Real-Time Water Quality Deployment Report

Voisey's Bay Network

June 16 to July 16, 2016

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

Contents

Prepared by:
Tara Clinton
Environmental Scientist
Water Resources Management Division
Department of Municipal Affairs & Environment
taraclinton@gov.nl.ca

Real Time Water Quality Monitoring

Department of Municipal Affairs and Environment staff 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 16, 2016, 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 16, 2016. This was the first deployment for the 2016 season.

Quality Assurance and Quality Control

As part of the Quality Assurance and Quality Control protocol (QAQC), an assessment of the reliability of data recorded by an instrument is made at the beginning and end of the deployment period. The procedure is based on the approach used by the United States Geological Survey.

At deployment and removal, a QAQC 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 QAQC Instrument at deployment and at removal, a qualitative statement is made on the data quality (Table 1).

Table 1: Ranking classifications for deployment and removal

	Rank				
Parameter	**Excellent**	**Good**	**Fair**	**Marginal**	**Poor**
Temperature (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 16	Deployment	Excellent	Excellent	Excellent	Poor	Excellent
	July 16	Removal	Excellent	Good	Excellent	Good	Excellent
Camp Pond Brook	June 16	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	July 16	Removal	Excellent	Good	Excellent	Good	Excellent
Reid Brook below Tributary	June 16	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	July 16	Removal	Excellent	Good	Good	Excellent	Excellent
Tributary to Reid Brook	June 16	Deployment	Excellent	Excellent	Excellent	Poor	Excellent
	July 16	Removal	Excellent	Fair	Excellent	Excellent	Excellent

During the deployment for **Reid Brook at Outlet of Reid Pond**, the temperature, pH, conductivity and turbidity all ranked as 'excellent'. Dissolved oxygen data ranked as 'Poor' at deployment. The discrepancy in dissolved oxygen values could be attributed to the location of the QA/QC sonde and the field sonde. Upon removal, temperature, conductivity, and turbidity all ranked as 'excellent'. pH and Dissolved oxygen ranked as 'Good'.

At the station on **Camp Pond Brook below Camp Pond**, temperature, pH, conductivity, dissolved oxygen and turbidity all ranked as 'Good' and 'Excellent'. During removal, temperature, pH, conductivity, dissolved oxygen, and turbidity all ranked as 'Good' or 'Excellent'.

During deployment of the field instrument at **Reid Brook below Tributary**, the water quality parameters all ranked as 'Excellent'. During removal, temperature, dissolved oxygen and turbidity all ranked as 'excellent'. The pH and conductivity data ranked as 'Good'.

Tributary to Reid Brook temperature, pH, conductivity, and turbidity all ranked as 'Excellent' during deployment. When the dissolved oxygen data was compare it ranked as 'Poor', which was the same as the ranking for the Reid Brook at Outlet of Reid Pond dissolved oxygen. This is possibly an indicator that this issue is with the dissolved oxygen probe on the QA sonde and not the field instrument being deployed. Upon removal, temperature, conductivity, dissolved oxygen and turbidity all ranked as 'Excellent', while the pH data ranked as 'Fair'. The field value of pH was 6.79 and the QA/QC value was 6.25. This is a small discrepancy in values and the 'Fair' ranking is likely due to the QA sonde not being acclimatized to the environment before the value was recorded.

Data Interpretation

The following graphs and discussion illustrate significant water quality-related events from June 16th to July 16th, 2016 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 this stringent QAQC protocol. Water Survey of Canada is responsible for QAQC of water quantity data. Corrected data can be obtained upon request.

Reid Brook below Tributary had turbidity data that indicated that there was debris blocking the sensor. Therefore the turbidity data from July 2nd 2016 through to July 16th 2016 was removed from the analysis as it did not represent the brook.

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 1.47 °C to 15.15 °C, with a median value of 5.94 °C (Figure 2). Water temperature is gradually increasing throughout the deployment period. This trend is expected as the air temperatures start to warm into the summer months (Figure 3).

There was a significant increase in water temperature on July 8th and 11th, and again on July 15th, 2016 (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.

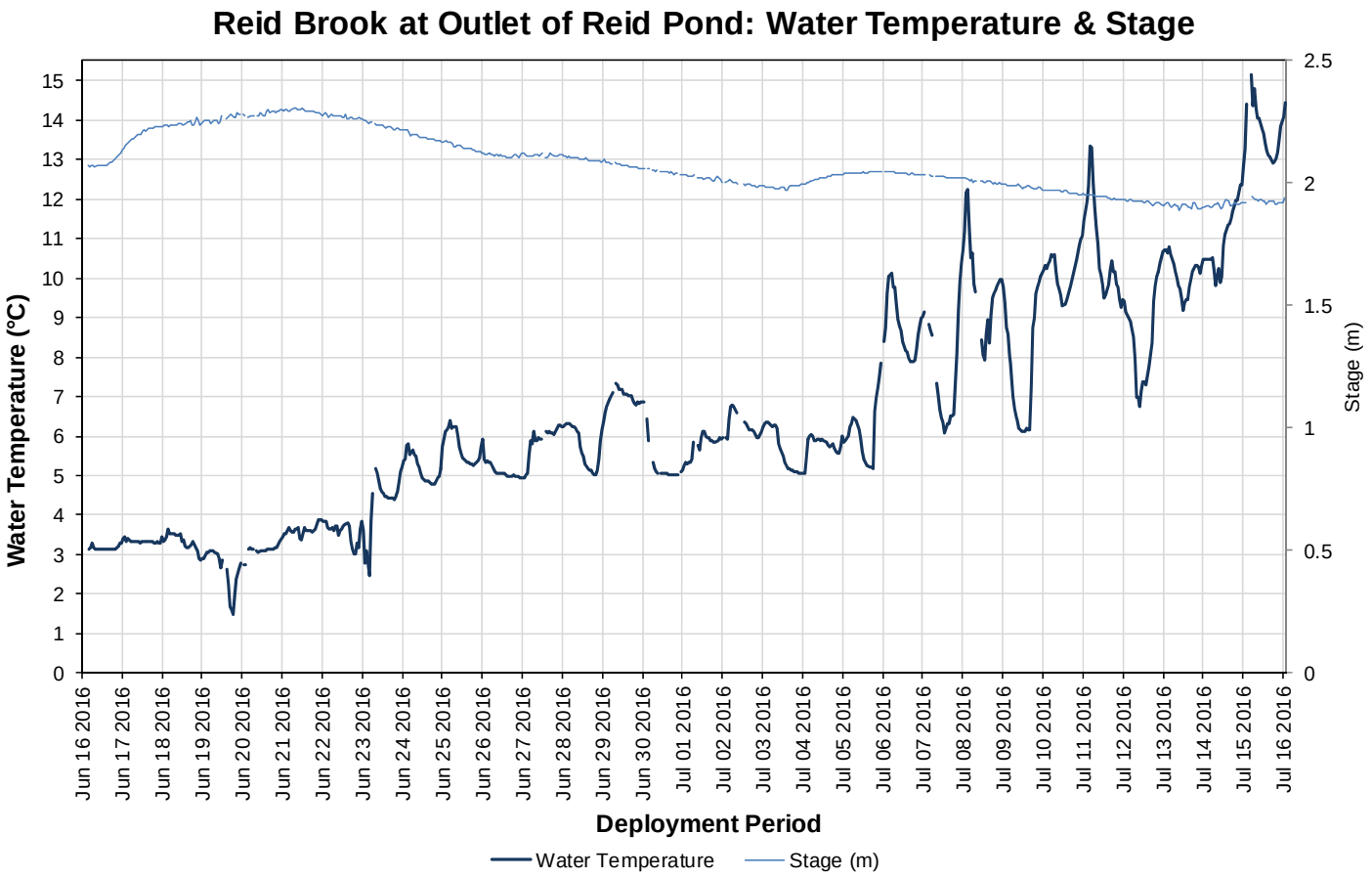

Figure 2: Water Temperature & Stage at Reid Brook at Outlet of Reid Pond

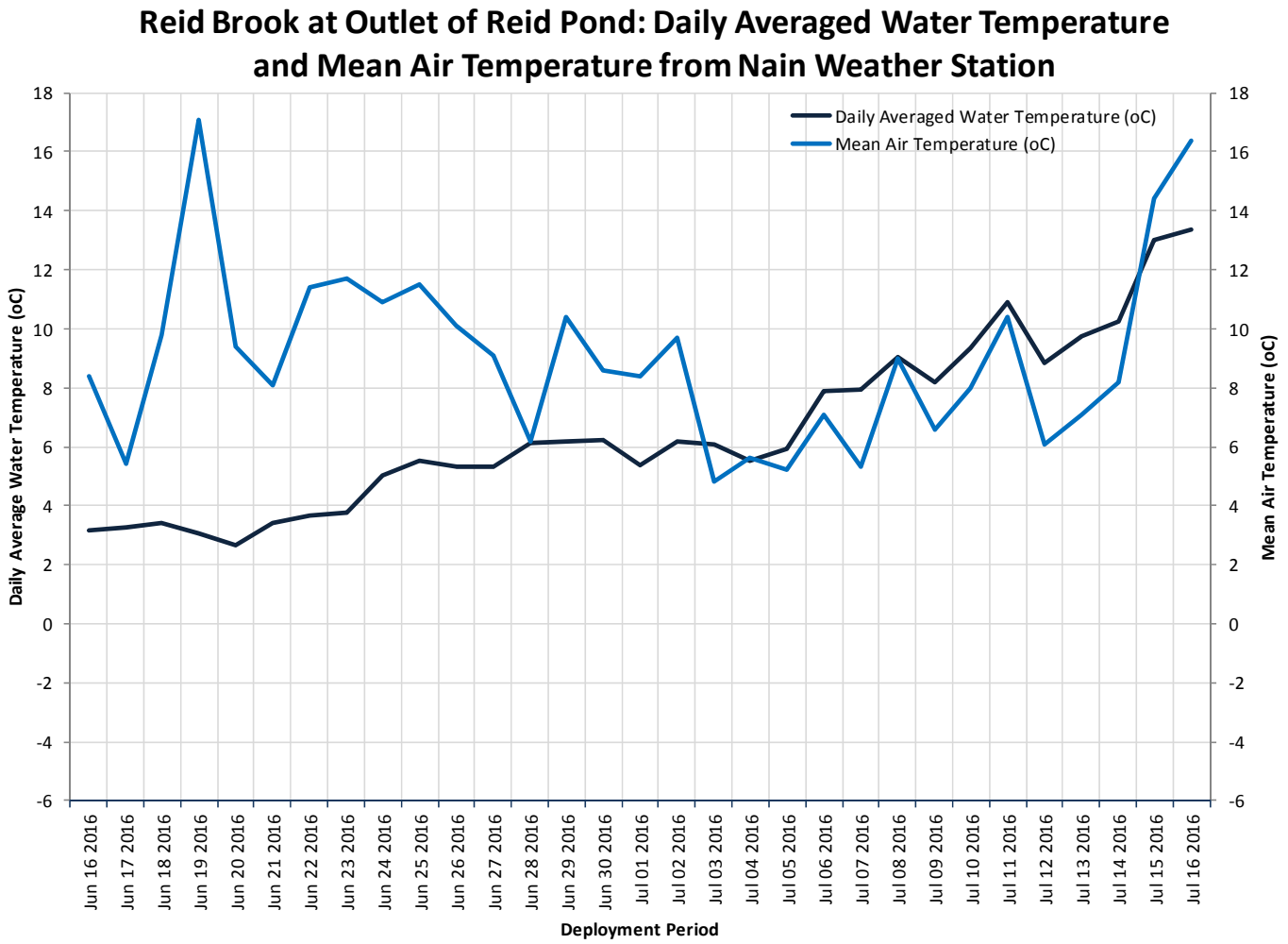

Figure 3: Daily Averaged Water Temperature at Reid Brook at Outlet of Reid Pond and Mean Air Temperatures from Nain Weather Station

pH

Throughout the deployment period, pH values ranged between 6.17 pH units and 7.54 pH units (Figure 4).

The pH levels are reasonably consistent during the deployment. The pH data decreases slowly over deployment and in July the pH dips slightly below the minimum Guideline for Protection of Aquatic Life. The Canadian Council of Ministers of the Environment (CCME) guidelines are just a basis by which to compare any dramatic change in the pH data within a dataset. Every brook is different with its own natural baseline conditions.

Natural processes such as rainfall and runoff will alter the pH of a brook for a period of time. This is evident on Figure 4, during and after high stage levels the pH data decreases slightly for short period of time. This is a natural process.

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.

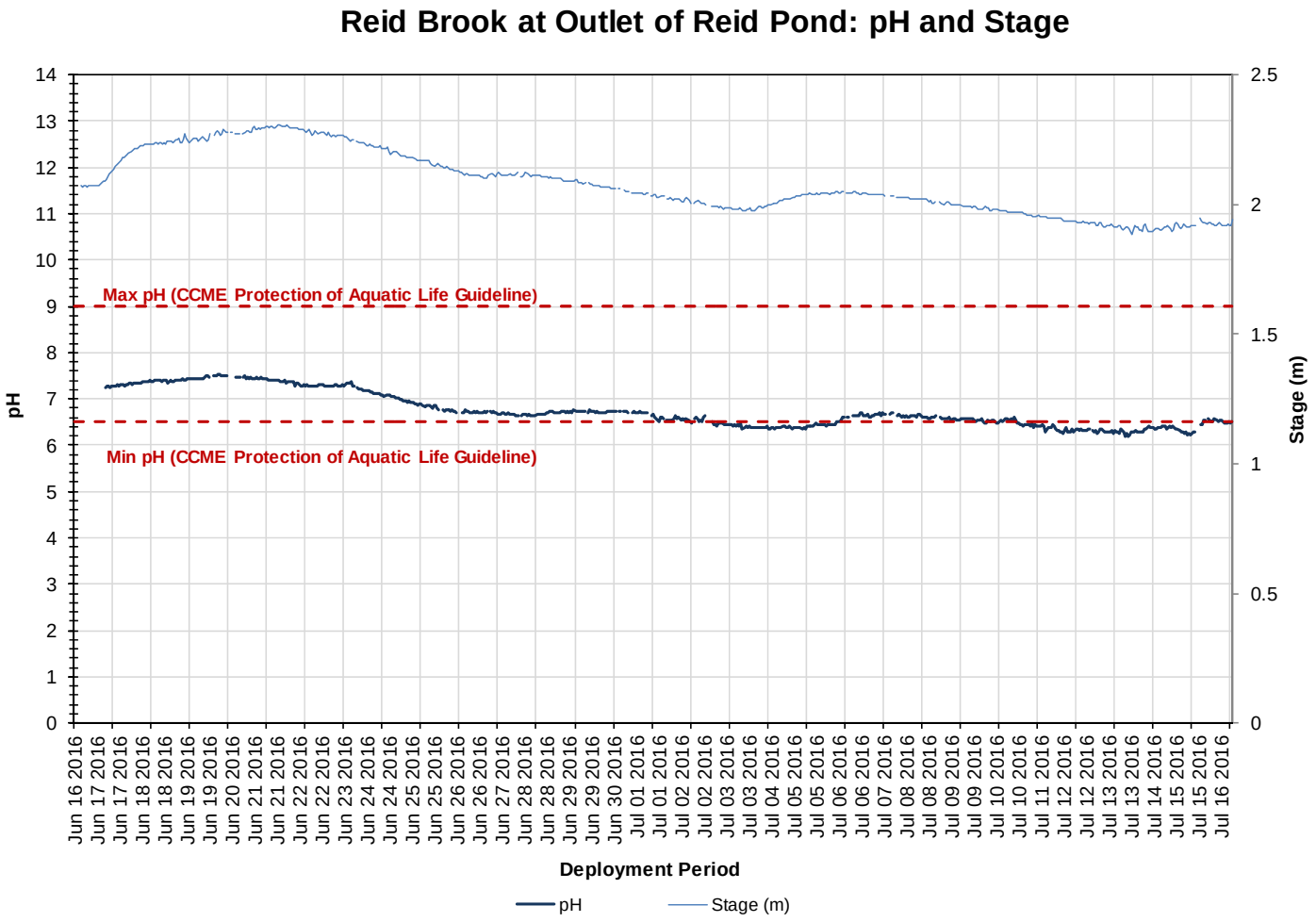

Figure 4: pH and Stage Level at Reid Brook at Outlet of Reid Pond

Specific Conductivity

The conductivity levels were within 10.3 µS/cm and 15.9 µS/cm during this deployment period. The conductivity at Reid Brook remains very stable. This is expected at this site as it is pristine in nature and a larger distance from any anthropogenic disturbances that could affect water parameters.

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.

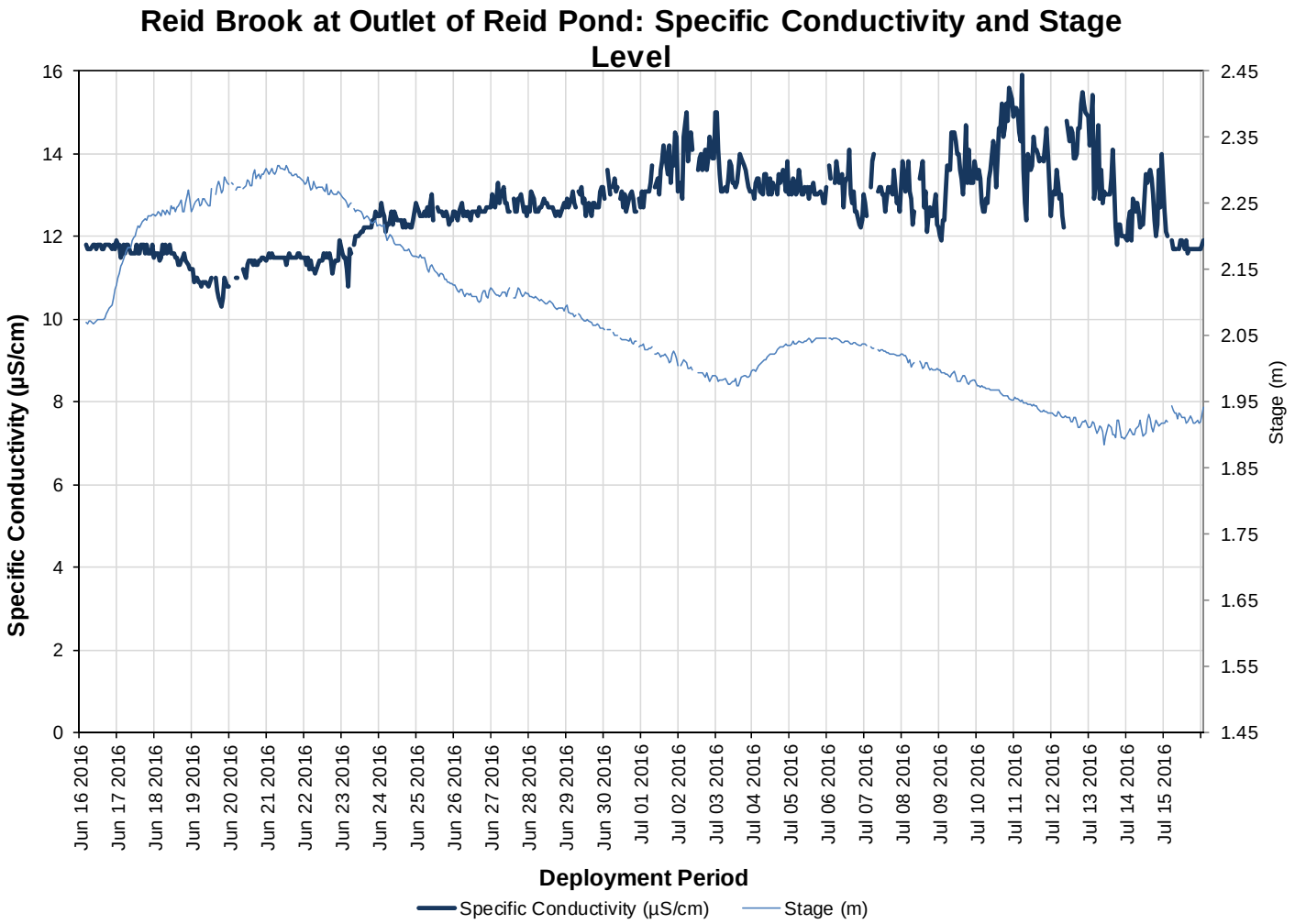

Figure 5: Specific Conductivity and Stage Level at Reid Brook at Outlet of Reid Pond

Dissolved Oxygen (mg/L & % Saturation)

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

During the deployment the dissolved oxygen concentration levels ranged within a minimum of 9.59 mg/L to a maximum of 12.46 mg/L. The percent saturation levels for dissolved oxygen ranged within 86.8% Saturation to 106.5% Saturation (Figure 6).

All the dissolved oxygen concentration values remained above the Guideline for the Protection of Early Life Stages (9.5mg/L). As the spring season changed to summer there was a natural increase in water temperature, this influenced the dissolved oxygen to decrease in the brook. This is evident from July 12th to July 16th as the dissolved oxygen concentration starts to dip.

July 3rd to July 4th, 2016 (indicated on Figure 8) had a couple of days of significant rainfall, which likely impacted the sensor slightly around that same time frame. Hence the variability in the values from July 4th to the end of deployment.

