010	0.00010	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013
Total Zinc (Zn)	0.0054	0.0050	mg/L	N/A	2017/06/14	2017/06/14	BAN	5027013

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