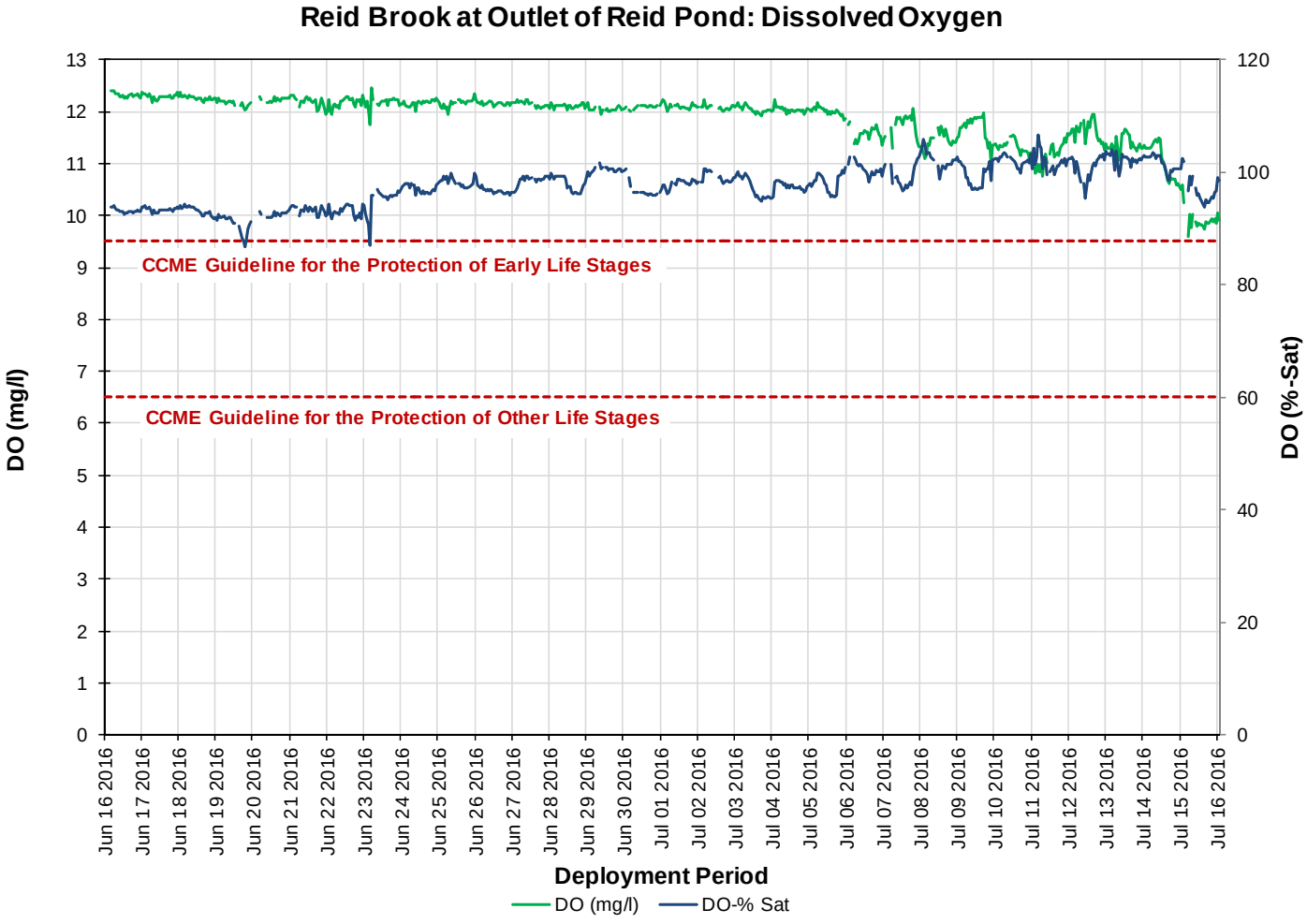

Figure 6: Dissolved Oxygen (mg/L & %Sat) at Reid Brook at Outlet of Reid Pond

Turbidity

Turbidity levels during the deployment ranged within 0.0 NTU and 41.3 NTU (Figure 7). The deployment data had a median of 0.3 NTU. Waterbodies all have a natural level of turbidity to the water quality. A significant increase in turbidity is of concern when monitoring brooks.

During rainfall or runoff, higher turbidity readings would be expected. Generally the turbidity levels increase for a short period of time and then return to within the range of the baseline. At this station, the higher turbidity events throughout this deployment period correlate with increases in stage potentially from precipitation or snow melt runoff. These factors can increase the presence of suspended material in water. This is likely the cause for the high turbidity on June 24th and June 25th, 2016.

Turbidity values can also increase if there is a decrease in water level and the natural material in the waterbody becomes concentrated. 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.

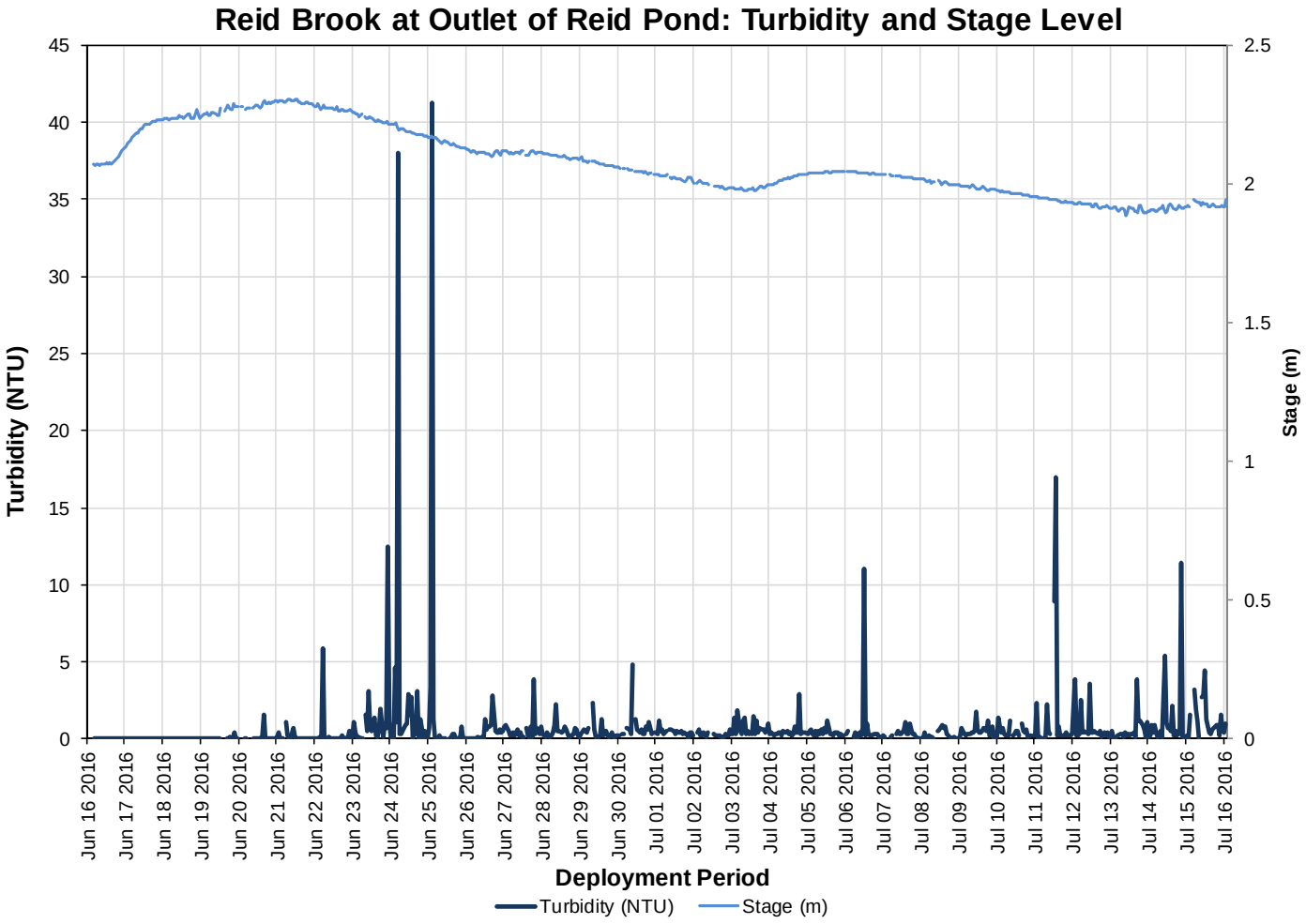

Figure 7: Turbidity and Stage Level at Reid Brook at Outlet of Reid Pond

Stage, Flow & Precipitation

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.

Stage is important to display as it provides an estimation of water level at the station and can explain some of the events that are occurring with other parameters (i.e. Specific Conductivity, DO, turbidity). Stage will increase during rainfall events (Figure 8) and during any surrounding snow or ice melt as runoff will collect in the brooks. However, direct snowfall will not cause them to rise significantly.

During the deployment period, the stage values ranged from 1.886m to 2.308m. The larger peaks in stage do correspond with substantial rainfall events as noted on Figure 8. Precipitation data was obtained from Nain Weather Station. Precipitation ranges for the deployment period were a minimum of 0.0 mm and a maximum of 12.7 mm on July 14th 2017.

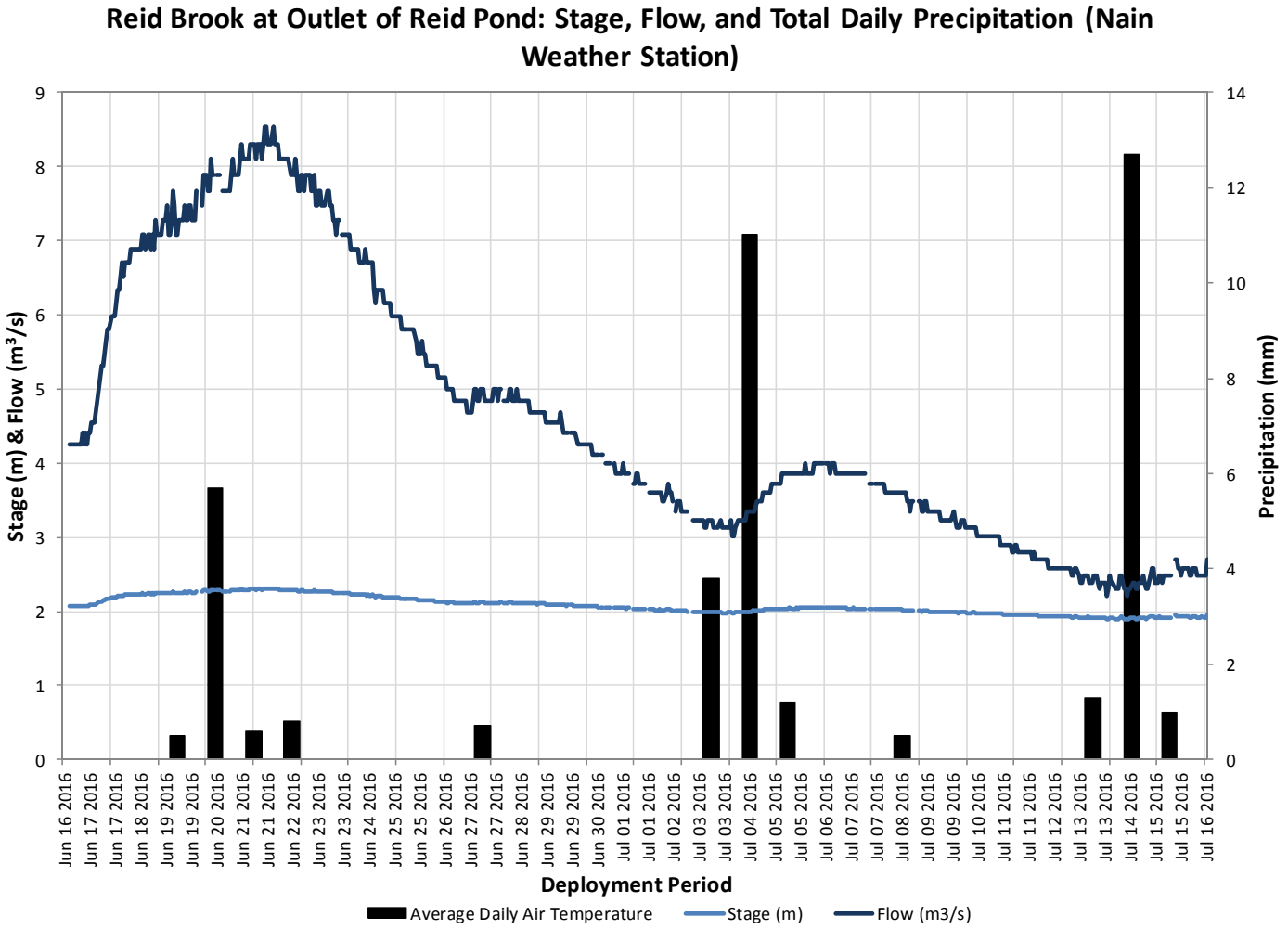

Figure 8: Daily Stage and Streamflow data from Reid Brook at Outlet of Reid Pond and Total Daily Precipitation from Nain, Labrador Weather Station

Camp Pond Brook below Camp Pond

Water Temperature

Water temperature ranged from 8.02°C to 20.06°C during this deployment period (Figure 9).

The water temperature at this station displays diurnal variations of the temperature. There is a gradual increase in the water temperature throughout this deployment. This is to be expected as the air temperatures increase with the change to summer climate (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. There is a significant drop in water and air temperatures on July 2nd to July 4th, 2016 (Figure 10). This change in temperatures was likely a result of precipitation that was recorded at Nain Weather Station during that time frame (Figure 15).

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.

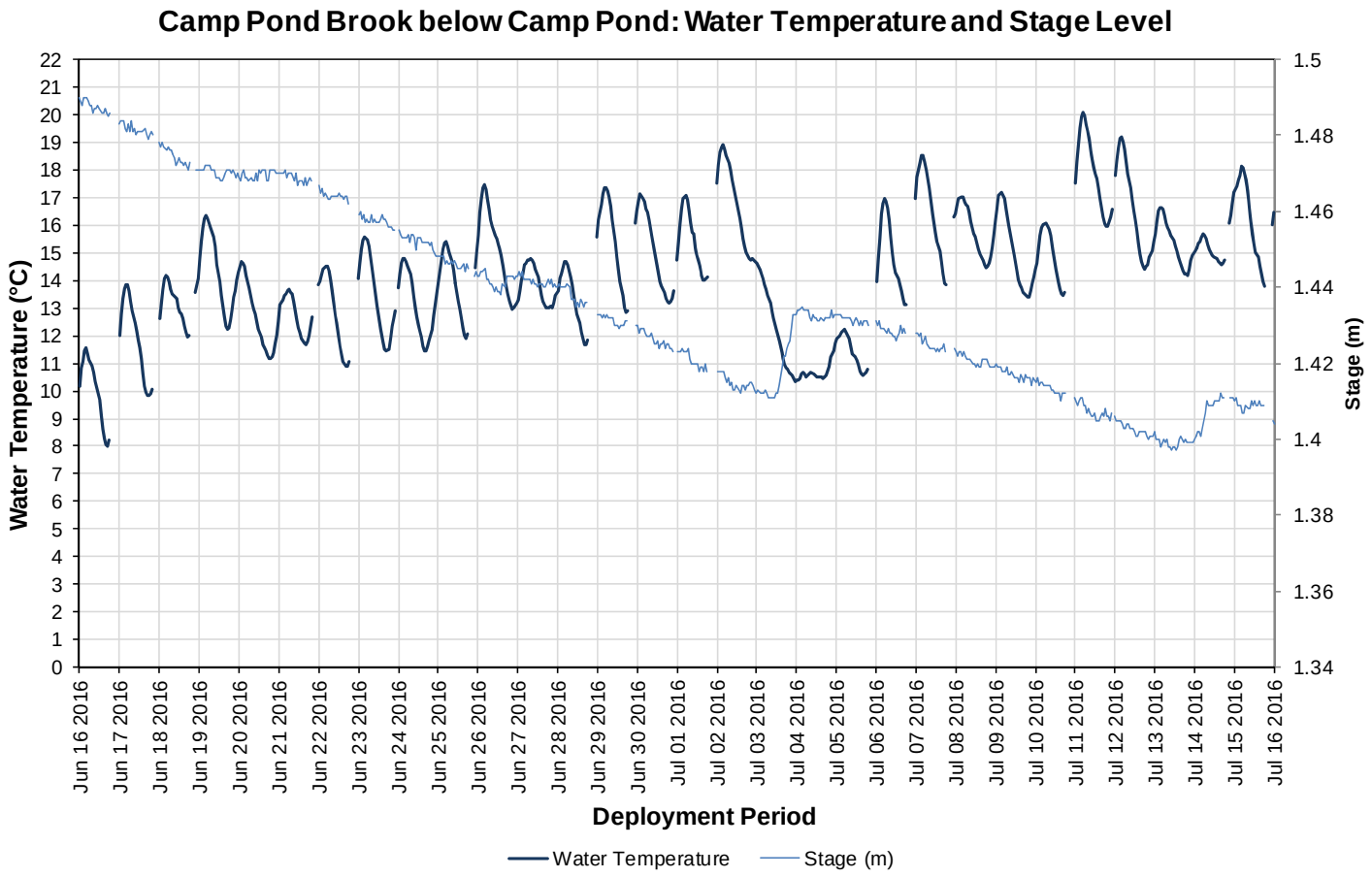

Figure 9: Water Temperature & Stage Level at Camp Pond Brook below Camp Pond

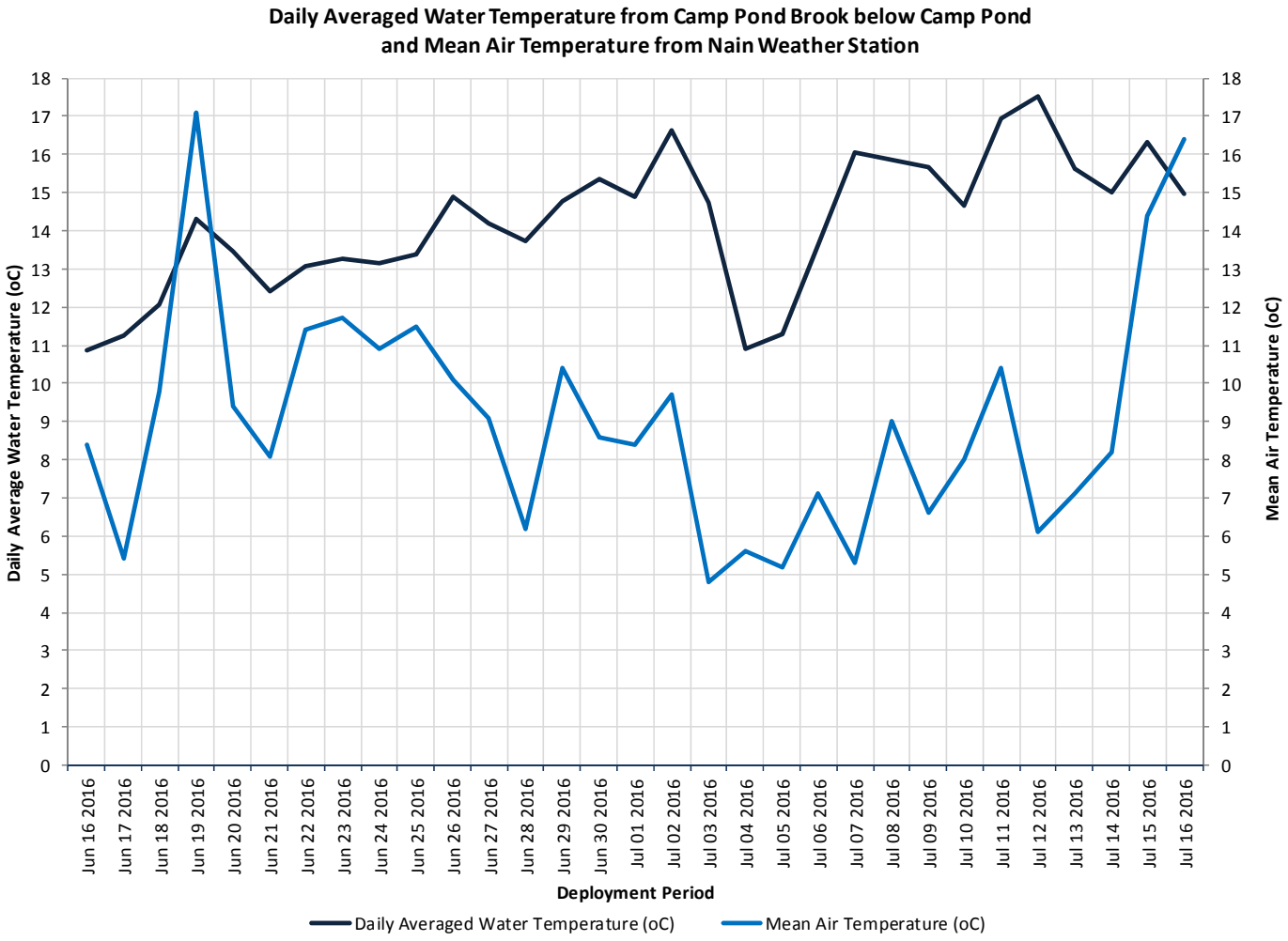

Figure 10: Daily Averaged Water Temperature at Camp Pond Brook below Camp Pond & Mean Air Temperature from Nain Weather Station.

pH

Throughout the deployment period, pH values ranged between 6.77 pH units and 7.20 pH units (Figure 11).

The pH levels are consistent during the deployment. The pH data remains within the Guideline for Protection of Aquatic Life. The Canadian Council of Ministers of the Environment (CCME) guidelines are just a basis by which to compare any dramatic change in the pH data within a dataset. Every brook is different with its own natural baseline range.

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

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.

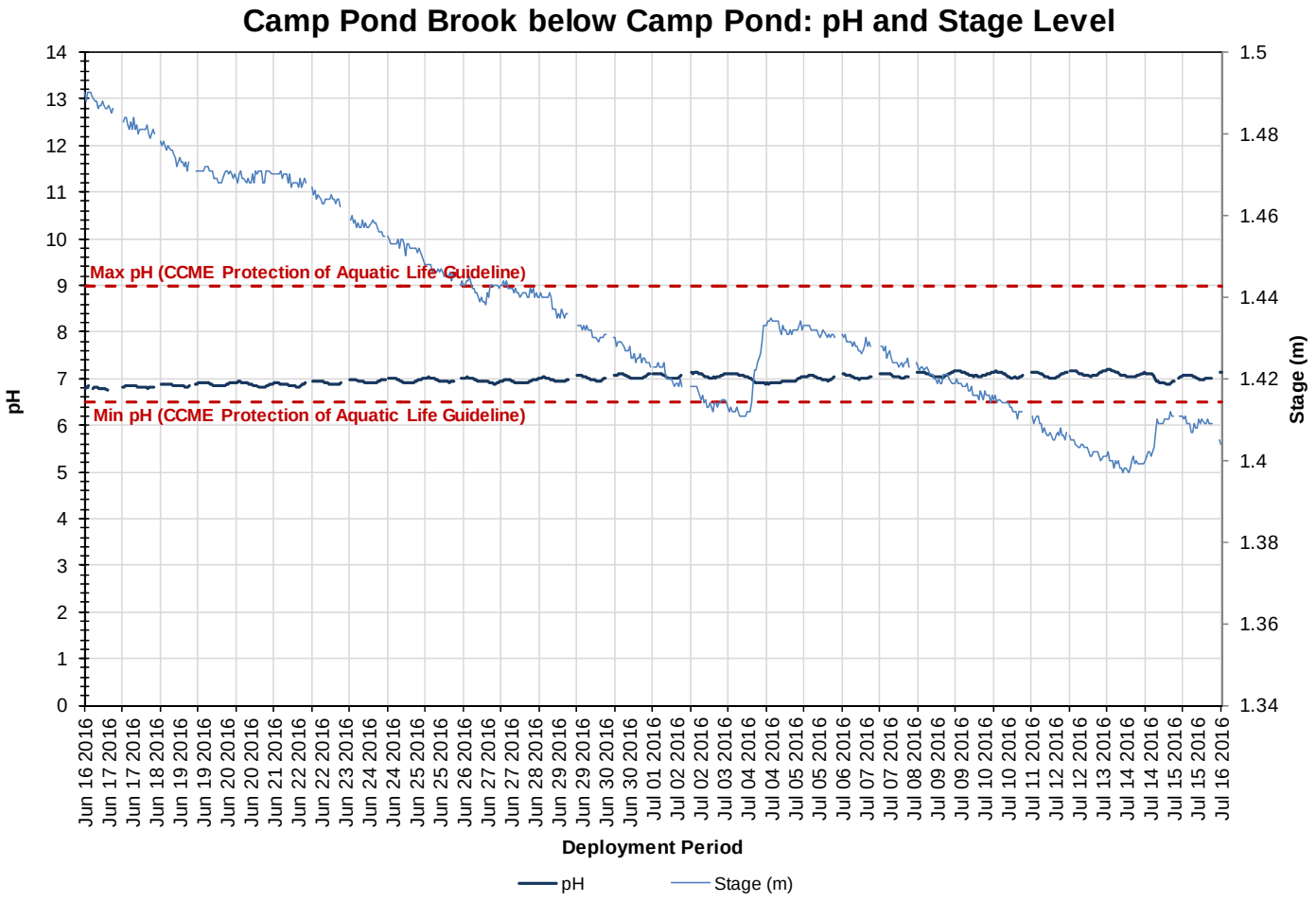

Figure 11: pH & Stage Level at Camp Pond Brook below Camp Pond

Specific Conductivity

Specific conductivity ranges from 28.6 µS/cm to 40.5 µS/cm with a median of 32.65 µS/cm. (Figure 12). At this location the conductivity levels increase with an increase in stage level. This is likely a result of the proximity of this station to the activity of the Voisey's Bay roadways. Generally increases in specific conductivity indicate extra suspended material in the water column.

On July 3rd and July 4th there is a rainfall event (Figure 15) which likely influenced the increase in stage level. At the same time the conductivity levels increased 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. Dropping water level can concentrate the present suspended material in the water column.

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.

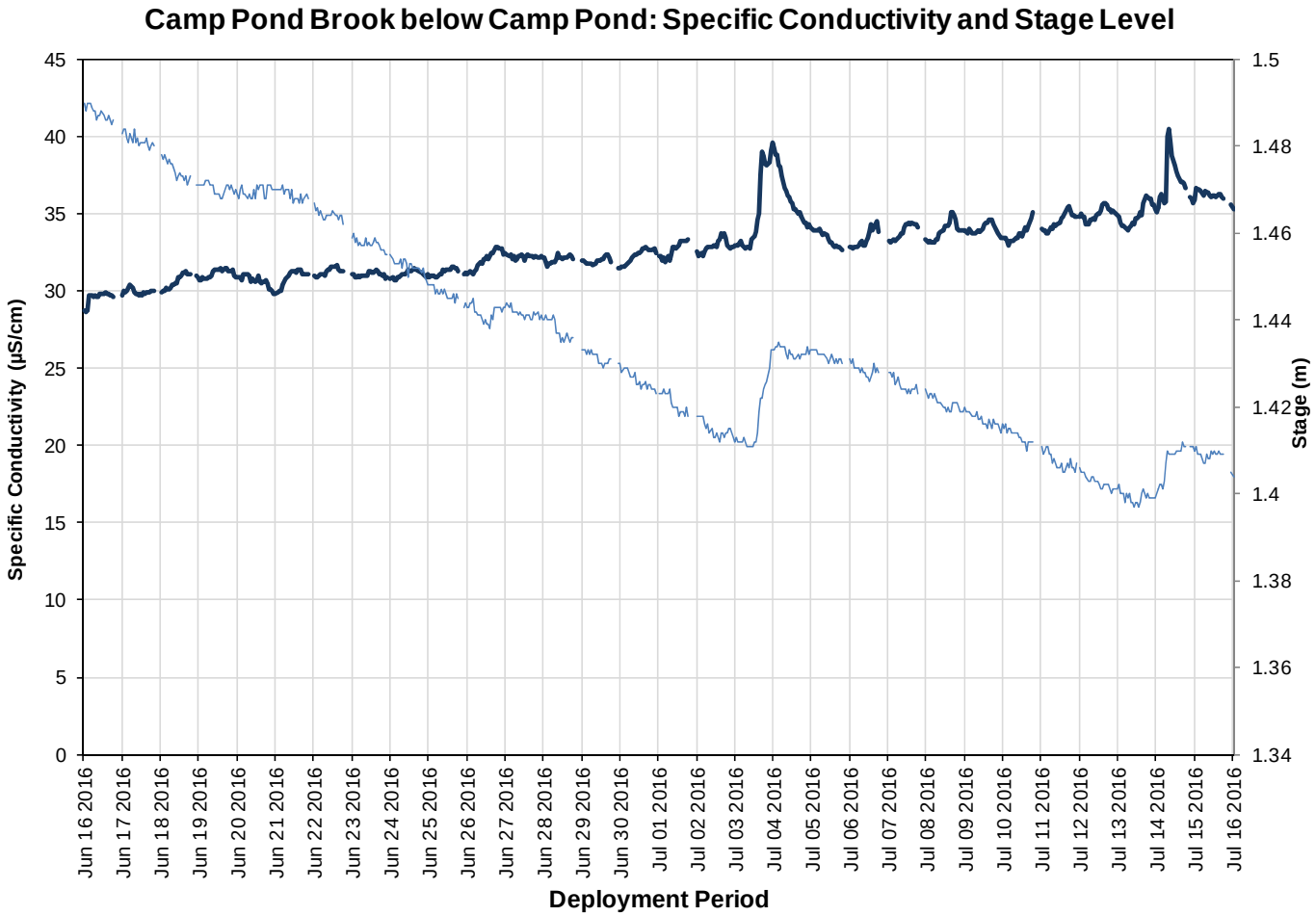

Figure 12: Specific Conductivity & Stage at Camp Pond Brook below Camp Pond

Dissolved Oxygen (mg/L & % Saturation)

Dissolved oxygen content ranges between 8.57mg/l and 11.34mg/l during the deployment period. The saturation of dissolved oxygen ranges from 88.6% to 103.3% (Figure 13). The water quality instrument measures dissolved oxygen (mg/L) with the dissolved oxygen probe and then the instrument calculates percent saturation (% Sat) with water temperature.

Dissolved oxygen concentration dipped below the CCME guideline of 9.5mg/L during the deployment period. This occurrence corresponds 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. On July 3rd and July 4th there is a rainfall event (Figure 15) which likely influenced the increase in dissolved oxygen (mg/L) and the dip in water temperature on the same dates.

There is also a gradual decrease in dissolved oxygen across the deployment period. This is to be expected as the air temperatures and subsequently water temperatures start to increase coming into the summer season.

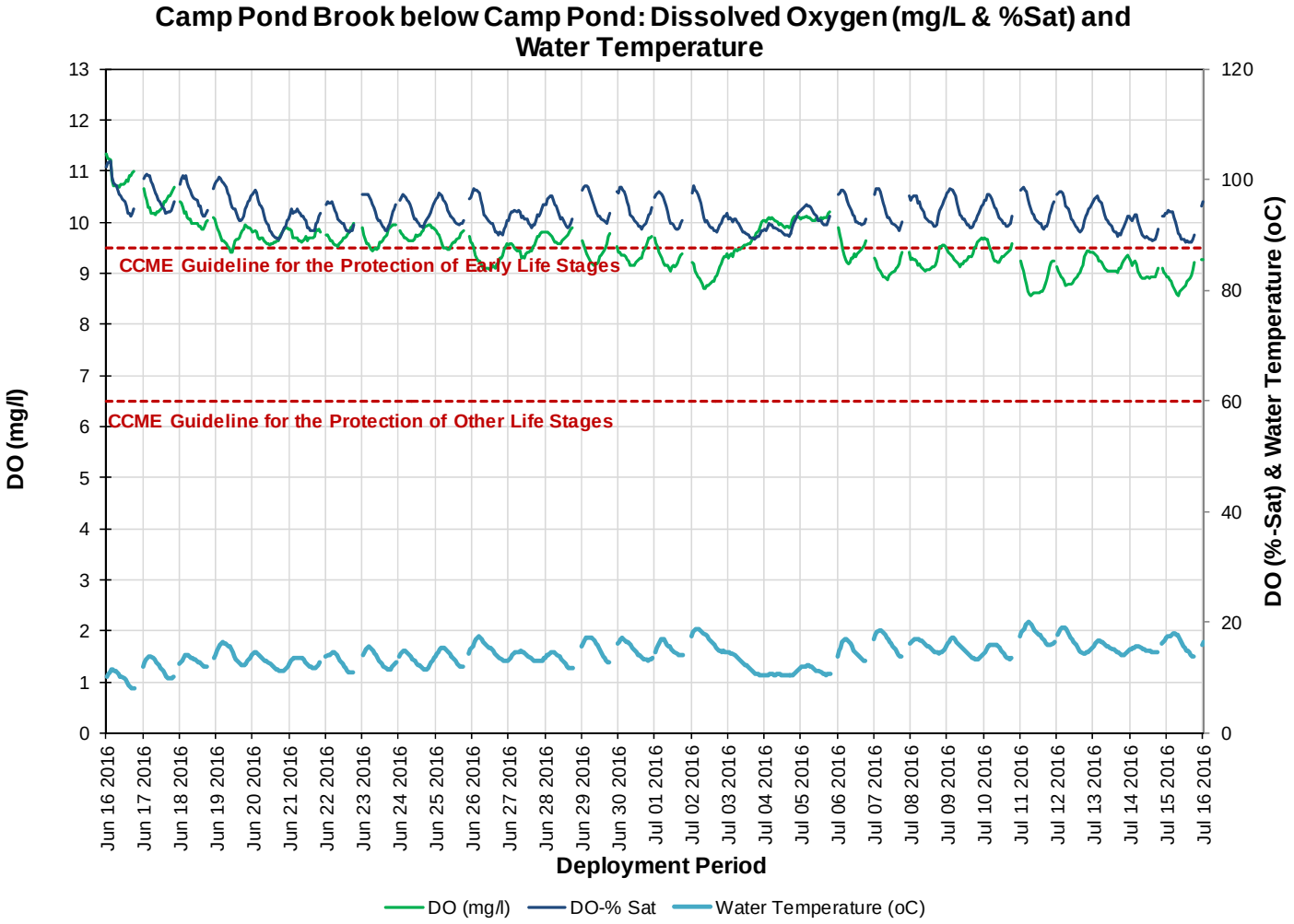

Figure 13: Dissolved Oxygen & Water Temperature at Camp Pond Brook below Camp Pond

Turbidity

Across the deployment period the turbidity ranges from 0.0NTU to 3.6NTU, with a median value of 0.0NTU (Figure 14). A median value of 0.0 NTU indicates there is very little natural background turbidity at this station during this deployment period.

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 (bubbles, drifting of algae or sunlight scattering). The turbidity peaks are not significant enough to correlate with any specific reason (i.e. rainfall, stage increase, runoff).

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.

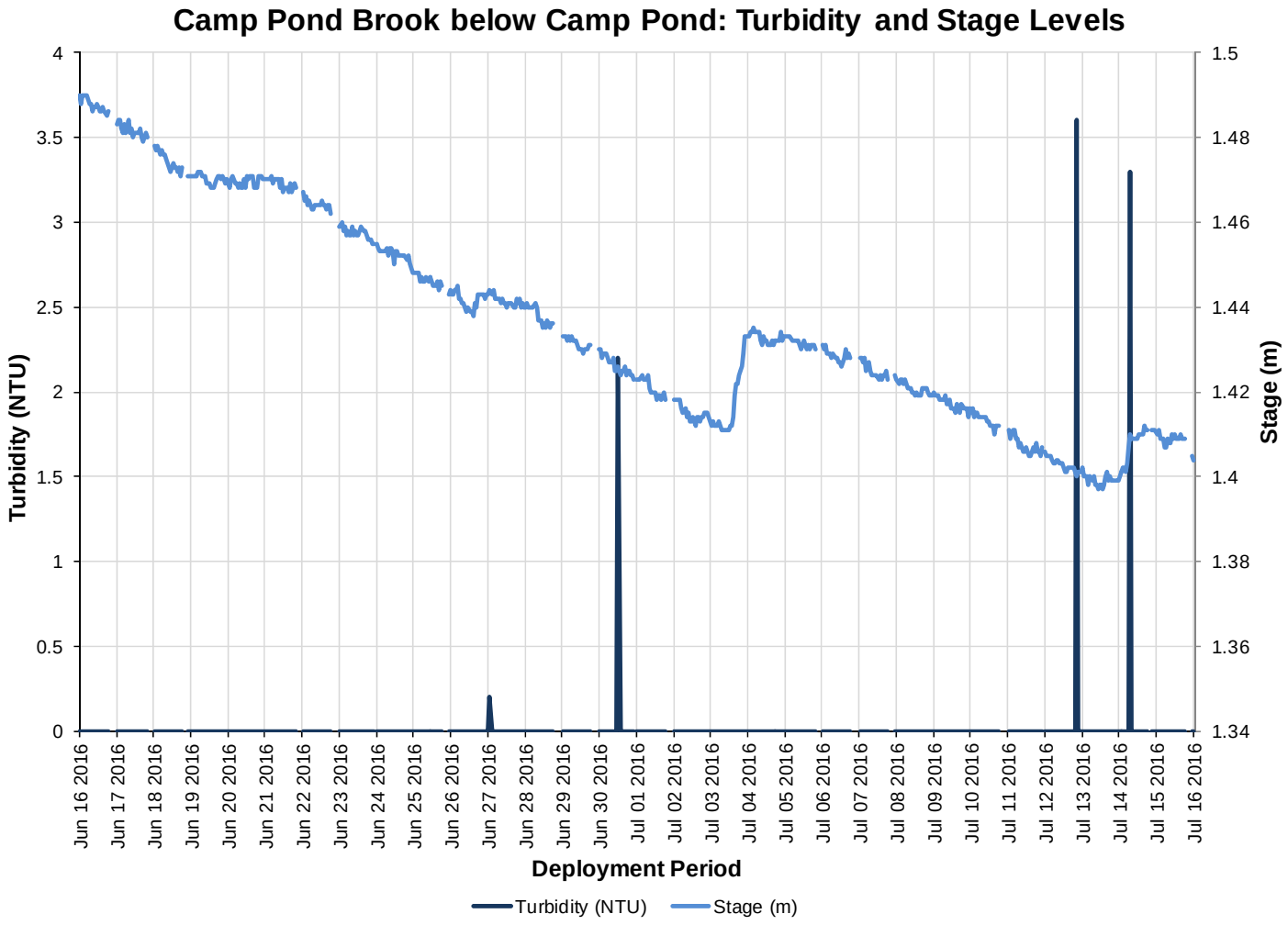

Figure 14: Turbidity & Stage Level at Camp Pond Brook below Camp Pond

Stage, Streamflow and Precipitation

WSC is responsible for QAQC of water quantity data (stage and flow). Corrected data can be obtained upon request.

Precipitation data was obtained from the Environment Canada weather station at Nain. The weather station is 30 km northeast of Voisey's Bay (Figure 15). Precipitation occurs on 12 days during the deployment period and amounts are small in magnitude, with the largest on July 14th accumulating 12.7mm of precipitation, although the precipitation on July 3rd to July 5th, seemed to have the largest impact on the water quality parameters.

During the deployment period, the stage values ranged from 1.397m to 1.49m. Streamflow had a minimum amount of 0.328m^3/s and a maximum flow of 0.75m^3/s.

Stage, streamflow and precipitation are graphed below to show the relationship between rainfall and water level (Figure 15).

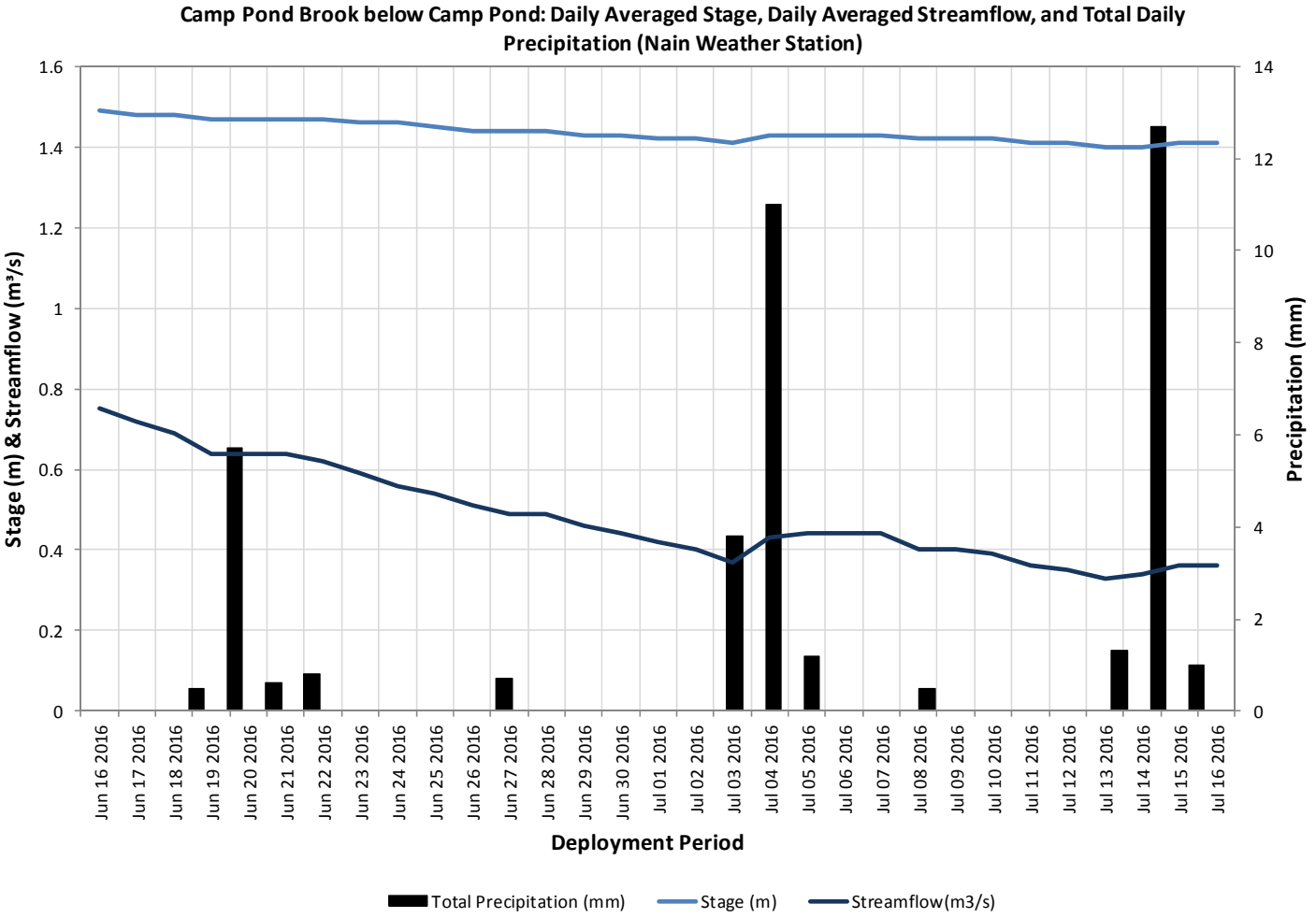

Figure 15: Stage, Streamflow, and Total Daily Precipitation (Nain, Labrador Weather Station) at Camp Pond Brook below Camp Pond

Reid Brook below Tributary

Water Temperature

Water temperature ranges from 6.39 °C to 14.19 °C, with a median value of 10.57°C (Figure 16).

The water temperature at this station displays diurnal variations of the temperature. There is a gradual increase in the water temperature throughout this deployment. This is to be expected as the air temperatures increase as the climate changes into summer (Figure 17).

This graph displays the relationship between stage decrease and water temperature increase. Temperature is influenced by the lower stage level and increases slightly for a short period of time. On July 3rd to July 5th there is a rainfall event (Figure 22) and drop in air temperatures (Figure 17) which likely influenced the decrease in water temperature on the same dates.

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.

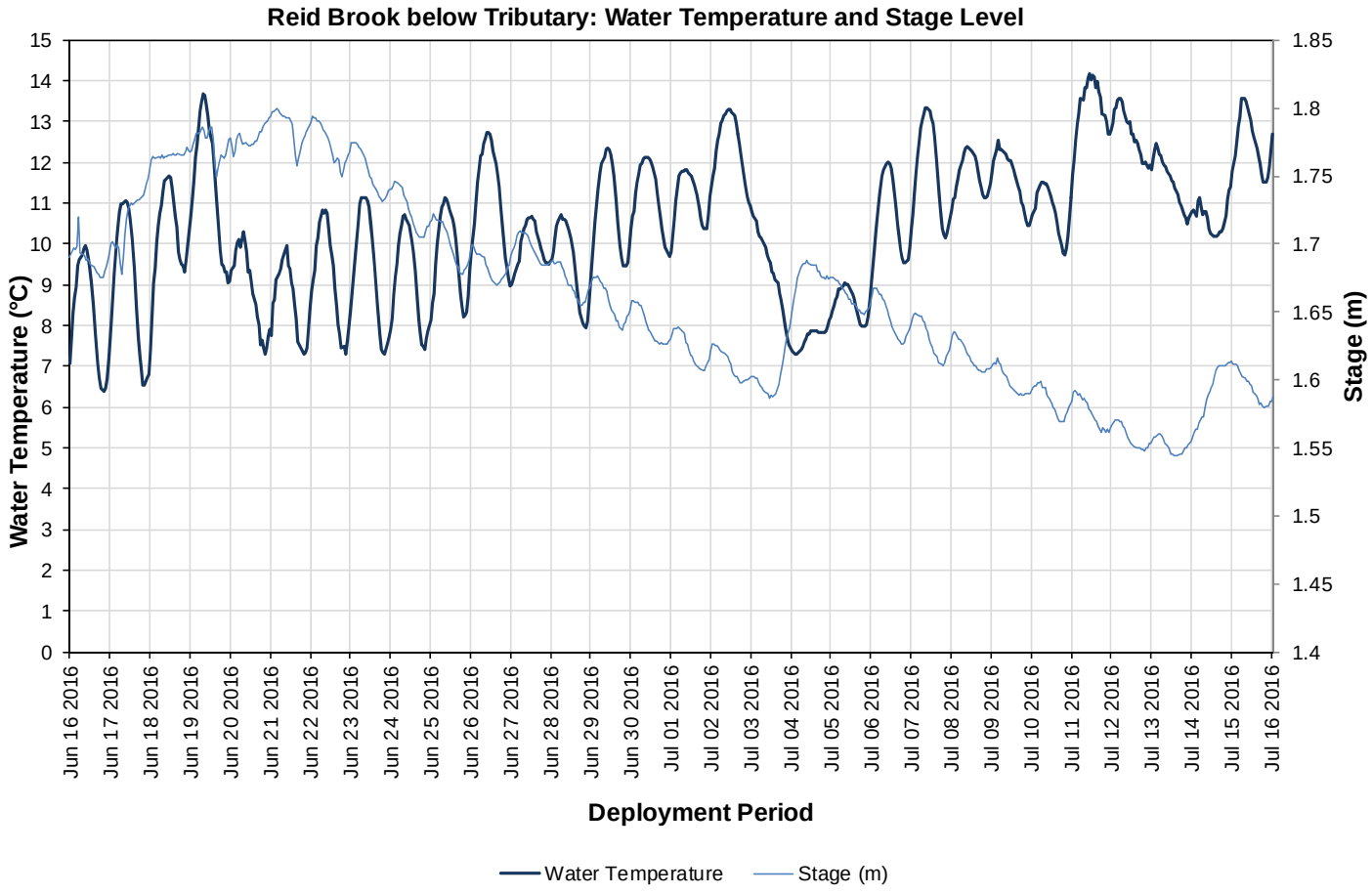

Figure 16: Water Temperature & Stage Level at Reid Brook below Tributary

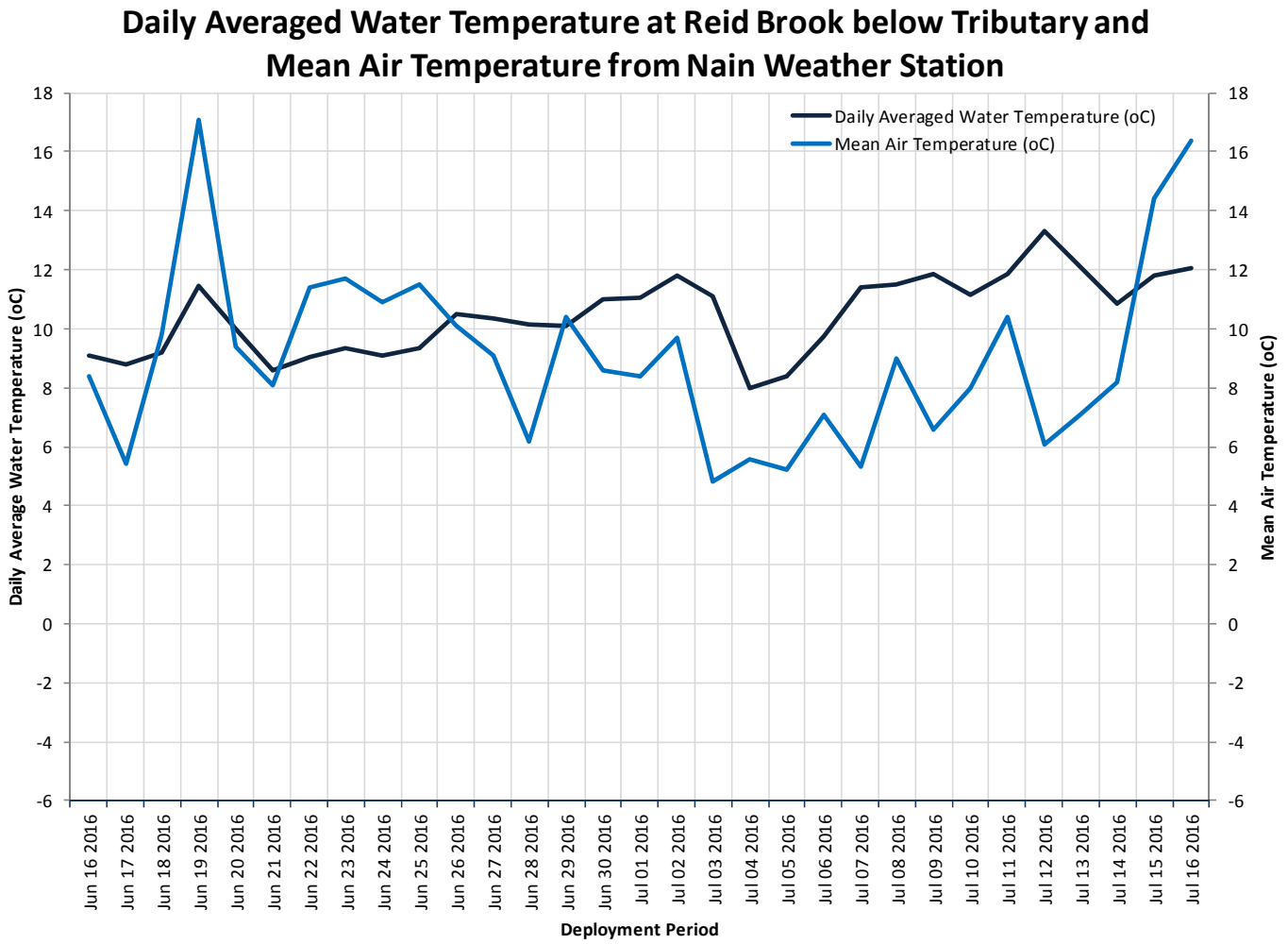

Figure 17: Daily Averaged Water Temperature at Reid Brook below Tributary and Mean Air Temperature from Nain Weather Station

pH

During this deployment this station had a pH range from 6.44 to 6.94 pH units, with a median value of 6.66 (Figure 18).

The pH data dips below the minimum CCME guidelines on a few occasions and these dips correspond with increases in stage. The stage increases are likely a result of precipitation, the addition of rain water causes the water to become slightly more acidic therefore the pH drops. Overall the pH levels at this station are reasonably consistent. On July 3rd to July 5th there is a rainfall event (Figure 22) which likely influenced the decrease in pH on the same dates.

The Canadian Council of Ministers of the Environment (CCME) guidelines are just a basis by which to compare any dramatic change in the pH data within a dataset. Every brook is different with its own natural background conditions.

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.

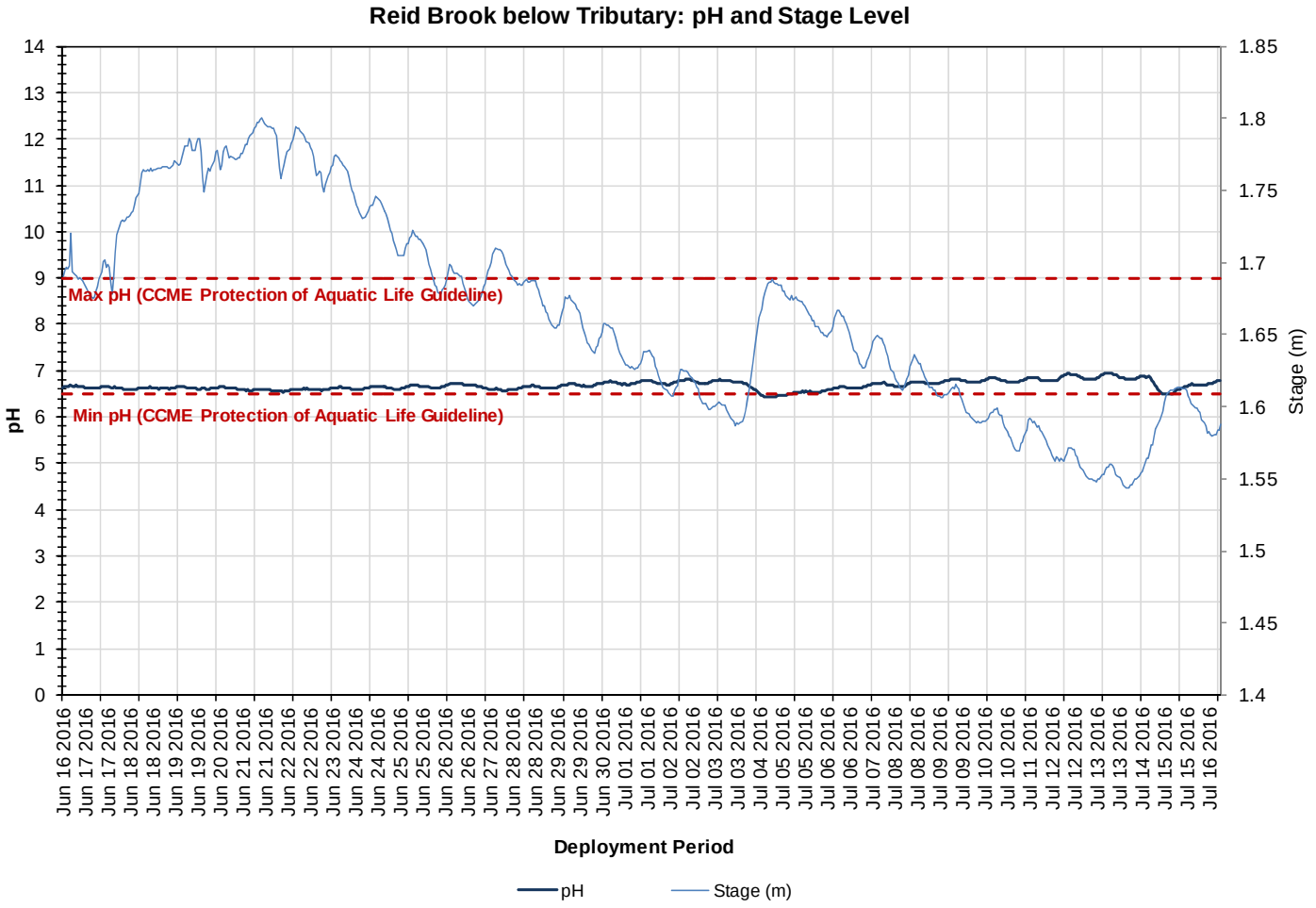

Figure 18: pH & Stage at Reid Brook below Tributary

Specific Conductivity

Specific conductivity ranges from 18.5µS/cm to 31.6µS/cm with a median of 24.8µS/cm (Figure 19). At this station as the stage level increases, the specific conductivity reacts by decreasing; this is likely a result of the dissolved solids being flushed through the brook for short period of time. This is evident on July 3rd to July 5th when there is a rainfall event (Figure 22) and the increase in water level decreases conductivity on the same dates.

Over the deployment period the conductivity levels are gradually increasing. This reaction is to be expected as the water level drops off with the change in season (Figure 19).

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.

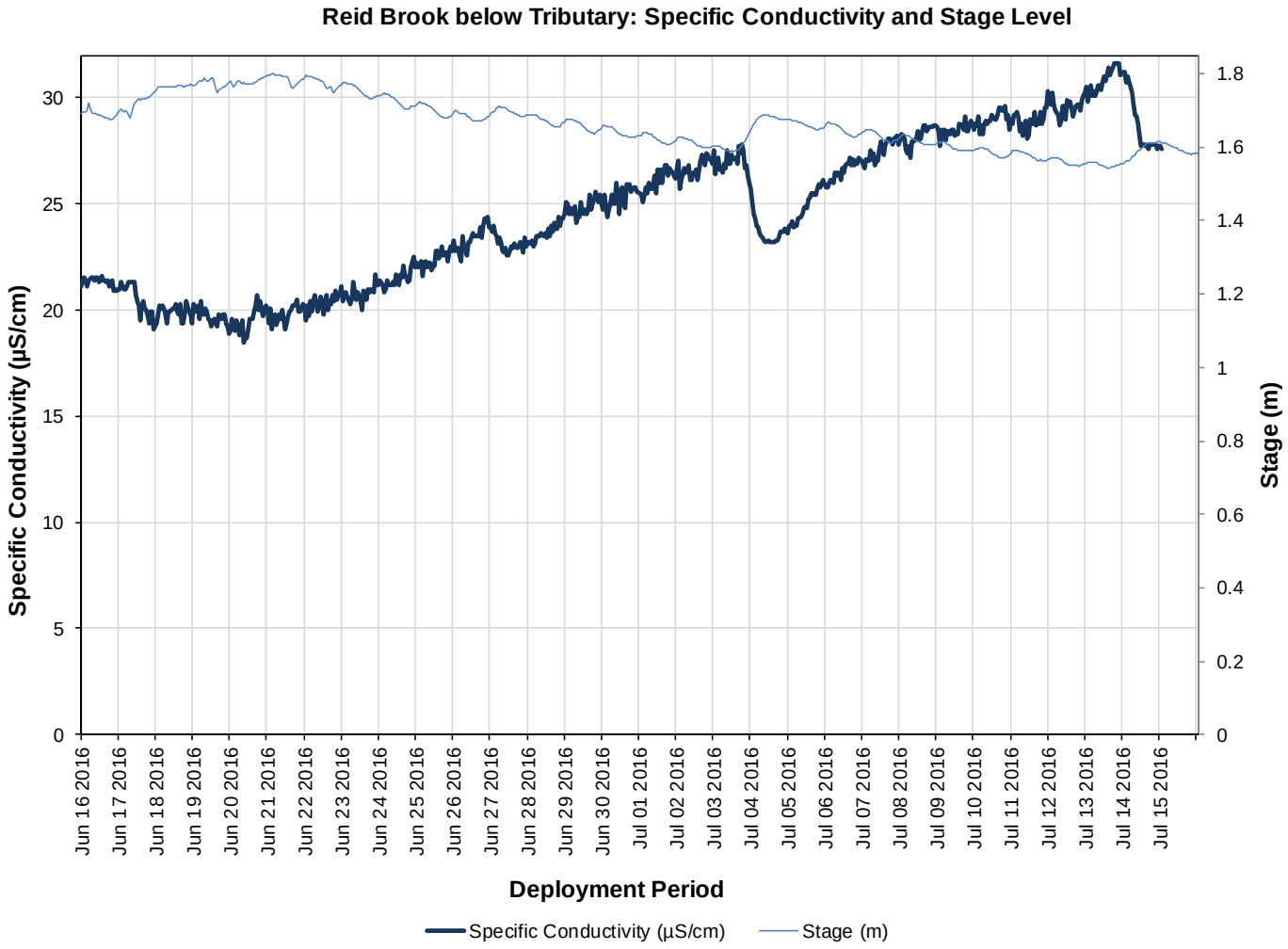

Figure 19: Specific Conductivity & Stage at Reid Brook below Tributary

Dissolved Oxygen

Dissolved oxygen content ranges between 9.61mg/l and 11.90mg/l during the deployment period. The saturation of dissolved oxygen ranges from 92.8% to 100.9% (Figure 20). The water quality instrument measures dissolved oxygen (mg/L) with the dissolved oxygen probe and then the instrument calculates percent saturation (% Sat) with water temperature.

Dissolved oxygen concentration remained above the CCME guideline of 9.5mg/L during the deployment period. The dissolved oxygen levels were reasonably consistent; there were small changes in dissolved oxygen that correspond with changes in water temperature at the same time.

On July 3rd to July 6th, 2016 the dissolved oxygen level in the brook flattened out with less of a diurnal pattern occurring. The DO was likely reacting to the lower water temperature and rainfall (Figure 22) on the same dates.

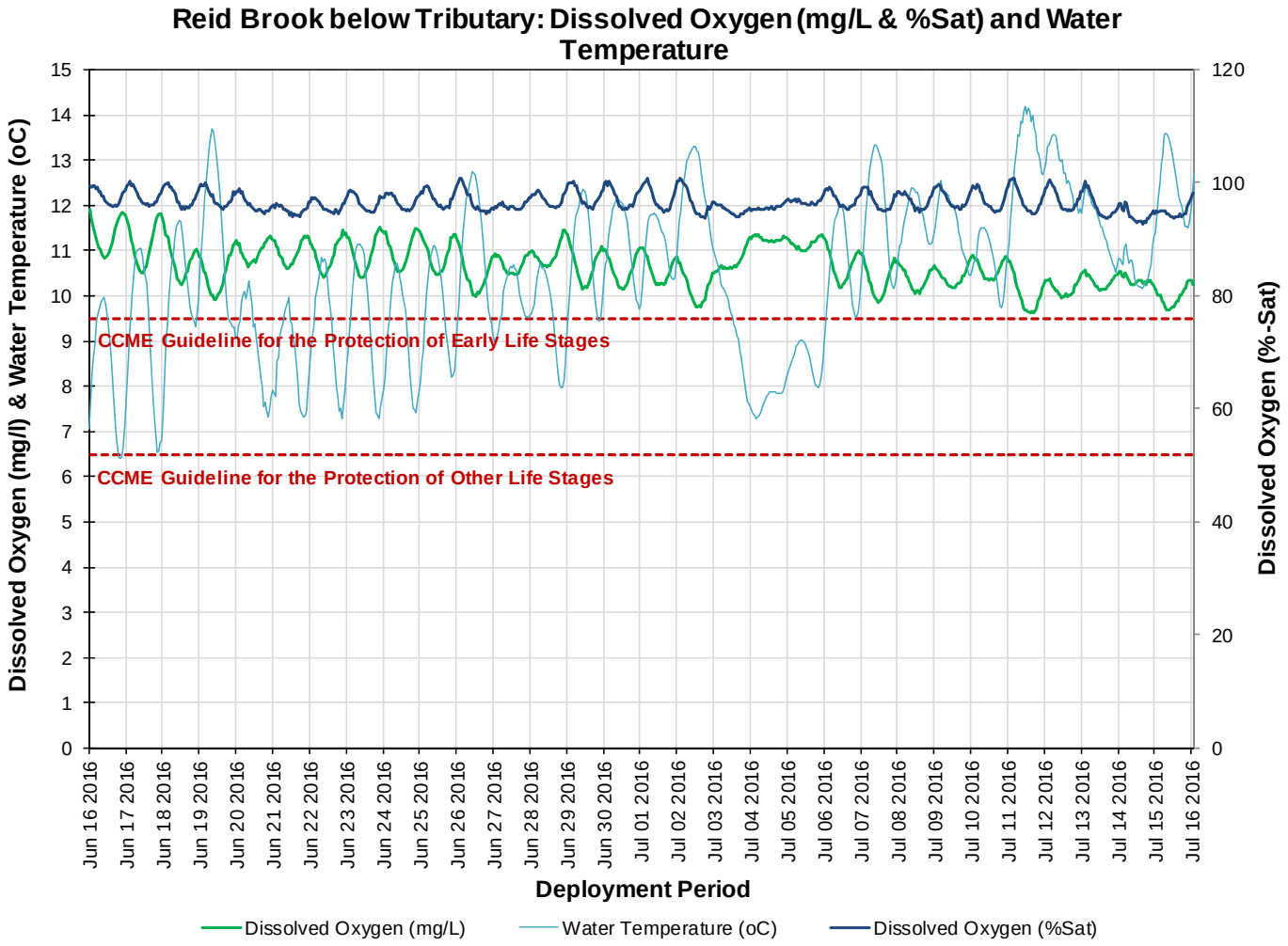

Figure 20: Dissolved Oxygen and Water Temperature at Reid Brook below Tributary

Turbidity

Turbidity ranges from 0.0NTU to 13.0NTU during the deployment period, with a median value of 0.0NTU (Figure 21). A median value of 0.0 NTU indicates there is very little natural background turbidity at this station during this deployment period.

There are a number of low - medium turbidity events at this station throughout the duration of this deployment. Some of the larger turbidity events correlate with an increase in stage level and likely a result of precipitation causing the mixing of solids in the water column (Figure 21).

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.

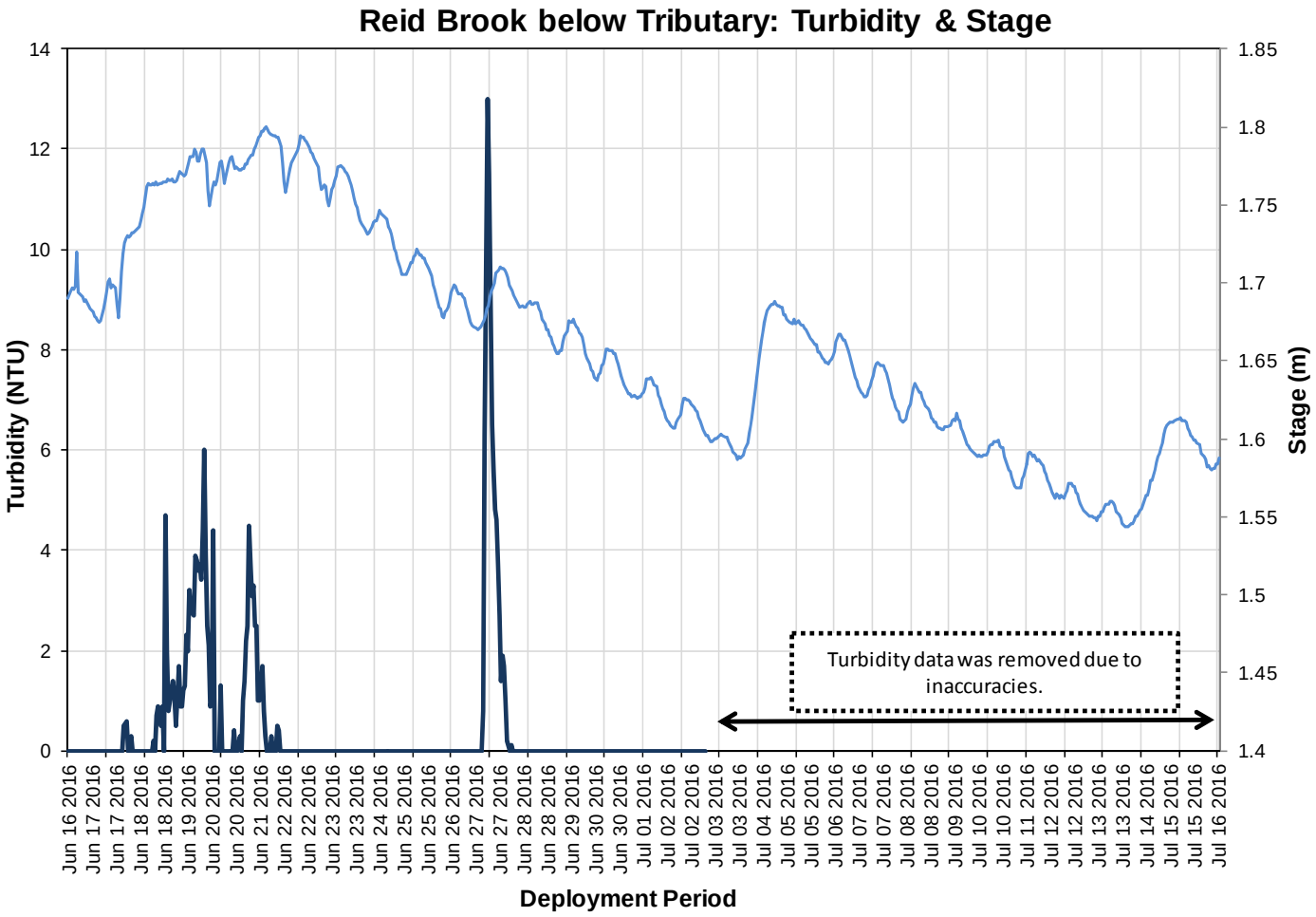

Figure 21: Turbidity and Stage Level at Reid Brook below Tributary

Stage, Streamflow and Precipitation

Stage, Streamflow and precipitation are graphed below to show the relationship between rainfall and water level (Figure 22). It is evident that the peaks in stage (m) and streamflow (m^3/s) data are a result of precipitation.

Precipitation data was obtained from the Environment Canada weather station at Nain. The weather station is 30 km northeast of Voisey's Bay. Precipitation occurs on 12 days during the deployment period and amounts are small in magnitude, with the exception of the largest on July 14th with 12.7mm of rain.

During the deployment period, the stage values ranged from 1.54m to 1.80m. Streamflow had a minimum amount of 3.02m^3/s and a maximum flow of 12.66m^3/s.

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.

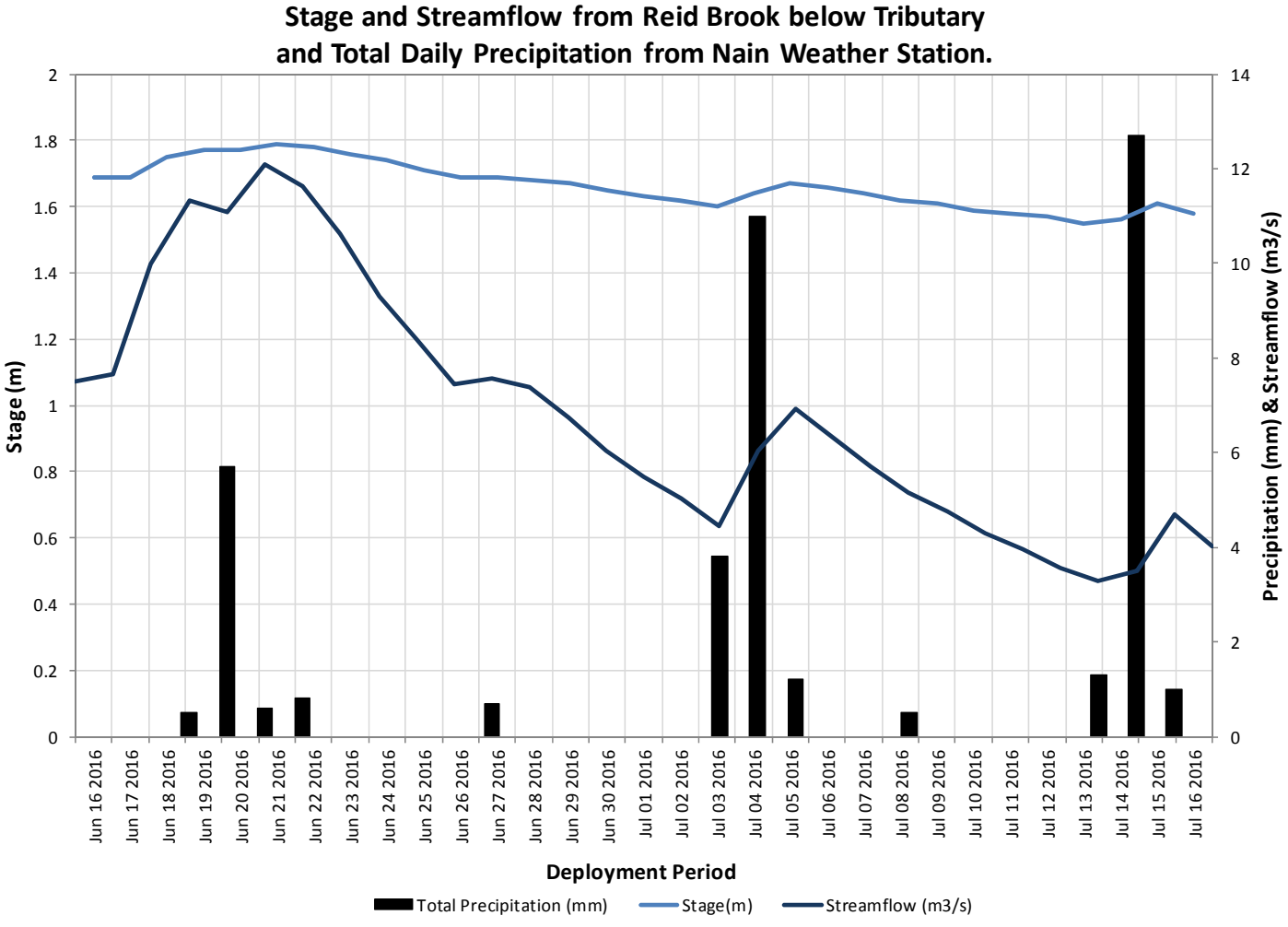

Figure 22: Stage, Streamflow, and Total Daily Precipitation (Nain, Labrador Weather Station) at Reid Brook below Tributary

Tributary to Reid Brook

Water Temperature

Water temperature ranges from 6.4 °C to 14.40 °C, with a median value of 10.80°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).

On July 3rd to July 5th there is a rainfall event (Figure 29) and drop in air temperature (Figure 24) which likely influenced the decrease in water temperature on the same dates. The water temperature on this graph displays the natural diurnal pattern. The large decreases in water temperature coincide with high stage events. This is a natural occurrence.

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.

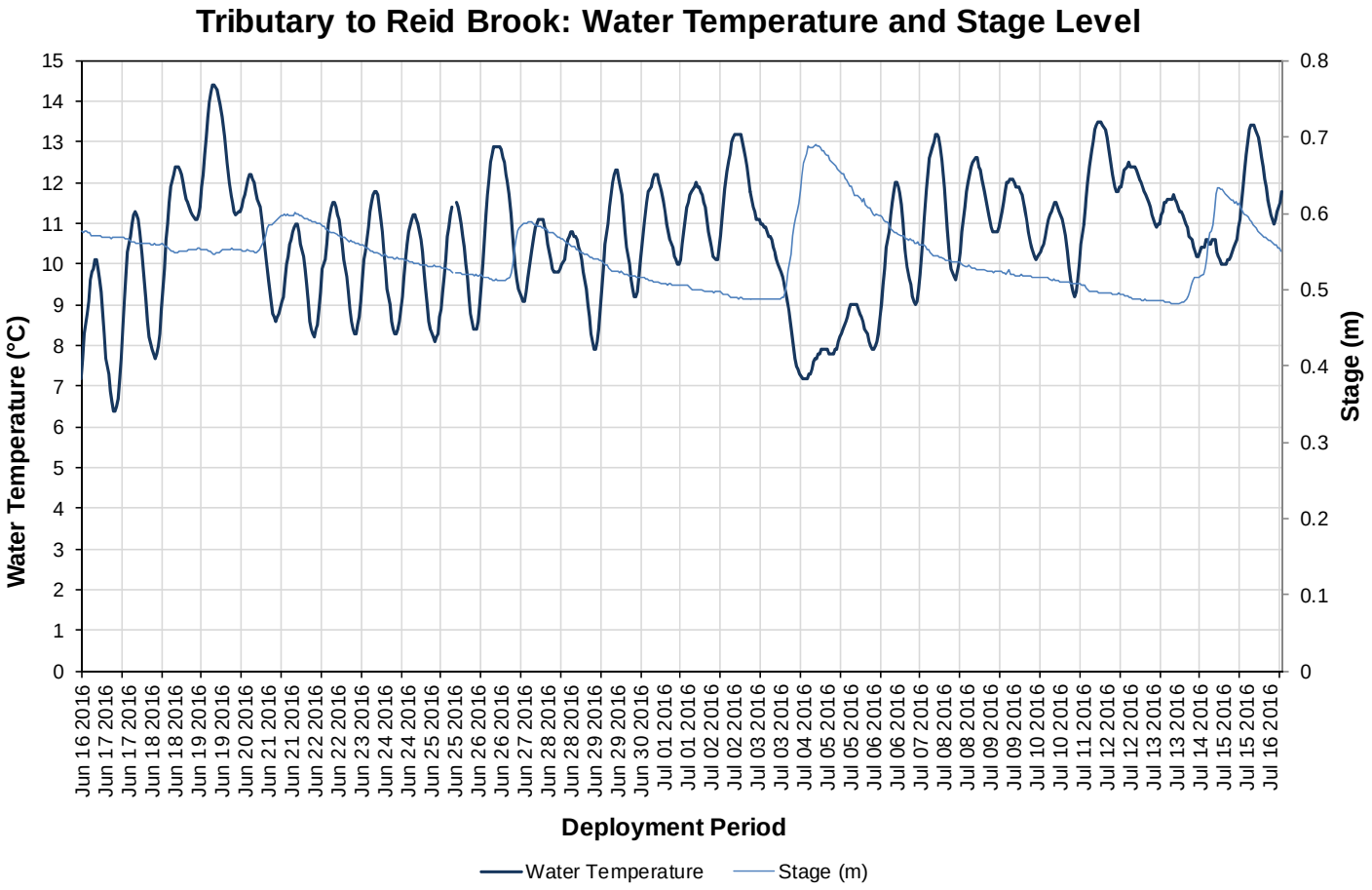

Figure 23: Water Temperature and Stage at Tributary to Reid Brook

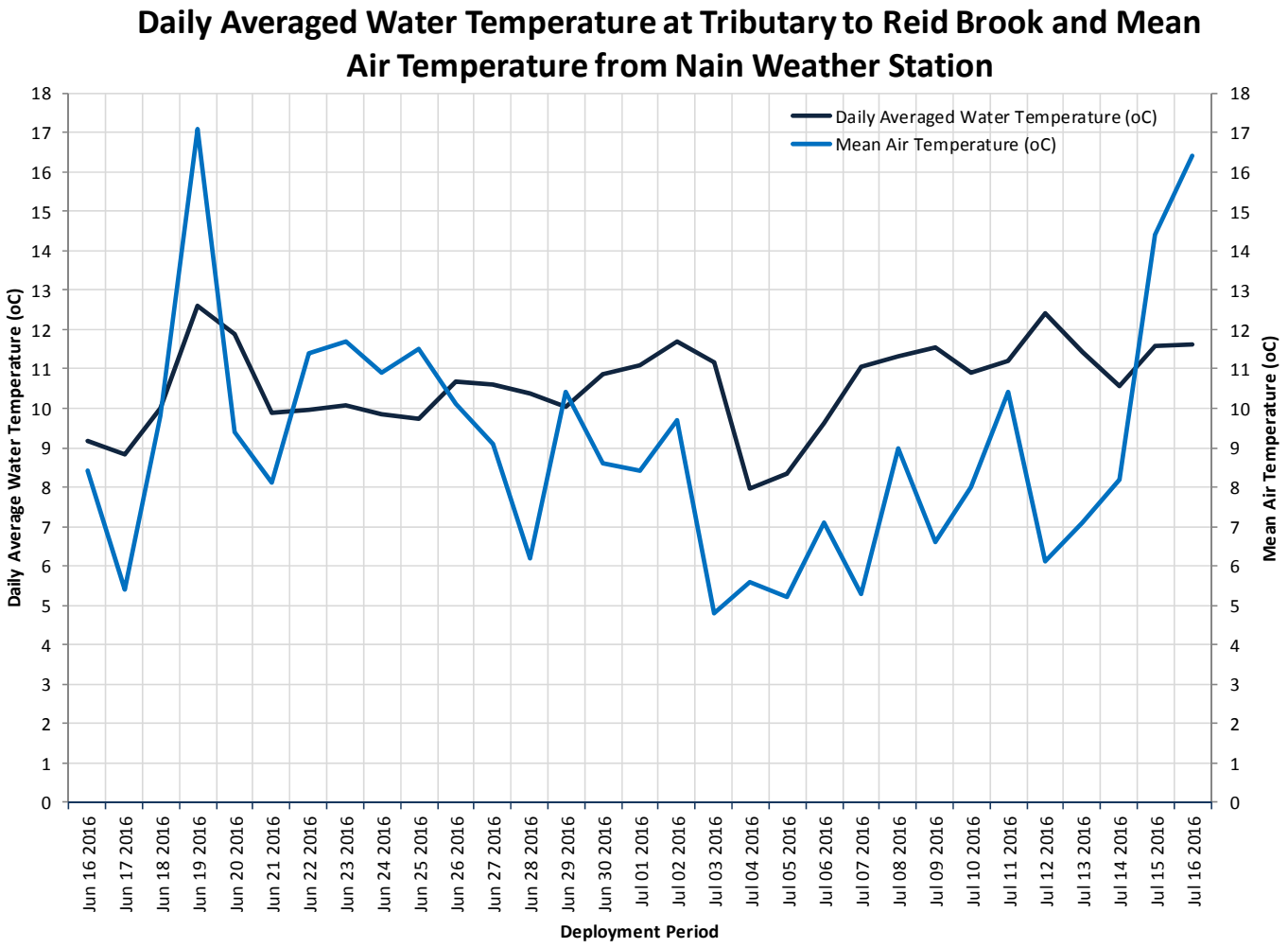

Figure 24: Daily Average Water Temperature at Tributary to Reid Brook and Mean Air Temperature from Nain Weather Station.

pH

pH ranges from 6.42 to 6.98 pH units, with a median value of 6.80 (Figure 25).

For most of the deployment the pH level is within the CCME guideline. Stage increases can indicate a rainfall event, and rainfall will influence the pH values to decrease for a short period of time (Figure 25). This is evident with pH levels below the guideline range on July 4th and July 14th, 2017.

The CCME guideline provides a basis by which to judge the overall health of the brook. Naturally, all streams are different and have a natural baseline conditions.

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.

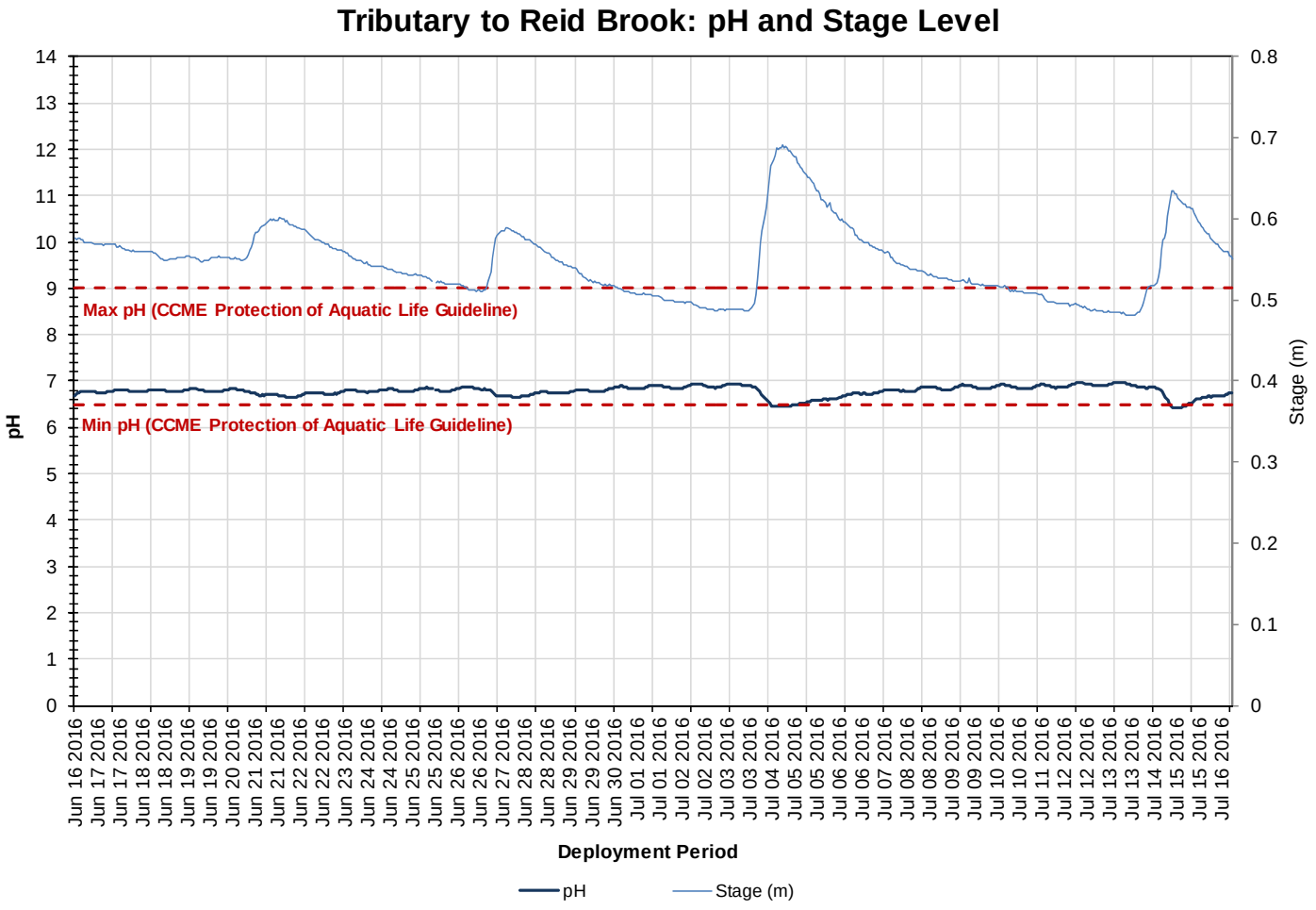

Figure 25: pH & Stage Level at Tributary to Reid Brook

Specific Conductivity

Specific conductivity ranges from 22.1µS/cm to 32.7µS/cm with a median of 26.4µS/cm. (Figure 26).

Generally the relationship between specific conductance and stage is inversed. When stage level rises, the specific conductance level drops in response as the increased amount of water in the river system dilutes the solids that are present (Figure 26). On July 3rd to July 5th there is a rainfall event (Figure 29) which 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 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.

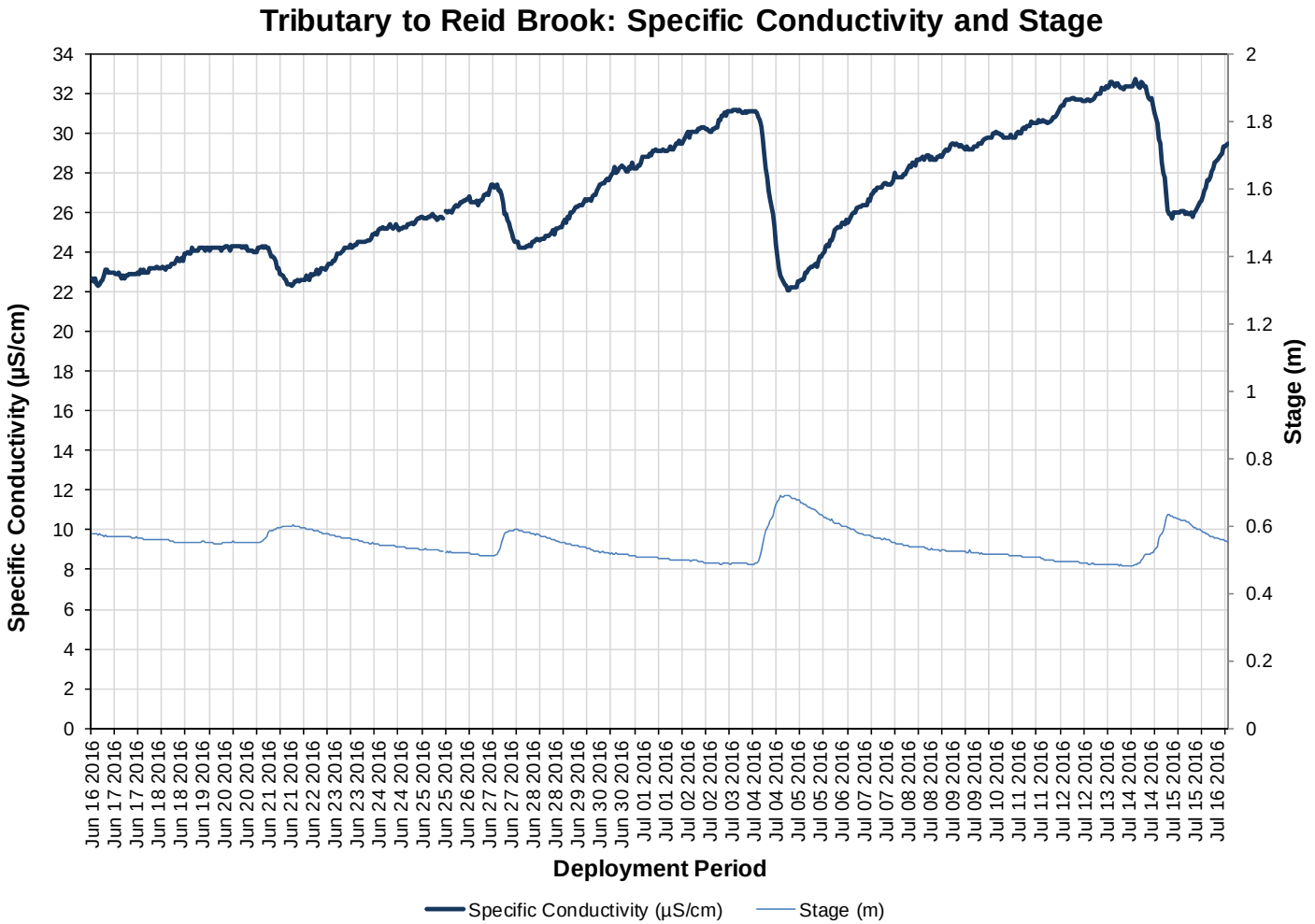

Figure 26: Specific Conductivity & Stage at Tributary to Reid Brook

Dissolved Oxygen

Dissolved oxygen content ranges between 9.75mg/l and 11.93mg/l during the deployment period. The saturation of dissolved oxygen ranges from 93.4% to 100.1% (Figure 27). The water quality instrument measures dissolved oxygen (mg/L) with the dissolved oxygen probe and then the instrument calculates percent saturation (% Sat) with water temperature.

During this deployment the dissolved oxygen mg/L levels remained above the CCME guidelines for the protection of early/other life stages. On July 3rd to July 5th there is a rainfall event (Figure 29) which likely influenced the increase in dissolved oxygen (mg/L) on the same dates.

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.

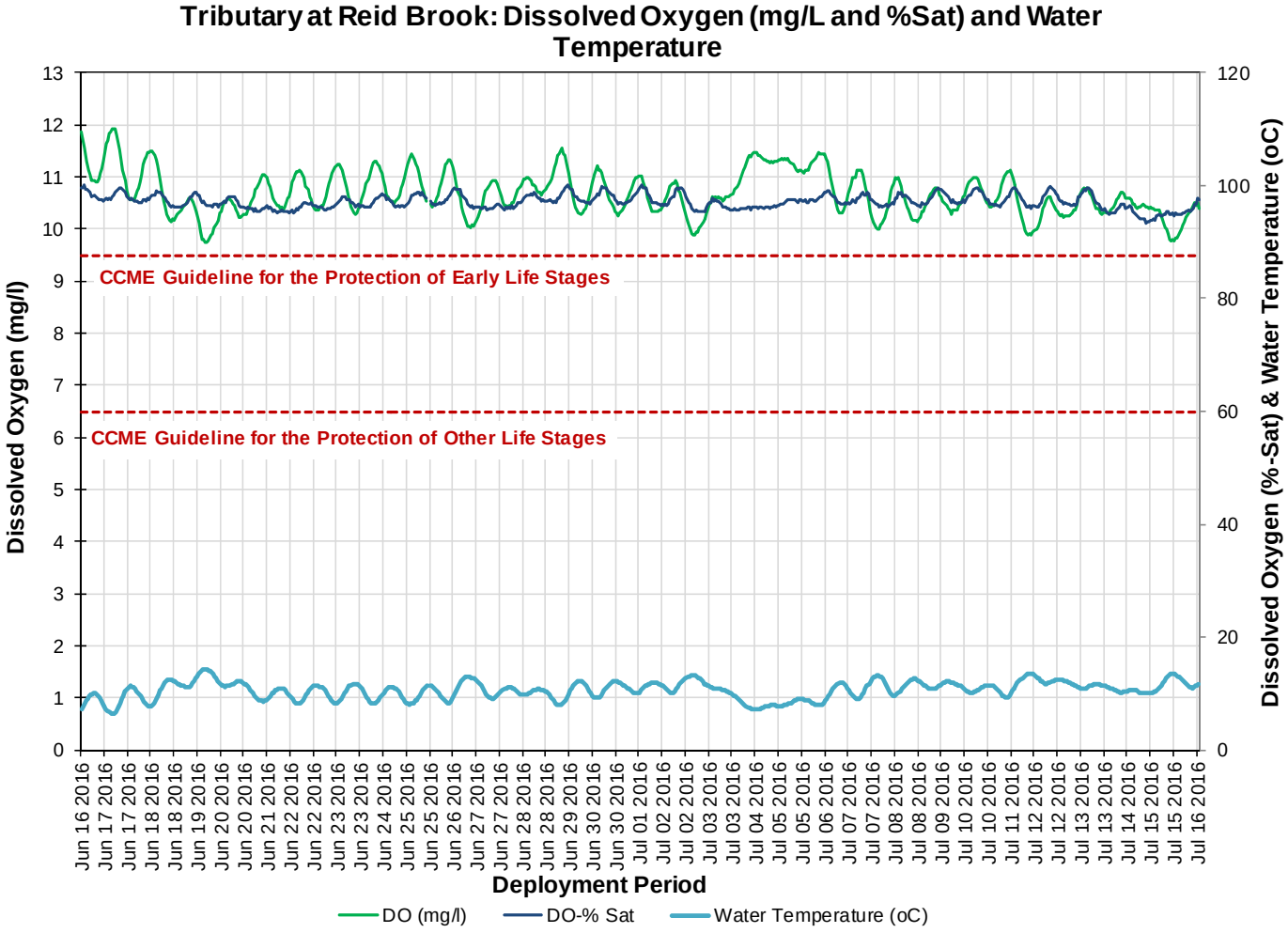

Figure 27: Dissolved Oxygen & Water Temperature at Tributary to Reid Brook

Turbidity

Turbidity ranges from 0.0 NTU to 52.3 NTU during the deployment period, with a median value of 0.0NTU (Figure 28). A median value of 0.0 NTU indicates there is very little natural background turbidity at this station during this deployment period.

There are a number of low and high turbidity events at this station throughout the deployment. Some of the larger turbidity events correlate with an increase in stage level, likely a result of rainfall. The increase in water volume can stir up solids and materials in the water column (Figure 28).

This particular site has sandy-clay like bottom to the brook. This material is easily disturbed during rainfall events or large increases in stage.

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.

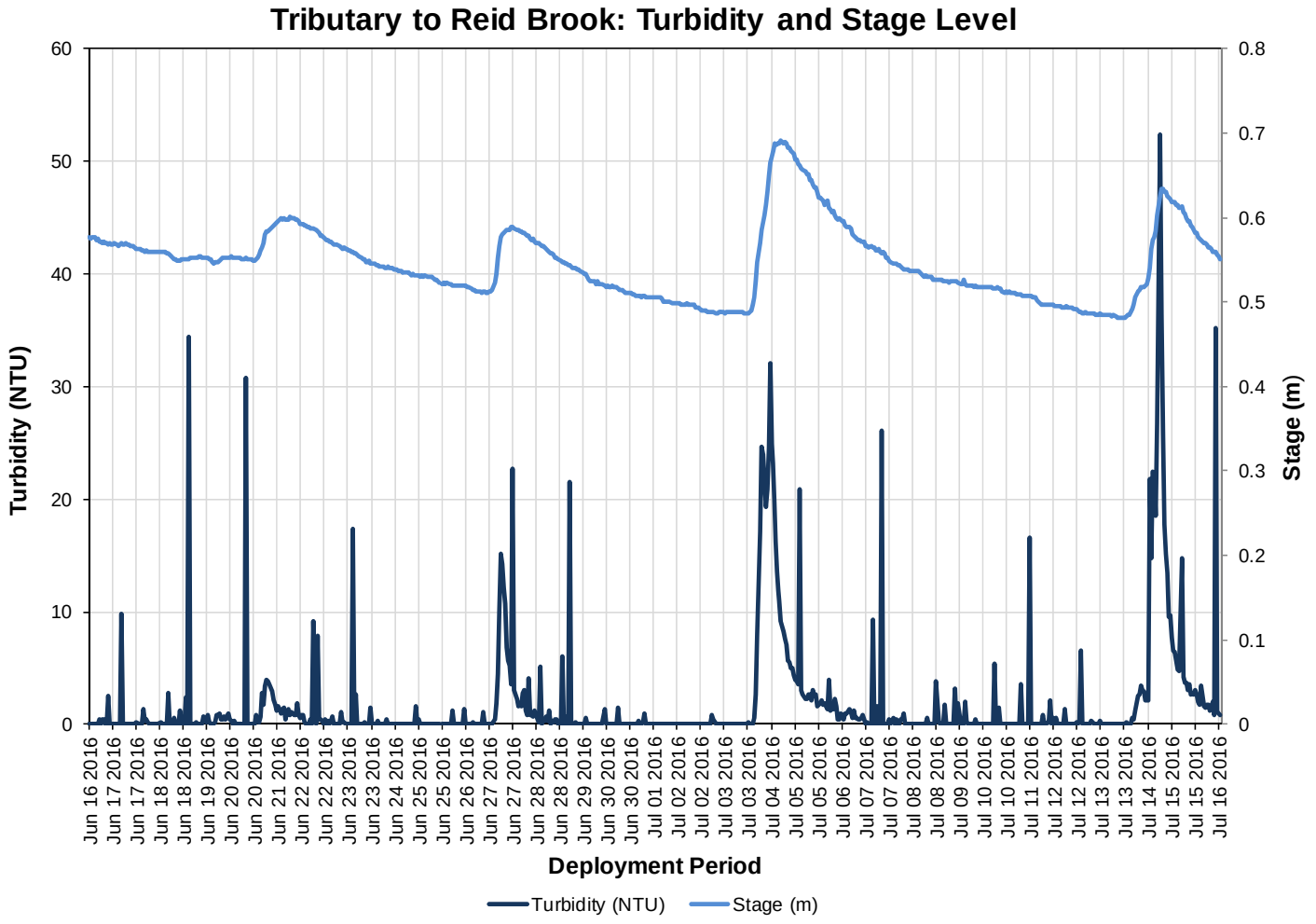

Figure 28: Turbidity & Stage at Tributary to Reid Brook

Stage, Streamflow, and Precipitation

Please note 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. Precipitation data was obtained from the Environment Canada weather station at Nain. The weather station is 30 km northeast of Voisey's Bay (Figure 29).

Precipitation occurs on 12 days during the deployment period and amounts are relatively small in magnitude, the largest rainfall occurs on July 14th, 2017 with a total of 12.57mm

During the deployment period, the stage values ranged from 0.48m to 0.69m. Streamflow had a minimum amount of 0.16m^3/s and a maximum flow of 0.81m^3/s.

Stage, Streamflow and precipitation are graphed below to show the relationship between rainfall and water level (Figure 29). It is evident that the peaks in stage (m) and streamflow data are a result of precipitation.

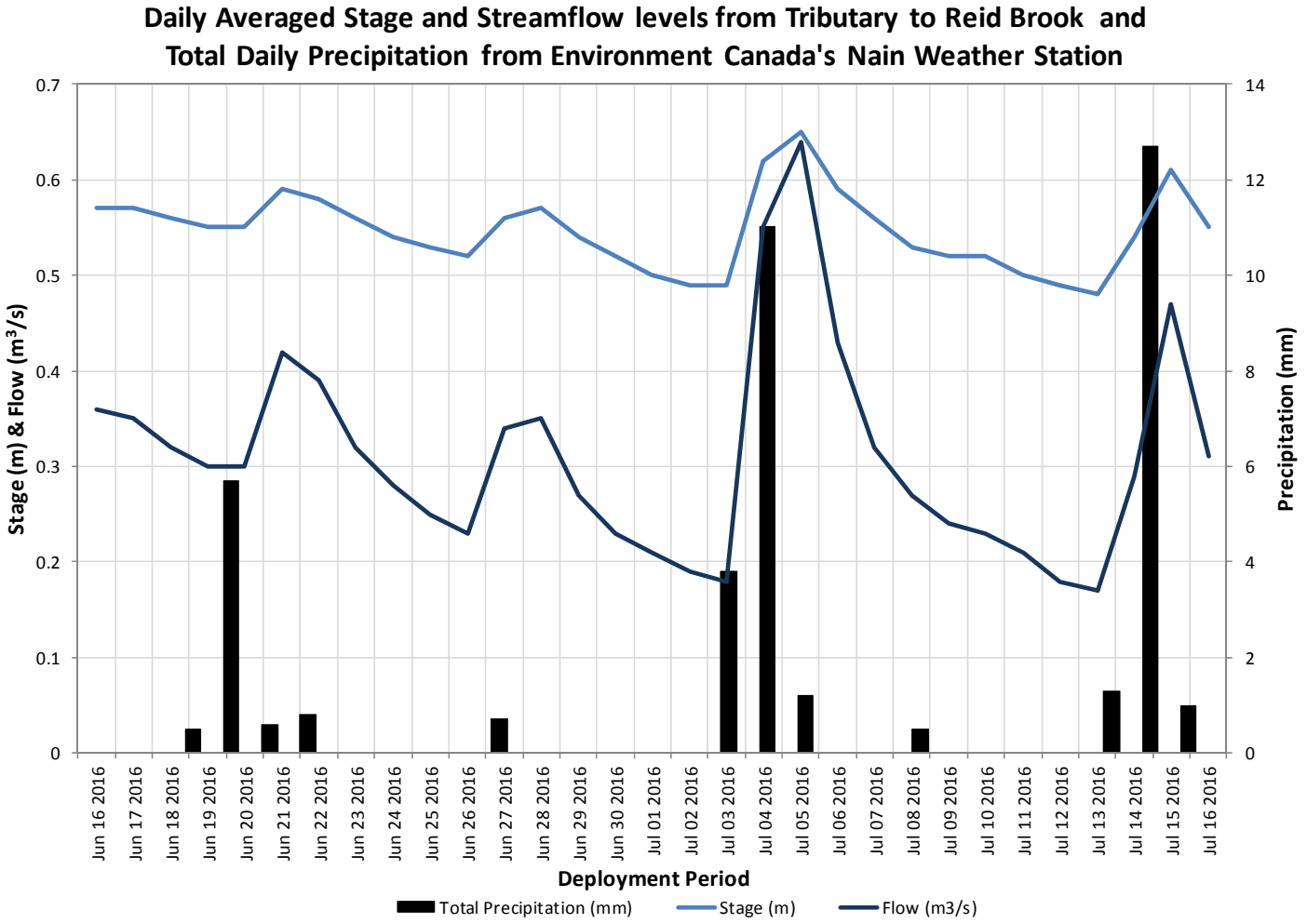

Figure 29: Daily Averaged Stage and Streamflow at Tributary to Reid Brook and Total Daily Precipitation (Nain, Labrador Weather Station)

Conclusions

The overall water temperatures across all stations were within a minimum of 1.47°C found at Reid Brook at Outlet of Reid Pond and a maximum of 20.06°C recorded at Camp Pond Brook below Camp Pond. These two stations also had the lowest water temperature minimum and highest water temperature maximum from 2015 deployment season. Overall the water temperature was increasing across the network of stations. The stations on Camp Pond Brook, Tributary to Lower Reid Brook and Lower Reid Brook are more sensitive to changes in the ambient air temperatures as these sites are brooks with continuously moving water. Reid Brook at Outlet of Reid Pond is a pond that has a larger surface area and is deeper. Ponds and lakes take a longer time to adjust to the ambient air temperature. This is likely the reason why Reid Brook at Outlet of Reid Pond maintains a lower minimum water temperature during this deployment season.

The pH values for this deployment ranged between a minimum of 6.18 pH units at Reid Brook below Reid Pond and maximum of 7.54 pH units also at Reid Brook at Outlet of Reid Pond site. Throughout this season the pH at all of the stations was reasonably consistent. When there were changes in the pH values it was during high stage events, indicating rainfall, which is a natural occurrence.

The overall specific conductivity across all stations were within a minimum of 10.3 µS/cm at Reid Brook at Outlet of Reid Pond and a maximum value of 40.5 µS/cm at Camp Pond Brook below Camp Pond. These two stations also had the lowest conductivity minimum and highest conductivity maximum from the 2015 deployment season. Conductivity values at Reid Brook at Outlet of Reid Pond were the lowest across deployment when compared to the other stations. Camp Pond Brook below Camp Pond maintains the highest median at 32.65 µS/cm, however this is to be expected with Camp Pond Brook being closer to the mine site and has an increased potential for roadway runoff and other anthropogenic influences.

Dissolved oxygen levels for the deployment period ranged between a minimum of 8.57 mg/l at Camp Pond Brook below Camp Pond and a maximum of 12.46 mg/l found at Reid Brook at Outlet to Reid Pond. These two stations also had the lowest DO mg/L minimum and highest DO mg/L maximum from the 2015 deployment season. Dissolved oxygen is lower at this time of year and varies diurnally as water temperature is greatly affected by ambient air temperature. All DO mg/L data for the stations except for Camp Pond Brook below Camp Pond remained above the CCME maximum guideline for the protection of early life stages. Camp Pond Brook station also had the highest maximum water temperatures for this deployment period, so the lower DO mg/L is to be expected.

Turbidity levels for the four real-time stations ranged within a minimum of 0.0 NTU from all stations and a maximum of 52.3 NTU at Tributary to Reid Brook. Tributary to Reid Brook site has sandy-clay like bottom to the brook. This material is easily disturbed during rainfall events or large increases in stage. It is likely the cause of why this brook has the highest maximum turbidity data for this deployment.

Overall the changes in the water quality for 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 the water quality the change only occurs for a short period of time and the water quality parameters do return to the original state.

APPENDIX A: Comparison Graphs

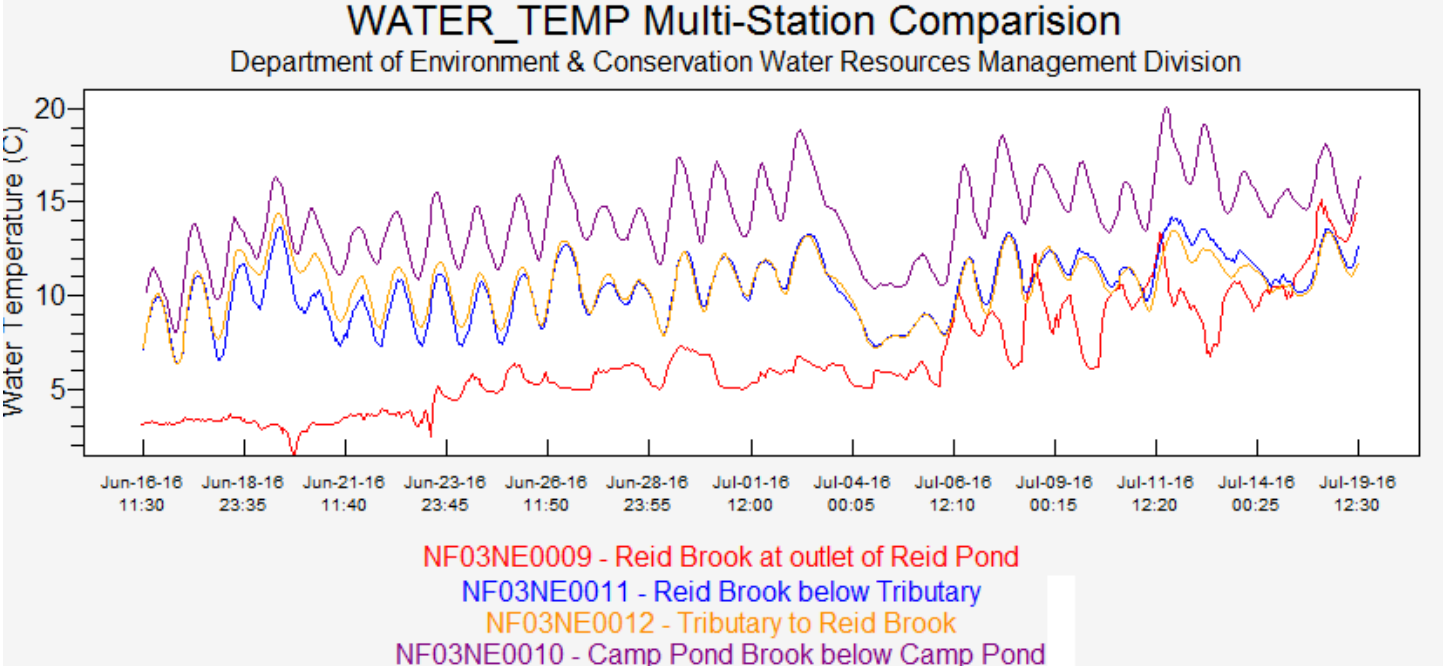

Figure A1: Comparison of Water Temperature at the Real-Time Stations in Voisey's Bay

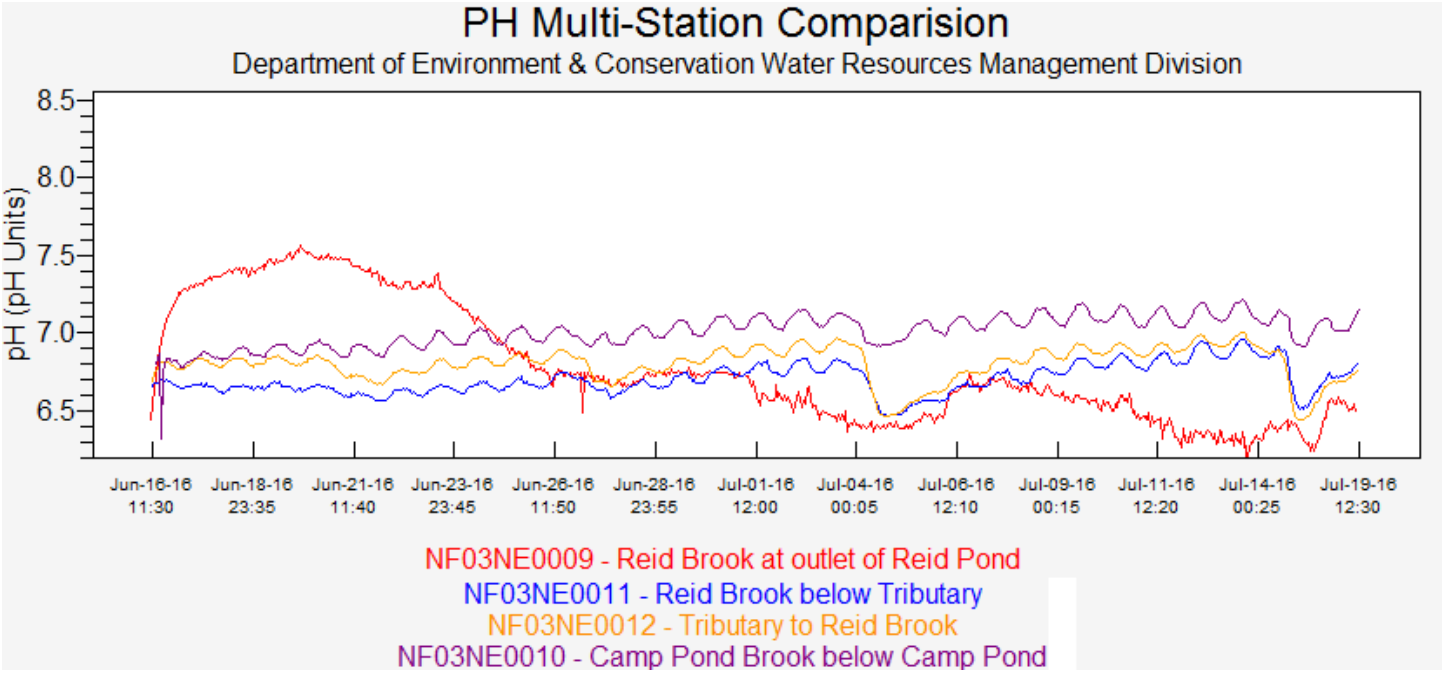

Figure A2: Comparison of pH at the Real-Time Stations in Voisey's Bay

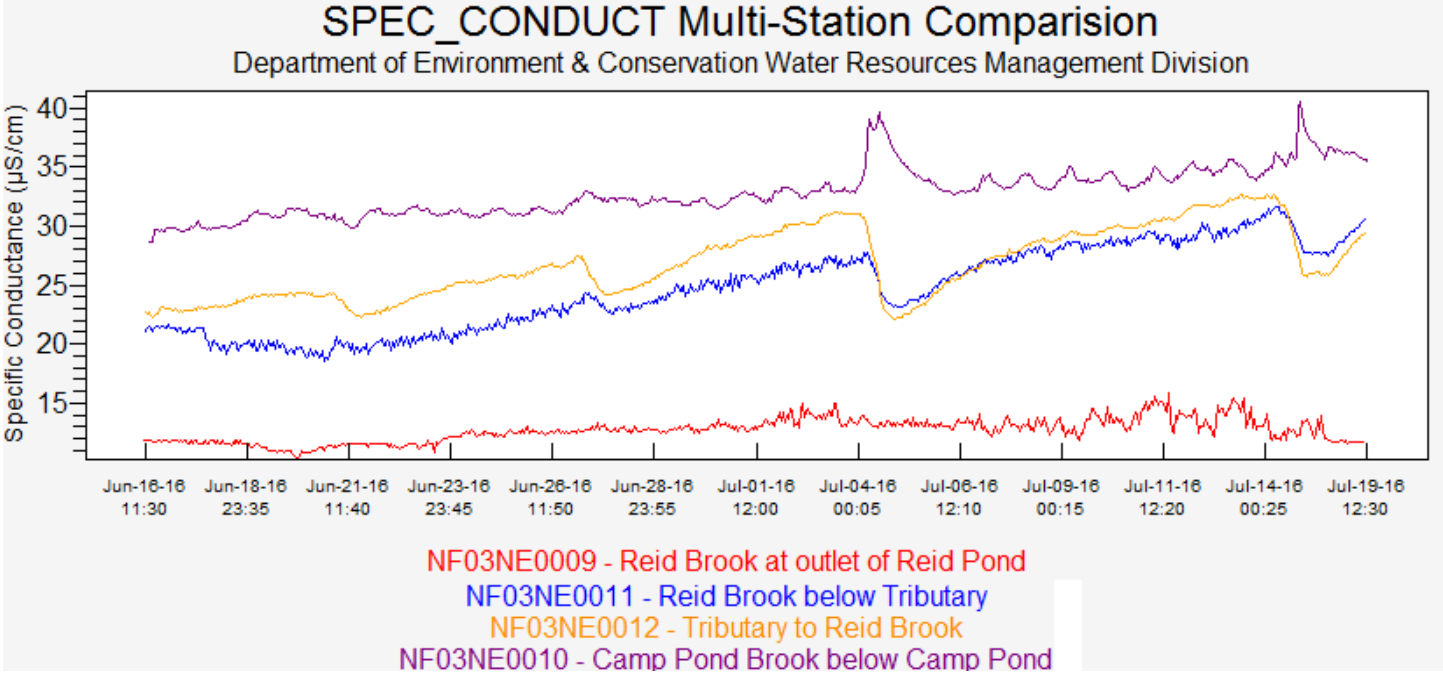

Figure A3: Comparison of Conductivity at the Real-Time Stations in Voisey's Bay

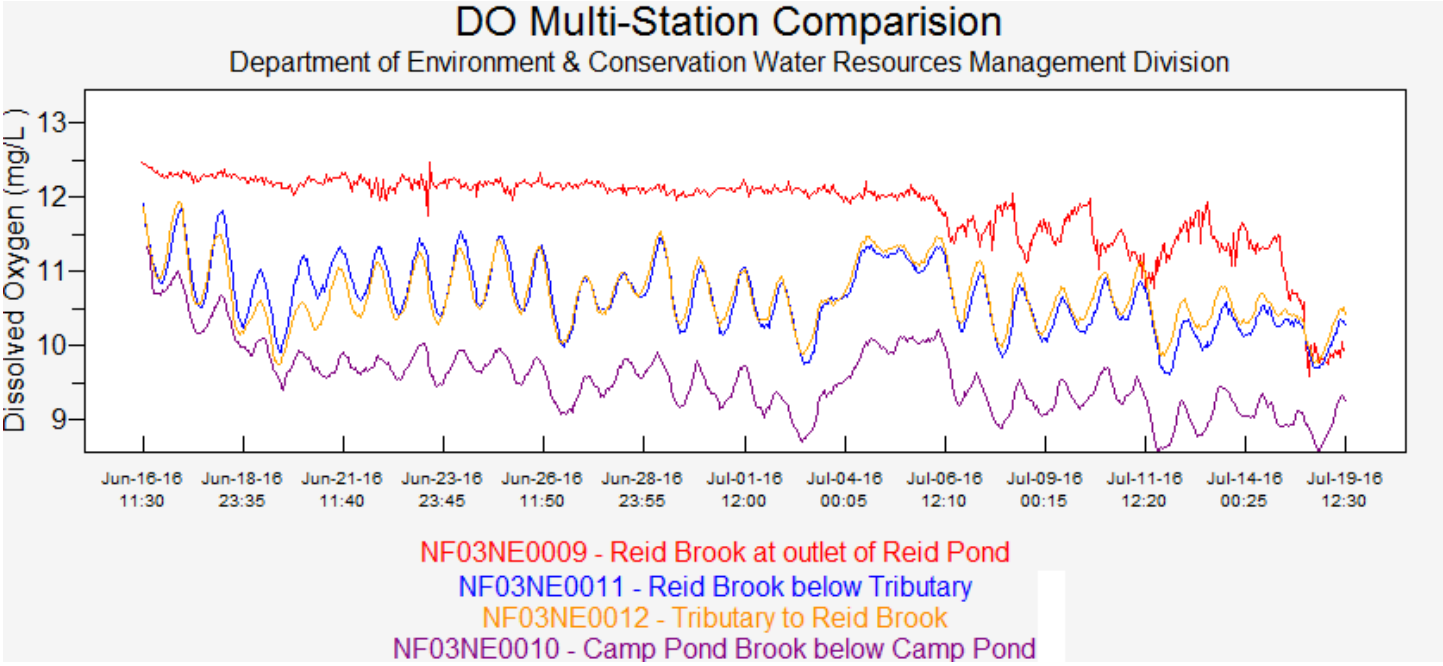

Figure A4: Comparison of Dissolved Oxygen (mg/L) at the Real-Time Stations in Voisey's Bay

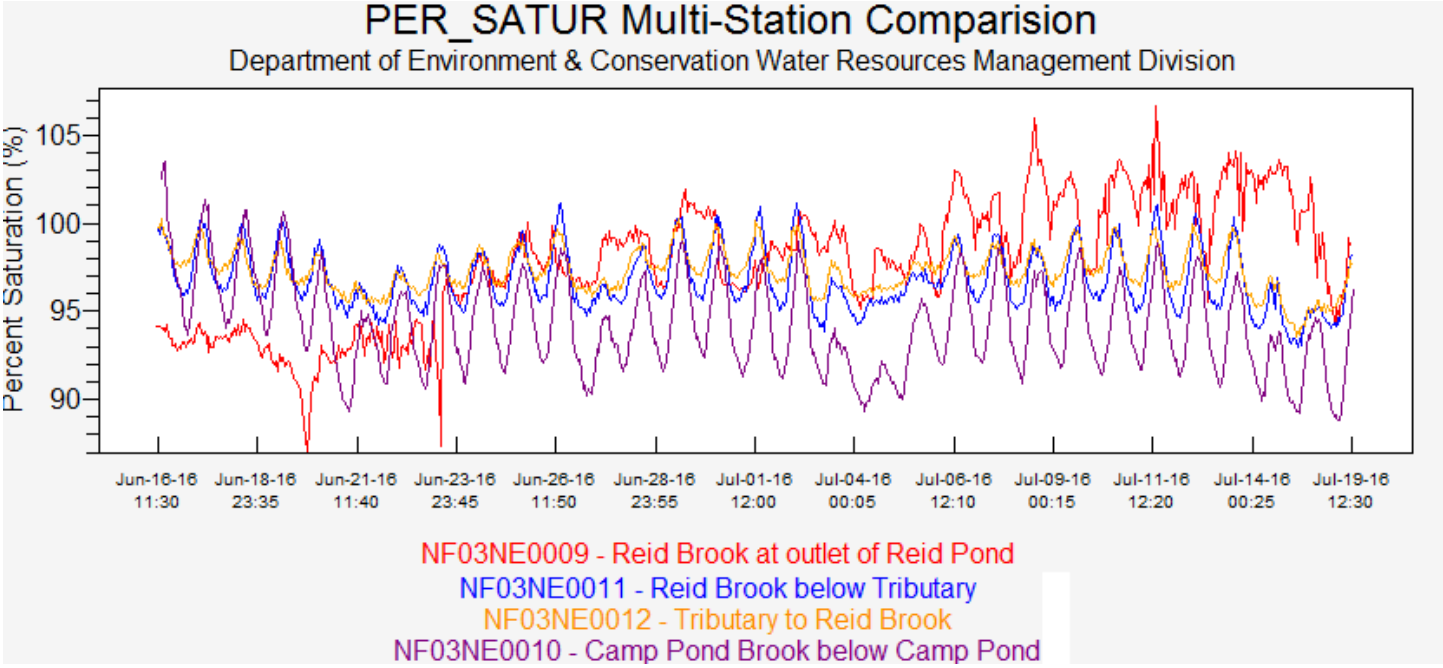

Figure A5: Comparison of Dissolved Oxygen (%Sat) at the Real-Time Stations in Voisey's Bay

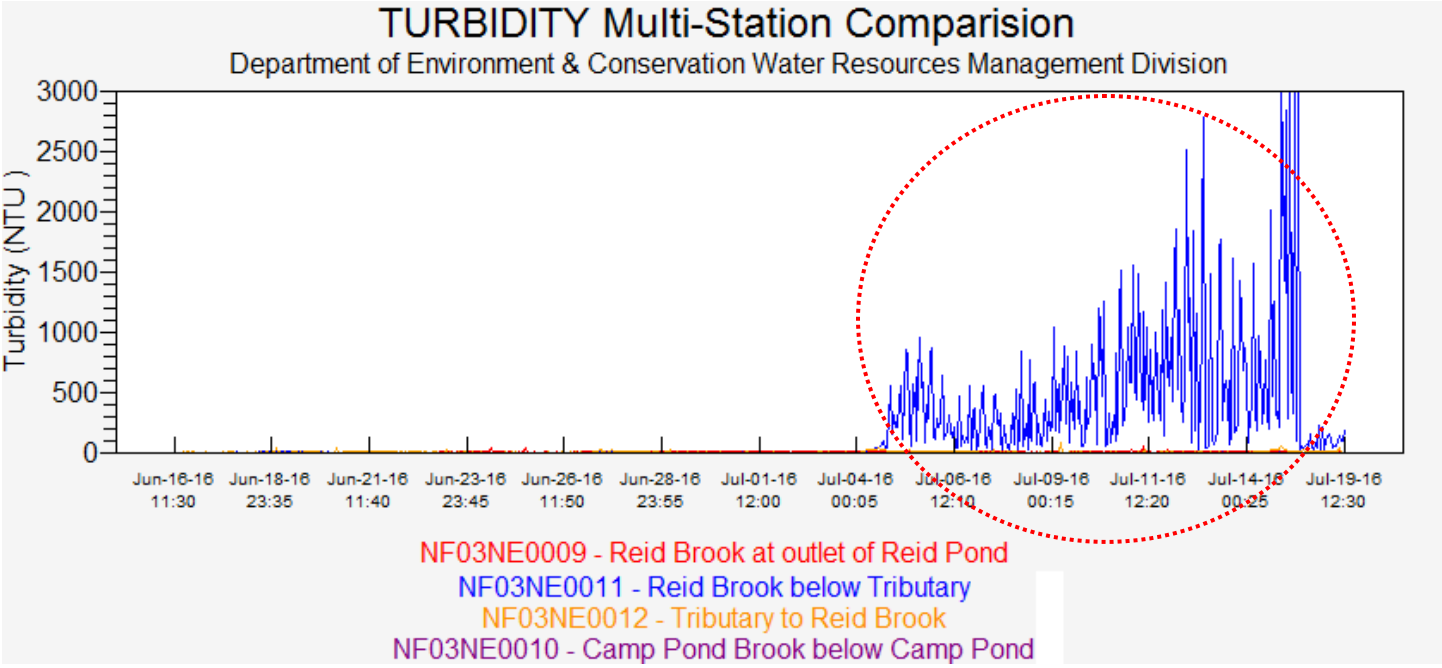

Figure A6: Comparison of Turbidity at the Real-Time Stations in Voisey's Bay. (The circled Reid Brook below Tributary turbidity data was removed for the report).

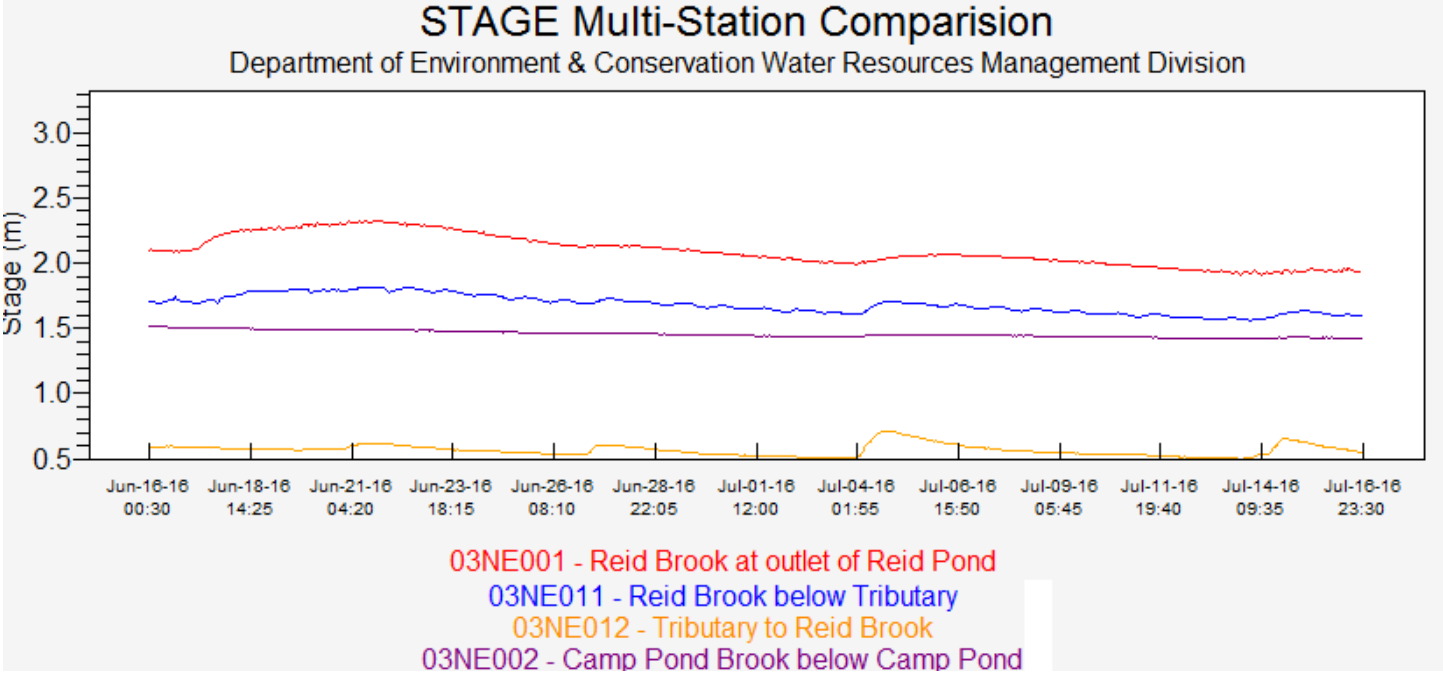

Figure A7: Comparison of Stage (m) at the Real-Time Stations in Voisey's Bay. Please note the stage and streamflow data on the graph below, is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data.

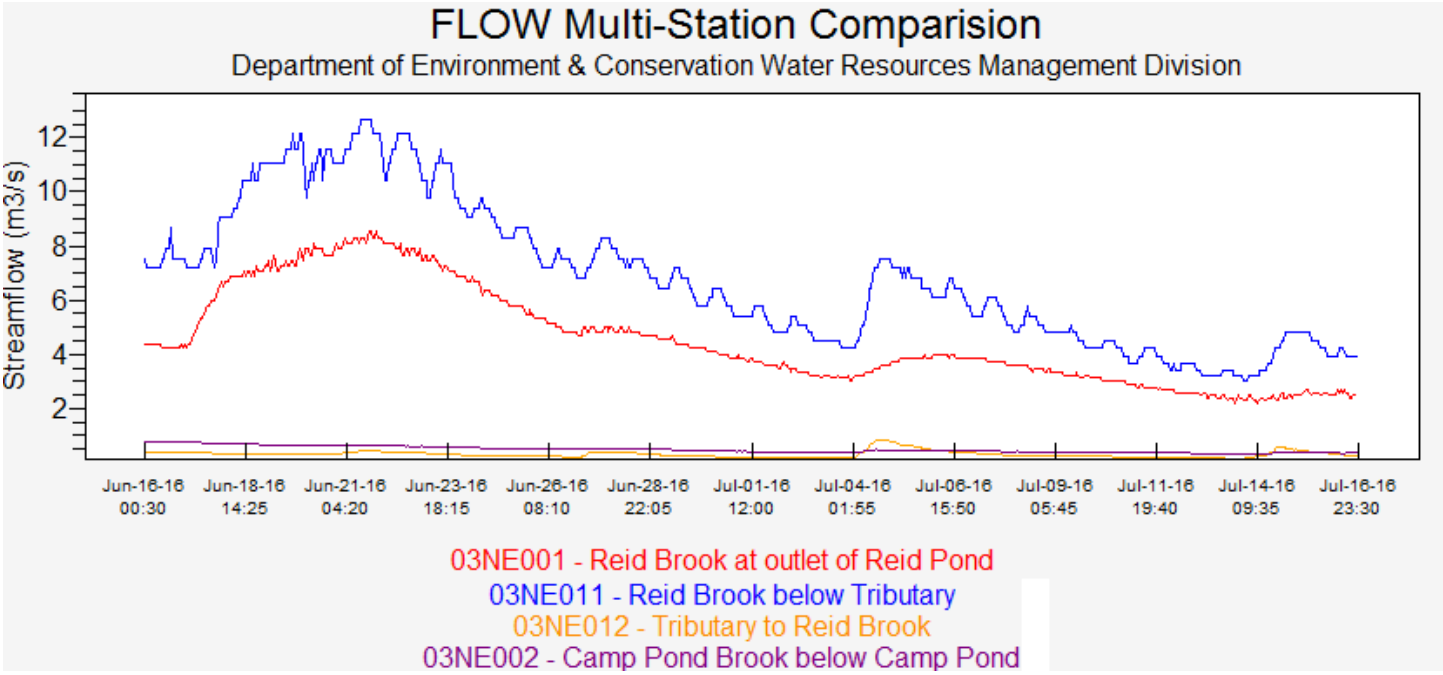

Figure A8: Comparison Flow (m^3/s) at the Real-Time Stations in Voisey's Bay. Please note the stage and streamflow data on the graph below, is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data.

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 #: B6C7328
Report Date: 2016/07/04

Department of Environment & Conservation
Site Location: VOISEY'S BAY
Your P.O. #: 215062145-2

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
COO343 Reid Brook at Outlet to Reid Pond								
Sampling Date 2016/06/16 10:06								
Matrix W								
Sample # 2016-6400-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Calculated TDS	10	1.0	mg/L	N/A	2016/06/30	2016/06/30		4547707
Hardness (CaCO3)	4.6	1.0	mg/L	N/A	2016/06/27	2016/06/27		4547700
Nitrate (N)	ND	0.050	mg/L	N/A	2016/06/30	2016/06/30		4547703
Inorganics								
Conductivity	14	1.0	uS/cm	N/A	2016/06/29	2016/06/29	KMC	4557889
Bromide (Br-)	ND	1.0	mg/L	N/A	2016/06/24	2016/06/24	FD	4553669
Total Alkalinity (Total as CaCO3)	5.8	5.0	mg/L	N/A	2016/06/29	2016/06/29	NRG	4559924
Dissolved Chloride (Cl)	1.7	1.0	mg/L	N/A	2016/06/29	2016/06/29	NRG	4559959
Colour	8.4	5.0	TCU	N/A	2016/06/29	2016/06/29	NRG	4559971
Dissolved Fluoride (F-)	ND	0.10	mg/L	N/A	2016/06/29	2016/06/29	KMC	4557892
Total Kjeldahl Nitrogen (TKN)	ND	0.10	mg/L	N/A	2016/06/25	2016/06/27	LHA	4555255
Nitrite (N)	ND	0.010	mg/L	N/A	2016/06/30	2016/06/30	NRG	4559978
Nitrogen (Ammonia Nitrogen)	ND	0.050	mg/L	N/A	2016/06/29	2016/06/29	NRG	4557542
Dissolved Organic Carbon (C)	1.8	0.50	mg/L	N/A	2016/06/28	2016/06/28	SMT	4557378
Total Organic Carbon (C)	2.1	0.50	mg/L	N/A	2016/06/28	2016/06/28	SMT	4557451
pH	6.79	N/A	pH	N/A	2016/06/29	2016/06/29	KMC	4557878
Total Phosphorus	ND	0.004	mg/L	N/A	2016/06/27	2016/06/27	SNR	4556093
Dissolved Sulphate (SO4)	ND	2.0	mg/L	N/A	2016/06/29	2016/06/29	NRG	4559966
Turbidity	0.23	0.10	NTU	N/A	2016/06/30	2016/06/30	JMV	4560953
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	ND	0.000013	mg/L	N/A	2016/06/28	2016/06/28	ARS	4557198
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	0.052	0.0050	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553447
Total Antimony (Sb)	ND	0.0010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553447
Total Arsenic (As)	ND	0.0010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553447
Total Barium (Ba)	0.0024	0.0010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553447
Total Boron (B)	ND	0.050	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553447
Total Cadmium (Cd)	ND	0.000010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553447
Total Calcium (Ca)	1.4	0.10	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553447
Total Chromium (Cr)	ND	0.0010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553447
Total Copper (Cu)	ND	0.0020	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553447
Total Iron (Fe)	ND	0.050	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553447
Total Lead (Pb)	ND	0.00050	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553447
Total Magnesium (Mg)	0.29	0.10	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553447
Total Manganese (Mn)	0.0021	0.0020	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553447
Total Nickel (Ni)	ND	0.0020	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553447
Total Potassium (K)	0.12	0.10	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553447
Total Selenium (Se)	ND	0.0010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553447
Total Sodium (Na)	0.83	0.10	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553447
Total Strontium (Sr)	0.0048	0.0020	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553447
Total Uranium (U)	ND	0.00010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553447
Total Zinc (Zn)	ND	0.0050	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553447

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 #: B6C7328
Report Date: 2016/07/04

Department of Environment & Conservation
Site Location: VOISEY'S BAY
Your P.O. #: 215062145-2

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
COO344 Camp Pond Brook below Camp Pond								
Sampling Date 2016/06/16 12:15								
Matrix W								
Sample # 2016-6401-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Calculated TDS	21	1.0	mg/L	N/A	2016/06/30	2016/06/30		4547707
Hardness (CaCO3)	10	1.0	mg/L	N/A	2016/06/27	2016/06/27		4547700
Nitrate (N)	ND	0.050	mg/L	N/A	2016/06/30	2016/06/30		4547703
Inorganics								
Conductivity	30	1.0	uS/cm	N/A	2016/06/29	2016/06/29	KMC	4557889
Bromide (Br-)	ND	1.0	mg/L	N/A	2016/06/24	2016/06/24	FD	4553669
Total Alkalinity (Total as CaCO3)	9.2	5.0	mg/L	N/A	2016/06/29	2016/06/29	NRG	4559924
Dissolved Chloride (Cl)	2.7	1.0	mg/L	N/A	2016/06/29	2016/06/29	NRG	4559959
Colour	23	5.0	TCU	N/A	2016/06/29	2016/06/29	NRG	4559971
Dissolved Fluoride (F-)	ND	0.10	mg/L	N/A	2016/06/29	2016/06/29	KMC	4557892
Total Kjeldahl Nitrogen (TKN)	0.14	0.10	mg/L	+/- <RDL	2016/06/25	2016/06/27	LHA	4555255
Nitrite (N)	ND	0.010	mg/L	N/A	2016/06/30	2016/06/30	NRG	4559978
Nitrogen (Ammonia Nitrogen)	ND	0.050	mg/L	N/A	2016/06/29	2016/06/29	NRG	4557542
Dissolved Organic Carbon (C)	2.9	0.50	mg/L	N/A	2016/06/28	2016/06/28	SMT	4557378
Total Organic Carbon (C)	3.0	0.50	mg/L	N/A	2016/06/28	2016/06/28	SMT	4557545
pH	6.95	N/A	pH	N/A	2016/06/29	2016/06/29	KMC	4557878
Total Phosphorus	0.007	0.004	mg/L	+/- 0.004	2016/06/27	2016/06/27	SNR	4556093
Dissolved Sulphate (SO4)	3.5	2.0	mg/L	N/A	2016/06/29	2016/06/29	NRG	4559966
Turbidity	2.5	0.10	NTU	N/A	2016/06/30	2016/06/30	JMV	4560953
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	ND	0.000013	mg/L	N/A	2016/06/28	2016/06/28	ARS	4557198
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	0.14	0.0050	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Antimony (Sb)	ND	0.0010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Arsenic (As)	ND	0.0010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Barium (Ba)	0.0061	0.0010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Boron (B)	ND	0.050	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Cadmium (Cd)	ND	0.000010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Calcium (Ca)	2.6	0.10	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Chromium (Cr)	ND	0.0010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Copper (Cu)	0.0042	0.0020	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Iron (Fe)	0.60	0.050	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Lead (Pb)	ND	0.00050	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Magnesium (Mg)	0.85	0.10	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Manganese (Mn)	0.014	0.0020	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Nickel (Ni)	0.025	0.0020	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Potassium (K)	0.55	0.10	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Selenium (Se)	ND	0.0010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Sodium (Na)	1.8	0.10	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Strontium (Sr)	0.015	0.0020	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Uranium (U)	ND	0.00010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Zinc (Zn)	0.038	0.0050	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604

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 #: B6C7328
Report Date: 2016/07/04

Department of Environment & Conservation
Site Location: VOISEY'S BAY
Your P.O. #: 215062145-2

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
COO346 Lower Reid Brook below Tributary								
Sampling Date 2016/06/16 11:27								
Matrix W								
Sample # 2016-6403-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Calculated TDS	18	1.0	mg/L	N/A	2016/06/30	2016/06/30		4547707
Hardness (CaCO3)	7.5	1.0	mg/L	N/A	2016/06/27	2016/06/27		4547700
Nitrate (N)	ND	0.050	mg/L	N/A	2016/06/30	2016/06/30		4548605
Inorganics								
Conductivity	23	1.0	uS/cm	N/A	2016/06/29	2016/06/29	KMC	4557889
Bromide (Br-)	ND	1.0	mg/L	N/A	2016/06/24	2016/06/24	FD	4553669
Total Alkalinity (Total as CaCO3)	6.3	5.0	mg/L	N/A	2016/06/29	2016/06/29	NRG	4559924
Dissolved Chloride (Cl)	2.2	1.0	mg/L	N/A	2016/06/29	2016/06/29	NRG	4559959
Colour	36	5.0	TCU	N/A	2016/06/29	2016/06/29	NRG	4559971
Dissolved Fluoride (F-)	ND	0.10	mg/L	N/A	2016/06/29	2016/06/29	KMC	4557892
Total Kjeldahl Nitrogen (TKN)	ND	0.10	mg/L	N/A	2016/06/25	2016/06/27	LHA	4555255
Nitrite (N)	ND	0.010	mg/L	N/A	2016/06/30	2016/06/30	NRG	4559978
Nitrogen (Ammonia Nitrogen)	ND	0.050	mg/L	N/A	2016/06/29	2016/06/29	NRG	4559804
Dissolved Organic Carbon (C)	3.5	0.50	mg/L	N/A	2016/06/28	2016/06/28	SMT	4557378
Total Organic Carbon (C)	3.9	0.50	mg/L	N/A	2016/06/29	2016/06/29	SMT	4559231
pH	6.88	N/A	pH	N/A	2016/06/29	2016/06/29	KMC	4557878
Total Phosphorus	ND	0.004	mg/L	N/A	2016/06/27	2016/06/27	SNR	4556093
Dissolved Sulphate (SO4)	2.3	2.0	mg/L	N/A	2016/06/29	2016/06/29	NRG	4559966
Turbidity	0.66	0.10	NTU	N/A	2016/06/30	2016/06/30	JMV	4560953
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	ND	0.000013	mg/L	N/A	2016/06/28	2016/06/28	ARS	4557198
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	0.098	0.0050	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Antimony (Sb)	ND	0.0010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Arsenic (As)	ND	0.0010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Barium (Ba)	0.0039	0.0010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Boron (B)	ND	0.050	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Cadmium (Cd)	0.000011	0.000010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Calcium (Ca)	1.9	0.10	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Chromium (Cr)	ND	0.0010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Copper (Cu)	ND	0.0020	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Iron (Fe)	0.27	0.050	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Lead (Pb)	ND	0.00050	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Magnesium (Mg)	0.64	0.10	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Manganese (Mn)	0.0041	0.0020	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Nickel (Ni)	0.0048	0.0020	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Potassium (K)	0.29	0.10	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Selenium (Se)	ND	0.0010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Sodium (Na)	1.6	0.10	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Strontium (Sr)	0.011	0.0020	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Uranium (U)	ND	0.00010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Zinc (Zn)	ND	0.0050	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604

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 #: B6C7328
Report Date: 2016/07/04

Department of Environment & Conservation
Site Location: VOISEY'S BAY
Your P.O. #: 215062145-2

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
COO345 Tributary to Lower Reid Brook								
Sampling Date 2016/06/16 10:47								
Matrix W								
Sample # 2016-6402-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Calculated TDS	20	1.0	mg/L	N/A	2016/06/30	2016/06/30		4547707
Hardness (CaCO3)	7.9	1.0	mg/L	N/A	2016/06/27	2016/06/27		4547700
Nitrate (N)	ND	0.050	mg/L	N/A	2016/06/30	2016/06/30		4548605
Inorganics								
Conductivity	24	1.0	uS/cm	N/A	2016/06/29	2016/06/29	KMC	4557889
Bromide (Br-)	ND	1.0	mg/L	N/A	2016/06/27	2016/06/27	FD	4555417
Total Alkalinity (Total as CaCO3)	8.4	5.0	mg/L	N/A	2016/06/29	2016/06/29	NRG	4559924
Dissolved Chloride (Cl)	2.4	1.0	mg/L	N/A	2016/06/29	2016/06/29	NRG	4559959
Colour	41	5.0	TCU	N/A	2016/06/29	2016/06/29	NRG	4559971
Dissolved Fluoride (F-)	ND	0.10	mg/L	N/A	2016/06/29	2016/06/29	KMC	4557892
Total Kjeldahl Nitrogen (TKN)	ND	0.10	mg/L	N/A	2016/06/25	2016/06/27	LHA	4555255
Nitrite (N)	ND	0.010	mg/L	N/A	2016/06/30	2016/06/30	NRG	4559978
Nitrogen (Ammonia Nitrogen)	ND	0.050	mg/L	N/A	2016/06/29	2016/06/29	NRG	4557542
Dissolved Organic Carbon (C)	3.6	0.50	mg/L	N/A	2016/06/28	2016/06/28	SMT	4557378
Total Organic Carbon (C)	4.0	0.50	mg/L	N/A	2016/06/29	2016/06/29	SMT	4559231
pH	6.87	N/A	pH	N/A	2016/06/29	2016/06/29	KMC	4557878
Total Phosphorus	ND	0.004	mg/L	N/A	2016/06/27	2016/06/27	SNR	4556093
Dissolved Sulphate (SO4)	2.2	2.0	mg/L	N/A	2016/06/29	2016/06/29	NRG	4559966
Turbidity	1.2	0.10	NTU	N/A	2016/06/30	2016/06/30	JMV	4560953
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	ND	0.000013	mg/L	N/A	2016/06/28	2016/06/28	ARS	4557198
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	0.10	0.0050	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Antimony (Sb)	ND	0.0010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Arsenic (As)	ND	0.0010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Barium (Ba)	0.0041	0.0010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Boron (B)	ND	0.050	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Cadmium (Cd)	ND	0.000010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Calcium (Ca)	2.0	0.10	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Chromium (Cr)	ND	0.0010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Copper (Cu)	ND	0.0020	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Iron (Fe)	0.30	0.050	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Lead (Pb)	ND	0.00050	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Magnesium (Mg)	0.67	0.10	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Manganese (Mn)	0.0046	0.0020	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Nickel (Ni)	0.0050	0.0020	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Potassium (K)	0.30	0.10	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Selenium (Se)	ND	0.0010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Sodium (Na)	1.7	0.10	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Strontium (Sr)	0.011	0.0020	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Uranium (U)	ND	0.00010	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604
Total Zinc (Zn)	ND	0.0050	mg/L	N/A	2016/06/24	2016/06/24	BAN	4553604

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

References

Canadian Council of Ministers of the Environment. (2014) "Canadian water quality guidelines for the protection of aquatic life" Canadian Council of Ministers of the Environment. Retrieved from: http://www.ccme.ca/en/resources/canadian_environmental_quality_guidelines/index.html

Canadian Council of Ministers of the Environment. (2014) "Water Quality Guidelines for the Protection of Aquatic Life" Canadian Council of Ministers of the Environment. Retrieved from: http://st-ts.ccme.ca/en/index.html?chems=162&chapters=1

OTT Hydromet (2017) "Hydrolab" Retrieved from: http://www.ott.com/en-us/products/water-quality-2/hydrolab-ds5x-multiparameter-data-sonde-855/

Mike Sader (2017) "Turbidity Measurement: A Simple, Effective Indicator of Water Quality Change". OTT Hydromet. Retrieved from http://www.ott.com/en-us/products/download/turbidity-white-paper/

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